The assessment of wood utilization rate at UD. Karya Lomba Shipyard, Aceh Besar, Indonesia

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Abstract. This research aims to analyze the wood utilization rate at the manufacture of the vessel’s frames in UD. Karya Lomba shipyard, Lamteh Village, Peukan Bada subdistrict, Aceh Besar. The study was carried out in March to April 2018 by observing several parameters such as type of wood used, the process of vessel frames making and the utilization level of wood including initial wood volume, the volume of wood used and the volume of unused wood. The descriptive method was done by comparing the volume of wood used with the early wood volume and the volume of unused wood with wood scratch. Vessel’s frames from two under construction vessels were used as the study object by the length of 7.10 m, 13 frames and made from Jackfruit wood (Artocarpus heterophyllus). Then the length of the vessel II with 15.50 m, 35 frames and made from Laban wood (Vitex pubescens). The results showed that the wood utilization rate for frames manufacturing on the ship I reached 38% and 60% of the vessel II reached 60% respectively.

1. Introduction
Indonesia’s biodiversity on marine and fisheries is quite popular in the world [1,2,3] is Most fishing vessels in Aceh are made in traditional shipyards. The development of fishing vessels in traditional shipyards still uses wood as the main material for timber in large quantities. The large amount of wood needs to be the main problem related at this time, due to the type of wood used as the main material for reducing shipments and production, so that shipbuilders need to be able to use wood as optimally as possible. Moreover, in the construction of vessel’s frames construction that is ship construction which has an important role in the transverse vessel strength, therefore the wood used for the manufacture of vessel’s frames must be a type of wood that has good and strong wood characteristics and characteristics. Vessel’s frames is also the most difficult part of its construction, so it needs a large amount of wood dimensions and produces no small amount of residual wood[4].
This research is needed to analyze the level of utilization of wood in the manufacture of vessel’s frames in the UD Karya Lomba ship yard. The work of the Lam teh Village Competition, Peukan Bada District, Aceh Besar Indonesia.

2. Materials and Methods
The method used was the case study method with the object under study, namely the vessel’s frames of the ship on 2 units of the ship being built in the UD Lomba Karya. Ship I with a length of 7.10 m, width of 1.45 m and 0.70 m has 13 vessel’s frames and Ship II with length of 15.50 m, width of 2.90 m and in 1.35 m has 35 vessel’s frames. The types of data needed included, the type of wood used, the process of making vessel’s frames, and the level of wood utilization which includes (initial volume of wood, volume of used wood and unused wood volume). Data analysis was carried out descriptively and carried out a comparative calculation by comparing the volume of wood used with the initial volume of wood and the volume of unused wood with the initial wood. Analysis of the utilization of vessel’s frames wood was presented as follows:

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P1 = \frac{b}{a} \times 100\%
\]
\[
P2 = \frac{c}{a} \times 100\%
\]

Description:
\( a \) = Initial wood volume \((V_a)\), \( b \) = Volume of used wood \((V_t)\), \( c \) = Volume of wasted wood \((V_{tb})\), \( P1 \) = Percentage between \( b \) with \( a \), \( P2 \) = Percentage between \( c \) with \( a \).

3. Results and Discussions
Types of wood used for vessel’s frames
Types of wood commonly used for the manufacture of vessel’s frames by traditional UD Lomba Karya ship yards consisted of 2 types of wood namely Laban \((Vitex pubesceus)\) wood and Jackfruit \((Artocarpus heterophyllus)\) wood (Table 1). The use of wood species is distinguished based on the size of the ship to be built, for vessels with a length of> 10m using laban wood \((Vitex pubesceus)\) while for ship length <10m using jackfruit wood \((Artocarpus heterophyllus)\) (figure 1).

| Ship | Wood Type          | Latin Name                | Local Name | Density (g/cm³) |
|------|--------------------|---------------------------|------------|----------------|
| I    | Jackfruit wood     | Artocarpus heterophyllus  | Bak panah  | 0.63           |
| II   | Laban wood         | Vitex pubesceus           | Bak Manee  | 0.87           |

Source: Primary Data
The physical properties of wood used by the UD Lomba Karya shipyard based on the National Standardization\[8\] are presented in Table 2.

| Wood Type     | Density | KA | KK |
|---------------|---------|----|----|
|               | Min     | Max | Mean | II-III | II-III |
| Jackfruit wood| 0,55    | 0,71| 0,61 |        |        |
| Laban wood    | 0,74    | 1,02| 0,88 | I      | I-II   |

Source: BSN (2006)

The level of utilization of wood in the manufacture of vessel’s frames

The level of wood utilization and the percentage of timber volume utilization used for vessel’s frames are presented in Table 3, Table 4, and, Table 5.

| Position | Type      | Va (m$^3$) | Vt (m$^3$) | Vtb (m$^3$) |
|----------|-----------|------------|------------|-------------|
| 1-8      | U bottom  | 0,163      | 0,073      | 0,089       |
| 9-11     | Round bottom | 0,089    | 0,026      | 0,063       |
| 12-13    | V bottom  | 0,054      | 0,018      | 0,037       |

Source: primary data

| Position | Type      | Va (m$^3$) | Vt (m$^3$) | Vtb (m$^3$) |
|----------|-----------|------------|------------|-------------|
| 1-15     | U bottom  | 1,392      | 0,875      | 0,535       |
| 16-28    | Round bottom | 1,144    | 0,637      | 0,507       |
| 29-35    | V bottom  | 0,266      | 0,171      | 0,055       |

Source: primary data
Table 5. Percentage of average used wood and wasted wood

| Ship  | P1 | P2    |
|-------|----|-------|
| Ship I| 38%| 62%   |
| Ship II| 60%| 40%   |

Source: primary data

Description:
P1: Percentage of average volume of wood used; P2: Percentage of average volume of wasted wood.

This is believed by ship craftsmen in the UD Lomba Karya as a form to maintain the stability of ship construction. According to the Indonesian Classification Bureau[6,8], the wood requirements for vessel’s frames construction are types of wood that have Specific Gravity (BJ) with a minimum value of 0.70 gr / cm³, a minimum Strong Class (KK) III, and a Durable Class (KA) Minimum III. Jackfruit wood (Artocarpus heterophyllus) used in shipbuilding by UD Lomba Karya ship yards has a density of 0.63 gr / cm³ when viewed from its specific gravity, it does not meet the minimum standards set by BKI, namely wood with a minimum density of 0.70 gr / cm³ but when viewed from a strong class (KK) and durable class (KA) jackfruit wood is a type of wood that is in accordance with the requirements of the type of wood used for making vessel’s frames. Laban wood (Vitex pubescens) is a type of wood recommended by BKI. Laban wood used by UD Lomba Karya has a BJ value above the minimum value set with a value of 0.87 gr / cm³, this is in accordance with the requirements of the type of wood used for making vessel’s frames.

The level of utilization of wood in the manufacture of vessel’s frames

a. The level of utilization of wood on ships I

The level of utilization of wood in ship I has an average percentage of 38% and the percentage of wood wasted by 62%. This indicates that the use of wood for the manufacture of vessel’s frames is still not optimal. For more details, it will be shown in (Figure 2) below:

Figure 2. Percentage of the level of utilization of wood in the manufacture of ship vessel’s frames I
In the position of vessel’s frames 9 to 11 the percentage of wasted wood is quite high, this is because vessel’s frames is in the form of a round bottom where the base vessel’s frames has an uneven base in other words has a curvature in the middle so that there is a lot of correction. Likewise with the 12th vessel’s frames, this is because V-shaped wood is used to make gaings derived from one whole wood which is also connected with side vessel’s frames, but to get a V shape that is in accordance with the shape of the bow of the ship, the cause is in the production of many volumes of wood is wasted. Whereas for the 13th vessel’s frames in making it comes from one type of wood destined for vessel’s frames on the bow of a V-bottom vessel with two parts of construction with a high utilization rate so that only a little unused wood.

b. The level of utilization of wood on ships II

The level of utilization of wood on ships II has a percentage of average wood consumption of 60% and the percentage of wood wasted by 40%. This shows that the use of wood for the manufacture of vessel’s frames is quite optimal. For more details it will be shown in (figure 3):

Figure 3. Percentage of the level of utilization of wood for making vessel’s frames on ships II

In the position of the vessel’s frames to 25 to the position of vessel’s frames to 28 the percentage of wasted volume is higher than the percentage of volume used this is because the vessel’s frames that will be installed in the form of a round bottom so as to get the curvature that corresponds to the hull there are many corrections to produce wood volume is wasted more. The next striking change was seen in the vessel’s frames of the bow section starting from the vessel’s frames to the 29th to the 35th vessel’s frames where the percentage of the volume of wood used was very high compared to the percentage of wood volume wasted because V-shaped wood used consisted of one whole wood and wood V which consists of two parts of wood which are joined already has a shape that is in accordance with the desired shape of the bow of the ship so that there is only a slight correction to get the curves that are in accordance with the shape of the bow of the ship [9].

4. Conclusion

The level of utilization of wood for the manufacture of vessel’s frames on vessel I has an average percentage of used wood of 38% and waste wood of 62%. For ships II the percentage of wood used is 60% and waste wood is 40%
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