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ANALYSIS OF ACTIVITY PLANNING IN THE 2765 DWT TANKER REPAIR PROCESS USING THE *CRITICAL PATH METHOD (CPM)*

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Abstract

Ships are basically a means of sea transportation, which connects an island or between regions of a country, which is used as passenger transportation, as well as transportation of goods. As the largest archipelagic country in the world, Indonesia has waters with two vast seas which are larger than the land. Therefore, sea transportation has an important role for the sustainability of the economy in Indonesia, so the need for developers in the maritime sector needs to be increased, one of which is in the field of Shipyards. In the ongoing docking process, it is necessary to schedule the work. So that the project runs in a structured manner, it is necessary to pay attention, because scheduling a project itself helps to detail the activities of an activity, the time required for project completion so that the project is on time Completion and there are no delays in workmanship Critical path method (CPM) itself is a method for identifying completion in a project to complete the completion of a project so that it is on time. And the authors use this method to help resolve and compare between the 2765 dwt tanker scheduling made by the shipyard and using the critical path method (CPM). The results of my research entitled " analysis of activity planning in the 2765 dwt tanker repair process using the critical path method (cpm) " are. The schedule made by the shipyard gets a completion time of 61 days, whereas if you use the critical path method, it takes 48 days.

Keywords: shipyard ; critical path method (cpm) ; project scheduling.

1. Introduction

Ships are basically a means of sea transportation, which connects an island or between regions of a country, which is used as passenger transportation, as well as transportation of goods. As the largest archipelagic country in the world, Indonesia has waters with two-thirds of the sea area larger than the land. Therefore, sea transportation has a very important role for the sustainability of the economy in Indonesia, one of which is in the process of supplying goods to areas that are difficult to reach or *isolated* , where access to these areas can only be passed, one of which is by using the ocean sector. .

Seeing the sea transportation sector which is one of the veins of the economy for Indonesia. hence the need for development in the *maritime* sector needs to be improved, one of which is in the field of shipyard/ *shipyard* which is a specially designed place equipped with supporting facilities for shipbuilding, maintenance and repair of ships **.** In the ongoing *docking process* , it is necessary to schedule work so that the project runs in a structured manner, it is necessary to pay attention, because scheduling a project itself helps to detail the activities of an activity, the time required for project completion so that the project is finished on time and there are no delays in workmanship.

Factors that affect the delay of a project according to Ali et.al (2012) are usually caused by delays in procuring materials, lack of preparation, inadequate human resources and scheduling of estimated time in doing work is not quite right. This can have a detrimental effect on a company if a project experiences a delay, the impact that results if a project experiences a delay is that the costs required increase. Because the amount previously estimated to be greater. Requires additional time to complete a project. Late payments, rescheduling due to disturbances and problems that arise in the project. And loss of reputation or trust in the company.

Several studies have been carried out related to job scheduling using the *Critical Path Method (CPM) method*. One of them is Galan Regatama's research (2019) *with* the title " *network planning* analysis of SPB TITAN 70 ship repair using the *critical path method* ". to 42 days with 25 critical activities with zero *slack value* from the project target achieved which was 32 days and the project is expected to experience an additional workforce of 52 workers. resulting in a work productivity of 24.2 kg/per person (per day) for resources, 5 welding machines (per day), and 2 pieces (per day) for forklifts.

Another research from YT Andhani, IP Mulyatno (2020) with the title " Rescheduling KN Ship Repair. KUMBA 470 DWT with the Critical Path Method in the Semarang Shipyard , "discusses the comparison of the duration of scheduling time between shipyards using the critical path method from the initial estimated time of 50 days to 41 days when using the critical path method

Based on the background of the study above, this study aims to , on the basis of previous research, minimize delays in a project that experiences delays, especially in the ship repair process. The author uses *the Critical Path Method (CPM)* to help solve problems in determining the optimal time for work in a project, as well as knowing the overall work flow that takes place in the future and serves as an evaluation of the schedule that was made before .

Project management

Project management is the process of planning and coordinating all work activities of a project from start to finish. Thus guaranteeing the implementation of a project effectively and efficiently in terms of timeliness, quality produced, and according to the time allotted. The purpose of implementing project management itself is to maximize the quality and potential of human resources in carrying out work, so that each individual can carry out their duties optimally in accordance with the provisions that apply in the project, to achieve a smooth work carried out.

Project Management Functions Dimyati & Nurjaman (2014) are:

1) Planning function (*Planning*). This function aims at making decisions that manage selected data and information to be carried out in the future, such as preparing long-term and short-term plans, and others.
2) Organizational function (*Organizing)* . The organizational function aims to unify a collection of human activities, which have their respective activities and are interconnected, and interact with their environment in order to achieve organizational goals, such as compiling the scope of activity, - others.
3) Implementation function (*Actuating*) . The implementation function aims to align all related organizational actors in carrying out activities/projects, such as task direction and motivation, and others.
4) Control function *(Controlling)* . The control function aims to measure the quality of performance and analyze and evaluate activities, such as providing suggestions for improvement, and others.

Critical path method

Critical Path Method (CPM) is a critical path method that uses a network with a *linear time-cost balance* . The *CPM* technique is carried out by compiling a network that is identified towards activities and using simple time estimates for each activity that shows the implementation period. *CPM* is one method in *network planning*. *CPM* began to be developed in 1957 by *JE Kelly* from Remington Rand and *MR Walker* from Dupoint after the development of the *PERT method* which was developed in the 1950s

According to Hari T Handoko, Asri Marwan & Subagyo Pangestu (1993) CPM stands for *Critical Path* Method (critical path method). *CPM* is a method of planning and controlling projects which is the most widely used system among all systems that use the principle of network formation. With *CPM*, the amount of time required to complete the various stages of a project is assumed to be known with certainty, as is the relationship between the resources used and the time required to complete the project. So, *CPM* is a network analysis that seeks to optimize the total cost of the project by reducing the total completion time of the project in question. The network preparation technique contained in *CPM* uses AOA (*activity on arrow*), meaning that arrows indicate activities or jobs with some description of their activities.

2. Method

This research is a research that uses the case study method as a guide. In addition, this study uses a descriptive analysis method where the research is focused on a case in detail and intensively. This research is a case study that pays attention to details in a particular case. The research sample was focused on a case study on the scheduling of the 2765 DWT tanker repair process. In collecting data, the authors use field studies to include identification of problems that exist when carrying out *on the job training activities* at the Shipyard in Lamongan, by studying ship repair procedures in the shipyard, helping researchers to schedule work using the *critical path method* is to evaluate the existing scheduling problems so that the order of ship repair activities is more detailed from the beginning of the docking process to completion.

3. Discussion

One of the shipyards in Lamongan district has received several ship repair projects, one of which is a type of tanker that has 2765 DWT, of these many projects, it is necessary to have proper and effective scheduling to maximize the work process. Therefore, in writing this final project, we will analyze the scheduling applied to the shipyard. The following is a list of ship repair work processes made by the shipyard:

Table 1. Repair of 2765 DWT ships in shipyards

No	Activity Activity	Duration	Work date	
			Start	finish
	YARDWARE PREPARATION			
1	provide the necessary facilities before repairs are carried out at the shipyard	2 days	sen, 07/03/2022	tue, 08/03/2022
2	Provide necessary tugboat services	1 days	wed, 09/03/2022	wed, 09/03/2022
3	docking service	1 days	thurs, 10/03/2022	thurs, 10/03/2022
	HULL CONTRUCTION REPAIR			
gastric cleansing				
4	oyster scrap	1 day	Fri,11/03/2022	Fri,11/03/2022
5	water jetting (high pressure)	1 day	Sat, 12/03/2022	Sat, 12/03/2022
6	water jetting (low pressure)	2 days	Mon, 14/03/2022	Tue, 15/03/2022
7	blasting	3 days	Wed, 16/03/2022	Fri, 18/03/2022
hull anode				
8	cut the zinc anode in the hull	1 day	Sat, 19/03/2022	Sat, 19/03/2022
9	cut the zinc anode in the ballast tank	1 day	Mon, 21/03/2022	Mon, 21/03/2022
10	Install the zinc anode in the hull	2 days	Tue, 22/03/2022	Wed, 23/03/2022
11	Install the zinc anode in the ship's ballast tank	3 days	Thurs, 25/03/2022	Sat, 26/03/2022
sea chest box and valve				
12	sea chest box (open, clean, painting according to procedure)	2 days	Mon, 28/03/2022	Tue, 29/03/2022
13	check valve (overhaul valve) in the engine room	1 day	Wed, 30/03/2022	Wed, 30/03/2022
thickness measurement				
14	shell expansion, tank top, bhd & internal, main deck and superstructure	1 day	Thurs, 31/03/2022	Thurs, 31/03/2022
repair or replating				
15	replate tank tops	4 days	Fri, 30/03/2022	Tue, 05/04/2022
16	replate side shell	5 days	Wed, 06/04/2022	Mon, 11/04/2022
17	bulkhead replate	2 days	Tue, 12/04/2022	Wed, 13/04/2022
18	replate frames or brackets	1 day	thurs, 14/04/2022	thurs, 14/04/2022
19	replace the tross rope foundation on the frocestel deck and poop deck	2 days	Fri, 15/04/2022	Sat, 16/04/2022
20	replate winch foundations, and winch brackets on the Frocastle deck and stern	2 days	Mon, 18/04/2022	Tue, 19/04/2022
21	replace new steps stearing gear room and poop deck	1 day	Wed, 20/04/2022	Wed, 20/04/2022
22	make a new vent head and replace the mash vent stone	3 days	thurs, 21/04/2022	Sat, 23/04/2022
23	replate top bullwork	1 day	Mon, 25/04/2022	Mon, 25/04/2022
24	change the foundation of life boy	1 day	Tue, 26/04/2022	Tue, 26/04/2022
25	replate lifeboat foundation	1 day	Wed, 27/04/2022	Wed, 27/04/2022

26	repair cargo tanks 1P-5P + 4S	4 days	thurs, 28/04/2022	Mon,02/05/2022
27	WBT bulkhead replate	1 day	Tue, 03/05/2022	Tue, 03/05/2022
28	unload sekerem	1 day	Wed,04/05/2022	Wed,04/05/2022
29	put cool	1 day	Thurs, 05/05/2022	Thu,05/05/2023
30	cut the anchor chain	1 day	Fri, 06/05/2022	Fri, 06/05/2023
31	install the steering cap stopper	1 day	Sat, 07/05/2022	Sat, 07/05/2022
	FINAL STAGE/SHIP FLOATING			
32	inspection or checking of equipment and repair of all existing activities by the classification bureau. Is it safe and feasible before the ship is operated again	2 days	Mon, 09/05/2022	Tue, 10/05/2022
33	ship painting	4 days	Wed, 11/05/2022	Sat, 14/05/2022
34	undocking service	1 day	Mon, 15/05/2022	Mon, 15/05/2022
	Total		61 Days	

In the scheduling that has been made as shown in Table 1 above, it has not implemented work according to the critical path or the path that must be prioritized first so this can result in delays due to inaccurate scheduling, which work must be done first and which schedule must be done next. And from the schedule that had been planned by the Lamongan shipyard, the duration of the 276 DWT tanker repair work was 61 days.

Scheduling planning uses the critical path method

The use of *the critical path method* aims to make it easier for the project to be carried out, every activity to be carried out will be planned in detail. Therefore, if there is a delay in project activities, it will be easy to detect which activities are experiencing delays. To find out which jobs are on the critical path, to get the critical path there are several steps including making connections between jobs, calculating the *forward pass*, calculating the *backward pass* , and calculating the total *float* . An activity can be said to be critical if its total *float* equals 0.

Develop a schedule of activities and relationship activities

Before scheduling using the *CPM method* , a relationship between jobs is needed to determine the relationship between the predecessor activity and the next activity. In making scheduling using *the critical path method* there are several possibilities, such as:

1. A job can be done simultaneously with other activities.
2. An activity can only be carried out if the previous activity has been completed.
3. An activity can be done separately without having to wait for the previous activity.

The following is the arrangement of relationships between activities in the 2765 DWT tanker repair project:

Table 2. Schedule of Activities and Relationships Between Activities

No	Activity Activity	code	preliminary code
	YARDWARE PREPARATION		
1	provide the necessary facilities before repairs are carried out at the shipyard	A	_
2	Provide necessary tugboat services	B	A
3	docking service	C	B
	HULL CONSTRUCTION		
gastric cleansing			
4	oyster scrap	D	C

5	water jetting (high pressure)	E	D
6	water jetting (low pressure)	F	K
7	blasting	G	H, L, M, I, AB
hull anode			
8	cut the zinc anode in the hull	H	E
9	cut the zinc anode in the ballast tank	I	E
10	Install the zinc anode in the hull	J	F
11	Install the zinc anode in the ship's ballast tank	K	X,AD
sea chest box and valve			
12	sea chest box (open, clean, painting according to procedure)	L	N
13	check valve (overhaul valve) in the engine room	M	N
thickness measurement			
14	shell expansion, tank top, bhd & internal, main deck and superstructure	N	E
repair or replating			
15	replate tank tops	O	G
16	replate side shell	P	O
17	bulkhead replate	Q	P,R,Z,AA
18	replate frames or brackets	R	O
19	replace the tross rope foundation on the frocestel deck and poop deck	S	Q
20	replate winch foundations, and winch brackets on the Frocastle deck and stern	T	S
21	replace new steps stearing gear room and poop deck	U	T
22	make a new vent head and replace the mash vent stone	V	W
23	replate top bullwork	W	Q
24	change the foundation of life boy	X	V
25	replate lifeboat foundation	Y	u
26	repair cargo tanks 1P-5P + 4S	Z	O
27	WBT bulkhead replate	A A	O
28	unload sekerem	AB	E
29	put cool	AC	AG
30	cut the anchor chain	AD	Y
31	install the steering cap stopper	AE	AC
	FINAL STAGE/SHIP FLOATING		
32	inspection or checking of equipment and repair of all existing activities by the classification bureau. Is it safe and feasible before the ship is operated again	AF	AE
33	ship painting	AG	J
34	undocking service	AH	AF

Table 2 above shows the relationship between activities which are symbolized or coded using letters, the table is able to show the relationship between activities which can be known which activities were in the past and which activities will be carried out afterwards. For example the activity 'providing the necessary facilities before repairs are carried out at the shipyard' which is symbolized by the letter A can be carried out without waiting for any work and as a precursor activity, work B and C can be carried out afterwards. For more details, see the AON image in Figure 1 below. this :

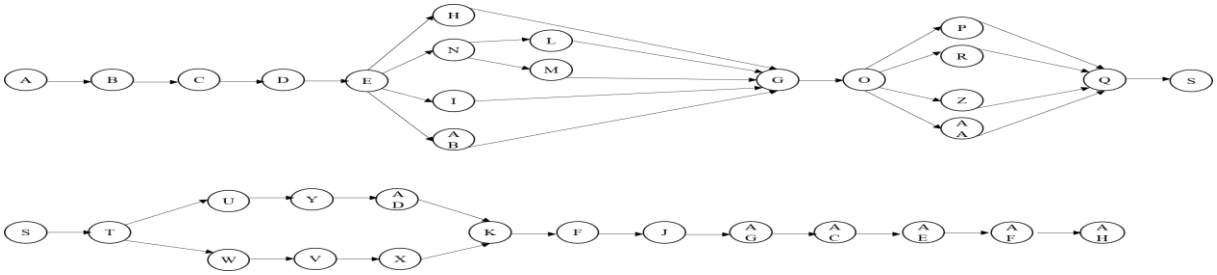

Figure 1 Simple AON 2765 DWT Tanker

Determine project completion time

In determining a project there are several terms that must be calculated in determining the completion time of a project, the terms referred to include:

1. Forward Calculation
   Forward Calculation is a calculation method that starts from Start (*Initial Event*) to Finish (*Terminal Event*) which is used to calculate the fastest completion time for an activity (EF) and the fastest time for an activity to occur (ES). Where EF is obtained from the sum between ES and Duration.

2. Countdown
   Countdown is a calculation from Finish to Start to find out the slowest time an activity occurs (LF) and the slowest time an activity occurs (LS) where LS is obtained from the reduction between LF and Duration. The following is the forward and backward calculation of the *Critical Path Method* . The following is the forward and backward calculation of the *Critical Path Method* .

Table 2. Calculation of forward and backward *Critical Path Method* .

Code	Duration	Ls	Lf	Ls	Lf	Floats
A	2 days	0	2	0	2	0
B	1 day	2	3	2	3	0
C	1 day	3	4	3	4	0
D	1 day	4	5	4	5	0
E	1 day	5	6	5	6	0
F	2 days	35	37	35	37	0
G	3 days	9	12	9	12	0
H	1 day	6	7	7	8	1
I	1 day	6	7	7	8	1
J	2 days	37	39	37	39	0
K	3 days	32	35	32	35	0
L	2 days	7	9	7	9	0
M	1 day	7	8	8	9	1
N	1 day	6	7	6	7	0

O	4 days	12	16	12	16	0
P	5 days	16	21	16	21	0
Q	2 days	21	23	21	23	0
R	1 day	16	17	20	21	4
S	2 days	23	25	23	25	0
Q	2 days	25	27	25	27	0
u	1 day	27	28	29	30	2
V	3 days	28	31	28	31	0
W	1 day	27	28	27	28	0
X	1 day	31	32	31	32	0
Y	1 day	28	29	30	31	2
Z	4 days	16	20	17	21	1
A A	1 day	16	17	20	21	4
AB	1 day	6	7	7	8	1
AC	1 day	43	44	43	44	0
AD	1 day	29	30	31	32	2
AE	1 day	44	45	44	45	0
AF	2 days	45	47	45	47	0
AG	4 days	39	43	39	43	0
AH	1 day	47	48	47	48	0

Determine the critical path of activity

After carrying out step by step as above starting from compiling activities and connecting between activities, the next step is to find the critical path of the scheduling which is prepared using *the critical path method* . The critical path itself is an activity path that does not have a grace period or *slack* = 0, so that the activity must be carried out according to a predetermined time. And if it is not done on time, it will cause delays in subsequent activities. In other words, the critical path is work that cannot be postponed at the time of execution.

For the cpm method it is focused on avoiding delays on the critical path rather than trying to shorten the critical path so that the project can be completed more quickly.

Systematically searching for slack time or critical path can be formulated as follows:

Slack = LS – ES or Slack = LF – EF

a. ES (*earliest activity start time*) The earliest start time of an activity. If the start time is stated in hours, then this time is the earliest time the activity starts.
b. EF (*earliest activity finish time*) The earliest completion time of an activity. EF of a previous activity = ES of the next activity
c. LS (*latest activity start time*) The slowest time an activity may start without slowing down the project as a whole.
d. LF (*latest activity finish time*) The slowest time the activity can be completed without slowing down the completion of the project.

Table 3. Critical Path of activities

No	Activity Activity	Duration	Introduction	slack	critical

1	provide the necessary facilities before repairs are carried out at the shipyard	2 days	A	0	Yes
2	Provide necessary tugboat services	1 day	B	0	Yes
3	docking service	1 day	C	0	Yes
4	oyster scrap	1 day	C	0	Yes
5	water jetting (high pressure)	1 day	D	0	Yes
6	water jetting (low pressure)	2 days	K	0	Yes
7	blasting	3 days	H, L, M, I, AB	0	Yes
8	Install the zinc anode in the hull	2 days	E	0	Yes
9	Install the zinc anode in the ship's ballast tank	3 days	E	0	Yes
10	sea chest box (open, clean, painting according to procedure)	2 days	L	0	Yes
11	shell expansion, tank top, bhd & internal, main deck and superstructure	1 day	N	0	Yes
12	replate tank tops	4 days	G	0	Yes
13	replate side shell	5 days	O	0	Yes
14	bulkhead replate	2 days	P,R,Z,AA	0	Yes
15	replace the tross rope foundation on the frocestel deck and poop deck	2 days	Q	0	Yes
16	replate winch foundations, and winch brackets on the Frocastle deck and stern	2 days	S	0	Yes
17	make a new vent head and replace the mash vent stone	3 days	W	0	Yes
18	replate top bullwork	1 day	Q	0	Yes
19	change the foundation of life boy	1 day	V	0	Yes
20	put cool	1 day	AG	0	Yes
21	install the steering cap stopper	1 day	AC	0	Yes
22	inspection or checking of equipment and repair of all existing activities by the classification bureau. Is it safe and feasible before the ship is operated again	2 days	AE	0	Yes
23	ship painting	4 days	J	0	Yes
24	undocking service	1 day	AF	0	Yes

In the table above, the calculation of *slack = 0 is obtained*. This activity is an activity that is on the critical path of the 2765 DWT tanker repair process. So that the work activities listed may not experience delays when starting a job and delays when it is time to complete the activity, the intended activities are as in Table 3 above, namely: ABCDENLGOPQSTWVXKFJ-AG-AC-AE-AF-AH

Comparison of Scheduling Made in Shipyards and Using the Critical Path Methode

In the execution of a project the most important thing is the planning and scheduling that will be carried out in the project because so that the project does not experience delays in completion in this analysis a comparison of the schedules made by the shipyard in one of the Lamongan shipyards is carried out and uses the *Critical Path Method (CPMs).*

The shipyard uses a schedule according to the order of ship repairs in general. And there is still no implementation of the critical path or work that must be done first and which must be done after. And in scheduling the repair of the 2765 DWT Tanker which had been made by the shipyard, it took 61 days of work, while in scheduling using *the critical path*

method for repairing the 2765 DWT Tanker, it took 48 days to work. It can be seen that the scheduling using *the critical path method* has a shorter time duration of 13 days but with the condition that there are no delays in materials and tools, bad weather, and other influences.

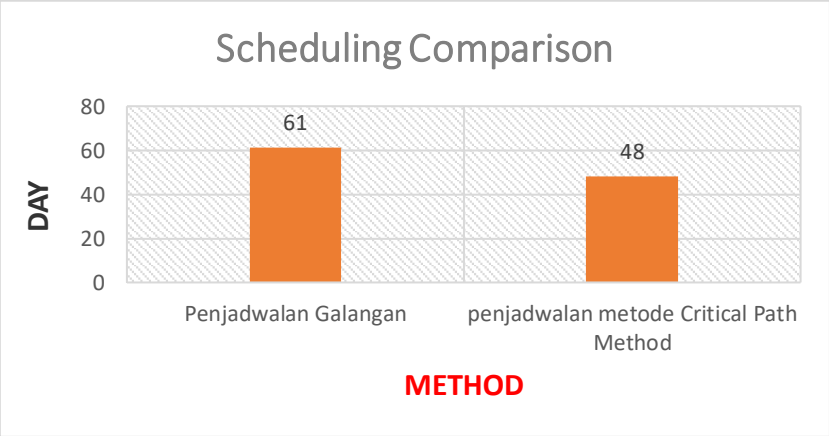

Figure 2. Comparison of Scheduling Comparison Charts

4. Conclusion

As for the results of my research analysis entitled "analysis of activity planning in the 2765 dwt tanker repair process using the *critical path method (cpm)* " it can be concluded that the scheduling made by the shipyard company gets the duration of time to complete the repair project tanker 2765 61 days. and the time required if using the critical path method has a duration of 48 days. So Scheduling using the critical path method is more efficient than the scheduling applied by the shipyard because it has a difference in duration of 13 working days, which is faster.

5. References

Dimyati, H., & Nurjaman, K. (2014). *Project management.* Yogyakarta: CV. Faithful Library.

Faizti, N. (2021). Getting to Know the Kinds of Qualitative Data Analysis in Research.

Hadi. (2016). Data validity check. *CHECKING THE AUTHORITY OF QUALITATIVE RESEARCH DATA ON THESIS* , 75.

Olivia, D., Afma, VM, & Anna, B. (2014). *Improvement Scheduling Design for the 42 M Tug Boat Building Project with the Critical Path Method at PT. Batam Expressindo Shipyard.* University of Riau Archipelago Batam.

Pradistya, RM (2021, February 10). *Triangulation Techniques in Qualitative Data Processing* . Retrieved August 4, 2021, from DQLab: https://www.dqlab.id/teknik-triangulation-dalam-pengolahan-data-kualitatif

Prasetyoko, RT (2011). *Project Scheduling Evaluation Using the CPM (Critical Path Method) and "S" Curve Analysis on the Cold Storage (Condencing Unit) Manufacturing Project at CV. Sidoarjo Engineering Development.* Faculty of Industrial Technology of the National Development University "Veteran".

Tardok, EL (2018). *Time Acceleration Analysis Using the CPM and Pert Methods in the Tanjung Priok Port Pier Development Project.* Faculty of Marine Technology Sepuluh Nopember Institute of Technology Surabaya.

A. Shah Ali, A. Smith, M. Pitt, and C. Hong Choon, “CONTRACTORS' PERCEPTION OF FACTORS CONTRIBUTING TO PROJECT DELAY: CASE STUDIES OF C OMMERCIAL PROJECTS IN KLANG VALLEY, MALAYSIA.”

J. Results, K. Scientific, G. Regatama, W. Amiruddin, and P. Mulyatno, "JOURNAL OF SHIPPING ENGINEERING Network Planning Analysis of SPB TITAN 70 Ship Repair Using the Critical Path Method," *J. Tek. Shipping* , vol. 7, no. 4, 2019, [Online]. Available: https://ejournal3.undip.ac.id/index.php/naval

YT Andhani, IP Mulyatno, and AWB Santosa, "KN Ship Repair Reschedule. KUMBA 470 DWT with the Critical Path Method in the Semarang Shipyard," *J. Tek. Shipping* , vol. 8, no. 3, pp. 231–238, 2020.

Shipbuilding Vocational High School Curriculum Team, Faculty of Marine Technology ITS, "Types of Docks and Their Functions," pp. 1–41, 2003.

BKI, "Rules for Classification and Surveys," vol. I, no. January, 2014.

AM & SP Day T Handoko, *Fundamentals of Operations Research* . Yogyakarta: BPFE., 1993.

Siswanto, *Operations Research vol 1* . Jakarta: Erlangga., 2007.

Chirillo, LD, RD Chirillo and Y. Okayama., 1983, *Integrated Hull Outfitting and Painting* , NSRP, Maritime Administration in cooperation with Todd Facific Shipyard Corp, USA.

Carmichael AW, 1919, *Practical Ship Production First Edition* , McGraw-Hill Book Company Inc, New York.

House and Hill, 2000" *Guide to Ship Repair Estimates".* Elsevier Butterworth – Heinemann.

PAL Indonesia, 2000, *Refresher Training: New Shipbuilding Management System; Production Planning For Managers* , PT.PAL Indonesia, Surabaya.

Storch, RL, Ham Minggu, CP, and Bunch, HM., 1995, *Ship Production Second Revision* , Cornell Maritime Press, Centreville.

Shipping Vocational High School Curriculum Team, 2003, *Get to Know the Types of Ships*, Ministry of National Education.

Watson DGM, 2002, *Practical Ship Design* . Elseiveir Science Ltd, London.

Jahidin, Saddam. Overview of Ship Production Process (ship production part 1). Learn Ship Blog. September 22, 2011. September 15, 2014.

Farisa Mukti Arta Mevia., Shipyard – Definition, Types, Methods and Industry https://wira.co.id/galangan-kapal/

Tardok, EL (2018). Time Acceleration Analysis Using the CPM and Pert Methods in the Tanjung Priok Port Pier Development Project. Faculty of Marine Technology Sepuluh Nopember Institute of Technology Surabaya.