

RISK MANAGEMENT IN HEAVY EQUIPMENT PERFORMANCE EVALUATION IN JAKARTA LRT PROJECT PHASE 1B

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ABSTRACT

Infrastructure projects, especially in the development of mass transportation systems such as light rail transit (LRT), rely heavily on the role of heavy equipment. The use of these machines is a decisive factor in the successful construction of a special mode of rail transport, in which the production capacity of the machine plays a major role in influencing the progress of the project. Therefore, an analysis of the capacity of production volumes is necessary. This study aims to evaluate the production volume capacity of The Jakarta LRT project Phase 1b, including analysis of the capacity of cranes, excavators, dump trucks, compactors, and other heavy equipment. The volumetric method is applied to calculate the volume capacity and productivity of heavy vehicles. The results of the analysis showed that the calculated volume and productivity of the machine have met the target according to the established schedule.

Keywords: Heavy Equipment, Light Rail Transit, Infrastructure, Productivity, Production Volume

INTRODUCTION

In the implementation of large-scale civil engineering projects, the use of heavy equipment is a very important factor and plays a crucial role in the successful completion of the project. This not only applies to the construction sector, but also includes the agricultural, forestry, and mining sectors. The operational effectiveness of the machine not only increases work productivity significantly, but also largely depends on a thorough understanding of various factors, such as routine maintenance costs, daily operating costs, as well as the technical specifications and functions of each tool used. In addition, the productivity of the machine is also influenced by various external factors, such as the duration of the project, the topography and terrain conditions of the project site, and the technical specifications of the selected machine. Therefore, the selection of heavy equipment that is not appropriate or not in accordance with the needs of the project can hinder the smooth construction and potentially increase the cost and time of project implementation significantly. Earthworks in the Jakarta LRT project Phase 1b is an important stage in the development of transport infrastructure. In general, earthworks aim to prepare the land and ensure the stability of the land to be used for the construction of rail lines and stations. This earthwork is vital because it supports the success of The Jakarta LRT phase 1b project, by ensuring soil stability, good water management, and land readiness for the next stage of development. To support the smoothness and efficiency of the entire earthwork process, heavy equipment is used such as excavators to dig and load soil, Dump trucks to transport materials, dozers to flatten soil piles, Motor graders

to tidy up the surface of the pile, and Vibratory rollers that function to compact the soil pile optimally.

METHODS

The research methods applied in this project are described through a flow chart that systematically describes the stages of research, starting from the preparation phase, data collection, data processing, to analysis of results, to ensure a structured and accountable research flow.

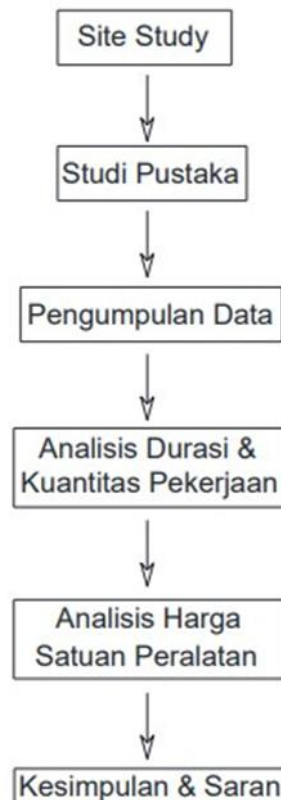


Figure 1. Research Flow Chart

The literature study was conducted by reviewing various relevant literature sources, especially books and scientific references that discuss heavy equipment in road construction projects. In addition, field data is obtained directly from the activities at the project site. The Data includes information on the operating costs of heavy equipment, plans for the implementation of work, as well as the scope of work. The types of heavy equipment used by contractor companies in the implementation of projects in the field are as follows :

- 1) Wheel Loader.
- 2) Vibration Roller;
- 3) Tandem Roller;
- 4) TrontonTruck;
- 5) Stone Crusher;
- 6) Pneumatic Tire Roller;
- 7) Motor Grader;
- 8) Hydraulic Excavator;
- 9) Dump Truck;

- 10) Compressor;
- 11) Asphalt Sprayer;
- 12) Asphalt Mixing Plant;
- 13) Asphalt Finisher;

The cycle period to be calculated is the cycle period of dump truck, hydraulic excavator, wheel loader.

1) Dump truck

The equation below can be used to calculate the cycle time of a dump truck :

$C_m = C_{m1} + C_{m2} + C_{m3}$; with the description C_m = cycle period, C_{m1} = fixed period (minutes), C_{m2} = load period, C_{m3} = travel period.

2) Hydraulic excavator

Based on Figure 2 below, the excavator cycle time can be determined.



Figure 2. Excavator Cycle Period

3) Wheel loader

Wheel loaders have a fixed period or fixed time of about 10.9 seconds. The filling process is determined using the V-loading method: $C_m = 2 \left(\frac{D}{F} + \frac{D}{R} \right) + Z$; with the information C_m = cycle period (minutes), D = transport route (m), F = forward rate (m/min), R = reverse rate (m/min); Z = fixed time (minutes).

Specifications of heavy equipment used in this project are as follows, namely :

1) Asphalt finisher

Expandable width : 2.5 m – 6m
Hooper capacity : 10 tons
Type: Mitsubishi MF55H

2) Hydraulic excavator

Type: Komatsu PC500LC-10 R
Bucket capacity : 3.8 m³
Net engine output : 360 HP

RESULTS AND DISCUSSION

The preparation of the project realization schedule is carried out through a systematic approach, taking into account each stage of the work in detail. This schedule is designed to provide clear guidance on the sequence of activities, duration of implementation, and allocation of resources needed to ensure the project runs effectively and efficiently. Based on the plan that has been prepared and agreed upon, the implementation of The Jakarta LRT phase 1b project is targeted to be completed within 270 effective working days, taking into account various supporting factors and potential obstacles that may occur during the implementation. The mobilization of heavy equipment is expected to take approximately 50 effective working days,

which includes the process of moving the equipment from the original location to the project site, as well as preliminary preparation to ensure that the equipment is optimally ready for use. After the mobilization phase is completed, finishing work that includes firebrace activities, surface refinements, and final quality evaluation is projected to require an additional time of about 25 effective working days. Thus, the total time required for mobilization and completion of the final work is approximately 70 effective working days. The entire duration has been taken into account thoroughly in the project implementation schedule, allowing work to be completed on time as originally planned. Therefore, the calculation of the volume and productivity of heavy equipment is a crucial aspect in ensuring the smooth execution of the main work, as shown in Table 1.

Chart 1. Production Capacity Operational Activities

No.	Type Of Activity	Work Effectiveness Time	Production Capacity	
			/ day (m ³)	/ hours (m ³)
1.	Mines	40	606,64	75,79
2.	Stack	20	399,82	38,18
3.	Aggregate Foundation Layer	19	46,60	4,81
4.	Pavement Aspa	7	66,88	7,64

This study conducted an analysis of the production volume capacity with the main objective of evaluating the effectiveness and efficiency of the use of heavy equipment in earthworks. The analysis includes an estimate of the production capacity of heavy vehicles used in the field, taking into account such important factors as the technical specifications of the tools, operational conditions, duration of work, as well as the characteristics of the project terrain. One of the crucial components in this analysis is the calculation of cycle time, machine capacity per cycle, and the level of operational efficiency. A comprehensive understanding of the cycle time and volume of heavy equipment production is essential to ensure the achievement of project implementation targets in a timely, efficient, and in accordance with the planned schedule.

Chart 2. Cycle Time Analysis Of Earthworks

No.	Equipment Used	Cycle Time
1.	Dump Truck	40
2.	Hydraulic Excavator	20

Capacity analysis of production volume aims to determine the working capacity of heavy equipment per hour based on topographic conditions. Cycle time needs to be calculated first because it is the basis in this analysis. The evaluation is carried out taking into account the actual use of the tool in the field, covering technical, operational, duration and efficiency aspects. The results of the analysis are presented in full in Table 3 for easy understanding

Chart 3. Analysis Of Volume Quantity Of Heavy Equipment On Soil Backfilling Activity

No.	Heavy Equipment	Machine Volume Quantity
1.	Dump Truck	20,43 m ³ /jam
2.	Motor Grader	14,11 m ³ /jam
3.	Vibration Roller	18,71 m ³ /jam
4.	Wheel Loader	49,75 m ³ /jam

Machine productivity is calculated based on field conditions, including cycle times, topography, and operational efficiency of each tool. The results are summarized in Table 4 as an overview of actual productivity in the field and can be used as a reference for evaluation during project implementation.

Chart 4. Average quantity of heavy equipment in excavation activities

No.	Heavy Equipment Used	Volume Of Work	Machine Volume Capacity	Effective Working Time	Number Of Tools
		(m ³ / hours)	(m ³ / hours)		
1.	Dump Truck	66,75	149,41	39	3
2.	Hydraulic Excavator		44,66		6

CONCLUSIONS

The project is expected to be effectively completed in 99 working days, based on the calculation of optimal production capacity and realistic duration of activity. In addition, several operational vehicles have been specially selected according to the needs of the work and field conditions, including :

- 1) Wheel loader.
- 2) Vibration roller;
- 3) Tandem roller;
- 4) Pneumatic tired roller;
- 5) Motor grader;
- 6) Hydraulic excavator;
- 7) Asphalt finisher;
- 8) Dump truck;

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