Cost Comparison for the Installation of Steel Frames vs Wooden Frames on a Traditional Wooden Fishing Boat in South Sulawesi

L Bochary\textsuperscript{1}, M R Firmansyah\textsuperscript{1*}, S Asri\textsuperscript{1}, G Sitepu\textsuperscript{1}, W Djafar\textsuperscript{1}, Zulkifli\textsuperscript{2}, A H Djalante\textsuperscript{1}, and M Arfah\textsuperscript{1}

\textsuperscript{1}Naval Architecture Department, Engineering Faculty, Hasanuddin University, Makassar, Indonesia
\textsuperscript{2}Marine Engineering Department, Engineering Faculty, Hasanuddin University, Makassar, Indonesia

*Email: mr.firmansyah@unhas.ac.id

Abstract. Traditional wooden fishing boats are still being produced by most of the traditional wooden shipyards in Indonesia specifically in the area of South Sulawesi. Nevertheless, the traditional wooden boat craftsman facing the difficulty of wooden log supply as the main wooden boat material especially for wooden frame construction despite the increasing demand for wooden material for the boat construction. The difficulty to acquire the specific wooden for wooden frame caused by the specific requirements of each wooden frame. They must be in the specific shape according to the specific curvature of each transversal boat section along the boat length. Hence, for the sustainability of wooden boat construction process, alternative material is needed for replacing the certain wooden boat construction component, especially for wooden frames. Fortunately, research relating to the use of alternative material for wooden boat construction have been conducted. The focus of the research is on the use of steel frame to replace the wooden frame on the wooden boat construction. This paper discusses the cost comparison for the fabrication and installation process as well as the material cost of the steel frame to the wooden boat construction with wooden frame to the wooden boat construction. The result shows that the cost for fabricating and installing steel frame is 13\% higher to compare to the wooden frame. However, if the total wooden boat construction cost is being considered, the total difference is only 3\%.

1. Introduction

South Sulawesi have been well known in Indonesia as the area for traditional wooden ship builder. The process of building Pinisi ship as one of the traditional boat yards in this area have been even recognized by UNESCO as one of the intangible cultural heritage of humanity [1]. Beside pinisi ship which commonly being used for cargo ship, cruise ship, hospital ship etc, the traditional wooden shipyards in this area are also built smaller wooden boat which being used for passenger boat between nearby islands, fishing boat, supply boat etc. The area of the traditional wooden shipyards is spread in some districts in South Sulawesi province which are Bulukumba, Sinjai, Takalar, Pangkep and Jeneponto district [2].

The wooden material for the boat construction in this area are obtained from some forests in Indonesia [3, 4]. Unfortunately, as there are increasing number of forests cutting and forest fire in Indonesia, the number of wooden materials for wooden boat construction becoming decreasing. If the
situation continuous, the sustainability for traditional wooden boat construction in South Sulawesi and Indonesia are threatened [2, 5].

Fortunately, Bochar et al. [6] have conducted research regarding alternative material for wooden boat construction component. Their research focus is on the steel material to replace the wooden material specifically on the wooden frames of the wooden boat. There are some problems have been identified in the application of steel frames on the wooden boat. Some of them are relating with the selection of the fabrication and installation technique of the steel frame as well as the cost for the use of steel frame which cover material and equipment cost and the cost for fabricating and installing the steel frame.

Some dissemination activities of the steel frame to the wooden boat craftsmen and to the wooden boat owners have been conducted by the researchers team in some traditional wooden boat shipyards in some area of South Sulawesi province. The participants are enthusiastic on the steel frame innovation [2]. They would like to apply the steel frames on their boat but still need to find out the cost for fabricating and installing the steel frames and be compared to the cost of fabricating and installing the wooden frames. The purpose of this paper is to determine the cost components and total cost for fabricating and installing the steel frame on the wooden boat construction and to compare with the wooden frame on the same wooden boat dimension.

The construction of this paper is divided into some sections. The next section discusses the wooden boat construction and the building method including the cost components for constructing the wooden boat using wooden frames. Then the steel frame innovation will be described along with the cost components for fabricating and installing the frames including the material and equipment cost. Then, the two cost components information will be compared and discussed. The discussion will be focus on the factors which influence the total cost which make the difference of the two. In the end, some conclusion will be drawn based on the analysis.

2. Wooden Boat

Wooden boat is a boat/ship where all construction components of the boat are from wooden material [7]. The dimension and capacity of the wooden boat are varying from the smallest wooden fishing boat to the biggest wooden cargo ship which can carry hundreds of ton cargoes from one island to other. The construction components of the respective boats are different as well including the type of the wood for the wooden construction components. Indonesian Classification Bureau (BKI) have regulated the dimension and the type of wooden boat for certain boat construction components [8].

2.1. Wooden Boat Construction

Different with steel ship, the construction component for the wooden boat consist of keel, keel at bow and stern, frames, deck beam, plank, longitudinal plank, etc (Figure 1). The list of the construction components must be strong enough as the wooden boat will face an uncertain sea environment during its voyage. Besides, the construction components must be able to minimize some vibrations of the boat engine [9].

The type of wood for each construction component cannot be selected randomly. The Indonesian Classification Bureau (BKI) [8] and National Standardization Bureau (BSN) through Indonesian national standard document have determined a list of qualified wooden types for the boat construction component [10]. The type of the wood is different for each construction component such as “bitti wood” (Vitex copassus) for frame, plank and deck plank, “ulin wood” (Eusideroxylon zwageri) which can be used for any part of the boat construction component especially the component which support the boat strength, “besi wood” (Instia palebanica) for keel, “jati wood” (Tectona grandis) which can be used for any construction component of the boat, etc. Hence, each type of wood can be used for some part of the wooden boat construction component [11]. The selection of the wood will determine the total cost for building the wooden boat as each type of wood has different cost.
2.2 Wooden Boat Construction Method

In this research, the current wooden boat craftsman method has been selected which being called the traditional wooden boat construction method for constructing the boat. Unlike modern wooden boat building technique, the traditional wooden boat technique build the boat from the keel then continued to the plank installation then frame installation (Figure 2) [12, 13].

The implication of the different approach for building the wooden boat is on the installation of the steel frame and on the total cost for building the boat. Hence, focus for the discussion in this paper is the cost for building the wooden boat both using the wooden frame and steel frame with traditional boat building method. The cost calculation for the latter is being conducted according to the fabrication and installation technique for the steel frame on the wooden boat construction.

2.3 Cost Component for the Wooden Boat Construction

In general, the cost component for using the traditional wooden boat construction method can be divided into material cost, equipment cost and manpower cost. Material cost is any cost related to the materials to be used on the wooden boat construction such as wood, plank, bolt and nut etc. Including in the material cost is the cost for preparation and assembly the wood component to other wood component and the cost for painting. Equipment cost is the cost related with the equipment used to build the wooden boat such as hammer, chainsaw, chisel etc. Manpower cost is the cost for both direct and indirect labor cost. The total cost will include the three of the cost components.
3. Steel Frame for the Wooden Boat
The reason for selecting the wooden frame to be replaced with the steel frame as the wooden frame is the most difficult wooden boat construction component to obtained to compare with other components. This is because the specific shape requirements of the wooden frames which must be according to the curvature of the wooden boat body.

The use of steel material for the steel frame have been analyzed by Bochary, et al. [6]. There are some reasons which become basis for selecting steel material to replace the wooden material such as the material is easy to find, can be easily shaped according the boat body curvature and obviously its stronger than wooden material. The shape of the steel frame is T profile. The selection of this profile shape is based on the consideration of the applied connection method between steel frame and other construction component on the wooden boat such as between steel frame and the wooden plank, steel frame with the longitudinal plank and between wooden keel and the steel frame. The dimension of T profile has been simulated and analyzed on some of the steel frames distances. The selection criteria are the ship strength and the steel frame flexibility to hold the wooden boat load together with other wooden construction component. The result of the analysis shows the dimension of the T profile steel frame for 10 GT of the wooden fishing boat.

3.1 Cost Component for Fabricating and Installing Steel Frames on the Wooden Boat Construction
In general, the cost components of both using wooden frame and steel frames of the wooden boat construction to be compared is the same. They are consisting of material cost, equipment cost and manpower cost. The difference cost components between the two are on the fabrication and installation of the steel frame on the wooden construction. They are different in terms of the material and equipment to be used and the manpower to do the work. For steel frame, the material to be used are steel plate, nut and bolts as well as electrodes, LPG and Oxygen gas for material works. Including in the material cost is the painting of the wooden construction components. The equipment to be used are different as well such as brander cutting machine, rolling bending plate machine, and welding machine while the manpower to do the work of fabrication and installation of the steel frame are reflected from their equipment such as welder, cutter, dan brander.

4. Fabricating and Installing Cost Comparison of the Steel and Wooden Frame of 10 GT Wooden Fishing Boat
As the fabrication and installation of steel frame on the wooden boat construction is never been done before, the cost for the works is not known. It is important to calculate the cost of fabrication and installation of the steel frames and then compare the result with the current wooden boat construction using wooden frame. The result of the comparison will be the references for the wooden boat craftsman in South Sulawesi specifically to whether use the steel frames on their wooden boat construction or not. The total cost of the wooden boat building both for the comparing frames is based on the same traditional wooden boat building method.

In this paper, the focus on the cost comparison is the material, equipment and manpower cost for fabricating and installation of the both frames as well as the total cost for building the wooden boat using both of the frames. Based on the information, the cost ratio between the boats using the wooden and steel frames then determined. Data of the comparing 10 GT wooden fishing boat can be seen in Table 1 below.

| Description                        | Dimension (m) |
|------------------------------------|---------------|
| Length overall (LOA)               | 16.5          |
| Length between perpendicular (LBP) | 12.6          |
| Breadth (B)                        | 3.2           |
| Height (H)                         | 1.2           |
4.1 Detail of Cost Components for Fabricating Wooden Frame Construction

In detail, the cost components of the wooden boat construction using wooden frames are divided into the material cost ($M_{wf}$), equipment cost ($E_{wf}$) and the manpower cost ($M_{pwf}$).

4.1.1 Material Cost ($M_{wf}$). Material cost for wooden boat construction using wooden frame consist of the material construction cost itself, material cost for binding the wooden construction components, painting cost and overhead cost.

The wooden construction components consist of keel, frames, side and deck planks, longitudinal planks, deck beams etc. In addition to those material, triangle wooden beams have been used to connect the boat keel and stem as well as to support the boat rudder (Table 2) [14]. The price of each material is obtained from the boat craftsmen in some of the traditional wooden boatyard. Besides the price of the boat construction component, the required number of each construction component for building the required boat is also shown in Table 2.

| Construction components | Construction components dimension (mm) | Number required | Cost (Rp) | Unit |
|-------------------------|--------------------------------------|----------------|----------|------|
| Keel                    | 1.200                                 | 15             | 15       | 6,500,000 | Rp/m³ |
| Wooden frame            | -                                    | 10             | 10       | 50,000   | Rp/piece |
| Triangle wooden beam    | -                                    | 20             | 20       | 2,000,000 | Rp/piece |
| Side plank              | 400                                  | 25             | 4        | 4,500,000 | Rp/m³ |
| Longitudinal plank      | 1.660                                | 14             | 5        | 45,000   | Rp/m |
| Longitudinal plank beam | 300                                  | 10             | 6        | 2,500,000 | Rp/m³ |
| Deck beam               | 300                                  | 10             | 6        | 2,500,000 | Rp/m³ |
| Deck plank              | 400                                  | 25             | 4        | 4,500,000 | Rp/m³ |

Material for binding the wooden boat construction components consist of bolts and nuts, “paso sappu” or (wooden peg) and wooden fiber for caulking. Information on the required material need and the price for binding the wooden boat construction can be seen in Table 3 below.

| Binder construction components | Diameter (mm) | Number required | Cost (Rp) | Unit |
|---------------------------------|---------------|----------------|----------|------|
| Bolts and nuts                  | 14            | 1.456          | 2,500    | Rp/piece |
| “paso sappu” (wooden peg)       | 1             | 3.600          | 500      | Rp/piece |
| Wooden fibre for caulking       | -             | 20             | 10.000   | Rp/kg |

The next cost component is for painting. The cost component consists of primer paint, finishing paint and thinner for dissolving the paint. The price both for the primer and finishing paint is the same which is Rp 68,000/liter while the total need for both paints is 73 liters respectively. The need for thinner is only about 15 liters for each paint, hence the total liter for both paints is 30 liters. The price for the thinner itself is Rp 22,500. The last material component which is considered here is the overhead (O/H) cost. This cost component is considered to be 5% of the total cost of the wooden boat building.

4.1.2 Equipment Cost ($E_{wf}$). Equipment used and the price for each equipment in the wooden boat construction process with wooden frames can be seen in Table 4.
Table 4. List of equipment to be used in the 10 GT wooden fishing boat construction process

| Equipments     | Price (Rp) |
|----------------|------------|
| Hammer         | 35.000     |
| Chisel         | 110.000    |
| Chainsaw       | 3.250.000  |
| Wooden planer  | 690.000    |
| Clamp c4       | 52.500     |
| Tape measure tool | 275.000   |
| Hand saw       | 76.500     |
| Hand drill     | 196.900    |
| Wrench         | 298.000    |
| Axe            | 99.000     |

4.1.3 Manpower Cost (\(M_{pwf}\)). The manpower cost in the wooden boat construction process is for the direct manpower. Based on the interview with the craftsmen, this cost component can be determined to be 30% of the total cost of the wooden boat building cost.

4.1.4 Total Cost for the Wooden Frame (\(T_{w}f\)). The total cost for the construction of the 10 GT wooden fishing boat is the accumulation of the previous discussed costs which consist of materials, equipment and manpower cost.

\[
\text{Total cost for wooden boat with wooden frame (} T_{w}f \text{)} = \text{Cost of } M_{w}f + \text{Cost of } E_{w}f + \text{Cost of } M_{pwf}
\]

Table 5 shows the summary of the required cost for building 10 GT of wooden fishing boat with wooden frames.

Table 5. Construction cost for the 10 GT wooden fishing boat with wooden frames

| Cost components   | Cost (Rp)   |
|-------------------|-------------|
| Materials (\(M_{w}f\)) | 338,527,648 |
| Equipment (\(E_{w}f\)) | 5,082,900   |
| Manpower (\(M_{pwf}\)) | 147,261,663 |
| Total wooden fishing boat building cost | 490,872,211 |

4.2 Detail of Cost Components for Fabricating Steel Frame Construction

The cost for building the wooden fishing boat with steel frames is based on the traditional wooden boat construction method. In detail, the cost components can be divided into materials cost (\(M_{s}f\)), equipment cost (\(E_{s}f\)) and manpower cost (\(M_{ps}f\)).

4.2.1 Material Cost (\(M_{s}f\)). Material cost for wooden boat construction using steel frame consist of the material construction cost itself, material cost for binding the wooden construction components, painting cost and overhead cost.

In general, the construction material cost for steel frame is the same with the cost the construction material cost for wooden frame. The difference of both can be seen in the material for the frame’s construction. Since steel material is being used for the frames, there is cost for fabricating the steel frames. The fabrication cost component includes the cost for the steel material itself, cost for LPG and Oxygen gases, electrodes etc. Table 6 shows the detail of the material cost for wooden boat with steel frames.
Table 6. The cost for steel frame construction component

| Construction components | Construction components dimension (mm) | Number required | Cost (Rp) | Unit |
|-------------------------|---------------------------------------|-----------------|-----------|------|
| Keel                    | P 1200 L 15 T 15                      | 1               | 6.500.000 | Rp/m² |
| Steel frame             | P 80 L 80 T 6                         | 55              | 481.618   | Rp/frame |
| Triangle wooden beam    | P - L 20 T 20                        | 1               | 2.000.000 | Rp/piece |
| Side plank              | P 400 L 25 T 4                       | 72              | 4.500.000 | Rp/m³  |
| Longitudinal plank      | P 1660 L 14 T 5                      | 6               | 45.000    | Rp/m³  |
| Longitudinal plank beam | P 300 L 10 T 6                       | 11              | 2.500.000 | Rp/m³  |
| Deck beam               | P 300 L 10 T 6                       | 56              | 2.500.000 | Rp/m³  |
| Deck plank              | P 400 L 25 T 4                       | 50              | 4.500.000 | Rp/m³  |

The cost for binding material for steel frames is the same with the required cost for wooden frames. The information can be seen in Table 3. The cost component for painting in steel frames construction is the same as well with wooden frames. The difference is for the required number of paints for each paint which is only requires 69 paints for each paint and the number of required thinner which is 1 liter less than for the wooden frames need.

The overhead cost is considered to be 5% as well of the total cost of the wooden boat building.

4.2.2 Equipment Cost ($E_{sf}$). The required equipment in the wooden boat construction process with steel frames can be seen in Table 7.

Table 7. List of equipment to be used in the 10 GT wooden fishing boat construction process

| Equipments                  | Price (Rp) |
|-----------------------------|------------|
| Hammer                      | 35.000     |
| Chisel                      | 110.000    |
| Chainsaw                    | 3.250.000  |
| Wooden planer               | 690.000    |
| Clamp c4                    | 52.500     |
| Tape measure tool           | 275.000    |
| Hand saw                    | 76.500     |
| Hand drill                  | 196.900    |
| Wrench                      | 298.000    |
| Axe                         | 99.000     |
| Welding machine             | 1.099.000  |
| Brender machine             | 2.592.000  |
| Rolling bending plate machine| 2.500.000  |
| Grinding machine            | 350.000    |

As can be seen in Table 7, for steel frames in the wooden construction, there are additional equipment required for steel frame fabrication consist of brander cutting machine, rolling bending plate machine, and welding machine. The additional direct manpower required will be welder, cutter, and brander.

4.2.3 Manpower Cost ($M_{sf}$). The manpower cost required is the same with the wooden frames which is 30% of the total cost of the wooden boat building cost.

4.2.4 Total Cost for the Steel Frames ($T_{sf}$). The total cost for the construction of the 10 GT wooden fishing boat with steel frames is the accumulation of the previous discussed costs which is:

$$ \text{Total cost for wooden boat with steel frame} (T_{sf}) = \text{Cost of } M_{sf} + \text{Cost of } E_{sf} + \text{Cost of } M_{psf} $$
Table 8 shows the summary of the required cost for building 10 GT of wooden fishing boat with steel frames.

**Table 8. Construction cost for the 10 GT wooden fishing boat with steel frame**

| Cost components          | Cost (Rp)    |
|--------------------------|--------------|
| Materials \((M_{sf})\)   | 429,430,202  |
| Equipments \((E_{sf})\)  | 11,623,900   |
| Manpower \((M_{pf})\)    | 189,023,187  |
| Total wooden fishing boat building cost | 630,077,289 |

### 4.3. Cost Comparison between Wooden Frames and Steel Frames

The cost comparison for using wooden frames vs steel frames in the 10 GT wooden fishing boat construction is conducted in two ways. The first comparison is between the cost required to fabricating and installing the wooden frames vs the steel frames and the second is between the total cost of building the wooden fishing boat using both of the frames. Based on the respective cost information, the cost ratio can be compared as well. The comparisons can be seen in Table 9.

**Table 9. Cost comparison between the use of wooden frame vs steel frame on a 10 GT wooden fishing boat construction**

| Description                                      | Wooden frame \((wf)\) | Steel frame \((sf)\) |
|--------------------------------------------------|------------------------|----------------------|
| Material and construction cost                   | 338,527,648            | 429,430,202          |
| Equipment cost                                   | 5,082,900              | 11,623,900           |
| Manpower cost                                    | 147,261,663            | 189,023,187          |
| Total boat building cost                         | 490,872,211            | 630,077,289          |
| Cost ratio for the installation of wooden frame vs steel frame | 1 : 1.13                |
| Total wooden boat building cost ratio between using wooden frame vs steel frame | 1 : 1.03                |

### 5. Discussion

The total cost of building the wooden fishing boat can be different among one boat craftsmen (boatyard) to another. The distinguishing cost components is on the different selected types of woods as well as different applied boat building method. Furthermore, the exact dimension for the 10 GT wooden fishing boat to be built is not the same among the boatyards as they have applied traditional boat building method. Hence, the discussed total cost for building the required wooden boat is based on the wooden boat which have being built in a boatyard in Takalar regency, South Sulawesi province. However, both the discussed cost ratio can be used as reference if other wooden boat shipyards need to build the same wooden fishing boat using steel frames.

One thing to note in the cost discussion is about the equipment cost. The equipment to use in the wooden boat construction is included in the total cost of building the required wooden boat. However, this cost can be the boatyard investment cost and be spent only on the first time of building the wooden boat using steel frames. Afterwards, it can be omitted and leave only the operational cost and material cost to be considered.

In Table 9, the cost for fabricating and installing the steel frames on the wooden boat is 13% higher to compare with the wooden frames. However, the cost ratio proportion become lower if the total building cost is considered. The use of steel frames to replace the wooden frames in a 10 GT wooden fishing boat only provides an additional of 3% of the total wooden boat building cost using wooden frames. This is because the proportion of fabricating and installing the boat frames on the total wooden boat building cost is small as well.
6. Conclusion
The total cost for building the wooden fishing boat using steel frames only 3% higher of the total cost for building the same ship using wooden frames. The small addition of the boat building cost using steel frames have increased the opportunity for the steel frames to be applied on the wooden fishing boat as well as other wooden boats. There are many advantages have been identified for the application of the steel frames on the wooden boat construction. Among them are it supports the sustainability of wooden boat construction as the consequence of the shortage supply of wooden material specifically for the wooden frames. Further, the application of steel frames on a traditional wooden boat construction method have opened the possibility for the application of modern wooden boat construction method instead of traditional boat building method in the area of South Sulawesi specifically and Indonesia in general.

Acknowledgments
The authors would like to thanks Directorate General of Higher Education (DGHE), Ministry of Research, Technology and Higher Education for its research grant under scheme Priority Application Research of Higher Education (PTUPT) DGHE in 2018/2019 so as this research work can be done.

References
[1] Unesco, 2017, Decision of the Intergovernmental Committee: 12.COM 11.B.13, https://ich.unesco.org/en/decisions/12.COM/11.B.13
[2] Bochary, L, Asri S, Firmansyah, M R, Alwi, M R, Rosmani, Misliah, Sitepu, G, Djafar, W, 2019, Ensuring the sustainability of wooden boat building through the training for wooden boat craftsman on making wooden frame pattern for the application of wooden steel innovation as a substitute for wooden frame in Takalar Regency, Jurnal Teknologi Terapan untuk Pengabdian Masyarakat, Vol. 2, No. 1 pp. 70 – 77. [In Bahasa]
[3] Ayuningsih, Dewi. 2007. Techno economy of the wooden boat construction in traditional wooden boatyard in Gebang village, Cirebon regency, West Java Province. Institut Pertanian Bogor, Bogor. [in Bahasa]
[4] Standar Nasional Indonesia (SNI), 2006, Types of woods for wooden boat construction. Badan Standar Nasional (BSN) untuk Pusat Standarisasi dan Lingkungan Hidup Departemen Kehutanan. [in Bahasa]
[5] Bochary, L. dan Larengi, F, 2012, Alternative for the use of steel frames on a 30 GT wooden boat construction, Journal Riset Teknologi Kelautan, Volume 10, No. 2, Halaman 121-272, Makassar. [in Bahasa]
[6] Bochary, L, Sitepu, G, Asri, S, Firmansyah, M R, 2018, Analysis of the use of steel frame as a substitute for wooden frame in an effort to support forest conservation and sustainability of wooden boat construction, Laporan Penelitian Terapan Unggulan Perguruan Tinggi (PTUPT), Lembaga Penelitian dan Pengabdian Masyarakat (LPPM), Universitas Hasanuddin. [in Bahasa]
[7] Biro Klasifikasi Indonesia (BKI), 1992, Guidance for the construction of motor sailing boat, Jakarta. Biro Klasifikasi Indonesia (BKI) Unit Inkomar. [in Bahasa]
[8] Biro Klasifikasi Indonesia (BKI), 1996, Classification and Construction Rules for wooden boat, Jakarta, Biro Klasifikasi Indonesia. [in Bahasa]
[9] Bochary, Lukman, 2004, An Introduction to fishing boat, Jurusan Perkapalan FT-UH. [in Bahasa]
[10] BSN. 2013. Design specification for wooden boat construction. Badan Standart Nasional. Jakarta. [in Bahasa]
[11] Ima Kusumawati, 2009, The wooden material utilization in the construction of wooden frames in UD Semangat Untung wooden boat yard, Tanah Beru village, Bulukumba regency, South Sulawesi province. [in Bahasa]
[12] Dewa, Sarifuddin, Haris muhammad, 2010, Technology for the construction of traditional wooden boat in Tanahberu village, Bulukumba regency. [in Bahasa]
[13] Rauf, A M, dan Chaerunnisa, A, 2003. The development of traditional wooden boat construction method in Bulukumba regency. Lembaga Penelitian Pengembangan Masyarakat Universitas Hasanuddin. Makassar. [in Bahasa]

[14] Karim, Abdul Azis, Hasbullah, Mansyur, dan Muhammad, Andi Haris, 2011. A study for the wooden boat construction dimension and connection model in a traditional wooden boatyard in Bulukumba regency. Jurusan Perkapalan Fakultas Teknik Universitas Hasanuddin. [in Bahasa]