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# Productivity Assessment in Roofing and Wall Painting Works Using Direct Observation Methods at Construction Site

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**Abstract**

The productivity of the construction industry is influenced by factors such as labour management, worker welfare, and coordination. However, challenges like inadequate training and poor resource allocation can hinder productivity, especially in tasks like roofing and wall painting. This study investigates worker productivity at two sites, RTM Building and Gapam Mosque in Melaka, focusing on roofing (914.2 $m^2$ and 136 $m^2$) and wall painting works (2560.7 $m^2$ and 1015 $m^2$). Using direct observation over two months, the study recorded average productivity rates of 40.88 $m^2$/h for roofing and 18.65 $m^2$/h for wall painting. Roofing showed higher productivity due to simpler material application and less detailed work. Factors such as task delays, insufficient resources, and uneven labour distribution were identified as key productivity barriers. By addressing these challenges and optimizing skilled labour, the study highlights ways to improve productivity and enhance construction project outcomes.

## 1. Introduction

The Malaysian construction industry is a cornerstone of the nation's economic growth, significantly contributing to the Gross Domestic Product and driving job creation across various sectors [10]. From the towering skyscrapers that pierce the skyline to the intricate network of roads, bridges, and railways that connect communities, the industry's impact is undeniable. It is more than just building; it is about creating the foundation for a thriving nation. However, a significant challenge facing the Malaysian construction industry is low productivity [1]. This translates to projects taking longer than anticipated, leading to cost over runs and impacting the overall efficiency of the construction process. Inadequate planning, such as insufficiently detailed schedules and resource allocation, can result in delays and unexpected setbacks. Factors such as inadequate planning, inefficient work practices, and a lack of skilled labour contribute to these productivity issues [6]. Moreover, a shortage of skilled labour with the necessary expertise in areas like construction technology and project management can hinder the efficient execution of projects. These factors collectively lead to performance that is less than optimal, impacting the industry's ability to meet deadlines and deliver projects within budget.

Productivity in the construction sector holds significant importance, influencing project costs, timelines, and overall success. Efficient processes and effective resource management minimize cost overruns, delays, and poor workmanship. Common challenges in Malaysia, such as labour shortages and inconsistent quality, often lead to inefficiencies and rework, increasing project expenses [42]. Timely completion of construction projects is essential for maintaining schedules and controlling costs. Poor planning and execution, identified as primary causes of delays which disrupt project timelines and escalate financial burdens. Enhanced productivity ensures projects stay on schedule and achieve better outcomes.

Using the observation method approach, the work study improves the way tasks are carried out and identifies the ineffective time associated with various operations using work measurement tools. This study applies the observation method to study the productivity of roofing works and wall painting works at two different sites: RTM Building, Melaka, and Gapam Mosque, Melaka. By employing the observation method, data on worker activities, such as time spent on productive and non-productive tasks, are systematically collected to evaluate the workforce's efficiency. Unlike other methods such as time study, which uses a stopwatch to directly measure task durations, the observation method provides a broader perspective by focusing on real-time work conditions, worker interactions, and site-specific challenges. For example, roofing work productivity at the RTM Building involves a smaller but more skilled workforce, while at Gapam Mosque, the larger workforce includes a significant proportion of general workers, impacting productivity differently. Similarly, for wall painting, factors such as worker availability, equipment setup time, and sequencing of tasks relative to other construction activities influence the outcomes.

This study utilizes the observation method to identify inefficiencies and provide recommendations for enhancing productivity in roofing and wall painting works. By analyzing worker allocation, site management practices, and work sequencing at the RTM Building and Gapam Mosque in Melaka, the study offers insights into optimizing labour deployment and addressing site-specific challenges to improve overall efficiency and outcomes.

## 2. Measurement of Productivity

In this study, productivity is measured by looking at the entire workforce as a single group, instead of separating different types of workers like masons or electricians. Construction projects have many workers, but this approach does not track individual or specific job productivity. Therefore, the results and suggestions might not apply to every type of worker. Labour productivity is a critical measure that reflects the efficiency of labour in producing goods or services. Various factors influence labour productivity, making it a multifaceted quantitative index [15]. Labour productivity can be measured in different ways, such as by comparing the reduction of produced capital to labour, which provides a comprehensive view by considering both factor allocation efficiency and technological levels [20].

Traditionally, worker productivity was a simple equation: output divided by input. In construction, this translates to the amount of work completed (output) compared to the time spent working (input). The total number of work units completed by a worker is then divided by the total labour hours to arrive at a more comprehensive productivity measure. The equation for labour productivity can be expressed as:

$$Productivity = \frac{Number\ of\ Units}{Total\ Worker - Hour} \tag{1}$$

This equation provides a basic yet essential measure of productivity, helping to evaluate the efficiency of labour in construction tasks. The relationship between labour and capital is fundamental in understanding productivity dynamics. For instance, the constant marginal share production function highlights that labour productivity increases with capital per unit of labour but at a decreasing rate [14].

Using project milestones to gauge productivity is another widely used technique. Project milestones are set at the outset by construction managers and other administrative staff of the general contractor and must be fulfilled by certain dates. Staff meetings are held at the conclusion of a predetermined time span (one or two weeks) to discuss the completion percentage of the milestones and to review the work progress. In those sessions, the general work progress plan is evaluated, and the productivity of the project as a whole is determined by looking at the percentages of tasks that are completed, typically with the use of project planning software. Despite being easy to follow, the milestone method does not provide any outcomes that could help defining the root of a possible productivity loss.

In conclusion, measuring and determining labour productivity are require a multifaceted approach that considers factors like capital-labour dynamics, technological levels, and efficiency constraints. By addressing these aspects, organizations and policymakers can gather productivity levels and drive sustainable economic growth.

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## 3. Interpreting Work using Observation Method

In construction, ensuring worker productivity is crucial for project success and efficiency. Monitoring worker activities can be effectively achieved through the direct observation method, which involves systematically recording worker activities in real-time. Unlike continuous observation methods, which can be labour-intensive and disruptive, the direct observation approach provides a practical way to collect accurate data without interfering with workflow.

The first step in applying the direct observation method is to define the specific tasks to be monitored. Sanders and Maloney (2007) emphasize the importance of identifying all relevant construction activities, such as roofing and wall painting to ensure comprehensive data collection. This step establishes the framework for understanding worker productivity across different task [47].

Next, determining the observation schedule is critical to capturing representative data. This involves setting fixed intervals during which observations are made throughout the workday. Unlike random intervals used in work sampling, fixed observation intervals in the direct method ensure consistency and simplify data collection while still providing an accurate snapshot of worker activities. During the observation periods, the observer records the type and duration of activities performed by workers, focusing on tasks such as roofing and wall painting [45]. Observations are conducted discreetly to minimize any potential influence on worker behaviour. The collected data provides detailed insights into productivity levels and highlights inefficiencies or delays in specific construction tasks. The direct observation method offers a practical and efficient way to measure productivity in real time, enabling construction managers to gather actionable data for improving task planning and resource allocation. This approach aligns with the goal of enhancing efficiency and quality in construction projects.

By referring the equation 1 (pages 2) it explains how productivity can be measured by dividing the number of units produced by the total worker-hours spent. It provides a simple yet effective way to assess the efficiency of workers on a construction site. By calculating the ratio of output (number of units, such as roofing or painting completed) to input (total worker-hours), it allows managers to understand how much work is being done for each hour of labour. This metric helps in evaluating workforce performance, identifying areas for improvement, and optimizing resource allocation to enhance overall productivity on the project. According to the Construction Industry Development Board (CIDB), this equation represents the latest standard for measuring productivity in the Malaysian construction industry, reflecting its relevance and importance in current practices.

**Table 1** *Works monitoring form for roofing and wall painting*

| Site | Date | Resources | | | Quantity ($m^2$) |
|---|---|---|---|---|---|
| | | Manpower | ($m^2$) | Material | |
| RTM Building | | Skill Worker | | | |
| | | General Woker | | | |
| | | Skill Worker | | | |
| | | General Woker | | | |
| Gapam Mosque | | Skill Worker | | | |
| | | General Woker | | | |
| | | Skill Worker | | | |
| | | General Woker | | | |

Table 1 presents a 'Works Monitoring Form for Roofing and Wall Painting.' This form is a tool for tracking and analyzing the progress and productivity of wall painting projects at different sites, in this case, 'RTM Building' and 'Gapam Mosque'. By consistently recording data in this table, project managers can gain valuable insights into various aspects of the wall painting work. For instance, the 'Manpower' section, which differentiates between 'Skilled Workers' and 'General Workers,' helps monitor labour utilization and identify potential skill gaps. Similarly, the 'Resources' and 'Material' columns provide information about the area being worked on and the materials used, enabling cost and resource management. In addition to wall painting, this table will also be used to measure productivity for roofing works, as the structure of the form allows for flexibility in documenting and analyzing data across different types of external works. This table is referenced from the Builder Construction Authority and serves as a key reference for ensuring proper project documentation and productivity tracking in construction [8].

## 3.1 Data Collection

Data collection is a fundamental aspect of any study, providing the empirical basis for analysis, interpretation, and conclusions. In the field of construction management, this study on worker productivity on construction sites will employ the direct observation method to measure and collect data on worker productivity. Data collection is a crucial component of the study methodology, involving systematic observation and recording of worker activities to gather numerical data for statistical analysis. This section will discuss the data collection process, focusing on the steps and rationale behind using the direct observation method.

## 3.2 Data Analysis

Data analysis was conducted using Microsoft Excel to ensure accuracy and efficiency in processing the collected data. Data from the observations were compiled in table form, as shown in Table 3.4, which summarizes the daily work activities and outcomes. The analysis focused specifically on working days and productivity values, providing a clear assessment of worker performance. This approach aligns with the observation method and direct method, as the data was obtained through real-time observations at construction sites.

The analysis was performed based on average productivity values to identify overall performance trends. Additionally, a line graph was generated using Excel to provide a clear visualization of productivity patterns over time. This graphical representation allowed for easier identification of fluctuations and insights into key factors affecting productivity, ensuring a more comprehensive understanding of the results.

## 4. Information from Selected Construction Sites

This study focuses on two construction sites: the RTM Building and Gapam Mosque, Ayer Keroh in Malacca. The RTM Building, a public infrastructure project, primarily involved repair work. The main tasks included replacing the old and deteriorated roof and repainting the walls, which had become faded over time. On the other hand, the Gapam Mosque project required complete demolition and rebuilding with a new design. However, for this study, data collection focused specifically on roofing and wall painting works to align with the study objectives.

For the roofing works, the area recorded at the RTM Building was 914.2 $m^2$, while at the Gapam Mosque, it was 136 $m^2$. Similarly, for wall painting works, the area recorded at the RTM Building was 2560.7 $m^2$, compared to 1015 $m^2$ at the Gapam Mosque. Data collection spanned two months, during which the area and duration of work completed by both skilled and general workers were systematically recorded. This data was gathered using direct observation to accurately assess worker productivity for these specific tasks.

## 4.1 Findings for Objective 1: Work Volume Analysis

In this section, the work volume for both roofing and painting works is analyzed to provide an overview of the tasks completed at the respective sites. The findings are based on the area covered, the number of workers involved, and the duration of work for each task. This analysis aims to provide a clearer picture of the workload at both the RTM Building and Gapam Mosque sites, setting the foundation for further evaluation of productivity in subsequent sections. The following subsections will present the work volume analysis for roofing works (4.1.1) and painting works (4.1.2).

### 4.1.1 Work Volume Analysis for Roofing Works

This section focuses on understanding the allocation of resources, including the number of skilled and general workers, as well as the area covered over several days at RTM Building and Gapam Mosque site. By evaluating the relationship between manpower and the area worked on, insights can be gained into the efficiency and productivity of the roofing process at both sites. The analysis will help identify factors that may have influenced the progress and performance of the roofing works. Table 2 below shows the data recorded which involves manpower and the area covered for roofing works.

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**Table 2** *Daily roofing work data for RTM building and Gapam mosque*

| Site | Day | Resources | | | | Quantity |
|---|---|---|---|---|---|---|
| | | Manpower | | | | ($m^2$) |
| RTM Building | 1 | Skill Worker | 3 | General Worker | 1 | 463 |
| | 2 | Skill Worker | 3 | General Worker | 1 | 262.2 |
| | 3 | Skill Worker | 3 | General Worker | 1 | 125 |
| Gapam Mosque | 1 | Skill Worker | 2 | General Worker | 5 | 35.6 |
| | 2 | Skill Worker | 2 | General Worker | 5 | 70.72 |
| | 3 | Skill Worker | 2 | General Worker | 3 | 29.56 |

In the roofing works at the RTM Building, a total area of 914.2 $m^2$ was covered over four days. On Day 1, a team of four workers, consisting of three skilled workers and one general worker, installed the roof for an area of 463 $m^2$ in 6 hours. On Day 2, the same team of workers covered 262.2 $m^2$, and followed by 125 $m^2$ on Day 3. The project at RTM Building involved consistent workforce allocation throughout the period, with the number of workers remaining the same each day, though the area worked on decreased as the project neared completion.

For the Gapam Mosque project, the total area worked on was 135.88 $m^2$, and the roofing work was completed in three days. On Day 1, a team of two skilled workers and five general workers covered an area of 35.6 $m^2$. On Day 2, the same team of workers increased the coverage to 70.72 $m^2$. On the final day, Day 3, the workforce decreased from seven workers to five, as the area of work became smaller, and fewer workers were needed to complete the task. The area covered on Day 3 was 29.56 $m^2$.

In summary, while both projects followed a similar pattern of work, the RTM Building had a larger area to cover, resulting in a steady workforce allocation throughout the project. In contrast, the Gapam Mosque project had a reduction in the workforce towards the end, as the area to be covered decreased. Although the RTM Building site had fewer workers compared to the Gapam Mosque site, the higher number of skilled workers at RTM contributed to better productivity. The team at RTM, with three skilled workers and one general worker, was more efficient in completing the roofing work. In contrast, the Gapam Mosque site, with seven workers but only two skilled workers, experienced slower progress. The limited number of skilled workers and the cramped workspace at Gapam Mosque hindered efficiency. Unlike RTM, which had a larger and more accessible area, the smaller space at Gapam Mosque made roofing installation more difficult and time-consuming.

### 4.1.2 Work Volume Analysis for Wall Painting Works

This section focuses on understanding the allocation of resources, including the number of skilled and general workers, as well as the area covered over several days at RTM Building and Gapam Mosque site. By evaluating the relationship between manpower and the area worked on, insights can be gained into the efficiency and productivity of the wall painting process at both sites. The analysis will help identify factors that may have influenced the progress and performance of the wall painting works. Table 3 below shows the data recorded which involves manpower and the area covered for wall painting works.

**Table 3** *Daily wall painting work data for RTM Building and Gapam mosque*

| Site | Day | Resources | | | | Quantity |
|---|---|---|---|---|---|---|
| | | Manpower | | | | ($m^2$) |
| RTM Buildings | 1 | Skill Worker | 1 | General Worker | 1 | 76.5 |
| | 2 | Skill Worker | 1 | General Worker | 1 | 79 |
| | 3 | Skill Worker | 1 | General Worker | 1 | 127.8 |
| | 4 | Skill Worker | 1 | General Worker | 1 | 122.5 |
| | 5 | Skill Worker | 1 | General Worker | 1 | 139.8 |
| | 6 | Skill Worker | 1 | General Worker | 1 | 142.8 |
| | 7 | Skill Worker | 1 | General Worker | 1 | 109.5 |
| | 8 | Skill Worker | 1 | General Worker | 1 | 127 |
| | 9 | Skill Worker | 1 | General Worker | 1 | 76.5 |
| | 10 | Skill Worker | 1 | General Worker | 1 | 77 |

| Site | Day | Resources | | | | Quantity |
|---|---|---|---|---|---|---|
| | | Manpower | | | | ($m^2$) |
| | 11 | Skill Worker | 1 | General Worker | 1 | 127.8 |
| | 12 | Skill Worker | 1 | General Worker | 1 | 122.54 |
| | 13 | Skill Worker | 1 | General Worker | 1 | 128.4 |
| | 14 | Skill Worker | 1 | General Worker | 1 | 76.5 |
| | 15 | Skill Worker | 1 | General Worker | 1 | 127.8 |
| | 16 | Skill Worker | 1 | General Worker | 1 | 77 |
| | 17 | Skill Worker | 1 | General Worker | 1 | 122.54 |
| | 18 | Skill Worker | 1 | General Worker | 1 | 128.4 |
| | 19 | Skill Worker | 1 | General Worker | 1 | 63 |
| | 20 | Skill Worker | 1 | General Worker | 1 | 75 |
| | 21 | Skill Worker | 1 | General Worker | 1 | 109.5 |
| | 22 | Skill Worker | 1 | General Worker | 1 | 127 |
| | 23 | Skill Worker | 1 | General Worker | 1 | 142.8 |
| | 24 | Skill Worker | 1 | General Worker | 1 | 54 |
| Gapam Mosque | 1 | Skill Worker | 1 | General Worker | 1 | 16 |
| | 2 | Skill Worker | 1 | General Worker | 1 | 112.2 |
| | 3 | Skill Worker | 1 | General Worker | 1 | 150.55 |
| | 4 | Skill Worker | 1 | General Worker | 1 | 79.3 |
| | 5 | Skill Worker | 1 | General Worker | 1 | 80.74 |
| | 6 | Skill Worker | 1 | General Worker | 1 | 123.6 |
| | 7 | Skill Worker | 1 | General Worker | 1 | 108.74 |
| | 8 | Skill Worker | 1 | General Worker | 1 | 101.6 |
| | 9 | Skill Worker | 1 | General Worker | 1 | 56.8 |
| | 10 | Skill Worker | 1 | General Worker | 1 | 132.54 |
| | 11 | Skill Worker | 1 | General Worker | 1 | 25.95 |
| | 12 | Skill Worker | 1 | General Worker | 1 | 26.95 |

The work volume analysis for wall painting works at the RTM Building and Gapam Mosque highlights notable differences in terms of total area covered, manpower allocation, and daily progress. At the RTM Building, a total of 2,560.7 $m^2$ was painted over 24 days. Each day involved a team of two workers: one skilled worker and one general worker. The daily area painted ranged between 54 $m^2$ and 142.8 $m^2$, with an average daily progress of approximately 106.7 $m^2$. The consistent manpower and steady progress suggest efficient resource allocation and favourable working conditions at the RTM site.

In comparison, the Gapam Mosque project involved painting a smaller total area of 1,015 $m^2$ over 12 days, with the same manpower structure as the RTM Building. The daily area painted ranged between 16 $m^2$ and 150.55 $m^2$, with an average daily progress of approximately 84.58 $m^2$. Although the team size remained the same, the productivity at Gapam Mosque was slightly lower. This could be attributed to the site's conditions, such as limited working space or additional complexities in painting smaller or more intricate areas. The significant difference in total areas painted which is 2,560.7 $m^2$ at the RTM Building versus 1,015 $m^2$ at Gapam Mosque also reflects the varying scope and scale of the two projects. The larger area at the RTM site, combined with consistent output, indicates a well-organized workflow and effective worker performance. In contrast, the smaller total area and fluctuating daily progress at Gapam Mosque suggest possible challenges in maintaining steady productivity, potentially due to site-specific limitations or the nature of the tasks required.

Overall, the analysis demonstrates how project size, site conditions, and resource allocation influence the work volume and productivity of wall painting works across the two sites.

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### 4.2 Findings for Objective 2: Productivity Measurement

To assess the productivity of workers in roofing and wall painting works, a detailed observation was conducted at the RTM Building and Gapam Mosque sites. The following analysis presents the productivity levels for both roofing and wall painting works, highlighting the differences and identifying key factors influencing worker performance at each site.

#### 4.2.1 Productivity Analysis of Roofing Works

To understand the productivity of roofing works, a graph has been created based on the recorded data, as shown in Figure 1. The graph shows how productivity changed over the working days, making it easier to see the progress and efficiency of the roofing tasks. The data includes the area of roofing completed by both skilled and general workers and the time it took them to finish. By analyzing this graph, we can spot patterns, assess worker performance, and gain insights into what factors might be affecting productivity during the metal deck roof installations.

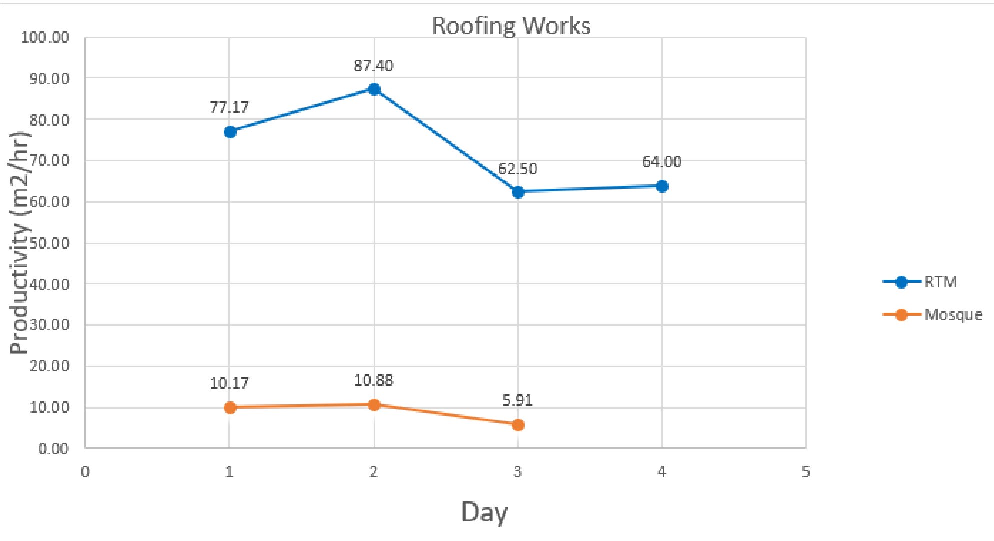


**Fig. 1** *Productivity of roofing works at selected construction sites*

The graph shows that the RTM site had much higher productivity compared to the mosque site. On Day 1, the RTM site started strong with a productivity rate of 77.17 $m^2$/hr, indicating a smooth and efficient workflow. This improved further on Day 2, reaching 87.40 $m^2$/hr, likely due to good teamwork and sufficient resources. However, things took a turn on Day 3, with productivity dropping to 62.50 $m^2$/hr, possibly due to challenges like material shortages or bad weather. By Day 4, there was a slight recovery to 64.00 $m^2$/hr, which suggests that some adjustments, like better planning or resource allocation, were made. Even so, productivity never returned to the peak level achieved on Day 2.

The mosque site, on the other hand, struggled with much lower productivity. On Day 1, productivity was just 10.17 $m^2$/hr, far below the RTM site's performance. There was a small improvement on Day 2, rising to 10.88 $m^2$/hr, but it wasn't enough to show real progress. By Day 3, productivity had dropped to 5.91 $m^2$/hr, pointing to significant challenges. The lower productivity at the mosque site was mainly due to less experienced workers and limited space, which made the job harder and took longer to finish. These issues caused delays, even though the roofing area at the mosque site was smaller than at the RTM site. The detailed data collected for the roofing works can be found in the appendix.

#### 4.2.2 Productivity Analysis of Roofing Works

Productivity in wall painting works is another key factor in assessing the efficiency of construction activities. To understand the productivity of wall painting works, a graph has been created based on the recorded data, as shown in Figure 2. The graph shows how productivity changed over the working days, providing a clear view of the progress and efficiency of the painting tasks. The data includes the area painted by both skilled and general workers and the time taken to complete the work. By analysing this graph, we can identify trends, evaluate worker performance, and gain insights into the factors that might be influencing productivity during the wall painting process.

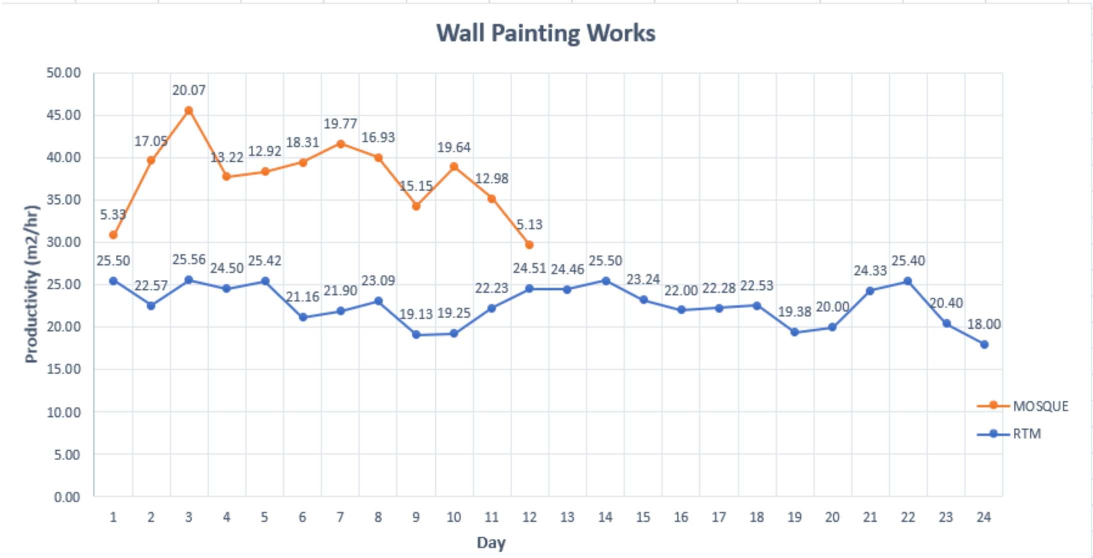


**Fig. 2** *Productivity of wall painting works at selected construction sites*

The provided graph illustrates the productivity of wall painting works at two construction sites, the RTM building and the Gapam Mosque, over a 24-day period. Productivity is measured in square meters per hour (m2/hr). Both sites handled by the team of one skilled worker and one general worker. The RTM building had a total painting area of 2560.7 $m^2$, while Gapam Mosque covered 1015 $m^2$. Differences in scale and site conditions influenced productivity at each location, which will be analysed through daily and weekly trends.

Overall, the graph reveals distinct productivity trends at both sites. The RTM building demonstrates a more consistent pattern with some fluctuations throughout the 24 days. A general downward trend is observed, interspersed with periods of increased productivity. In contrast, the Gapam Mosque exhibits greater variability in productivity, characterized by several peaks and troughs, suggesting that factors affecting productivity at the Mosque are more dynamic.

For the first week of a 24-day data collection period, the RTM building initially exhibited a productivity of 25.50 m2/hr, which gradually declined throughout the week with a slight increase on the final day. In contrast, the Gapam Mosque began with lower productivity (5.33 m2/hr) but demonstrated a significant increase on day 2, reaching a peak on day 3 before gradually declining. The data from the first week highlights several factors that may have influenced productivity at both sites, including differences in crew experience, the complexity of the work, material availability, and weather conditions. At the mosque site, productivity on the first day was much lower than expected. This was primarily due to delays in starting the painting work, as preparatory tasks had to be completed first tasks that were not initially accounted for in the data collection. As a result, the productivity recorded on the first day does not fully represent the workers' actual performance during the painting activity.

Next, for the second week on day 8 to day 14, the RTM building's workers maintained a steady pace throughout the week, starting strong and continuing at a consistent speed. This steady progress was likely due to their ability to focus solely on painting tasks without being interrupted by other activities. In contrast, productivity at the mosque site showed more fluctuations. The workers started off well but experienced a slight slowdown midweek before picking up speed again. It can see from the data above, which shows from 16.93 m2/hr going down to 15.15 m2/hr and rise up to 19.64 m2/hr. However, towards the end of the week, productivity dropped significantly. This was because the remaining areas to paint were smaller, which naturally reduced the pace of work. Since the mosque site was smaller than the RTM building, the painting work there was completed earlier, finishing by the 12th day.

For the third week which shows data from day 15 to day 21, the productivity was initially high on Day 15 and remained steady on the following two days. However, a notable decrease in productivity occurred on Day 18, followed by a further reduction on Day 19. The graph shows a slight dip in how much wall painting work was done at the RTM building on day 18 and day 19. This likely happened because of light rain in the morning on those days, which probably meant the painters had to start a bit later, giving them less time to paint. Also, it seems the crew decided to finish up some smaller touch-up jobs before moving on to painting larger areas. While this was important to do, it might have slowed down their overall progress for those days. Productivity slightly improved on Day 20 and then significantly increased on Day 21, reaching the peak productivity level for this period.

For the last week data recorded, the graph shows how fast the wall painting work went at the RTM building over three days, from Day 22 to Day 24. On day 22, the workers were quite productive, covering an impressive 25.40 m2/hr. However, productivity dropped to 20.40 m2/hr on day 23 and further decreased to 18.00 m2/hr on day 24. This decline in productivity can be attributed to the diminishing scope of painting work. As the project progressed, the workers likely had fewer and fewer large areas to cover. By day 23 and day 24, they may have primarily focused on touch-up work and minor details, which naturally requires less time and effort compared to painting large surfaces. These shift in focus from large-scale painting to smaller touch-up tasks would explain the observed decrease in productivity. To get a better understanding of what caused this slowdown, it would be helpful to look at how fast they painted on previous days, keep track of things like the weather and any delays, and even talk to the workers themselves to see what they think might have slowed them down.

## 5. Conclusion and Recommendation

This study successfully assessed the productivity of roofing works and wall painting works at the RTM Building and Gapam Mosque in Melaka, revealing average productivity rates of 40.88 $m^2$/hour for roofing works and 18.65 $m^2$/hour for wall painting works. The findings highlighted that higher productivity in roofing works was achieved at the RTM Building due to a greater proportion of skilled workers and fewer site constraints, while the Gapam Mosque faced challenges such as limited space, fewer skilled workers, and logistical issues. To improve productivity, several recommendations are proposed: for roofing works at the RTM Building, improving project planning, communication, and material transportation contingency plans is essential, while at the Gapam Mosque, increasing the number of skilled workers and enforcing stricter supervision would enhance discipline and work quality. For wall painting works, increasing manpower and optimizing scaffolding use at the RTM Building would enhance efficiency, while improving scheduling and coordination at the Gapam Mosque, including aligning painting tasks with other construction work and allocating specific time slots, would minimize delays and maximize productivity. Implementing these measures would significantly optimize productivity in future construction projects.

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## Conflict of Interest

Authors declare that there is no conflict of interests 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.*

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