Analysis of resources allocation on passenger ship reparation project using work breakdown structure method in PT. XYZ

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Abstract. Each project generally conducts planning and makes a project schedule, when the project should start and completed, how the project will be carried out, and how to provide its resources. Resources are one of the factors that affect the project's limited amount of profit. So we need a careful and good planning with limited resources in implementing the project in order to use resources efficiently. The purpose of this study is to evaluate the reparation project planning so that there are no more delays in the project by detailing the work package through the Work Breakdown Structure (WBS) method, which in previous studies showed that there was a delay of 4 days using the S-curve. The study was carried out on the KMP (Passenger Motor Ship) repair project at the shipyard PT. XYZ The type of research method used is descriptive qualitative case study approach and purposive sampling. Research methods are using Fault Tree Analysis (FTA) to determine the triggering factors for delays, Critical Path Method (CPM) to determine critical paths, Work Breakdown Structure (WBS) to determine the division of work package levels, WBS dictionary for job identification and resource requirements. Obtained a percentage of 91.3%. Due to the result of work package similarities is $x \geq 75\%$, there is a tendency for the work package of the WMP KMP Dictionary to further the KMP Repair Project.

Keywords: FTA, CPM, WBS, Project, Resources, Repair, Shipyard

1. INTRODUCTION
Indonesia is a maritime country with most of its territory being the sea. The position of this region makes Indonesia to be known as a maritime continent to connect between islands from the western tip of Sabang Island to Merauke.

The presence of PT. XYZ has a mission to provide optimum service to shipyard service users, develop market segments for ships, use integrated quality control methods, and develop human resources in accordance with technological advancements. PT. XYZ provides services in the form of repair and construction of new ships. To do both of the projects ideally is when the work can be completed in a short time, at a low cost, and produce good quality output. To improve the performance of a repair service industry, many variables need to be considered for each job.

In this case, the method used in a project becomes a major factor because it will greatly affect the implementation time of the entire project, both the funds used for the method itself and the resources in the form of heavy equipment and human resources involved in its development (Sumarsono, 2014). Many cases have occurred related to the lack of standardization of work which causes delays in time and costs to be uncontrolled resulting in the addition of the work time of each work to the planning schedule. To standardize works in construction projects, an appropriate reference used in project
management science is WBS (Work Breakdown Structure). WBS is used because it is more systematic and able to explain the scope of each work item in detail.

2. LITERATURE REVIEW

2.1. Project Planning

Project planning is a planning method that can arrange carefully the sequence of activities or the use of resources for these activities so that the project can be completed as soon as possible by using minimal resources. Planning a project is not easy, because a project has limitations such as time, quality, and cost. Therefore, it needs strong fundamental to understand the theoretical basis that can be accounted for when evaluations can be traced to the origin of an existing problem.

2.2. Work Breakdown Structure (WBS)

According to PMBOK 5th edition, the definition of WBS is a description or decomposition of the hierarchy of the total scope of work that must be carried out by the project team to complete the project objectives. WBS manages and defines the total scope of the project, and states the job specifications in the project scope statement. Each lower level in WBS, shows a higher level of detail of the work in the project. WBS is usually a structured diagram and a hierarchy of tree structure diagrams. WBS preparation is done by top down, with the aim that the components of activities remain oriented towards the project objectives.

![Figure 1. WBS Tree Diagram](Resource: Project Management Institute Practice Standard for Work Breakdown Structures, Second Edition, 2006)

The first step in this research is to conduct a literature study related to the WBS format which is a reference where there is no detailed research about WBS-based resource planning so that the format reference material used comes from WORK BREAKDOWN STRUCTURE GUIDE, Version 1.1 Idaho Transportation Department (2011). The WBS dictionary contains an overview of each WBS element with the resources and processes needed to produce each element. This gives a correlation to the details of the technical documents. In addition, this table also shows that the list of WBS elements is in the format which shows a hierarchical relationship.
The WBS dictionary is a document that describes each element in the WBS that includes the Statements of Work (SOW), describes the work contents of the WBS and Base of Element (BOE) elements, and explains how the budget calculations of each element are made (R. Max in Wideman Comparative Glossary of Project Management Terms v2.0). In the WBS dictionary it should contain written descriptions of each element with some additional field descriptions that are part of a complete SOW and detail the activities carried out (Ward, G. F., 2001).

2.3. Fault Tree Analysis (FTA)

Fault Tree Analysis (FTA) is one of the deductive analysis methods by describing an enumeration graph and analyzing how a damage can occur and some chance of damage occurring (Blanchard, 2004). FTA is more focused on damage that has the highest level of importance (undesired top-level event). FTA will describe logical connections (logical connections) between damage and errors that occur on the system by using Boolean symbols. To describe an enumeration graph, researchers need to know the Boolean symbol as a type of relationship between events in the system. In order to stay within the range of page requirement, the FTA example and symbols can be read in Ericson, Clifton (1999).

2.4. Critical Path Method

The Critical Path Method (CPM) appeared in 1957 which is used as the maximum developed by J.E. Kelly and M.R. Walker. CPM assumes that the time of the activity is known exactly so it only requires one estimated time for each activity. The CPM method shows a critical path, which is a path that has a series of activity components with the longest total amount of time and shows the fastest time to complete a project. So that the critical path consists of a series of critical activities, starting from the first activity to the last project activity. The critical path is important in project implementation, because in this pathway there are activities that if the implementation is delayed or late will cause overall project delays. Sometimes in a network there is more than one critical path. To determine the critical path, it is necessary to identify each activity in the network namely: Earlist Start Time (ES), Earliest Finish Time (EF), Latest Start Time (LS), Latest Finish Time (LF)

3. RESEARCH METHODOLOGY

This research methodology is the steps taken in carrying out a study.
3.1. Identification Problem
After conducting the pre-research, the researcher got the result that the KMP reparation project XYZ experienced a delay of 4 days, where the project was supposed to be completed on January 20, 2019 but in reality the project was completed on January 24, 2019. Based on the S-curve graph, a significant delay began to occur on January 5, 2019. For more detailed information, you can see the attached ship repair project Gantt Chart. To analyze the delay factor, the researcher used the Fault Tree Analysis (FTA) method qualitatively.

3.2. Data Collection Procedure
Passenger Ship Repair Project XYZ (RO-RO)
Company : Shipyard PT. XYZ
Time : 09.00 – 16.00 WIB
Location : Jakarta – Gresik

The type of research method used is descriptive qualitative case study approach. The sampling technique used was purposive sampling with interviews with experts with a minimum of 7 years experience in ship repair project work at the shipyard, then researchers also conducted field observations, and documentation. To be more accurate, researchers use reliable reference sources from books, journals, and theses related to previous research. Data needed for the evaluation of this project include Repair List, Project Schedule, Material Receipt Recapitulation, and activity reports.

Figure 3. S Curve Repair Project KMP. XYZ

Figure 4. Fault Tree Analysis Delayed Repair Project KMP XYZ, Continued
4. RESULT AND DISCUSSION

From the results of interviews with experts, the results of the FTA are Figure 7 above and Figure 8 as follows:

![Fault Tree Analysis](image)

**Figure 5. Fault Tree Analysis** Delayed Repair Project KMP XYZ

Based on the results of interviews with experts, it was agreed that the main factor of the problem of the delay in the XYZ passenger ship repair project was due to the procurement of resources, both material and labor that was still inadequate. In replating and interior work packages, it was found that there were problems running out of material and labor shortages, causing a setback to work. Therefore, the researcher decided to analyze the resource allocation in the hope that it would help with the preparation of the project in terms of both cost and time using the Work Breakdown Structure (WBS) method.

In the XYZ ship repair project, researchers conducted an analysis of the interrelationship of activities with the critical path method (CPM). In this project, it was found 3 lines of criticism, namely:

a. A–E–G–O–P–Q
b. A–E–L–O–P–Q
c. A–E–M–O–P–Q

With the longest project completion time, namely during: 6 + 11 + 5 + 1 = 25 day

![Critical Path Method](image)

**Figure 6. Critical Path Method (CPM)** Ship Repair Project XYZ
It can be seen that work that has the potential to cause delays is found in Replating Top, Docking, Overall Construction, Interior, Propulsion, Undocking, and Finishing. So that it can be stated that some of this work needs to be further investigated so that researchers can formulate the needs of each of these jobs.

From the results of field observations, input by experts and other supporting data, the researcher makes the Work Breakdown Structure (WBS) which is divided into several levels as shown in table 1.

Table 1. Level WBS Ship Repair Project XYZ

| Color | Level | Note             |
|-------|-------|------------------|
|       | 1     | Project’s Name   |
|       | 2     | Work Category    |
|       | 3     | Type of Work     |
|       | 4     | Location         |
|       | 5     | Work Package     |

Based on the results of interviews of experts and literature studies, researchers formulated all the level of WBS Diagram Tree as shown in figure 10. From the Tree Diagram, the researchers only developing one work category namely Specific Service. It is consist of 10 types of work were formulated in the WBS Dictionary with description and resource allocation information. Below are two example of types of work as follows:

Table 2. WBS Cleaning Dictionary

Description : Emptying and cleaning of waste tanks.

| Location       | Activity             | Resource                        |
|----------------|----------------------|---------------------------------|
| Engine Room    | Cleaning task inside ship | Supervisor, sewerage outlet     |
| Trimming       | Labor                | Manager, waste storage tube     |
| Intermediate Room |                  |                                |

Table 3. WBS Interior Dictionary

Description : Renovation or renewal of additional facility for passengers.

| Location         | Activity             | Resource                        |
|------------------|----------------------|---------------------------------|
| Bridge           | Renovation of additional facility | Project Manager, Paint Brush |
| Passenger Rooms  | Fix minor damage     | Tukang, Floor ceramics, Drill   |
| Toilet           |                      | Cement, Hammer, Cement, Tool   |
| Prayer Room      |                      | Wooden board, Nut              |
| Tools Warehouse  |                      |                                |
Figure 7. All Level of WBS Diagram Tree Ship Repair Project XYZ
5. CONCLUSION
From the result of calculating the data, it can be concluded that:
1. Based on the results of the qualitative Fault Tree Analysis (FTA), it was found that the Procurement of Resources was the main factor causing delays in the XYZ passenger ship repair project.
2. Based on Critical Path Method (CPM) results, there are 3 critical path, specifically:
   
   A → E → G → O → P; A → E → L → O → P; A → E → M → O → P
   
   With the longest project completion time of 25 days.
3. Based on the results of the preparation of the Work Breakdown Structure (WBS) Diagram Tree obtained 5 levels. Level 1, the name of the project is the KMP Repair Project. XYZ Level 2, occupational clumps, consists of Preparation, General Service, Specific Service, Mechanics, and Administrative Completion. Level 3, type of work. Level 4, job location and level 5, the work package contains detailed job information at a predetermined location.
4. Researcher only formulate Specific Service work families because these work groups require complex resource planning and there is no clear standardization in PT. XYZ The WBS dictionary KMP Repair Project is divided into a Package of Gastric Care Work, Replating Work, Pipe Replacement Work, Cleaning Work, Interior Work, Sea Chest & Valve Work, QA / QC Work, Anchor Care, Propulsion System Care, Docking / Undocking Work and work mechanic.
5. Based on the calculation of trends in the KMP work package, a percentage of 91.3% was obtained. Because there is a work package equation of x ≥ 75%, it is stated that H0 is accepted so that there is a tendency for the work package of the WBS KMP Dictionary towards the next KMP Repair Project.

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