International Journal of Innovative Technology and Exploring Engineering (IJITEE)
ISSN: 2278-3075 (Online), Volume-9 Issue-3, January 2020

Determinants of Project Time Performance: Evidence from Water Transmission Projects

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Abstract: ***This study aimed to examine the factors that influence time performance in water transmission projects consisting of internal and external factors of time planning, application of crashing methods and PERT methods. The study uses a quantitative approach that takes the object of research on a water transmission project with a sample of 52 peoples and data analyzed with regression. The research findings show that the factors that significantly influence the time performance of the water transmission project are the external factors of time planning and PERT methods, while the internal factors for time planning and crashing methods don't have a significant effect on time performance. Based on these findings, in the implementation of water transmission projects, the external factors and PERT methods must be a priority for improving project time performance.***

Keywords: Project time performance, internal factors, external factors, crashing method and PERT method.

I. INTRODUCTION

The construction sector has an important role in the economy both in the context of providing employment and infrastructure development to support community economic activities. The construction sector is considered as a catalyst to encourage the growth of other sectors [1], because it plays a role in providing basic infrastructure such as housing, connectivity, water supply, and electricity [2]. The construction sector in Indonesia contributes around 10.49% to the Gross Domestic Product [3] so that shows the important role of the construction sector in economic development in Indonesia.

One of the basic and general problems faced by actors of construction sector is delays in project implementation [4]–[6]. Globally, projects are experiencing delays of around 40% [7], [8]. This condition illustrates the lack of time performance in the process of completing construction projects, causing many negative impacts. Delay in project implementation generally always has adverse consequences for both the project owner and contractor because it creates conflict and debate about what and who is the cause as well as the demands of time and cost [9].

Revised Manuscript Received on January 30, 2020.
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Projects that are not completed on time also cause disputes, contractors lose reputation, lose future project opportunities, reduce or even lose profits, bankruptcy, and termination of contracts [2].

This research focuses on the implementation of types of water transmission projects in Indonesia. The implementation of the water transmission project also experienced a similar problem with other construction projects, namely the problem of delays. Data shows that in 2018 out of 25 water transmission projects that were delayed by 15 (60%) projects, on time were 3 projects (12%), and completed 7 projects (28%). This problem also has the potential to have a negative impact on contractors both in terms of financial and reputation. In addition, because of the water transmission project is related to the public interests, the problem of delays in project completion has the potential to interfere with community interests.

The time of project implementation that still experienced many problems requires an effort to explore the factors that can cause a lack of performance in project implementation time. Therefore, this study aims to investigate the determinants of the time performance of a water transmission project by examining the factors of the internal and external factors planning the project implementation time, crashing method, and Program Evaluation and Review Technique (PERT). This research is expected to produce significant findings to help improve project time performance, specifically in water transmission construction projects.

II. LITERATURE REVIEW

Time performance is a basic criterion for success in a construction project [10]. Time performance is the process of comparing work in the field with a planned schedule. Duration can be interpreted as the time needed to complete an activity or task that has been determined. While the project implementation time is the time determined by the owner to use, use or lease the project building.

According to Egwunatum (2017), time performance is calculated in terms of percentage increase in the actual settlement period during the planned settlement period, i.e the difference between the actual completion time and the planned completion time. Dissanayaka dan Kumaraswamy (1999) show a formula for measuring the project time index, which is a comparison between the actual duration and the planned duration. Related to this formula, Le-Hoai, Lee, dan Nguyen (2013) explain that the actual duration is the duration of the project completion date and the planned duration is the estimated duration listed in the agreement.

An index exceeding 1 will indicate the project exceeds the planned value, an index of less than 1 will indicate completion before the planned completion, and an index equal to 1 indicates that the completion of the contract is on time as planned. While Kometa, Olomolaiye, dan Frank (1996) explain that projects with a percentage of delays below 10% are considered exceptional in terms of time performance, projects that are between 10% and 20% late are considered to be average projects, and which are having a delay of more than 20% is considered a bad project.

Many factors can trigger project delays, such as improper contractor planning, poor field management, contractor experience, inadequate contractor finance, problems with subcontractors, material shortages, labor supply and equipment availability and damage [8], late payment from the project owner, internal and external environment and lack of credibility of workers in planning the implementation of project work [15].

While in the study Feyzbakhsh, Telvari, dan Lork (2017) mentioned a number of factors that caused project delays, namely labor expertise, delays in equipment supply, design changes, access to project sites, delays in material delivery, planning and scheduling, rainfall intensity, communication bad, and the problem of late payment from the owner.

This research focuses on several factors that are suspected to be determinants of project time performance, namely the environmental factors consisting of internal factors and external factors, crashing method, and Program Evaluation and Review Technique (PERT).

The first is organizational environment. Organizational environment is generally known to have two forms, namely internal and external. Internal environment refers to the framework, situation and factors within the organization that affect the organization whose components include management structure, physical assets, stakeholders, human resources, finance, technology, goals and organizational values [17].

The internal factors are usually also identified as factors that become the strengths and weaknesses of the organization which includes organizational structure, culture, and resources [18]. The internal environment of the organization also includes aspects of core competencies, resources and abilities [19].

While external factors are factors outside of the organization that affect the operation of the organization both concerning macro-economic and micro-economic factors with components including consumers, suppliers, the public, competitors and the government [17].

External factors consist of politics, law, ecology, technology, socio-culture, and economics [19] which are also identified as factors that provide opportunities as well as corporate threats [18].

In the context of the implementation of a project, both factors must be calculated and analyzed appropriately in the process of preparing the project implementation time so that the project does not experience obstacles and finish on time.

Further is the crashing method factor.

This method is most commonly used to shorten project duration by assigning additional manpower and equipment to each activity. Project crashing is done so that work is completed by crossing time and costs and by increasing the number of work shifts, the number of hours worked, the amount of labor, the amount of material availability, and using more productive equipment and faster installation methods as a component of direct cost costs [20]. Project crashing is implemented by improving the schedule using network planning which is on a critical path. Project scheduling is something more specific and is part of project planning [21].

Project scheduling also relates to timelines and the determination of dates in which several resources such as human resources and equipment work together in carrying out the activities needed to complete the entire project and are the foundation of the planning and scheduling system [22]. According to Kraiem and Dickmann (1987), complete and precise project scheduling is the main key to the timeliness of project implementation. Delay can be considered as a result of not fulfilling the planned schedule that has been made, because the reality conditions are not the same or in accordance with the conditions when the schedule was made.

Lastly is PERT method. PERT is a method that aims to reduce the delay of activities (projects, production, and techniques) as well as obstacles and differences, coordinate and harmonize various parts as a whole of work, and accelerate the completion of projects [23]. The emphasis of PERT is directed at trying to get the best timeframe (in a more accurate direction). PERT uses an approach with assumes that the timeframe of activities depends on many factors and variations, so it is better for the estimation to be given a range using three estimated figures, namely optimistic, pessimistic and realistic time [23].

Optimistic time is the shortest time an event that might occur assuming everything goes according to the planning. Pessimistic time is the longest time required and realistic time is the most appropriate time to complete activities in the PERT network. According to Heizer dan Render (2015) the use of PERT has a number of benefits in managing a project, namely providing important information related to the period of project completion, the likelihood of completion of the project before the specified date, the stages of critical activities, activities that have a relatively loose deadline, the date of the activity begins and the date the activity ends.

III. RESEARCH METHOD

This research uses a quantitative approach with a survey method. The quantitative approach is used to statistically test the influence of internal factors, external factors in the time planning process, the application of the crashing method, and the application of the PERT method on project time performance.

The study was conducted on a water transmission project consisting of 10 work packages with a population of 60 peoples. Sampling using Slovin formula obtained by the number of respondents as many as 52 people.

Data collection using a 5-point scale questionnaire ranging from Strongly No Effect (1) to Strongly Effect (5). The questionnaire was first tested for validity and reliability, the results of which showed that the internal environment variable had an Alpha coefficient = 0.741, an external environment = 0.616, a crashing method = 0.868, and a PERT method = 0.841. Research data were analyzed using multiple regression.

IV. RESULT AND DISCUSSION

4.1. Demographic Description

This study used a sample of 55 people with demographic profiles consisting of position, education and tenure (Table 1). Respondents in this study were mostly Site Engineers of 16 people (29.09%) followed by the position of Head of Project (25.45%). Based on their educational background some of the respondents in this study were strata 1 of 44 people (80%).

Among the criteria of respondents based on their work experience, most of them are working in 5-10 years with a total of 21 people (38.18%).

Table 1: Demographic Description of the Sample (n= 55)

Description	Frequency (F)	Percentage (%)
Job Position		
Head of Project	14	25.45
Site Engineer	16	29.09
Engineering Administration	8	14.55
Project Control	6	10.91
Others	11	20.00
Education		
Doctor/Ph.D.	1	1.82
Magister	4	7.27
Undergraduate	44	80.00
Diploma	3	5.45
Senior High School	3	5.45
Tenure		
> 10 years	13	23.64
5 – 10 years	21	38.18
3 – 4 years	13	23.64
1 – 2 years	8	14.55

4.2. Descriptive Statistics

This study consists of four variables, namely the internal environment (X1), the external environment (X2), the crashing method (X3), the PERT method (X4) and time performance (Y). The results of the descriptive statistical calculations for each of the variables are presented in Table 2.

Table 2: Descriptive Statistics of the Variables

Descriptive Statistics	Variables				
	X1	X2	X3	X4	Y
Minimum	1.00	1.00	1.00	2.00	4.17
Maximum	5.00	5.00	5.00	5.00	4.00
Mean	3.92	3.86	4.06	4.09	4.00
Median	4.00	4.00	4.00	4.00	0.70
Mode	4.00	5.00	4.00	4.00	0.49
Standard deviation	1.03	1.16	0.84	0.75	3.00
Variances	1.06	1.36	0.71	0.57	5.00

From a number of descriptive statistical values above that can describe variable conditions is the mean value. The mean value for the internal environment variable (X1) is 3.91 on a scale of 1 to 5, thus providing an illustration that the internal factors in water transmission in the category are quite good. The average value for the external environment (X2) is 3.85 which means the condition of external factors in water transmission in the category is quite good. The mean value for the crashing method variable (X3) is 4.06 which gives an illustration that the application of the crashing method to water transmission is in the good category. The PERT method variable has an mean value of 4.08 which means that the PERT application method for water transmission is in the good category. While for the time performance variable (Y) have mean value 4.17 which gives an illustration that the time performance of water transmission is in good condition.

4.3. Hypothesis Testing

The results of the first regression test produce the coefficient of determination and the coefficient of determination as shown in Table 3.

Table 3: Correlation and Coefficient of Determination

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.771[a]	0,594	0,56	0,323

a. Predictors: (Constant), X4, X1, X3, X2

b. Dependent Variable: Y

The correlation coefficient obtained is 0.771 which shows a strong relationship between internal factors, external factors, Crashing method, and PERT method with time performance is 0.771. The value of coefficient of determination is 0.594 which can be interpreted that the contribution of internal factors, external factors, crashing method, and the PERT method to the time performance of 59.4%. Furthermore, to test the significant effect simultaneously using the F test as shown in Table 4.

Table 4: Test of ANOVA

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	7,018	4	1,754	16,851	.000[b]
	Residual	4,789	46	0,104		
	Total	11,807	50			

a. Dependent Variable: Y

b. Predictors: (Constant), X4, X1, X3, X2

The results of the ANOVA test obtained an F-*value* of 16.851 with a p-*value* of 0,000 < 0.05, thus indicating that Ho is rejected, which means internal factors, external factors, crashing method, and PERT method simultaneously affect on time performance. Further for a partial test is performed using the t-test whose results are shown in Table 5.

Table 5: Regression and t-test

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	0.986	0.582		1.695	0.097
	Internal factor	0.221	0.114	0.242	1.933	0.059

External factor	0.155	0.063	0.336	2.479	0.017
Crashing method	0.147	0.136	0.125	1.081	0.285
PERT method	0.278	0.13	0.261	2.134	0.038

a. Dependent Variable: Time Performance

Based on the regression results in Table 5 for the influence of internal factors on time performance, the regression coefficient is 0.221, t-*value* 1.933 and p-*value* = 0.059. P-*value* > 0.05 so that Ho is accepted, which means that internal factors have no significant effect on time performance. Regression coefficient for the influence of external factors on time performance obtained a regression coefficient of 0.155, t-*value* 2.479 and p-*value* = 0.017 < 0.05 so that Ho is rejected. This means that external factors have a significant effect on time performance. Furthermore, for the influence of the crashing method on time performance, the regression coefficient is 0.147, t-*value* 1.081 and p-*value* = 0.285 > 0.05 so that Ho is accepted, which means that the crashing method has no significant effect on time performance. While for the effect of the PERT method on time performance the regression coefficient obtained is 0.278, t-*value* 2.134 and p-*value* = 0.038 > 0.05 so that Ho is rejected, which means the crashing method has a significant effect on time performance.

From the results of the statistical analysis above it can be seen that only two factors significantly influence project time performance, namely external factors and PERT methods. Associated with external factors, it is known that there are three parties that play a very important role, namely the support of the government, suppliers and professional organizations. Government support is needed for planning the time of the water transmission project implementation, considering that the water transmission projects mostly come from projects provided by the government. Related to the supplier factor, in planning the time of project implementation, the availability of suppliers is very influential, so it is necessary to have good procurement management in order to provide goods and services at low prices, quality, and delivered on time. The procurement department also has the role of obtaining sources of quality raw materials and components and / or becomes a bridge in fostering existing suppliers with various quality improvement programs. The procurement department is also required to be able to create excellence in terms of time. To support the advantage in terms of time, the procurement department can certainly choose suppliers who have the ability to send goods in a shorter time without having to sacrifice quality and increase prices. While professional organizations are organizations whose members are practitioners who establish themselves as professions and join together to carry out social functions that cannot be carried out in their individual capacities. In this case the water transmission project requires experts such as the Indonesian Water Contractors Association (AKAINDO), the Indonesian Water Resources Contractors Association (AKSDAI), the Association of the Indonesian Groundwater Drilling Company (APPATINDO), the Indonesian Water Contractors Association (GAPKAINDO), and the Association of Indonesian Water Contractors Indonesian Water Building (AKBARINDO). Therefore, professional organizations influence the time planning for implementing water transmission projects.

While related to the PERT method, it is also important to be able to realize projects in a timely manner. The PERT method uses three time estimates for each activity namely optimistic, pessimistic and realistic time. Projects that use the PERT method will be known when the project is finished, what the sequence of work is, when it starts, when it finishes, which work is the longest, which work is delayed, and which work needs special attention. With such information in place, the contractor can make the anticipations needed to ensure the project is completed on time.

V. CONCLUSION

Performance of water transmission project time is significantly influenced by external factors of time planning and PERT methods, while internal factors for time planning and crashing methods don't show a significant effect on time performance. Therefore the external planning time and PERT methods are proven to make a significant contribution in influencing the project completion time performance in water transmission projects. Based on these findings, in the implementation of water transmission projects, the contractor must really pay attention to external factors such as government support, suppliers, client trust, competitors and professional organizations in preparing project planning. In addition, the contractor must also apply a carefully structured PERT method to provide accurate and detailed information related to the project completion process.

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