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Comparison Of Installation Wages for Granite Tiles in Large and Small Spaces Using the Method Productivity Delay Model

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ABSTRAK: Kinerja tenaga kerja merupakan faktor utama dalam penyelesaian proyek konstruksi. Pekerjaan pemasangan granite tile di area sempit lebih menghadirkan tantangan tersendiri akibat banyaknya potongan yang tidak dapat dimanfaatkan secara optimal, sehingga meningkatkan biaya melebihi RAB proyek. Penelitian ini menganalisis kinerja tenaga kerja dalam pemasangan granite tile pada area sempit dan luas, yang berdampak pada efisiensi biaya proyek konstruksi. Pekerjaan di area sempit lebih kompleks karena banyaknya potongan yang tidak dapat dimanfaatkan secara optimal, sehingga realisasi biaya sering melebihi RAB. Studi ini bertujuan menentukan koefisien tukang pasang serta membandingkan harga satuan upah pada kedua kondisi tersebut. Observasi lapangan dilakukan dengan metode MPDM untuk mengukur produktivitas pekerja, termasuk waktu penundaan dalam siklus kerja. Penelitian ini bersifat kuantitatif dengan studi pada proyek hotel yang memasang granite tile berukuran 40 × 40 cm. Hasilnya menunjukkan bahwa koefisien tenaga kerja untuk pemasangan di area luas adalah 0,124, sedangkan di area sempit 0,136. Biaya upah pemasangan di area luas tercatat Rp 44.400 per m², sementara di area sempit Rp 45.864 per m². Penelitian ini memberikan kontribusi praktis dalam perencanaan anggaran upah dan teknis dalam penyusunan analisis harga satuan pekerjaan untuk meningkatkan efisiensi proyek konstruksi.

Kata Kunci: *Produktivitas; MPDM; Granite Tile*

ABSTRACT: Labor performance is a key factor in the completion of construction projects. The installation of granite tiles in confined areas presents unique challenges due to the high number of unusable tile cuts, which can increase costs beyond the project's budget plan (RAB). This study analyzes labor performance in granite tile installation across narrow and spacious areas, focusing on its impact on construction cost efficiency. Work in confined areas is more complex due to excessive cutting waste, often resulting in actual costs exceeding the planned budget. The study aims to determine the labor coefficient and compare the unit labor costs between the two working conditions. Field observations were carried out using the MPDM to measure worker productivity, including delay time in each work cycle. This quantitative research was conducted on a hotel project that used 40 × 40 cm granite tiles. The results showed that the labor coefficient for tile installation in spacious areas was 0.124, while in confined areas it was 0.136. The labor cost per square meter was recorded at Rp 44,400 in spacious areas and Rp 45,864 in confined areas. This study provides practical contributions to labor cost planning and technical insights for preparing unit price analysis to improve efficiency in construction projects.

Keyword: *Productivity; MPDM; Granite Tile*

I. INTRODUCTION

In construction project execution, labor is one of the most critical elements influencing project success in terms of quality, time efficiency, and cost-effectiveness. A key indicator for evaluating labor performance is productivity, which is defined as the ability to utilize resources effectively and efficiently to achieve work targets [1]. With the growing awareness of the importance of human resources in organizational success, labor is now considered a strategic asset that significantly contributes to the achievement of project goals [2].

Labor productivity is influenced by a variety of factors, including the type of work, working environment conditions, as well as individual skills and experience. In construction projects, especially during the interior finishing phase, space characteristics and technical complexities often become major challenges that affect job difficulty. The workforce's ability to adapt and manage resources effectively

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plays a crucial role in overcoming these challenges. Therefore, a comprehensive understanding of actual on-site conditions is essential for enhancing efficiency and minimizing waste.

In practice, tasks such as ceramic or granite tile installation frequently encounter technical difficulties, particularly in confined spaces. Limited room dimensions often increase the number of unusable material cuts, resulting in more waste and longer completion times. These factors directly impact productivity and may lead to labor costs exceeding the project's estimated budget (Bill of Quantity)[3].

Previous studies have shown that restricted space and the complexity of interior work can significantly reduce work efficiency [4]. In addition, managerial factors and on-site conditions also play a crucial role in influencing labor performance [5]. In the context of interior work, especially in floor covering installation such as granite tiles, narrow workspaces hinder worker mobility, limit the use of supporting tools, and increase the likelihood of human error. These cumulative effects can lead to reduced daily productivity and greater material wastage, ultimately affecting overall project efficiency.

However, there remains a gap in research that specifically compares worker productivity in granite tile installation between spacious and confined areas using a quantitative approach such as the Method Productivity Delay Model (MPDM). MPDM is a productivity analysis method that takes into account effective working time and delays caused by factors such as labor, work environment, tools and equipment, management, and material availability.

In light of this background, this study aims to measure productivity and determine the labor coefficient for granite tile installation in both large and small spaces using the MPDM method. It also seeks to compare the unit labor wage costs in these two conditions to offer practical contributions toward optimizing project budgets and improving implementation efficiency—ensuring that projects are completed with better outcomes in alignment with planned schedules and cost estimates.

II. THEORETICAL BASIS

Construction Project Management

Construction project management is the process of planning, organizing, executing, and controlling resources to achieve project objectives efficiently and effectively. The success of a construction project largely depends on the coordination of labor, materials, equipment, and the working methods employed. Each stage of the project—from planning to completion—requires a systematic approach to optimize time, cost, and work quality [6].

Project management involves several phases, including initiation, planning, execution, monitoring and control, and project closure. The initial step in this process involves formulating the project concept, which includes identifying problems or opportunities that need to be addressed. In the planning stage, objectives are set, schedules are developed, budgets are calculated, and resources are allocated to meet the desired outcomes. During the execution phase, the project plan is implemented by engaging the project team and coordinating assigned tasks. Subsequently, monitoring and control are conducted to ensure that the project stays on track and to address any issues that arise during implementation [7].

Labor Performance in Construction Projects

Performance is a critical aspect that must be understood and communicated to relevant stakeholders in order to evaluate the extent to which an institution has achieved its goals, in alignment with its organizational vision. It also serves to identify both the positive and negative impacts of operational policies [8]. In construction, labor performance is a key factor that influences both the efficiency and effectiveness of a project. High performance directly contributes to labor productivity, particularly in completing tasks accurately and on time.

Labor productivity is a measure of how efficiently a specific output is produced by utilizing available resources optimally. In the context of construction, it refers to the ratio between the amount of work completed and the time and effort expended. Productivity is affected by various factors, including the skills and experience of the workers, their physical condition, and environmental factors such as material availability, equipment, and project management quality [9]. High productivity reflects effective labor utilization that results in timely and cost-efficient project completion. On the other hand, low productivity may indicate inefficiencies in the work system, such as delays, poor coordination, or limited access to necessary tools and equipment, all of which can hinder workflow [4].

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In the installation of building materials such as granite tiles, labor productivity is influenced by internal factors (such as skills, experience, and physical condition) as well as external factors (including the work environment, tools, and spatial conditions) [10]. In construction projects, labor productivity is typically evaluated by comparing output to input, accounting for both effective working time and delays [11].

Granite Tile Installation in Construction

Granite tile is a widely used flooring material in construction projects due to its high durability and aesthetic appeal [12]. The installation process involves surface preparation, measurement, cutting, placement, and final finishing steps such as grouting and cleaning. In confined spaces, the complexity of installation increases due to a higher frequency of unusable tile cuts, which leads to extended working times and increased labor costs [13].

***Method Productivity Delay Model* (MPDM)**

The MPDM is an analytical framework used to assess labor productivity in construction projects by providing a detailed breakdown of working time [9]. MPDM categorizes work time into three primary components: direct work (effective working time), supportive work (indirect time), and delay time. Through this method, labor productivity is evaluated based on the ratio between effective working time and the total time spent within a work cycle.

This model is particularly useful for identifying the root causes of delays in construction activities, which may stem from either internal factors—such as worker skills and equipment reliability—or external factors—such as environmental conditions and material availability. MPDM is also frequently applied to evaluate labor efficiency and to devise strategies aimed at optimizing workforce productivity at the project site [14].

The MPDM framework segments labor time into the following categories:

1. Effective working time – the actual time spent directly completing the primary task.
2. Supportive or non-productive time – time not directly used for task completion but still necessary, such as tool and material preparation.
3. Delay time – lost time due to external disruptions like material shortages, unclear work instructions, or site conditions [14].

By using MPDM, construction managers can conduct a more thorough analysis of labor efficiency and systematically identify the factors that contribute to reduced productivity [15].

Labor Coefficient in Cost Analysis

The labor coefficient refers to a quantitative measure indicating the number of workers required to complete a specific task within a certain unit of time or area. In construction cost estimation, this coefficient plays a critical role in developing the Bill of Quantities (BoQ) and optimizing resource allocation [16].

Differences in labor coefficients between installations in wide versus confined spaces can have a direct impact on unit labor costs per square meter. A higher labor coefficient reflects increased labor demand, which consequently drives up overall project labor expenses [17].

III. METHOD

This study adopts a quantitative approach, focusing on the analysis of measurable numerical data. The goal of this descriptive quantitative research is to provide an objective overview of the observed conditions through field observations and literature review, which together support well-grounded conclusions. A critical step in this process is determining the data sources to ensure that data collection methods align with research needs. This study utilizes two types of data: primary and secondary.

Primary data are obtained directly from the research subjects, either by the researcher or through collaboration with relevant personnel. In this study, primary data include work cycle time, delay duration, and worker profiles. Meanwhile, secondary data refer to pre-existing information used as supporting references, such as the project's Bill of Quantities (BoQ) and architectural drawings.

To collect data, several research instruments were employed:

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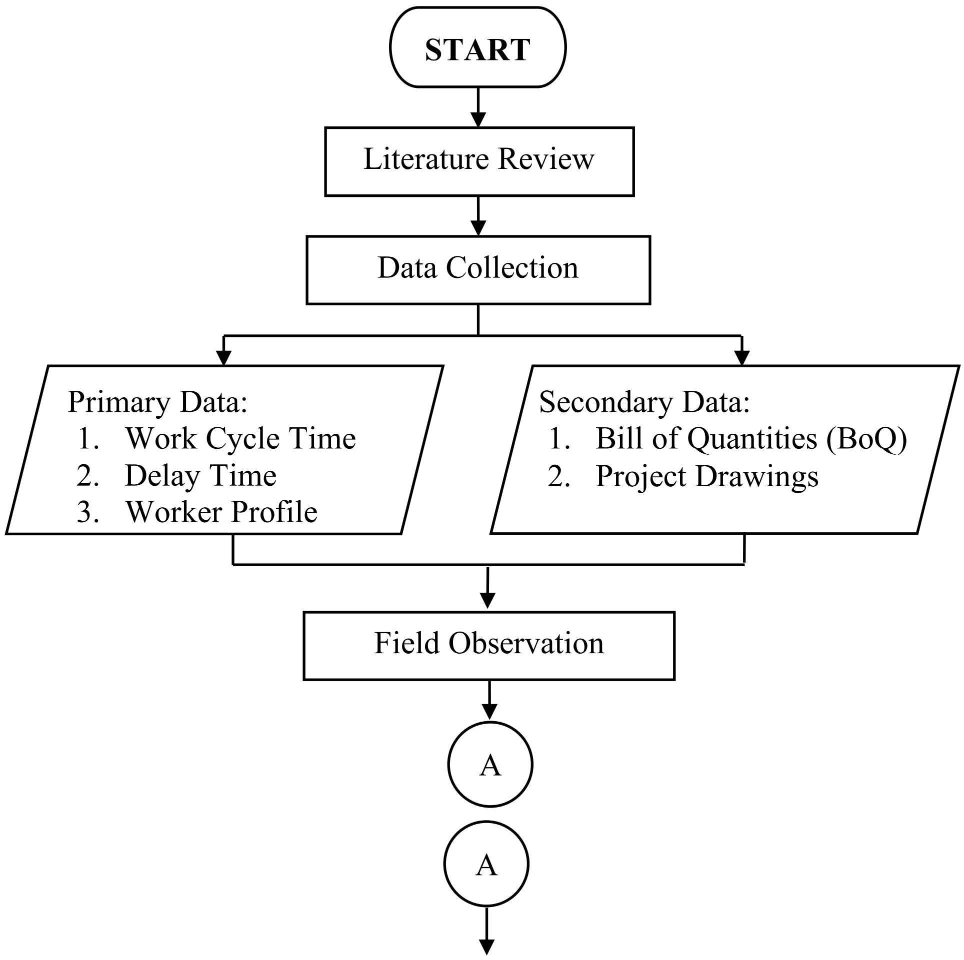
1. Observation – Researchers closely monitored the activities of workers during granite tile installation to record work cycle times.
2. Data Collection Sheets – Observation results, including work cycle times and delay durations, were recorded using standardized MPDM-based forms.
3. Interviews – Conducted with workers and foremen to gather background information and determine wage rates.

The main focus of this research is to analyze how the Productivity Delay Model (MPDM) influences labor productivity during granite tile installation and to calculate labor unit costs. The methodology involves the following steps:

1. Collecting secondary data such as shop drawings and unit cost analyses,
2. Conducting field observations to gather productivity data,
3. Analyzing labor productivity using the MPDM approach,
4. Determining labor coefficients, and
5. Comparing labor costs in large versus confined working areas.

MPDM is a tool designed to measure productivity levels in construction projects by evaluating work efficiency and identifying delays. This model classifies time into three categories—effective work time, supportive time, and delay time—and attributes delays to five core factors: labor, environment, equipment, management, and material availability.

By applying MPDM, project teams can gain a deeper understanding of the obstacles affecting labor efficiency. This approach supports more informed decision-making in project planning and management by highlighting specific areas that require improvement. Overall, MPDM is highly beneficial for construction projects that demand high levels of time and cost efficiency, offering practical insights for optimizing workforce performance and reducing unnecessary delays.



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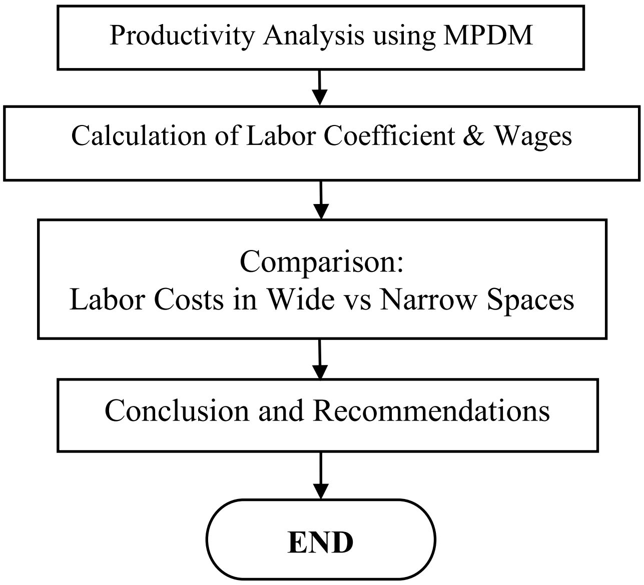

Figure 1. Research Flowchart

IV. DISCUSSION

This study was conducted in two distinct types of workspaces: wide areas with a total volume of 35 m², and narrow areas measuring 7 m² in total. To ensure consistency in measuring productivity, the unit of production for the granite tile installation was observed in increments of 5 m² for both categories. Each area was evaluated based on a single complete work cycle.

The study used three sample rooms from each category—wide and narrow spaces—employing the same worker across all tasks to maintain the validity of the results. The wide-area category included the Housekeeping Room, Lift Lobby, and Back Kitchen, while the narrow-area category consisted of the Janitor Room, Deposit Room, and Storage Room. The selection of three rooms per category was based on representational relevance and spatial limitations of the case study project, and was considered sufficient to reflect typical working conditions in both space types. This balanced sampling approach aimed to ensure a valid comparison between the two groups.

To reduce individual variability, all tasks were performed by the same worker, who exhibited consistent characteristics. The same tools and tile installation techniques were used throughout the study. Environmental factors—including lighting, supervision, and material availability—were also controlled and kept uniform across all locations, ensuring that the productivity data would accurately reflect the influence of spatial characteristics.

The worker involved in this study had similar attributes: 40 years of age, a high school education, and 15 years of relevant work experience. The material installed during the study was 40 × 40 cm granite tiles, which were applied using standard procedures in accordance with established construction practices.

Calculation of Production Cycles in Wide and Narrow Areas

In this study, detailed time recordings were conducted for each activity involved in the granite tile installation process across both wide and narrow workspaces. The analysis focused on one full work cycle for each type of space, with each cycle covering an area of 5 m². This measurement aimed to assess differences in installation duration and identify the factors influencing labor productivity under varying spatial conditions.

Observations were centered on a single worker (Worker 1), who carried out tasks across three different locations to capture a more representative dataset reflecting the variability of worksite conditions. Each stage of the task—from preparation, installation, to final touches—was documented systematically to evaluate work efficiency and uncover potential causes of delay.

The time calculations obtained for wide areas are presented in Table 1, which illustrates the distribution of work time within one installation cycle:

Table 1. Installation Time Calculation for Wide Area

Worker	Description	Area			Average (s)
		House Keeping	Lobby Lift	Back Kitchen	
1	Work Time (s)	16.289	19.706	18.662	18.219
	Delay	175	161	76	
	Total (s)	16.464	19.867	18.738	

From the data in Table 1, the average time required for tile installation in wide areas was recorded at 18,219 seconds. Comparatively, installation time in narrow areas shows a variation that can be seen in Table 2 below.

Table 2. Installation Time Calculation for Narrow Area

Worker	Description	Area			Average (s)
		Janitor Room	Deposit Room	Storage Room	
1	Work Time (s)	19.754	18.952	20.057	19.728
	Delay	147	158	116	
	Total (s)	19.901	19.110	20.173	

Based on Table 2, the average installation time in narrow areas was 19,728 seconds. During execution, delays were noted, primarily caused by management-related and human factors. Examples of management delays include waiting for mortar availability, while human delays involved workers engaging in conversations or taking smoking breaks. These delays were essential to account for in the productivity assessment.A breakdown of the delay times observed in both wide and narrow spaces is presented in the following tables:

Table 3. Delay in Production Cycle for Wide Area

Area	Work Time (s)	Human Delay (s)	Management Delay (s)	Keterangan
House Keeping	16.289	175	-	*delay*
Lobby Lift	19.706	161	-	*delay*
Back Kitchen	18.662	76	-	*delay*
Jumlah	54.657	**412**	**0**	**-**
Rata-rata	18.219	**58,86**	**-**	**-**

Data Processing for Worker 1: Granite Tile Installation in Wide Areas

1. Production Cycle Time

   The production cycle time refers to the total duration required by a worker to complete one full cycle of granite tile installation. This includes all stages of the task—from preparing tools and materials, performing the installation, to executing the final finishes. In this study, the average time recorded to complete one production cycle in wide areas was 18,219 seconds.
2. Production Delay

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Delays during the installation process were primarily attributed to labor and management-related factors. A common example of such delays is when workers pause the task to engage in casual conversation instead of continuing the job. Insufficient supervision and a lack of time discipline can significantly reduce labor productivity, ultimately affecting the overall efficiency of the project.

Table 4. Production Cycle Delay in Narrow Areas

Area	Production Time (s)	Management Delay (s)	Notes
Janitor Room	19.754	147	*delay*
Deposit Room	18.952	158	*delay*
Storage Room	20.057	116	*delay*
Total	58.763	**421**	**-**
Average	19.588	**140**	**-**

Based on Table 4, the average production time per cycle in narrow areas is 19,588 seconds, with an average delay caused by management factors of 140 seconds. These delays occurred consistently across all three rooms—Janitor Room, Deposit Room, and Storage Room—suggesting recurring managerial issues such as unclear work instructions or poor coordination.

MPDM Calculation

The MPDM is a method used to measure labor productivity by analyzing the total work cycle time and identifying delays. It distinguishes between productive and non-productive time to assess efficiency more accurately. This approach helps reveal issues such as poor coordination or limited workspace, providing valuable insights for improving workforce management and project planning. The MPDM calculation for the wide-area installation is shown in the following table:

Table 5. MPDM Data Calculation – Worker 1 in Wide Area

Worker	Total Production Time (s)	Number of Cycles	Avg. Cycle Time (s)	(Cycle Time - Delay)/n
1	0	0	0	0
	18.219	1	18.219	18.219

Table 6. MPDM Data Calculation – Worker 2 in Narrow Area

Unit	Total Production Time (s)	Number of Cycles	Avg. Cycle Time (s)	(Cycle Time - Delay)/n
Non-delayed Cycle	0	0	0	0
Overall Production	19.728	1	19.728	19.728

From Tables 5 and 6, it is evident that the average work cycle time for the worker in the wide area was 18,219 seconds, while in the narrow area it was 19,728 seconds. Although neither cycle experienced recorded delays, the difference in average times indicates that workspace dimensions influence labor efficiency. Narrow areas tend to increase the production cycle duration, likely due to physical constraints or restricted mobility during the granite tile installation process.

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Worker Productivity Calculation

The productivity of Worker 1 and Worker 2 during the granite tile installation in wide and narrow areas is calculated as follows:

Table 7. Worker Productivity in Wide and Narrow Spaces

Worker	Total Production Time (s)	Effective Time (s)	Overall Productivity (m²/day)
1	18.219	17.807	8,08
2	19.728	19.588	7,35

Based on Table 7, labor productivity during granite tile installation varies depending on the workspace conditions. In wide spaces, the productivity of the worker was recorded at 8.08 m²/day, while in narrow spaces it was lower, at 7.35 m²/day. This difference indicates that limited workspace can significantly affect labor efficiency, particularly in terms of movement and installation processes.

In this study, daily work duration was set at 8 hours, with each work cycle including multiple tasks such as preparation, material cutting, tile placement, and final finishing. The lower productivity in narrow spaces may be attributed to limited mobility, a higher number of unusable tile cuts, and constraints in tool usage and material distribution.

Granite Tile Labor Coefficient

The unit cost analysis for granite tile installation in both wide and narrow areas was conducted after determining productivity results using the MPDM. The labor coefficient plays a critical role in unit price analysis for construction projects.

To calculate the labor coefficient for granite tile installation, the number of workers and their ideal daily productivity were considered. Each area had one worker: Worker 1 in the wide space (8.08 m²/day) and Worker 2 in the narrow space (7.35 m²/day). The labor coefficient for each was calculated as follows:

Table 8. Labor Coefficient and Installation Cost for Granite Tile Workers

Description	Coefficient (OH)	Unit Wage (Rp)	Total Cost (Rp/m²)
Worker 1 – Wide Area	0,124	120.000	14.880
Worker 2 – Narrow Area	0,136	120.000	16.320

As shown in Table 8, the productivity analysis revealed that the labor coefficient for granite tile installation is 0.124 in wide areas and slightly higher at 0.136 in narrow areas. This suggests that installations in confined spaces require more time and effort due to restricted mobility and the increased number of unusable tile pieces. Assuming a standard daily wage of Rp 120,000, the cost per square meter of tile installation is Rp 14,880 in wide areas and Rp 16,320 in narrow areas.

This cost difference highlights how limited workspace leads to higher installation costs due to increased complexity and reduced efficiency. These findings are important for budgeting in construction projects, especially when planning strategies to improve labor productivity and minimize material and time waste.

Comparison of Granite Tile Installation Wages

In this study, productivity analysis and labor coefficient calculations were focused solely on the workers directly involved in granite tile installation. Other labor roles—such as general workers, foremen, and supervisors—were evaluated using the standard values from the 2021 Ministry of Public Works (PU)

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Analysis Guidelines. This approach was adopted to provide more specific insights into the efficiency and productivity of tile installers under varying workspace conditions. Furthermore, the research aimed to compare labor costs for installations in wide and narrow areas, as shown in Table 9, to assess how workspace constraints affect labor costs in construction projects.

Table 9. Labor Costs for Installation in Wide Areas

Description	Unit	Coef	Unit Price (Rp)	Total Cost (Rp)
General Worker	OH	0,250	105.000,00	26.250,00
Tile Installer	OH	0,124	120.000,00	14.880,00
Head Foreman	OH	0,013	125.000,00	1.625,00
Supervisor	OH	0,013	127.000,00	1.651,00
Total Labor Cost				**44.406,00**

Table 10. Labor Costs for Installation in Narrow Areas

Description	Unit	Coef	Unit Price (Rp)	Total Cost (Rp)
General Worker	OH	0,250	105.000,00	26.250,00
Tile Installer	OH	0,136	120.000,00	14.880,00
Head Foreman	OH	0,013	125.000,00	1.625,00
Supervisor	OH	0,013	127.000,00	1.651,00
Total Labor Cost				**45.846,00**

The wage comparison for granite tile installation between wide and narrow workspaces reveals a significant impact of spatial conditions on labor efficiency and project costs. Based on the data in Tables 9 and 10, labor costs in wide areas amount to Rp 44,406 per m², while in narrow areas they increase to Rp 45,846 per m², showing a difference of Rp 1,440 per m². This difference is attributed to the increased complexity of installations in tighter spaces, which often require more tile cutting, longer work durations, and generate more unusable material. Additionally, restricted mobility further reduces worker productivity, thus increasing labor costs.

These findings suggest that more efficient layout planning and installation strategies should be implemented to minimize the negative impact of limited space on productivity and project expenses.

V. CONCLUSION

The study concludes that workspace conditions significantly influence labor productivity in granite tile installation. Narrow areas present distinct challenges such as limited worker mobility, higher cutting intensity, and increased work time. Based on the MPDM calculations, the productivity coefficient in narrow spaces was found to be 0.136, higher than the 0.124 observed in wide spaces, directly resulting in increased labor costs per square meter. Although the difference in labor cost Rp 1,440 per m² may seem small, its effect becomes substantial when scaled across large projects. Therefore, project managers are advised to allocate additional time and budget for work in confined areas and consider layout optimization strategies during the planning phase to improve workforce efficiency and minimize material waste. Furthermore, using appropriate installation tools and incorporating space limitations into the design phase can help reduce time loss and worker fatigue.

For future research, it is recommended to apply the MPDM method to other construction tasks such as ceiling installation, plumbing, or electrical works and test its application in varied room geometries or multi-level spaces to gain a more comprehensive understanding of how spatial design influences labor productivity.

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