Analysis of the Acceleration of Tower Project Activities using the What/If Method

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Abstract

In the construction of the Pegadaian Tower project, the delays experienced were evidenced by the project implementation not being in accordance with the plans that had been designed before the construction process began. The project planning made by the contractor is planned for the topping off process or final floor casting of the superstructure construction phase to be carried out in September 2022 or in the 18th month of the total 25 months of work on this project. Efforts made to adjust the implementation of the plan were to accelerate this project, where the acceleration was carried out using the What/If method by adding working hours (overtime) and the number of workers at the research object who worked on the Mezzanine floor to the 5th floor at the superstructure stage. Apart from the What/If method as an acceleration solution, initial efforts were made by evaluating the project schedule using the Precedence Diagramming Method (DPM) network planning method with the help of Microsoft Project software. The analysis carried out resulted in good acceleration where the acceleration analysis using the What/If method can speed up the completion of superstructure construction so that it can help achieve the topping off target in September according to what has been planned in the schedule. Meanwhile, adding labor and working time to these three important activities can speed up the duration of the project so that the project avoids contract loss penalties with the owner.

Keywords: construction, what/if method, acceleration, precedence diagramming method, Microsoft Project

1. Introduction

Until the middle of 2022, Indonesia is recorded to have 275.77 million people spread across 34 provinces and 17,000 islands. The increasing population in Indonesia has led to an increase in the need for housing and transportation areas. Therefore, infrastructure development for the community needs to be increased in all parts of Indonesia. Improvements in facilities throughout Indonesia have resulted in building density so that the availability of land is increasingly narrow in big cities such as the capital city of Jakarta. Therefore, high-rise buildings are one of the types of buildings that are chosen by the community to be a place to live and are the right choice for companies that want to enlarge their office buildings because they can help efficient use of land in urban areas with a broader community capacity, such as Pegadaian Tower development.

The Pegadaian Tower is one of the supporting facilities to reduce building density in the Salemba area, Central of Jakarta. In this project, there was a delay in work where the target set for completion of the superstructure construction was September based on the schedule. However, there were obstacles in its implementation due to the workers' lack of productivity, so they could not complete according to the target. The impact caused by the delay in the completion of the structural construction

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section hinders further work, which impacts increasing project implementation time.

To be able to complete this project following the planned target, proper project management is needed. The definition of project management itself is a discipline in terms of planning, organizing, and managing to achieve project goals. In overcoming these problems, research on the anticipation of delays in project completion time was carried out [1-4]. The important thing that must be considered in order to get a logical result is scheduling. Scheduling is essential because every activity carried out during construction is well planned to impact project completion positively. In this study, the alternative used is the What/If Analysis method by adding labor and working time [5-6].

What/If analysis is an effort to use a relatively short time by considering the project's critical path in determining activities that can be shortened by using the Critical Path Method (CPM) to achieve a job with better results and benefits. In addition, this research will use the help of Microsoft Project 2021 software and Microsoft Excel. It is expected that using these methods and software can produce logical and realistic scheduling so that the duration of the construction work is carried out according to what has been planned so that it does not have an impact on the next construction stage.

2. Material and Method

The data obtained is in the form of calculating work time from three work activities in each zone on each floor to determine the critical path using Microsoft Project 2021 software as a data input and processing tool. Next, the calculation of the addition of the number of workers and the addition of overtime hours is carried out using the Microsoft Excel. The study methodology is shown in Fig. 1.

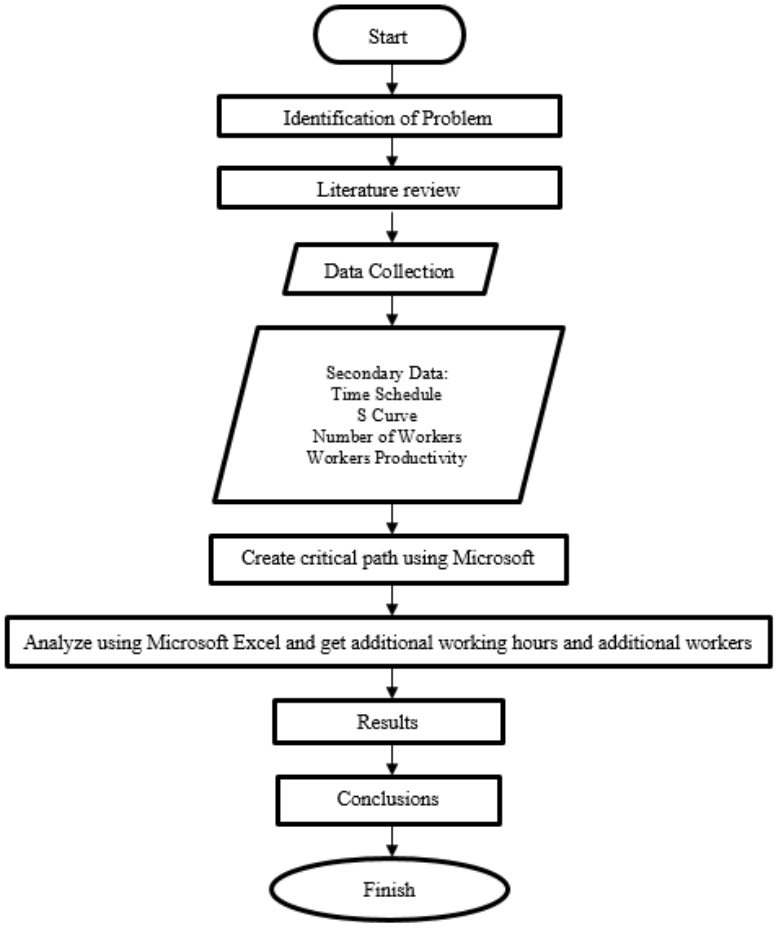

Fig. 1 Study methodology

The What/If analysis method [5-7] is a technique to speed up the duration of the completion of a project that is late by adding resources in the form of increasing the number of workers according to the needs of the implementation of activities in the field and adding overtime hours from a total of 8 hours of regular work on activities that are experiencing a critical path and need to be prioritized for resolution. This method is significant to use as a reference for increasing the number of workers and adding overtime hours to contractors as service providers to make them more efficient and effective in speeding up work in a construction project [8-9]. This research begins by analyzing the critical paths of the three essential activities in constructing the superstructure from the Mezzanine floor research object to the 5th floor of each work zone in the project work schedule. Table 1 and 2 show the activities that must be prioritized in completing the work, where these results are obtained from searching for critical paths using the Critical Path Method assisted by Microsoft Project software.

Table 1 Critical Path Method

Task Name	Duration (days)	Task Name	Duration (days)	Task Name	Duration (days)	Task Name	Duration (days)	Task Name	Duration (days)
Mezzanine Floor	36 days	2nd Floor	58 days	3rd Floor	18 days	4th Floor	16 days	5th Floor	18 days
C	8 days	A	10 days	A	8 days	A	5 days	A	8 days
Reinforcing	3 days	Reinforcing	4 days	Reinforcing	3 days	Reinforcing	2 days	Reinforcing	3 days
Formwork	3 days	Formwork	4 days	B	8 days	Formwork	2 days	Formwork	3 days
Casting	2 days	B	9 days	Reinforcing	3 days	Casting	1 day	B	12 days
A	16 days	Reinforcing	3 days	C	8 days	B	9 days	Reinforcing	4 days
Reinforcing	8 days	Formwork	3 days	Reinforcing	3 days	Reinforcing	3 days	Formwork	4 days
B	18 days	D	13 days	Formwork	3 days	C	9 days	Casting	4 days
Reinforcing	10 days	Reinforcing	6 days	Casting	2 days	Reinforcing	3 days	C	12 days
D	11 days	Formwork	6 days			Formwork	3 days	Reinforcing	4 days
Reinforcing	5 days	Casting	1 day					Formwork	4 days
Formwork	4 days							Casting	4 days

Table 2 The data on work volume

Working Floor	Volume		
	Reinforcing	Formwork	Casting
Mezzanine	69.45	1487.25	316.50
2	79.48	1389.05	373.69
3	27.14	764.05	303.69
4	27.14	643.05	207.19
5	23.30	644.55	207.19

The additions to the number of workers are made using Microsoft Excel with the formula as follows [7], where a is the normal productivity per day, c is the crash productivity, and d is the crash duration.

$$a = \frac{Volume}{Normal\ Duration} \quad (1)$$

$$c = a + \frac{a\ x\ extra\ manpower}{manpower} \quad (2)$$

$$d = \frac{Volume}{c} \quad (3)$$

3. Results and Discussion

In increasing the number of workers, things that need to be considered are the workforce requirements of the job and the capacity of the scope of work available in the field, taking into account the health and safety of the workers in the field. The addition of workers to the implementation of each job must not have a negative impact, hindering other workers from completing other work currently underway simultaneously. In addition, it is also necessary to carry out good supervision of the workforce where the crowded workspace results in reduced productivity in the workforce (Table 3). In adding the number of workers, it is calculated and added using worker data from the data that has been compiled by the engineer of PT. Pembangunan Perumahan (PP) for the Pegadaian Tower development project (Table 4 and 5).

Table 3 The labor productivity monitoring data

MONITORING HARIAN
PEKERJAAN BEKISTING DAN PERANCAH
PT WKS, PROYEK PEGADAIAN TOWER

No.	Tanggal	Zona	Variabel	Sat.	Jenis Pekerjaan									Total/Rerata	Sat.
					Pasang Horisontal (Balok)	Pasang Vertikal (Kolom)	Bongkar Bekisting	Pasang Perancah	Bongkar Perancah	Reshoring	Pasang Tangga	Pembersihan (K3)	Finishing		
450	37	24/05/2022	A	Progress	m^3		10		220				220	10	460	m^3
451				Manpower	orang		9		8		-		2	2	21	orang
452				Produktivitas	m^2/OH	-	1	-	28	-	-	-	110	5	14	m^2/OH
453			B	Progress	m^3	441	8		441				441	8	1.340	m^3
454				Manpower	orang	4	12		5		-		2	2	25	orang
455				Produktivitas	m^2/OH	110	1	-	88	-	-	-	221	4	42	m^2/OH
456			C	Progress	m^3	485	15		220				485	15	1.220	m^3
457				Manpower	orang	6	12		11		-		2	2	33	orang
458				Produktivitas	m^2/OH	81	1	-	20	-	-	-	243	7	35	m^2/OH
459	38	25/05/2022	A	Progress	m^3			220		220			220	10	670	m^3
460				Manpower	orang			2		3	-		2	2	9	orang
461				Produktivitas	m^2/OH	-	-	110	-	73	-	-	110	5	30	m^2/OH
462			B	Progress	m^3	441	8					441	441	8	1.781	m^3
463				Manpower	orang	10	15				-	4	2	2	38	orang
464				Produktivitas	m^2/OH	44	1	-	-	-	-	110	221	4	47	m^2/OH
465			C	Progress	m^3				220				485	15	1.205	m^3
466				Manpower	orang				6		-		2	2	13	orang
467				Produktivitas	m^2/OH	-	-	-	37	-	-	-	243	7	45	m^2/OH
468			A	Progress	m^3			220		220			220	10	670	m^3
469				Manpower	orang			2		3	-		2	3	10	orang

FORM HARIAN BEKISTING | FORM HARIAN BESI | GRAFIK

Table 4 Extra manpower data

Worker	Foreman/Subcontractor	Before	Now	Plan	Lack
Reinforcing	GND	35	50	85	35
Formwork	PT. WKS	51	94	118	24
Casting	SPR	10	11	18	7
Total		96	155	221	66

According to research conducted, an alternative that can be taken to complete the project is to add working hours to the total regular working hours in a day. The addition of working hours for each job is carried out by following the decree of the Minister of Manpower and Transmigration of the Republic of Indonesia concerning overtime working time and overtime pay, wherein article 1, paragraph 1 of the ministerial decree indicates that “Overtime is work time that exceeds 7 (seven) hours a day and 40 (forty) hours 1 (one) week for 6 (six) working days in 1 (one) a week or 8 (eight) hours a day, and 40 (forty) hours 1 (one) week for 5 (five) working days in 1 (one) a week or working hours on weekly rest days and or on official holidays determined by the government.” Furthermore, in article 3, paragraph 1, which states that “Overtime can only be done for a maximum of 3 (three) hours in 1 (one) day and 14 (fourteen) hours in 1 (one) week. Overtime hours are carried out after regular working hours are finished where the standard working time of the workers is 8 hours a day, starting at 08.00 and ending at 17.00 with one-hour break from 12.00 until 13.00.”

The addition of working hours (overtime) is carried out by adding 3 hours of working duration following the work to be carried out regarding the decision of the Minister of Manpower and Transmigration of the Republic of Indonesia and considering Occupational Health and Safety (HSE) in the workforce to avoid accidents in the field. The more significant the increase in the duration of work, the greater the indication of a decrease in productivity for each worker due to the additional working hours (overtime). The addition of working hours (overtime) decreases each worker's productivity during regular

working hours. The decrease is caused by workers feeling tired, having limited sight at night, and temperatures turning colder. Productivity for each workforce is calculated based on a graph [10] indicating a decrease in productivity caused by additional working hours (Fig. 2 and Table 6).

Table 5 Calculation of additional manpower

Work Area	Type of Work	Duration (days)	Volume	Manpower	Duration of Working Hours	Productivity /Day	Extra Manpower	Crash Productivity	Crash Duration
Mezzanine									
C	Reinforcing	3	69.453	8	8	23.15	2	28.939	2
	Formwork	3	1487.250	4	8	495.75	2	743.625	2
	Casting	2	316.500	5	8	158.25	1	189.900	2
A	Reinforcing	8	69.453	5	8	8.68	4	15.627	4
B	Reinforcing	10	69.453	5	8	6.95	3	11.112	6
D	Reinforcing	5	69.453	6	8	13.89	3	20.836	3
2nd Floor									
A	Reinforcing	4	79.479	6	8	19.87	2	26.493	3
	Formwork	4	1389.048	5	8	347.26	2	486.167	3
B	Reinforcing	3	79.479	6	8	26.49	2	35.324	2
	Formwork	3	1389.048	5	8	463.02	2	648.222	2
D	Reinforcing	6	79.479	4	8	13.25	4	26.493	3
	Formwork	6	1389.048	4	8	231.51	4	463.016	3
	Casting	1	373.690	5	8	373.69	1	448.429	1
3rd Floor									
A	Reinforcing	3	27.139	3	8	9.05	2	15.077	2
B	Reinforcing	3	27.139	4	8	9.05	2	13.569	2
C	Reinforcing	3	27.139	5	8	9.05	2	12.665	2
	Formwork	3	764.048	5	8	254.68	2	356.556	2
	Casting	2	303.690	5	8	151.85	1	182.214	2
D	Reinforcing	3	27.139	6	8	9.046	2	12.062	2
	Formwork	3	764.048	5	8	254.683	2	356.556	2
	Casting	2	303.690	5	8	151.845	1	182.214	2
4th Floor									
A	Reinforcing	2	27.139	4	8	13.57	2	20.354	1
	Formwork	2	643.048	4	8	321.52	2	482.286	1
	Casting	1	207.190	5	8	207.19	0	207.190	1
D	Reinforcing	2	27.139	5	8	13.5695	2	18.997	1
	Formwork	2	643.048	5	8	321.524	2	450.134	1
5th Floor									
B	Reinforcing	4	23.296	6	8	5.82	2	7.765	3
	Formwork	4	644.548	5	8	161.14	2	225.592	3
	Casting	4	207.190	3	8	51.80	2	86.329	2
C	Reinforcing	4	23.296	5	8	5.82	2	8.154	3
	Formwork	4	644.548	5	8	161.14	2	225.592	3
	Casting	4	207.190	4	8	51.80	2	77.696	3
		113					66		76

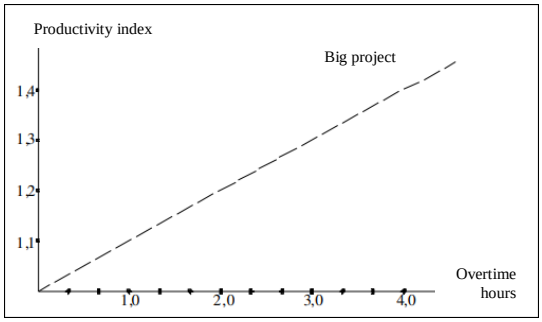

Fig. 2 Indication of decreased productivity in the workforce

Table 6 Calculation result of decreased productivity in manpower

Overtime Hours	Decreased Productivity Index	Productivity Reduction Coefficient	Work Performance Percentage (%)
A	B	C=A/B	D=C×100%
1	1.1	0.9	90%
2	1.2	0.8	80%
3	1.3	0.7	70%

Table 7 Calculation result of additional working hours (overtime)

Work Area	Type of Work	Duration	Volume	Manpower	Duration of Working Hours	Productivity/ Day	Productivity/ Hour	Extra Working Hour	Coefficient	Crash Productivity	Crash Duration
Mezzanine											
C	Reinforcing	3	69.453	8	8	23.15	2.894	3	0.7	29.228	2
	Formwork	3	1487.250	4	8	495.75	61.969	3	0.7	625.884	2
	Casting	2	316.500	5	8	158.25	19.781	3	0.7	199.791	2
A	Reinforcing	8	69.453	5	8	8.68	1.085	3	0.7	10.960	6
B	Reinforcing	10	69.453	5	8	6.95	0.868	3	0.7	8.768	8
D	Reinforcing	5	69.453	6	8	13.89	1.736	3	0.7	17.537	4
2nd Floor											
A	Reinforcing	4	79.479	6	8	19.87	2.484	3	0.7	25.086	3
	Formwork	4	1389.048	5	8	347.26	43.408	3	0.7	438.418	3
B	Reinforcing	3	79.479	6	8	26.49	3.312	3	0.7	33.447	2
	Formwork	3	1389.048	5	8	463.02	57.877	3	0.7	584.558	2
D	Reinforcing	6	79.479	4	8	13.25	1.656	3	0.7	16.724	5
	Formwork	6	1389.048	4	8	231.51	28.938	3	0.7	292.279	5
	Casting	1	373.690	5	8	373.69	46.711	3	0.7	471.784	1
3rd Floor											
A	Reinforcing	3	27.139	3	8	9.05	1.131	3	0.7	11.421	2
B	Reinforcing	3	27.139	4	8	9.05	1.131	3	0.7	11.421	2
C	Reinforcing	3	27.139	5	8	9.05	1.131	3	0.7	11.421	2
	Formwork	3	764.048	5	8	254.68	31.835	3	0.7	321.537	2
	Casting	2	303.690	5	8	151.85	18.981	3	0.7	191.704	2
D	Reinforcing	3	27.139	6	8	9.05	1.131	3	0.7	11.421	2
	Formwork	3	764.048	5	8	254.68	31.835	3	0.7	321.537	2
	Casting	2	303.690	5	8	151.85	18.981	3	0.7	191.704	2
4th Floor											
A	Reinforcing	2	27.139	4	8	13.57	1.696	3	0.7	17.131	2
	Formwork	2	643.048	4	8	321.52	40.190	3	0.7	405.924	2
	Casting	1	207.190	5	8	207.19	25.899	3	0.7	261.578	1
D	Reinforcing	2	27.139	5	8	13.57	1.696	3	0.7	17.131	2
	Formwork	2	643.048	5	8	321.52	40.191	3	0.7	405.924	2
5th Floor											
B	Reinforcing	4	23.296	6	8	5.82	0.728	3	0.7	7.353	3
	Formwork	4	644.548	5	8	161.14	20.142	3	0.7	203.435	3
	Casting	4	207.190	3	8	51.80	6.475	3	0.7	65.394	3
C	Reinforcing	4	23.296	5	8	5.82	0.728	3	0.7	7.353	3
	Formwork	4	644.548	5	8	161.14	20.142	3	0.7	203.435	3
	Casting	4	207.190	4	8	51.80	6.475	3	0.7	65.394	3
		113									90

Calculating the addition of working hours (overtime) will shorten the completion of each activity carried out shortened in each activity (Table 7). This calculation follows the following procedure, namely (i) known volume of work, known duration of work during regular working hours, (ii) manpower productivity per day occurs after the addition of working hours (overtime) for each activity with the assumption of working in one day for eight regular working hours plus three working hours (overtime). All regular workers participate in overtime work, and there is no additional worker either in regular or overtime work.

4. Conclusions

Based on the results of the analysis and calculations in this study, conclusions can be drawn on the following. The acceleration using the What/If method can make the objectives of this research achieved, where the most efficient solution is to adding workers to make topping off that has been planned by the contractor on the planned schedule to the owner in September can occur so that the contractor avoids late penalties from the agreed contract. The acceleration of adding 66 workers can speed up delays, from 277 working days, the superstructure can be completed in 221 working days so that the topping off in November is carried out in September. The project acceleration with the What-If Method can take place properly and efficiently if the material for a project is always supplied adequately without any problems so that there are no work activities that the workforce can carry out.

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