DESIGNING AND CONSTRUCTING A FRP BOAT FOR SEAWEED FARMER IN JENEPONTO REGENCY

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ABSTRACT

The characteristics of the community activity in the coastal line area of South Sulawesi are related with the activity on the sea such as fishing, seaweed cultivation, etc. In Jeneponto regency, around 44% of the fishing production is from seaweed cultivation. Some researchers have discussed the seaweed cultivation itself but none have been found discussed their boat related problems. It has been identified that one problem that the seaweed farmer in Jeneponto and possibly in the other area along South Sulawesi coastal line face is related with their boat carrying capacities. Research on their boat carrying capacity is significant since one boat in a seaweed farmer group is used by the members of the group. Hence, in harvest time, because of the limited capacity of their boat, one group member must wait up to 12 days before his turn. The aim of this paper is to design and construct a FRP boat for them to be used so as to minimize the waiting time for one member of the group to use the boat. The design of the boat is to fulfil the common criteria of the boat safety. For the seaweed farmer as well as local boat craftsmen, some training has been given to them to increase their technology skills to build and maintain FRP boat. The result of the project shows that the capacity of the proposed boat has increased more than 3 times of the initial boat. Besides, the new boat has shown satisfactory result in some tests including inclining test, turning circle test, loading and unloading test, speeding measurement and even capsizing test.

Keywords: seaweed farmer, FRP boat, boat carrying capacity, boat design, boat construction

Introduction

Most of the regency in South Sulawesi Province is a coastal area with hundreds of kilometres of its coastal line. Hence, the characteristics of the community activity for living are related to the activity on the sea such as fishing, seaweed cultivation, salt making, etc. In Jeneponto regency, around 44% of the fishing production is from seaweed cultivation as can be seen in Figure 1. This production represents the big number of community activities for living on the coastline area are from seaweed cultivation.

Figure 1. Fishing production in Jeneponto (Badan Pusat Statistik, 2015).

There are some researches have been conducted which related to the seaweed cultivation itself. One research discusses the process of increasing seaweed farmer’s income (Irmayani, Yusuf and Arsy, 2015). Other research is more focus on the seaweed farming development in supporting the coastal...
management sustainability (Zamroni, Laoubi and Yamao, 2011) and a contribution to the seaweed farmer sustainability livelihood (Zamroni and Yamao, 2013), while Datu Eranza et.al (2015) on the other hand focuses their discussion on determinant factors of women participation in a seaweed farming. These researches focus on the seaweed and seaweed farmers’ development. Although it seem that the seaweed cultivation development process have all been covered in those researches, but one important aspect that need to be considered and missing in their discussion which support the whole process of the seaweed cultivation process is the farmer’s boat to transport the seaweed from the cultivation area to the beach.

It has been identified that one problem the seaweed farmer in Jeneponto and possibly in the other area along South Sulawesi coastal line face is related with their boat carrying capacities. Along Jeneponto coastal line, the seaweed cultivation business is a home business activity. The business activity is run in person and in group. The seaweed farmers in group usually consist of 12 farmers sharing one boat among them. In seaweed harvest time, the member in a group uses the group boat in turn to harvest in their own seaweed cultivation. As their boat has small capacities, it takes time for each seaweed farmer to finish their harvesting process as they must go and forth several times. Hence, the last seaweed farmer must wait for up to 12 days for his turn.

On the preliminary survey, the need of the seaweed farmers on their boat has been identified and can be described as follows:

- The proposed boat have more carrying capacities so that in one go, a boat can carry more harvests and hence reduce the harvest time for one seaweed farmer.
- The proposed boat must be easy to operate and has good boat stability since their current boat has unstable stability.
- The proposed boat must have strong boat skin since their current boat skin is not thick and constructed without frames.
- Since their boat is from fiberglass (FRP), they require some skills on fiberglass works so that they can build new fiberglass boat and repair it if leak as well.

Hence in this activity, knowledge of boat building and maintenance on the fiberglass boat technology needs to be transferred to the boat craftsmen in Jeneponto Regency. The extension of the technology transfer need to covers the seaweed farmers as well.

Based on above description, the aim of the project is to increase the technology skills to build and maintain fiberglass small boat for fiberglass craftsmen and seaweed farmer by developing fiberglass boat design and building the boat by still considering the working area environment. Output of the tasks is a design and a prototype of small fiberglass boat. This boat was built by the participants who get involved in the training for building the fiberglass boat with the supervision from the authors.

Methods
The mechanism and design of the fiberglass boat prototype building activities can be described as follows:

1. Field Survey
This activity is conducted in order to get data and information (Morrison, 2012) regarding the fiberglass craftsmen boat building activity in Jeneponto. The survey location is in the area of boat building craftsmen and seaweed cultivation area in Binamu District, Jeneponto Regency.

Points to be surveyed are:
- Geometry and construction system of fiberglass boat
- Boat building method which have been applied by the fiberglass boat craftsmen
- Transportation operation pattern for seaweed seed and seaweed harvest.
The above data and information are collected by direct measurement as well as questionnaire with fiberglass boat craftsmen as well as fiberglass boat user in the survey location.

2. **Design the fiberglass boat prototype**
Based on the above data and information, a propose boat designs will be developed which include boat geometrical design, general arrangement, construction profile, material testing, boat strength analysis as well as hydrostatic and stability analysis. The proposed fiberglass boat designs are developed by the authors with the support by JICA Team as the main sponsor for this activity. The discussion will also be conducted with the seaweed farmers as the final users.

3. **Building the fiberglass boat prototype**
The fiberglass boat prototype was built according to the developed design. The location for the boat building is in Pattontongan area, Biringkassi village, Binamu subdistrict, Jeneponto regency.

The building process will be started with a technical training on how to build fiberglass boat to the participants. The participants consist of some students from Naval Architecture Study Program, Engineering Faculty, Hasanuddin University as well as fiberglass boat craftsmen and the fiberglass boat final user from Pattontongan area, Biringkassi village, Binamu subdistrict, Jeneponto regency.

The whole process of the fiberglass boat building will be coordinated and supervised by the authors. In the supervision process, some students of naval architecture study program who get involved in the training process will be included.

4. **Testing the fiberglass boat prototype**
After finishing the construction of the fiberglass boat, some tests on the boat will be conducted in order to guarantee that the fiberglass boat to fulfil all the minimum requirements for a boat to sail. The testing to the boat will consist of inclining test, loading and unloading test, turning circle test and capsizing test.

5. **Design improvement**
The main objective of the boat test is to analyze and evaluate the performance of the fiberglass boat. Based on the result of the test, some improvements will be made on the boat design. The improved boat designed will be used to build the next fiberglass boat.

**Results**
The seaweed farmers in Jeneponto use two types of boat which is small boat or “sampan” which made of wooden log and boat which is made of fiberglass reinforced plastic (FRP). The wooden boat type has increasingly lost its popularity. The seaweed farmers tend to use another type of boat from fiberglass for some reasons such as easy to operate as well as easy for maintenance.

Even though the size of the fiberglass boat is bigger than the boat from wooden log, but the fiberglass boat made by the craftsmen in Jeneponto regency has the design characteristics relatively the same with the boat from wooden log. Abdul Gaffar (the head of “Bentangan Laut”, one of the seaweed business activity group) said that in general, the seaweed boats which being used in the Pattontongan area has the main dimensions (Figure 2) as follows:

- Dimension: Length overall (L) = 7 m.;
- Breadth (B) = 0.6 m.; and
- Depth (H) = 0.65 m.
The boat capacity of the fiberglass boat is 5 seaweed lines or equal to 300 kgs approximately. With the seaweed production about 150 up to 200 seaweed lines, and with 5 days harvest time, the maximum seaweed transportation frequency with small rough sea condition is 50 times (pp) while with calm water is about 30 times.

Beside boat capacity issue, there are some other issues have been found on the current seaweed fiberglass boat. The proportion of the boat main dimension ratio is found to be big. Length (L) and Breadth (B) or L/B ratio is relatively big. Breadth (B) and Depth (T) or B/T ratio is small, hence it has unstable stability (Hardjono, 2010). Therefore, the boat must be equipped with outrigger to maintain boat stability. As in the wooden boat, the boat was constructed with no frames for reinforcement. The boat skin is not thick; hence it’s weak and fragile.

Based on the current design, some improvements have been made and proposed in order to overcome the issues in the current fiberglass boat. It can be seen in Table 1 below that the proposed designed has more carrying capacities compare to the initial boat. It is about 3 times more carrying capacity of the initial boat. The boat main dimension proportion is relatively small and hence it has good stability. The comparison of the original boat characteristics and the proposed boat characteristics can be seen in the following table:

<table>
<thead>
<tr>
<th>Boat main dimension</th>
<th>Initial boat</th>
<th>Proposed boat</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOA (Length of the Deck Sheer)</td>
<td>6.62 meter</td>
<td>5.25 meter</td>
</tr>
<tr>
<td>LWL (Length of Water Line)</td>
<td>6.26 meter</td>
<td>4.97 meter</td>
</tr>
<tr>
<td>B (Breadth)</td>
<td>0.6 meter</td>
<td>1.5 meter</td>
</tr>
<tr>
<td>H (Depth)$_{\text{max}}$</td>
<td>0.78 meter</td>
<td>0.6 meter</td>
</tr>
<tr>
<td>H (Depth)$_{\text{midship}}$</td>
<td>0.63 meter</td>
<td>0.525 meter</td>
</tr>
<tr>
<td>T (Draught)</td>
<td>0.34 meter</td>
<td>0.3 meter</td>
</tr>
<tr>
<td>Volume</td>
<td>0.614 m$^3$</td>
<td>1.504 m$^3$</td>
</tr>
<tr>
<td>Displacement</td>
<td>0.629 ton</td>
<td>1.542 ton</td>
</tr>
<tr>
<td>Carrying Capacity</td>
<td>5 sl = 0.3 ton</td>
<td>15 sl = 0.9 ton</td>
</tr>
</tbody>
</table>

Table 1. Boat main dimension comparison

Production house and workshop building

In order to facilitate the knowledge transfer of boat building and maintenance on the fiberglass boat technology as well as the boat building practice to the boat craftsmen in Jeneponto, a production house and workshop for that purpose have been built in Patontongan Area, Biringkassi Village, Binamu Subdistrict, Jeneponto Regency. The main aim of the production house and its workshop construction are as a production house for training the participants both of the seaweed farmer and the students of naval architecture and as a workshop for the construction and assembly of boat body and deck.

A training for participants was conducted in this production house and workshop to provide the participants with a comprehensive understanding of knowledge regarding boat design and
construction, the process of boat mold construction, the knowledge of how to read the boat design drawing, the process of translating the boat design drawing into practice, the knowledge of fiberglass reinforced plastic (FRP) and how to apply the FRP into practice.

The participants are coming from the seaweed farmers and boat craftsmen (12 participants) and some students from the naval architecture study program (6 students).

*Fiberglass boat prototype building*

As in other FRP boat construction, the boat and deck mold construction have been made as a basis for the construction of the fiberglass boat body and deck. The beginning construction of the boat deck mold in this activity is to ensure that the erection schedule of the boat by assembling the boat body and deck can be achieved.

Some different layers of fiberglass are then being applied to the boat body and the boat deck. The number of fiberglass layers on the body and deck of the boat determined by the strength need of each part. The main aim of layering the body boat and body keel with fiberglass as well as the starting construction of boat deck mold is to form the proposed body of the planned boat. The required applied layers of the body and keel is to ensure the strength requirements of the boat are to be fulfilled.

When the fiberglass application have been done to the boat body and boat deck, before the two part of the boat are been combined to make the complete boat, then frame construction, longitudinal girder construction as well as the boat bulkhead construction need to be installed on the boat body. The main aim of the frame construction as well as the connecting boat deck and boat body is to increase the strength of the boat body and to assembly the boat component into one piece of a more complete boat. Except for the bulkhead construction, some boards are included in the construction of the bulkhead for stronger construction. The main aim of the bulkheads installation to boat body is to guarantee that the boat has the required boat reserve buoyancy so as if the boat has an accident (flooding), the boat still be able to float instead of sinking. The final construction of the proposed boat can be seen in Figure 3.

![Figure 3. The final construction of the proposed boat](image)

*Fiberglass boat tests*

As the requirements of the finishing ship or boat, some tests need to be done to the finished ship or boat in order to find the functionality of the finished ship and boat according to the specified designed. The boat test is conducted to identify any deficiencies needing correction. The boat test marks the interim step between the completion of the boat construction and its official acceptance for service. Often during this phase of testing, problems arise relating to the boat which can result of the boat returning to the builder to address the concern. Once a boat tests are successfully completed, then usually plans for the actual delivery ceremony will take shape.
There are some tests have been conducted to the boat which are:

- **Inclining Test** is to determine the position of the boat centre of gravity in an empty boat condition. This test is very important as the location of the boat centre of gravity is significant on the calculation of the boat stability. The distance vertical of the boat centre of gravity is 0.27 m from boat keel. The inclining test process can be seen in Figure 4 (a), (b) and (c).

![Inclining Test Preparation](image1)
![Inclining Test Test](image2)
![Inclining Test Test with Person](image3)

Figure 4. (a), (b) Inclining test preparation, (c) test with a person on the deck side

- **Loading Test** is to determine the loading capacity of the boat on the maximum draught. The loading cargo is the real seaweed which will be used by the seaweed farmer for harvesting time (Figure 5 (a) and (b). The maximum loading capacity of the boat is ±1000 kgs or equal to 15 seaweed lines (Figure 5 (c)).

![Seaweed Loading Process](image4)
![Full Seaweed Loading](image5)
![Seaweed Weighing](image6)

Figure 5. (a) seaweed loading process, (b) full seaweed loading, (c) seaweed weighing

- **Turning Circle Test** to determine on full loading condition turning ability of the boat. The maximum turning ability of the boat is ±5 m or equal to 1 boat length. The process of the turning circle test can be seen in Figure 6 (a) and (b) while the result of the test can be seen in Figure 6 (c). In this test, the speed of the boat has been measured as well. On 15 HP of engine power, the boat speed is 10 knots on empty loading condition while on full loading condition the boat speed is 6.5 knots.

![Turning Circle Test Preparation](image7)
![Turning Circle Test](image8)
![Curve of Boat Turning Circle](image9)

Figure 6. (a) Turning circle test preparation, (b) turning circle test, (c) curve of the boat turning circle
- Capsizing Test to determine the ability of the boat to keep floating on a scenario flooding condition. This test is an additional test for boat floating ability when flooding. The result of the test shows that the boat is still floating despite the cargo hold is fully filled with sea water (Figure 7 (a) and (b)). In the upside down position, the boat is still floating as well (Figure 7 (c)). This is because the designed volume of the boat reserve buoyancy is bigger than the boat volume.

![Figure 7. (a) fill the boat with sea water, (b) the boat filled with sea water, (c) the boat upside down position](image)

**Discussion**

There are some common problems have been identified was faced by the seaweed farmer in Jeneponto Regency or probably by the other Regency in the coastal line of South Sulawesi as well. They are related with their boat carrying capacity; boat construction is unstable and depends on the outrigger for its stability, the required skills of fiberglass knowledge for boat building and maintenance.

Their problems have been solved in this paper by designing and constructing a new proposed boat. The characteristics of the proposed boat compared to the initial boat in answering their boat related problems can be described as follows:

**Problem: Boat carrying capacities**

**Solution:** The proposed boat has been designed and constructed with more boat carrying capacities. The result of loading test shows that the boat carrying capacity is increase more than 3 times of the initial boat carrying capacity. Initially, the boat carrying capacities is max 5 seaweed lines (±300 kgs) and for the proposed boat, the carrying capacity is up to 15 seaweed lines (±1000 kgs). Hence, the waiting time for one seaweed farmer for his turn in harvest time is reduced significantly from 1 – 12 days waiting time initially to only 1 – 3 days.

**Problem: Boat construction is unstable and depends on the outrigger for its stability.**

**Solution:** The proposed boat has been designed and constructed with a stable condition since the main dimension ratios are in the stability ratio range. The result of the inclining test shows that the location of the boat center of gravity is 0.27 m from the boat keel. This location indicate that with the boat full seaweed loading condition, the boat center of gravity will not move a little bit farther then the initial location. Hence the boat will keep in a stable condition. The boat in range stability ratio will in turn omitting the installation of outriggers to stabilize the boat. The absence of outrigger will ease the boat operationalization in harvest time.

For boat maneuverability, the result of turning circle test shows satisfactory value. In this test, the diameter for one circle is only 5 meters for the proposed boat. This number represents the turning ability of the boat to prevent collision during sailing. It means that, at least 5 meters distance required between the boat and one object in front for the boat to prevent collision with the object by turning the boat. Compare this number with the initial boat turning circle ability of 15 - 20 meters.
As an addition for the boat safety, capsizing test was conducted. This test is uncommon practice to be applied for a new ship or boat as the boat is conditioned to be flooded up to the boat deck. The result of the capsizing test shows that in any condition, the boat was still floating instead of sinking. Overall, the result of the tests to the boat shows satisfactory value according to the safety requirements of a boat. Hence, it can be said that the boat will be safe to be used by the seaweed farmers.

For project continuity, some participants from the local boat craftsmen as well as from the seaweed farmers themselves have been trained and provided with the knowledge of fiberglass work in building and maintain their fiberglass boat.

Conclusions
In summary, the project implementation has succeeded in achieving the project target and some other objectives which are:
1. Increasing skills for building fiberglass boat for fiberglass craftsmen and seaweed farmer
2. The proposed boat has more carrying capacity.
3. The proposed boat is easy to operate and has good boat stability.
4. The boat has strong boat skin and constructed with frames
5. The boat has been proved safely to be used by the seaweed farmers.

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References
Badan Pusat Statistik (2015), Jeneponto dalam Angka (Jeneponto in Figure) 2015, Badan Pusat Statistik Kabupaten Jeneponto.
Hardjono, S (2010), Identifikasi Rasio Parameter Kapal Penumpang Catamaran Berbahan FRP, Jurnal Sains dan Teknologi Indonesia Vol. 12, No. 3, Desember 2010 Hlm.159-165.
Morrisan (2012), Metode Penelitian Survei, Penerbit Prenada Media.