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# Productivity Analysis of The Pindad Excava200 Pontoon Excavator in The Masangan River Normalization Project Pasuruan Regency

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**Abstract**

River sedimentation reduces channel capacity and increases flood risk, making river normalization essential for restoring hydraulic performance. The success of such projects depends substantially on the productivity and operational efficiency of heavy equipment operating under waterlogged conditions. This study aimed to determine the productivity of the Pindad Excava200 pontoon excavator in the Masangan River Normalization Project, Pasuruan Regency. A quantitative applied research design was employed. Primary data were collected through direct field observations of bucket capacity, cycle time, work efficiency, operating hours, equipment condition, and fuel and lubricant consumption, while secondary data were obtained from project documents, equipment specifications, relevant literature, and the 2026 Analisis Harga Satuan Pekerjaan (AHSP). Productivity was calculated for sediment dredging and finishing operations using the observed operational parameters. The results showed that the excavator achieved a productivity of 52.35 $m^3$/hour, equivalent to 418.80 $m^3$/day, during dredging and 67.79 $m^3$/hour, equivalent to 542.32 $m^3$/day, during finishing. Fuel consumption was 0.357 L/$m^3$ for dredging and 0.268 L/$m^3$ for finishing, whereas lubricant consumption was 0.010 L/$m^3$ and 0.007 L/$m^3$, respectively. In conclusion, finishing operations were more productive and resource-efficient than dredging operations because of their shorter cycle times and simpler operational sequences. These findings may support more accurate equipment planning and resource allocation in comparable river normalization and hydraulic engineering projects.

## INTRODUCTION

The Masangan River is located in Masangan Village, Bangil District, Pasuruan Regency, East Java, and has a length of approximately 6.53 km. The river forms part of the Kedunglarangan Watershed (Daerah Aliran Sungai [DAS] Kedunglarangan) and functions as a natural watercourse that conveys runoff from upstream to downstream areas. In recent years, the Masangan River has experienced substantial sedimentation

caused by the accumulation of silt, sand, and solid waste transported by river flow. This sediment accumulation has reduced the river's conveyance capacity, obstructed water flow, and increased the risk of flooding in residential areas along the riverbanks, particularly during the rainy season. These conditions indicate the need to restore the river's hydraulic function through river normalization activities (Annas et al., 2024; Bangkit et al., 2024).

River normalization is one of the primary flood-control measures implemented through sediment dredging, channel improvement, and enhancement of river conveyance capacity to maintain efficient downstream flow (Kurniawan et al., 2026; Laurentia et al., 2022). In addition to reducing flood risk, river normalization aims to maintain riverbank stability, control sediment accumulation, and improve the river's function as a natural drainage system. Successful implementation requires construction equipment capable of operating efficiently under aquatic and waterlogged conditions to achieve effective dredging performance (Yahni et al., 2025).

Heavy equipment plays a crucial role in the implementation of river normalization projects by accelerating sediment dredging, reducing dependence on manual labor, and improving construction efficiency (Peraturan Menteri Pekerjaan Umum Dan Perumahan Rakyat Republik Indonesia Nomor 8 Tahun 2023 Tentang Pedoman Penyusunan Perkiraan Biaya Pekerjaan Konstruksi Di Bidang Pekerjaan Umum Dan Perumahan Rakyat, 2023; Mulya, 2024; Sentana et al., 2024; Suari et al., 2025; Sujiono & Basuki, 2024). Equipment selection should be adapted to site characteristics because each machine has different operational capabilities under varying field conditions. Inappropriate equipment selection may reduce productivity, delay project completion, and increase operational costs (Jaya et al., 2022).

One of the heavy-equipment units used in the Masangan River normalization project is the Pindad Excava200 pontoon excavator. The excavator operates on a floating pontoon platform, enabling it to perform dredging activities in river sections that are inaccessible to conventional land-based excavators (Chen et al., 2023; Desse & Mengesha, 2024; Diasz & Sarya, 2023). The pontoon platform provides operational stability during sediment excavation and allows the equipment to operate in water bodies with varying depths (Farizki et al., 2025; Ngo et al., 2022; Rasa & Handayani, 2023). Therefore, the Pindad Excava200 pontoon excavator is well suited to river normalization projects conducted under waterlogged and muddy site conditions (Alfandi et al., 2023).

Despite its suitability for river normalization work, the productivity of the Pindad Excava200 pontoon excavator is influenced by several factors, including bucket capacity, cycle time, work efficiency, material characteristics, operator performance, and site conditions. Failure to adequately account for these factors may reduce equipment productivity, resulting in project delays and higher operational costs (Eraku et al., 2025).

Heavy-equipment productivity analysis is an important component of construction planning and project evaluation. It provides information on the actual work

output that equipment can achieve under field conditions. The results may be used to estimate project duration, equipment requirements, operational efficiency, and project costs. Accordingly, productivity analysis serves not only as a means of evaluating equipment performance but also as a decision-support tool for improving the effectiveness of construction project implementation.

## METHOD

This study employed a quantitative approach with an applied research design to determine the productivity of the Pindad Excava200 pontoon excavator used in the Masangan River normalization project in Pasuruan Regency. The analysis focused on actual equipment productivity under field operating conditions and compared the results with the theoretical productivity specified in Circular Letter of the Director General of Construction Development No. 47/SE/DK/2026 concerning the 2026 Analisis Harga Satuan Pekerjaan (AHSP).

The research was conducted along approximately 6.53 km of the Masangan River normalization project area in Pasuruan Regency. The work primarily involved sediment dredging to restore river conveyance capacity and reduce flood risk. Because much of the work area was submerged, dredging operations were performed using the Pindad Excava200 pontoon excavator, which operated from a floating pontoon platform and provided access to submerged working areas.

Data were collected through literature review and direct field observation. The literature review covered scientific publications, previous studies, relevant regulations, and technical references related to heavy-equipment productivity, river normalization, and productivity calculations based on the 2026 AHSP. Field observations were conducted directly at the project site during sediment dredging operations.

Primary data included river dimensions, dredging volume, excavator bucket capacity, bucket fill factor, cycle time, effective working hours, daily operating hours, equipment condition, material characteristics, river depth, pontoon positioning, operator performance, and operational constraints. Field data were documented using observation records, photographs, and contractor operational reports. Secondary data were obtained from project documents, engineering drawings, equipment specifications, relevant literature, and regulatory documents.

The analysis began by calculating the actual productivity of the Pindad Excava200 pontoon excavator using field observation data. The calculation incorporated bucket capacity, bucket fill factor, cycle time, work efficiency, and effective working hours. Equipment productivity was expressed in cubic meters per hour ($m^3/h$). The calculated productivity was then compared with the theoretical productivity specified in the 2026 AHSP to evaluate equipment performance under actual field conditions.

The analysis also considered factors affecting productivity, including site conditions, material characteristics, operator performance, waiting time, and operational interruptions during project execution. The comparison between actual and theoretical productivity was subsequently used to evaluate the operational performance of the

Pindad Excava200 pontoon excavator and to formulate recommendations for heavy-equipment planning and management in river normalization projects with similar site conditions.

## RESULTS AND DISCUSSION

### Specifications of the Pindad Excava200 Pontoon Excavator

The Pindad Excava200 Pontoon Excavator was the primary heavy equipment used for the Masangan River normalization project. The excavator operates on a floating pontoon platform, enabling dredging activities in water-covered areas that are inaccessible to conventional land-based excavators. The equipment is powered by a diesel engine with a rated output of 127 kW at 2.000 rpm and a maximum torque of 705 Nm at 1.500 rpm, providing sufficient power for sediment excavation under river conditions.

**Table 1.** Technical Specifications of the Pindad Excava200 Pontoon Excavator

| **Pindad Excava 200** | |
|---|---|
| Type | BF06M2012C |
| Rated Power | 127 kW |
| Power Rating Standard | DIN/ISO 3046 IFN |
| Engine Speed | 2.000 rpm |
| Maximum Torque | 705 Nm @ 1,500 rpm |
| Engine Configuration | Inline 6-cylinder, vertical |
| Engine Displacement | 6.057 L |
| Fuel Type | Diesel (DIN 51601) |

Source: Project Data

**Table 2.** Technical Specifications of the Pindad Excava200 Pontoon Excavator (Continued)

| ***Digging Force* (kN)** | |
|---|---|
| *Arm Length* | 2,84 m (*standart*) |
| *Bucket Digging Force* | 153 |
| *Arm Crowding Force* | 119 |
| Kapasitas *Bucket* (ISO *heaped*) | 0,86 $m^3$ |
| *Boom Cylinder* | 125 mm x 1300 mm |
| *Arm Cylinder* | 140 mm x 1500 mm |
| *Bucket Cylinder* | 120 mm x 1070 mm |
| **Lubrication and Fluid Capacity** | |
| Fuel Tank | 440 L |
| Cooling System | 15,2 L |
| Engine Oil | 16 L |
| Travel Reduction Gear | 2 x 5,3 L |
| Swing Reduction Gear | 3 L |
| Hydraulic Oil Tank | 230 L |
| **Pontoon Dimensions** | |
| Length × Width × Height | 9 m x 1,5 m x 1,5 m |
| Bow Inclination Angle | 60° |

Source: Project Data

**Cycle Time Data of the Pindad Excava200 Pontoon Excavator**

The cycle time (CT) of the Pindad Excava200 Pontoon Excavator was determined through direct field observations using a stopwatch to record the duration of each operating component. The average cycle time for both dredging and finishing activities is presented in Tables 3 and 4.

**Table 3.** Cycle Time Data of the Pindad Excava200 Pontoon Excavator for Sediment Dredging

| No. | Component | Description | Average Time (s) |
|---|---|---|---|
| 1 | Digging Time | Excavation and bucket filling | 18 |
| 2 | Swing Loaded | Swinging with loaded bucket to the dumping location | 16 |
| 3 | Dumping Time | Dumping the excavated material | 11 |
| 4 | Swing Empty | Swinging back to the excavation position | 15 |
| 5 | Travel Time | Equipment traveling/repositioning | - |
| | | **Total Cycle Time** | **60** |

Source: Project Documentation

**Table 4.** Cycle Time Data of the Pindad Excava200 Pontoon Excavator for Finishing Work

| No. | Component | Description | Average Time (s) |
|---|---|---|---|
| 1 | Digging Time | Excavation and bucket filling | - |
| 2 | Swing Loaded | Swinging with loaded bucket to the dumping location | - |
| 3 | Dumping Time | Dumping the excavated material | - |
| 4 | Swing Empty | Swinging back to the excavation position | 15 |
| 5 | Travel Time | Equipment traveling/repositioning | 30 |
| | | **Total Cycle Time** | **60** |

Source: Project Documentation

Based on the measured cycle time presented in Tables 3 and 4, a clear difference can be observed between the dredging and finishing operations in terms of both the total cycle time and the operational components involved. For the sediment dredging activity, the total cycle time was 60 seconds, consisting of four active components: digging time (18 s), loaded swing (16 s), dumping time (11 s), and empty swing (15 s), while no travel time was recorded during the operating cycle. This indicates that dredging represents a complete excavation cycle involving material excavation, transportation, dumping, and return to the excavation point. Among these activities, the digging process required the longest duration, indicating that excavation and bucket filling constitute the most time-consuming stage of the dredging operation.

In contrast, the finishing operation exhibited a shorter total cycle time of 45 seconds, consisting only of empty swing (15 s) and travel time (30 s). The absence of digging, loaded swing, and dumping activities indicates that finishing work does not involve material excavation or disposal. Instead, it primarily consists of equipment movement and surface leveling, with travel time accounting for the largest proportion of

the operating cycle. The travel time was twice as long as the empty swing time, demonstrating that equipment repositioning was the dominant activity during the finishing process.




**Figure 1.** Average Cycle Time of the Pindad Excava200 Pontoon Excavator for Sediment Dredging and Finishing Operations
Source: Processed by the Authors

**Productivity Parameters of the Pindad Excava200 Pontoon Excavator**

The productivity of the Pindad Excava200 amphibious pontoon excavator is determined by the integration of its technical specifications and the environmental conditions encountered during water-based operations. The primary parameters affecting equipment performance include the bucket capacity, cycle time, and equipment efficiency. Additional factors such as the characteristics of the dredged material, including soft mud and compacted sediment, as well as the operator's ability to coordinate excavator movements while maintaining pontoon stability, also influence the overall production capacity expressed in cubic meters per hour ($m^3/h$).

**Productivity Parameters for Sediment Dredging**

The productivity parameters used to calculate the production capacity of the Pindad Excava200 Pontoon Excavator during sediment dredging are presented in Table 5.

**Table 5.** Productivity Parameters of the Pindad Excava200 Pontoon Excavator for Sediment Dredging

| No. | Productivity Parameter | Symbol | Value | Description |
|---|---|---|---|---|
| 1 | Engine Power | Pw | 170 HP | Rated engine power |
| 2 | Bucket Capacity | V | 0.86 m³ | Fully loaded bucket capacity |
| 3 | Bucket Fill Factor | Fb | 1.1 | Easy operating conditions with colloidal soil of moderate moisture content |
| 4 | Equipment Efficiency Factor | Fa | 0.83 | Good operating condition |
| 5 | Excavation Conversion Factor | Fv | 0.90 | Excavation depth less than 40% of the maximum digging depth |
| 6 | Time Conversion | – | 60 min | Conversion from hours to minutes |
| 7 | Cycle Time | CT | 60 s | Time required to complete one operating cycle |

Source: Processed by the Authors

**Production Capacity Calculation for Sediment Dredging**

The production capacity of the Pindad Excava200 Pontoon Excavator was calculated using the productivity parameters presented in Table 4. The calculation is as follows:

$$Q = \frac{V \times F_b \times F_a \times 60\ minute}{T_s \times F_v}$$

$$Q = \frac{0{,}86\ x\ 1{,}1\ x\ 0{,}83\ x\ 60\ minute}{1{,}00\ x\ 0{,}9}$$

$$Q = 52{,}35\ m^3/hour$$

The calculation indicates that the excavator is capable of producing 52.35 m³ of dredged material per hour under the observed field conditions.

**Fuel Productivity Calculation**

Fuel consumption was estimated based on the hourly engine power requirement using the following equation:

$$H = (10\% - 12\%) \times Pw \times Fuel\ Price$$

$$H = 11\% \times 170 \times 27000$$

$$H = 504900/hour$$

The hourly fuel cost per unit production is calculated as:

$$H1 = \frac{H}{Q} = \frac{504900}{52{,}35} = 9646\ m^3/hour$$

The corresponding fuel productivity is:

$$Productivity \frac{9646}{27000} = 0{,}357\ liter/m^3$$

Thus, the average fuel consumption of the Pindad Excava200 Pontoon Excavator during sediment dredging is 0.357 L/m³.

**Lubricant Productivity Calculation**

Lubricant consumption was estimated using the following equation:

$$I = (0{,}25\% - 0{,}35\%) \times Pw \times Lubricant\ Price$$

$$I = 0{,}30\% \times 170 \times 44810$$

$$I = 22853/hour$$

The hourly lubricant cost per unit production is:

$$I1 = \frac{I}{Q} = \frac{22853}{52{,}35} = 437{,}503\ m^3/hour$$

The lubricant productivity is therefore:

$$Productivity = \frac{437{,}503}{44810} = 0{,}010\ liter/m^3$$

The calculation shows that the lubricant consumption of the Pindad Excava200 Pontoon Excavator during sediment dredging is 0.010 L/m³, indicating relatively low lubricant usage compared with its production capacity.

**Productivity Parameters of the Pindad Excava200 Pontoon Excavator for Finishing Work**

The productivity parameters used to determine the production capacity of the Pindad Excava200 Pontoon Excavator during sediment finishing operations are presented in Table 6.

**Table 6.** Productivity Parameters of the Pindad Excava200 Pontoon Excavator for Finishing Work

| No. | Productivity Parameter | Symbol | Value | Description |
|---|---|---|---|---|
| 1 | Engine Power | Pw | 170 HP | Rated engine power |
| 2 | Bucket Capacity | V | 0.86 m³ | Fully loaded bucket capacity |
| 3 | Bucket Fill Factor | Fb | 1.1 | Easy operating conditions with colloidal soil of moderate moisture content |
| 4 | Equipment Efficiency Factor | Fa | 0.83 | Good operating condition |
| 5 | Excavation Conversion Factor | Fv | 0.90 | Excavation depth less than 40% of the maximum digging depth |
| 6 | Time Conversion | – | 60 min | Conversion from hours to minutes |
| 7 | Cycle Time | CT | 45 s | Time required to complete one operating cycle |

Source: Processed by the Authors

**Production Capacity Calculation for Sediment Finishing**

The production capacity for sediment finishing was calculated using the following equation:

$$Q = \frac{V \times F_b \times F_a \times 60\ minute}{T_s \times F_v}$$

$$Q = \frac{0{,}86\ x\ 1{,}1\ x\ 0{,}83\ x\ 60\ minute}{0{,}75\ x\ 0{,}9}$$

$$Q = 67{,}79\ m^3/hour$$

The calculation indicates that the Pindad Excava200 Pontoon Excavator is capable of achieving a production capacity of 67.79 m³/h during sediment finishing operations.

**Fuel Productivity Calculation**

Fuel consumption was estimated based on the hourly engine power requirement using the following equation:

$$H = (10\% - 12\%) \times Pw \times Fuel\ Price$$

$$H = 11\% \times 170 \times 27000$$

$$H = 504900/hour$$

The hourly fuel cost per unit production is:

$$H1 = \frac{H}{Q} = \frac{504900}{67{,}79} = 7234\ m^3/hour$$

The corresponding fuel productivity is:

$$Productivity = \frac{7234}{27000} = 0{,}268\ liter/m^3$$

Therefore, the average fuel consumption during sediment finishing operations is 0.268 L/m³.

**Lubricant Productivity Calculation**

Lubricant consumption was calculated as follows:

$$I = (0{,}25\% - 0{,}35\%) \times Pw \times Lubricant\ Price$$

$$I = 0{,}30\% \times 170 \times 44810$$

$$I = 22853/hour$$

The hourly lubricant cost per unit production is:

$$I1 = \frac{I}{Q} = \frac{22853}{67{,}79} = 327{,}188\ m^3/hour$$

The lubricant productivity is:

$$Productivity = \frac{327{,}188}{44810} = 0{,}007\ liter/m^3$$

The calculation shows that the lubricant consumption during sediment finishing operations is 0.007 L/m³, which is lower than that of the dredging operation due to the higher production capacity and shorter cycle time.

## CONCLUSION

The study concluded that the Pindad Excava200 pontoon excavator achieved a productivity of 52.35 m³/hour, equivalent to 418.80 m³/day, during sediment dredging and 67.79 m³/hour, equivalent to 542.32 m³/day, during finishing operations in the Masangan River Normalization Project. Fuel consumption was 0.357 L/m³ for dredging and 0.268 L/m³ for finishing, while lubricant consumption was 0.010 L/m³ and 0.007 L/m³, respectively. Accordingly, finishing operations demonstrated higher productivity and lower fuel and lubricant consumption per unit volume than dredging operations. This difference was primarily associated with shorter cycle times and the absence of excavation, loaded swing, and material-dumping activities during finishing operations.

Future research should validate these findings through repeated observations across different working periods, operators, sediment characteristics, river depths, weather conditions, and pontoon positions. Comparative studies involving different excavator models and project locations are also recommended to assess the broader applicability of the productivity estimates. In addition, future studies should compare observed field productivity directly with the 2026 Analisis Harga Satuan Pekerjaan (AHSP) benchmark and examine operational costs, equipment downtime, maintenance

requirements, and environmental impacts. Such analyses would provide a more comprehensive basis for equipment selection, project duration and cost estimation, and improved heavy-equipment management in river normalization projects.

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