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## COMPARATIVE ANALYSIS OF LABOUR PLASTERING TIME ON LABOUR PRODUCTIVITY WITH WORK SAMPLING METHOD

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### Abstract

This study aims to analyze the level of productivity and Labour Utilisation Rate (LUR) in plastering work using the Work Sampling method and evaluate the effectiveness of work time utilization between 08.00 am - 12.00 pm and 13.00 pm - 17.00 pm . Data collection was conducted through direct field observation over three working days. The study's results indicate that the highest productivity was 14.30 m<sup>2</sup>/hour during the 13.00 pm - 17.00 pm , while the lowest productivity was 6.86 m<sup>2</sup>/hour during the 08.00 am - 12.00 pm . The Labour Utilisation Rate (LUR) during the 08.00 am - 12.00 pm and 13.00 pm - 17.00 pm was 57.9% and 65.9%, respectively, indicating that the 13.00 pm - 17.00 pm was more effective than the 08.00 am - 12.00 pm . There was a significant difference between the two time periods. This was due to more contribution time in the 08.00 am - 12.00 pm than in the 13.00 pm - 17.00 pm . Overall, the plastering work could still be categorized as effective, as indicated by the average Labour Utilisation Rate (LUR) of 61.9%, which exceeded the minimum effectiveness threshold of 50%..

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**Keywords:** Productivity, Work Sampling, Labour Utilisation Rate, plastering

## Introduction

Productivity typically refers to the connection between the results achieved and the resources utilised during the production (Ali, 2019; Indriani et al., 2023; Pawiro et al., 2015). Productivity is a key problem to be solved in the development sector that directly impacts project success (Shehata & El-Gohary, 2011). According to Olomolaiye et al. (1998), productivity factors differ across countries and regions. Jarkas et al. (2016) revealed that Oman faces major challenges in the construction industry due to low Labour productivity. This also applies to Indonesia, where construction Labour productivity is affected by labourforce management, skill development, material and equipment optimisation, and efficient coordination (Anditiaman et al., 2020). Understanding the factors that affect productivity is crucial to improving labour efficiency and ensuring success in overall infrastructure development.

In the face of these challenges, improving the skills and labour efficiency of the labourforce is a key parameter in improving the competitiveness of the construction industry. Labour is an influencing parameter in productivity measurement (Aswed, 2016; Elizar et al., 2020; Ghoddousi et al., 2017). Building awareness and commitment to the importance of Labour productivity is the first step in improving project efficiency (Montaser et al., 2018). Joshi & Shrestha (2019), and Lawaju et al. (2021) confirmed that engineering, material, and environmental factors have a major role in determining Labour productivity. Material is a parameter that greatly affects productivity. One example is the delay of materials when labour is about to begin, which causes labours to be unable to carry out their duties, resulting in decreased productivity (Ballesteros-perez et al., 2018; Durdyev & Mbachu, 2018; Hernandi & Tamtana, 2020). Increased productivity reduces construction costs, minimises relabour, and improves operational efficiency (Hwang et al., 2017). Boughaba & Bouabaz (2020) and Nabil et al. (2023) stated that the rate of Labour productivity is indirectly a parameter that determines the success or failure of the project. The lower the level of productivity, the greater the likelihood of delays in labour; conversely, the higher the productivity, the smaller the risk of delays (Dharsono & Hindun, 2024; Muchdarsyah, 2003; Prasetyo et al., 2017).

The amount of labour completed and achievements are the main indicators in assessing productivity (Bamayi et al., 2022). Various methods measure labour productivity, but these measurements are difficult to do accurately (Andi Andi et al., 2004; Yanti, 2017). Work Sampling assesses Labour productivity (Firman Kresna & Dewita H, 2016). The methodology employed in this study involves the direct acquisition of field data, which enhances the reliability and accuracy of labour productivity measurements (Taufan, 2018). Work Sampling allows the identification and reduction of non-productive activities to increase labour efficiency (Diniaty & Febriadi, 2015). Work Sampling can be divided into three approaches: field rating, productivity rating, and 5-minute rating (Oglesby et al., 1989). This study uses productivity rating, classifying Labour activities into effective, contributory, and ineffective labour. Research with this method has been done before, such as by Muslim et al. (2019), Bagaskara & Triana (2024) and Dharsono & Hindun (2024), which resulted in a LUR value of more than 50%.

LUR produces a value of productivity and the level of effectiveness of Labour, which is processed into a Labour coefficient value (Azzam et al., 2019; Baharin et al., 2020; Buraida, 2012; Kevin et al., 2019). The magnitude of the LUR value can be used to determine how effective or productive Labour is in a project (Ashad et al., 2020). Frequent differences in the LUR at any time are caused by not fulfilling the right Labour, so the results are not optimal. Several factors, such as labour skills, weather, and labour experience, influence the lack of optimisation of labourforce quality (Durdyev et al., 2018; Oktavio et al., 2020). Factors such as education and health levels also affect Labour productivity (Baharin et al., 2020). According to Jusmidah (2016) and Norjana & Zulfiati (2020), labouring time is a factor that contributes to differences in the LUR because there are significant differences in labour patterns between 07.00 am – 12.00 pm and 13.00 pm -

17.00 pm. This condition can affect labour productivity therefore, an effective workforce management strategy is essential to optimize productivity and minimize variations in the LUR.

Construction project labour is divided into structural, architectural, and utility building components (Aghazadeh et al., 2019; Hwang et al., 2017). Architectural labour is divided into several main components: walls and partitions, ceilings, floors, roofs, and finishing and coating.

This study focuses on finishing labour, namely plastering, which is an important part and is almost always present in every construction activity. Plastering labour directly affects the aesthetic quality and surface protection of buildings. Therefore, this labour requires high productivity so that the implementation time and quality of labour can be optimised (Pascoal et al., 2017). Therefore, this study is important to determine labour productivity in plastering, thereby serving as a basis for more efficient human resource planning and control efforts in construction projects. Measurement of Labour productivity in plastering labour has been previously studied by Yuneta et al. (2024), Suharto & Sulistio (2020), Ferdatama Gama Bagaskara & Budi Priyanto (2023). This study aims to analyze the level of productivity and LUR in plastering labour by applying the Work Sampling method. In addition, this research also compared the effectiveness of labouring time between 07.00 am – 12.00 pm and 13.00 pm -17.00 pm on the 5th floor of the University Of Bengkulu Hospital Construction Project.

## Research Methods

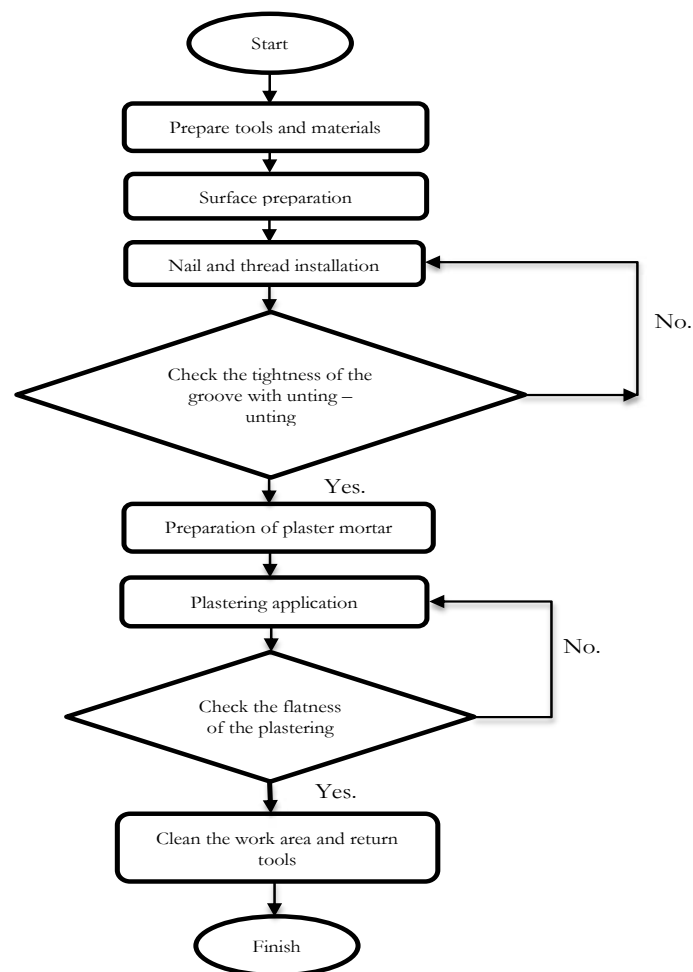


Figure 1. Stages of plastering labour

As illustrated in Figure 1, the stages of plastering work consist of a series of sequential processes that outline the workflow of laborers in completing wall plastering tasks in a systematic manner. This study adopts a quantitative approach utilising direct observation techniques conducted over three consecutive days in the field. The selection of this three day observation period is justified by the repetitive and consistent nature of the observed work activities, which showed no substantial variation in either type or execution method across the days. Accordingly, a three-day duration was considered adequate to capture representative patterns of labor productivity while minimizing the collection of redundant data. This duration was chosen because it was a regular working day that was not affected by disruptions, such as the first day of work, which may be slow due to re-planning, or the last day of the working week, which may be affected by a decrease in motivation or the completion of weekly targets, which is sufficient to represent natural variations in labour productivity during one week. Observations were conducted in two time sessions 07.00 am – 12.00 pm and 13.00 pm -17.00 pm. Three workers assigned to plastering tasks were observed. Observations were made using the work sampling method with a productivity rating approach, where labour activities were classified into effective, contributory and ineffective labour (Muslim et al., 2019). The data used in this research is primary data, namely, the volume of plastering labour used to calculate the productivity value and the number of effective, contributing, and ineffective labours, which are summed up based on their classification. The total value of each plastering labour is used to calculate the LUR carried out on the Bengkulu University Teaching Hospital Project. The stages of plastering labour can be seen in Figure 1.

### **Data Collection**

Data for the University Of Bengkulu Teaching Hospital Project was collected using quantitative descriptive methods through direct observation in the field. This method was chosen because the data came from the ongoing activities of workers, enabling valid and accurate data to be obtained. The observations aimed to collect information on the volume of plastering work carried out and categorize the types of plastering activities into three groups: effective, contributive, and ineffective.

### **Data Analysis**

#### **Productivity**

Individual labour productivity, also referred to as partial productivity, represents the efficiency of a single input type within the production process (Yanti, 2017). In general, labour productivity is defined as the quantity of output (goods or services) produced by a labour within a specific unit of time, such as per hour, day, month, or year (Simanjuntak, 2005). In the context of construction activities, particularly plastering labour, productivity is typically measured by the area completed by a labour within a given time frame. In this case, the output is measured in units of area (m<sup>2</sup>), while the input is represented by the total person hours expended to complete the task. Labour productivity in this context can be calculated using the following formula:

$$P = \frac{O}{I}$$

Information :

- P = Productivity (m<sup>2</sup>/minute)
- O = Output (m<sup>2</sup>)
- I = Input (minute)

### Work Sampling

A Work Sampling method, combined with a productivity rating approach, can be utilised to measure labour productivity in construction projects. In this method, labours activities are categorised into three types: effective, essential contributory, and ineffective. Upon completion of the observation period, the number of labours engaged in each category of activity is recorded in order to calculate labour effectiveness using the LUR approach. The LUR can be determined using the formula proposed by Oglesby et al. (1989), which is as follows :

$$LUR = \frac{\text{effective work} + \frac{1}{4} \text{ contributory work}}{\text{total observation}} \times 100\%$$

### Research Results and Discussion

The overall recapitulation is obtained by calculating productivity in units of m<sup>2</sup>/hour. The results of productivity on plastering labour for 3 days are presented in Table 1.

Table 1. Recapitulation of Plastering Labour Productivity

Day	Time	Duration (Hour)	Number of Plasterer	Area (m <sup>2</sup> )	Productivity (m <sup>2</sup> /jam)	Average (m <sup>2</sup> /jam)
1	08.00 am – 12.00 pm	4	3	24.57	6.14	6.86
2		4	3	29.74	7.44	
3		4	3	27.96	6.99	
1	13.00 pm – 17.00 pm	4	3	56.07	14.02	14.30
2		4	3	65.27	16.32	
3		4	3	50.31	12.58	

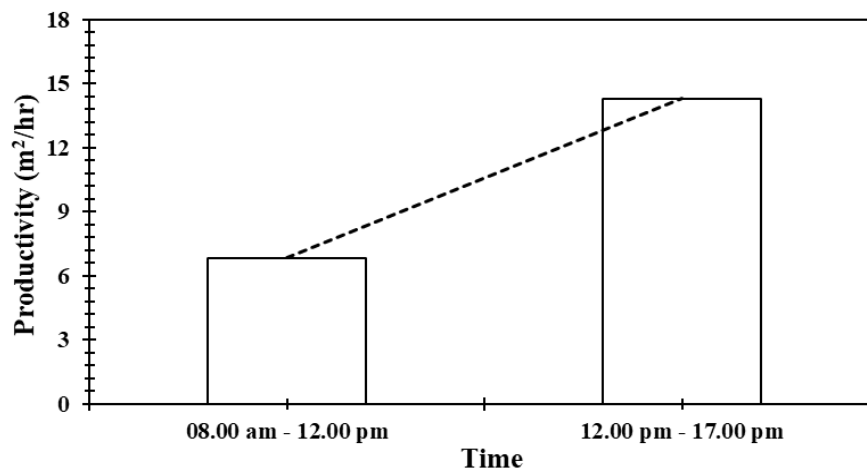


Figure 2. Productivity Value of Plastering Labour

The productivity of plastering labour varies due to various factors, such as rework, environmental conditions, and a lack of materials and labour skills, which can lead to considerable variations in output levels (Agbo et al., 2022). In a study by (Kharmale & Biswas, 2015) the productivity value for deep plastering work was recorded at 1,90 m<sup>2</sup>/hour. This study analyzed labour productivity by dividing working hours into two time intervals, 08.00 am –12.00 pm and 13.00 am –17.00 pm, the findings revealed that productivity levels were consistently higher during the second interval than during the first. This discrepancy is likely because preparatory tasks were

concentrated earlier, reducing adequate working time compared to the latter interval, where core construction activities were already underway, and the workflow had become more stable. In Figure 2, labour productivity was recorded at 14.30 m<sup>2</sup>/hour during the 08.00 am –12.00 pm, compared to only 6.86 m<sup>2</sup>/hour in the 08.00 am –12.00 pm and 13.00 am –17.00 pm. This indicates a considerable variation between the two time periods. Low productivity is generally associated with disruptions or inefficiencies during the execution of work. In construction projects, productivity is typically assessed based on the range of random variations in daily output when the project is well managed. This range is bounded by the Upper Control Limit (UCL) and Lower Control Limit (LCL), which serve as indicators of process stability and effective control throughout the project implementation.

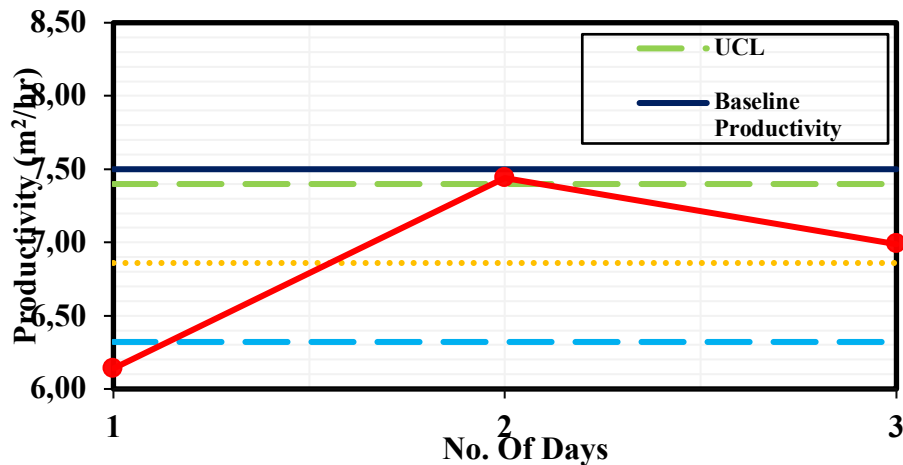


Figure 3. Variability in daily cumulative productivity rates of plastering ( 08.00 am - 12.00 pm )

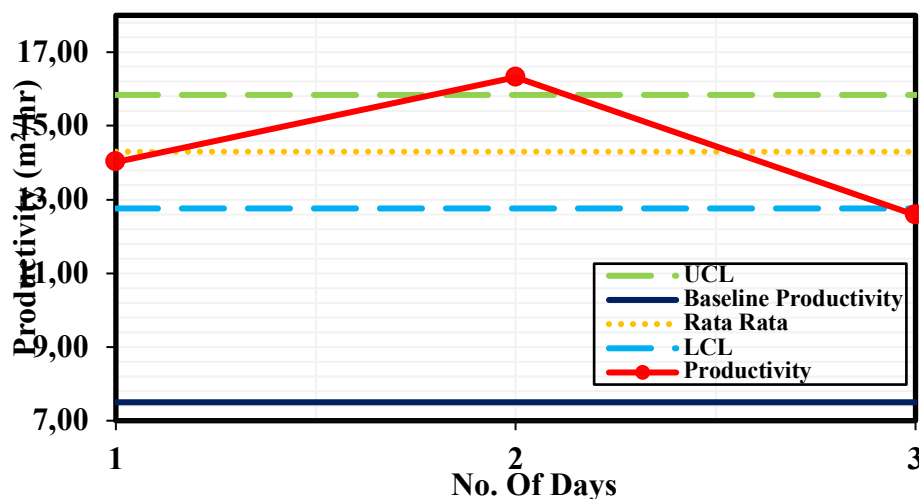


Figure 4. Variability in daily cumulative productivity rates of plastering ( 13.00 pm - 17.00 pm )

Figure 3 shows the variability of labour productivity over three consecutive 08.00 am - 12.00 pm : 6.14 m<sup>2</sup>/hour, 7.44 m<sup>2</sup>/hour, and 6.99 m<sup>2</sup>/hour. All productivity values are still within the calculated control limits an upper control limit of 7.40 m<sup>2</sup>/hour and a lower control limit of 6.32 m<sup>2</sup>/hour). However, it should be noted that on the first day, the productivity value was close to the lower control limit, which could indicate potential inefficiency or disruption to the 08.00 am - 12.00 pm work process. Figure 4 shows the variability of worker productivity during the day over three consecutive days: 14.02 m<sup>2</sup>/hour, 16.32 m<sup>2</sup>/hour, and 12.58 m<sup>2</sup>/hour. The calculated control

limits are 15.84 m<sup>2</sup>/hour for the upper control limit and 12.76 m<sup>2</sup>/hour for the lower control limit. All productivity values remain within the established control limits. However, it should be noted that on the third day, the productivity value was close to the LCL, which may indicate potential inefficiency or obstacles in the 08.00 am - 12.00 pm work process. The observed productivity metrics all lie within their respective statistical control limits albeit at the extremities of those bounds thereby demonstrating that the underlying work process is statistically stable and remains under control (Montgomery, 2022). However, it should be noted that the productivity values of the first 08.00 am - 12.00 pm were very close to the lower control limit, indicating potential inefficiencies at the start of work. These observations highlight the importance of quantifying disruptions to understand their impact on project performance. In this case, the Disruption Index and Performance Ratio are useful metrics for identifying inefficiencies in project activities and providing an overview of the project's overall effectiveness.

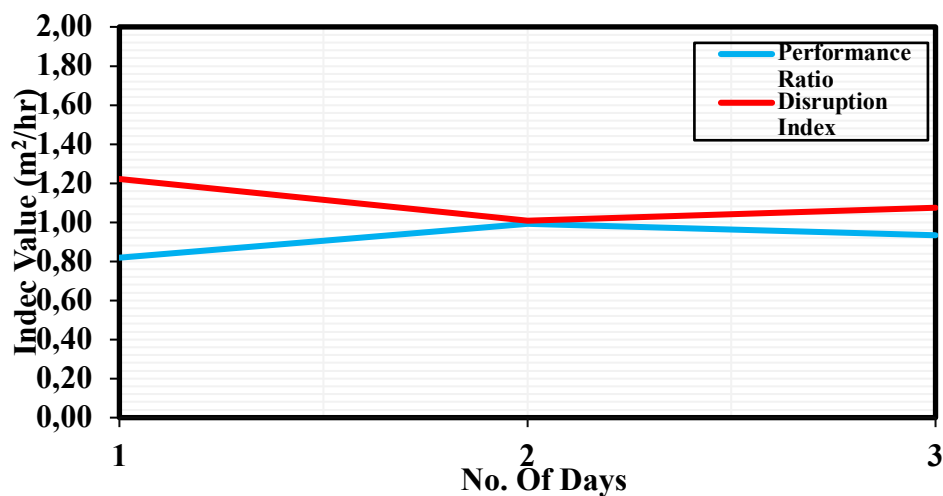


Figure 4. Disruption Index and Performance Ratio values at Time ( 08.00 am - 12.00 pm)

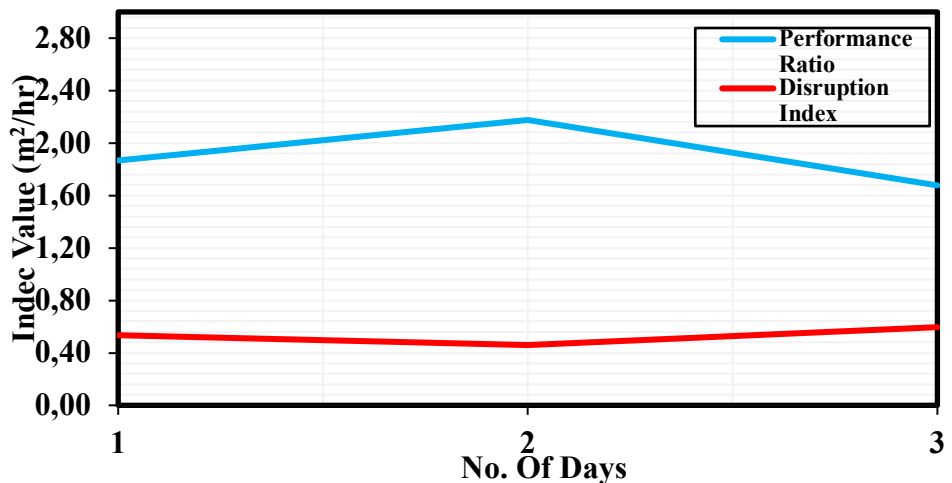


Figure 5. Disruption Index and Performance Ratio values at Time ( 13.00 pm - 17.00 pm)

Figure 4 and 5 show the Disruption Index and Performance Index values, where the Disruption Index values range from 0 to 1.00 (Thomas & Napolitan, 1995). A higher Disruption Index (DI) value indicates that more projects experienced disruptions in abnormal working days or inefficient work activities (Kharmale & Biswas, 2015). This indicates significant obstacles in project implementation that can affect schedules, quality, and costs. Conversely, the Performance Ratio (PR) is an indicator used to measure the efficiency of project implementation against targets

or plans (Olomolaiye et al., 1998). A lower PR indicates better project performance, as the project can be completed more efficiently than its planning (Kharmale & Biswas, 2015). Thus, a low PR (close to 0) indicates that the project is progressing according to the target or even better than planned. Figure 4 displays the DI values over three consecutive days, namely 1.22, 1.01, and 1.07. Therefore, a DI value exceeding 1.00 indicates that work activities are inefficient. Meanwhile, the PR values over the three consecutive days were 0.82, 0.99, and 0.93. A lower PR value indicates that project performance is better, as the project can be completed more efficiently than the plan. Figure 5 shows the DI values over three consecutive days, which were 0.53, 0.46, and 0.60. Therefore, a DI value below 1.00 or lower indicates that work activities are running efficiently. Meanwhile, the performance ratio values for the three consecutive days were 1.87, 2.18, and 1.68. A high PR value indicates that much of the work is ineffective. Therefore, it is necessary to evaluate effective, contributing, and ineffective time through direct observation during the first two work sessions of the day.

Table 2. Results of Recapitulation Data Collection (08.00 - 12.00)

Day	Plasterer A			Plasterer B			Plasterer C			Total		
	Effective (Minute)	Contribution (Minute)	Ineffective (Minute)	Effective (Minute)	Contribution (Minute)	Ineffective (Minute)	Effective (Minute)	Contribution (Minute)	Ineffective (Minute)	Effective (Minute)	Contribution (Minute)	Ineffective (Minute)
1	113	104	23	86	147	7	95	107	38	294	358	68
2	131	104	5	140	88	12	101	113	26	372	305	43
3	129	91	20	120	95	25	94	114	32	343	300	77

Table 3. Results of Recapitulation Data Collection (13.00 - 17.00)

Day	Plasterer A			Plasterer B			Plasterer C			Total		
	Effective (Minute)	Contribution (Minute)	Ineffective (Minute)	Effective (Minute)	Contribution (Minute)	Ineffective (Minute)	Effective (Minute)	Contribution (Minute)	Ineffective (Minute)	Effective (Minute)	Contribution (Minute)	Ineffective (Minute)
1	162	70	8	159	35	33	96	111	31	432	216	72
2	205	16	19	172	48	33	98	114	30	460	178	82
3	146	66	28	127	81	32	93	120	27	366	267	87

Tables 2 and 3 summarise the results of the direct observations conducted in the 07.00 am – 12.00 pm and 13.00 pm -17.00 pm. These observations were classified into three categories: effective, contributory, and ineffective. Table 2 shows the duration of activities based on these categories over three consecutive 08.00 am - 12.00 pm. On the first day, 294 minutes were spent on effective work, 358 minutes on contributory work, and 68 minutes on ineffective work. On the second day, the durations recorded for each category were 372 minutes for practical work, 305 minutes for contributory work, and 43 minutes for ineffective work. On the third day, the respective durations were 343 minutes, 300 minutes, and 77 minutes, table 5 displays activity duration data based on job categories over three 13.00 pm - 17.00 pm s. On the first day, 432 minutes were spent on effective work, 216 minutes on contribution work, and 72 minutes on ineffective work. The second day saw each category record 460 minutes for practical work, 178 minutes for contribution work, and 82 minutes for ineffective work. On the third day, meanwhile, the time spent on practical work was 366 minutes, on contribution work 267 minutes, and on ineffective work 87 minutes. It can be seen from the observation days that the number of ineffective work hours was higher during the day, causing the Disruption Index to increase. This indicates that more projects experienced disruptions in the form of abnormal working days or work activities that ran inefficiently and were not smooth. The analysis shows that the highest labour productivity was recorded during the 13.00 pm - 17.00 pm session on the second day. This optimal performance was mainly due to the absence of preparatory tasks, such as cleaning the site and arranging the workspace, which had been completed in the 08.00 am - 12.00 pm. As a result, workers could immediately engage in core plastering activities without delay. Gerek et al., (2016) stated that plastering work groups with higher experience levels tend to show more optimal work

efficiency than groups with medium or low experience. Based on the summary table according to 08.00 am –12.00 pm and 13.00 am –17.00 pm, there are differences, so a comparison of times is needed to determine which is more productive.

Based on the observation time recapitulation results presented in Tables 2 and 3, a LUR analysis was conducted to evaluate the productivity level of plasterers. This analysis aims to identify the period during which workers perform at their best. The LUR calculation results are presented in Tables 4 and 5, which show observation data for two time intervals: (08.00 am –12.00 pm) and 13.00 pm - 17.00 pm (13.00 pm –17.00 pm)

Table 4. Based on Data Collection (08.00 - 12.00)

Activity Type	Number Of Observations	Proportion (%)	Total (%)	LUR (%)
<i>Effective</i>	336	46.7	46.7	57.9
<i>Contributory</i>	321	44.6	91.3	
<i>Ineffective</i>	63	8.7	100	
Total	720	100		

Table 5. Based on Data Collection (13.00 - 17.00)

Activity Type	Number Of Observations	Proportion (%)	Total (%)	LUR (%)
<i>Effective</i>	419	58.2	58.2	65.9
<i>Contributory</i>	220	30.6	88.8	
<i>Ineffective</i>	80	11.2	100	
Total	720	100		

Table 4 contains data from observations conducted in the 08.00 am - 12.00 pm session. Of the total 720 observations, 336 activities (46.7%) were categorized as practical activities, 321 activities (44.6%) as contributive activities, and 63 activities (8.7%) as ineffective activities. Based on the proportion of practical activities to total productive activities effective and contributive, the LUR value was 57.9%. These results indicate that over half of the workers' productive activities in the 08.00 am - 12.00 pm session directly contributed to completing their work. In contrast, Table 5 presents observation data for the 13.00 pm - 17.00 pm session, which shows an increase in the proportion of practical activities to 419 activities (58.2%). Contributive activities decreased to 220 activities (30.6%), while ineffective activities experienced a slight increase to 80 activities (11.2%). Despite an increase in ineffective activity, LUR in the 13.00 pm - 17.00 pm session increased significantly to 65.9%, indicating that labour efficiency in completing core tasks tended to be higher during this period. This condition occurred because, at that time, the workers could directly carry out their core work, namely plastering, without having to do preparatory work such as cleaning the land or arranging the work area. These preparatory activities are completed in the 08.00 am - 12.00 pm, allowing the entire 13.00 pm - 17.00 pm to be fully utilised for effective work. The more productive labouring time is determined by comparing the proportion of activities classified as effective, ineffective, and contributing in the 07.00 am – 12.00 pm and 13.00 pm -17.00 pm observation times. This comparison aims to identify the most productive labouring time based on labour activities performed during the labour process. Figure 6 compares the proportion of each activity category, which can be used to evaluate working time efficiency and identify factors affecting labour.

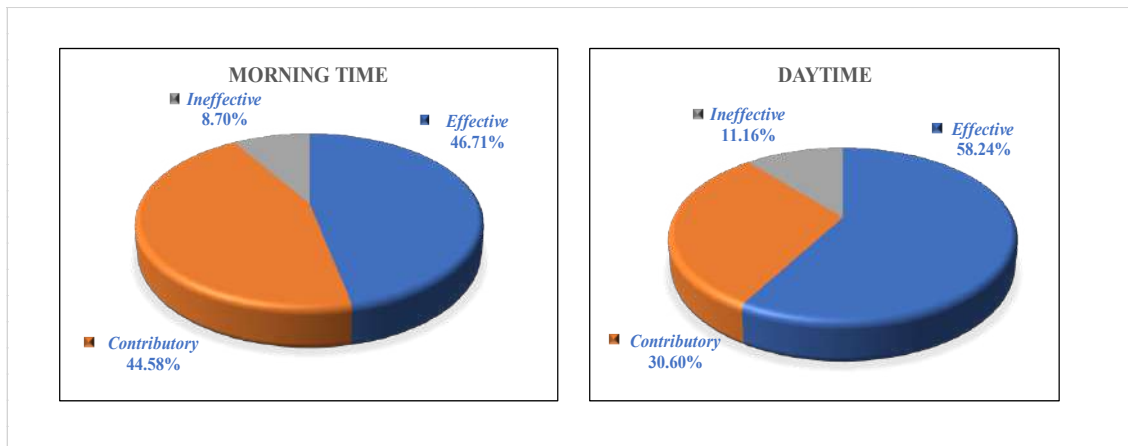


Figure 6. Comparative Relationship of Proportions and Types of Activities by Time Observations

The lower productivity in the 08.00 am - 12.00 pm is due to the relatively balanced proportion between contribution and effective activities, so that the time allocated for the main work is more limited. This condition directly impacts the greater LUR value in the 13.00 pm - 17.00 pm , where the workforce can focus more on completing the main work without being distracted by preparatory work or contribution work that is dominant in the 08.00 am - 12.00 pm.

The results of this study are in line with the research of Norjana & Zulfiati, (2020), which resulted in a greater productivity value during the day compared to the 08.00 am - 12.00 pm. The difference in productivity based on working time is studied to determine a more optimal labour pattern to improve labour efficiency in construction projects. By classifying parameters in the form of work activities into productive, contributive, or non-productive, as well as measuring worker duration and additional parameters, such as output per hour. Table 6 presents an overall recapitulation of the plastering labour, as well as detailed data proportions, which are shown in Figure 7.

Table 6. Based on Observation Time Total

Activity Type	Number Of Observations	Proportion (%)	Total (%)	LUR (%)
<i>Effective</i>	756	52.5	52.5	61.9
<i>Contributory</i>	541	37.6	90.1	
<i>Ineffective</i>	143	9.9	100	
Total	1440	100		

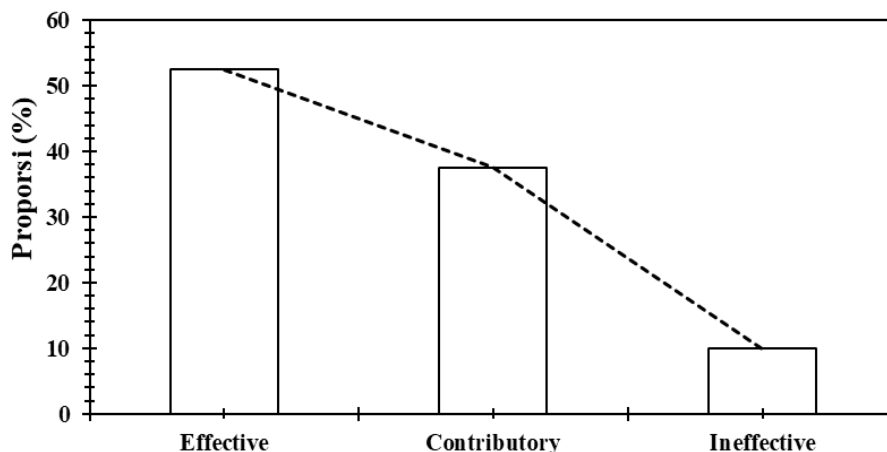


Figure 7. Proportion and Types of Effective, Contributory and Ineffective Activities

Based on the results of the overall calculation, the percentage level of effectiveness of plastering labour shows that Labour spends 52.5% of the total labouring time in the practical category, 37.6% in the contributing category, and 9.9% in the ineffective category. Thus, based on the Labour Utilisation Rate (LUR) value obtained, which is 61.9%, although there is a significant difference between productivity in the 07.00 am – 12.00 pm and 13.00 pm -17.00 pm, indicating that the overall Labour productivity remains effective, as evidenced by an LUR exceeding 50% (Oglesby et al., 1989). The existence of a project management unit in the form of construction worker training can minimize ineffective activities, which are expected to improve the quality and managerial skills and perfect the skills of workers. Regular training programs can enrich the skills and experience of construction workers in real terms, in addition to providing awards or bonuses, which can also improve the competence and abilities of construction workers to increase labour productivity (Van Tam, 2024). The implications of this research suggest that implementing structured training and incentive programs within construction projects significantly reduces unproductive time and enhances labour efficiency. Furthermore, these findings can be utilized by project managers and policymakers to develop labour management strategies that focus on continuous skill development and motivation, ultimately contributing to more sustainable and effective construction project outcome.

### Conclusion

The analysis and discussion of labour productivity results indicate that the value of plastering work varies. The highest value was recorded on the second 13.00 am - 17.00 pm, at 16.32 m<sup>2</sup>/hour, while the lowest was recorded on the first 08.00 am – 12.00 pm at 6.14 m<sup>2</sup>/hour. The Work Sampling Method shows that the Labour Utilisation Rate (LUR) is 61.9%. Comparing the LUR for 08.00 am – 12.00 pm and 13.00 pm -17.00 pm work shows that the LUR is higher in the 13.00 pm - 17.00 pm, at 65.9% than in the 08.00 am - 12.00 pm, at 57.9%. This study observed that the amount of work contributing to the 08.00 am - 12.00 pm differed from that of the 13.00 pm - 17.00 pm, which could reduce productivity values. Therefore, a project management unit consisting of training and incentives was implemented to enhance skills and avoid inappropriate work. As a result, the construction team can utilize time more efficiently and minimize work delays by achieving optimal productivity values.

The study is limited by its focus on a specific task (plastering work) and the restricted observation period to standard working hours. External factors such as worker fatigue, weather conditions, and site-specific challenges were not explored in depth. Further research should consider a broader range of construction activities and extend the observation period. Additionally, evaluating the long-term impact of training programmes and incentives on workforce productivity

could provide a more comprehensive understanding of sustainable workforce optimisation strategies.

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