A Study of Traditional Shipyard Existing Conditions at the Ujong Baroh Fishery Base, West Aceh, Indonesia

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ABSTRACT

The large increase in the number of traditional fishing vessels in West Aceh and the limited facilities for repairing these vessels indicate the great potential for developing shipyards around the port. However, the shipyards that produce fishing vessels in West Aceh still use traditional technology, resulting in relatively low productivity. Therefore, the aim of this research is to determine the initial conditions of shipyards in West Aceh and their production capacity. The research method deploys a qualitative approach along with data collection techniques through surveys. The social aspects studied include the development of Human Resources (HR), materials, production equipment, funding, and shipbuilding methods. The results of this research show that the condition of the shipyards in West Aceh is adequate due to their strategic location with large areas of land and proximity to the sea or river, making the process of unloading completed ships easier. There are two types of shipyards in West Aceh: land shipyards and water shipyards. In the area, there are six (out of nine) active land shipyards and three (out of five) active water shipyards.

Keywords-fishing boats; shipyard; West Aceh

I. INTRODUCTION

Many of the residents of coastal communities [1] earn their livelihood in the marine sector. West Aceh is a coastal area on the west-south coast of Aceh, with a high number of people migrating there [2]. Considering the industrial development, especially in the shipping sector [3, 4], Indonesia is a maritime country with most of its area being surrounded by oceans. The enormous and abundant potential of the sea must be exploited to support the economy and improve the welfare of its people. One way to maximize the benefits of the marine potential is by optimally empowering fishing vessels [5]. The shipyards that produce fishing vessels in West Aceh still use traditional technology obtained from previous workers, so the shipyard productivity is relatively low [6]. According to [7, 8], the shipbuilding industry has shortcomings that are still far from the potential, capacity, needs, and efforts to advance technology. This is illustrated by the fact that most ships in Indonesia were launched in the recent years. The increase in the number of traditional fishing boats in West Aceh [9], which is quite large, in combination with the limited facilities available for repairing ships, generate a great need to develop shipyards around the port on the basis of a social-technical aspect [10-11]. When making changes to a company to achieve planned productivity, it is necessary to alter a method or work system that is deemed unproductive [4, 12-14]. In the future, the demand for ships and especially for various sizes and types of semi-modern ships will increase, which in line with the economic development and the development of maritime trade traffic will necessitate a ship company's capacity to allocate a project [15]. One way to overcome delays in a project is by accelerating it. However, acceleration may increase the cost of project implementation [16, 17].

Taking into account the aforementioned background, the considered problem in this research can be formulated through the following questions: What are the initial conditions of the traditional shipyards at the Ujong Baroh fishing base, West Aceh, and, how can the production capacity of the traditional shipyard in West Aceh be increased? So, the aim of this research is to determine the initial conditions of these shipyards and their production capacity.

II. RESEARCH METHOD

The method used in this study involves conducting direct observations in the field. The survey method is a data collection technique carried out through the distribution of questionnaires and interviews. The selection of respondents for the interviews was carried out deploying the purposive sampling method. Purposive sampling is a technique for selecting participants who are considered the most appropriate or relevant to the research being conducted. In this method, samples are selected based on certain characteristics that are in accordance with the objectives of the study, rather than randomly. This approach is often employed in qualitative research, where researchers need data from some groups of individuals who have special knowledge or experience about the topic being studied. The assessment of the existing conditions of the shipyard was carried out by evaluating several social aspects related to the construction of the shipyard at the Ujong Baroh Fisheries Base, West Aceh:

- Human Resources (HR)

The development of shipyard HR is accomplished on the basis of the existing conditions, while it prioritizes developing the efficiency of direct workers. The construction of fishing boats is carried out at a traditional wooden shipyard.

- Materials

Material procurement is the initial stage of the production process and entails the selection and purchase of the materials needed for shipbuilding. After the materials are acquired, the next step constitutes material planning during which materials are arranged according to the needs and the design of the ship. Next, production equipment is prepared and planned for use so that the shipbuilding process may run efficiently and effectively.

- Production Equipment

Production equipment is divided into two categories, namely hand tools and power tools. Hand tools are equipment operated manually. Meanwhile, powered equipment uses an energy source, such as electricity or fuel, to run.

- Funding

The planned funding can be obtained from various sources, including internal company funds, loans from banks or financial institutions, private investments, grants from government or non-government organizations, as well as contributions from business partners or sponsors. This diversification of funding sources aims to ensure the

sustainability and smooth running of the projects being implemented.

- Ship Building Methods

The traditional wooden ship building method is conducted by installing the hull skin first and continuing with installing the trusses in accordance with the existing hull. According to the ship building theory, during ship construction, the ivory must be placed first with the hull skin being adjusted to the shape of the existing ivory. This procedure renders the productivity of traditional ship building low. Therefore, changes in the construction methods need to be made for work productivity to be increased.

III. RESULTS AND DISCUSSION

There are 14 shipyard units the in West Aceh, as can be seen in Table I, nine land shipyards (out of which six are active) and 5 water shipyards (3 active).

TABLE I. SHIPYARDS IN WEST ACEH

No.	Shipyard name	Status	Use
1	Bijeh Mata	Active	Land
2	Tunas Muda	Active	Land
3	Haikal	Active	Land
4	Jaya Marga	Active	Land
5	Seulawah Agam	Active	Land
6	Mita Bersama	Active	Land
7	Do'a Aneuk	Inactive	Land
8	Ata Tuha	Inactive	Land
9	7 Agam	Inactive	Land
10	Syafira & Khairil	Active	Water
11	3 Saudara	Active	Water
12	Tendar Pemuda	Active	Water
13	Tabina Rezeki	Inactive	Water
14	Ata Droe	Inactive	Water

The obtained results are described below.

A. Human Resources (HR)

HR consist the most important resource in an organization, since people or employees provide their energy, talent, creativity, and effort to the organization or company. HR are valuable assets for an organization, therefore their efficiency and productivity must be increased in order to achieve an organizational climate that is able to optimally encourage, develop, and improve the already possessed abilities and skills [18, 19].

Tables II-III outline the number of ships that have been produced by each active shipyard. HR development at the inland shipyard, entails: Bijeh Mata Shipyard with 4 workers having produced ±90 ships, Tunas Muda Shipyard with 3 workers having produced ±70 ships, Haikal Shipyard with 4 workers having produced ±81 ships, Jaya Marga Shipyard with 7 workers having produced ±200 ships, Seulawah Agam Shipyard with 6 workers having produced ±120 ships, and Mita Shipyard with 5 workers having produced ±60 ships. The sizes of the produced ships vary. Do'a Aneuk Shipyard's last productive year was 2021, employing 3 workers and producing ±30 ships. This shipyard is inactive due to the decreasing consumer demand. The Ata Tuha Shipyard's last production was in 2018, with 3 workers employed and ±23 ships produced. This shipyard is inactive because its employees are not permanent. Finally, the 7 Agam Shipyard's last production was in 2020, with 5 workers employed and the number of ships produced was ±65 units. This shipyard is inactive because there was a delay in the delivery of materials. The number of ships produced per year is oriented to consumer demand and the size of the ship's GT, usually ranges from 3 to 6 ships. Syafira and Khairil Shipyard employs 6 workers and approximately 170 ships were produced. 3 Saudara Shipyard employs 3 workers and approximately 30 ships have been produced. Pemuda Tendar Shipyard employs 5 workers and approximately 53 ships were produced. Tabina Rezeki Shipyard's last production was in 2021, with 4 workers employed and approximately 65 ships produced. This shipyard is inactive due to the lack of workers, resulting in non-permanent employees. Ata Droe Shipyard's last production was in 2019, with 3 workers employed and approximately 21 ships produced. This shipyard is inactive due to limited and outdated technological equipment.

TABLE II. WORKERS AND ACTIVE LAND SHIPYARDS

Name	Workers	Produced Vessels
Bijeh Mata	4	± 90
Tunas Muda	3	± 70
Haikal	4	± 81
Jaya Marga	7	± 200
Seulawah Agam	6	± 120
Mita Bersama	5	± 60

TABLE III. WORKERS AND ACTIVE WATER SHIPYARDS

Name	Workers	Produced Vessels
Syafira & Khairil	6	± 170
3 Saudara	3	± 30
Tendar Pemuda	5	± 53

B. Materials

A wooden ship is constructed starting from the keel, then the frame, and then the rest of its parts are manufactured. The wood used must have preservation qualities. Preservation is the resistance of wood to pest attacks, namely insects and fungi [20, 21]. Strength is the resistance of wood to external mechanical forces, including bearing capacity, tensile strength, durability, and so on. The wood utilized in wooden ship construction is classified into durable class quality and strong class quality.

Table IV shows the amount of wood needed, in m³, to build a ship per Gross Ton (GT), by the land shipoyards. The materials utilized at land shipyards are: Bijeh Mata shipyards use *Meranti* wood *(Shorea* spp), with wood sizes of (10 m^3) for ships of 5 GT, (13 m^3) 10 GT, and (16 m^3) 15 GT. Tunas Muda Shipyard utilizes *Laban* wood *(Vitex pinnata)*, with wood sizes of (11 m^3) for ships of 5 GT, (14 m^3) 10 GT, and (19 m^3) 20 GT. Haikal Shipyard uses *Meranti (Shorea* spp) and *Laban* wood *(Vitex pinnata)*, with wood sizes of (13 m^3) for ships of 10 GT, (18 m^3) 15 GT, and (21 m^3) 20 GT. Jaya Marga Shipyard employs *Damar* wood (*Agathis dammara)*, with wood sizes of (18 m^3) for ships of 20 GT, (22 m^3) 25 GT, and (26 m^3) 30 GT. Selawah Shipyard utilizes *Meranti (Shorea* spp), *Laban (Vitex pinnata)*, and *Damar* wood (*Agathis*

dammara), with wood sizes of (10 m^3) for ships of 5 GT, (13 m^3) 10 GT, (16 m^3) 15 GT, (18 m^3) 20 GT, (20 m^3) 25 GT, and (25 m^3) 30 GT. Mita Bersama Shipyard uses *Meranti* wood *(Shorea* spp), with wood sizes of (10 m^3) for ships of 5 GT, (14 m^3) 10 GT, (18 m^3) 20 GT, and (20 m^3) 25 GT. Regarding the inactive shipyards, the Do'a Aneuk shipyard, which used semantok wood, the Ata Tuha shipyard, which employed *Meranti* wood *(Shorea* spp) and *Laban* wood *(Vitex pinnata)*, and the 7 Agam shipyard, utilized *Damar* wood (*Agathis dammara).*

TABLE IV. UTILIZED WOOD – ACTIVE LAND SHIPYARDS

Shipyard	Wood Type	Ship Size (m^3)					
		5 GT	10 GT	15 GT	20 GT	25 GT	30 GT
Bijeh Mata	Meranti	10	13	16			
Tunas Muda	Laban	11	14		19		
Haikal	Meranti, laban		13	18	21		
Jaya Marga	Damar				18	22	26
Seulawah Agam	Meranti, laban, damar	10	13	16	18	20	25
Mita Bersama	Meranti	10	14		18	20	

Different observations concerning the damage parameter when using certain materials in water docks or repair yards can be made. There are many factors (natural, mechanical, etc.) that can damage ships. Hence, every ship needs regular maintenance or upkeep, in order for possible accidents to be minimized when the ship is anchored at sea. This maintenance includes the repair of ship leaks, wood and ship tusks replacement, ship renovation, repaint, propeller replacement, etc.

C. Production Equipment

Based on the results of the interviews performed with shipyard owners, the following is the equipment deployed to support shipbuilding operations at the shipyard. Production equipment is divided into two tool types, namely hand tools and power tools. Hand tools constitute work equipment whose operation employs human power. In contrast, power tools are work tools whose operation deploys electric power. The hand tools used involve: axes, which are utilized to cut wood and achieve curvature, hoes, which are used for digging, cleaning the ground from grass, or for leveling the ground in such a way that it is easy to place a ship, pickaxes, which are deployed for wood cutting, hammers, which are used for hitting inserting pegs and joining the parts of the ship, chisels, which are employed for carving wood or hard-to-reach parts of the ships, crowbars, which are utilized to remove nails or other objects, nails, bolts, and meters.

The power tools used are: Senso, for wood cutting machines. Crab, to smoothen the wood surface. Drill, to make holes in the wood for nuts and bolts to be installed. Jekso, or what is usually called an electric saw, for cutting wood, iron, and other materials. A router, to make holes in hard material surfaces, for example plastic or wood. It can also be used to cut, shape edges, and form profiles or carvings on wooden surfaces. When deployed in shipyards, hand tool and power tool equipment is always combined to produce high quality products.

D. Funding

The planned funding sources are divided into three categories: establishing cooperation between traditional shipyards, assistance obtained from the government including easy loans from banks or SMEs, and owning the shipyard directly [22]. Considering funding for onshore shipyards, all of them use funding sources from the owners directly except the Mita Bersama shipyard and the 7 Agam shipyard, which utilize funding sources emerging from joint ownership. The funding for water yards or repair yards is obtained from funding sources coming from the owner directly.

E. Ship Building Methods

1) Molding the Keel

The first thing to do when building a ship is making/printing the keel. The keel is the bottom part of a ship. The keel length usually ranges from 18 to 20 m. The keel of a ship should be constructed from a single piece of wood that is not joined, but since it is difficult to obtain long pieces of wood, the keel is made by connecting the available wood. Keel printing consists of various keel types according to the needs and desires of the customer. In general, it consists of a basic keel, an upright keel, and a hull keel. A vertical keel is a keel that is upright along the length of the ship, 5/8 thicker than the base keel, situated at 4/10 of the vertical keel in the middle of the ship.

2) Assembly of the Keel with Deck Beam and Transom

The laying of the keel constitutes the beginning of the ship's construction, usually celebrated because it is considered the day the ship was born. When making a small ship, it starts from a ship seed, or what is called a jukung, acting as the basic foundation. This ship seed is processed from one intact tree trunk. This type of jukung is quite large and deep. In order for it to be formed, it requires heating with fire up to an extent where the width of the ship matches the desired size.

3) Manufacture/Printing Height

The height is divided into two classes, namely the bow height and the stern height. The bow height is adjusted to the slope of the bow that an individual wishes to make. Then the girth is assembled after the ship is ready. After that, it is assembled with a bow girth with a height adjusted to the slope of the bow that is to be made.

4) Ship Hull Assembly

The ship's skin is useful for providing longitudinal structural strength to the ship. Receiving loads from the ship and its cargo, the former acts as a watertight covering from the bottom to the top of the ship. The ship's hull is planked, starting from installing the most basic plank, which is connected to the keel and the height of the bow. When a plank is installed on the base, the next plank should be installed in a balanced manner between the right and the left of the ship, simultaneously, while being shaped according to the width of the ship to be made. Installing this ship's hull skin board without using nails, simply requires dowels or dowels with ironwood, with an adjusted distance of at least 10 cm between the pegs. The ship's skin lanes are named with the letters a, b, c, d, and so on, starting

from the base lane. Plate connections are represented with numbers 1, 2, 3, and so on from the front to the back. A ship hull made of planks meeting the length of the ship is difficult to be obtained. However, the ship's hull can be filled by connecting different parts. Connecting ship hulls, though, leads to construction weaknesses, especially detected in the connection method [23].

5) Assembling the Left and Right Tusks

Tusks are the skeletal structure of a ship that strengthens the hull and forms the body of the ship. The tusks' function is to connect the hull planks to one another and strengthen them in the transverse direction. Together with the hull planks, the tusks resist water pressure from the outside. Thus, the tusks must be strong and the joints must be as minimal as possible, or better yet, the tusks should be without joints. The ivory is usually called frame. The name of the ivory is adapted to its location. The tusks located around the bow are named bow tusks. The tusk that is located at the widest point of the ship is called the big tusk. The ivory located in the propeller shaft sheath is called the button ivory.

6) Installation of Galar and Wrang

Once the tusks have been installed, the installation of the wrang and galar beams or galar kim should be carried out, acting as reinforcement for the construction of this connecting vessel through the utilization of nails or bolts.

7) Placing Decks

The deck structure depends on the number of decks on the ship. The deck located below is the base deck. The deck situated above is the upper deck. Between the base deck and the upper deck there is an intermediate deck. The deck is made of waterproof wooden planks arranged side by side and resting on the ship's trusses. To make the deck waterproof, the gaps between the boards used are filled with waterproof fiber and bonded with tar, while resin can be also used.

8) Construction of Ship Platform (wheelhouse)

The bridge is the ship's command room, where the ship's steering wheel is placed along with the navigation equipment. Additionally, there is usually a captain's room and a radio room. The platform is commonly placed in a position that offers good visibility to all directions.

IV. CONCLUSION

This study deploys a survey method to describe the existing conditions of the shipyards at the Ujong Baroh Fisheries Base, West Aceh, with a focus on aspects: such as human resource development, material procurement, production equipment, funding, and shipbuilding methods. This study highlights the importance of developing the effectiveness of the workforce, efficiency in material procurement and planning, the use of appropriate equipment, the diversification of funding sources, and the need for changes in traditional ship construction methods to increase productivity.

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