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Study on development of shipyard type for supporting pioneer ship in Indonesia

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Abstract— Based on the geographical conditions of Indonesia, especially the eastern region of Indonesia, a national sea transportation system is needed that can be a bridge for remote, isolated and undeveloped islands using pioneering sea transportation. The problem is when the pioneer ships carry out maintenance and repairs, where the pioneer ship population of 82% operates in the eastern part of Indonesia and 18% operates in the western region of Indonesia, while 70% of shipyards are located in Western Indonesia and the remaining 30% are located in Eastern Indonesia. The purpose of this study is to determine the appropriate type of shipyard. The methods used in this study were the fishbone and SWOT methods. As many as 11 locations in Indonesia are selected for surveys. Construction of shipyards for pioneer ships takes into account shipyard availability in the area of operation, the number and type of vessels operating. The results show that the best shipyard location to support the operation of pioneer ships is located in the Bitung Region or in the Sorong Region with the type of shipyard in the form of a slip way.

1. Introduction

The Indonesian state is an archipelago consisting of thousands of islands, both large and small islands, where each island is separated by the sea. Based on Indonesia's geographical conditions, a national sea transportation system is needed that can be a bridge for these islands. Because the level of diversity of islands in Indonesia is high and related to various fields of community life, the sea transportation system is also adjusted to the conditions of the region. One of the sub-systems of the national sea transport system is Pioneer Sea Transportation, which is organized by the government, by providing operating subsidies to the pioneer fleet. Pioneer Sea Transportation is a logical consequence of the ability of national sea transportation in a country that is still commercially limited [1]. In 2017 the fleet of pioneer ships had 96 routes served by 46 government-owned pioneer ships and 50 private-owned vessels, where pioneer ships operating in the Eastern Region of Indonesia amounted to 82% and in the Western Region of Indonesia amounted to 18%. On the contrary, the number of shipyards in Indonesia for the western region amounted to 70% while in the eastern region amounted to 30%. In order to maintain the feasibility of pioneer ships, it is necessary to manage ships in the technical field of ships which include maintenance, docking and supply of spare parts. The need for docking ports on each pioneer shipping route is very necessary to maintain ship performance and passenger safety [2, 3].

2. Methodology

2.1. Fishbone method

Fishbone diagram or cause effect diagram [4] was used to determine the best shipyard location for pioneer ships (Figure 1).



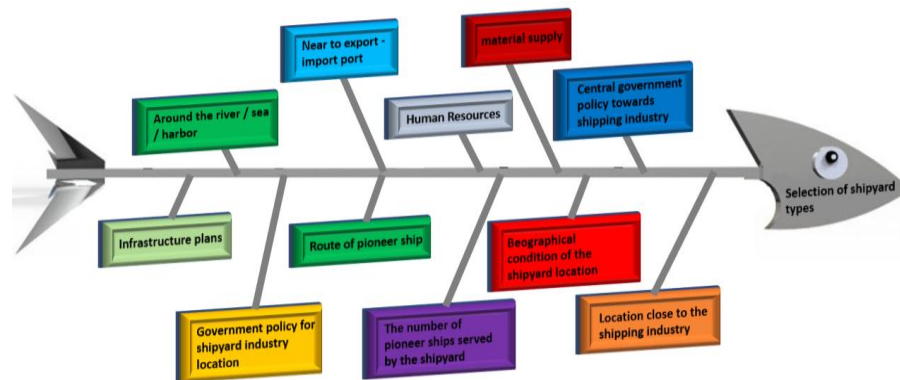


Figure 1. Fishbone Method

There are eleven places / locations determined to be surveyed in accordance with the needs of pioneer shipyards. The locations are as follows: Teluk Bayur, Tanjung Pinang, Tanjung Perak, Kupang, Kendari, Bitung, Ambon, Ternate, Sorong, Jayapura and Manokwari.

Determination of shipyards for pioneer ships was determined by taking into account shipyard availability for operations or routes from pioneer ships in both the western and eastern regions of Indonesia. Figure 2 shows the position or location of shipyards in Indonesia in which almost the entire shipyard is in the western region, especially on the island of Sumatera [5]. It can be seen in Figure 2 that the pioneering shipyards for the eastern part of Indonesia are still very small in number, while the most pioneer ship shipping routes are in the eastern part of Indonesia. Because of that, in this research, it was focused on researching the type of shipyard that is appropriate for pioneer ships in the eastern part of Indonesia.

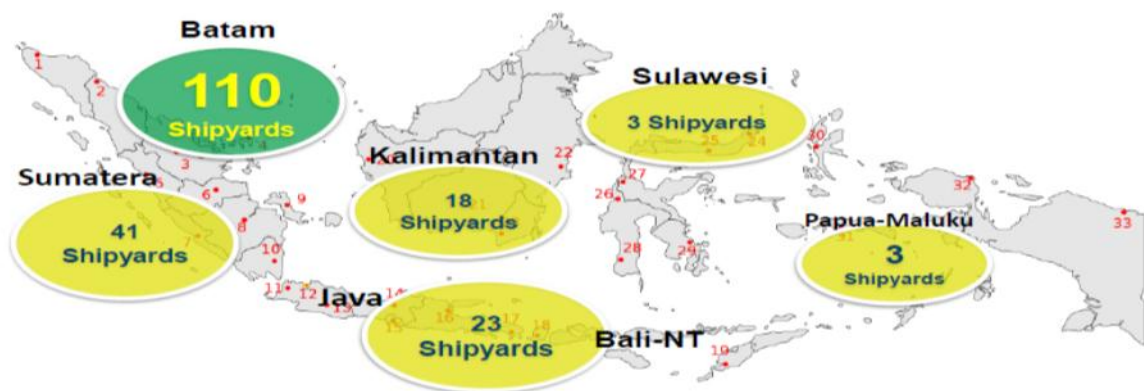


Figure 2. Shipyard Location at Indonesia

2.2. SWOT method

The analysis used to determine the review strategy for shipyard supply was SWOT (Strength, Weakness, Opportunity and Threat) analysis [6]. This method was used to determine the feasibility for providing shipyards. SWOT analysis is obtained from the identification of conditions, potential and problems of each shipyard with related aspects [6]. From the concept, then it is translated the advantages and disadvantages of both internal and external factors in a matrix that describes the conditions of interrelation with each other. The basic concept of SWOT in this study can be seen in Table 1.

Table. 1 SWOT Analysis

Internal Factors	External Factors	(Opportunity)	(Threats)
	(Strength)	(SO) Use power to capture opportunities	(ST) Use force to avoid threats
	(Weakness)	(WO) Overcoming weaknesses by making decisions	(WT) Minimize weaknesses and avoid threats

The analysis of SWOT is done through internal and external factors i.e. using power to capture opportunities (SO), overcoming weaknesses by making decisions (WO), using force to avoid threats (ST) and minimizing weaknesses and to avoid threats (WT) [6].

Alternative strategies in the SWOT analysis include:

1. SO Strategy, which is a strategy that uses power to take advantage of opportunities.
2. ST strategy, which uses power to overcome threats.
3. WO Strategy, which is a strategy to minimize weaknesses to seize opportunities.
4. WT Strategy, which is a strategy to minimize weaknesses to escape threats.

3. Results and Discussions

3.1. Pioneer ship

Number of pioneer ships increase from 96 in 2016 to 113 in 2018. Those ships are service by state company (PT Peln) and by private companies and mostly sail in eastern Indonesia. Dimension and capacity of pioneer ship ranging from 200 DWT – 2000 GT (Table 2). An example of dimension and detail of pioneer ship can be seen in Figure 3.

Table 2. Ship Dimension

No	Ship Type	Length Over All	Breadth	Height	Draft
1	2000 GT	68,50	14,00	6,20	2,90
2	1200 GT	62,80	12,00	4,00	2,70
3	750 DWT	58,50	11,20	3,90	2,60
4	500 DWT	51,80	10,40	3,80	2,50
5	350 DWT	46,20	9,75	3,70	2,40
6	200 DWT	44,30	9,00	3,60	2,30

**Figure 3.** Pioneer ship

3.2. Analysis of shipyard

Of the types of needs in the shipyard that must be considered from the maintenance of ships in general, such as inspection on ships which are consist of several stages of survey (Figure 4).



Figure 4. Annual survey

Analysis of shipyard needs is a very important thing to do because it is important to produce an ideal shipyard in accordance with the needs in the field. Based on analysis, there are several aspects to consider to getting the best strategy in manufacture pioneer shipyard (Table 3).

Table 3. Benefit of shipyard building

No.	Description	Benefits
1.	Shipyard Availability	The availability of shipyards in pioneer ship shipping routes plays an important role. The current condition of around 70% of pioneer ships operating in the eastern region, while the distribution of shipyards is 70% more in the western region.
2.	Shipyard Utilities	Pioneer ship activities, both for repair and maintenance activities can be disrupted because the appropriate shipyard utility is not available, so for this condition pioneer ships will wait for a certain time.
3.	Ship Utilities	As a result of the mobility or the mobility of the ship, the time used for this activity causes the ship to be longer than the repair and maintenance time, it cannot carry out service activities on the specified route.
4.	Use Of Fuel	The use of ship fuel is needed for the movement of ships from the shipping route to the shipyard which will carry out repairs or maintenance of the ship, so that the further the shipyard will require large amounts of fuel which will ultimately require large financing.
5.	Ship Mobility	Ship mobility and de-mobility are needed for the movement of ships from the shipping route to the shipyard.
6.	Number and Type Of Ship	The number and type of pioneer vessels operating are small and medium sized vessels, so that not all shipyards can accept this condition due to costs especially for large shipyards. Whereas for small shipyards, not all of them can make repairs or maintenance because the infrastructure is inadequate, so owning a shipyard is a necessity coupled with the increasing number of ships.

7.	Support Cost	In addition to costs for fuel usage, other operational costs are payment of salaries of human resources, lubricating oil, food ingredients, drinking water and other costs required for ship mobilization activities.
8.	Replacement Ship	The mobilization and demobilization of ships from the shipping route to the shipyard and vice versa which requires time, so that for the routes that occur in the void.
9.	Time for Ship Repair and Maintenance	The repair and maintenance of pioneer vessels is very much dependent on the APBN / APBD where the implementation must be through tender, planning for repairs and maintenance will be disrupted if there is a change in the APBN schedule so that it will change the schedule of ship maintenance and repair activities, if there is a change resulting in an improper sea ship pioneer.
10	Optimum Service	With the proximity of shipyards with pioneer ship shipping routes, especially in eastern Indonesia, it can be minimized the mobilization and demobilization time of pioneer vessels, because the time for pioneer ship mobilization can be shortened so that services will be optimized for service users.
11.	Ship Maintenance and Repair Service	Scheduling the maintenance and repair of ships will be more flexible because the shipyard is self-owned in addition to that because more and more ships will be needed to schedule ship maintenance and repairs. If there is damage to the ship or other emergency activities, ship repair scheduling will be easy, fast.

3.3. Selection of Pioneer Shipyards location

Pioneering shipyard planning must be planned from several aspects that are in accordance with the purpose and objectives [7, 8] because this will help the development of the pioneer shipyard for the foreseeable future. The following are things that need to be considered in the planning of pioneer shipyards:

1. The location of shipyards for pioneer ships is prioritized on ports visited by pioneer ships.
2. Criteria for the selection of shipyard locations for pioneer vessels are as follows: being in the port environment, in addition to being closer to the shipping route also to facilitate obtaining material supplies, human resources (HR) are very influential on shipyard performance.
3. Close location with material supply for ship repair.
4. Central government policy on shipping industry The Investment Coordinating Board (BKPM) maps 12 potential areas for the development of the shipyard industry.
5. Regional spatial plan (RTRW) is a general spatial plan from the city area
6. The ship route as from the path that has been determined from the beginning to the end of the trip
7. Geographical conditions are very influential in shipyard development areas so that geographical conditions must be able to accommodate shipyards and their development for the future.

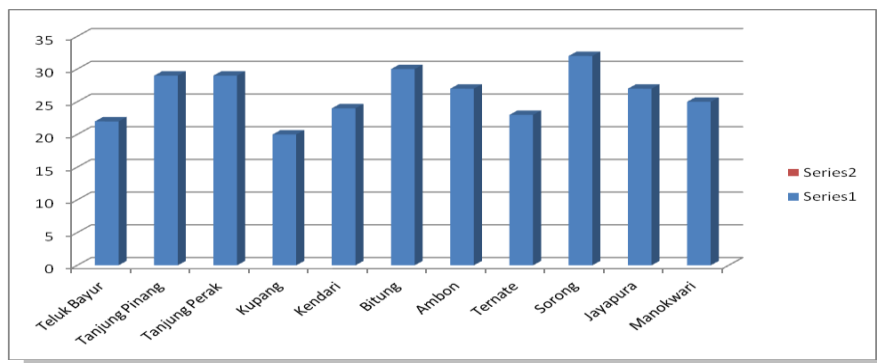
Of the eleven locations determined, several surveys were carried out in accordance with the requirements of pioneer shipyards (see Figure 1 for the requirement surveyed). The place was surveyed based on original data from the field. These data are then used as references for this research. The results of the survey observations conducted can be seen in the Table 4 and Figure 5.

Based on data collection, data analysis and other related information, the location of shipyards for pioneer ships which are the priority to be used as locations in Eastern Indonesia are Sorong Region and Bitung Region. The location for the western region of Indonesia are in the Tanjung Pinang and Tanjung Perak regions, but the priority remained in the eastern region was due to lack of facilities and availability of shipyards in the eastern region for pioneer ships. Furthermore, these location will be used as a place for the construction of a pioneer shipyard.

Table 4. Necessary shipyard location

NO	ITEM	SURVEY LOCATION										
		Teluk Bayur	Tanjung Pinang	Tanjung Perak	Kupang	Kendari	Bitung	Ambon	Ternate	Sorong	Jayapura	Manokwari
1	Around River/Sea/Port	★★★	★★★★	★★★★	★★★★	★★★★	★★★★	★★★★	★★★★	★★★★	★★★★	★★★★
2	Near to Export and import port	★★★★	★★★★	★★★★	★★★★	★★★★	★★★★	★★★★	★★★★	★★★★	★★★★	★★★★
3	Human Resources	★★	★★★★	★★★★	★	★★	★★★★	★★	★	★★	★★	★
4	Material Supply	★★	★★★★	★★★★	★	★★	★★	★★	★	★★★★	★★	★★
5	Government policy on the shipping industry	★★	★★★★	★★★★	★	★★	★★★★	★★	★★	★★★★	★★	★★
6	Infrastructure Planning	★★	★★★★	★★★★	★★	★★	★★	★★	★★	★★★★	★★	★★
7	Infrastructure Planning	★	★★★★	★★★★	★	★	★★	★★	★	★★★★	★★	★
8	Route of Shipping	★	★	★	★★	★★	★★★★	★★★★	★★★★	★★★★	★★★★	★★★★
9	Shipyard Availability Priority	★	★	★	★★	★★	★★★★	★★★★	★★★★	★★★★	★★★★	★★★★
10	Shipyard Geography At the location	★★★★	★★★★	★★★★	★★★★	★★★★	★★★★	★★★★	★★★★	★★★★	★★★★	★★★★
11	Location near to the shipping industry	★★	★★★★	★★★★	★	★★	★★★★	★★	★	★★★★	★★	★★
TOTAL ITEM		22	29	29	20	24	30	27	23	32	27	25

★ = Enough
 ★★ = Good
 ★★★★ = Very Good

**Figure 5.** Shipyard location

3.4. Selection of pioneer ship docking

SWOT analysis is used to determine the feasibility of providing shipyards which is obtained from the identification of conditions, potential and problems of each shipyard with related aspects as presented in Table 5.

From the results of SWOT analysis in Table 5, we now see the potential for repair and repair shipyard designs that will be made for pioneer ship types. There are also several provisions and the need to choose the type of docking such as:

1. type of ship that is relatively medium-small
2. cheap (affordable) manufacturing costs
3. effective and efficient operation
4. easy maintenance and low cost
5. does not need enough power
6. does not require special experts

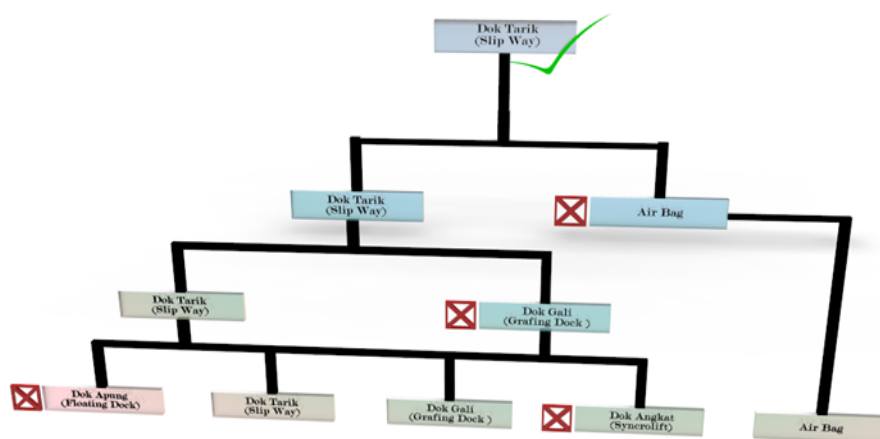
In determining the type of docking used in a shipyard based on several aspects mentioned above. So that a shipyard that is very effective and efficient will be obtained for pioneer ships.

Table 5. Selection of docking ship

No	Type Dock	s	w	o	t
1	Floating Dock	- Moveable - Big Ship	- Expensive Building - Expensive Operational Cost - Expensive Maintenance Cost - Big Ship - High Corrosion	- Easy to Move - Can Join	- Depth - Sedimentation - Draft
2	Graving Dock	- Big Ship - Long Life Time	- Expensive Cost - Expensive Operational - Middle Maintenance	For Shipyard Industries Building	- Depth - Sedimentation - Draft
3	Slip Way	- Middle Ship - Middle Maintenance - Low Energy - Human Resources Normal	- Relative Medium - Can't Move - Middle Life Time	- Ship can move - Development shipyard very good	- Silting - Draft
4	Air Bag	- Cheap operational - Low Maintenance - Low Energy - Human Resources Normal	- Relative Medium - Flat Shape - Easy to roll over - Short Life Time	- Ship can move - Development shipyard very good	- Rules Operational - Certification
5	Syncrolift	- Fast - Location	- Small Ship / Middle Ship - Expensive Building - Expensive Operational - High Corrosif		- Technology - Certification - Human Resources Very Good

SWOT analysis in Table 5 for five types of dock is used for shipyard selection as seen in Figure 6. The floating dock and graving dock are not chosen because they are docks made for large type of ships, and in addition to manufacturing that requires a lot of cost and virgin and operation reveals experts in the field of drilling. Lift dock is a very modern type of dock however it is not selected because of the system, the new type of dock requires a number of winches on the left and right sides of the dock and it is expensive in operating and maintenance costs. The water air bag is cheap in financing and even simple maintenance but it is not suitable for pioneer shipyards because it is specialized with U-type hulls or almost boxes while most pioneer ship has the V-shaped ship hull. In addition security of the air bag is also not good and the regulations that have not yet entered certification.

Based on the six needs listed above and SWOT analysis, slipway pioneer ship docking is chosen as the most suitable for these location. The type of shipyard chosen is the type of pull dock or slipway because it is easy to operate, relatively cheap in operation and maintenance, does not require highly skilled of human resources and it has good security [9].

**Figure 6.** Shipyard selection diagram

3.5. Equipment in the pioneer shipyard

Equipment facilities are needed to support the repair or construction of pioneer ships. Therefore, the following are the supporting tools needed (Table 6). The equipment used in shipyard must be in international standard and being certified.

Table 6. Shipyard Equipment

No	Equipment	Unit
1	Winch For Slip Way	1 Set
2	Wire Rope For Slip Way	1 Set
3	Crane	3 Units
4	Forklift	2 Units
5	Lathe Machine	2 Units
6	CNC Machine	1 Units
7	Bending Machines	1 Units
8	Welding Equipment	3 Units
9	Safety Equipment	1 Set
10	Generator Engine	3 Units

3.6. Shipyard design concept of pull dock

In the design of this shipyard, it is specific for the repair of passenger goods ships or commonly referred to pioneer ships. The dock system design is also adapted for pioneer ships using the pull dock. Following are design drawings of dock and pull docks (Figure 7)

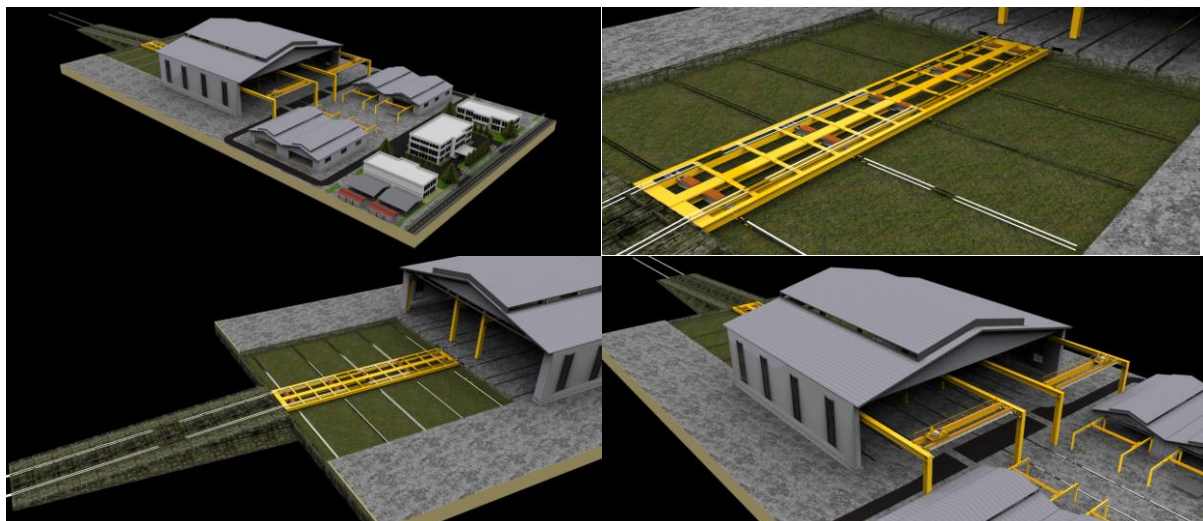


Figure 7. Shipyard Design

The docking process uses the Drag Document, so the pioneer ships were directly pulled into the hangar to be repaired. Once it is above the slipway, it is pulled up using a winch that has been connected with slip way to the 80 x 18 meter connecting rail and add a few amplifiers to support the 2000 Gt vessel and there are five rails arranged horizontally so that it can be moved / jerked to the left side and right side / from one rail to the other rail and can directly enter the repair shop with five rail links to enter the maintenance and repair process.

In the 80 x 100 m repair shop with a height of 40 m from the sea level, this workshop / hangar has five lines that are used as a place to stand from the usual ship drawing process in five ships in one workshop. In the workshop several activities were carried out. Among them are the repair of pioneer

ships or the construction of new ships. The workshop is equipped with equipment in accordance with the needs of the workshop. (Figure 8).

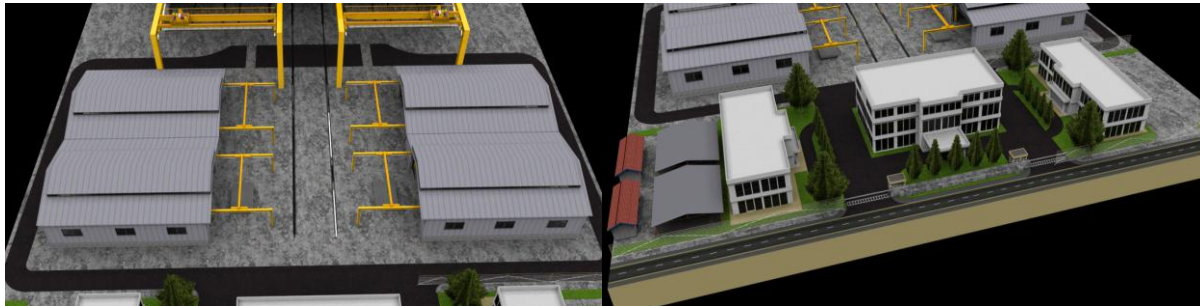


Figure 8. Workshop production, construction , pipe, mechanics, outfitting, electrical and office

This production section focuses more on reparations because there is no new ship construction. In the field of production, the practitioner obtains information about the official report which contains reports on each workshop work which in turn will make the actual minutes. The shipyard office is one of the facilities that is used as a place to start the main activities in the ship building process, namely the preparation of technical requirements, the initial draft, the draft contract and then the contract process. In the office section there are three buildings and one resting place / canteen. (Figure 8).

4. Conclusion

Based on data collection, data analysis and other related information, conclusions can be made as follows:

1. The location of shipyards for pioneer ships which are the priority to be used as locations are located in Eastern Indonesia i.e. the Sorong region and the Bitung region.
2. The locations for the western region of Indonesia were selected in the Tanjung Pinang and Tanjung Perak regions, but the priority remained in the eastern region was due to a lack of facilities and availability of shipyards in the eastern region for pioneer ships.
3. The type of shipyard chosen is the type of pull dock or slipway because this type of shipyard is easy to operate, relatively cheap in operation as well as maintenance, does not require highly skilled human resources and it has good security.
4. Shipyard uses is equipped with a cover or hangar so the ship repair work is not disturbed by natural conditions such as heat and rain, thus the work is expected to be more productive.
5. Shipyards are equipped with construction, machinery equipment and plumbing workshops to support the repair of pioneer ships.

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