Fast Missile Boat Project Planning using CPM and What If Analysis Method

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Abstract. This paper discusses analysis of fast ship missile project planning with CPM and What If analysis. The poor performance can cause project delay and cost overruns, these two things often occur in a project management. Scheduling has an important role to control the project. Good scheduling is required because it will affect the product quality. Scheduling is useful to manage the activities so that the project completion time can be as short as possible and it is used to determine the costs of the project are in optimum condition. The alternatives that can be used to overcome the delay project namely increasing labor and equipment. Project planning can be done to determine whether the project is already in optimum condition. Alternatives that can be used to overcome the delay in the project is to increase labor and equipment, the next is to look for the optimum solution taking into account the duration and gain of each alternative.

1. Introduction

On the construction of a project such as shipbuilding, construction management requires detailed work schedules to anticipate delays in project. Project delays can be anticipated with the acceleration in the implementation, but the cost factor need to be considered. Acceleration can be done by extra working hours, tools, and increasing the number of workers. The minimum added cost would be chosen for the best accelerations scenario [1].

The poor performance caused the delay time, poor quality, and cost overruns often occur in a project. Scheduling has an important role to control the project. Good scheduling required because it will affect the product quality. Scheduling activities are planned so that the project completion time can be as short as possible while taking into account the cost of the project are in optimum condition.

By using the Critical Path Method (CPM) planning process for all activities that must be completed in the project will be easier. CPM will be outlined in a whole list of activities required to complete the project, or the duration of time required for each activity, as well as human resource planning. From this process it will get critical path of a network diagram, which will include some activities that can be shortened to obtain the most efficient project execution [2].

This paper discusses project planning of fast ship missile PT.X. The objectives of this paper are to calculate the critical path of the project and to investigate the additional time and workers needed to accomplish the project. Project planning was conducted by the Critical Path Method (CPM) and What If Analysis. The project is starting to ship in early 2016 began the design, fabrication stage starting in September 2016 and expected to be completed by the end of 2017. The result of this paper can be used...
as a reference in order to avoid delays in the project. Fast Missile Boat has an overall length of 60m, width 8.1m, height 4.85m deck, and the total weight 460ton.

![Fast Missile Boat General Arrangement](image)

Figure 1. Fast Missile Boat General Arrangement[3]

2. Materials And Methods
The flow and procedure of the study is conducted by the stages as follow. Firstly, a literature review is performed by referring to the materials as contained in text books, journals, codes and standards, rules and regulations.

2.1 Data Collection
Collecting data in this research include the type of activities on development projects fast ship missiles, schedule and duration of the activity, the dependence between the activities with other activities, cost estimates and other support elements.

2.2 Compile Critical Path Method (CPM)
Making the project schedule using the Critical Path Method according to the sequence dependence of the project where all activities must be linked to each other in accordance with the logic of dependency that is common in ship projects. Then from the Critical Path Method will be known the critical path and critical activities that were likely to cause delays in Fast Ship Missile project.

2.3 Analysis of Projects Using What If Analysis
Create a project acceleration analysis using What If Analysis in order to determine the number of workers and extra work hours. This step is useful to accelerate the duration of the project so that the project completion time is not too late.

3. Results And Discussion

3.1 Earliest Event Time and Latest Event Time
In CPM (Critical Path Method) there are several activity namely EET (Earliest Event Time), LET (Latest Event Time), Total Float, Free Float, and Independent Float. In the CPM method will also get a critical path that connects the critical activities are activities that should not be delayed. There are two methods of calculation that can be used to identify critical method. Firstly, the Forward pass which calculates the earliest times at which activity may start and the project completed. Secondly, Backward pass which calculate the latest start for activities [4].

3.2 Critical Path Method
CPM (Critical Path Method) is a project management technique that uses only one factor of time per activity. CPM is the fastest path to work on projects, where each project is included on the line was not given the time pause / break to process. If there is a delay in the critical path, it will affect the
overall completion of the project. Completion of the overall project can be accelerated by the acceleration in activities that are on the critical path [5]. The critical path is the path that consists of activities that will result in a delay when the late completion of the project. In CPM (Critical Path Method) is known EET (Earliest Event Time), LET (Latest Event Time), Total Float, Free Float, and Independent Float. In the CPM method will also get a critical path that connects the critical activities are activities that should not be delayed [6].

Table 1. Earliest Event Time and Latest Event Time

| ID Number | Activity                              | Duration (days) | Successor | EET  | LET  | Float |
|-----------|---------------------------------------|-----------------|-----------|------|------|-------|
| A         | Preparation Plate & Profile           | 10              | B         | 10   | 10   | 0     |
| B         | Steel Cutting & Bending Plate         | 23              | C         | 33   | 33   | 0     |
| C         | Sub Assembly                          | 109             | U         | 142  | 142  | 0     |
| D         | Transport & Crane Area                | 60              | E         | 70   | 72   | 2     |
| E         | Assembly Block                        | 45              | O         | 115  | 117  | 2     |
| F         | Fabrication Outfitting                | 10              | I         | 10   | 53   | 43    |
| G         | Fabrication Outfitting Electricity    | 15              | L         | 15   | 65   | 50    |
| H         | Fabrication Outfitting Machinery      | 20              | J         | 20   | 50   | 30    |
| I         | Sub Assembly Outfitting               | 12              | M         | 22   | 65   | 43    |
| J         | Sub Assembly Outfitting Machinery     | 15              | K         | 35   | 65   | 30    |
| K         | Install Steelworks Machinery          | 5               | N         | 40   | 70   | 30    |
| L         | Install Steelworks Electricity        | 5               | O         | 20   | 70   | 50    |
| M         | Install Steelworks Outfitting         | 5               | V         | 27   | 70   | 43    |
| N         | Pre Erection Outfitting               | 15              | Q         | 55   | 147  | 92    |
| O         | Blasting & Painting Block             | 10              | P         | 125  | 127  | 2     |
| P         | Erection Block                        | 20              | Q         | 145  | 147  | 2     |
| Q         | Fit Up                                | 4               | R,S       | 149  | 151  | 2     |
| R         | Welding                               | 8               | Z         | 157  | 159  | 2     |
| S         | Fairing Block                         | 3               | R         | 152  | 162  | 10    |
| T         | Install Out fittings & Piping         | 15              | W         | 177  | 177  | 0     |
| U         | Install Electricity                   | 10              | V         | 152  | 152  | 0     |
| V         | Install Machinery                     | 10              | T         | 162  | 162  | 0     |
| W         | Repair Painting & Steering Gear       | 5               | Y         | 182  | 182  | 0     |
| X         | Finishing Outfitting                  | 22              | Z         | 229  | 229  | 0     |
| Y         | Install Propeller                     | 25              | X         | 207  | 207  | 0     |
| Z         | Final Painting                        | 10              | –         | 239  | 239  | 0     |
3.3 Project Delay
A project must have a schedule to keep on time. In a sense, the work should be completed within a predetermined time. However, due to constraints experienced, it cannot be met and the work is delayed. As a result, the entire schedule has been set originally to be chaotic because it impacts on the company’s financial problems. This delay will prolong the duration of the project as well as the rising cost of construction can even affect both. As for the impact received by the owner and the client is a loss of resources to be placed on other projects and increased costs directly resulting in increased employee salaries, rent equipment, and other things that reduce profits [7]. Delays in a project can result in increasing the cost and time of execution of the project. This is often caused by design changes, the effects of weather, lack of labor, materials or equipment, and access to difficult locations. The delays are often caused by the owner of the project, which is due to an error in the process of planning, selection and specification of the influence of the things that are unexpected. So for all the parties concerned, project delays are often a source of friction because all parties will suffer the same loss of magnitude. This can be seen in terms of the owners, project delays will certainly bring losses since the owner will experience a reduction in income because of the delay operation of the facility that has been booked [8].

3.4 What If Analysis on CPM
Analysis of "What If" is a study which aims to monitor the project so as to avoid delays in project execution. Analysis of "what if" have to be done before the project is implemented, and can be used as a reference for the project manager to be able to quickly take the right decision and effective when there is a discrepancy with the actual schedule plan schedule. In fact the decision-making process is not separated from the factors of uncertainty and doubt. A good decision maker will consider all possibilities that would cause a mismatch to what has been planned. Results of the analysis presented in graphical form sensitivity is very communicative and easy to use, which graph shows the relationship between the type of activity which is accelerated by an additional number of workers or the number of additional hours of work per day. The construction project that is both flexible and complex is a high-risk work because the process out and have a lot of factors involved, so that the analysis of What If the CPM is necessary to apply. Analysis What If the CPM model of asking "What if there is a delay in one activity?", Hence the role of the float will look at non-critical activities [9]. Due to the events of late, it must be accelerated activity followers a project completed on time by

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**Figure 2. Critical Path Method**
improving worker productivity in the activity concerned. Possible acceleration of activity can be done by increasing the number of working hours by the number of permanent workers, increasing the number of workers during normal working hours, and the last to create a new group of workers who work outside working hours [10].

Formula for calculating manpower addition is:
\[
\Delta n = n' - n = \frac{\sum \text{manhour}}{d's \times H} - n
\]  (1)

Formula for calculating working hour addition is:
\[
\Delta H = H' - H = \frac{\sum \text{manhour}}{d's \times n} - H
\]  (2)

\[
\sum \text{manhour} = ds \times n \times H
\]  (3)

Where:
\(\Delta n\) = manpower addition
\(n\) = normal total amount of manpower
\(\sum \text{manhour}\) = amount of manhour
\(\Delta H\) = working hour addition
\(H\) = normal working hour
\(d's\) = duration of acceleration

Based on the network diagram, activity C or Sub.Assembly will late until 7 days and it affects total duration of this project. Table 2 shows the calculation of the What If Analysis with scenarios 7 days delay.

Calculation for activity Instal Outfitting & Piping (T):

Duration/\(ds\) = 15 hari
Float = 0
\(n/\) normal amount of worker = 8 man
\(\Sigma \text{Manhour} = n \times H \times ds = 960\)
\(H/\) normal working hour = 8 hour
Duration of acceleration / \(d's = ds + float - delay = 8\) day
Calculation requirement \(= d's < ds \Rightarrow yes\) (qualify)
\(1/2ds > delay \Rightarrow yes\) (qualify)

Based on formula then the calculation are as shown below:

Additional workers
\[
\Delta n = \frac{\sum \text{manhour}}{d's} - n = 7 \text{ man}
\]

Additional time
\[
\Delta H = \frac{\sum \text{manhour}}{d's} - H = 7 \text{ hour}
\]
Table 2. What If Calculations

| Activity | Duration / ds | $\sum_{\text{man}}$ hour | Float (day) | Delay (day) | d's (day) | d's<ds | 1/2 ds > delay | n (man) | $H$ (hour) | $\Delta n$ (man) | $\Delta H$ (hour) |
|----------|---------------|--------------------------|-------------|-------------|-----------|--------|---------------|---------|----------|----------------|-----------------|
| T        | 15            | 960                      | 0           | 7           | 8         | yes    | yes           | 8       | 8        | 7,00           | 7,00            |
| U        | 10            | 480                      | 0           | 7           | 3         | yes    | no            | 6       | 8        | -              | -               |
| V        | 10            | 480                      | 0           | 7           | 3         | yes    | no            | 6       | 8        | -              | -               |
| W        | 5             | 160                      | 0           | 7           | -2        | yes    | no            | 4       | 8        | -              | -               |
| X        | 22            | 1056                     | 0           | 7           | 15        | yes    | yes           | 6       | 8        | 2,80           | 3,73            |
| Y        | 25            | 1600                     | 0           | 7           | 18        | yes    | yes           | 8       | 8        | 3,11           | 3,11            |
| Z        | 10            | 240                      | 0           | 7           | 3         | yes    | no            | 3       | 8        | -              | -               |

4. Conclusions
A study has been conducted for the case of Fast Ship Missile Project Planning. The findings of the study could be revealed as follows:

- Critical Path of this project is contained of Preparation Plat & Profile (A), Steel Cutting & Bending Plate (B), Sub. Assembly (C), Install Electricity Cable Connection (U), Install Machinery (V), Install Outfitting & Piping (T), Repair Painting & Steering Gear (W), Install Propeller (Y), Finishing Outfitting (X), dan Final Painting (Z).
- To prevent delays in Sub. Assembly activity (C) takes 13 additional workers and 14 hours of additional hours of work.

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