ANALYSIS OF MAN-HOUR REQUIREMENTS AND SCHEDULING FOR FLOATING DOCK REPAIRS

Salsabila Ramadhani[1*], Fitri Hardiyanti [1], Gaguk Suhardjito[1], Rachmad Tri Soelistijono[2], Aang Wahidin[3]

[1]Business Management Department, Shipbuilding Institute of Polytechnic Surabaya (SHIPS), Surabaya, Indonesia
[2] Shipbuilding Department, Shipbuilding Institute of Polytechnic Surabaya (SHIPS), Surabaya, Indonesia
[3]Design and Construction, Shipbuilding Institute of Polytechnic Surabaya (SHIPS), Surabaya, Indonesia

E-mail: salsabilaarnp@gmail.com

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ABSTRACT

A floating dock (FD) is a platform for ship construction and repair. Structural damages to a FD can significantly reduce ship docking productivity, leading to substantial losses for shipyard companies. In order to restore its operational capabilities, repairing the damaged FD becomes essential. This research aims to plan and analyze the schedule to ensure the efficiency and effectiveness of FD repair activities. The process begins with the establishment of a Work Breakdown Structure (WBS), followed by determining the required man hours (MH) and scheduling using the Precedence Diagram Method (PDM). Finally, the S-curve is made for monitoring the progress of the FD repairment. The findings of this study, based on a case study involving a 6700 TLC FD, reveal a WBS comprising 66 repair tasks including two tasks for FD testing and finishing in addition to four areas of hull, walls, deck and tanks, piping systems, and machinery. The MH requirement for these tasks is 4048 MH. From the scheduling results, it was found that the duration was 12 days, with a total of 53 critical activities and 25 critical paths in the floating dock repair work using the precedence diagram method.

Keyword: Floating Dock, Repairment Schedule, Work Breakdown Structure, Precedence Diagram Method (PDM), Man-Hours

Introduction

Indonesia, with its extraordinary maritime advantages, requires ships as the main support for sea transportation. With adequate facilities, ship construction and repair can support Indonesia's goal of having a strong maritime industry. A shipyard is a place that used as a place to manufacture and repair ships. Where every shipyard has facilities that support ship construction and repair activities. Which consists of graving dock, floating dock, slip way, airbags, and so on.

One of them is in a shipyard that located in Bangkalan, Madura. Where in their ship repair and construction process, the shipyard company uses floating dock as the main pillar and the most requested by their owner surveyor. Floating dock itself is a construction structure at sea that is used for docking ships by sinking and floating them in a vertical direction. This floating dock construction is generally made of steel plates, where the electricity supply source is obtained from land or from the floating dock itself [1] In addition, due to the floating dock is a floating structure, the good balance and stability of the floating dock itself is necessary to ensure safety and security in the ship docking process.

Reviewed from the way a floating dock works, it sinks and floats up when the ship is lifted vertically [2]. Therefore, due to these conditions, a routine regulation and control system is needed to maintain stability when the floating dock is operating.

Thus, the floating dock must be maintained properly. However, if maintenance is not carried out regularly, it will cause huge losses. This happened to a shipbuilding company domiciled in Bangkalan, Madura. Their floating dock was damaged, which was caused by the condition of the floating dock's deck.

The damaged of floating dock is presented in Figure. 1. The deck was deformed, where the plate and web frame were corroded and thin. Therefore, when the ship is docked, where the ship's anchor position is in the thin web frame and plate area, the deck cannot support the weight of the ship then it experiences a tear. Which causes the floating dock to sink and be completely paralyzed. Apart from that, there are bulkheads between tanks that are not tight, which makes the floatation of floating dock is difficult because water cannot be localized in a one tank. And this condition spreads to various mechanical components of the floating dock.

This damage caused the queue for ships to lengthen, and ship repairs were delayed beyond the predetermined schedule. The conditions of this waiting times can make ship docking productivity decrease drastically. Because the ship that will be docking cannot carry out repairs on the floating dock. This floating dock’s capacity able to carry out on two ships at one time for two weeks, imagine the losses that experienced by the shipyard companies due to the reduced productivity of this floating dock. In order to this repairment of the floating dock there are no delays that could harm the shipyard company in Madura, the researchers made a scheduling plan so as the repair activities were efficient and effective.

Some of researcher has been conducted study on man hour requirement and work scheduling such as time scheduling planning by applying the precedence diagram method in bridge construction [3] then planning the completion time for the hotel development project using the precedence diagram method [4] next estimation material requirements, man hours, and plate replacement costs on barge marine power 3042 [5]. However, none of those researchers were applied the man hour requirement and scheduling with precedence diagram method in floating dock repairment. Therefore, this study will discuss the possibilities of applying those method into floating dock repairment case.

Methodology

In this section of the methodology consist of five stages. Firstly, problem identification and formulation are a stage that explains and identifies problems that occur by looking for primary data from the company and determining the topic of the final assignment being researched. With the problems identified, this is an important first step in research to determine the formulation of the problem.

Secondly is literature studies and field studies are used to find the theoretical basis for floating docks, project management, WBS, people hours, PDM, s-curve. In addition, also look for journals related to research. The field study was carried out at the company where the case study was conducted, namely at a shipyard located in East Java

Next is data gathering. At this stage, data is collected as supporting material for analyzing the problems being studied. The data collected consists of primary data and secondary planning data. Primary data was obtained directly from the field, through observations and interviews with parties related to floating dock repairs. Interviews in this study were used to find out the causes of damage to the floating dock and what work was done to repair the floating dock. In the interviews conducted, purposive sampling was used, where the sample selection technique takes certain considerations into account. The selection of a group of subjects in purposive sampling is based on certain characteristics that are considered to have a close relationship with the known characteristics of the population. The selection of respondents is based on people who truly understand the issues raised, have work experience, judging by their level of education and position. Then secondary data is obtained from company data. The data was carried out at the on the job training site which is one of the shipyards in East Java. One of them is material prices.

Next step is data processing, at this stage it begins by using a work breakdown structure for identify the activities in floating dock repairment. Next step is to determine man hours, after everything is determined, it is followed by the other precedence diagram method to determine the network and get the critical path.

Theoretical Basis

In this paper, various methods are used. Consisting of work breakdown structure, man hour requirements, and precedence diagram method. First method is work breakdown structure, known as a method of organizing a project into a hierarchical reporting structure. The scheduling process begins with identifying project activities [6]. After the first activity is known, it can be continued into planning. For this floating dock’s repair project, the work breakdown structure can be divided into several parts such as the hull, walls, decks and tanks, as well as systems and machinery.

After project activities are identified, the next step is to calculate man hours. Is a unit of measurement used in project management to measure the effort required to complete a task [7]. This involves how many hours of work and the number of workers required to complete each activity, according to Cornelia for calculating the productivity using the formula: [8]

$$P = \frac{M}{T \times JTK} \tag{1}$$

Explanation:
P = Productivity
M= Weight or Unit
JTK = Total Manpower
T = Duration

After finding productivity, the next step is to calculate man hours. using the formula: [5]

$$JO = \frac{M}{P} \tag{2}$$

Explanation:

JO = Man Hour
M = Weight or Unit
P = Productivity

For the next method, the precedence diagram method is used to determine the network and get the critical path. Precedence diagram method is a project scheduling method where activities are written in nodes which are generally rectangular in shape, with arrows as an indication of the relationship between the activities concerned [9]. The critical path is the path that takes the longest to implement of all existing paths. The critical path or critical path is formed from critical activities [10] it's the path that has the smallest amount of slack. Slack itself is the difference between late start and early start or the difference between late finish and early finish [11].

The method that used in this paper includes the initial steps such as job identification with work breakdown structure, calculation of man hours. In addition, the use of the PDM method to determine activities and critical paths is easy, all of which are important in planning and managing floating dock repair projects efficiently and effectively.

And the last stage is conclusions and suggestions. After the data is analysed and discussed, conclusions and suggestions can be produced which are the final results of a final research assignment, and become policy comparisons for researchers.

Result and Discussion

This section discusses the analysis of the man hour requirement and scheduling of floating dock repair results. The details of the work breakdown structure consist of sixty-six repair works that must be carried out. with two additional works in the form of floating dock trials and finishing, as well as four areas namely hull, walls, decks and tanks, piping systems and machinery. The four areas mentioned are divided into the work that must be done. Consisting of replating¸ doubling, disassembling, assembling, installing, opening and installing, cleaning¸ draining, painting, fabrication, repair. After that, apart from the parts and work to be done, there are types or objects to be done. Namely consisting of scaffolding, girders, top and web, pipes, engine motors, railings and so on according to the frame and size of each.

From the results of man hours calculations from the weight formula divided by productivity. With the formula in Equations 2.1 and 2.2 the need for man hours for repairing the floating dock presented in Table 1 that requires 4048-man hours. The longest time was 192 hours, consisting of work on replating the inner hull on the north side frame 4, 5, 7, 8. Replating the main deck and internal frame 11-16, installation of tank 1 right frame 28, realigning the main deck deformation, Bilge Motor Repair and Fire Pump Repair. And the shortest time is only 8 hours people. It consists of doubling the hull crane pipe on the north side of frame 8, disassembling the doubling plate of the left hull frame 5-8, replating bracket elbow frame 8 12, replating senta bracket, replating top and web tank 1, replating top and web frame, doubling main plate. Deck frame 13, Doubling longitudinally, installing zinc anode,

Figure. 1 The Damaged of Floating Dock

Table 1. Total of Man Hour Requirement

All Activities	M	P	MH
Replate	20374	275	2104
Installation	3029	49,11	384
Doubling	309	25	64
Realign	1125	6	192
Cleaning	1	0,021	48
Drain water	1	0,016	64
Open and installation manhole	1	0,016	64
Repipe	12	0,27	224
Repair	7	0,09	752
Repair	7	0,09	752
Fabrication and Installation	11	0,42	112
Overhaul	56	7,13	16
Paint	1	0,13	8
Floating Dock Trial	1	0,13	8
Finishing	1	0,13	8
Total	24929	364	4048

Table 2. Critical Activities of Floating Dock Repair

Critical Activities	
Code	**Activity**
I	Left hull plate Overhaul frame 5-8
H	North Hull Pipe Crane Hull Doubling frame 8
AT	Tank Bulkheads D oubling
AX	Drain Water Tank
A	North Inner Hull frame 4, 5, 7, 8 Replate
AJ	Main deck and Internal frame 11 – 16 Replate
AN	Tank Right 1 frame 28 Installation
AV	Realign the deformed main deck
AK	Deck frame 13/14 - 18/19 and elongated web Replate
BE	Bilga Motor Repair
BG	Fire Pump Repair
BC	Power Pack Motor Repair
BH	Power Pack Valve Repair
J	Right Pump Wall Space Replate
M	Inner South Wall frame 3,4,6,7 Replate
AD	Transverse Replate of Right Tank 1 frame 28, 33, 37, 41
AF	Web Frame 1-4 Replate
AH	Left Tank 2 and 3 Replate
AL	Deck ¾ - ⅞ and Elongated Web Replate
G	Left Stern Inner Scaffoding Hull Installation
K	Right Plate Pump Wall Space Replate
S	Transverse Girder frame 8, 10, 12 Replate
X	Elbow frame 9 13 Replate
Critical Activities	
Code	**Activity**
AG	Deck Replate and New Pillar Installation
BM	New Bilga Motor Installation
BK	Disassemble Ducting damaged (Old)
N	Inner north west wall frame 6-8 Replate
R	South Inner Wall frame 13/12 - 8/9 Replate
T	Longitudinal Long Girder 17 – 21 Replate
AB	Top and Web Senta Tank 10 Replate
K	Right Plate Pump Wall Space Replate
S	Transverse Girder frame 8, 10, 12 Replate
X	Elbow frame 9 13 Replate
AG	Deck Replate and New Pillar Installation
BM	New Bilga Motor Installation
BK	Disassemble Ducting damaged (Old)
N	Inner north west wall frame 6-8 Replate
R	South Inner Wall frame 13/12 - 8/9 Replate
T	Longitudinal Long Girder 17 – 21 Replate
AB	Top and Web Senta Tank 10 Replate
AW	Cleaning above the tank 1
AZ	Tank 6 Repipe (North Side)
BB	Air Pipe Tank 3 Repipe
L	South Inner Wall frame 3 Replate
Q	South East wall manhole frame 16 Replate
U	Right Girder frame 5 – 8 Replate
W	Longitudinal Elbow frame 5 Replate
V	Longitudinal Elbow frame 8 – 12 Replate
AA	Top and Web Tank 1 Replate
AE	Elongated Tank ½ frame 24 28 Replate
AP	Zinc Anode 12 tank Installation
AR	Elongated Stern frame 28, 36 - 39, 43 – 44 Doubling
AU	Tank ⅔ Doubling and Transverse Stern Installation
BA	Air Pipe Deck above Tank 6 Repipe
BJ	Fabrication and Installation New Left Ducting
BI	Fabrication and Installation New Right Ducting
BL	Paint New Ducting
AQ	Main Deck Plate frame 13 Doubling
AS	Longitudinal Doubling, Zinc Anode Installation
AC	Top and Web Frame Replate
Z	Senta Bracket Replate
Y	Elbow Bracket frame 8 12 Replate
BN	Floating dock Trial
BO	Finish

Doubling Tank bulkhead, Fabrication and Installing new right Ducting, dismantling damaged (old) Ducting, Painting new Ducting, Trial Floating Dock, and Finishing.

The results of the scheduling using precedence diagram method for floating dock repair, presented on Table 2 and **Error! Not a valid bookmark self-reference.**. Table 2 shows the 53 critical activities, and **Error! Not a valid bookmark self-reference.** shows the 25 critical paths respectively. In **Error! Reference source not found.** the critical path is also shown in a graphical presentation.

Table 3. Critical Path of Floating Dock Repair

Critical Path	
Path	**Activity Code**
1	I – H – AT – AX – A – BN – BO
2	I – H – AT – AX – AJ – J – K – BN – BO
3	I – H – AT – AX – AJ – M – N – BN – BO
4	I – H – AT – AX – AJ – M – R – L – BN – BO
5	I – H – AT – AX – AJ – M – R – Q – BN – BO
6	I – H – AT – AX – AN – AH – BN – BO
7	I – H – AT – AX – AV – BN – BO
8	I – H – AT – AX – AK – AD – S – T – U – BN – BO
9	I – H – AT – AX – AK – AD – S – T – AE – BN – BO
10	I – H – AT – AX – AK – AD – X – W – BN – BO
11	I – H – AT – AX – AK – AD – X – W – BN – BO
12	I – H – AT – AX – AK – AD – X – V – BN – BO
13	I – H – AT – AX – AK – AF – AB – AA – AC – BN – BO
14	I – H – AT – AX – AK – AF – AB – AA – Z – BN – BO
15	I – H – AT – AX – AK – AF – AB – AA – Y – BN – BO
16	I – H – AT – AX – AK – AF – AB – AR – AQ – BN – BO
17	I – H – AT – AX – AK – AF – AB – AU – AS – BN – BO
18	I – H – AT – AX – AK – AF – AW – AP – BN – BO
19	I – H – AT – AX – AK – AF – AW – AP – BN – BO
20	I – H – AT – AX – AK – AL – AG – BN – BO
21	I – H – AT – AX – BE – BM – AZ – BA – BN – BO
22	I – H – AT – AX – BE – BM – BB – BN – BO
23	I – H – AT – AX – BE – BK – BJ – BI – BL – BO
24	I – H – AT – AX – BE – BC – BN – BO
25	I – H – AT – AX – BG – BH – BN – BO

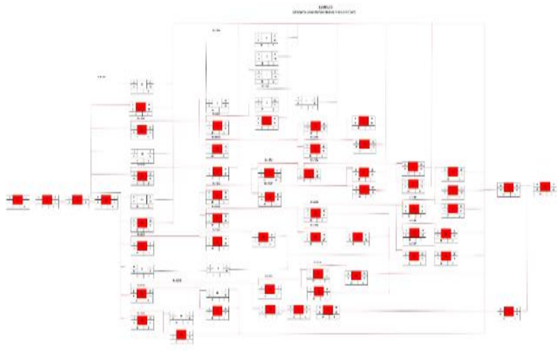

Figure 2. Critical Path

Conclusion

From this study the following concluding remarks are presented below:

- The scheduling using the Precedence Diagram Method for floating dock 6700 TLC repair found that the duration was 12 days, with a total of 53 critical activities and 25 critical.
- The Work Breakdown Structure consist of sixty-six repair works that must be carried out. with two additional works in the form of floating dock trials and finishing, as well as four areas namely hull, walls, decks and tanks, piping systems and machinery. The four areas mentioned are divided into the work that must be done. Consisting of replating¸ doubling, disassembling, assembling, installing, opening and installing, cleaning¸ draining, painting, fabrication, repair.
- The man hour requirements needed is 4048-man hours.

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References

[1] Pramono, D. R., Imron, A., Misbah, M. N.: Analisa Kekuatan Memanjang Floating Dock Konversi dari Tongkang dengan Metode Elemen Hingga. Jurnal Teknik ITS. 5 (2), 48-52 (2016)

[2] Soeryanto, Mashuri, A. A., Bina, S.: Proses Repairing Ponton di PT.Dok dan Perkapalan Surabaya. Otopro.12 (2), 50-56 (2017)

[3] Irvan, M., Khaidir, I., Permata, R.: Perencanaan Penjadwalan Waktu dengan Metode PDM (Precendence Diagram Method) Studi Kasus: Pembangunan Jembatan Desa Rantau Limau Manis, Kecamatan Tabir Ilir, Kabupaten

Merangin, Provinsi Jambi. Program Studi Teknik Sipil, Universitas Bung Hatta (2020)
[4] Koilam, F. E., Dundu, A. K. T., TJ, A. T.: Perencanaan Waktu Penyelesaian Proyek Pembangunan Hotel Marron Resort Tomohon dengan Menggunakan Precedence Diagram Method. Jurnal Sipil Statik. 8 (5), 749-754 (2020)
[5] Amalia, Y. et al.: Estimasi Kebutuhan Material Jam Orang dan Biaya Penggantian Plat pada Barge Marine Power. 9th Applied Business and Engineering Conference, pp. 442-454 (2021)
[6] Winata, D. H.: Perencanaan Penjadwalan Waktu dengan Metode PDM (Precedence Diagram Method) (2021)
[7] Brian, A.: Aplikasi Man Hours dalam Aktifitas Proyek untuk Penerapan Manajemen Biaya Proyek dalam PMBOK. Jurnal Teknik: Universitas Muhammadiyah Tangerang. 7 (1), 26-35 (2018)
[8] Warsika, D. P.: Analisis Waktu dan Biaya berdasarkan Analisa Produktivitas Tenaga Kerja pada Proyek Pembangunan Konstruksi. Thesis, Universitas Udayana (2017)
[9] Laksito, B.: Studi Komparatif Penjadwalan Proyek Konstruktif Repetitif Menggunakan Metode Penjadwalan Berulang (RSM) dan Metode Diagram Preseden (PDM). Media Teknik Sipil, Surakarta (2005)
[10] Nasution, A. H.: Manajemen Industri. Andi, Yogyakarta (2006)
[11] Gray, C. A., Larson, E. W.: Manajemen Proyek Proses Manajerial. Andi, Yogyakarta (2007)