Analysis of Schedule Overrun Methods in Acceleration of Scheduling in the Ploso Bridge Construction Project

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Abstract

Covid-19, one of the natural disasters that causes delays in construction projects. The temporary lockdown policy, which was imposed at the beginning of the Covid-19 pandemic in Indonesia, causes delays in construction project. One of the project experiencing delays is the construction of the Ploso Bridge. Scheduling methods were needed to speed up the construction works. Fast tracking and crashing methods were used in this research to accelerate the preparation and soil work in the critical path of the Ploso Bridge. The result of the research is that by using the fast tracking method the duration is accelerated by 18 days compared to the normal duration. Whereas using the crashing method by adding one and two overtime hours, this reduces the duration of the project by 13 and 23 days respectively. Therefore, the crashing method by adding two overtime hours seem to be the most effective method to accelerate the duration of the project.

Keywords
Construction project, covid-19, crashing, delay, fast track

1. Introduction
In this globalization era, the building construction industry has developed rapidly. Not only has it developed rapidly in developed countries but also in developing countries like Indonesia. In Indonesia there are a number of infrastructures being constructed which makes the construction industry in Indonesia is very developed now. This is because the Indonesian Government is now trying to develop an equal infrastructure development so that every province in Indonesia can compete with the rest of the world in terms of building construction development (Basuki 2017).

However, at the end of 2019, all over the world has experienced the Covid-19 pandemic, which makes delays in the construction projects. The pandemic causes all of the activities within the office and in the construction project to be reduce to 50% of the capacity. Therefore, an acceleration method is needed to achieve the required target that is set at the planning phase of the construction project (Santoso 2017).

Applying an acceleration method however will result in an addition in the total cost of the construction project. This is due to the overtime added for the workers, redesigning the construction method or adding extra number of workers available. A method is needed to calculate the most effective acceleration needed for the construction project. By applying 2 types of acceleration methods, the most effective acceleration in terms of duration and cost will be achieved (Stefanus et. al. 2017).

Natural disasters is one the impact that leads to project delays, it is unpredictable. These natural disasters that causes project delays can be flooding, earthquakes, epidemic disease and so on (David and Bhupendra 1989). The Covid-19 pandemic is one of a natural disasters can causes project delays throughout the world. This is due to the temporary lockdown policy that is placed by the Indonesian Government at the beginning of the pandemic, which set the policy

of maximum quota of working to 50% capacity that leads to the shortage of workers needed in the construction projects (Kompas.com 2020).

This is also experienced by the Ploso Bridge Construction project. The number of workers were reduced to comply with the health and safety protocol due to the Covid-19 pandemic. The contractor had to manage the construction project in a systematic way so that the duration of the project still comply to the contract agreement to avoid any fine due to construction project delays. However if acceleration method is to accelerate the project, there might be extra cost imposed to the project. Therefore, an acceleration method calculation is needed such as fast tracking and crashing to get the most effective accelerated duration needed for the construction project (Dundu and Malingkas 2019).

The fast tracking and crashing method are some of the methods used in accelerating duration of construction project. In the fast tracking method, work items are set to work in parallel if applicable. Whereas in the crashing method, a change in the construction method, an addition to the number of worker, adding work shifts or adding overtime can be applied (Jonanda 2019).

Based on the background of this research, the problem of the construction project especially for the Ploso Bridge construction project is that there are delays caused by the Covid-19 pandemic. Therefore, acceleration methods are used to achieve the most effective acceleration duration that can be applied to the Ploso Bridge construction project. The acceleration method used in this research is the fast tracking and crashing by adding overtime. The scope of the research only focused on the preparation and soil work in the critical path of the Ploso Bridge construction project.

2. Literature Review

This research is based on some previous literatures, which were used as reference and guidance to the research:

- Research conducted by Aslinda Armalisa, Dessy Triana and Meassa Monikha Sari is by adding 3 to 4 hours of overtime which resulted to 83 days and 80 days respectively of accelerated duration of the project. The initial project duration was 115 days (Armalisa et. al. 2018).
- Research conducted by Arief Kurniawan is that the application of the fast tracking method on the critical path can reduce the risk of cost overruns, and can save time for 15 days or 12.5% of the original project implementation time (135 days to 120 days) (Kurniawan 2017).
- Research conducted by Mulyadi Lalu, Iskandar Tiong and Aziz M. Shidqul is to accelerate using the fast tracking method, which results in 12 days savings from 132 days of project calendars or a 9.09% reduction from the project calendar (Lalu 2019).

3. Research Methodology

This is research is based on a case study of the Ploso Bridge construction project. The research flowchart can be seen in Figure 1. The research methodology of this research is by collecting necessary data such as the (1) cost budget plan, (2) detailed project work scheduling duration and (3) S curve of the project. Analysis are carried out such as (1) designing the network diagram to determine the critical path of the project and (2) fast tracking and crashing methods are used to accelerate the project duration. Both results will be compared and the most effective result will be chosen.

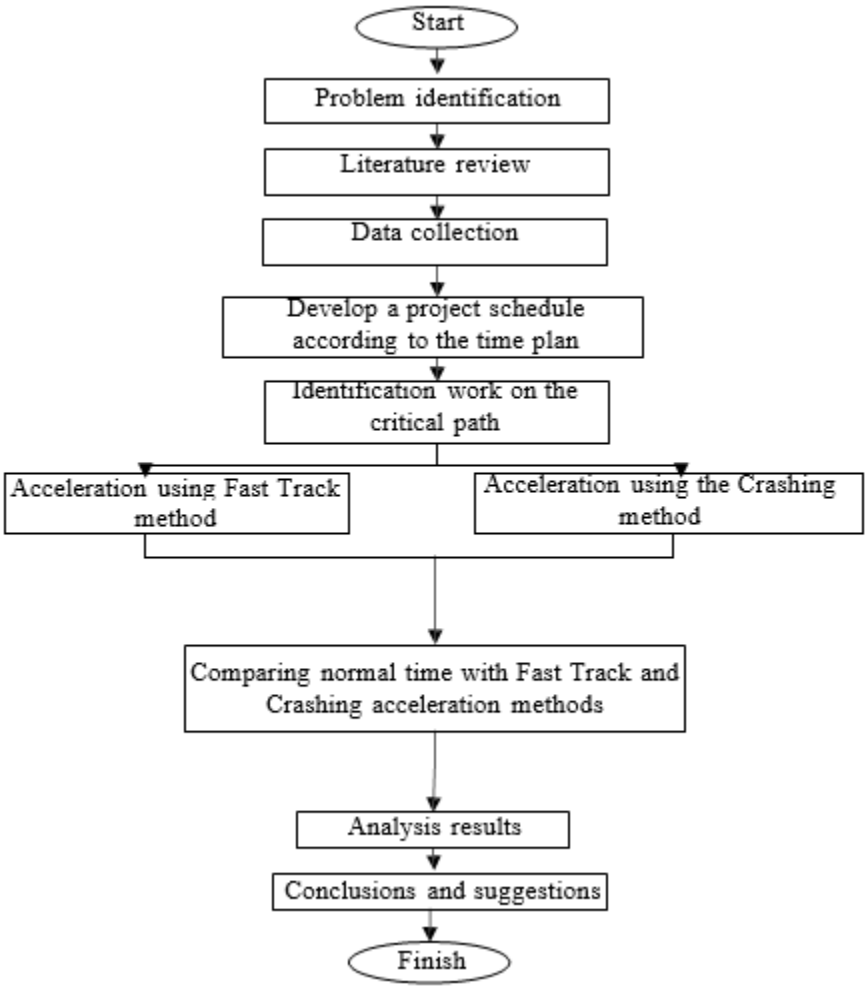

Figure 1. Research Flowchart

4. Data and Analysis

4.1 Project Data

The project case study data of this research is as followed:

- Project : Ploso Bridge Construction
- Location : Ploso Village, East-Java Province
- Total cost : Rp 125.861.033.000,00
- Total duration : 445 day

4.2 Critical Path Determination

In determining the critical path of the construction project, a network diagram was developed based on the work breakdown structure of the Ploso Bridge construction project. Microsoft Project is used to developed the network diagram and identify the critical path of the construction project. The preparation and the soil work of the project are considered some crucial phases in a project, as it is at the beginning of the project. Therefore, in this research only the preparation and soil work of the Ploso Bridge construction project is analyzed for the acceleration analysis. Using the Microsoft Project, the critical path of the project, especially for the preparation and soil work can be determined. Part of the critical path of the project using the Microsoft Project can be seen in Figure 2 and the detailed work that can be accelerated using the fast tracking and crashing method can be seen in Table 1.

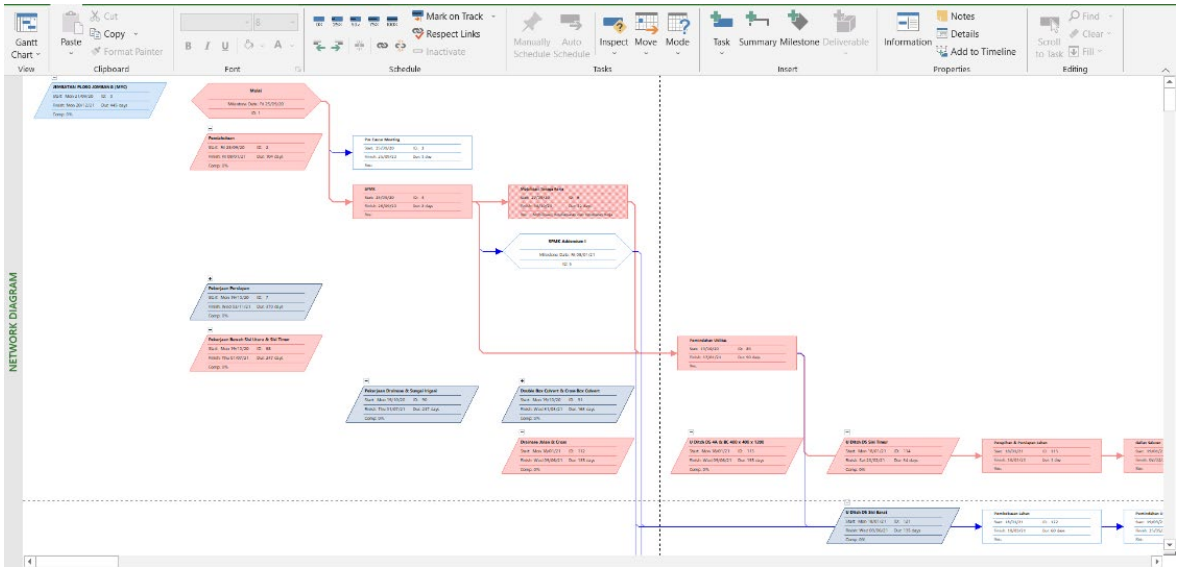

Figure 2. Critical Path using Microsoft Project

Table 1. Details Work of Preparation and Soil Work

ID	Work Details	Duration	Predecessor
89	Moving Utility	90 days	6;4
115	Land Clearing and Preparation	1 day	89
116	Drainage Digging	15 days	115
117	Overlays & Compaction of Preferred Embankments	15 days	116FS-12d
118	Install U-Ditch DS 4A	13 days	117
119	Install BC 400 x 400 x 1200	10 days	118FS-10d
120	Grouting Joints	2 days	119
132	Digging for Overlay	3 days	120
133	LPA Overlay & Compaction	1 day	132
134	Work Floor Concrete Casting	1 day	133
135	Install Steel Reinforcement	2 days	134
136	Install Formwork	2 days	135
137	Rigid Formwork Casting	2 days	136
138	Open Rigid Formwork	1 day	137FS+7d
278	Land Preparation	5 days	138
280	Piling Work	6 days	278
282	Piling Work	3 days	280
284	Piling Work	3 days	282
286	Piling Work	3 days	284
288	Piling Work	3 days	286
290	Piling Work	3 days	288
372	Pile Cap Digging	2 days	290
373	Pile Boring	2 days	372
374	Work Floor Install	1 day	373FS+1d
375	Pile Cap Formwork	1 day	374
376	Pile Cap Steel Reinforcement	1 day	375
377	Pile Cap Concrete Casting	1 day	376
378	Open Pile Cap Formwork	1 day	377FS+7d

4.3 Fast Tracking Method

Fast tracking method changes the relationship between each work from Finish-to-Start (FS) into Start-to-Start (SS). This is done using Microsoft Project. After the relationships between works are changed, the network diagram and the detailed sequencing of the work will also be updated in Microsoft Project. The detailed work after the fast tracking method is applied can be seen in Table 2.

Table 2. Fast Tracking Acceleration Work Details

ID	Work Details	Duration	Predecessor	Predecessor fast track
89	Moving Utility	90 days	6;4	6;4
115	Land Clearing and Preparation	1 day	89	89SS+86d
116	Drainage Digging	15 days	115	115SS+1d
117	Overlays & Compaction of Preferred Embankments	15 days	116FS-12d	116FS-12d
118	Install U-Ditch DS 4A	13 days	117	117SS+14d
119	Install BC 400 x 400 x 1200	10 days	118FS-10d	118FS-10d
120	Grouting Joints	2 days	119	119SS+9d
132	Digging for Overlay	3 days	120	120SS+1d
133	LPA Overlay & Compaction	1 day	132	132SS+1d
134	Work Floor Concrete Casting	1 day	133	133SS+1d
135	Install Steel Reinforcement	2 days	134	134SS+1d
136	Install Formwork	2 days	135	135SS+1d
137	Rigid Formwork Casting	2 days	136	136SS+1d
138	Open Rigid Formwork	1 day	137FS+7d	137FS+7d
278	Land Preparation	5 days	138	138SS
280	Piling Work	6 days	278	278SS+4
282	Piling Work	3 days	280	280SS+5
284	Piling Work	3 days	282	282SS+2d
286	Piling Work	3 days	284	284SS+2d
288	Piling Work	3 days	286	286SS+2d
290	Piling Work	3 days	288	288SS+3d
372	Pile Cap Digging	2 days	290	290SS+2d
373	Pile Boring	2 days	372	372SS+2d
374	Work Floor Install	1 day	373FS+1d	373FS+1d
375	Pile Cap Formwork	1 day	374	374SS+1d
376	Pile Cap Steel Reinforcement	1 day	375	375SS+1d
377	Pile Cap Concrete Casting	1 day	376	376SS+1d
378	Open Pile Cap Formwork	1 day	377FS+7d	377FS+7d

Based on the fast tracking acceleration analysis, the total duration of construction work was able to be accelerated by 18 days resulting in the total duration of 427 days. As seen in Table 2, the items of work were changed into SS that enables the work item to be done in parallel that can reduce the duration of the project itself.

4.4 Crashing Method

The type of crashing method used in this research is by adding overtime for the workers. Alternatives of adding 1 and 2 hours of overtime is selected in this research. In Table 3 and Table 4 are the detailed work after adding 1 hour and 2 hours of overtime can be seen.

Table 3. Crashing 1 Hour Overtime Acceleration Work Details

ID	Work Details	Normal Duration	Crashing Duration (1 hours)
89	Moving Utility	90 days	81 days
115	Land Clearing and Preparation	1 day	1 day
116	Drainage Digging	15 days	14 days
117	Overlays & Compaction of Preferred Embankments	15 days	14 days
118	Install U-Ditch DS 4A	13 days	12 days
119	Install BC 400 x 400 x 1200	10 days	9 days
120	Grouting Joints	2 days	2 days
132	Digging for Overlay	3 days	3 days
133	LPA Overlay & Compaction	1 day	1 day
134	Work Floor Concrete Casting	1 day	1 day
135	Install Steel Reinforcement	2 days	2 days
136	Install Formwork	2 days	2 days
137	Rigid Formwork Casting	2 days	2 days
138	Open Rigid Formwork	1 day	1 day
278	Land Preparation	5 days	5 days
280	Piling Work	6 days	6 days
282	Piling Work	3 days	3 days
284	Piling Work	3 days	3 days
286	Piling Work	3 days	3 days
288	Piling Work	3 days	3 days
290	Piling Work	3 days	3 days
372	Pile Cap Digging	2 days	2 days
373	Pile Boring	2 days	2 days
374	Work Floor Install	1 day	1 day
375	Pile Cap Formwork	1 day	1 day
376	Pile Cap Steel Reinforcement	1 day	1 day
377	Pile Cap Concrete Casting	1 day	1 day
378	Open Pile Cap Formwork	1 day	1 day

Table 4. Crashing 2 Hour Overtime Acceleration Work Details

ID	Work Details	Normal Duration	Crashing Duration (2 hours)
89	Moving Utility	90 days	75 days
115	Land Clearing and Preparation	1 day	1 day
116	Drainage Digging	15 days	13 days
117	Overlays & Compaction of Preferred Embankments	15 days	13 days
118	Install U-Ditch DS 4A	13 days	11 days
119	Install BC 400 x 400 x 1200	10 days	9 days
120	Grouting Joints	2 days	2 days
132	Digging for Overlay	3 days	3 days
133	LPA Overlay & Compaction	1 day	1 day
134	Work Floor Concrete Casting	1 day	1 day
135	Install Steel Reinforcement	2 days	2 days
136	Install Formwork	2 days	2 days
137	Rigid Formwork Casting	2 days	2 days
138	Open Rigid Formwork	1 day	1 day

278	Land Preparation	5 days	5 days
280	Piling Work	6 days	5 days
282	Piling Work	3 days	3 days
284	Piling Work	3 days	3 days
286	Piling Work	3 days	3 days
288	Piling Work	3 days	3 days
290	Piling Work	3 days	3 days
372	Pile Cap Digging	2 days	2 days
373	Pile Boring	2 days	2 days
374	Work Floor Install	1 day	1 day
375	Pile Cap Formwork	1 day	1 day
376	Pile Cap Steel Reinforcement	1 day	1 day
377	Pile Cap Concrete Casting	1 day	1 day
378	Open Pile Cap Formwork	1 day	1 day

Based on the crashing method by adding 1 hour of overtime for the workers, the total duration of construction work was able to be accelerated by 13 days from the initial duration resulting in the total duration of 432 days. Whereas the crashing method by adding 2 hour of overtime for the workers, the total duration of construction work was able to be accelerated by 23 days from the initial duration resulting in the total duration of 422 days.

5. Conclusion

Based on the result of the acceleration analysis using the fast tracking and crashing method, the fast tracking method was able to reduce the project duration by 18 days (4,05%), the 1 hours overtime addition reduces by 13 days (2,92%) and the 2 hours overtime addition reduces by 23 days (5,17%) from the initial duration. The comparison result can be seen in Figure 3.

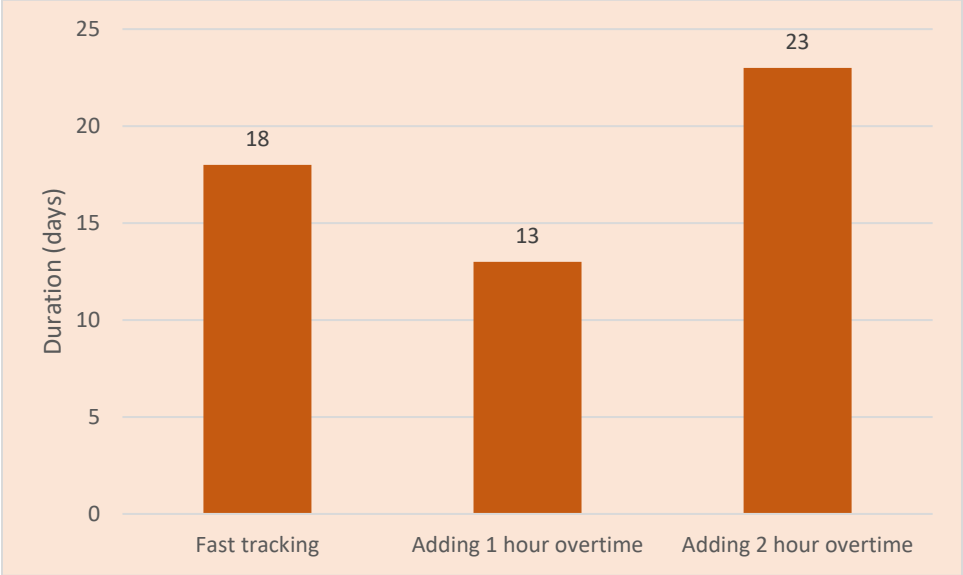

Figure 3. Result Comparison

Based on the results, it show that by accelerating only the preparation and soil work in the Ploso Bridge construction project, the most effective alternative to accelerate the project is by adding 2 hours of overtime for the workers. Due to the Covid-19 pandemic circumstances, where the amount of workers are being regulated, the use of the crashing method as an alternative in accelerating the project is more suitable. The used of 1 and 2 additional hour of overtime in the crashing analysis is due to the regulation imposed by the Central and Local Government where maximum

working hour is up to 19.00. The normal working hours at the Ploso Bridge construction project is from 08.00 – 17.00, therefore by adding 1 or 2 additional overtime hour it will still comply to the regulation set by the Governments.

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Biographies

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Putri Arumsari joined the Civil Engineering Department of Binus University in November 2015 as a lecturer. She graduated her Bachelor Degree in Civil Engineering from Binus University in 2011 and graduated her Master Degree in Infrastructure Management from Universitas Indonesia in 2015. She currently doing her Doctoral Degree in Construction Management in Universitas Tarumanagara. Her main interest in research is about building maintenance and have written several proceedings and journals on the topic.

Jose Leonard Lie graduated from Civil Engineering Binus University in 2021. While studying his bachelor degree, he was also the Laboratory Assistant for several years.