Low-Cost Remote Control Barge Boat to Feeder Fish

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ABSTRACT

The purpose of this study was to design a low-cost and portable remote control fish feeder barge boat to support increased production in the fishing industry. Research procedures include literature review - research aims - design - material selection - fabrication - material selection. This research resulted in the design of an automatic fish feeder system using a remote control with low-cost efficiency and portable. Barge boat functioned as fish food sender to a large fish pond with remote control as a controller. This remote-control system makes it easier for farmers to feed fish automatically and evenly in the middle and corners of fish ponds. Barge boat test results obtained a cargo capacity of 1 KG with automatic openings glided by the force of gravity. The time gained in one barge boat trip is 137 seconds with a pool length of 220 m at a speed of 0.5m/s. The results of the economic analysis show that barge boats are not expensive and portable, compared to other commercially available devices. The design of the barge boat remote control material uses plywood material coated with waterproof paint so that it can reduce the cost of manufacture and suitable for use by farmers. Feeding with this system allows successful cultivation schemes to be implemented because it can take into account the proper feeding, thereby avoiding economic losses such as food waste that can lower water quality, thereby polluting water quality.

KEYWORDS

Barge Boat, Low Cost, Feeder Fish

INTRODUCTION

Fish farming is highly developmental as the main source of food for humans [1]. Considerable potential in the fishing industry, especially that must be increased production. Increased production in fisheries cannot be separated from the process of feeding fish. Feeding is the main factor that determines the efficiency and cost of it is important to know when to stop feeding to maximize the efficiency of fish feed. Fish feeding is one of the jobs that require more supervision and human resources. Proper feeding of fish is a challenge for fish farmers [2]. The right amount of food should be provided to avoid economic losses such as food wastage that can degrade water quality, thus polluting water quality [3]. Other studies have also shown that over-feeding causes feed waste, poor water quality, lower economic benefits, and additional environmental pollution leading to faster deaths in fish [4], [5]. Whereas good water conditions are a process to ensure the quality of water environment and ecology of fish productivity cultivation to be high [6].

Fish feeding is a considerable difficulty, especially large ponds that reach several hectares wide. In large ponds feeding with human labor can only sow fish feed by the pond, so that fish feed can not be evenly distributed to the middle of the pond [7]. Farmers have to walk around a large pond by approaching hordes of fish while feeding manually, it is very ineffective and draining. The development of automatic fish feeding machine devices is a solution to improve the efficiency of fish feeding [8]. The development of simple mechanical feed devices became a necessity in semi-intensive and intensive aquaculture systems [9]. Some research results report various types of automatic fish feed tools to overcome the problems of fish feeding, feeders, and monitoring feed consumption. Ritu (2019) designed a barge with human muscle power used to drive as well as to drive feeders, where the main part of the feeder is a cylinder feed drum mounted on a power shaft, barge, propeller, and steering settings [9]. The barge system was also developed by Oka (2018), where fish feed media is automatically used in offshore cultivation [10]. Feed barge developed is a barge that functions as a fish food sender to a floating pond that serves as a controller of fish activities and conditions around the pond both temperature and oxygen levels.
Other results reported a type of feeder with a fuzzy logic control algorithm, a web-based application, and a proposed microcontroller that could feed fish by combining mechanical and electrical systems in controlling feeding [3], [11], [12]. A type of robot was also developed for feeding that has an intelligent system that can be used and installed on android smartphones [13]. The system allows owners to effectively manage administration via smartphone. Some research results with automatic feeding system have several disadvantages, including the need for a high investment cost exceeds the income of fish farmers. Automatic feeding also leads to excessive feeding, leading to food wastage and pool water pollution [14]. Based on this perspective, fish farmers more often decide when and how much fish feed will be given. So to meet the demand of fish farmers to be more useful in the fishery sector, the development of fish feeding barge is designed with easy construction, low cost, and low maintenance requirements [14].

The research aims to design barge boats using low cost and portable remotes. Different from other barge boats, a barge boat is categorized as an easy construction to assemble with a maximum load capacity of 1 KG. The construction of materials is designed to light and simple so that it does not require complex shipbuilding stability. This has the effect of reducing costs large or more economically. The driving force uses a medium-rotation electric motor ahead / astern that is capable of carrying heavy loads with wider cruising power. The stability of the barge is safer and not easily sunk and the movement of the ship using a single rudder that is easy to maneuver according to the form of ship construction. Based on the above specifications, this machine was developed to facilitate feeding and reduce feed wastage during fish feeding operations according to their needs. The contribution of research helps fish farmers in providing feed remotely controlled by remote, so that barge can explore the corner of the pond to channel fish feed. Manual feeding takes hours to feed a large pond. Remote feeding, which combines manual excellence and mechanical feeding, can reduce human work, feed wastage, and economical feed manufacturing. This system provides an intensive sustainable impact aquaculture system, improving productivity and profitability.

LITERATURE REVIEW

Fish Feeding

Fish feeding must be done correctly to produce a good fish cultivation system. Good fish feeding is one of the factors determining the success of the fish farming business [15]. The feed is the most important element in supporting the growth and survival of fish. The way of feeding fish can be done by sown evenly on all parts of the fish pond, not using the origin of the spread that eventually many stackers one side of the pond. The wrong portion of feed can cause fish to be full, even though the feed needs to develop in the space on the body of the fish so that it can be digested properly [16]. Also, a good fish feed making material is a feed that contains nutrients for fish, a taste favored by fish, and easy to digest. Good quality feed is an important factor determining the success of fish cultivation, one way to reduce feed costs is by using feed efficiently both in the selection of types, quantities, schedules, and ways of feeding by the needs and habits of fish.

Archimedes' Concept

Archimedes' law is a law which states that any object dipped in either whole or part in fluid, shall receive an upthrust or buoyancy force [17]. The amount of buoyancy received, the value is equal to the weight of the water transferred by the object (weight = mass of objects x acceleration of gravity) and has the opposite direction of force (direction of heavy force down, the direction of buoyancy force up). Also, buoyancy can be reduced by reducing the energy that is thrust on objects [18]. The sinking object will get an equally large lifting force. The Archimedes principle is often proven for the special case of right circular cylinders or rectangular solids taking into account the difference in hydrostatic force between the upper and lower surfaces (flat and horizontal) which is then generalized that the principle actually applies to a body of fickle shape [19]. Buoyancy decreases as we reduce the injected energy.

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Archimedes principle is often proven for the special case of right circular cylinders or rectangular solids taking into account the difference in hydrostatic force between the upper and lower surfaces (flat and horizontal) which is then generalized that the principle actually applies to the body whose shape changes [19]. Buoyancy decreases as we reduce the injected energy. More clearly figure 1 is the concept of Archimedes

\[ FA = \rho_c V_b g \]  

Description:

- \( FA \) = buoyancy (N)
- \( \rho_c \) = density of liquid substances (kg/m\(^3\))
- \( V_b \) = volume of dyed objects (m\(^3\))
- \( g \) = gravity (m/s\(^2\))

Ship Stability

The stability of the ship is often referred to as the balance of the vessel, in other words, the balance of the vessel at the time of float runs steadily and is able to return to its original position after obtaining external forces from the outside such as waves, wind, and others [20]. The stability of the ship is divided into two; first initial stability is stability in static or still, conditions, and second dynamic stability is stability in moving or dynamic conditions. In the ship's dynamic stability, the ship's ability to withstand or avoid external healing forces is directly proportional to the area below the static stability curve [21]. Where the Stabilizing curve shows the relationship between the enforcer's arms at various angles of inclination variation at constant weight changes. So if the ship has high dynamic stability then the ship has the ability to withstand outside styles well.

Ship stability planning is essential as an early stage of design for ship safety [22]. The safety of the ship is very important in order to avoid the case of an overturned ship. It happened because the ship was affected by the unbalanced rolling motion [23]. It is important to review the flotation line and the contribution of buoyancy force to the stability of the vessel as a controller for the dynamic position that hits the body of the vessel [24]. Therefore, the design of the ship must be able to maintain and balance the ship while walking so that the floating vessel is partially submerged in water [22]. This is reasoned because the specific density of the air is much lower than the fluid, although it ignores the atmospheric pressure experienced by the ship's part located above the surface of the water. In figure 2 below describes the analysis of rotational motion with floating objects.

\[ \text{Figure 1. Schematic Archimedes [19]} \]

\[ FA = \rho_c V_b g \]  

\[ \text{Figure 2. Coordinate system (a) The rotation line rotates clockwise with floating objects; (b) floating objects rotating in a clockwise direction with a flotation line [25]} \]
Ship Construction

A ship is a building with a shape and construction that can float on water at a certain speed. The ship can float on water because the ship gets a force pressed up by water as big as the down press force generated by the weight of the vessel's broad unity. On that basis, the ship can float on water. In its construction, a good construction design system, shape, and design are required in order for the ship to have good safety. Basically the construction of the ship consists of the body of the ship and the upper building. The body of the ship in this case is the left and right hull, the base of the ship as well as one or more decks. The superstructure is an additional building on the body of a ship that is partly the length of the ship and in some cases can be as long as the ship. The width of the upper building is equal to the width of the ship, while the building that is smaller than the width of the ship is called a deckhouse located on top of the upper building [26].

Ship Control Working Principle

In principle, the ship's control system uses a propulsion system consisting of a pump that sucks water from a hole at the bottom of the boat, acceleration is carried through the impeller, and then water is forced out again through a hole in the stern [27]. In this waterjet propulsion system, the sucked water will be pushed out from the back of the ship which results in the force of the ship's movement forward. The rudder on the waterjet is fused with the drainpipe, where the water pushed out from the back of the ship is used not only to push the ship forward but also to push the vessel to turn. The waterjet propulsion steering system has its advantages, where the ship is able to turn at a smaller angle than a conventional rudder. The linear movement of the waterjet also eliminates the characteristic skewness of the boat/ship using conventional propellers.

RESEARCH METHODS

The research procedure for designing a fish feeder barge boat includes several stages that must be done. As in Figure 2 below literature review requires a strong foundation in building a state of the art and theory. The main characteristics of fish feeders such as lightweight, good confusion, and low cost are thought out in the purpose of the study. The design process includes sketch drawing design, material selection to cost analysis on each material. Fabrication is done after the design and material are completed, where the fabrication work performs the manufacture of barge boat from scratch and finishing. Testing is carried out to test the functionality of barge boats as well as data and results recorded and analyzed as well. In general, the research procedure can be seen in Figure 2.

Figure 3. Research Methods

The fabrication process of barge boat equipment includes several stages, namely the manufacture of hull barge boats, making cargo barge, making bridge barge, and assembly process. Several stages of the process result in material needs to be detailed in Table 1.

Table 1. Types of materials and specifications

<table>
<thead>
<tr>
<th>No</th>
<th>Material</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Motor brushell</td>
<td>540 Crawler Brushed</td>
</tr>
<tr>
<td>2</td>
<td>Esc</td>
<td>wp -1040-brushed BEC : 5V/2A</td>
</tr>
<tr>
<td>3</td>
<td>Servo</td>
<td>Servo Tower pro mg995 Torsi 10 kg</td>
</tr>
<tr>
<td>4</td>
<td>Battery</td>
<td>Battery lippo 7,4 volt 45 cell , 4500 mAh</td>
</tr>
<tr>
<td>5</td>
<td>Propeller</td>
<td>P40d47 three balde</td>
</tr>
<tr>
<td>6</td>
<td>Charger battery</td>
<td>imax 3.4.7</td>
</tr>
<tr>
<td>7</td>
<td>Tripleks</td>
<td>Type of wood</td>
</tr>
<tr>
<td>8</td>
<td>Glue</td>
<td>Adhesive glue</td>
</tr>
<tr>
<td>9</td>
<td>Remote control (rx / rx )</td>
<td>Turnigy analog 2.4 ghz 6 channel</td>
</tr>
</tbody>
</table>
The testing stage is done by testing the barge boat whether it can function properly. This test was carried out on a pond area of one goldfish seed pond on average about 3,000 m² with a pond circumference of about 220 m with feed as much as 1 KG on barge boat.

RESULT AND DISCUSSION

The design of the barge boat based on remote control produces a prototype with cargo or cargo of 1 KG. The design process starts from hull design, cargo design, and lastly bridge design. The hull has a length of 550 mm, a width of 220 mm, and a height of 80 mm. The cargo section has a funnel length of 149 mm, a funnel width of 149 mm, and a funnel height of 90 mm. The bridge has two main parts: the accommodation section and the bridge section. The prototype results can be seen in figure 4 below.

The testing process of the tool is carried out by providing fish feed weighing 1 KG with a pond of 3,000 m² with a pond circumference of about 220 m. Fish feeding is done by circling all parts of the pond to the corner of the pond with the position of the fish in the future. The cargo section where the fish feed is also controlled by the remote so that it can be opened and closed as desired. Fish breeders can control the feeding of fish on the side of the pond and do not have to walk around the vast pond. In more detail, the tool testing process is shown in figure 5 below.

![Figure 4. Results Design barge boat based on remote control](image1.png)

![Figure 5. Testing Fish Feeding with Barge Boat Remote Control](image2.png)
The data obtained from the measurement of the ship's body is:

\[ T = 40 \text{ mm} = 0.04 \text{ m} \]
\[ L = 220 \text{ mm} = 0.22 \text{ m} \]
\[ P = 50 \text{ mm} = 0.05 \text{ m} \]
\[ P_2 = 400 \text{ mm} = 0.4 \text{ m} \]

I. \[ V = \frac{1}{2} \cdot T \cdot L \cdot P \] (2)

\[ V = \Delta A \cdot T \]
\[ \Delta A = \frac{1}{2} \cdot P \cdot L \]
\[ = \frac{1}{2} \cdot 0.04 \cdot 0.05 \]
\[ = 0.001 \text{ m}^3 \]

\[ V = \Delta A \cdot T \]
\[ = 0.001 \cdot 0.22 \]
\[ = 0.00022 \cdot 2 \]
\[ = 0.00044 \text{ m}^3 \]

II. \[ V = P_2 \cdot L \cdot T \]
\[ = 0.4 \cdot 0.04 \cdot 0.22 \]
\[ = 0.00352 \text{ m}^3 \]

The number of submerged parts of the ship is \( I + II = 0.00044 + 0.00352 = 0.00396 \text{ m}^3 \)

The legal calculation of Archimedes buoyancy obtained is

\[ \Box = \rho_{\text{air}} \cdot g \cdot V_{\text{submerged water}} \] (3)
\[ \Box = 1 \cdot 9.8 \text{ m/s} \cdot 0.00396 \text{ m}^3 \]
\[ \Box = 0.038808 \text{ N.m} \]

Motor Torque Calculation:

\[ F=W= A \cdot V \] (4)
\[ F = 7.2 \cdot 3.35 \]
\[ F = 24.12 \text{ Watt} \]

\[ W = \frac{n \cdot 2 \cdot \text{rpm}}{60} \]
\[ W = \frac{3.14 \cdot 2 \cdot 6800}{60} \]
\[ W = 711.73 \text{ N.m} \]

\[ T = \frac{F}{W} \]
\[ T = \frac{24.12}{711.73} \]
\[ T = 0.033 \text{ Nm} = 33 \text{ milinewton} \]

Barge Barrier Board Calculation:

Air resistance I

\[ \Delta \text{ Obstacles} = T \cdot L \]
\[ = 0.168 \cdot 0.18 \]
\[ = 0.0302 \text{ m} \]
Drag resistance = \( \text{rd} \)

\[
\text{rd} = \frac{1}{2} \cdot \text{\( \alpha \)} \cdot \text{cd} \cdot \Delta \text{Obstacles} \cdot V
\]

\[
\text{rd} = \frac{1}{2} \times 1.12 \times 0.82 \times 0.0302 \times 0.5
\]

\[
= 0.00693 \text{ N}
\]

Air resistance II

\[
\Delta \text{Obstacle} = \text{T.L}
\]

\[
= 0.04 \times 0.22
\]

\[
= 0.0088 \text{ m}^2
\]

Drag resistance = \( \text{rd} \)

\[
\text{rd} = \frac{1}{2} \cdot \text{\( \alpha \)} \cdot \text{cd} \cdot \Delta \text{Obstacles} \cdot V
\]

\[
\text{rd} = \frac{1}{2} \times 1.12 \times 0.82 \times 0.0088 \times 0.5
\]

\[
= 0.00202 \text{ N}
\]

Water Resistance

\[
\Delta \text{Obstacle} = \text{T.L}
\]

\[
= 0.04 \times 0.22
\]

\[
= 0.0088 \text{ m}^2
\]

\[
\text{rd} = \frac{1}{2} \cdot \text{\( \alpha \)} \cdot \text{cd} \cdot \Delta \text{Obstacles} \cdot V
\]

\[
\text{rd} = \frac{1}{2} \times 1000 \times 0.82 \times 0.0088 \times 0.5
\]

\[
= 1.804 \text{ N}
\]

Obstacles Total

\[
\text{Rt} = \text{Air resistance I} + \text{air resistance II} + \text{water resistance}
\]

\[
\text{Rt} = 0.00693 + 0.00202 + 1.804
\]

\[
\text{Rt} = 1.812 \text{ N}
\]

Barge boat speed calculation

\[
\text{Pe} = \text{Rt} \cdot \text{Vservis}
\]

\[
\text{Pe} = 1.812 \text{ N} \times 0.5 \text{ m/s}
\]

\[
\text{Pe} = 0.906 \text{ watt}
\]

Calculation of weight Barge board without charge

The empty weight without the weight that is only weighed by the equipment to push the boat is = 2.20 kg

Barge board calculation with charge

Boat weight with cargo is the weight of the load of fish feed with a maximum weight of 1 kg is full weight = empty weight + feed weight 3.20 kg = 2.20 kg +1 kg.
Figure 6. Comparison Graph of Feed Weight and Time

Figure 6 above is a comparison graph of feed weight (KG) and time (seconds). The results of the time measurement showed the feed launch time until exhausted by circling the pond by an average of about 3,000 m² with a pool circumference of about 220 m that takes about 137 seconds. The calculation of time is indicated with a time of 137 seconds, it can squander 1 KG of feed in one trip, if 2 KG it takes 274 seconds in two trips. The model of launching fish feed by opening by using a gravitational system is carried out continuously until the feed runs out. The launch of the 1KG feed can be set by opening and closing the automatic door from the remote control.

The load capacity in the barge boat is 1KG while the empty weight of the barge boat is 3.20 KG. So that it can be calculated the capacity of the ship's buoyancy force or the moment of the ship, if it exceeds the feeding capacity there is an overload because the dimensions of the size of the ship are not by the load. The results showed that the number of submerged parts of the ship was 0.00396 m³ so that the resulting buoyancy was 0.038808 N.m. In the process of testing the ship's maneuvering equipment can rotate left and right. At the time of turning ballast, the ship is functioning properly so that there is no accident or overturned ship full load state with fish feed 1KG plus the weight of the ship 2.20 KG or in an empty state with an empty weight of 2.20 KG ship.

The speed generated in the test was 0.5m/s with a total load of 1KG. Dc motor drive is used to supply the energy source from the battery as a rechargeable power storage so that the calculation of ship resistance is generated by 1,812 N according to the results. In the material of remote control, barge boat is a material that is cheap and easy to get but quality so that it can reduce the cost of manufacture. The quality is certainly for the ease that can be formed and modified. Designing the formation of materials from plywood can be treated with coating using iron paint to be more resistant to watertight. In contrast to composite fiber materials that certainly require a greater cost. The result of the implementation of this tool provides evidence, barge boat provides convenience for freshwater fish farmers in feeding fish evenly for large ponds. Even feeding can certainly increase fish grow faster so that it has implications for fish productivity. The concept of a barge boat is very mobile, very easy to get under, and moved to other fish ponds with great distances.

CONCLUSIONS

This research resulted in the design of a fish feeder barge boat using a remote control with simple control, low-cost efficiency, and portable. The results of the analysis ensure that the development of barge boat categorized as low cost and portable can be moved according to the fish pond that will be fed fish. Barge boat is prospectively used in countries that have a fresh fish cultivation industry. The significance of a barge boat with function as fish food sender to a large fish pond with remote control as a controller. This remote control system makes it easier for farmers to feed fish automatically and evenly in the middle and corners of fish ponds. The feeding process relies on cargo with a capacity of 1 KG with automatic openings gliding by gravitational forces. The time gained in one barge boat trip is 137 seconds with a pool length of 220 m at a speed of 0.5m/s. The design of the barge
boat remote control material uses plywood material coated with waterproof paint so that it can reduce the cost of manufacture and suitable for use by farmers. Feeding with this system allows a successful cultivation scheme to be implemented because it can take into account the proper amount of feed, thereby avoiding economic losses such as food waste that can degrade water quality, thereby polluting water quality.

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