Design and future application of mobile fish platform for local fishermen in the archipelago regions

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Abstract. The archipelago regions are spread out in some parts of Indonesia. These regions are related to maritime issues such as transportation, resources, infrastructures, and others. There are problems faced by local fishermen such as unavailable preservation facilities, sparse fish collectors and low income. A continuous study has been executing by the authors to define a proper fishing boat. A prototype of mobile fish platform was defined in the study to be operated in Moluccas waters. The fish platform was mobile catamaran type and provided with multi-fishing gears. The results of design and layout are presented in this paper. The study has been executed up to the platform construction phase and will complete in the future. In future scenario, the captured fishes will be transferred from the mobile fish platform to the existing fish cages to keep them alive. The whole scenario of future fishing operations with the mobile fish platform are also presented in this paper. The output of study is defined as prototype and will be tested at sea for technical and economic aspects before applying to users. The whole aim of future study is expected to increase fishermen catching products, to keep the fish alive for buyers and to increase economic aspects for the local fishermen.

1. Introduction
As a big maritime country, Indonesia has a great potential of marine products such as ocean energy, natural gas, fishes, and other products. Many fishes are spread out along Indonesian waters to make this country has plenty of fish resources. Fishes are exploited by local fishermen up to international fishing companies to fulfill local and domestic consumptions as well as international markets. The fishes are caught by using simple fishing boats and devices by local fishermen in restricted waters. Meanwhile, modern fishing boats exploit this marine product widely in Indonesian waters. The local fishermen catch fishes individually or in small groups. The catching products by local fishermen with simple fishing devices is small. However, since the number of local fishermen in Indonesia coastal area are so high the total catching product will be high.

In fact, many problems are still faced by local fishermen due to some internal and external factors. This affects the income and living standard of the local fishermen. This situation is found in many Indonesian coastal areas. A solution was found the authors. This study designs a mobile fish platform that will be used by local fishermen. The mobile fish platform is equipped with multi fishing gears that will be operated any times and at any places. The mobile fish platform can be used to catch some kinds of pelagic and demersal fishes. Other benefit of the mobile fish platform is to catch and keep the fish alive and to transport them to floating fish cages (local name of “keramba”). This method keeps fishes alive while waiting for buyers to collect them. The mobile fish platform can be used for small fishermen groups or big fishing companies particularly in operating in remote archipelago regions where fish preserving is unavailable.
2. Literature Review

2.1 Traditional Fish Platform

Methods of fishing used by local fishermen in Indonesian coastal areas are generally in traditional ways. This condition results in less catching product and low income. Many local fishermen groups developed their modern fishing devices. However, there are a lot of local fishermen still struggle with traditional devices. One kind of traditional fishing device used by local fishermen is floating fish platform. This device is known by local name of *bagan* as seen in Figure 1. *Bagan* is equipped with a single fishing gear i.e. lifting net and is operated at night time to catch small pelagic fishes such as: *(local and latin name):* *layang* (*decyterus spp*), *kembung* (*Restrelinger*), and *layur* (*trichiurus lepturus*).

Based on hull material, *bagan* are of two types that is raft and boat *bagans*. Raft *bagan* has two hulls which are made of bamboo raft while boat *bagan* has two hulls which are made of small wooden boat [1,2,3,4]. Bamboo rafts or wooden boats are the left and right hulls of *bagan* which serve as buoyant. Those two hulls relate to wooden beams or bamboos. Based on hull type, *bagans* are classified in two-hull *bagan* (catamaran type) and three-hull *bagan* (trimaran type). *Bagan* is anchored to prevent it from drifting at sea. Besides, there is another traditional fishing devices named ‘*rumpon*’ as shown in Figure 2. *Rumpon* has a function of collecting fishes, caught by purse seiners. Some previous studies executed by the authors found a type of *rumpon* that may be applied in the future [5,6,7].

Catching operation of *bagan* is executed at the nighttime with the aid of light. This is due to the fish behaves as positive phototoxic which means tendency of close the light [8,9]. The role of light is to collect the fish in a “catchable area” then catching process can be executed by using net or other catching devices [1]. Other requirements in operation of *bagan* are the condition of waters close the coast or in the bay protected from excessive wind, current and waves, water deep which is less than 50 meters and sea water is in clear condition [3].

![Figure 1. Traditional bagan with 2 and 3 hulls](image1)

Other factor which affect the success of catching operation of *bagan* is determination of proper fishing ground and water depth [10,11]. Fish aggregating device is added to attract many fishes to stay under *bagan* [1]. Baskoro et al [12] suggested the addition of fish shelter as device to collect many fishes under *bagan* to increase catching product.
2.2 Problems and Solutions of the Operation of Bagan

During the operation of bagan, there are a lot of problems faced by the local fishermen. Those problems are listed as follows:

- There is no available preservation of fish, post fish catching process for local fishermen
- There are no available markets in remote areas or small islands where the local fishermen are struggled to sell their products
- Since bagan is tied to the anchor (at sea bottom), the existence of fish depends on fish migration pass through bagan
- The operation of bagan use only single fishing gear, that is, lifting net, which is only for catching one kind of fish, i.e small pelagic fish
- External factors such as moonlight, strong sea current and fish mature period also affect the existence of small pelagic fish at sea

The problems mentioned above affect the income of the local fishermen who operate bagan as their fishing device. As a result, the living standard of local fishermen in many parts of Indonesian coastal areas is getting worse. In fact, there are many benefits that may be achieved if bagan can be utilized in a proper way. Such benefits may be explained as follows:

- Bagam is easily operated near islands by small group of persons (at least 4 persons)
- Bagam has a great potency to be operated near a lot of islands Indonesian waters

The solution to be offered in previous study [13,14] were based on the following facts:

- Bagam should be utilized to increase the fish product by applying multi-gears devices such as lifting net, bottom long line and bottom fish trap.
- Bagam can be used to catch any demersal and pelagic fishes by using multi-fishing gears
- Bagam should be in mobile condition to make catching process in many places
- Bagam should be designed to be operated at day and nighttime
- Bagam should be equipped with fish cages to keep the fish alive while waiting for buyers

The kind of bagan with those requirements above is known as “Mobile Fish Platform (MFP)”. Solution offered in this study includes:

- The Mobile Fish Platform is equipped with self-propulsion device (outboard engines) to move MFP to other fishing grounds for catching operation.
- Mobile fish platform is equipped with multi-fishing gears (lifting net, bottom long-line and trap net) in order to catch small pelagic fishes as well as demersal fishes such as: grouper, snapper, red fishes and any kinds of lobsters.
- Mobile fish platform is equipped with other rumpons devices to increase the amount of catching operation during the night.
3. Methodology
The study ends with defining a prototype of mobile fish platform (MFP) and mechanical system of multi-fishing gears. This output was obtained by the following steps:

- Survey the location of fishing grounds for placing mobile fish platform. The objective of this work is to obtain the dimensions and configurations of bagan and rumpon, potential fishing grounds and other factors experienced by local fishermen.
- Design of mobile fish platform, mechanical systems, and fishing devices. The objective this work is to obtain a proper configuration of mobile fish platform, mechanical systems and catching devices. The output of this step is blueprint and working drawings that to be used in constructing MFP and mechanical systems and catching devices.
- Constructing MFP, mechanical system and catching devices. The objective of this work is to obtain a proper dimension and layout of MFP, mechanical system and catching devices.

The study will be continued with sea trial to evaluate performance of MFP, mechanical systems and catching devices. This work will be continuing to confirm the design output, evaluation and improvement of technical aspect and economic feasibility as a reference for future design.

4. Design Process and Construction of Mobile Fish Platform
Design process of mobile fish platform (MFP) is principally similar to the process of other seagoing ships. The main difference lays on the function, lay-out, and outfit. The design procedure contain some iterations process in early design phase. The output of first iteration should be evaluated, analyzed and modified until the design process satisfy the objective and requirements. This process is expressed in spiral design. A number of iterations are needed to satisfy a proper design result [15,16,17]. The design process need input design, design parameters, computations, determination of design output and design specification. Design parameters of mobile fish platform include mission requirements, dimensions and hull geometrical forms, space lay-out, weight components and their centres, trim and stability, speed and engine power, structure components, prime mover and system, ship outfit, as well as fishing gears and cost.

Design process of mobile fish platform begins with mission requirements. Design parameters are computed and analyzed at each iteration in a design spiral until determination of proper parameters. A design consideration was taken into account that, at this moment, design parameters have not stated as ‘optimal’ for the reason that mobile platform design is a prototype. It is needed more improvements and corrections during the real operation of platform at certain operation period. The main requirement in design is a large amount of catching product. This requirement may be obtained when many fishes exists under MFP, placement of MFP at proper fishing grounds, a good lightning system, a wide net area and high speed of net hauling. A requirement of many fishes exist under the platform is obtained when operating the mobile platform, meanwhile a good lightning system dan wider net area are determined during the design process. However, the requirement of wider net area affect other design parameters.

Input design parameters are defined as follows: catching capacity of 2.5 tons and service speed \( V_{MFP} \) of 6 knots. Other design considerations are platform profile is catamaran type, hull material is fibreglass reinforced plastic (FRP), vertical structure of hull is Class I woods, transverse structure is steel profiles combined with vertical Class II woods and one small control house above the transverse structure. The lay-out of platform include: fish net between two hulls, fish holds and other storages in the main hulls, two units of outboard engines \( 2 \times 40 \) HP placed at transom stern, hauling winch placed at the midle of right hull, while electric generator is placed at the midle of left hull and control navigation and operation control as well as crew accomodation are placed at upper house. Design process are started with a sketch and determination of dimensions, hull forms and lay-out of the platform. Weight components and their centers are computed in details. Trim and stability are determined based on weight details. Transverse structures are computed to ensure the strenght of MFP. Type and capacity of propulsion system are determined at design phase while service speed will found during sea trial. Ship outfits and cathing
devices are fixed during design process. Some references concerning previous design and operation of small fishing boats material FRP from the author are applied in this work [18,19,20].

Table 1. Main dimensions and hydrostatic parameters of mobile fish platform

| Parameter                        | Symbol | Value | Unit |
|----------------------------------|--------|-------|------|
| Length overall                   | L_{OA} | 10.10 | m    |
| Length of waterline              | L_{WL} | 9.91  | m    |
| Beam                             | B      | 8.00  | m    |
| Beam of one hull                  | B_{hull}| 0.90  | m    |
| Draft                            | T      | 0.47  | m    |
| Deck height                       | H      | 1.00  | m    |
| Displacement                      | Δ      | 9.40  | ton  |
| Prismatic coefficient             | C_{P}  | 0.86  |      |
| Block coefficient                 | C_{B}  | 0.79  |      |
| Midship coefficient               | C_{M}  | 0.92  |      |
| Longitudinal center of buoyancy (from AP) | L_{CB} | 4.66  | m    |
| Vertical center of buoyancy (from BL) | V_{CB} | 0.412 | m    |
| Transverse radius of metacenter   | B_{M}  | 21.05 | m    |
| Transverse metacentric           | G_{M}  | 18.50 | m    |
| Immersion                        | TPC    | 0.152 | ton/cm |

Results of design dimensions and hydrostatic parameters are presented at Table 1. General arrangement of MPF is showed in Figure 4 and body plan is showed in Figure 5. Design specification of MFP consist of deadweight capacity of 4.25 tonnes and lightweight of 5.15 tonnes to make the total weight of 9.40 tonnes. The amount of payload of 3.45 represents the maximum capacity of fish to be carried by MFP. The power required to move MFP at the speed of 6 knots is 80 horsepower (2 × 40 hp) which is two outboard engine type. Lifting net used at MFP has net area of 67.20 m² and depth of 20 meters is moved by a winch power of 5 kW. An electric power of 5 kVA is provided to supply electric power to the winch. The MFP is operated by four (4) persons at fishing ground area near the shore or small islands. Light capacity of 0.5 to 1.0 kVA is provided for catching operation at night. Meanwhile, other cathing device of vertical line is provided. Maximum depth of this vertical line is 100 meters. The number of vertical line is 20 units where each unit is set for 5 fishing hooks. In addition, 20 units of trap nets type folding are provided also with the maximum depth of 50 meters.

Figure 4. General arrangement of mobile fish platform
The steps of construction of mobile fish platform are construction of template framework, hull template and main hull. Lines plan of hull are transferred into mould loft (scale 1:1) to draw body plan, profile plan and half-breadth plan. The next step is to cut off frames at plywood sheet, arrangement of frames in longitudinal direction and assembly the template framework and setting framework shell. The template framework is then covered with FRP and wooden ribs to create hull template. Two hulls of mobile platform are developed up to this time and the work is continue to assembly the whole construction, see Figures 6 and 7.

The success operation of mobile fish platform highly depends on its mobile to the potential fishing grounds and is supported by technical equipment provided at MFP. The output of design are platform dimensions and configuration, design specification and catching devices obtained during design process. Determination of parameters in this preliminary design stage consists of net area, spaces at mobile platform, correlation between displacement and total weight, stability and require power [15]. Stability parameter is determined due to criterion of $GM_0 > 0.15$ m based on IMO Code on Intact Stability [21]. However, this criterion is applied for merchant vessels and is not for MFP. Further analyse of stability parameters at intact and damage conditions should be executed in the future. The real speed and engine power will be obtained during sea trial test. The construction works is still ongoing or in progress and will be completed for mechanical systems in the future. The mobile fish platform (MFP) is a new prototype. Therefore, during sea trial process some corrections and records will be required as reference for the future design.
5. Future Applications
The existing mobile fish platform (MFP) has been developed up to hull part. The mechanical system will be completed in the future. In addition, the MFP will be developed further for another function. In this case, the MFP will be provided with fish cages. There are two kinds of fish cages developed by the authors, which are:

- **Floating cage:** Floating cage is placed at sea surface. This device is used to cultivate the small pelagic fishes.
- **Bottom cage:** Bottom cage is placed at sea bottom. This device is used to cultivate the demersal fishes and any kind of lobsters.

Both kind of cages can be made a lot as required. Those cages should be placed in restricted calm waters with limited depth. In this case the cages should be managed and controlled well. The main function of fish cages is to keep the fishes alive. By this method, the owners can sell the life fishes to the buyers. The layout of the combination of the MFP and fish cages is shown in Figure 8.

![Figure 8. Future application of mobile fish platform](image)

6. Conclusions and Recommendations
Problem concerning the operation of traditional fish platform (*bagan*) was solved by the introduction of mobile fish platform (MFP) equipped with mechanical systems and multi-catching devices. The study was executed up to the construction of MFP. Some comments were concluded as follows:

- The study of the traditional fish platform (*bagan*) is executed to find a new design of mobile fish platform (MFP) with the result of design specification including dimensions, configurations and lay out of mechanical systems as well as fishing devices.
- The configuration of MFP is designed to increase the amount of fish by providing multi-fishing devices, mobile systems to allow a wide range of operation MFP at may places and any times.
- Other devices of fish cages are introduced to keep the catching fish alive for selling periods.
- Future works of sea trial should be executed in order to obtain the real product of MFP.
- The results of study will be applied to local fisherme to increase the income and worth living

**Acknowledgements**
Special gratitude is addressed to the Directorate General of Research and Development Empowerment, Ministry of Research, Technology and Higher Education, Republic of Indonesia for Research Grant, of Applied Product Research 2017.

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