

# Analysis of Dominant Factors Which Causing Delay and the Appliance of Critical Path Method in Order to Catching Up the Gap Delay in Advance Projects of Work Accessibility

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## ABSTRACT

A project has its arranged plan and timeliness schedule to limit the work project. However, these arranged plans and schedules sometimes do not work accordingly to the reality in the field, sometimes it causes delays in project completion. This research was done in an advanced project on work accessibility of Soekarno Hatta International Airport. The research method used descriptive quantitative with project scheduling analysis by Critical Path Method (CPM), The dominant factors which caused project delays were analyzed through Fishbone diagram and Pareto diagram. The research object population were all projects owned by PT XYZ with a sample of the Advanced Project of work Accessibility amounted to 40 sources. The data used in this research was in the form of project S curve in 2020. The results explain that the implementation of Critical Path Method (CPM) in duration work schedule for advanced projects of work accessibility. It is said that the optimal time of work project was 960 days, while the timeliness schedule based on an addendum contract 2 will take 1012 days, so through these CPM schedules the work duration will be 52 days more effective. The dominant factors causing delays in the advanced project of the accessibility at Soekarno-Hatta International Airport were (1) changes in the scope of work contractors (2) pandemic outbreaks, (3) delayed payments, (4) changes in plan models and (5) lack of coordination and supervision in the field.

**Keywords:** Project delays, fishbone diagram, pareto diagram.

## INTRODUCTION

Infrastructure is physical facilities and base or anything as the main support for the implementation of a process of activity; one sample is public service activities. In advance of infrastructure development, it is necessary to manage the quality of work projects. A project has an arranged plan and timeliness to the project work schedule time. However, in its implementation sometimes it does not work as it plans and matches the reality in the field so it would affect the work project completion.

PT XYZ is one of the state-owned companies which engaged in airport service business. PT XYZ continues to carry out various infrastructure developments and provide the best service to airport service users, especially Soekarno-Hatta International Airport. During these work periods, problems and obstacles were often occurred which resulted in delays in work on some projects at Soekarno Hatta International Airport.

Advanced project of work accessibility is one of the projects which developed by PT XYZ at Soekarno Hatta Airport that includes with road and bridge construction work. Currently, the delays in work project occurred because the Covid-19 pandemic, so the current temporary work

has a slowdown progress. As it shown in Table 1.

**Table 1: The Progress on Advanced Project of Work Accessibility**

No	Work items	Work Progress		
		Plan	Realization	Deviation
1	Preparation Work	6,54%	6,52%	-0,01%
2	North Frontage Job	5,65%	5,68%	0,03%
3	North Interchange Work	13,18%	8,82%	-4,36%
4	South Frontage Job	13,22%	16,81%	3,59%
5	South Interchange Work	4,16%	3,52%	-0,63%
6	North Diagonal and Clover Work	4,97%	3,80%	-1,17%
7	South Diagonal and Clover Work	6,29%	4,68%	-1,61%
8	Main Bridge Work	6,97%	5,47%	-1,51%
9	Electronic Work	0,00%	0,00%	0,00%
10	Electrical Work	0,14%	0,00%	-0,14%
11	Utility Handling Work	8,32%	7,52%	-0,80%
Total		69,44%	62,84%	-6,60%

Source: PT XYZ (2020)

According to the Table 1, it shows that almost all parts of the advanced project of work accessibility have experienced delays. The greatest delay happen on the southern perimeter work from 13.178% of the progress that was planned to be progress was 8.8215% so the delay deviation was -4.36%. Meanwhile, the smallest part of the delays experienced has in the preparatory work from 6,5356% of the planned progress, 6,5238% realized progress so the delay deviation was -0.001%.

To overcome these delays issues, the things that should be done by taking a methodical approach and conducting research on each work project processed. The method that could be done is in the form of critical path method. Viewing from those above needs, this research aimed to discussing further regarding the analysis of timeliness planning and causes of work delays in these advanced projects of Work Accessibility.

## LITERATURE REVIEW

A project is an activity that carried out with certain time and resources in order to achieve a specified final result. To achieving these final results, those project activities are limited by budget, schedule, and quality, which are known as three constraints (triple constraints) (Rani, 2016: 5). The basic function of project management consists of managing the scope of work, time, cost and quality. According

to Rani (2016:24-25) the basic functions contained of: managing the project scope, managing the scope of time/schedule, managing costs and quality or grade.

### Critical Path Method (CPM)

The Critical Path Method (CPM) first discover in 1957 and developed by J.E. Kelly and M. R. Walker (Tarore, 2002). The critical path method is oriented on various project activities in scheduling that project activities. This method could identify the critical path in a set of activities which have been revealed dependencies between activities. The critical path is a set of interdependent activities that should be done according to the planned time, otherwise the entire work project would be too late (Olivier de Weck, 2012). The steps that should be taken in CPM are as follows (Sharma & Ghupta, 2018):

- 1) Preparation of a work breakdown structure i.e. a list of all activities required for project completion.
- 2) Estimation of the time involved in each activity.
- 3) The determination of dependency between activities is to interpreted the preferred correlation among various activities
- 4) Network building based on previous and successful correlations. Initial Timing: This relates to the earliest occurrence of an event.

- 5) Latest Timing: shows the time at which all activities involved in the event should be completed without delaying the project.
- 6) Float Estimation: The term float represents the amount of time pending activity in completion beyond the EFT estimate without affecting the overall project completion time.
- 7) Identification of Critical activities: The path which creates through the incorporation of critical activities which is known as the critical path. The critical path is the longest path that seen by estimated the completion time after the longest stretch of dependent activity.

According to Heizer & Render (2011:95) CPM is a project management technique which uses only one time factor per activity, meaning that a CPM network consists of branches and nodes which reflect by activity and the nodes symbolize in the beginning and the end of an activity. If there has a delay in one activity, it would affect on the overall delay in the project duration. Critical path analysis has a two-pass process consist of a forward pass and a backward pass to find out the right time schedule for an activity. ES (earliest start) and EF (earliest finish) are determined during the forward pass. LS (late start) and LF (late finish) are determined during the backward pass (Heizer and Render, 2014: 105-109). This Following picture is an example of a CPM which could be seen in Figure 1.

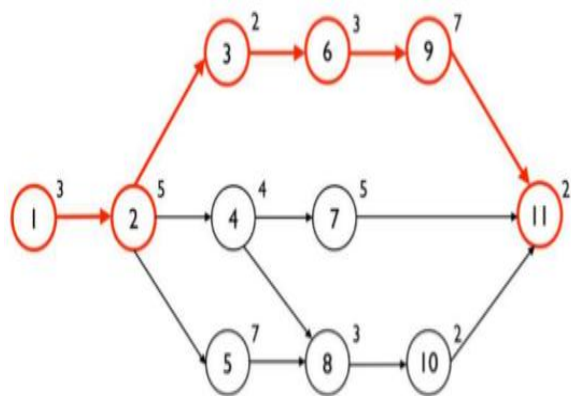


Figure 1: CPM Network  
Source: Heizer & Render (2011:99)

## Project Delay

Delay is an arranged time which is not done according to the activity plan, causing one or several activities which follow to be delayed or not completed according to the planned schedule (Erviyanto, 2005). The factors that causing this project delays could be grouped into 3 main causes, namely (Messah, et al, 2013):

### 1) Non Excusable Delays

Causes which included in this type such as;

- a) Inaccurate workforce planning
- b) Delays in providing tools/materials due to negligence of contractors
- c) Poor quality of workforce.
- d) The type of equipment used which not match with the project
- e) Lack of contractor experience

### 2) Excusable Delays

Causes which included in this type such as :

- a) Unstable socio-political environment
- b) Unforeseen things happen such as storm floods, earthquakes, landslides, fires, bad weather.
- c) The feedback response from surrounding community which is not support the work project

### 3) Compensable Delays

Causes which included in this type of delay were include:

- a) Take long time to get work permit approval
- b) An owner-to-contractor payment system which is not according to the contract
- c) Change in scope of work / construction details
- d) There are frequent work delays
- e) Insufficient funds from the owners

Based on Suyatno (2010) the impact from delays will cause losses, namely: For owners, the project delays cause loss of income from the use or lease of facilities or buildings. For contractors, delays in project completion would increase overhead cause of increased an extra time. For consultants, the project delays result in consultants' delay in scheduling time on other projects.

### Fishbone Diagram

The Fishbone diagram is also known as the Ishikawa Diagram because it was found in the 1960's and Dr. Kaoru Ishikawa was developed this diagrammatic model. It is said to be a fishbone diagram because this diagram is shaped like a fishbone skeleton whose parts include the head, fins and spines (Dharmawan, 2016). Fishbone diagrams are usually used to reveal the causes of problems at the problem identification stage. These basic concept of a fishbone diagram is that the main problem is placed on the right side of the diagram or on the head of the fishbone frame. The causes of the problem are described in the fins and thorns (Slameto, 2015).

The stages that should be taken in preparing the Fishbone Diagram could be described as follows (Asmoko, 2013):

- 1) Create a Fishbone Diagram outline.
- 2) As for The next step is searching for the main factors which influence or as root in the problem.
- 3) Find the causes and grouping each of causes for the problem.
- 4) The next step, after find out the problem and what causing it then could described in the Fishbone Diagram.

### Pareto Chart

According to Heizer and render (2014: 255) Pareto chart is a method for managing errors, problems for defects to help focus its attention on problem solving efforts. Joseph M. Juran popularized this Pareto chart by stating that 80% of the company's problems are the result of its cause which only 20%. Pareto charts are a combination of two types of graphics, namely column charts and line charts.

### RESEARCH METHODS

This research were included in quantitative descriptive. Time scheduling analysis of the work plan in this research used CPM (Critical Path Method). Data collection through interviews with informants to find the factors which cause work delays that occur through the Fishbone diagram and Pareto chart. The population used in this research object is all projects owned by PT XYZ with samples of Advanced Project from Work Accessibility. The sampling technique used in this research was purposive sampling technique. The resource persons in the research were personnel of agencies related to the Advanced project of Work Accessibility which totaling of 40 people. The research variables were described in Table 2.

Table 2: Research Variables

Variable	Dimension	Indicator	Type of Data	Data Collection Technique
Project Delay Factors (Alaghbariet al.2007)	Owner Factor	Plan figure change	Primary	Interview
		Delay in approving figure	Primary	Interview
		Change of contractor's scope of work	Primary	Interview
		Lack of field coordination and supervision	Primary	Interview
		Pending payments	Primary	Interview
	Contractor Factor	Lack of human resources provision	Primary	Interview
		Lack of provision of tools	Primary	Interview
		Lack of material supply	Primary	Interview
		Field coordination failure	Primary	Interview
		Low productivity	Primary	Interview
		Schedule planning failure	Primary	Interview
External Factors	Lack of provision of subcontractors	Primary	Interview	
	Pandemic disease	Primary	Interview	
		Work restrictions	Primary	Interview
Project Scheduling (Ervianto, 2007)	Critical Path	ES=Earliest Start EF = Earliest Finish LS = Latest Start LF = Latest Finish LS-ES = 0 LF-EF = 0	Secondary	Project S Curve Data

Source: Data processed (2020)

## RESULT & DISCUSSION

### Network

Network of count forward and countdown networks. By knowing the normal time required for each work, then it can be described the dependency relationship between activities on the accessibility work continuation project which refers to Addendum II can be seen in table 3.

**Table 3: Dependency Relations among Activities (Addendum II)**

No.	Job Description	Previous Activities	Duration (Day)
A	Preparation Work	-	145
B	North Frontage Job	A	281
C	North Interchange Work	B	466
D	South Frontage Job	A	281
E	South Interchange Work	D	510
F	North Diagonal and Clover Work	A	624
G	South Diagonal and Clover Work	A	600
H	Main Bridge Work	C,E	727
I	Electronic Work	H	90
J	Electrical Work	H	209
K	Utility Handling Work	A	109

Source: Data processed, 2020

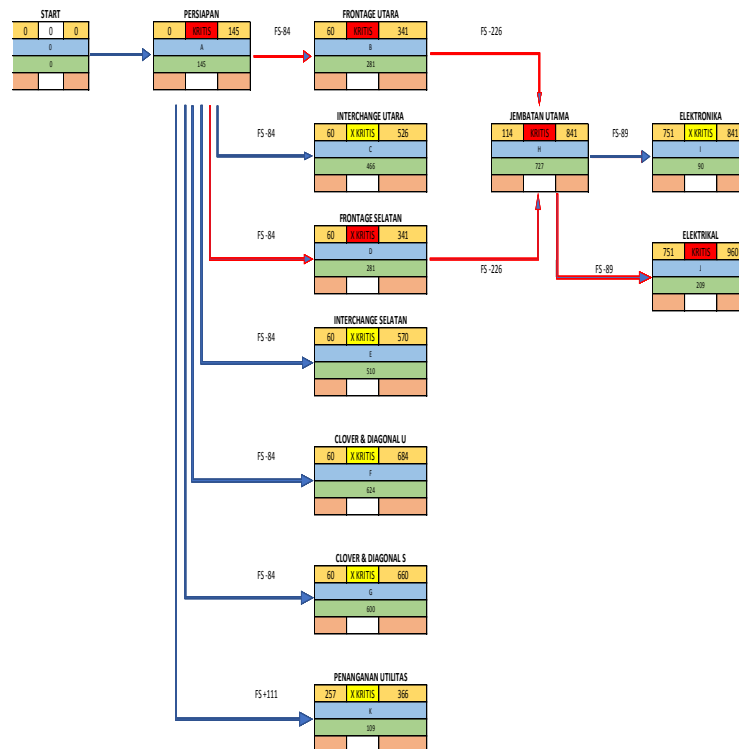
In Table 3, it could be seen that the North Frontage, South Frontage, North Clover & North Diagonal, South Clover &

South Diagonal works were carried out after the preparatory work completed. Whereas the North Interchange work could be carried out after the North Frontage and South Interchange work could carried out after the South Frontage work. Meanwhile, the Main Bridge work was carried out after the activities at the North Interchange and South Interchange work are completed, meaning that the North Interchange and South Interchange work activities were previous activities before the Main Bridge work. Furthermore, the evaluation of previous activities could be illustrated in table 4.

**Table 4: Dependency Correlation between Activities (Evaluation)**

No.	Job Description	Previous Activities	Duration (Day)
A	Preparation Work	-	145
B	North Frontage Job	A	281
C	North Interchange Work	A	466
D	South Frontage Job	A	281
E	South Interchange Work	A	510
F	North Diagonal and Clover Work	A	624
G	South Diagonal and Clover Work	A	600
H	Main Bridge Work	B,D	727
I	Electronic Work	H	90
J	Electrical Work	H	209
K	Utility Handling Work	A	109

Source: Data processed, 2020



**Figure 2: Forward Count Network**



From the Table 4. it is known that the work of the North Frontage, North Interchange, South Frontage, South Interchange, Clover & North Diagonal, Clover & South Diagonal could be done simultaneously by dividing the work team into 4. Furthermore, it could be drawn like forward count network diagram as a normal time like could be illustrated in Figure 2.

After drawing the forward count diagram then it can be explained if the work requires a duration of 960 working days with electrical work as the final activity with the longest duration. After depicting it with a forward count diagram, then a normal project time countdown network would created as shown in Figure 3.

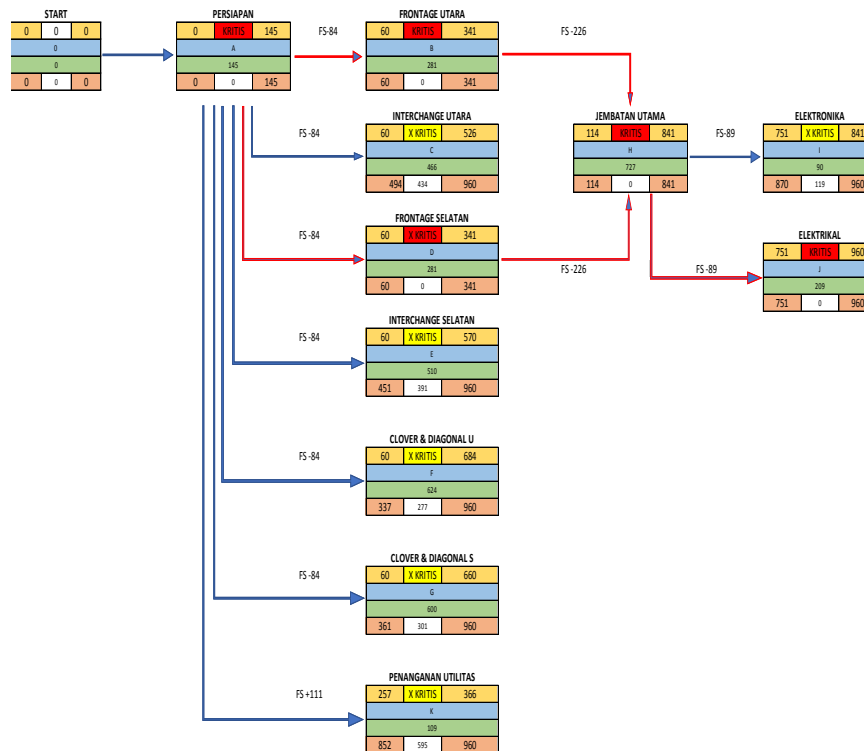


Figure 3: Backward Countdown Diagram

### Critical Path Analysis (CPM)

Based on the analysis which has been done on the advanced project of work

accessibility, it can be seen that the critical path activity and non-critical activity with the slack time are shown like in table 5.

Table 5: Critical Path and Slack Time

No.	Job Description	Duration (Day)	ES	EF	LS	LF	SLACK	Critical Path
1	Preparation Work	145	0	145	0	145	0	Critical
2	North Frontage Job	281	60	341	60	341	0	Critical
3	North Interchange Work	466	60	526	494	960	434	Non-critical
4	South Frontage Job	281	60	341	60	341	0	Critical
5	South Interchange Work	510	60	570	451	960	391	Non-critical
6	North Diagonal and Clover Work	624	60	684	337	960	277	Non-critical
7	South Diagonal and Clover Work	600	60	660	361	960	301	Non-critical
8	Main Bridge Work	727	114	841	114	841	0	Critical
9	Electronic Work	90	751	841	870	960	119	Non-critical
10	Electrical Work	209	751	960	751	960	0	Critical
11	Utility Handling Work	109	257	366	852	960	595	Non-critical

Based on Table 5, it could be seen that the critical path is in activity A (Preparation), activity B (North Frontage),

activity D (South Frontage), activity H (Main Bridge) and activity J (Electrical) which is marked by having slack time = 0.

Furthermore, a critical path diagram (CPM) accessibility as shown in Figure 4. could be drawn on advanced project of work

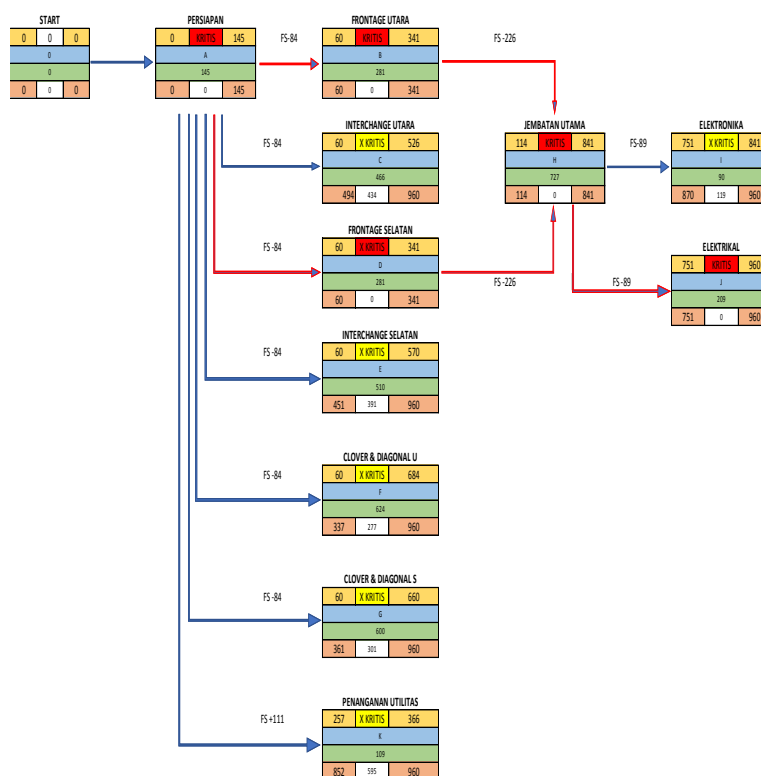


Figure 4: Critical Path Diagram

According to the Figure 4, it could be seen that the critical path at the Soekarno-Hatta International Airport accessibility project is located in the A-B-H-

J and A-D-H-J lines which have the longest time of 960 days. Other activity paths could be found out about the activity time requirements such as in table 6.

Table 6: Activity path based on critical path diagram (CPM)

No	Critical Path System	Time Required (Days)
1	A - b - h - i	145 + (281-84) + (727-226) + (90-89)
2	A - b - h - j	145 + (281-84) + (727-226) + (150-89)
3	A - d - h - i	145 + (281-84) + (727-226) + (150-89)
4	A - d - h - j	145 + (281-84) + (727-226) + (150-89)
5	A - c	145 + (466-84)
6	A - e	145 + (510-84)
7	A - f	145 + (624-84)
8	A - g	145 + (600-84)
9	A - k	145 + (109+111)

Scheduling through Critical Path Method (CPM) for advanced projects of work accessibility has an optimal duration of 960 days compared to the implementation time of the addendum II contract which takes 1012 days, the CPM method has a difference of 52 days. The results from the analysis above were strengthened by research from Caesaron and Thio (2015) with the critical path method (CPM) which could

help project managers to achieve their goals such as estimating project completion time by looking for critical paths, identifying the start and end of each activity and calculating the amount of slack time on every activity. The results of this research explained that according to project record data, the Ruko Development Project (Jl. Pasar Lama No.20, Glodok) takes 222 days, while the scheduling for completion of the Ruko

Development Project (Jl. Pasar Lama No.20, Glodok) used the CPM method. That completion duration for 198 days. According to Andawei (2014) by adopting CPM, a network of scheduling techniques will allow the project managers to determine the correct budget request and right completion time. Katara and Amponsah (2013) explained that the CPM is one of several operations research techniques which developed in the late 1950s to assist project managers in planning, scheduling, and controlling their projects. With the

implementation of CPM it is possible to complete the project in either 84 months or 67 months thus it will allow the project to be completed earlier than the minimum project time.

### Project Delay Factors

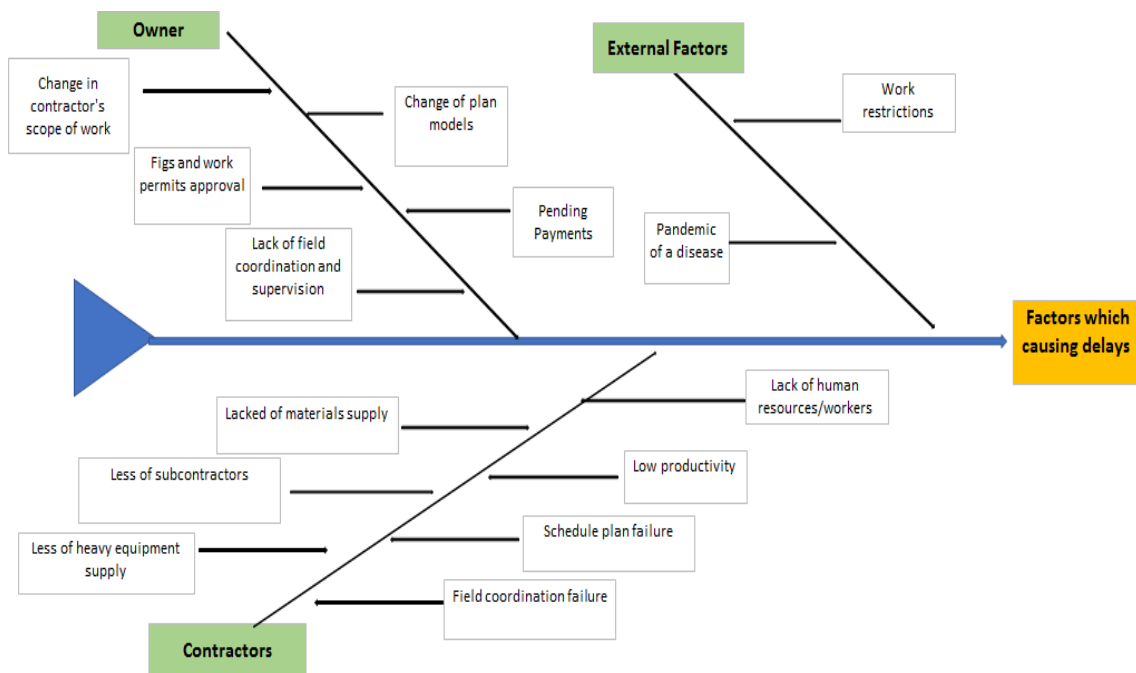
From the interviews results which have been done, there were 5 main factors that causing delays in the Advanced project of work accessibility Based on owner's views, contractors and consultants of the Court.

**Table 7: Main Factors which causing delay view from Owner, Contractors and Consultants of the Court**

No.	Owner View	Contractor's View	Constitutional Court Consultant's view
1	Change in contractor's scope of work	Pending Payments	Pandemic of a disease
2	Pandemic of a Disease	Pandemic of a Disease	Change in contractor's scope of work
3	Pending Payments	Change in contractor's scope of work	Low Productivity
4	Schedule plan failure	Lack of field coordination and supervision	Field coordination failure
5	Change of plan models	Work restrictions	Lack of equipment supply

Furthermore, Results of the researchers' analyzes regarding the factors which causing delay could be describe by

the cause and effect diagram (fishbone diagram) as it shown in Figure 5.



**Figure 5: Fishbone Diagram related to the Factors which causing the Project Delay**

Hereafter, the respondents were asked to choose 1 (one) of the 14 (fourteen) the most dominant factors which causing delay. Then the 14 (fourteen) factors chosen by the respondent could be seen from the Table 8.

Based on Table 8. The top 5 most dominant factors which causing project delays are:

- 1) Change in scope of work of contractors by 10 people
- 2) Pandemic Outbreak by 8 people

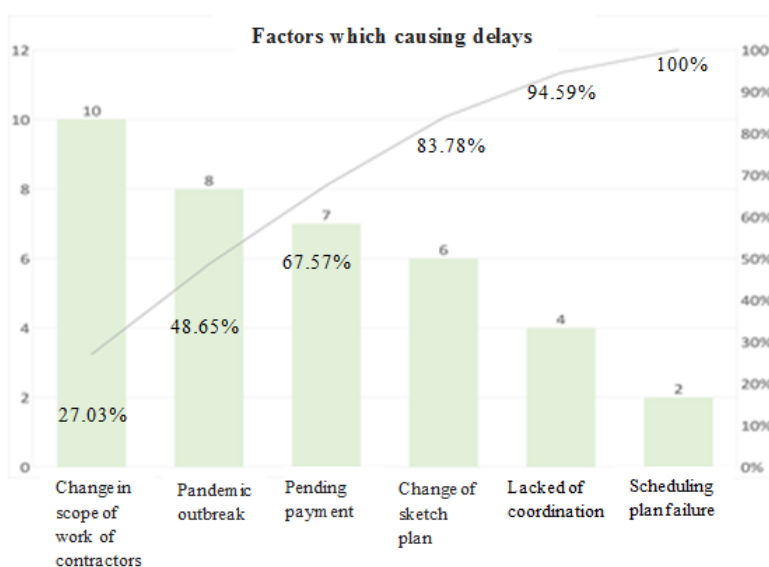


- 3) Pending Payment by 7 people
- 4) Change of sketch plan by 6 people
- 5) Lack of coordination and field supervision by 4 people

The dominant factors that cause delays in the advanced project of work accessibility could be depicted in the Pareto chart as it shown in Figure 6.

**Table 8: The Dominant Factors Cause of Delay in Advanced Project of Work Accessibility by Rank**

No	Delay Factors	Total Respondents
1	Change in contractor's scope of work	10
2	Pandemic of a disease	8
3	Payment pending	7
4	Change in plan model	6
5	Lack of field coordination and supervision	4
6	Schedule planning failure	2
7	Lack of human resources available	1
8	Work restrictions	1
9	Field coordination failure	1
Total		40



**Figure 6: Pareto Chart of Factors which causing Project Delay**

From the five dominant factors which causing delays in project completion, it represents one main factor which is the owner factor. According to Messah, YES, et.a (2013) delays are due to changes in the scope of work and payment systems which are not according to the contract or pendings, which include in the Compensable Delays group, meaning that this delay is caused by service users, so the contractor is entitled to have an extension of the project completion time (Levis and Atherley, 1996). This confirmed by Saputra's research (2017) which described that the delay in the ABC mall construction project is due to the change in image, lack of coordination by the owner and an additional scope of work, including the

compensable delay group. In this research, the external factors were also as the main cause of delays in project completion due to the pandemics outbreak (Covid-19) and the issuance of the Presidential Decree No. 12 of 2020 related to the Designation of Non-Natural Disaster for the Spread of Corona Virus Disease 2019 (COVID-19) as a National Disaster which causes a slowdown of work on the advanced project of work accessibility. Based on Park (1979), contractor delays in the implementation of construction projects often occur, one of that by disasters so they are included in the Excusable Delays group. Then it could be interpreted if the delay in the Advanced project of work accessibility at Soekarno Hatta Airport were also included in the

concurrent delay group, namely delays that occur simultaneously between two or more.

The correct steps which need to be consider in reach the gap delays in advanced projects of work accessibility were include like in the following below:

- 1) Needs to focus on the planning aspect in terms of the suitability of the work sketch at the location of the work to be carried out, namely by identifying the work location against existing utilities which related to the work.
- 2) In order to avoid the impact of pandemic outbreaks, the need for intense implementation of health protocols at work.
- 3) The Payments which are delayed need to rearrange the payment schedule for contractor so those work still could be done by the time arranged, then the progress plan of the work could be achieved as it adjusted.
- 4) To avoid a lack of coordination in the field, it is necessary to form a field team which involves all related parties in carrying out the work.
- 5) In scheduling and monitoring work appliance, so the Critical Path Method could be practices in these advanced projects of work accessibility.

## CONCLUSION

### Conclusion

- 1) The dominant factors causing delays in these Advanced project of work accessibility at Soekarno Hatta International Airport are: Changes in the scope of work of contractors, pandemic outbreaks, pending payments, changes in plans and lack of coordination and supervision
- 2) By applying these Critical Path Method (CPM) in timeliness duration for this advanced projects of work accessibility is known has optimal time for project work is 960 days, while the timeliness duration based on addendum contracts 2 takes 1012 days, so it could be concluded that through the CPM method then the timeliness duration will be 52

days more effective compared to the bar chart method that has been done.

- 3) The Improvements which could be made in catching up with the gap delays in advanced projects of work accessibility such as:
  - a) Need to focus on the planning aspect.
  - b) Highly intense of health protocols implementation.
  - c) Scheduled payments are provided to pay the contractor.
  - d) It is necessary to form a field team which involves all parties related in carrying out work.
  - e) Using the Critical Path Method (CPM) in the implementation of advanced project of work accessibility.

### Suggestion

- 1) The Critical Path Method could be advised to PT XYZ to put up in this advanced projects.
- 2) Activities or works that included in the critical path need to get limelight so there would be no delays which could interfere the other work.
- 3) As for Further research, Perhaps you want to do these similar scheduling, you need to include the calculate of costs, not only in terms of time.
- 4) In carrying out this project activities, it is expected that all parties involved could manage the possibilities that arise which could causing this project delays as described in the Fishbone Diagram.

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