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Labour Productivity for External Works Construction: Case Study in Kluang, Johor

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Abstract

The construction industry in Malaysia faces persistent productivity challenges, including a shortage of skilled labour, high worker turnover, and equipment inefficiencies, which lead to project delays, reduced output, and compromised quality. Accurate labour productivity data is critical for optimizing workforce allocation, scheduling, and resource utilization; however, the lack of such data hinders effective decision-making. This study evaluates labour productivity in external infrastructure projects, focusing on roadworks, drainage systems, and sewerage systems in Kluang, Johor. Using direct measurement methods, productivity rates across various tasks were assessed, and the impacts of factors such as site conditions, weather disruptions, and workforce experience were analyzed. The findings highlight the positive influence of skilled labour and appropriate equipment on productivity, while adverse weather and site-specific challenges were identified as significant contributors to inefficiencies. Effective site management was found to be a key determinant of improved labour productivity and adherence to project timelines. Recommendations include workforce training, enhanced site management practices, and optimized labour allocation to mitigate delays, improve productivity, and deliver competitive project outcomes.

1. Introduction

The productivity of construction labour in external activities, such as road construction, drainage, and sewerage systems, is a critical determinant of project efficiency and overall economic growth. Labour productivity in the construction sector is a significant cost driver, accounting for 30%-50% of total project costs (1). To ensure long-term success, businesses in this sector must prioritize boosting worker productivity (2). Enhanced productivity not only shortens project timelines but also improves infrastructure quality, which is crucial for urban planning and sustainability. Factors such as workforce skill levels, management practices, and working conditions significantly influence labour productivity in these external activities (3). Research highlights that effective communication, and proper training can lead to substantial improvements in productivity rates (4). However, several challenges, including unequal labour compensation, unsafe working environments, unclear career progression, limited access to training programs, and delays in on-site work schedules, hinder the engagement and efficiency of skilled labour in the construction industry (5). Addressing these dynamics is essential for contractors aiming to optimize operations, ensure timely project delivery, and maintain cost efficiency.

This study aims to establish construction labour productivity through direct observation at the Parkland Project in Kluang, Johor. The primary objectives are to measure the quantity of external works in the construction project and to analyze the productivity of construction workers performing these tasks. The scope of the study focuses on the productivity of labour involved in external activities such as roadwork, drainage, and sewerage systems, with particular attention to skilled workers and the efficiency of foreign labour. The research also considers the time required to complete the project and categorizes workers based on their roles as domestic or foreign labourers. Further classifications include nationality, years of experience, and age, which are critical factors influencing labour productivity. Data collection adheres to the terms outlined in the project agreement, ensuring alignment with the developer's timeline and scope of work. By examining these variables, the study provides insights into optimizing labour efficiency and improving project outcomes in the construction sector.

Direct observation is a valuable method for evaluating performance and organizing tasks more effectively on construction sites. By closely monitoring work activities, this technique enables the identification of inefficiencies and facilitates the implementation of improvements, ultimately enhancing system efficiency, organization, and time management. These improvements contribute to better project outcomes and bolster the reputation of companies within the competitive construction sector. This study aims to identify potential changes that can improve construction site productivity, with a particular focus on optimizing labour performance, resource utilization, and project scheduling. Effective organization and coordinated planning of development programs are essential to achieving these objectives, as they ensure that workforce capabilities are maximized, and project timelines are met. Additionally, the study highlights the importance of integrating advanced planning tools and real-time data collection methods to support decision-making and streamline project execution. By leveraging these strategies, construction firms can enhance productivity, reduce delays, and improve overall project efficiency, ultimately contributing to the sector's growth and sustainability.

2. Methodology

This study employs the observation method to measure the productivity of construction workers in external infrastructure projects, including roadworks, drainage systems, and sewerage systems. Direct observation was selected as the primary method to acquire real-time data from construction sites, providing decision-makers with accurate insights into productivity levels. Traditional techniques in the construction industry often rely heavily on manual input and subjective interpretation, limiting their accuracy and scope for improvement when effective monitoring is absent. By contrast, the observation method facilitates the systematic collection of site records, enabling an analysis of both the quantity and quality of work performed (6). Direct observation involves systematically watching and recording activities or behaviors as they naturally occur without interference, making it a robust qualitative and quantitative tool for capturing real-world construction data.

This study investigates labour productivity through a case study conducted at a construction site in Parkland, Kluang, Johor. The focus was on external activities such as roadwork, drainage, and sewerage systems, which were actively being performed during the observation period. A site diary was used to record daily activities, track progress, and document worker productivity over two months. The recorded observations were then compiled into structured data tables for detailed analysis. This approach ensures the collection of precise and actionable data, supporting better decision-making and enhancing overall construction productivity.

A detailed briefing was conducted to outline the ongoing construction activities, which included roadwork, drainage, and sewerage. Following the briefing, key personnel managing these activities provided insights into their respective areas of work, enhancing the understanding of construction processes and informing the observation approach. Throughout the observation period, a site diary was meticulously maintained as the primary tool for capturing real-time data. This diary systematically recorded specific tasks performed, the workforce involved, and the time required for each activity. The structured documentation process ensured that data collection was organized, reliable, and aligned with the study's objectives.

The design of the data collection process began by identifying essential information, drawing on previous studies such as (7), which highlighted critical factors affecting worker productivity. These factors included site area identification, the location of storage areas, and the specific construction activities being performed. Analysis of crew size and gang composition in active construction areas was conducted to assess labour resource allocation and its impact on productivity. Next. analysis of crew size and composition was conducted to understand labour resource allocation across different construction tasks. This analysis was essential for identifying factors influencing productivity and evaluating the relationship between workforce utilization and output. Additionally, the tools and equipment used in various tasks were assessed to determine whether manual labour or machinery was employed, enabling the study to identify effective and efficient methods for optimizing productivity.

Material movement logistics were also examined to ensure efficient scheduling and organisation. Regular updates and monitoring of material handling practices minimised wastage and ensured smooth operations. The length of the workday, including daily working hours and allocated rest periods, was another significant factor analysed. Break times, typically from 10:00 to 10:30 a.m., 12:00 to 1:00 p.m., and 3:00 to 3:30 p.m., were documented to evaluate their impact on worker well-being and overall productivity.

Data collection spanned a two-month period, during which observations were compiled into structured data tables. This allowed for monthly analyses of the quantity of work completed, providing a comprehensive understanding of labour efficiency in external construction activities.

3. Result and Discussion

This chapter presents the analysis of data collected through direct observation, a method that involves firsthand observation of phenomena in their natural setting. The systematic approach to data collection ensured alignment with the research objectives and provided real-time insights into construction site activities. The analysis aims to conclude the study's focus and to provide a deeper understanding of labour productivity and operational efficiency. The findings derived from this method contribute to a more comprehensive understanding of the research problem.

3.1 Productivity of The External Works

The observations focused on three key construction activities: road construction, drainage system installation, and sewerage system construction. Each activity was analyzed to examine the processes involved, workforce engagement, and the challenges encountered. In roadwork, tasks included laying foundations, applying asphalt, and ensuring proper alignment and leveling in accordance with design specifications. The drainage system installation emphasized efficient water flow and the prevention of waterlogging, involving precise excavation and the accurate placement of pipes and channels. Similarly, the implementation of the sewerage system involved constructing and laying pipelines to establish waste management infrastructure, requiring strict adherence to safety and engineering standards.

Furthermore, these observations provided valuable insights into the construction methodologies employed on site. The discussion highlighted productivity patterns, resource allocation strategies, and specific challenges faced during each activity. This analysis serves to inform best practices and identify areas for improvement in labour efficiency and operational planning within the construction sector.

3.2 Productivity for Roadwork Laying

These observations focused on roadwork laying, the process of laying a premix road at the construction site involved constructing a road 26 feet wide and 800 meters long. This task began with the distribution of binder and wearing course materials, 65 mm and 50 mm thick, respectively, using three lorries. These materials were pre-heated in a paver machine to ensure uniform consistency. Crushed stones were then evenly sprinkled over the surface and leveled to align with the predetermined road grade, ensuring stability and durability. A JCB machine was employed to assist in the leveling process, ensuring the surface was smooth and compacted. This was a critical step to prevent uneven areas and maintain the required grade. Following the preparation of the base, tar was applied as the final layer to create a smooth and resilient surface. Proper curing and compaction techniques were employed to enhance the road's strength, enabling it to withstand heavy traffic and adverse weather conditions.

The analysis of roadwork productivity revealed an average productivity rate of 21 units/day, with activities such as repairing telecom pipes and stocking materials like Crusher Run playing a significant role. Skilled labourers, with experience levels ranging from 3 to 15 years, achieved a maximum productivity of 14 m^2/day when repairing telecom pipes. However, the study highlighted that adverse weather conditions, particularly heavy rain, significantly impacted progress. On several occasions, work had to be halted, leading to delays and reduced output. This underscores the importance of effective scheduling and contingency planning to mitigate the effects of weather disruptions on productivity.

The discussion demonstrates that a combination of skilled labour labour, proper equipment, and systematic processes are key to achieving optimal productivity in roadwork activities. However, external factors like weather remain a challenge, emphasizing the need for adaptive strategies in project planning and execution.

3.3 Productivity for Drainage System

The drainage system at the construction site utilised concrete pipes measuring 600 mm in length and 300 mm in depth, capable of covering an area of 2.7 meters. These pipes, known for their durability and pressure resistance, were supported by materials such as sand, cement, and brick. A cement-sand mixture served as the binder, while bricks provided structural support. The workforce comprised seven individuals: four skilled workers proficient in pipe laying and concrete work, and three unskilled workers responsible for manual labour. The machinery employed included a Crawler Excavator for trenching and heavy material movement, a Lorry for material transport, and a Backhoe for excavation and backfilling. The construction process required precision to ensure proper pipe alignment, compaction, and sealing, which are crucial for the long-term functionality of the drainage system.

Analysis of the drainage activities during October 2024 revealed an average productivity rate of 35 m^2/day. Key tasks included clearing earth drainage, installing PVC pipes, and laying concrete pipes. Skilled labourers, primarily local workers with 7 to 18 years of experience, led the activities with support from unskilled labourers. Despite significant challenges caused by severe rainfall, which frequently interrupted tasks such as installing concrete pipes, several activities were completed efficiently. For instance, hydrant and crossing installations maintained a consistent productivity rate of 15 m^2/day. The combination of experienced labour and appropriate machinery played a critical role in sustaining productivity amidst these challenges.

In November 2024, drainage activities improved significantly, averaging 28 units/day. Key tasks included laying mild steel (MS) pipes and adjusting U-drainages. Under favorable conditions, the productivity rate for laying MS pipes reached 50 m/day, while adjustments to U-drainages achieved 30 m^2/day. However, severe rainfall continued to disrupt operations, causing delays and necessitating operational pauses. Despite these setbacks, the involvement of skilled workers with 8 to 20 years of experience helped maintain high productivity under favourable weather conditions.

The discussion highlights that while adverse weather posed recurring challenges, the integration of skilled labour labourers, efficient machinery, and systematic processes significantly enhanced productivity in drainage activities.

3.4 Productivity for Sewerage System

The observations focused on the installation of the sewerage pipeline at the rear of residential units, utilizing 750 mm-long pipes featuring a Y-joint connector (225 mm x 150 mm) to merge multiple sewage lines into the main system via the manhole. This component is crucial for ensuring the efficient management and flow of wastewater. The sewerage system was constructed using durable clay pipes and L-bowl pipes, selected for their corrosion resistance and ability to withstand high pressure. A backhoe was employed to excavate trenches for the pipelines, minimizing disruption to the surrounding environment. Additional equipment, such as compactors, was used to stabilize the soil around the pipes, preventing movement and ensuring long-term stability.

The task required a small workforce of three: two skilled workers responsible for pipe alignment and connection and one unskilled worker assisting with material handling. This workforce, comprising one Malaysian and two Bangladeshi workers, reflects the diverse labour composition typical of construction projects. The proper installation of sewerage systems is critical for preventing blockages, leaks, and environmental contamination. Emphasis was also placed on safety measures, particularly during excavation and pipe-laying tasks, to ensure worker safety in confined and potentially hazardous areas.

Analysis revealed that sewerage operations had the lowest productivity among all observed activities, averaging 15 units/day, with most effort focused on adjusting sewerage pipes. Skilled workers with 5 to 15 years of experience maintained a steady output of 5 units/day, demonstrating consistency even under challenging conditions. However, progress was significantly hindered by adverse weather, particularly rainfall, which caused interruptions during key stages of pipe installation. While drainage activities exhibited higher productivity, sewerage operations underscored the influence of weather on overall performance, emphasizing the need to account for weather in project scheduling and resource allocation.

3.5 Analysis

In the study, productivity is measured using standard units of output, such as cubic yards, tons, and square feet, which are commonly used in construction. Contractors often define productivity more narrowly, based on units of output directly tied to specific tasks (8). The concept of earned value enables the integration of multiple related operations, such as roadwork, drainage systems, and sewerage systems, to assess overall productivity. Productivity in this study is measured in terms of units of production per labour hour, which provides a clear metric for evaluating workforce efficiency. To quantify labour productivity, to compute it, (8) divide units of work by person-hours, equation (Eq. 1) is used:

$$Productivity = \frac{Unit\ of\ Output}{Input\ (labor\ hour)} \tag{1}$$

This equation calculates the number of units produced per hour of labour, offering a direct measure of how efficiently the workforce is performing. The collected data on units of output and labour hours enables the analysis of labour productivity for each task or activity on the construction site, providing insights into areas for improvement. Contractors and project managers often focus on labour productivity as a critical factor in project cost management and scheduling (9). This method ensures the data collected is both accurate and actionable for evaluating worker performance and optimizing labour allocation (10).

According to the research data, several factors affect labour productivity. In Malaysia's construction industry, from October to December last year, frequent rainfall and a lack of skilled machinery operators had a big impact on productivity. For the impact of heavy rainfall, can lead to saturated and unworkable soil conditions, often resulting in the complete suspension of construction activities. This not only delays project timelines but also increases costs due to extended labour and equipment usage. A study highlighted that heavy rainfall, and increased temperatures are significant factors affecting construction projects, impacting visibility for workers and machinery operators and creating unfavourable working conditions (15).

In Malaysia's construction industry, heavy rainfall and a shortage of skilled machinery operators are two significant factors affecting labour productivity, particularly with respect to total working time, number of workers, and quantity of work completed (16). Heavy rainfall, particularly during the monsoon season, frequently causes delays and work stoppages, reducing the number of productive hours available for construction tasks. Wet conditions slow critical activities such as excavation, concrete placement, and structural assembly, thereby extending project timelines. Additionally, rain affects worker efficiency, as idle time increases when tasks cannot be performed safely. The impact extends to material wastage, as rainwater can damage construction materials like cement, leading to additional costs and rework. Furthermore, muddy and waterlogged ground reduces the efficiency of heavy machinery, further contributing to project delays and lowering the overall output of completed work.

For the shortage of skilled machinery operators may play important role in constructions. The Malaysian construction sector faces a notable shortage of skilled labour, particularly in operating specialized machinery. This shortage leads to inefficiencies, increased errors, and potential safety hazards on-site. The reliance on unskilled foreign labour exacerbates this issue, as many lack the necessary training for specialized tasks. A study found that unskilled labour has a significant negative impact on project performance during the construction phase (5).

The lack of professional machinery operators also poses a significant challenge to construction productivity. Inexperienced workers require more time to operate essential equipment such as excavators, cranes, and loaders, resulting in slower task execution and frequent equipment breakdowns. Poor handling of machinery increases the risk of accidents, leading to additional work stoppages and safety concerns. Due to inefficiencies in machine operation, more manual labour is often required, increasing workforce demands and operational costs

(17). Additionally, skilled operators are in high demand and often leave for better-paying projects, causing workforce instability.

These issues reduce the total amount of work completed, as tasks take longer to complete and more resources are required to compensate for inefficiencies. To mitigate these problems, construction companies must implement more effective weather-planning strategies, invest in skill-development programs for machinery operators, and improve site management practices to enhance overall productivity (5).

4. Conclusion and Recommendation

This study highlights the complexities of labour productivity in the construction sector, particularly in external infrastructure projects in Malaysia (11). It emphasizes the importance of collecting direct data on labour inputs, productivity rates, equipment utilization, and material use to identify inefficiencies and optimize construction processes (4). The findings reveal that while challenges such as adverse weather conditions, site-specific constraints, and varying levels of labour experience persist, targeted research into productivity can lead to significant advancements in efficiency, quality, and competitiveness within the industry.

The construction and maintenance of infrastructure, including roadworks, drainage systems, and sewerage systems, are governed by established standards such as the JKR Standard Specification for Road Works (12), JKR Drainage Manual (13), and the Sewerage Services Act 1993 (14). These guidelines ensure that safety, durability, and environmental considerations are integral to project execution. Despite facing challenges, skilled labour, experience, and favourable weather conditions have positively influenced work progress across roadworks, drainage and sewerage activities. However, disruptions caused by heavy rainfall have significantly affected productivity, especially in tasks like pipe installations and concrete work, underscoring the critical impact of weather on construction projects.

The data collected underscores the necessity of understanding productivity patterns in activities such as drainage, sewerage, and roadwork construction. With productivity rates ranging from 15 m^2/day to 50 meters/day, the study highlights the interplay between external factors like weather and site conditions and internal factors such as labour expertise and equipment availability in shaping overall productivity outcomes. These insights are essential for driving improvements and fostering resilience in the construction industry.

To enhance productivity rates in construction works, several recommendations aim to address challenges and improve efficiency. Consistent and accurate data collection methods, including real-time tracking of labour input, productivity, and material usage, are essential, with advanced analytics tools aiding in identifying inefficiencies. Weather conditions, particularly heavy rainfall, significantly impact productivity; thus, weather-resilient planning and scheduling, including buffer periods and adaptive processes, should be prioritized.

Workforce allocation can be optimized by deploying the appropriate mix of skilled and unskilled labour, coupled with targeted training to upskilled workers, leveraging their varied experience levels. Addressing site traffic and access issues through organized material handling, storage optimization, and reduced congestion will further minimize delays. Fostering a culture of continuous improvement by integrating lean construction principles, encouraging worker feedback, and eliminating inefficiencies will drive long-term gains. Lastly, establishing baseline productivity measures, setting performance targets, and benchmarking against industry standards will provide actionable insights for focused improvements.

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Conflict of Interest

The authors declare that there is no conflict of interest regarding the publication of the paper.

Author Contribution

The authors are responsible for the study conception, research design, data collection, data analysis, result interpretation and manuscript drafting.

Appendix A: Data Summary October 2024

Appendix A *Table data summary October 2024*

Category	Drainage
Activity Type	Laying mid-steel pipes, adjusting U drainage.
Average Productivity	29 units/day.
Maximum recorded Productivity	35 m/day under laying concrete pipes.
Labour Force	Skilled workers with 7–18 years of experience.

Appendix B: Data Summary October 2024

Appendix B *Table data summary November 2024*

Category	Drainage	Sewerage	Roadwork
Activity Type	Laying mid-steel pipes, adjusting U drainage.	Adjusting sewerage pipes.	Repairing telecom pipes, stocking materials like Crusher Run.
Average Productivity	28 units/day.	15 units/day.	21 units/day.
Maximum Productivity	35 unit/day under favorable conditions.	Consistent output of 5 units/day, regardless of weather.	14 m^2/day for repairing telecom pipes.
Labour Force	Skilled workers with 7–20 years of experience.	Skilled workers with 5–15 years of experience.	Skilled workers with 3–15 years of experience.

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