Development of fishing vessel shipyard in traditional Lampulo, Banda Aceh

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Abstract. The construction of ships at the Lampulo shipyard has not all used the rules according to naval architecture. But there may be ineffectiveness in the use of raw materials such as a lot of wasted wood volume. This research was conducted to know the types of wood and equipment used for traditional shipbuilding and know the process of traditional shipbuilding. This research used a survey method and data was collected by interviewing and observation. This research is located in the Kutaraja Ocean Fishery Port, Banda Aceh conducted from March to April 2021. The results showed that the types of wood commonly used as raw materials for shipbuilding in traditional shipyards were bangkirai wood (Shore Laevifolia Endert), laban wood (Vitex Punesceus Vahl), balau wood (Hopea Calebica Burck), meranti merah wood (Shorea Acuminata Dyer), tembusu wood (Fagraea Fragrans Roxb), bungur wood (Lagerstroemia Speciosa Pers), and merbau wood (Intsia Bijuga). The equipment used still uses non-electronic equipment, only drill work that uses electricity. Meanwhile, the traditional shipbuilding process generally begins with laying the keel and installing the crest. Next, continued by frames installation, hull plank then upper hull main frame. Hereinafter, deck floor installation, hatches manufacture, and superstructure construction. The final stage of shipbuilding process is machining, painting, installing engines, propellers, and steering. Thus it can be said that the construction of a fishing vessel in Lampulo still traditionally a hereditary habits.

1. Introduction
Fishing boats are an essential factor in increasing fishing production and making it easier for fishers to carry out fishing activities. As a means of production, fishing vessels must meet the eligibility requirements, including good quality stability and maneuverability, minimum motion resistance, and solid construction [1].

Most of the fishermen in the Lampulo shipyard generally use wooden boats in their fishing operations. According to [2], ships made of wood must have high strength and resistance to attack by marine organisms so that they are expected to operate for a more extended period. Based on the observations made, one of the obstacles faced in the traditional Lampulo shipyard is the lack of optimal fishing facilities (ships) used by fishermen. It happened because the construction of ships at the Lampulo shipyard has not all used the rules according to naval architecture. Even though the construction of ships without using these rules, the quality of ships built at the Lampulo traditional shipyard is excellent, but there may be ineffectiveness in the use of raw materials such as a lot of wasted wood volume [3].

For this reason, research is needed regarding the construction of ships that are built traditionally. So this study aims to determine the types of wood and equipment used for traditional shipbuilding and to know the process of traditional shipbuilding.
2. Material and Methods

This research is located in the traditional shipyard of the Kutaraja Ocean Fishery Port, Banda Aceh conducted from March to April 2021. This research used a survey method and data was collected by interviewing and observation. The data and information collected consisted of primary data and secondary data. Primary data was obtained by means of direct interviews with respondents who were guided by the questions that had been provided and direct observations of the types of wood and the criteria of wood and the equipment used in the construction of ships. While secondary data obtained from the study of literature relevant to the object of study that supports the research.

The selected sample was determined purposively, meaning that the researcher directly interviewed people who were considered to be familiar with the types and criteria of wood used in shipbuilding (ship craftsmen and shipyard owners). While the data analysis used in this study is a qualitative descriptive analysis to help identify the causal relationship of a phenomenon so that a detailed picture of a phenomenon is obtained [2].

Figure 1. Research Location

3. Results and Discussion

3.1. Types of Wood Used

The criteria for selecting the type of wood by ship craftsmen at the Lampulo traditional shipyard in shipbuilding are strong, durable, not easily broken, and easy to shape wood. These criteria are the same as research [4], [5], [6]. That the criteria for wood to build ships are to be strong, not easily broken, easily floated, and resistant to attacks by wood-destroying organisms, especially marine animals.

The results of interviews that have been conducted show that they are more likely to choose solid and durable wood so that the ship can last a long time. The selection of this type of wood is the basis for the community to use the wood as a priority or alternative [5]. Several types of wood are used as the main priority used in shipbuilding because raw materials are widely available in the natural forest area of Aceh Province, making it easier for ship craftsmen in terms of saving costs and time.

Field observations show that there are seven types of wood that are generally used in the Lampulo shipyard as raw material for shipbuilding. These types of wood are used to make ship hulls, superstructures, and rudders. The types of wood can be seen in Table 1.

| Table 1. Types of wood used as raw materials for traditional shipbuilding. |
3.2. Equipment Used

The equipment used in traditional shipyards in shipbuilding still uses simple tools and equipment. This is because shipyards are still traditional, and such equipment has been a hereditary habit [8], [9]. Some of the equipment used in traditional shipyards in Lampulo can be seen in Table 2.

**Table 2. Equipment used in Traditional Wooden Shipbuilding**

| No | Equipment Used | Types of Equipment | Function |
|----|----------------|--------------------|----------|
| 1  | Ax             | Non-Electronic     | Used for Cutting Trees |
| 2  | Saw            | Non-Electronic     | Cutting Wood and Forming Wood Pieces As You Want |
| 3  | Chisel         | Non-Electronic     | Sculpting Wood in Hard-to-Reach Parts of the Ship |
| 4  | Bolt           | Non-Electronic     | Auxiliary Tools for Attaching Ship Construction Parts |
| 5  | Hammer         | Non-Electronic     | Tools for Hitting, Inserting Pegs and Sealing Ship Parts |
| 6  | Machete        | Non-Electronic     | Cutting Twigs on Trees and Making Pegs |
| 7  | Clamps         | Non-Electronic     | Aids to Bend Wood on a Ship |
| 8  | Measuring Instrument | Non-Electronic       | Measuring Ship Dimensions |
| 9  | Electric Drill | Electronic         | Perforating Wood to Install Nuts and Bolts |
| 10 | Crab           | Non-Electronic     | Smoothing Wood Parts |

Source: Research data (2021).

The results of field observations rarely found modern electronic equipment, which could provide convenience for ship craftsmen in the process of shipbuilding work. Nevertheless, the ships produced in this region have proven their capabilities and strength.

3.3. Traditional Shipbuilding Process

The first shipbuilding process at the Lampulo traditional shipyard is determining the dimensions and sketches the shipyard owner will make. The size and sketch of the ship come from two sources, namely from the ordering party and the shipyard owner itself. If the ordering party is accompanied by drawings
of the general arrangement, lines plan, deck profile, and profile construction, the shipyard owner makes the ship based on the detailed drawings. But if detailed drawings do not accompany it, the shipyard owner will determine the dimensions and sketches. After that, the selection of quality wood materials or blocks is carried out according to the ship's parts to be built [10], [11].

After the preparation stage is complete, then proceed by making malls or patrons, while the ship construction parts need to be made into malls are the ship curved parts such as bow girth, stern ridge, frame, knee or elbow, curved plank boards, beams and so on. Furthermore, process of cutting the wood according to profile, some components are difficult to make from a piece of wood, so they must be made from several pieces of wood and then joined. After being connected, gluing, steaming and, if necessary, bolting to ensure the connection becomes strong. Based on observations made, the shipbuilding process in Lampulo traditional shipyard generally includes:

1. Keel and hull installation

   The first shipbuilding was keel, a ship that shouldn’t be connected because it’ll reduce the keel’s power. It average length used to build Lampulo traditional shipyard measure 15-20 meters, but due to the difficulty of obtaining long wood, keel can be made by connecting the available wood. Rear keel attachments on motorized vessels shall be avoided, joints shall not be under hatches or large deck openings.

   ![Figure 2. Wooden keel](image)

   2. Bow and stern installation

   Hull installation of bow mast’s assisted by auxiliary reinforcement to enforce the bow height on the keel. For plank installation on bow height, grooves or sponges are made, with a depth equal to the plank thickness and a slope equal to it plank slope, then placed knee between the bow and keel, where the knee is made of curved wood. Stern frame installation by continuing the propeller height on keel up to deck beam. The stern keel has two parts, viz. the lower part which is attached to propeller shaft and the upper part which is mounted continuously forward to the rear bulkhead of the engine room. The stern height and thickness also bow height may change as long as required cross-sectional size is maintained. The height between the sponges is at least 2.5 times the thickness of the plank board.

   3. Frame and Bracket Floor (Wrang) Installation

   Frame’s installed into a single unit, reinforced bracket floor in the middle and auxiliary reinforcement upper side of frame. It’s mounted on the keel by starting with marking the frame location on the keel, followed by placing notches on the keel or bow and stern crest, adjusting, drilling and ending with it linking. Bracket floor’s made together with the frame and assembled into an frame. Once they’re all installed, the new inner keel is installed on the ship's frame.

   4. Block Frame Beams and Kim Frame Beams
Block frame beams and kim frame beams are installed along the ship without breaking (through bulkheads) inside of the tusks in lane below the deck and fastening the beams to the tusks using bolt nuts. To support block frame beams stand up, a knee brace’s installed with both arms attached to the upper block frame beams, while the middle is attached to girdle. Lower block frame beams installation is the same as top beam but is carried out after installed. Kim frame beams function is to hold deck beams and bind tusks. Kim frame beams or bilge frame beams have the same function as block frame beams, only they are located under the tusks, so they’re tied by frame beams above, middle, and bottom, fastening is done with bolts whose depends on the block frame beams’ thickness.

5. Deck Beams Installation
Deck beam laying above hard beams and coincides with frame, then combined into a unit of wooden ship transverse strength. Continuous deck beams unbroken as wide as ship or until hatch covers. Deck beams must be tilted on both ends of about 4 cm for draining water above deck into drain hole.

![Deck beams](image)

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6. Bulkhead Installation
Bulkheads on ships are needed for room division and limiting between rooms on ship. Fishing boat’s divided into several rooms, viz. engine room, fish loading room, accommodation room and fore peak room. The bulkhead construction on wooden ships consists of; Bulkhead frame, has been installed during frame installation, then the surface of frame attached to the bulkhead. Bulkhead frame, has been installed during frame installation, then the surface of frame attached to the bulkhead. Bulkhead deck beams, have been installed during frame installation, marking the location of the top end of tonnage upright or reinforcing beams. Bulkhead reinforcement beams have been installed during bulkhead deck beams construction, then another beam is installed at the specified place. Bulkhead board, starting from bottom board, plank board and benchmark board that was installed during the frame installation, flattened slope of bulkhead board bottom side until it sticks tightly to keel. For strengthen the density, the wood’s cooked as in plank boards, then install another bulkhead board from the bottom up.

7. Plank Boards and Deck Boards Installation
Plank board’s installation starts from the keel plank, specifically the keel lane board and base lane boards which are under the machine foundation installed after frame is completed properly. Plank board cutting should be radially and in length as long as possible and divided evenly. The plank joints of upper beam girders and deck side caps shall not lie in the same plane. Other work that must be in sequence with plank installation is keel planks, bilge lanes, side lanes and top lanes installation. Before being installed, the selected plank board must be leveled with a sharp shaving tool until the specified thickness
is obtained. If there is no board that’s sufficient in length for plank board strip, next, several plank board pieces which are blunt connected are used at time of plank board installation.

Figure 4. Plank boards installation

Deck board is something fitted on the ship which function as a foothold for the Ship's crew (ABK) in carrying out their activities and as a laying of fishing gear on the ship. To make it waterproof, the gaps between boards used are filled with waterproof fibers and tied with tar, resin can also be used. The deck board consists of several parts, such as:

Deck side cover board, consisting of a curved part (front and back) and a straight part. For curved parts manufacture used patrons made according to required arch. In order to penetrate the tusks and join the deck planks, notches were made to facilitate installation. Center deck board, consisting of several strips of plank located in the middle deck which is thicker than the other deck boards. Another deck board, installed between center deck board and deck side cover consisting of several planks layers. Wood used is radially cut wood wherever possible.

8. Loading Ship Room (Palkah) and Engine Room Installation

Loading ship room or palkah room are used to accommodate the caught fish in which there are chunks of ice, so that the boards made of sheaths and form a space up to the main deck. Between casing and ship plank there’s an empty space which is usually filled with foam, coconut belt or sawdust to strengthen casing position. The construction parts include; longitudinal supports, dead beams, floorboards and siding, hatch sills and sheathing boards. While hatch threshold construction consists of base beams, wall boards, and hatch covers.

Fishing boat engine room construction consists of machine foundations (engine propulsion, pumps, and generators), floor beams, floorboards and engine room sills. The slope of machine foundation on lower side is adjusted to tusks slope where the machine foundation beams are placed. The foundation for the auxiliary propulsion engine’s installed starting in front of bulkhead to it rear.

9. Upper Building Installation

The shape, size, and layout of upper building depends on customer or ship owner wishes, which can be made multilevel or just one. For fishing boats, the upper building is usually not multistory with the construction parts composition as follows; pedestal beams, struts, girders, long reinforcing beams, wall boards, beams, roof beams, roof beams, roof boards, and roof railings. It begins with frame reinforced manufacture with reinforcing beams, then the framework’s attached to the holder planned then continued with board’s installation. Fastening bolts are installed to secure it superstructure and run from the superstructure through the deck and are attached with cover rings or nuts. Planks for hatch edges and
engine room windows should always be bolted together from the side and shouldn’t be made of too light a material.

10. Blocking and Collecting

Blocking is the process of sealing a wooden ship's hull building against water so that the ship remains afloat. The materials commonly used by the Lampulo traditional shipyards in wooden ships construction are resin and rope. Pakal or often referred as masonry is one of important requirements for wooden shipbuilders. Placing and caulk is carried out in gaps between lanes, plank board’s connection, walls, roofs, hatch thresholds, engine room sills, bulkheads and other connections requiring impermeability. Packs number required based on gap between strips and boards joints.

11. Dead Beams and Propeller Shaft Tubes Installation

Dead beams serve as a support for the construction parts that flank them so their positioned exactly as planned also used as a connector between propeller shaft tube beam and keel. Dead beam also placed between propeller shaft tube beam and shaft stern. For propeller shaft tube, shape and size depends on propeller shaft, it’s installed to dead beam and knee which is located to keep propeller in the water.

4. Conclusion
The results showed that the construction of fishing boats in Lampulo is still done traditionally. This can be seen from the many ship craftsmen using non-electronic equipment and the type of wood used was still based on hereditary habit.

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