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ANALYSIS OF LABOR NEEDS USING THE RESOURCE LEVELING METHOD ON THE MAIN STRUCTURE OF HIGH-RISE BUILDINGS

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Abstract

The distinctive characteristic of construction projects is that they involve a series of activities that are carried out once and within a specific timeframe. As project development progresses, there are limitations in the availability of resources, an imbalance in the workforce, sharp fluctuations, and the requirement for significant expenses. Labor and costs need to be analyzed based on existing qualifications throughout the project using the resource leveling method with the aid of Microsoft Project 2013 software to achieve more efficient and ideal results. Labor analysis is conducted based on real conditions on the field before and after the leveling process. The allocation before the leveling process experiences sharp fluctuations and exceeds the daily availability of labor. After the leveling process, the fluctuations are low, and the allocation obtained before the leveling process was 1575 people consisting of foremen, carpenters, masons, ironworkers, and laborers, resulting in a total cost of IDR 154,175,000. Meanwhile, after the leveling process, the labor obtained was 1540 people with the same qualifications as before leveling, resulting in a total cost of IDR 150,500,000, and the actual cost amounted to IDR 201,395,000. Thus, labor and costs after leveling produce the most efficient and ideal allocation.

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Key Words

Resource Allocation, Resource Leveling, Labor Costs

Introduction

Construction projects are characterized as a series of activities that only occur or are carried out once, with a certain period that can vary, depending on the scope of the project, the level of difficulty of implementation, and other factors. Although the length of the project period can vary, generally, construction projects tend to have a relatively short duration [1].

As the current growth of project development progresses, there are limitations in the availability of quality resources and labor imbalances. The allocation of labor that is said to be effective and efficient must ensure optimal use of resources and time during the project. Conversely, inefficient labor allocation can lead to unproductivity, where the number of workers may become excessive or even less. Fluctuations that are not sharp can be the reason for a project to experience delays [2].

For example, on a certain day, labor may not have tasks, but the next day, the need for labor jumps suddenly for a short period, and then the next day only requires some labor. This causes fluctuations in the labor requirements graph and causes cost waste [3].

With this problem, it is important to analyze and overcome the situation by analyzing the even distribution of construction project implementation by applying the *Resource Leveling method*. Resource *leveling* in project management can help reduce imbalances or fluctuations in resource utilization, especially for labor.

The utilization of technological advances in construction project scheduling can be enhanced by applying specialized software. One example is *Microsoft Project*, which can process project schedule planning and control accurately and efficiently on a large scale. In other words, the program can produce relevant and up-to-date reports at every project stage [4].

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Literature Review

Labor Resources

The three main elements that become resources in construction projects are the presence of labor, materials or materials, and equipment [5]. Labor providers have a significant impact on construction project delays. The preparation and utilization of human resources in construction projects greatly affect the achievement of the final form of the building structure under construction [6]**.** Projects often have tight time constraints among their activities, which technological or organizational limitations can cause. Scheduling in a project involves setting start times for each activity to meet all time and resource constraints while achieving several predetermined goals [7].

Resource Leveling

Resource Leveling is a process that aims to even out the daily use of resources during the project to reduce fluctuations. Typically, this is implemented by moving non-critical activities into possible time ranges, otherwise known as available floats. This process is implemented to balance the use of resources without affecting the total duration of the activity. This process can be achieved by reducing the number of workers in periods with very high resources and allocating excess labor to periods where resources are lower [5].

Software Microsoft Project 2013

Microsoft Project 2013 is a schedule management software supporting various project planning, implementation, and evaluation aspects. This application integrates various project management techniques that have been proven effective. Microsoft Project also features the ability to record and monitor the use of resources, including labor, materials, and equipment. Another advantage of Microsoft Project is its ability to produce detailed and accurate reports according to the needs and progress of the project at each phase. Thus, this program can provide up-to-date and relevant reports for every project stage [4].

Research Methods

Location, Subject, and Object of Study.

This research is located on Kyai Mojo Street, Yogyakarta City. Precisely in the Pingit police dormitory flat, Yogyakarta. The subject of this study consists of a workforce that experiences fluctuations and requires equity in using human resources through the Resource Leveling process.

Data Collection Methods

The data collected was obtained from interviews and data submission to the contractor. Data processing will be processed using *Microsoft Excel* and Microsoft *Project 2013 software.*

Workforce Identification

In this study, the calculation of the period quantity is carried out with the calculation limit using the coefficient stipulated in PUPR Ministerial Regulation Number 1 of 2022 and recapitulating the number of daily workers through *Microsoft Project 2013* software, thus requiring consideration in using labor efficiency by real conditions in the field and calculating the number of workers manually. For the project to be studied, work on the main structure will take place from the fifth week, which falls in June and ends in the fourteenth week in August. The *bar chart* is shown in Table 1.

Table 1: Bar Chart Jobs

No	Description	Weight (%)	June				July				Agustus		
			5	6	7	8	9	10	11	12	13	14	15
1	1st Floor	2.323											
2	2nd Floor	5.432											
3	3rd Floor	4.620											
4	4th Floor	4.211											

5	5th Floor	2.376											

Labor Requirements

Adding the number of workers involved in each activity performed during a single workday is necessary to determine labor requirements. Calculate how many workers are needed for each type of task to be performed, considering the specifications and scale of the ongoing work. The labor requirements can be determined using the following equation [8]:

Period Quantity = Volume x Daily Weight ……..(1)

Daily labor requirement = Period Quantity x Labor Coefficient ……..…….(2)

Determining the Relationship Between Tasks

In managing task interdependencies in the project, data will be entered into Microsoft Project 2013 to identify the relationships between tasks. Not all task relationships in this project are the same; some tasks may start or end simultaneously, while others may only begin several days after the previous task has ended. Therefore, these task dependency relationships will be organized using the predecessor's feature, which indicates connections with preceding activities. [9].

Determining Maximum Labor Force

The maximum labor force can be determined based on a report from the contractor or an analysis using the coefficients listed in the Ministry of Public Works Regulation No. 1 of 2022.

Table 2. Maximum number of workers per day

Labor	Amount (Contractor)	Amount (Analysis Result)
Foreman	1	2
Carpenter	3	1
Craftsman Iron	6	7
Bricklayer	8	10
Worker	18	28

Table 2 shows that the maximum amount of labor provided by the contractor is lower than that obtained from the analysis. Therefore, to minimize the risk of ineffective labor, the maximum amount of labor must be used is data derived from contractors [3].

Analysis *Resource Leveling*

In a project, fluctuations in labor requirements often occur, where sometimes the demand for labor increases sharply and at other times decreases significantly. This leads to instability in resource allocation. To overcome this, efforts are needed to balance the use of resources to avoid excess labor[10]. Resource leveling is a method that adjusts the start and end schedule of a job by taking into account the limitations of existing resources to balance between the needs and availability of these resources[11].

Results and Discussion

Data Processing Results

Daily labor requirements for projects are calculated by analyzing the volume of work and time required for each task by the PUPR Regulation No. 1 of 2022 provisions. This process refers to the schedule that has been prepared for the implementation of the project. Details regarding duration, scheduling, inter-work relationships, and day-to-day labor needs are collected through document studies. Once the data is collected, the information is inputted into *Microsoft Project 2013*. During input, there is a limit on the number of workers used for the project. After the data is entered and inputted, *the software* will show whether there

are excess resources. If no excess resources exist, the process is continued by analyzing *resource leveling* to allocate labor more effectively and optimally.

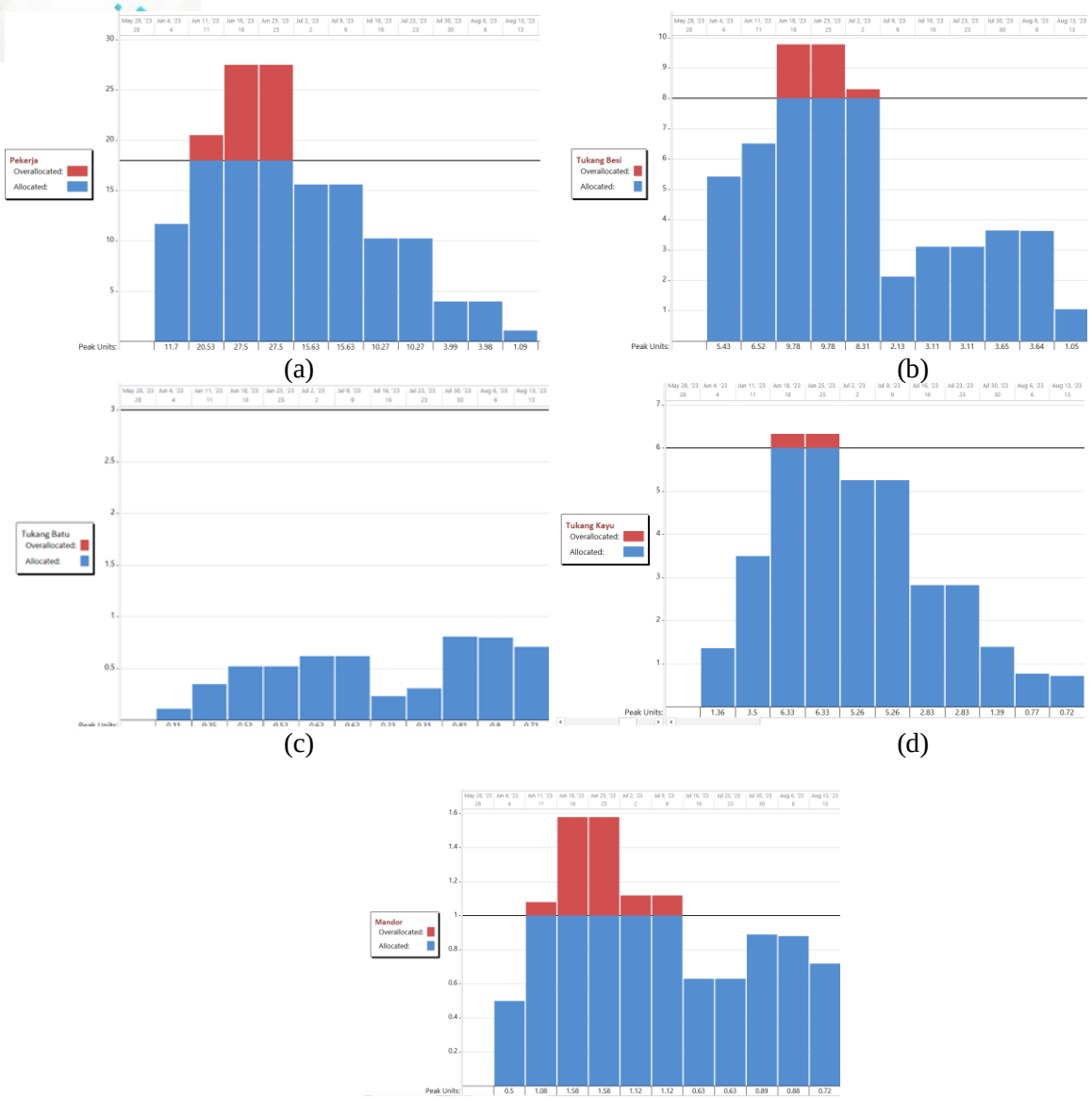


Figure 1. Resource Graph Drawing before Leveling (a.)Worker, (b.)Blacksmith, (c.)Mason, (d.)Carpenter, (e.) Foreman

The labor chart shown in Figure 1 shows that each peak unit signifies that one person has worked full time for 8 hours in one day. The red color above the boundary line on the graph indicates that the labor allocation has exceeded the maximum limit of the number of workers employed daily. Details of labor wages in real conditions in the field and before leveling are shown in Table 3 and Table 4, namely:

Table 3. Real Labor Wages in the field

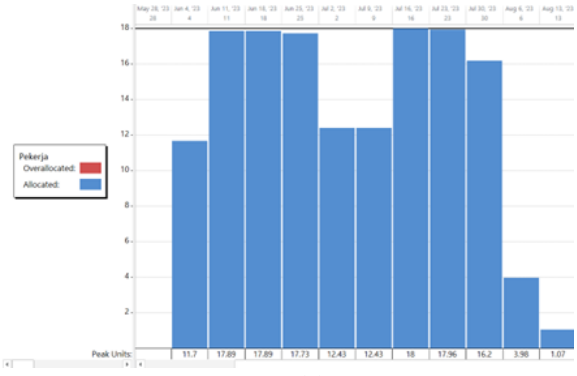
Labor	Total manpower	Price Per Day	Total Price (Number of Kindergartens x Price Per Day)
Foreman	70	IDR 110,000	IDR 7,700,000

Carpenter	329	IDR 100,000	IDR 32,900,000
Craftsman Iron	476	IDR 100,000	IDR 47,600,000
Bricklayer	181	IDR 100,000	IDR 18,100,000
Worker	1001	IDR 95,000	IDR 95,095,000
		Total	IDR 201.395.000

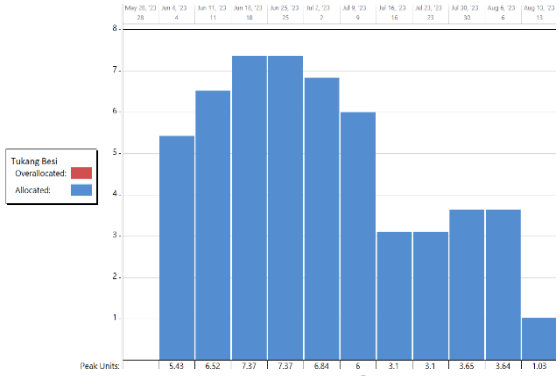
Table 4. . Labor Wages Before *Leveling*

Labor	Total manpower	Price Per Day	Total Price (Number of Kindergartens x Price Per Day)
Foreman	91	IDR 110,000	IDR 7,700,000
Carpenter	217	IDR 100,000	IDR 32,900,000
Craftsman Iron	350	IDR 100,000	IDR 47,600,000
Bricklayer	70	IDR 100,000	IDR 18,100,000
Worker	847	IDR 95,000	IDR 95,095,000
		Total	IDR 154.175.000

Based on the existing budget plan for the project, table 3 and Table 4 explain labor costs in real conditions in the field and conditions before the leveling process, where real conditions in the field require a total cost of IDR 201,395,000 and labor costs before the leveling process is carried out which is IDR 154,175,000.



(a)



(b)

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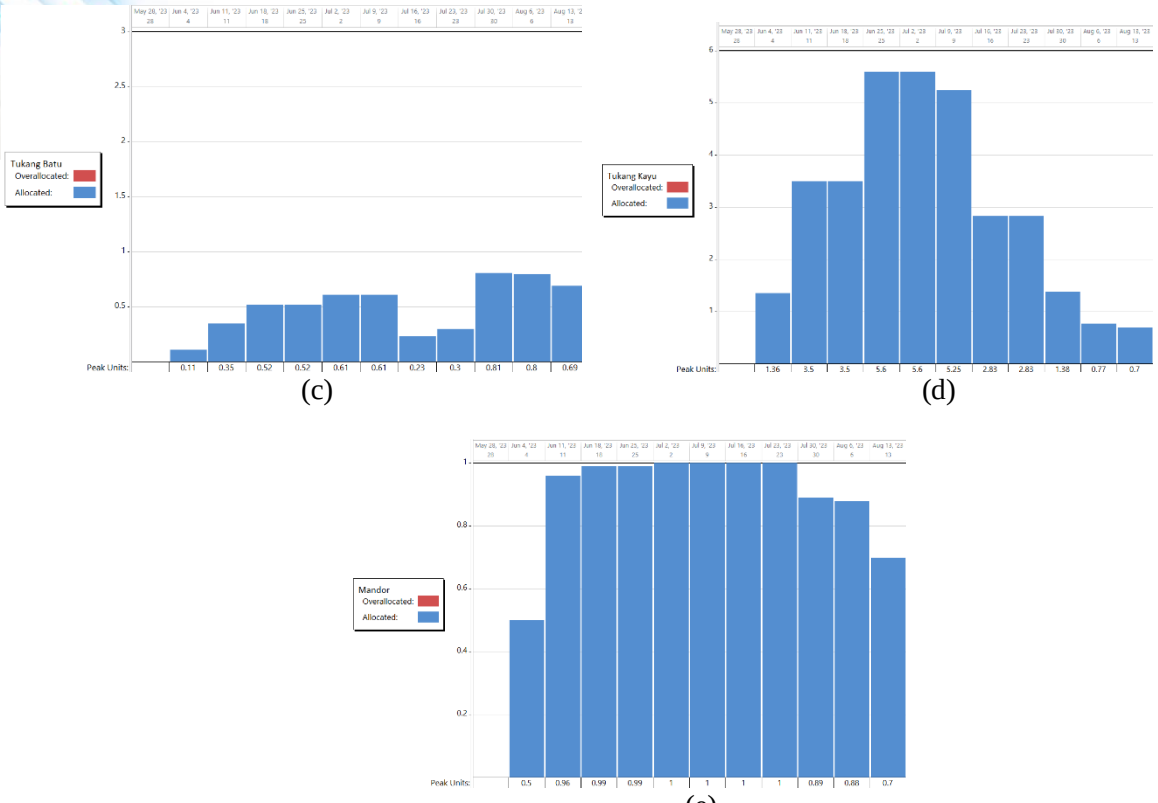

Gambar 2. Gambar *Resource Graph* setalah Leveling (a.)Worker, (b.)Crastman Iron, (c.)Bricklayer, (d.)Carpenter, (e.)Foreman

After implementing the leveling process, graphics The allocation in Figure 2 shows more stable fluctuation without existing workers who exceed the maximum daily availability limit. Distribution power visible post-leveling works more equally than the condition previously. The project's total duration, pre- and post-leveling, is 70 days calendar. Labor Wage Details Work after leveling is available in Table 5.

Labor	Total manpower	Price Per Day	Total Price (Number of Kindergartens x Price Per Day)
Foreman	70	IDR 110,000	IDR 7,700,000
Carpenter	217	IDR 100,000	IDR 21,700,000
Craftsman Iron	343	IDR 100,000	IDR 34,300,000
Bricklayer	70	IDR 100,000	IDR 7,000,000
Worker	840	IDR 95,000	IDR 79,800,000
		Total	IDR 150,500,000

Based on the existing budget project, Table 5 explains the cost of power work under conditions after leveling with total costs of IDR 150,500,000.

During the project, comparing cost allocation power work, including worker, bricklayer, craftsman carpenter, foreman, and craftsman iron on the field, before and after the leveling application, showed differences in very high costs. Table 5 compares costs to make power work more economical after the *leveling* process.

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Table 6: Recapitulation of Labor Costs

Planning	After Leveling	Disparity	Field Rill	After Leveling	Disparity
154,175,000	150,500,000	2.38%	201395000	150,500,000	25.27%

Recapitulation Before and after *Leveling*

Comparison weekly allocation For workers, bricklayers, craftsmen, carpenters, foremen, and craftsmen, iron shows a big change before and after leveling in the field. Condition This is visualized in Figure 3 using different code colors: blue represents the condition field, yellow Represents the condition before leveling, and gray represents the condition after the *leveling* process.

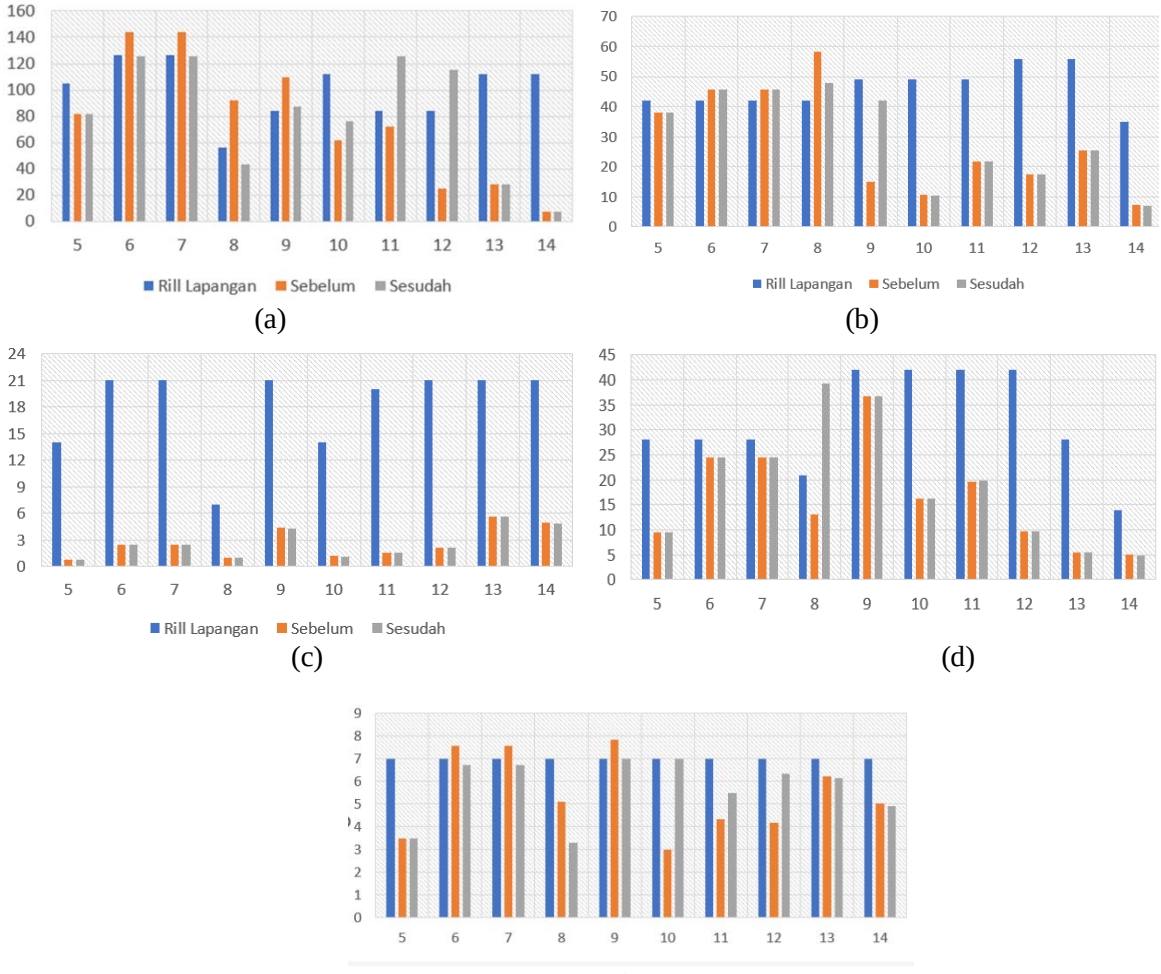

Figure 3. Comparison Number of Workers Per Qualification Leveling (a.)Worker, (b.)Crastman Iron, (c.)Bricklayer, (d.)Carpenter, (e.)Foreman

Based on the analysis, a significant difference can be seen for five (5) resources between the planning condition, actual field condition, and the auto-schedule leveling condition, which shows a striking disparity. The following compares the number of workers, as shown in Table 4.14.

Table 7: Comparison of Labor Requirements for Planning, After Leveling, and Actual Field Conditions

Manpower	Planing	*Auto schedule*	Disparty	Real Condition	Auto Schedule	Disparty
Foreman	91	70	-23.08%	70	70	0.00%
Carpenter	847	840	-0.83%	1001	840	-16.08%
Craftsman Iron	70	70	0.00%	181	70	-61.33%
Bricklayer	350	343	-2.00%	476	343	-27.94%
Worker	217	217	0.00%	329	217	-34.04%

After performing resource leveling with the auto schedule feature, it is observed that the duration for planning, actual field conditions, and after leveling remains unchanged at 70 working days.

Table 4.8 Recapitulation of Duration Before, Actual Field Conditions, and After Resource Leveling

Perencanaan	Setelah Leveling	Disparitas	Rill Lapangan	Setelah Leveling	Disparitas
70	70	0.00%	70	70	0.00%

Conclusion

After Analyzing existing data, below is a summary of possible conclusions withdrawn that is :

1. Implementing the Resource Leveling method with the help of Microsoft Project 2013 has been applied to ensure optimal use of labor by evening out the distribution of human resources throughout the project and demonstrating more excellent stability compared to the fluctuations often encountered in the field. This analysis has proven that the resource leveling method can even out the number of workers who were previously overallocated or exceeded the maximum number of workers per day. This shows that the method effectively and efficiently manages human resources.
2. From the analysis conducted, it was found that the actual number of workers in the field based on the supervisor's report was 2,057 people, which produced a graph and an even daily allocation of labor. Before the leveling process, the labor requirement was 1,575 people, but the resulting graph showed high fluctuations and daily allocations that exceeded the maximum limit, making it inefficient. After the leveling process in accordance with AHSP Permen PUPR No. 1 of 2022, the number of workers decreased to 1,540 people, resulting in a graph with lower fluctuations and more even allocation. Although using fewer workers than in the field, the main structural work could be completed in 70 calendar days, precisely according to the schedule set by the project owner. This result indicates that the labor allocation that has undergone the leveling process is the most efficient.
3. The resource leveling process was implemented to increase the efficiency of labor utilization by evenly distributing the workload throughout the project, which helps reduce resource wastage. A significant disparity was found in the analysis of labor costs conducted in the field and comparisons before and after the leveling process. The labor costs for the main structural work in the field reached IDR 201,395,000. Meanwhile, according to calculations based on AHSP Permen PUPR No. 1 of 2022, before leveling, it was IDR 154,175,000, and after leveling, it became IDR 150,500,000. Thus, the disparity between planning and after-leveling decreased by 2.38%. Meanwhile,ual field costs and after leveling also showed a significant gap, with a decrease of 25.27%. Therefore, cost savings occurred with the implementation of the leveling process, indicating that the most efficient labor costs are obtained after the leveling process is carried out.

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