

# Manufacturing of Indonesian Wooden Traditional Ships

Nofrizal,<sup>a,\*</sup>

<sup>a)</sup>*Ocean and Aerospace Research Institute, Indonesia*

\*Corresponding author: 6281371992109@mms.telkomsel.com

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## ABSTRACT

Traditional ship-building is still widely practiced in Indonesia. Every province and regions have different characteristics in the design and production process of the traditional ships. The production process and procedure of traditional ship is far from the influence of advance technology. This study presents traditional shipbuilding process in the Kepulauan Riau, Indonesia. Survey three traditional shipbuilders in Bintan island, Mana Island, and Kelong island are carried out to get the production process by interviewing master and taking photo for documentation as case study. It is found that strip plank method with both fire and pressing techniques is used in production traditional ship in Kepulauan Riau, Indonesia. L-Joint technique is applied between keel-stem frame and T-joint technique between keel-stern-post.

**KEY WORDS:** *Ship Design; Traditional Shipbuilding.*

## 1.0 INTRODUCTION

Transport over water is a necessity in most parts of the world. A ship is a complex vehicle designed to convey or transport people, goods from one place to another through water. Its production combines three different areas of specialties: naval architecture, marine engineering and ship building. The overall process of ship construction is costly, time consuming and complex. Thus these are the reasons why efforts on constructing the most cost effective ship have been the main objective on almost all shipbuilders around the world.

Ship production is the act of producing ship. The improvement in ship design and construction has been a process of evolution, slow at first, but gathering speed over the centuries, leading ultimately to the sophisticated ships of the 21<sup>st</sup> century. It is interesting to compare the simplest dugouts still to be found in less developed parts of the world and to appreciate that the design of even these humble craft has variations brought about by experience in operation. Following on from carved logs, dugouts, and similar craft, early shipbuilders in many middle eastern lands produced vessels constructed with papyrus, and elsewhere craft, like the coracle and the kayak, were formed of animal skins stretched over timber framework.

The era of wooden boat is gradually going into extinction with the advent of technological breakthrough but the need to re-echo its usefulness and ornamental features is considered paramount because apart from the fact that it's a reminder of technological advances, the importance in area of low cost of production, it's cultural beauty and the low pollution associated should never be underestimated, hence, the need for a consistent manufacturing methodology.

This study covers only the traditional ship building around the South East Asia precisely Bintan region in Kepulauan Riau Province in Indonesia. In this research, all necessary information was collected by visiting three traditional shipyards in Kijang, Mana and Kelong island in Kepulauan Riau, Indonesia through interviewing and documentation.

## 2.0 LOCATION OF TRADITIONAL SHIPYARDS

Kepulauan Riau is one of provinces in Indonesia which is an archipelago area consist of large and small islands around 2.408 islands whereas 366 islands have been inhabited and 2.402 islands have not been yet. Total area of Kepulauan Riau Province is 253.420 km<sup>2</sup> consist of 242.825 km<sup>2</sup> (96%) by sea, and the land area is 10.595,41 km<sup>2</sup> (4%) as shown in Figure.1.

Current research seeks to promote a better understanding production process of traditional ship in Kepulauan Riau, Indonesia. As case study, the research carried out by visiting three wooden shipbuilders as follows: Kijang-Bintan Island, Kelong

island, and Mana island in Kepulauan Riau, Indonesia as shown in Figure.2. All information and data are collected through interview and documentation.



Figure.1: Research location in Kepulauan Riau-Indonesia.



Figure.2: Three traditional shipyards visited in Kepulauan Riau Province, Indonesia.

### 3.0 TRADITIONAL SHIP PRODUCTION PROCESS

In production process, production of traditional ship is not much different from modern ship. The difference is only the way of build which is still traditional. All of the process is done by human power with the help of traditional equipment such as: saw or chainsaw, electric plane, small and big press, black thread and ruler, electric borer, gauge, nail, bolt, hammer, blow. The worker involved in traditional shipbuilding usually will be led by a master called the master shipbuilder or master shipwright or master craftsman. The master alone will have the plan inside his mind. The master usually does consultation with his experienced assistant and owner to ensure the ship they want to build will not only satisfy the owner but also be capable of sailing.

Each traditional shipbuilder has its own unique way in constructing ships. As an example, a traditional shipyard in Mana island was using fire bending technique in fastening planks, but traditional shipyards in Kijang and Kelong island were using pressing technique. However, these shipyards have different techniques between each other, in general, these shipyards have similar production process techniques to be derived. Figure.3 shows a flowchart of the traditional shipbuilding process which starts from material until delivery.



Figure.3: Flowchart of traditional shipbuilding process.

#### 3.1 Contract and Payment

The contract and payment in traditional shipbuilding is mainly based on trust. The owner usually will have full trust on the judgment of the master shipbuilder to determine every technical aspect of the ship. However, it is up to the owner whether the owner wants to reduce the production cost needed by reducing the size and material used or not.

After a couple of negotiations, a written agreement is made, usually in a simple ceremony that will be attended by a number of important people such as the village leaders or religion leader, who act as witnesses. In the agreement, only few details are enlisted such as the type of the ship, length, depth and the thickness of the hull. There are no blueprints or sketches, however, if the owner presents the blue print to the master shipbuilder, it won't be a problem for them to build based on the blue print.

The payment can be done in two methods, whether the owner provides all the material needed and only pays the shipbuilder to build it or the shipbuilder will handle all the process and the owner only needs to provide them with the money. Either way, the payment usually will be paid gradually depending on the progression of the ship construction. All of the above are being carried out solely based on trust from both sides.

#### 3.2 Material Selection

Wood is the main material for manufacturing traditional ships, which mostly consist of Kayubesi or Ironwood tree. Ships made out of the Kayubesi can last approximately 30 years. The Kayubesi logs will be chosen based on experience by the master, which is required practical knowledge of the properties of the

wood. This is to ensure the quality of the wood which is sufficient to build a ship and enough to avoid cracking when the fire bending process takes place. Resak Tree (*Shorea spp*) can also be used as replacement material to built wooden ship, however the ship can only last approximately 15 years and inexpensive compared using Kayubesi.

Traditional shipyards in Bintan region prepare using Resak rather than Kayubesi due to most owner requirement, inexpensive and availability material in the market. This material were order from Lingga island Dabo-Singkep. The raw material then are be transport to timber mill to be cut into required planks and keel. But, sometimes, the timber was cut by the shipyard using chainsaw. The raw materials are storage in the traditional warehouse as shown in Figure.4.



Figure.4: Raw material storage in simple warehouse.

### 3.3 Material Dried up and Planner

#### Nature Dried up Process

The material should be cleaned and dried up outside of the yard in order to build good quality of ships. If the material wets or damps, the material is more brittle and lead to the emergence of organisms that would threaten the quality of material. This nature dried up process is by living the material under the sun to ensure dry and not humid. When the wood is enough dry, the material is moved and kept inside the yard for further drying up process as shown in Figure.5. This drying up process usually took four months as minimum requirement which depends on the wheatear, but sometimes took up to a year. During the time of preparing the material, the shipyard will be modified or reequip with proper equipment so that the construction can be carried out. Some shipbuilders even build a totally new shipyard if it is necessary.

#### Material Planner

Planes are used to flatten, reduce the thickness of, and impart a smooth surface to a rough piece of lumber or timber. Planner is used to produce horizontal, vertical, or inclined flat surfaces on work-pieces usually too large for shaping. Special types of planes are designed to cut joints or decorative moldings.



Figure.5: Clean material dried up under the sun (a) and enough dry material kept inside the yard (b).

### 3.4 Cutting Process

In cutting process, the traditional shipyards in Kepulauan Riau, Indonesia do not use the principal drawing of the ships such as: sheer plan, half-breadth plan, and body plan. The frames are shaped based on experience and instinct using moulds and flexible rule.

The mould may be of skeleton form and may serve for several frames as shown in Figure.6. It is usually a thin plank to cut the form of a ship timber and serves as a template for scribing the members for the workmen, who saw, hew, and adze them into shape.



Figure.6: Molds used as guidance for frame shaping.

#### Cutting Machine

Mower is used, a traditional mower which a gear cutter controlled by electrically formed in a vertical which aims to cut timber and timber board. Besides cutting process is used to cut wood are also used chainsaw, but sometimes the cutbacks are still not accurate as shown in Figure.7.



Figure.7: traditional cutting machine – chainsaw.

### 3.5 Keel Process

#### Building Slip

A yard prepared for shipbuilding. It includes one or more slips, or inclined planes on which a vessel in its cradle is supported while on the stocks in the process of construction, or upon which a ship is hauled for repair.

#### Longitudinal Main Stiffener

The keel, forming as it does the lower boundary of the longitudinal section, is spoken of as the backbone of the vessel as shown in Figure.8. The pieces are obtained in as long lengths as possible, varying in size according to the size of the vessel.



Figure.8. Longitudinal main stiffener

#### Keel Laing Down

The production process of the traditional ship is started from the keel part, in Indonesian language is called Lunas. The keel is the backbone of ships and provides the most important longitudinal strength for the ship. The keel is cut from 5 x 5 inches, or larger, and then it is laid onto support wooden blocks fastened to the floor in the yard as shown in Figure.7. The keel must be kept

firmly in position. The measure of the keel is of course according to the chosen ship design which is normally based on owner requirement. The keel was made from dry up straight Kayubesi or Resak to prevent deformations during the construction. This was normally decided by the owner based on life of the ship and availability of the wood in the market.

### 3.6 Frames Installation Process

#### Frames of Traditional Ship

The ship was strengthened by frames, which were made up of straight and curved timbers. The frames were made of a number of pieces called futtocks which are scarfed together as shown in Figure.9. Required number of futtocks in one frame is according to the length of the sections of the requisite height. They are called as the first, second, or third buttock, terminated by the top-timber. The first buttock which is located at bottom of ship fastened to the keel, called Gading Bawah in Indonesian language. The term futtock is also applied to the complete half of a frame.



Figure.9: Typical example futtocks installed in traditional ship.

#### Bottom Frame

The futtocks, commonly called the ribs of the vessel, are the curved or crooked timbers giving the shape, to which the planking is fastened. The master makes patterns of the futtock based on instinct and experience using drawing tool which is called 'Mould', which is used to choose the best-shaped timbers. The wood was cut to shape and refine the shape using adzes to chip off unneeded material. The futtocks were scarfed, fastened with small press before they were bolted as shown in Figure.10. The master were hoisted the bottom into place one by one, atop the keel, forming the basic skeleton of the ship.



Figure.10: Bottom frames installed on the keel.

**Stem**

The stem which is called Haluan in Indonesian language respectively, are fastened to the keel using wooden plugs and roves, and adjusted into position using supporting rods attached to a rugged beam above the ship. The stern frame is located vertically in the end of keel and stem frame is located diagonally in the front of keel are assembled as shown in Figure.11.

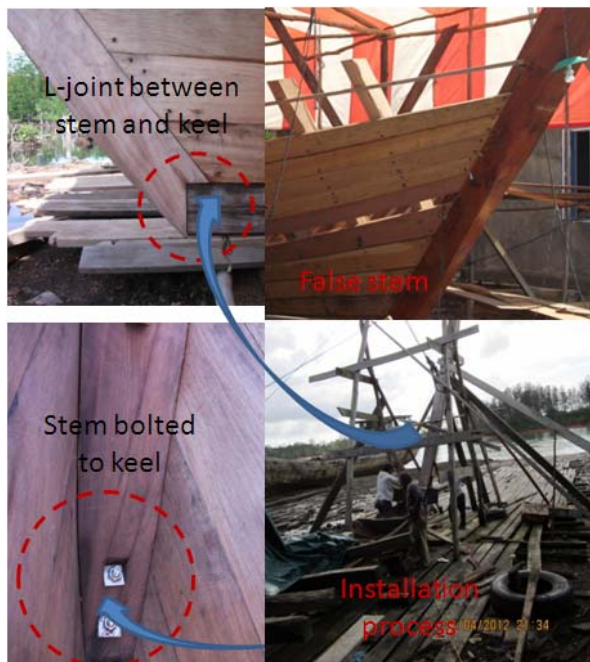


Figure.11 Stem assembled with L-connection to the keel.

Stem is the foremost boundary of a vessel, which is often the most complicated part, a nearly vertical continuation of the keel. Traditional wood typically has five types of the stem construction which are cutwater, rabbet, false, round brass, and nose types. In the Kepulauan Riau, shipyards mostly use false stem

construction. Each side of inner stem called apron is beveled to form a rabbet to scarf planks. Front of the stem is shaped into diagonal and the bottom part is connected to keel.

**Stern Post**

Stern, which is called Buritan in Indonesian language, is a slightly raking straight piece, rising from the after end of the keel as shown in Figure.12. The stern post forms the after boundary of the frame of the ship, being the after continuation of the keel to the height of the deck, and forms a receptacle for the after ends of the outside planking.

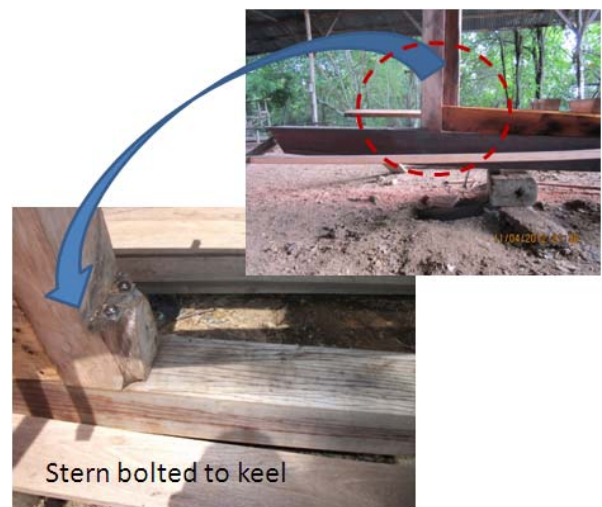


Figure.12 Stern installed with T-connection to the keel.

**Further Frames Installation**

Three initial long frames are firstly jointed to the bottom frames which are located in the foreship and midship and short frames are jointed between the bottom and the long frames as shown Figure.13. Then small plank are fastened to the long frames from stem until stern frames. This small plank guider is a function as guide line for installation next long frames as shown in Figure.14.

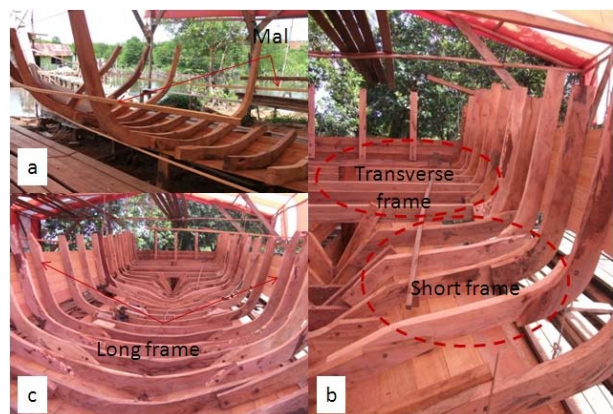


Figure.13: Initial long frames and mal (a), short frame (b) and long vertical frame (c).



Figure.14: Upper planks assembled to vertical frame

### 3.7 Planks Fastening Process

#### Ceiling

That portion of the inside skin of a vessel between the deck-beams and the limberstrakes on each side of the keelson. It is also called the foot-waling. The strakes of the ceiling immediately below the shelf-pieces which support the deck-beams are called clamps. The outside planking is called the skin

#### Planking

Planks are used to cover exterior and interior surfaces of the ribs or frames, and on the beams of a ship. A line of planking is a strake, and is named from its position, as garboard strake, sheer strake, etc. The planking process as follow: the first three planks are planed into shape and fastened to the keel at each side by presser through the T-profile of the keel, just as if the keel was a strake. Starting aft at the stern, each plank is temporarily fastened with clamps to adjust and fine tune the bevel along the top edge of the strake. Several adjustments and trials may have to be carried out until the plank can be permanently clinkered. The strake ends next to the stem and stern are thinner than the strakes amidships to make it easier to twist and bend them into the correct position.

What make Indonesian traditional ship a bit different is that between the two joining plank, strip of caulking bark tree is place, separating the two planks with 1-2 mm layer of a natural material with impressive sealing properties. After the hull is finished, outfitting will be carried out to install other necessary thing. Most of traditional ship usually will have modified stern part nowadays so that engine can be installed. All of these procedures were being done without any plan.

#### Hot Bending Technique

Some shipyards used hot bending technique using diesel oil and fire for curving and bending wood into form of the vessel at the time of the planking and the ceiling. This hot bending technique was used to perform the wood easily into ships form, so that at the time of bending, the wood does not break. In this hot banding

technique, diesel oil firstly was spread onto the wood as oil base combustion, to prevent its cracking occurs along the wood to be shaped, properties of diesel oil was absorbed into the wood, assist in heating the wood thoroughly. Then, the wood would be fired to acquire the curvy shape of a ship hull and then is joined edge on edge using ironwood dowels as shown in Fig.16.



Figure.15 Planks fastening at bottom frames of ship.



Figure.16: Planks bended using fire technique

#### Calking

The process of filling the seams between the planks of vessels, and of spreading the ends of the treenails, by driving in cotton or oakum, to make the seams watertight. Oakum is made by cutting old ropes and cables into short lengths called junk and picking that to pieces. The seam is opened with a dumb-iron or deck-iron, driven with a calking mallet, and the threads of oakum driven in, one after another.

#### Putty and paint

After calking, the seams are painted with a moderately thick

paint, working it in well, so that it covers the calking material and serves as a binder for the putty. After the paint is dry, the planking should again be planed.

### 3.8 Further Processes

After planks fastening process, the ship is launched. The process of launching traditional ship in Indonesia mostly carried out with the front side launching. Poop deck framing work and deck working, done at the time when the ship after the launch process. The process is similar to the activity at framing, ceiling, planking and hot wooden process. After accommodation processing, the ship was painted into one form to reduce the risk of material by the rapid destruction of the environment. Manufacture of pipes and ventilation work were carried out during outfitting and ventilation pipes arranged as possible, so when there is no failure in performance plumbing fixtures and other Outfitting. Engine and propeller were selected based on the size of the ship that was built and how much power it takes weeks to push the boat with the desired speed. Finally, the ship is tried to test the speed and manoeuvring capability.



Figure.17: Outfitting and Engine installation.

### 4.0 CONCLUSIONS

Production process of traditional ship in Kepulauan Riau, Indonesia has been investigated. Production process and procedure are collected by interviewing the masters, workers, and taking photos and videos as documentations during visiting traditional shipyards in Bintan, Mana and Kelong islands. The results show that the production methods of the traditional ships in these regions were similar to the traditional Lapstrake method with different at joint technique at keel-stem frame in which this region was using L-joint technique.

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