Acceleration Model for Completion of Infrastructure Projects Using the Foreign Loan Funding Scheme (Case Study: Dam X)

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***Abstract*—** In the process of working on the project, undesirable things can occur such as delays in project work that occur due to various factors such as unfavorable weather conditions, design changes and planning errors. There is also no exception in the implementation of projects with foreign loans, there are problems related to budget disbursement which can result in project delays. This study uses a questionnaire method to owners, supervisory consultants, and experienced contractors in dam construction to obtain a model for accelerating the completion of this project. The results of this study found that the 2 most dominant factors were in the main dam work category, namely extreme weather conditions and land availability in the dam construction area. The acceleration strategy used is the crashing method and the result is that the project completion is 93 days faster than the original implementation schedule. However, the consequence of this method is an increase in construction costs of 3,292,201,639.21 IDR.

***Keywords*—** Foreign Loan, Dam, Acceleration, Infrastructure Project.

I. INTRODUCTION

The government through Presidential Regulation of the Republic of Indonesia Number 42 of 2005 concerning the Committee for the Acceleration of the Provision of Infrastructure explains several types of infrastructure whose provision is regulated by the government, namely transportation infrastructure, road infrastructure, irrigation infrastructure, market infrastructure, drinking water and sanitation infrastructure, telematics infrastructure, electricity infrastructure, and oil and gas transportation infrastructure. This classification of infrastructure can be categorized as basic infrastructure because it is needed by the wider community so that it needs to be regulated by the government.

Delays that occur can be caused by many things, both expected and unexpected causes. Delays in dam construction projects are starting to receive a lot of attention due to the project's complexity from design and implementation (Gasasira et al, 2016). However, most projects are rarely completed within the scheduled time as they require effective and efficient management. Therefore, the reasons behind the time delay can be controlled or uncontrollable. Gasasira et al (2016) presented the causes that caused delays in Dam construction projects in Rwanda and found the main causes were delays in making decisions from clients, lack of proper management schedules, failure in cost estimation from contractors, inadequate contract management, inadequate supply poor design and delays in design, errors in estimation and lack of land investigation by consultants, and land acquisition issues. These causes were discovered as a result of the survey. However, geographic location also affects developing countries due to their size, which increases the level of exposure to ecological risks, especially those related to adverse weather conditions. A significant cause of delays during the construction of Dam projects in Nepal was identified as ecological conflict which caused delays in project progress and weakened the ability to complete projects on time.

Delay in project completion can be defined as the elapsed time either beyond the completion date specified in the contract or beyond the date agreed by the parties for project completion. The implementation of projects that are not in accordance with the planned schedule and is considered a common problem in construction projects. Stating that delays in construction can lead to a number of changes in the project such as final completion, lost productivity, increased costs and termination of contracts. Project delays can be caused by the contractor, owner, or caused by natural and environmental conditions beyond human capabilities or called force majeure.

The construction of dams in Indonesia cannot be separated from the problem of delays. Dam construction is a complex task, especially during the construction phase, and dam construction in Indonesia is no exception, where there are many time delays and cost overruns.

The main objective of this study is to determine the dominant factors causing the delay in dam work

category. The dominant factor will be analyzed for its acceleration strategy with a crash program.

II. LITERATURE REVIEW AND METHODS

The problems that exist in the background of this research are then formulated into a question sentence that reflects the relationship between the two variables. Literature review was conducted to collect and study references related to this research. From the literature review and case studies as well as secondary data collection carried out by researchers, it can be seen that the variables that influence the implementation of dam construction project construction.

The analyzed variables were then summarized and validated to the experts in the form of a questionnaire. For primary data collection, the researcher made a second stage questionnaire in the form of a pilot survey which was distributed to respondents, namely a representative sample of the population of this study, the parties involved in the planning and implementation process of infrastructure projects using foreign loan funding schemes (case study: Dam X).

Data analysis was carried out using regression analysis to determine the relationship between these factors so that the factors that most influenced the delay in project implementation would be obtained.

This study uses a quantitative description approach that was implemented in the dam construction project in Indonesia (case study: Dam X). Sugiyono (2009: 147), descriptive research is used to describe the data that has been collected as it is.

Based on the choice of research strategy, it has been determined that the research method carried out is a survey. Cooper and Emory (Business Research Methods, 1996, p. 12), survey research is research conducted to obtain data by giving questionnaires or interviews and recording the answers for re-analysis.

Questionnaires are a set of questions that are logically related to the research problem, and each research is the answers that have meaning in testing the hypothesis (Nazir, 1983, p. 149). Suroyo Anwar (2009: 168), the questionnaire is a number of questions or written statements about factual data or opinions related to the respondent, which are considered facts or truths that are known and need to be answered by the respondent.

Respondents were set at least 30 randomly selected people who have experience in dam projects.

The questionnaires instrument in this study used a Likert scale. Ordinal measurement scale is a number that is given where the numbers contain the meaning of level (Nazir, 1983, p.149). The ordinal scale used allows researchers to sort their respondents from the lowest level to the highest level according to certain attributes.

Research Data Processing

The survey was conducted using questionnaires and interviews with dam experts with experience in dam construction. Data collection in this study was carried out into 4 phases of questionnaire, namely: phase 1: data collection (initial expert validation); phase 3: data collection (pilot survey); phase 3: data collection (respondent questionnaire); phase 4: data collection (final expert validation).

The data is processed using SPSS software on a computer, questionnaire data analysis is carried out to test the validity and reliability tests on all factors resulting from respondents' answers. Firstly, calculated the value of the Frequency Index (FI) to obtain a ranking order of factors based on the number of occurrences. Frequency Index (FI) formula is:

$$\textit{Frequency Index}\ (\text{F.I})\ (\%) = \Sigma \left(\frac{a\,n}{5\,N}\right) x100$$

where:

a = weighted value of each variable (1 = very low, 2 = low, 3 = moderate, 4 = high, 5 = very high);

n = number of respondents who chose the weight value;

N = Total number of respondents.

Secondly, calculated the value of the Relative Importance Index (RII) to determine the level of influence of each factor. Relative Importance Index (RII) formula is:

$$\text{RII} = \frac{5.n5 + 4.n4 + 3.n3 + 2.n2 + 1.n1}{5N}$$

Where:

n5 = Number of respondents who answered "Very Influential"

n4 = Number of respondents who answered "Influential"

n3 = Number of respondents who answered "Sufficiently Influential"

n2 = Number of respondents who answered "less influential"

n1 = Number of respondents who answered "No Influence"

N = Total number of respondents

Ranking Analysis

This analytical method is useful for determine the rank of the respondents and give priority to study variables.

Then the data obtained were analyzed by the mean rank or average value that will be used to determine the factors delay on the project.

This mean is obtained by adding up the data of all individuals in the group, then divided by number of individuals.

Crashing Method

After the required data is collected, then the crashing process is carried out. The acceleration process in this research this is done by emphasizing the duration of activities on the critical path with additional treatment, namely the addition of labor, material and equipment. After knowing the activities that are on the critical trajectory, then next calculate cost slope.

III. RESULT AND DISCUSSION

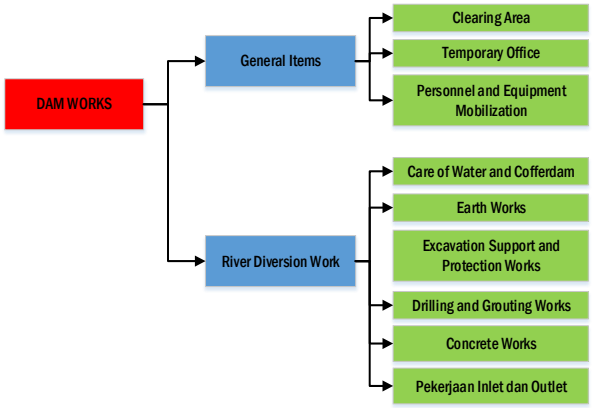
Work Breakdown Structures

The dam consists of the main building structure, such as the main dam, spillway, and diversion tunnel or channels and complementary building structures, namely the intake building, facility building and roads.

To facilitate the implementation of dam construction, it is necessary to create a Work Breakdown Structure (WBS).

In this stage, primary data and secondary data are collected for the establishment of WBS level 1 to level 3 for dam construction projects. The WBS standard is based on self-processed data and dam construction project data.

The development of WBS results that have been validated by experts shows that each work package is carried out based on the selected method that is relevant to the project and work location. From the description of the main and supporting work on the construction project (dam X), a WBS standard is prepared which consists of 9 job categories as shown in the picture below:



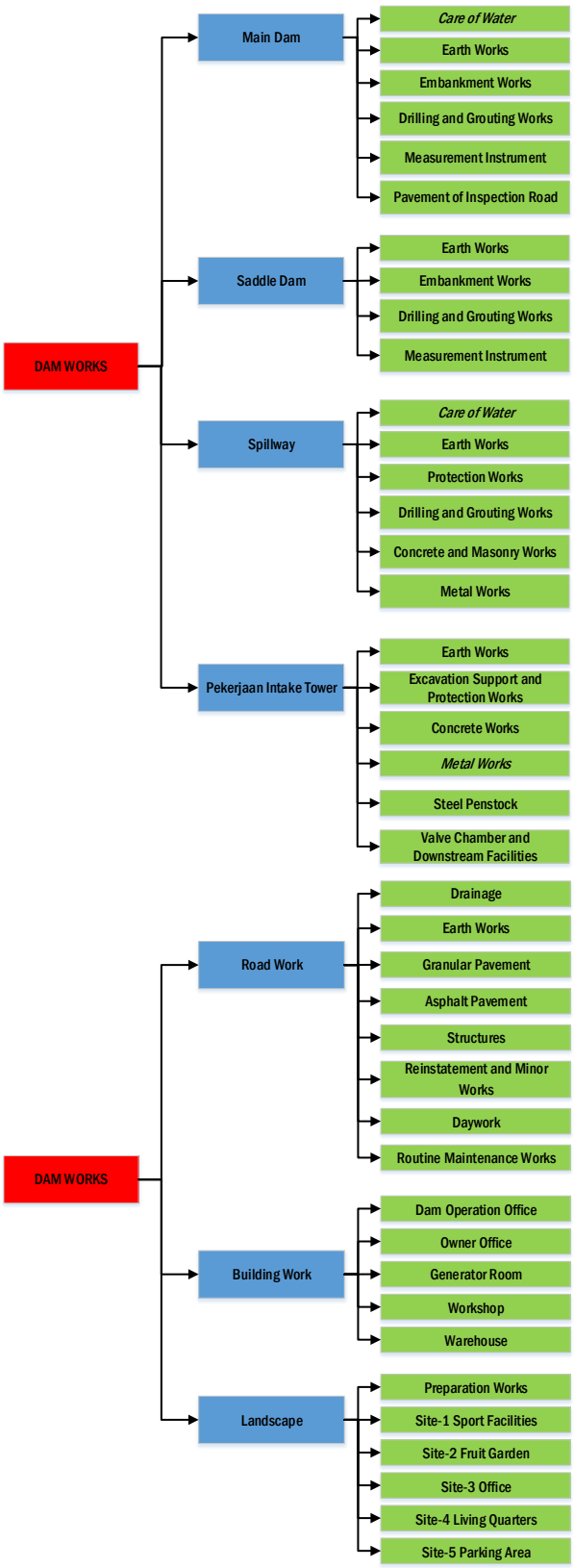


Figure 1: Works Breakdown Structure (WBS) Construction of Dam Project

From the survey results, respondents have analyzed data related to what questions contribute to delays in dam construction projects using the Frequency Index (FI) and Relative Importance Index (RII) values. After knowing the results of the value of the Frequency Index (FI) and

the value of the Relative Importance Index (RII) in each category of dam work, then to get the main factors that cause delays in the dam project, an analysis will be carried out by mapping the value of the Frequency Index (FI). and the Relative Importance Index (RII) using quadrant diagrams.

Through this diagram, it can be seen that the factors contained in quadrant 1 are factors that have high importance, large impact, categorized in the high priority llevel. The results of mapping with quadrant diagrams can be seen in the Figure 2:

The dominant factor causing delays in infrastructure projects.

The discussion of this research will be discussed regarding the discussion of the results of data analysis obtained from the respondents. Collected data in this study are primary data and secondary. Respondents' answers obtained accumulated, then calculated using Relative Importance Index (RII) and Factor Index (FI) Analysis. Based on the literature study and pilot survey, 54 factors were found that caused project delays based on 8 work categories. From the analysis of the data obtained 10 factors in order of highest to lowest rank are shown on Table 1:

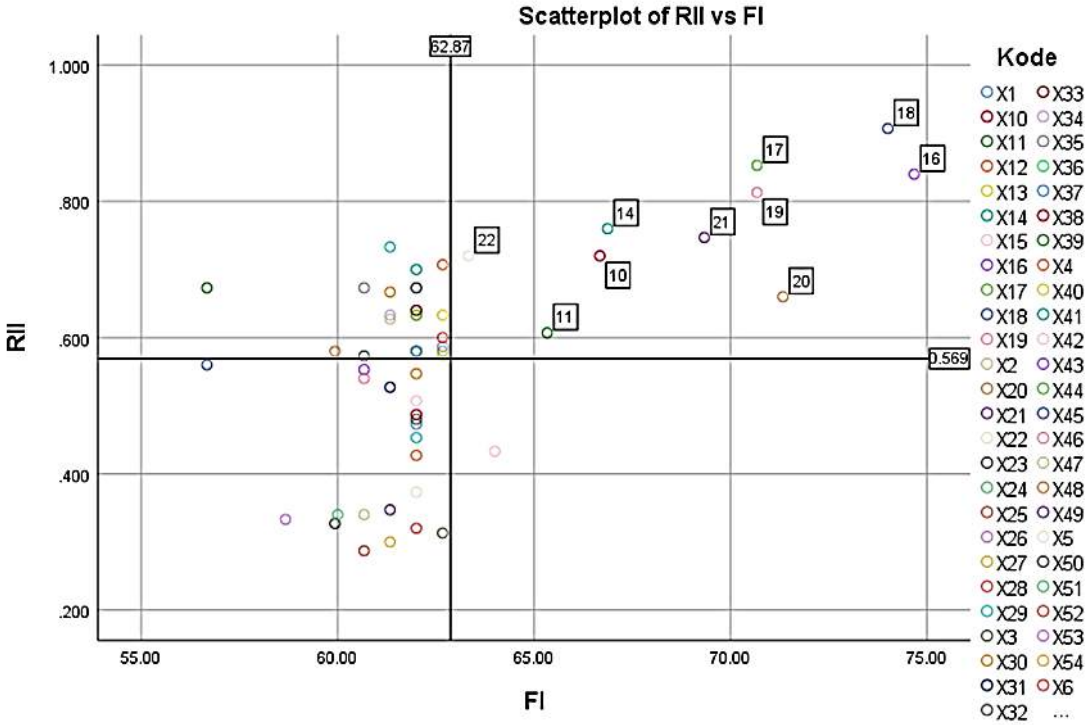


Figure 2: Quadrant Diagram based on Dam Construction Project Delay Factors
Source: Author's Computation

Table 1: Dominant factors that cause Dam project delays

Dominant Factors		Ranking Factors
X18	Extreme weather conditions	1
X17	Embankment material is not in accordance with specifications	2
X16	Land acquisition in the dam construction area	3
X19	The actual condition of the dam foundation is not good	4
X14	The discrepancy between the dam foundation elevation plan drawing and the actual field	5
X21	Delivery of stockpile material is behind schedule planned by the Contractor	6
X10	There was a collapse during the tunnel excavation	7
X22	Poor site management by Contractor	8
X11	The estimated length of time for tunnel excavation is not correct	9
X20	Delays in delivery of stockpile materials from third parties	10

Crash Cost and Cost Slope Calculation

The relationship between cost and time can be analyzed in each category of work, especially for work on the critical path which plays an important role in determining the timeliness of completion of a dam project. The overall project time and duration will be reduced by reducing the time and duration of activities that are on a critical path or path. In the discussion of this paper will be limited to calculations for work contained in the critical path by using cost calculations under normal conditions and cost calculations in crash cost and cost duration conditions so that the cost slope of each activity on the critical path is obtained.

The summary of the calculation is shown on Table 2:

Table 2: Summary of Calculation Crash Cost

NO	Description	UNIT	EMBANKMENT				
			ZONA 1	ZONA 2	ZONA 3	ZONA 4	ZONA 5
1	Volume of work	cu.m	155.200	85.100	47.100	909.500	45.500
2	Labor costs	IDR	2.615	2.615	2.615	20.065	20.065
3	Unit cost (Wages of workers + Materials + Equipment)	IDR	82.110	91.902	91.885	247.605	245.565
4	Normal duration	day	860	860	860	860	860
5	Normal Cost	IDR	12.743.472.000	7.820.860.200	4.327.783.500	225.196.747.500	11.173.207.500
6	Crash duration						
	a. Daily productivity	cu.m	180	99	55	1.058	53
	b. Hourly productivity	cu.m	26	14	8	151	8
	c. Daily productivity after crash	cu.m	202	111	61	1.186	59
	d. Crash duration	day	767	767	767	767	767
7	Crash Cost of Workers' Wages						
	a. Normal hourly wages	IDR	67.422	36.969	20.461	3.031.443	151.655
	b. Overtime fee per hour	IDR	134.844	73.938	40.922	6.062.886	303.311
	c. Crash cost per day	IDR	606.798	332.722	184.151	27.282.986	1.364.899
8	Crash Cost Material Cost						
	a. Normal hourly wages	IDR	821.529	454.479	251.406	18.622.463	916.216
	b. Overtime fee per hour	IDR	821.529	454.479	251.406	18.622.463	916.216
	c. Crash cost per day	IDR	6.572.230	3.635.834	2.011.248	148.979.704	7.329.731
9	Crash Cost alat						
	a. Normal hourly wages	IDR	1.227.921	807.709	447.040	15.754.323	788.149
	b. Overtime fee per hour	IDR	1.227.921	807.709	447.040	15.754.323	788.149
	c. Crash cost per day	IDR	9.823.366	6.461.674	3.576.320	126.034.582	6.305.193
10	Total Crash Cost	IDR	13.038.778.316	7.998.724.219	4.426.209.978	231.825.423.759	11.503.049.889

From the results above, the consequence is the addition of direct costs such as the cost of workers' wages due to additional working hours (overtime), additional materials and equipment costs used due to additional working hours, but with the acceleration of the duration of work, the indirect costs have decreased. Indirect costs in the form of general overhead costs and project profits for contractors the duration of the project completion acceleration is 767 days from the initial project duration of 860 days. Then, proceed with calculating the Cost Slope on the Zone 1 – 5 embankment work for Main Dam, the result is a Cost Slope of 80,968,983.45 IDR per day for the duration of the crash. So, the total project implementation time is 1,456 calendar days from 1,549 calendar days when the initial project execution time. The method of crashing the implementation time of the work will affect the direct and indirect costs of the project, as shown on Table 3:

Table 3: Comparison of project cost and time under normal and crashing conditions

Project Condition	Direct Cost (IDR)	Non-direct Cost (IDR)	Total Cost (IDR)	Duration (day)
Normal	261.262.070.700,00	39.189.310.605,00	300.451.381.305,00	860
Crashing (oevetime)	268.792.186.160,47	34.951.396.783,74	303.743.582.944,21	767

In table 3 it can be seen that the total cost for the normal condition project is 300,451,381,305 IDR and the crashing condition project is 303,743,582,944,21 IDR so that there is an increase in cost of 3,292,201,639.21 IDR. Meanwhile, the project duration has accelerated for 93 calendar days.

IV. CONCLUSION AND RECOMMENDATIONS

The results of this study found that the 2 most dominant factors were in the main dam work category, namely extreme weather conditions and land availability in the dam construction area. The acceleration strategy used is the crashing method and the result is that the project completion is 93 days faster than the original implementation schedule. However, the consequence of this method is an increase in construction costs of 3,292,201,639.21 IDR.

For further research, it can be considered that activities on the critical path need special attention and supervision to reduce the risk of delays in a project. The choice of alternative project acceleration should be adjusted to the environmental conditions and existing resources and can make better network planning so that it can produce a more optimal project work duration.

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