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Cost and Time Comparison Analysis Using Microsoft Project (Case Study: Phase VII Work of the Surabaya Tanjung Perak Berlian Pier Structure Strengthening Project)

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A B S T R A C T

Sometimes the execution of a project does not proceed smoothly because there are barriers that impede the present work. Uncertain weather conditions are one of the most common challenges encountered in the field during the Tanjung Perak Diamond Pier Structure Strengthening project in Surabaya. This is because the initial planning did not account for the weather conditions that would occur during the project's implementation. As a result, rescheduling is carried out to generate a reasonable and realistic timetable. Many strategies are employed in scheduling, with the expectation that the method will help in planning and scheduling. The goal of this research is to determine the time necessary for project implementation after rescheduling. This research is analytical in character. Secondary data, such as schedules and Budget Plans (RAB), are collected by directly requesting the necessary data from related parties, then evaluating the initial schedule, and finally preparing a new schedule using Microsoft Project tools and the Critical Path Method (CPM). The results of this study obtained a rescheduling duration of 99 days, 22 days faster than the actual planned duration of 121 days, and a fee of IDR. 28,535,441,605 of the initial planned cost of IDR. 35,017,986,296.10.

1. Introduction

Construction projects are a series of sensitive work mechanisms because every aspect of a construction project influences one another[1]. During the implementation of construction projects, there is often a discrepancy between the planned schedule and the realization on the ground which can result in an increase in implementation time and an increase in implementation costs so that project completion is hampered [2]. The causes of delays that often occur are due to changes in the project situation, design changes, the influence of weather factors, inadequate workers, material or equipment needs, planning errors, or specifications[5]. Delays in the implementation of construction projects can be overcome by accelerating the

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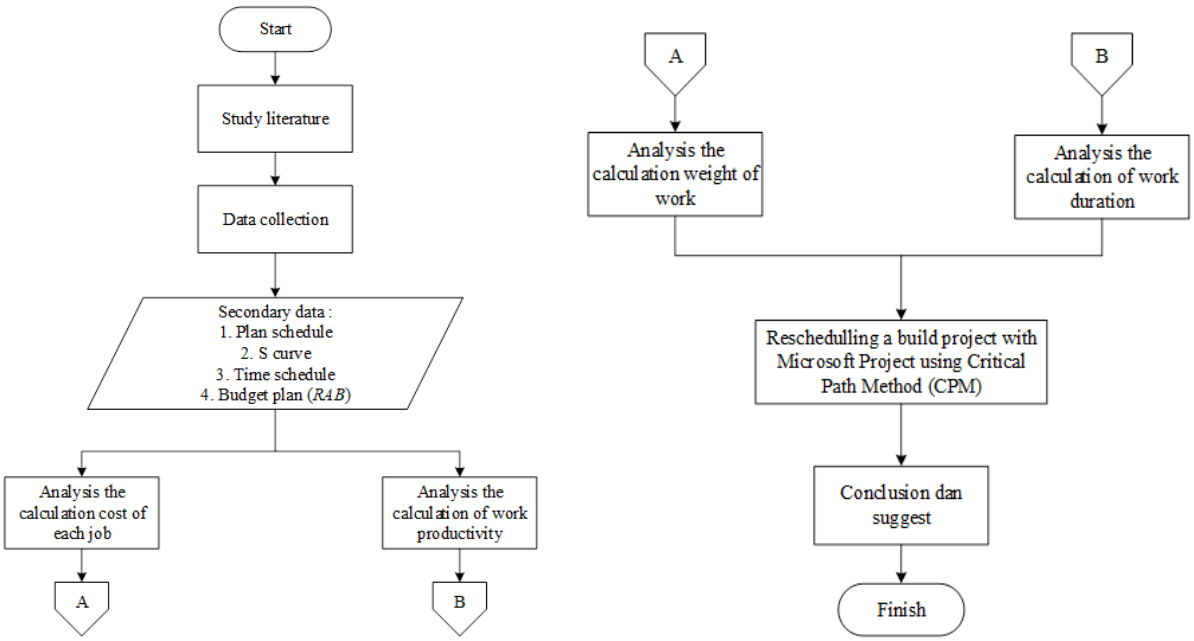
implementation to achieve the target plan [20]. In this study, to be able to carry out a construction project such as the Tanjung Perak Diamond Pier Structural Strengthening Work project in Surabaya, project management is required. In a job, it is found that one of the obstacles that is often encountered in the field in the Tanjung Perak Surabaya Diamond Pier Structural Strengthening Work project is the time condition, This is because in carrying out the initial planning the planners did not consider the time calculations that would occur during project implementation. The impact caused by the short time condition is the delay in the project which increases the duration of the work and the budget for the implementation of the project. In overcoming project delays that occur due to a short time, it is necessary to reschedule the development project, to facilitate project rescheduling in carrying out each project activity, it is necessary to do it sequentially and on time [4]. To start calculating project costs, you need to use software starting from Microsoft Excel, Microsoft Project, and others [3]. In this study, the authors used software, namely (software) Microsoft Project, for the basis of calculations on Microsoft Project using the Critical Path Method (CPM) as a support for this research [6].

By the research background described above, this study proposes problem identification, namely calculating how much money is obtained after rescheduling with Microsoft Project using the Critical Path Method (CPM) [7]. In this study, there is also a need to limit writing problems due to limited data [9]. The limitations of the problem are first, rescheduling is done using special scheduling software, namely Microsoft Project 2019, for basic calculations on Microsoft Project using the Critical Path Method (CPM) [8]. Second, this study only analyzes the work of stage VII kade 426 to 228 on the Tanjung Perak Diamond Pier Structure Strengthening Work project in Surabaya. And third, this research is only rescheduling to speed up project implementation[10].

From the description of the existing problem formulation, the focus of this study aims to compare the results of the total duration and final costs of implementing the project after rescheduling with the Microsoft Project [11].

2. Research Method

The following is a flowchart of the research implementation of the Rescheduling of the Tanjung Perak Berlian Pier Structural Strengthening Project, Surabaya using Microsoft Project.



(Source: Author, 2023)

Figure 1. The flowchart above is an explanation of the research flow used to solve the research problem

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3. Description and Technical

Research Methods

Research techniques are part of a research step that is useful for finding solutions to existing problems so research can be very useful in solving existing difficulties [12]. In the problem-solving process, research methodology can also present alternative explanations as an option. This rescheduling implements Microsoft Project 2019, with the Critical Path Method (CPM) as a calculation tool [13].

Research Subjects

Individuals or objects that are used as research subjects are something that is used as a source of information for data collection in a study [14].

The subject of this study was the Rescheduling of the Tanjung Perak Berlian Pier Structure Strengthening Project, Surabaya using the Microsoft Project [15]. The basic calculations on Microsoft Projects using the Critical Path Method (CPM)[16].

Data collection

Data collection is carried out by directly requesting the required data from related parties[17]. The data obtained is secondary data. The data obtained are in the form of:

1. Schedule Plan
2. S-Curve
3. Time Schedule
4. Recapitulation of the Budget Plan

4. Results and Discussions

Data Analysis

Before further discussing rescheduling, we will explain related data from the schedule for the implementation of the Tanjung Perak Diamond Pier Structure Strengthening project in Surabaya, which experienced a scheduling discrepancy. As for the discrepancy in the schedule that occurred during project implementation, that is, the scheduling plan should have started on January 1, 2022, and ended on March 31, 2022, with a total of 90 days, but the realization in the field began on January 8, 2022, and ended May 10, 2022 with a total of 121 days, which means having a duration of 31 days longer than the planned schedule. Besides that, after obtaining the progress data of the entire work, there are still many that are not according to schedule, resulting in the overall progress of the work not achieving 100% results, therefore The solution to overcome the discrepancy in the schedule is by rescheduling the schedule for the Wharf Structure Reinforcement project Tanjung Perak Surabaya.

Rescheduling of the Surabaya Tanjung Perak Berlian Pier Structure Strengthening Project

The following are the steps required in rescheduling:

1. Perform RAB calculations in which the volume and unit price of each job are obtained, and in rescheduling this the direct costs do not change, This is because there is no additional volume of work, and the indirect costs have changed, this is due to -costs related to indirect costs will still increase with increasing duration and schedule discrepancies.[17] The following is the initial plan for RAB recapitulation:

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Table 1. RAB recapitulation

Number	Job type	Total Unit Cost (IDR)
1	**Pile Work**	16,621,226,739.11
1.1	Steel Pipe Sheet Pile	3,045,087,220.00
1.1.1	Procurement SPSP Ø = mm, t=mm, L=m'	235,331,000.00
1.1.2	Procurement Joint Type Clutch (Type C - T)	1,411,679,364.00
1.1.3	Transport to Location and Positioning	-
1.1.4	Erection	1,525,200.00
1.1.5	Splicing	808,126,328.98
1.1.6	Cutting	16,621,226,739.11
1.1.7	Marine Painting	3,045,087,220.00
1.1.8	Sacrificial Anode Cathodic Protection – Aluminium Anode	927,985,200.00
1.1.9	Pile fin plate work	52,699,320.00
1.1.10	Clutch Cover Work	11,263,560.00
2	**Concrete Works**	
2.1	Concrete Filling Poles – Concrete K.430	198,920,388.08
2.21	Rebar Filling Pole	403,383,487.75
2.2	Clutch filler concrete – K.430 concrete	41,228,613.96
2.3	Concrete Capping Beam – Concrete K.430	1,536,967,750.96
2.3.1	Rebar Capping Beam	1,869,558,304.03
2.3.2	Capping Beam Formwork	737,271,489.67
2.3.3	4" PVC pipe	3,950,100.00
2.4	Kanstin Concrete – Concrete K.430	8,169,515.64
2.4.1	Rebar Kanstin	13,970,777.66
2.4.2	Kanstin Formwork	4,013,900.80
2.4.3	Canstin painting	5,421,741.68
3	**Join Filler**	272,975.40
4	**Completeness and Accessories Work**	
4.1	Existing Fender Dismantling Work	81,100,250.00
4.2	Existing Bollard Dismantling and Trimming Work	9,632,040.00
4.3	Fender Cone 1100, Include Frontal Frame	3,730,090,800.00
4.4	Bollard Cap. 100 Tons	186,010,240.00
4.5	Companion Bollard Addition Work	16,620,740.00
4.6	Access Ladder	105,228,600.00
4.7	Procurement and installation of Kade meters	10,346,840.00
5	**Demolition Work**	
5.1	Demolition (Concrete Chipping)	33,315,049.05
5.2	Disposal of Demolition Materials (Concrete Chipping)	10,722,513.87
6	**Stockpile Work**	
6.1	Sand Dump Work	1,025,236,901.67
7	**Closing / Duct Cover Work**	
7.1	Elbow Steel L.75.75.6	-
7.1.1	Elbow Steel L.75.75.7 (80 Thickness)	155,632,892.80
7.2	Chequered Plate t = 6mm	-
7.2.1	Chequered Plate t = 6mm (Tebal 80)	180,971,412.24
8	**Duct Corner Protector Work**	-
8.1	Angle steel L.75.75.6	-
8.1.1	Angle steel L.75.75.6 (80 thickness)	46,974,312.00

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8.2	Bar D13-250	2,377,873.30
9	**Pile Remaining Stacking Work**	
9.1	Transport of Remaining Piles	-
10	**Pier Levelling Work**	
10.1	Dismantle Existing Paving	7,156,606.36
10.2	Procurement and Installation of K-500 Quality Paving	842,770,753.99
10.3	Lean Concrete Concrete Quality K-125	607,235,109.82
10.4	Disposal of Paving Leveling Demolition Materials	3,667,004.78
10.5	Lean Concrete Formwork	24,861,853.20
	Total	35,017,986,296.10

Source: project data (2022).

2. After the unit price for each job is obtained from the Budget Plan, the next step is to calculate the total cost of each job, while calculating the total cost of each job.
3. After obtaining the total cost of each job and the value of the project, the next step is to calculate the weight of the work.
4. The next step is to calculate the productivity of each job in a day, The Tanjung Perak Diamond Pier Structure Strengthening project in Surabaya has 8 hours of work per day, but before going further in the calculation of the previous productivity, productivity/hours is required for each each job and for the equation used for each job each is different depending on the main equipment to assist in doing the job.
5. The next step is to calculate the duration of each job. The data needed to calculate the duration of the work are the work productivity in a day and the volume of the work.
6. After getting the duration of the work, it can be seen the number of variations that occur between the duration of the plan and the duration of the rescheduling results. Rescheduling is done by putting the realization in the field in the form of a schedule to get a logical and realistic schedule.[18] In the planned schedule, the duration needed to complete the project at this stage is 90 days, and in reality, there is a delay of up to 121 days. From the two durations, a variation of 31 days is obtained, for 31 days the indirect costs will continue, therefore The next step is to calculate the amount of indirect costs incurred during the delay, The following are the calculation steps:
   A. Costs in construction projects are divided into two, namely Project Budget Plan and Execution Budget Plan From project data obtained Budget Plan contains information related to items needed to complete a project as a whole while the Execution Budget Plan contains information related to costs needed for resources each job. [19]
   B. To simplify the calculation, it will be assumed that the indirect cost is 15% according to the Regulation of the Policy Agency for Procurement of Goods or Services (LKPP) Number: 12 of 2021, Concerning Guidelines for the Implementation of Procurement of Goods/Services through Providers, that Calculation of Self-Estimated Prices (HPS) for Construction Work based on the results of calculating unit price costs by a planning consultant (Engineer's Estimate) based on a Detailed Engineering Design consisting of Drawings and Technical Specifications, the HPS Calculation has taken into account profits and reasonable overhead costs for Construction Works of 15%. In this calculation, it is assumed that 15% indirect costs consist of 5% overhead from the Budget Plan and 10% profit from the Budget Plan.
   C. For more details, here are the steps for the calculation:
      1. Knowing the amount of RAB obtained from project data, namely the total Project Value plus the indirect project costs of 10% multiplied by the Execution Budget

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Plan costs. From the data obtained, it is known that the Budget Plan value is Rp. 35,017,986,296.10

2. After obtaining the results of the Total Budget Plan calculation, we calculate the indirect costs which consist of 2 parts with the following division:

- Profit = 10% × Budget Plan
- Overhead = 5% × Budget Plan

Then obtained:

- Profit = 10% × Rp. 35,017,986,296.10
  = IDR. 3,501,798,629.61
- Overhead = 5% × Rp. 35,017,986,296.10
  = IDR. 1,750,899,314.81

3. After obtaining each indirect cost, the next step is to calculate indirect costs during the delay period, as follows:

Indirect costs/day = (Total Direct Costs (Overhead))/Duration
= (IDR. 1,750,899,314.81)/90
= IDR. 19,454,436.83

Then obtained indirect costs with a variation of 31 days amounted to:
= 31 days × IDR. 19,454,436.83
= IDR. 603,087,541.73

So the total indirect costs are:
= Profit + Overhead (with a variation of 31 days)
= IDR. 3,501,798,629.61 + IDR. 603,087,541.73
= IDR. 4,104,886,171.34

After the total indirect costs are obtained, the final step is to calculate the total amount of the budget plan by adding up the plan budget plus the total indirect costs. Calculation:
Total Budget Plan = planned + Total indirect costs
= IDR. 35,017,986,296.10 + IDR. 4,104,886,171.34
= IDR. 39,122,872,467.44

Indirect costs/day = (Total Direct Costs (Overhead))/Duration
= (IDR. 1,750,899,314.81)/90
= IDR. 19,454,436.83
Then obtained indirect costs with a variation of 31 days amounted to:
= 31 days × IDR. 19,454,436.83
= IDR. 603,087,541.73
So the total indirect costs are:
= Profit + Overhead (with a variation of 31 days)
= IDR. 3,501,798,629.61 + IDR. 603,087,541.73
= IDR. 4,104,886,171.34

4. After the total indirect costs are obtained, the final step is to calculate the total amount of the budget plan by adding up the plan budget plus the total indirect costs. Calculation:

Total Budget Plan = planned + Total indirect costs
= IDR. 35,017,986,296.10 + IDR. 4,104,886,171.34
= IDR. 39,122,872,467.44

7. After obtaining the duration for each job, the next step is to continue using Microsoft Project. In doing this rescheduling using Microsoft Project 2019 with the steps mentioned in the previous chapter.

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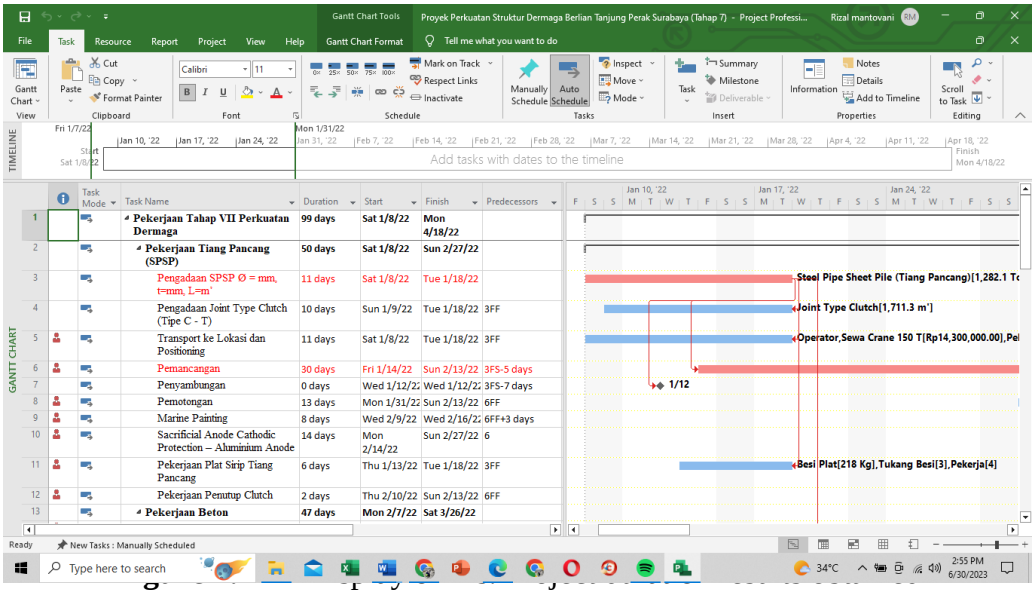
8. After all the series of steps in scheduling using Microsoft Project 2019, the rescheduling stage has been completed and the following is the result of rescheduling using Microsoft Project 2019 in the form of a display of duration after rescheduling and calculating the total cost.

Discussion of Data

After analyzing using Microsoft Project 2019, the following results are obtained:

1. The duration obtained after rescheduling is 99 days, starting from 08 January 2022 and ending on 18 April 2022 with 2 special days off. The realization in the field starts on January 8 and ends on May 10, 2022, with a total of 121 days.



2. Some work items do experience ups and downs in price value. This is because when rescheduling is carried out, the duration is added and also reduced to obtain a project duration that is completed on time. So the value also changes and goes up and down so that you get the results you want. The total cost of each job obtained using Microsoft Project 2019 is as shown in Table 1 below:

Table 2. Total Cost of Each Job Using Microsoft Project 2019

Num	Job Type	*Fixed Cost* (IDR)	*Total Cost* (IDR)
1	**Pile Work**		
1.1	Steel Pipe Sheet Pile		
1.1.1	Procurement SPSP Ø = mm, t=mm, L=m'	16,621,272,610.00	16,621,272,610.00
1.1.2	Procurement Joint Type Clutch (Type C - T)	3,045,087,220.00	3,044,402,700.00
1.1.3	Transport to Location and Positioning	235,331,000.00	25,872,000.00
1.1.4	Erection	1,411,679,364.00	89,718,000.00
1.1.5	Splicing	0	0.00
1.1.6	Cutting	1,525,200.00	5,252,000.00
1.1.7	Marine Painting	808,124,620.00	5,872,000.00
1.1.8	Sacrificial Anode Cathodic Protection – Aluminium Anode	927,985,200.00	858,292,000.00
1.1.9	Pile fin plate work	52,699,320.00	9,342,220.00
1.1.10	Clutch Cover Work	11,263,560.00	2,743,000.00
2	**Concrete Works**		
2.1	Concrete Filling Poles – Concrete K.430	198,921,675.50	180,522,500.00
2.21	Rebar Filling Pole	403,383,480.50	80,318,300.00
2.2	Clutch filler concrete – K.430 concrete	41,228,441.40	46,921,600.00
2.3	Concrete Capping Beam – Concrete K.430	1,536,973,443.60	1,515,721,220.00
2.3.1	Rebar Capping Beam	1,869,558,314.00	25,530,000.00

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2.3.2	Capping Beam Formwork	737,270,581.00	13,191,900.00
2.3.3	4" PVC pipe	3,950,100.00	11,327,400.00
2.4	Kanstin Concrete – Concrete K.430	8,172,689.50	19,026,620.00
2.4.1	Rebar Kanstin	13,970,814.00	17,818,000.00
2.4.2	Kanstin Formwork	4,013,900.80	15,517,600.00
2.4.3	Canstin painting	5,422,032.00	2,555,500.00
3	**Join Filler**	202,204.00	231,800.00
4	**Completeness and Accessories Work**		
4.1	Existing Fender Dismantling Work	81,100,250.00	12,865,000.00
4.2	Existing Bollard Dismantling and Trimming Work	9,632,040.00	9,669,100.00
4.3	Fender Cone 1100, Include Frontal Frame	3,730,090,800.00	3,269,003,050.00
4.4	Bollard Cap. 100 Tons	86,010,240.00	192,812,240.00
4.5	Companion Bollard Addition Work	16,620,740.00	4,348,000.00
4.6	Access Ladder	105,228,600.00	85,433,000.00
4.7	Procurement and installation of Kade meters	10,346,840.00	7,266,485.00
5	**Demolition Work**		
5.1	Demolition (Concrete Chipping)	33,314,879.50	10,681,000.00
5.2	Disposal of Demolition Materials (Concrete Chipping)	10,722,459.30	8,488,000.00
6	**Stockpile Work**		
6.1	Sand Dump Work	1,025,235,538.80	759,178,000.00
7	**Closing / Duct Cover Work**		
7.1	Elbow Steel L.75.75.6		
7.1.1	Elbow Steel L.75.75.7 (80 Thickness)	155,632,841.00	157,624,000.00
7.2	Chequered Plate t = 6mm		
7.2.1	Chequered Plate t = 6mm (Tebal 80)	180,971,329.00	169,171,000.00
8	**Duct Corner Protector Work**		
8.1	Angle steel L.75.75.6		
8.1.1	Angle steel L.75.75.6 (80 thickness)	46,974,312.00	42,030,000.00
8.2	Bar D13-250	2,377,869.00	2,898,000.00
9	**Pile Remaining Stacking Work**		
9.1	Transport of Remaining Piles	-	-
10	**Pier Levelling Work**		
10.1	Dismantle Existing Paving	7,156,587.00	7,050,000.00
10.2	Procurement and Installation of K-500 Quality Paving	842,770,275.00	613,398,000.00
10.3	Lean Concrete Concrete Quality K-125	607,235,968.00	565,186,000.00
10.4	Disposal of Paving Leveling Demolition Materials	3,667,104.00	4,352,000.00
10.5	Lean Concrete Formwork	24,861,853.20	22,539,760.00
	Total Cost after Rescheduling		28,535,441,605.00

(Source: Author 2023).

3. The total Budget Plan after rescheduling is IDR 28,535,441,605 of the Total Budget Plan obtained from the data for the 7th phase of the work project of IDR Rp. 35,017,986,296.10.

Based on the previous explanation regarding the data that has been obtained, it appears that this rescheduling requires a shorter time when compared to its implementation in the field. This is because in carrying out rescheduling it is by the realization in the field as outlined in the form of a schedule. In the planned schedule that is realized in the field, it takes a duration of 121 days with 2 special holidays to complete the work at this stage, while for rescheduling results it only takes a duration of 99 days with 2 special holidays to complete the work project at this stage. There is a visible comparison, namely the results of rescheduling, the completion of which is 22 days faster than the actual schedule in the field.

The schedule realized in completing the 7th phase of this project which will affect the duration of completing all stages of this project which will be faster. The results of this

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rescheduling will also affect the amount of costs obtained in completing the 7th phase of this project to be reduced.

The total cost obtained from the rescheduling results is IDR 28,535,441,605, with details of the costs of work activities that go through the critical path of Rp. 3,489,250,680.00 and work activities that do not go through the critical path of IDR 25,046,190,925. Compared to the initial cost of the work plan in stage 7 of this project which amounted to 35,017,986,296.10, the total cost of rescheduled results is less and the use is efficient so that the project is completed more quickly. As for the indirect costs that have increased due to variations/delays in the implementation of phase 7 of the Tanjung Perak Pier Structure Strengthening project, Surabaya, this is IDR 4,280,316,240.75 consisting of 10% profit and 5% overhead from the rescheduled Project value. So the total Budget Plan is obtained from the rescheduling results of IDR 32,815,757,845.75. So the total Budget Plan from the rescheduling results is less than the total cost of the planned budget that has been added with a total indirect cost of IDR 39,122,872,467.44. The cost of rescheduling the work in stage 7 will also have an impact on the overall total project completion costs which will be reduced and also effective in completing project work so that it can be completed more quickly.

5. Conclusion and Suggestion

5.1 Conclusion

From the existing data, the initial plan for phase 7 work at the Berlian Tanjung Perak pier strengthening project in Surabaya, the total duration realized in the field required a duration of 121 days, while rescheduling results only required a duration of 99 days. A comparison can be seen, namely the results of the rescheduling which was completed 22 days faster than the actual schedule in the field. From the existing initial plan data, it is also known that the total cost of the RAB is IDR 35,017,986,296.10, while the result after rescheduling is IDR 28,535,441,605 so the known difference is IDR 6,482,544,691.1. There is a comparison, namely the total cost of rescheduled results is less and the use is efficient so that the project is completed more quickly. From the results of the duration and costs obtained from the rescheduling of phase 7 work on the Berlian Tanjung Perak Surabaya pier structure strengthening project compared to the existing project realization plan data it is better and more effective.

5.1 Suggestion

Contractors and consultants are advised to work together in improving project control to identify factors that hinder work and cause delays in project implementation. The aim is to conduct an earlier evaluation of these factors so that delays do not occur again in phase VIII and subsequent stages of the Tanjung Perak Surabaya Diamond Pier Structure Strengthening project. In this case, the delay also has an impact on increasing the overall costs listed in the project's Budget Plan (RAB).

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