

PERFORMANCE EVALUATION OF HEAVY EQUIPMENT IN THE JAKARTA LRT PHASE 1B PROJECT

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ABSTRACT

Infrastructure projects, particularly in the development of mass transportation systems such as light rail transit (LRT), are highly dependent on the role of heavy equipment. The use of heavy equipment is a determining factor in the success of specialized rail transportation development, where the production capacity of heavy equipment plays a major role in influencing project progress. Therefore, an analysis of production volume capacity is essential. This study aims to evaluate production volume capacity in the Jakarta LRT Phase 1B project, including an analysis of the capacity of cranes, excavators, dump trucks, compactors, and other heavy equipment. Volumetric methods were applied to calculate the volume capacity and productivity of heavy vehicles. The analysis results show that the calculated volume and productivity of heavy equipment have met the targets in accordance with 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 applies not only to the construction sector, but also to the agriculture, forestry, and mining sectors. The operational effectiveness of heavy machinery not only significantly enhances work productivity but also heavily depends on a comprehensive understanding of various factors, such as routine maintenance costs, daily operational expenses, as well as the technical specifications and functions of each piece of equipment used. Additionally, heavy equipment productivity is influenced by various external factors, such as project duration, topographical conditions and site terrain, as well as the technical specifications of the selected heavy equipment. Therefore, selecting the wrong or inappropriate heavy equipment for project needs can hinder construction progress and potentially increase project costs and duration significantly. Earthwork in the Jakarta LRT Phase 1B project is a critical stage in transportation infrastructure development. Generally, earthwork aims to prepare the site and ensure soil stability for the construction of rail tracks and stations. This earthwork is vital as it supports the success of the Jakarta LRT Phase 1B project by ensuring soil stability, proper water management, and site readiness for subsequent construction phases. To support the smoothness and efficiency of the entire earthwork process, heavy equipment such as excavators are used for digging and loading soil, dump trucks for transporting materials, dozers for leveling soil piles, motor graders for smoothing the surface of soil piles, and vibratory rollers for optimally compacting soil piles.

METHODS

The research method applied in this project is described through a flow chart that systematically illustrates the stages of research, from the preparation phase, data collection, data processing, to analysis of results, to ensure a structured and accountable research process.

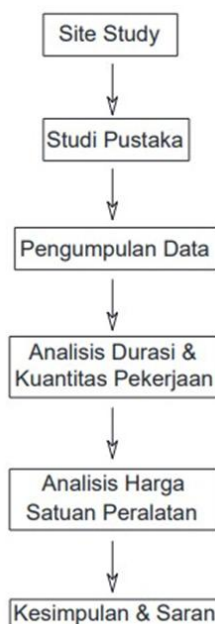


Figure 1. Research Flow Chart

The literature study was conducted by reviewing various relevant sources, particularly books and scientific references discussing heavy equipment in road construction projects. In addition, field data was obtained directly from activities at the project site. The data included information on heavy equipment operating costs, work implementation plans, and the scope of work. The types of heavy equipment used by contractors in the implementation of projects in the field are as follows:

- 1) Wheel Loader.
- 2) Vibration Roller;
- 3) Tandem Roller;
- 4) Tronton Truck;
- 5) Stone Crusher;
- 6) Pneumatic Tired 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 trucks, hydraulic excavators, and wheel loaders.

- 1) Dump truck

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

$C_m = C_{m1} + C_{m2} + C_{m3}$; where C_m = cycle period, C_{m1} = fixed period (minutes), C_{m2} = loading period, C_{m3} = travel period.

- 2) Hydraulic excavator

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



Figure 2. Excavator Cycle Period

3) Wheel loader

The wheel loader has a fixed time period of approximately 10.9 seconds. The loading process is determined using the V-loading method: $C_m = 2 \left(\frac{D}{F} + \frac{D}{R} \right) + z$; where C_m = cycle period (minutes), D = transport route (m), F = forward speed (m/minute), R = reverse speed (m/minute); Z = fixed time (minutes).

The specifications of the heavy equipment used in this project are as follows:

- 1) Asphalt finisher
Paving width: 2.5 m – 6 m
Hopper 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 project implementation schedule is prepared using 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 required to ensure the project runs effectively and efficiently. Based on the plan that has been developed 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 as well as potential obstacles that may arise during implementation. The mobilization of heavy equipment is estimated to take around 50 effective working days, which includes the process of moving the equipment from its original location to the project site, as well as initial preparations to ensure that the equipment is ready for optimal use. After the mobilization phase is complete, the finishing work, which includes cleaning, surface refinement, and final quality evaluation, is projected to require an additional 25 effective working days. Thus, the total time required for mobilization and completion of final work is approximately 70 effective working days. The entire duration has been thoroughly calculated in the project implementation schedule, enabling the work to be completed on time as per the initial plan. Therefore, calculations of the volume and productivity of heavy equipment are crucial aspects in ensuring the smooth implementation of the main work, as shown in Table 1.

Table 1. Production Capacity of Operational Activities

No.	Type of Activity	Effective Work Time	Production Capacity	
			/ Day (m ³)	/ Hour (m ³)
1.	Excavation	40	606,64	75,79
2.	Pile	20	399,82	38,18
3.	Aggregate Foundation Layer	19	46,60	4,81
4.	Asphalt Pavement	7	66,88	7,64

This study analyzes production volume capacity with the primary objective of evaluating the effectiveness and efficiency of heavy equipment usage in earthworks. The analysis includes estimating the production capacity of heavy vehicles used in the field, taking into account important factors such as technical specifications of the equipment, operational conditions, duration of work, and project site characteristics. One of the crucial components of this analysis is the calculation of cycle time, heavy equipment capacity per cycle, and operational efficiency levels. A comprehensive understanding of cycle time and heavy equipment production volume is essential to ensure that project implementation targets are achieved on time, efficiently, and in accordance with the planned schedule.

Table 2. Cycle Time Analysis of Earth Excavation Work

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

Production volume capacity analysis aims to determine the working capacity of heavy equipment per hour based on topographical conditions. Cycle time must be calculated first because it forms the basis of this analysis. The evaluation is carried out by considering the actual use of equipment in the field, including technical, operational, duration, and efficiency aspects. The results of the analysis are presented in full in Table 3 for ease of understanding.

Table 3. Analysis of Heavy Equipment Volume Quantity in Land Filling Activities

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

The productivity of heavy equipment is calculated based on field conditions, including cycle time, topography, and the operational efficiency of each piece of equipment. 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.

Table 4. Average Quantity of Heavy Equipment in Earth Excavation Activities

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

CONCLUSIONS

This project is estimated to be completed effectively within 99 working days, based on calculations of optimal production capacity and realistic activity duration. In addition, several operational vehicles have been specifically 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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