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Analysis Of Labor Qualifications Using The Resource Leveling Method On The Main Structure Work Of Multi-Story Buildings

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Abstract. *Construction projects are related to infrastructure development in Indonesia, which is an important foundation for economic growth by supporting mobility, trade, and connectivity between regions. Infrastructure development also supports the utilization of labor resources in Indonesia. This research aims to analyze the availability of labor in a construction project. The Resource Leveling method is used to level the labor needs in the project. The results showed that there was an allocation of labor that exceeded the maximum daily availability before equalization. The initial allocation based on qualifications showed that the maximum number of workers consisted of 2 foremen, 1 head carpenter, 1 head ironworker, 1 head mason, 5 carpenters, 5 ironworkers, 1 mason, and 13 workers. After equalizing the workforce, the maximum number of workers required is 1 foreman, 1 head carpenter, 1 head ironworker, 1 head mason, 4 carpenters, 4 ironworkers, 1 mason, and 13 workers. This research emphasizes the importance of workforce equalization to avoid over-allocation and ensure efficiency in construction projects.*

Keywords*: Construction Project, Labor, Resource Leveling*

BACKGROUND

Construction project development is one of the efforts to develop infrastructure by utilizing labor resources that are needed for project work. In its implementation, a project's success depends on its workforce's ability. The availability of labor as a resource is often limited due to considerations of various factors and the quality of the workforce. A good allocation of labor will result in an optimal duration of completion and use of resources. Performing *Resource Leveling* on resources in a project aims to minimize the uneven use of labor resources. The purpose of the research conducted on the construction project of the main structure of a multi-story building is to analyze labor based on labor qualifications by examining the allocation of labor in planning and labor in the field based on the contractor's daily report.

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THEORETICAL STUDY

Human Resources

Human resources are very important in any work, including in construction. Mistakes in the use of human resources can cause huge losses to a construction project. With a professional and competent workforce, a company will be able to operate properly despite having all the necessary modern equipment. The important role of human resources lies in its ability to ensure that all aspects of the project run efficiently and effectively.(Zainullah et al., 2012). To develop superior human resources, a quality basic education foundation is needed. The workforce of the future requires solid foundational skills gained from quality basic education. Investment in teacher training is critical to ensuring students receive a good education, ultimately resulting in a more skilled and well-rounded workforce.(Richards, 2023)

Labor Qualifications

According to the U.S. Department of Labor, presented by Imam Satyarno and then cited by Haryadi (2010), construction labor, commonly called fitters, can be divided into the following areas:

a. Masons (brick masons, block masons, stone masons) are responsible for building simple walls and working on the external ornamentation of buildings.
b. Carpenters cut, join, and assemble wood and other materials to build structures such as buildings, roads, and bridges.
c. Concrete masons or concrete finishers handle concrete work from formwork preparation, casting, and maintenance to finishing.
d. Construction equipment operators operate construction equipment or machinery and perform necessary checks and repairs.
e. Steelworkers (reinforcing iron and metal workers) assemble concrete reinforcing steel and construction steel.
f. Construction laborers assist the builders in various tasks at the construction site.

Resource Leveling

Resource equalization is a complex optimization challenge that involves adjusting project schedules (start and finish dates) to meet resource allocation needs. This complexity increases dramatically on large projects involving hundreds or even thousands of activities. Success in meeting this challenge can provide great benefits to the construction groups involved through efficient resource management.(Kyriklidis & Dounias, 2023). Resource Leveling, or even distribution of human resources, is a scheduling technique that aims to reduce fluctuations in labor usage throughout a project. This technique adjusts non-critical activities

to be carried out at optimal times according to labor availability. In projects, labor often accounts for the largest portion of costs. Therefore, project managers need to pay close attention to this to avoid waste. However, scheduling results are usually far from satisfactory.(Arfadri et al., 2022).

***Microsoft Project* 2019**

Microsoft Project is a project management application used to plan, manage, control, and report project-related information. This software is capable of designing, setting schedules, and monitoring project progress. Microsoft Project can be applied to various types of projects, including construction projects, software development, and other projects.(Christy et al., 2013). The benefits of Microsoft Project are (Wowor et al., 2013):

1. Store project details in a database, including tasks, relationships between function, resource usage, costs, critical path, and other elements.
2. Utilize this information to calculate and maintain schedules, costs, as well as other project elements, and assist in creating project plans.
3. Monitor project progress to ensure the project is completed on time and within the planned budget.

RESEARCH METHODS

Type of Research

This research uses quantitative methods, referring to information expressed in the form of numbers and obtained through field data collection. Quantitative research is a process of investigating social issues based on testing a theory consisting of variables measured numerically and analyzed through statistical methods to evaluate the truth of the theory's predictive generalizations. (Ali et al., 2022).

Research Stages

1. Data Collection

In this study, secondary data was obtained from PT PP (Persero) Tbk, as the contractor. The secondary data includes an analysis of the unit price of work (AHSP), a contractor daily report, a contractor weekly report, an S curve, and a volume of work.

2. Analysis

Data analysis using the *Resource Leveling* method, with the first step by identifying labor qualifications in the main structural work of multi-story buildings, the second step by calculating the coefficient on labor with *Microsoft Excel 2019* software, the third step by analyzing labor using *Microsoft Project 2019* software, the last step is to recapitulate the comparison of the number of planning workers.

a. Identification of Labor Needs

Identification was carried out by preparing interviews based on daily field implementation reports and the project's Unit Price Analysis. Furthermore, the results were compared with the labor arrangement to determine the labor used.

b. Identification of Labor Qualifications

Details of labor on the main structural work of multi-story buildings identified according to their qualifications are presented in the following table:

Table 1. Workforce Qualifications

No.	Labor Qualifications
1.	Foreman
2.	Head Carpenter
3.	Head Ironworker
4.	Head mason
5.	Carpenter
6.	Ironworker
7.	Stonemason
8.	Workers

c. Determining Labor Requirements

To determine labor requirements, it is necessary to add the number of workers involved in each activity during a working day. Calculate the number of workers required for each type of work, taking into account the specifications and scale of the work in progress. Labor requirements can be calculated using the following equation (Minarosi et al., 2021) :

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

Daily Labor Requirement = Period Quantity x Labor Coefficient.....(2)

d. Determine the relationship between jobs

To manage dependencies between tasks in the project, data will be entered into Microsoft Project 2019 to identify relationships between functions. Not all task relationships in this project are the same; some tasks may start or end at the same time, while other tasks may only start a few days after the previous task is completed. Therefore, these task

dependencies will be organized using a predecessor feature that shows the relationship with the last activity. (Christy et al., 2013)

e. Determining Maximum Labor Requirements

The maximum amount of labor can be determined based on the contractor's daily report or an analysis using the coefficients used by the contractor based on the project's Unit Price Analysis.

Maximum number of workers per day

No.	Labor	Total (Contractor)	Total (Analysis)
1.	Foreman	1	2
2.	Head Carpenter	1	1
3.	Head Ironworker	1	1
4.	Head mason	1	1
5.	Carpenter	4	5
6.	Ironworker	4	5
7.	Stonemason	1	1
8.	Workers	13	13

Table 2 shows that the maximum amount of labor provided by the contractor is lower than the result of the analysis calculation. Therefore, to minimize the risk of labor ineffectiveness, the amount of labor used should match the data from the contractor.(Yanti, 2017)

Resource Leveling Analysis

In a project, there are often fluctuations in labor requirements, which sometimes increase sharply and, at other times, decrease drastically. This instability causes problems in resource allocation. To overcome this, efforts are needed to balance the use of resources to avoid excess labor. Resource leveling is a method that adjusts the start and end work schedules by taking into account the limited resources available so that the need and availability of resources can be balanced.(Waluyo & Aditama, 2017)

RESULTS AND DISCUSSION

After processing the data, it was obtained and ready for analysis. The *resource leveling* analysis on labor is carried out on jobs that are on the non-critical path. The *resource leveling* analysis uses the Microsoft Project program. The results of the study of labor allocation before and after leveling are displayed in the form of bar charts.

Before *Resource Leveling*

Here's how the *Resource Graph* looks before *Resource Leveling*:

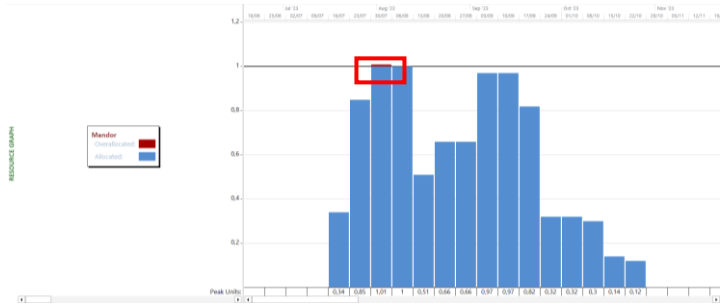

Figure 1. *Resource Graph* Before Foreman *Leveling*

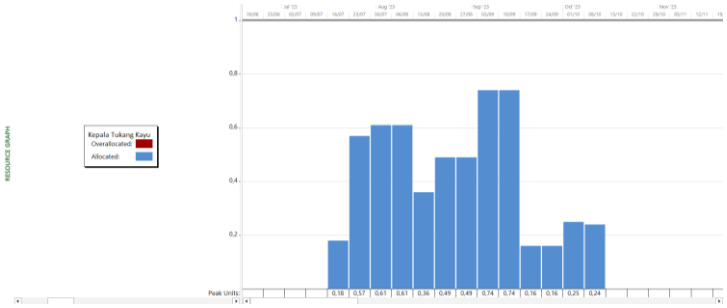

Figure 2. Resource Graph Before Leveling the Head Carpenter

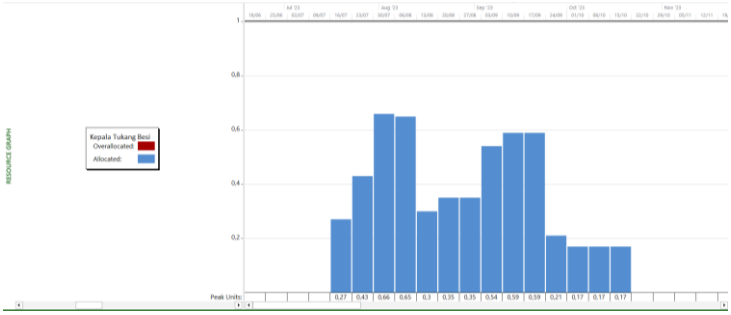

Figure 3. Resource Graph Before Leveling the Head Ironworker

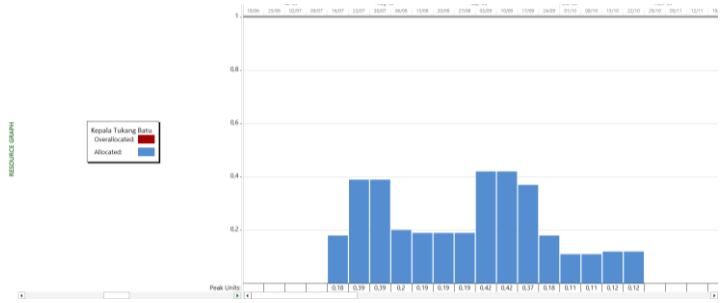

Figure 4. *Resource Graph* Before *Leveling* Head Masons

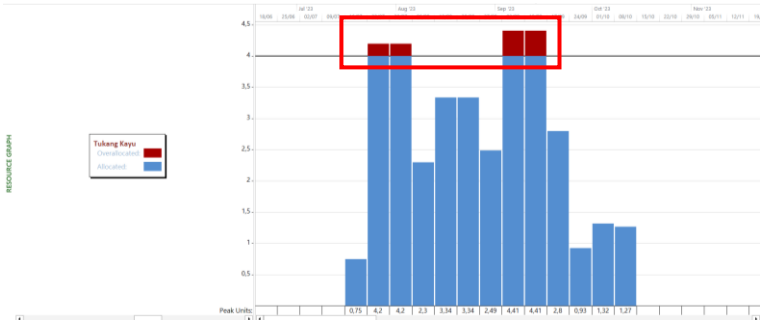

Figure 5. Carpenter *Resource Graph* Before *Leveling*

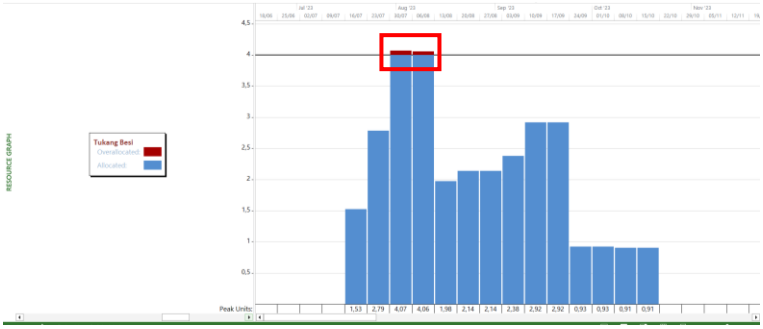

Figure 6. *Resource Graph* Before *Leveling* Ironworker

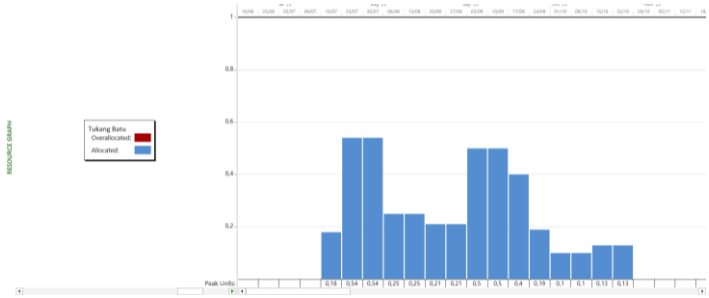

Figure 7. *Resource Graph* Before *Leveling* Masons

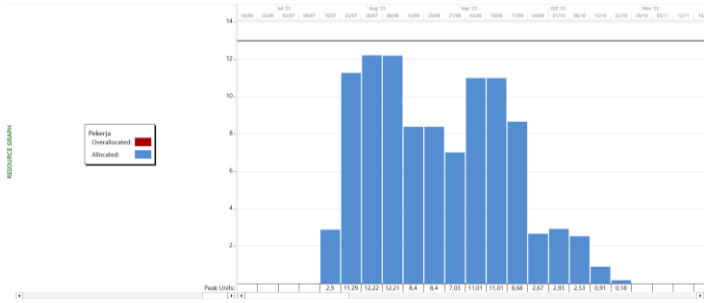

Figure 8. *Resource Graph* Before *Leveling* Masons

The labor graphs in Figure 1 to Figure 8 indicate that each peak represents one person who has worked a full 8-hour day. The red color above the boundary line in the graph shows that the labor allocation has exceeded the maximum number employed in a single day a breakdown of the number of workers.

Table 3. Labor Recapitulation Before *Leveling*

Week	Foreman	Head Carpenter	Head Ironworker	Head mason	Carpenter	Ironworker	Stonemason	Workers
	OM	OM	OM	OM	OM	OM	OM	OM
17	7	7	7	7	7	14	7	21
18	7	7	7	7	35	21	7	84
19	14	7	7	7	35	35	7	91
20	7	7	7	7	21	35	7	91
21	7	7	7	7	28	14	7	63
22	7	7	7	7	28	21	7	63
23	7	7	7	7	21	21	7	56
24	7	7	7	7	35	21	7	84
25	7	7	7	7	35	21	7	84
26	7	7	7	7	21	21	7	63
27	7	7	7	7	7	7	7	21

Week	Foreman	Head Carpenter	Head Ironworker	Head mason	Carpenter	Ironworker	Stonemason	Workers
	OM	OM	OM	OM	OM	OM	OM	OM
28	7	7	7	7	14	7	7	21
29	7	0	7	7	14	7	7	21
30	7	0	0	7	0	7	7	7

After *Resource Leveling*

Here's how the *Resource Graph* looks after *Resource Leveling*:

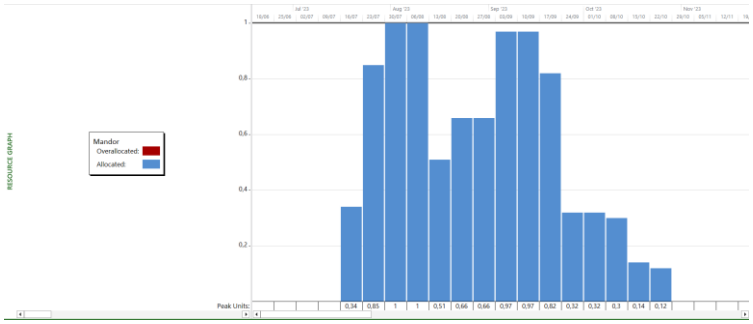

Figure 9. *Resource Graph* After Foreman *Leveling*

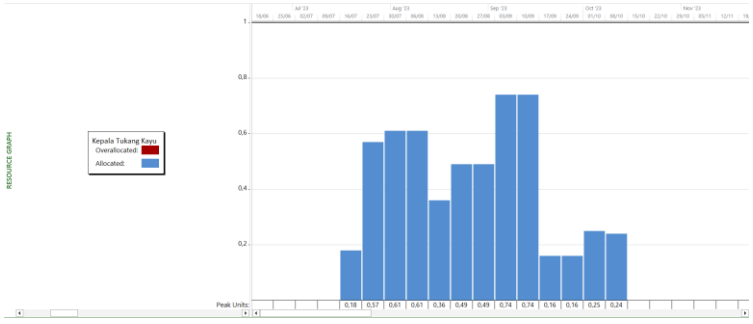

Figure 10. *Resource Graph* After *Leveling the* Head Carpenter

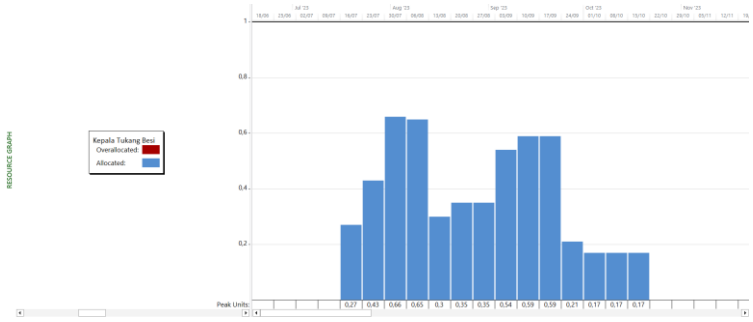

Figure 11. *Resource Graph* After *Leveling the* Head Ironworker

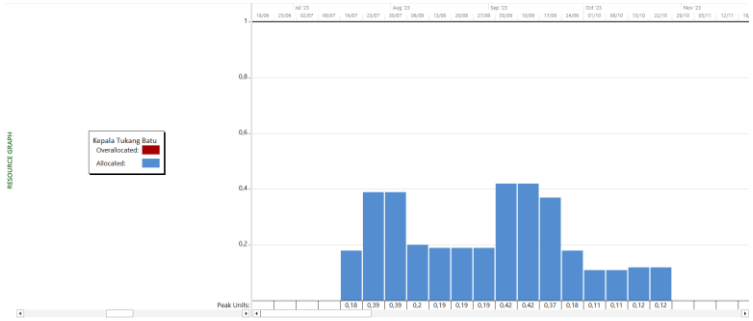

Figure 12. *Resource Graph* After *Leveling the* Head Bricklayer

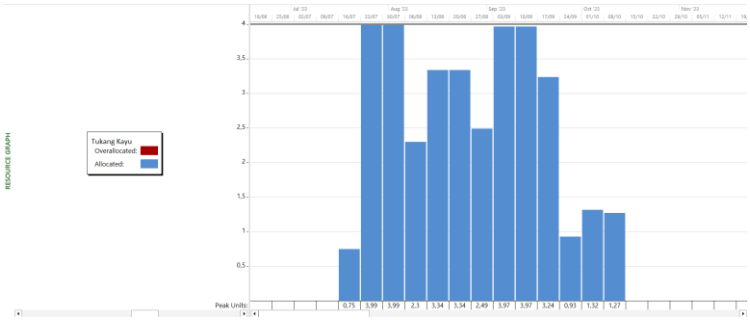

Figure 13. *Resource Graph* After Carpenter *Leveling*

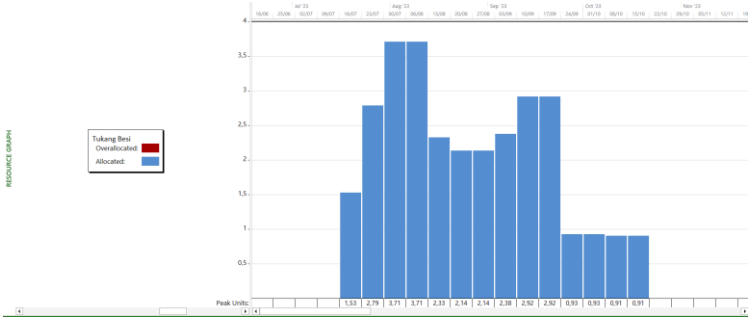

Figure 14. *Resource Graph* After *Leveling the* Ironworker

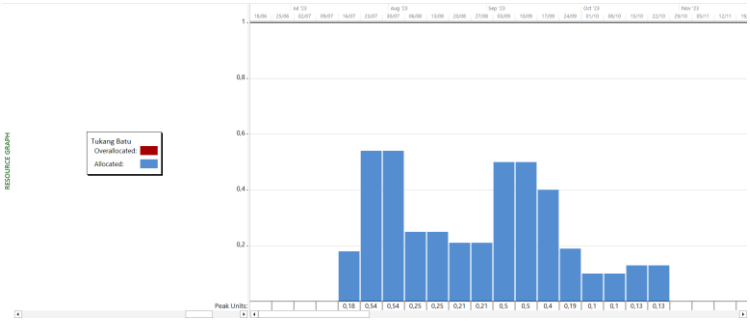

Figure 15. *Resource Graph* After *Leveling the* Masons

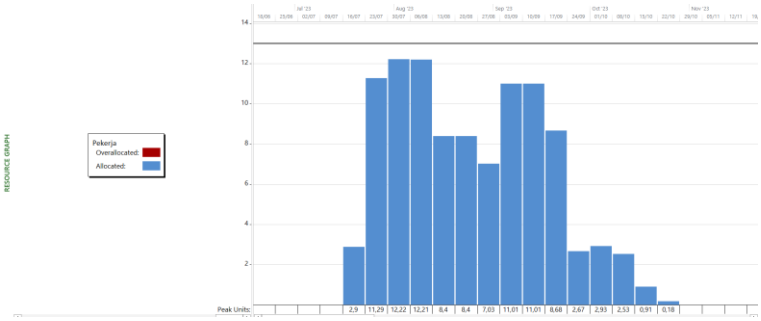

Figure 16. *Resource Graph* After Worker *Leveling*

After completing *Resource Leveling*, *it* can be seen on the *Resource Graph* that labor has gone through the equalization process, so it does not occur *overall*.

Table 3. Labor Recapitulation After *Leveling*

Week	Foreman	Head Carpenter	Head Ironworker	Head mason	Carpenter	Ironworker	Stonemason	Workers
	OM	OM	OM	OM	OM	OM	OM	OM
17	7	7	7	7	7	14	7	21
18	7	7	7	7	28	21	7	84
19	7	7	7	7	28	28	7	91
20	7	7	7	7	21	28	7	91
21	7	7	7	7	28	14	7	63
22	7	7	7	7	28	21	7	63
23	7	7	7	7	21	21	7	56
24	7	7	7	7	28	21	7	84
25	7	7	7	7	28	21	7	84
26	7	7	7	7	21	21	7	63
27	7	7	7	7	7	7	7	21
28	7	7	7	7	14	7	7	21
29	7	0	7	7	14	7	7	21
30	7	0	0	7	0	7	7	7

Recapitulation Before And After *Resource Leveling*

The Following Is A Comparison Chart Before And After *Resource-Leveling*:

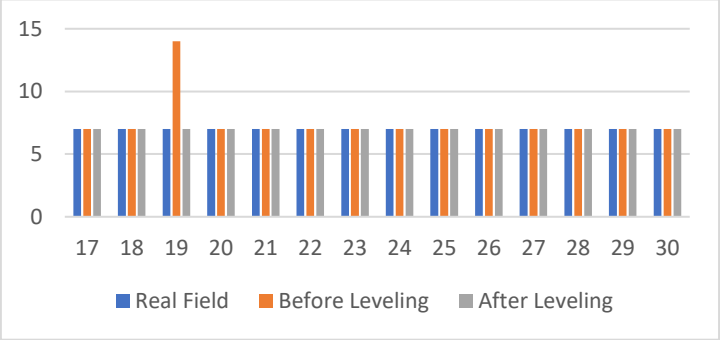

Figure 17: Comparison Chart of Foreman Labor

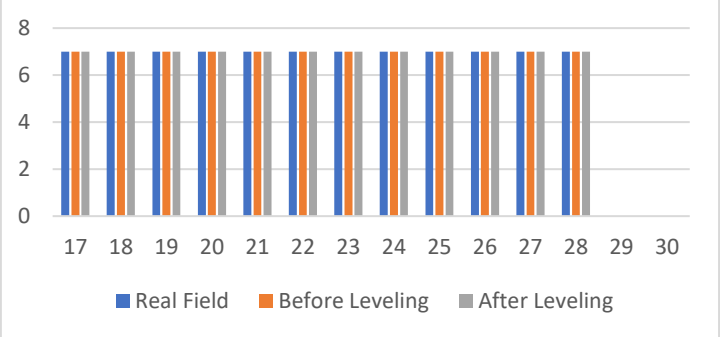

Figure 18: Comparison Chart of Head Carpenter Labor

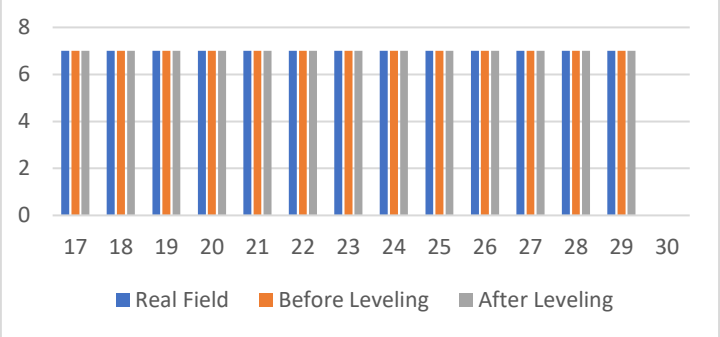

Figure 19. Head Ironworker Labor Comparison Chart

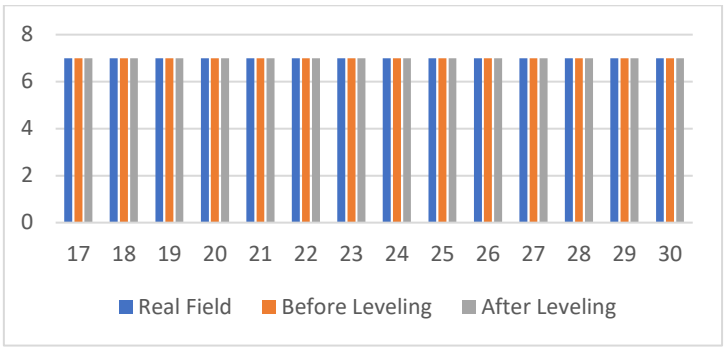

Figure 20. Head Mason labor comparison chart

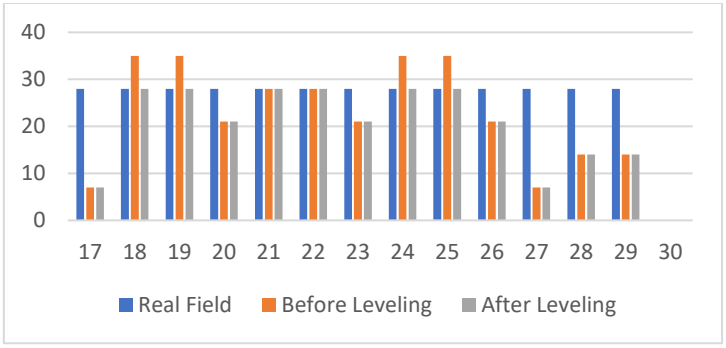

Figure 21: Comparison Chart of Carpenter Labor

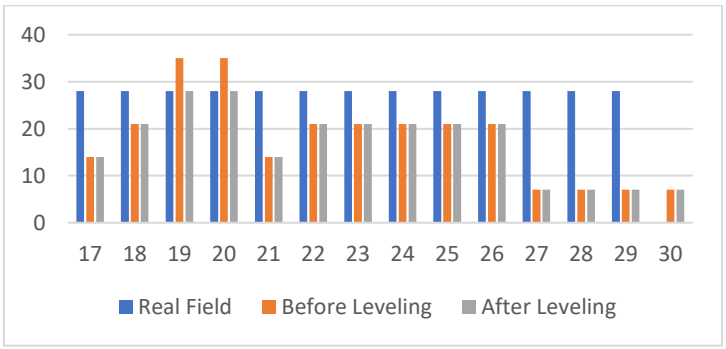

Figure 22. Ironworker Labor Comparison Chart

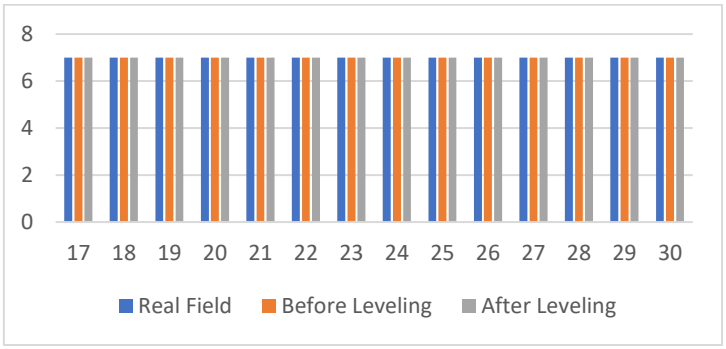

Figure 23: Comparison chart of Mason labor

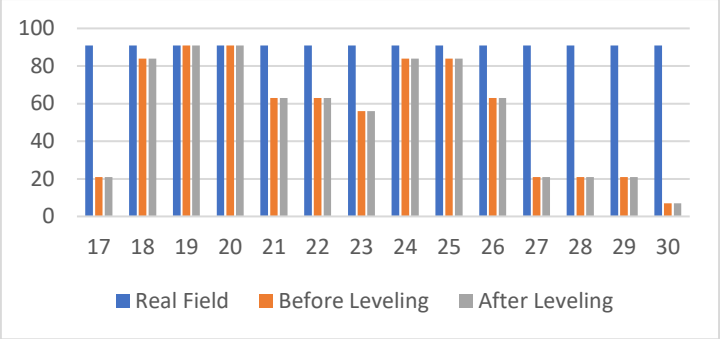

Figure 24: Worker Labor Comparison Chart

CONCLUSIONS

Resources Leveling implements optimal labor management, helping implementers utilize the existing workforce according to the needs in the field. From the analysis of labor needs using the Resources Leveling method for the main structural work of multi-story buildings, several conclusions can be drawn, namely the identification of labor qualifications in the main structural work on multi-story buildings including foreman, head carpenter, head ironworker, head mason, carpenter, ironworker, mason, and worker. In the comparison results of the analysis of labor resources based on labor qualifications with ideal conditions based on the contractor's AHSP and daily reports using the *resource leveling* method, it can be concluded that the amount of labor based on the contractor's AHSP is greater than the amount of labor from the daily report. Allocation of a number of resources is carried out without extending the duration of work based on labor qualifications with the resource leveling method; the results obtained with the maximum number including, foreman 1 person, head carpenter 1 person, head ironworker 1 person, head mason 1 person, carpenter 5 people, ironworker 5 people, mason 1 person, and workers 13 people.

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