Analysis of Workforce Resource Planning Using the Resource Leveling Method and Microsoft Project

Muhamad Raka Abdurahman[1*], Siti Nurasiyah[1], Istiqomah[1]
[1] Civil Engineering Study Program, Indonesia University of Education
*Corresponding Author: Muhamad Raka Abdurahman. Email: raka16082003@upi.edu

Abstract

Increased construction activity requires effective project planning and implementation, particularly in terms of workforce management. Uncontrolled fluctuations in workforce requirements often lead to inefficiencies in terms of both cost and time. This study aims to analyze workforce planning and apply resource leveling techniques to stabilize workforce requirements for the construction project of Bandung Islamic Hospital. The research method used is a case study with a quantitative approach, involving the collection of secondary data from the project implementers and scheduling analysis using Microsoft Project software. Labor demand calculations were based on work volume, duration, and work coefficients using the formula T = (k × V)/N. Initial results indicate overallocation of labor, particularly in December 2023 and January 2024, exceeding the available labor capacity (72 people). The leveling process was conducted in two stages, auto schedule and manual schedule. The manual scheduling method proved to be more effective because it was able to reduce fluctuations in labor requirements without extending the project duration. After resource leveling was performed, the labor histogram showed a stable distribution that did not exceed available capacity. The total duration of the structural work also decreased from 366 days to 345 days, demonstrating time efficiency. This study emphasizes the importance of labor planning and resource leveling techniques to achieve efficiency in construction projects.

Keywords: Labor, Resource Leveling, Scheduling

1. INTRODUCTION

Increased development in the construction sector requires acceleration and efficiency in project implementation. However, in practice, construction projects often face obstacles related to time, cost, and quality. Project scheduling is an important tool for efficiently managing the duration of activities, covering aspects such as time, labor, equipment, materials, and finances. Accuracy in scheduling has a significant impact on achieving project targets and avoiding delays and cost overruns.

Resource management, particularly labor, plays a crucial role in project implementation. A common problem that is often encountered is an imbalance in the distribution of work among workers, which results in fluctuations in labor requirements from time to time. At the case study site, this imbalance is addressed by increasing or decreasing the number of workers through subcontractors. However, this practice is inefficient, as the recruitment and training processes require significant time and costs. Meanwhile, retaining workers without tasks also adds to the project's cost burden. Therefore, better workforce management is needed through resource leveling techniques, so that labor needs can be aligned with availability without compromising productivity or extending project duration.

1.1 Workforce Planning

The workforce is one of the main resources that determines the success of a construction project. Workforce planning requires qualifications that match the needs of the project, both in terms of skills and work efficiency. Workforce productivity is a key indicator in planning, namely the amount of work completed in a given unit of time (2). Based on this productivity, the number of workers and wage rates can be determined, either through a lump-sum system or daily wages.

Labor planning aims to ensure the availability of labor in accordance with project requirements and timelines. Inaccuracies in planning can lead to serious issues later on. Therefore, planning must take into account the volume of work, duration, and labor coefficient, using the formula (3):

$$T = \frac{k \times V}{N}$$

Explanation:
N = number of workers
k = labor coefficient
V = volume of work
T = duration of work

1.2 Resource Leveling

Resource leveling is a method for minimizing fluctuations in resource utilization in construction projects. This technique is carried out by adjusting the schedule of non-critical activities within their float limits, without adding to the duration of the project. The main objective is to achieve a more even distribution of resource utilization over time (1).

Fluctuations in labor requirements will result in waste if not addressed promptly. In such situations, project implementers face two options: transferring workers to other projects or continuing to bear the costs of unproductive workers. Therefore, schedule adjustments are essential, particularly for non-critical activities that still have time flexibility. The schedule must be arranged in such a way that the distribution of labor becomes more ideal and efficient (4).

1.3 Microsoft Project Program

Microsoft Project is a computer application or software program used primarily for scheduling construction projects. Microsoft Project is also capable of recording and monitoring the use of human resources and equipment. The program records labor requirements, fixed costs, total project costs, and helps control the use of labor on the job to avoid overallocation (excessive use of labor)(5).

2. METHOD

This study uses a quantitative approach with a case study method, focusing on the application of resource leveling techniques in building construction projects. Data was obtained through documentation and information gathering from project implementers. Descriptive analysis was conducted on the application of resource leveling theory and methods, particularly in scheduling and workforce planning.

2.1 Research Object

The object of this study is the Bandung Islamic Hospital Construction Project, using a case study approach related to the objectives of the study. This construction project is owned directly by Bandung Islamic University. The 10-story building is intended as a health and safety facility located in the Nagreg area of West Java. The use of the case study method is based on the issues encountered in the field, with data provided by the implementing party. This data is then analyzed, specifically through calculations and the allocation of available human resources.

2.2 Data Inventory

The main data in this study consists of Detailed Engineering Design (DED), Actual Work Duration, Number of Workers in the Field, and Worker Coefficient. DED is used as a model to calculate the volume of structural work. The following is the structural work duration data for the first floor.

Table 1 Structural work duration data

Structural Work Duration						
	No	Item	Duration	Start	Finish	Predecessors
		Beamn				
Ground Floor	3	Reinforcement	21	Wed 01/11/23	Fri 24/11/23	
	4	Formwork	21	Thu 02/11/23	Sat 25/11/23	3SS+1 day
	5	Concreate casting	10	Fri 01/12/23	Tue 12/12/23	9FF

	Slab				
7	Reinforcement	21	Wed 15/11/23	Fri 08/12/23	3SS+12
8	Formwork	21	Thu 02/11/23	Sat 25/11/23	3SS+1 day
9	Concreate casting	10	Fri 01/12/23	Tue 12/12/23	7SS+14
	Column				
11	Reinforcement	17	Fri 08/12/23	Wed 27/12/23	9SS+6
12	Formwork	20	Sat 09/12/23	Mon 01/01/24	11SS+1 day
13	Concreate casting	12	Fri 22/12/23	Wed 03/01/24	11SS+12

3. Results and Discussion

3.1 Calculation of Labor Requirements

In calculating labor requirements, several pieces of information are needed, either from the construction contractor or from your own calculations or research. Based on the references outlined earlier, the data/information required for labor planning includes volume, duration, and work coefficients (Husein, 2009). Therefore, the labor requirement calculation will be as follows. Given the information on the steel reinforcement work for the first-floor columns:

Work Volumn = 93537.52 Kg

Duration = 17 days

Coefficient = 0.0016

Number of workers:

$$N = \frac{k\ x\ v}{T}$$
$$= \frac{0.0016\ x\ 93537.52}{17}$$
$$= 8.8035$$
$$\approx 9\ People$$

The calculation is performed for each floor and work.

Table 2 Calculation of the number of workers

No	Item Pekerjaan	Volume	Durasi	Koef	Jumlah pekerja
	Lantai 1				
1	Beam				
	Reinforcement	65852.69	21	0.0016	6
	Formwork	2618.49	21	0.22	28
	Concreate casting	284.74	10	0.16	5
2	Slab				
	Reinforcement	41342.19	21	0.0008	2
	Formwork	3356	21	0.22	36
	Concreate casting	419.53	10	0.16	7
3	Column				
	Reinforcement	93537.52	17	0.0016	9
	Formwork	1813.74	20	0.22	20
	Concreate casting	312.08	12	0.4	11

3.2 Microsoft Project Input

Once the planning data has been obtained, the next step is to enter it into Microsoft Project software. This process includes inputting the project profile, start and end dates, working hours, job duration, number of workers, and relationships between activities (predecessors). The results of data processing are displayed in the form of a Gantt Chart and histogram.

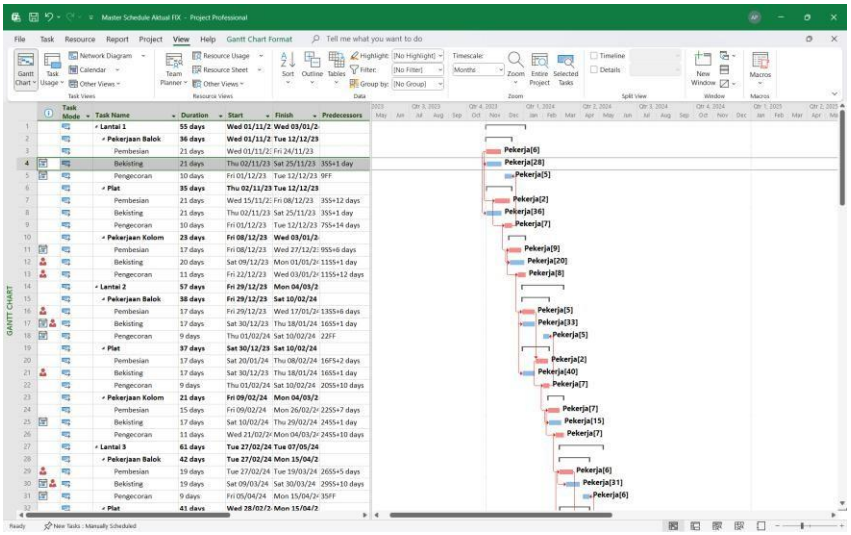


Figure 1 Gantt Chart Display

The workforce histogram in Microsoft Project illustrates the quantity of workforce required for each period. The amount of workforce is contributed by each job included in that period.

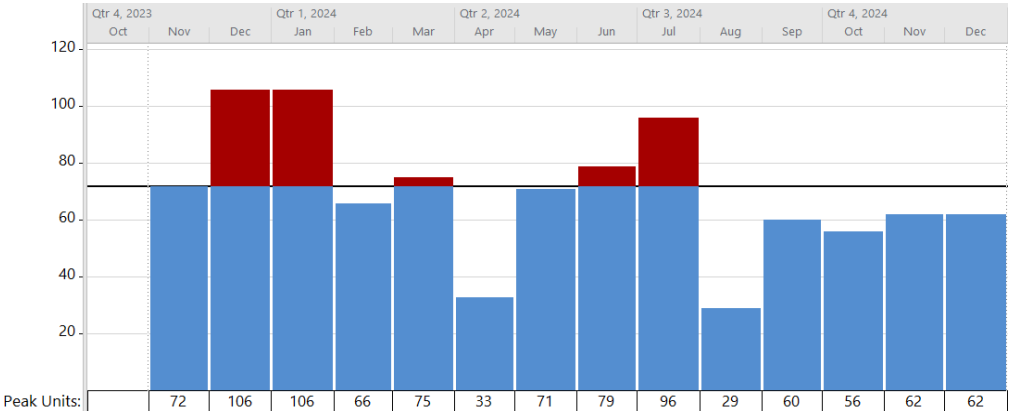


Figure 2 Workforce plan histogram

Based on the workforce histogram, it can be seen that upper structure work is overallocated or has excess workforce requirements in certain periods. Only 72 workers are available in the field, according to previous data. Meanwhile, in December 2023 and January 2024, the peak demand for workers reached 106 workers. This indicates that over-allocation occurred in December and January by 34 workers, followed by subsequent months: March by 3 workers, June by 7 workers, and July by 24 workers. Additionally, labor demand also shows a fluctuating trend.

3.3 Resource Leveling with Autoschedule and Manual Schedule Methods

The process of leveling labor resources is carried out in two stages, which will ensure that the implementation of structural work in the field does not exceed the available resource capacity. The following are the project statistics from the time schedule for the implementation of structural work in the field before leveling.

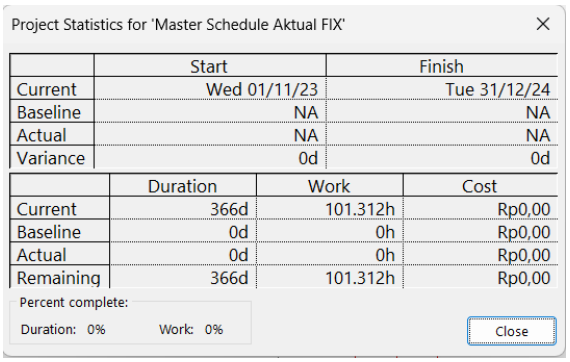


Figure 3 Actual Project Statistics

The first leveling stage uses the auto schedule method. Auto schedule is a feature offered directly by Microsoft Project to provide solutions to related problems. However, leveling using this method is considered ineffective because the results of leveling still exceed the available resources and show fluctuating trends, as shown in the following figure:

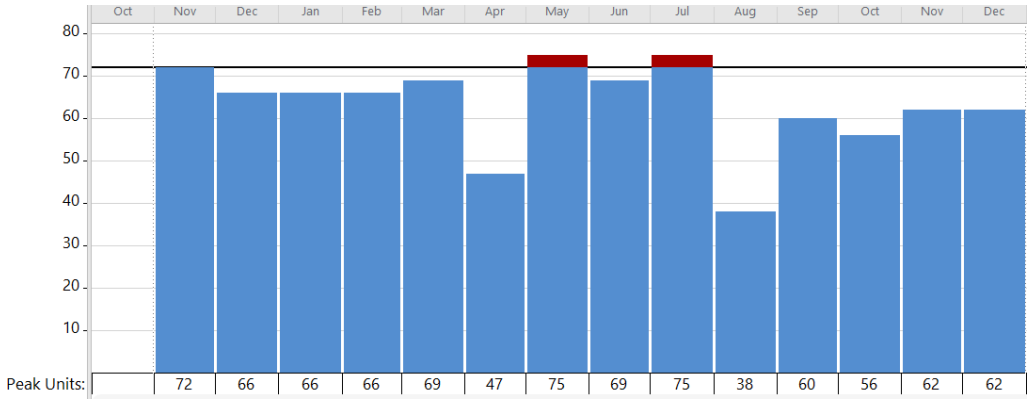
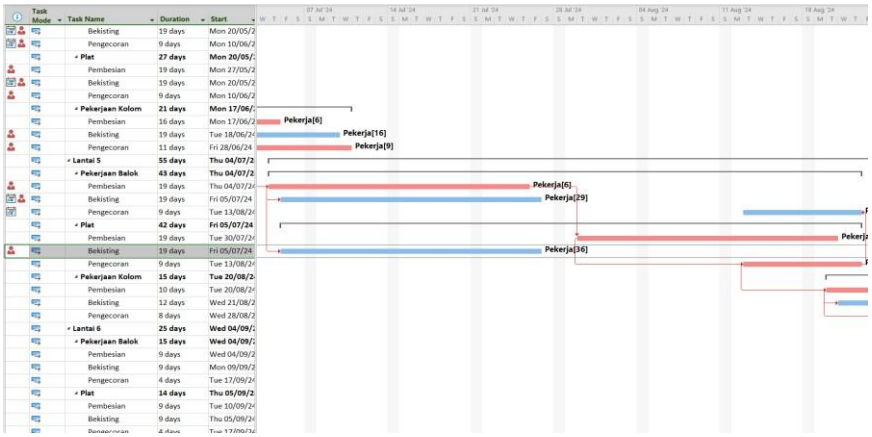


Figure 4 Leveling with the autoschedule method

Therefore, resource leveling was carried out again through Resource Leveling Analysis, followed by a manual schedule method. This method was carried out by shifting/accelerating/delaying non-critical activities during the float period. In the case shown in the following figure, the installation of the slab formwork began one day after the beam reinforcement was completed. This activity was included in the time schedule as a non-critical activity, so it could be delayed without disrupting other activities.



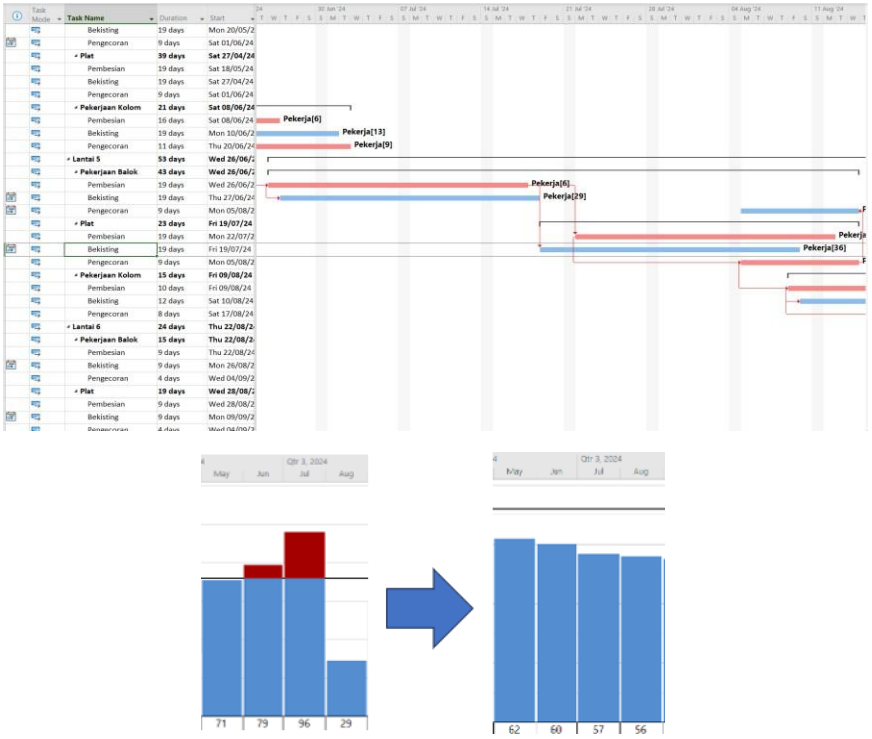


Figure 5 Leveling using the manual schedule method

After performing leveling using the manual schedule method, the labor requirement histogram becomes as follows

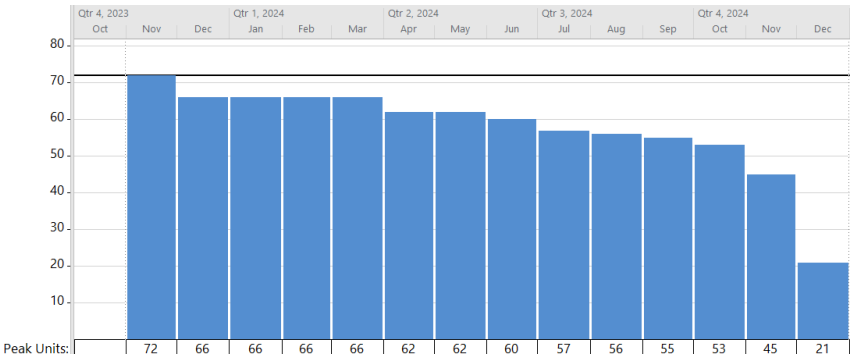


Figure 6 Results of resource leveling using a two-stage method

The histogram of the Resource Leveling Analysis results shows that the labor requirement does not exceed the availability in the field, which is 72 workers. The labor requirement also illustrates a downward distribution pattern graph, which is in line with the theory presented earlier that good resource planning is one that does not experience fluctuations and shows one of the four distribution pattern graphs (4).

Project Statistics for 'Master Schedule Aktual FIX Setelah Leveling'

	Start	Finish
Current	Wed 01/11/23	Fri 06/12/24
Baseline	NA	NA
Actual	NA	NA
Variance	0d	0d

	Duration	Work	Cost
Current	345d	100.840h	Rp0,00
Baseline	0d	0h	Rp0,00
Actual	0d	0h	Rp0,00
Remaining	345d	100.840h	Rp0,00

Percent complete:
Duration: 0% Work: 0%

Close

Figure 7 Project statistics after leveling

From the static project data, it can be seen that the total duration for the implementation of structural work is 345 days. The total duration of the work after Resource Leveling Analysis is 21 days faster than the implementation in the field.

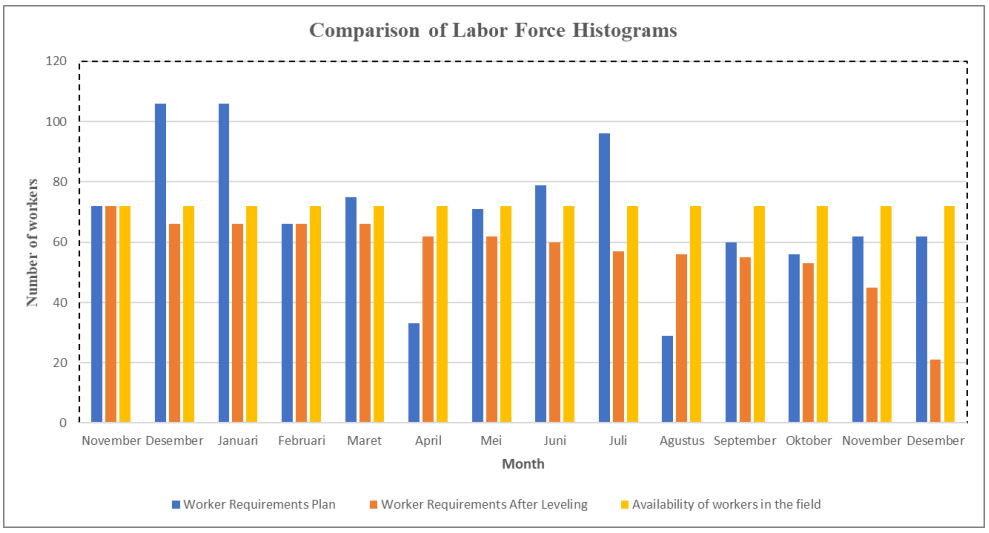


Figure 8 Histogram Comparison

4. Conclusions

Workforce planning using resource levelling in the Bandung Islamic Hospital construction project with a manual schedule resulted in an acceleration of the structural work duration, which was 21 days faster than the work in the field, namely 345 days. In addition, with the application of resource levelling, the workforce requirements in the field decreased from a peak of 106 workers to 72 workers in accordance with the availability in the field.

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