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Mini Aquatec Mobilize General Plan Design as a Means of Increasing Food Security Through Cultivation and Ecotourism

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ABSTRACT

The Mini Aquatec Mobilize design is an innovation given as the development of a floating chart, which is currently used as a place for fish farming. This development aims to optimize the function of a crab for cultivation, fishing, and tourism. It is placed on the cruise line, 5 miles from the coast, with coverage of the coastal area of Madura. Through this innovation, food security is hoped to increase through fish farming and ecotourism for the community. The purpose of this study is to design a general plan. The general plan is a drawing to determine the location of the rooms, equipment, and the amount of equipment on board in 2D form. The method used uses a comparison ship, which is then carried out by making designs through application assistance. From the research, the main ship dimensions were L = 15.00 m, B = 4.00 m, H = 1.71 m, and T = 0.86 m. With a total of 20 passengers and the need for lights for aquaculture, namely 2 (20 watts) deck lights, 2 (500 watts) spotlights and 12 (15 watts) decoy lights.

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INTRODUCTION

Madura Island is an area passed by the Madura Strait; of course, the most significant potential in this area is fisheries, where most of the population works as fishermen (Ustadi et al., 2022). The mini aquatic mobilize facility is a solution to the problems currently faced by fishermen in the form of fishing gear that has not been effective, and the existing potential needs to be maximally utilized. Later, the mini aquatic mobilization can be used for fish farming, fish attractors, and tourist attractions for anglers. Another advantage is the energy used for lighting in cultivation using solar cell energy (Pratiwi et al., 2020). Figure 1 is the geographical location of Madura Island.

Figure 1. Map of Madura Island (BAPPEDA Jatim, 2014)

The creation of this cultivation facility is not only for the community's welfare but also to support the government in the blue economy program initiated by President Jokowi in 2021. Figure 2 is a blue economy program.

Figure 2. Blue economy program (BPPSDM, 2023)

In 2018, Indonesia's maritime sector contributed around 10.4%. Meanwhile, countries such as China, Korea, the United Kingdom, and others can contribute at least 30% to the Republic of Indonesia's Maritime and Fisheries Regulation No. 28 of 2021 (KKP, 2021a) concerning the organization of marine spatial planning. As well as ministerial regulation No. 19 of 2021, article 3 point b states that the population of fish resources has decreased in the last five years (KKP, 2021b). It is recorded that Madura Island has a total of 530,728 fish farms, of which 45 are floating nets, and there are still no cages.

The following results from previous research regarding developing ships as a place to attract fish.

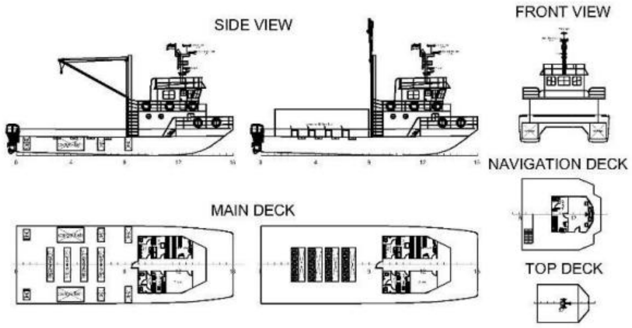

Figure 3. 2-in-1 catamaran fishing - tourism boat (Resnaji & Hasanudin, 2018)

Figure 3 is a facility that only focuses on fishing and tourism. So, it needs to be more efficient, and using cranes requires experts to operate the equipment. The length of 16 meters is incompatible with the waters of Sampang Regency, which has a limited harbor. In addition to the above facilities, there are other facilities in the form of a ship resembling a charter, but can move from place to place. However, with a width of 9 meters, this does not correspond to the conditions in Sampang.

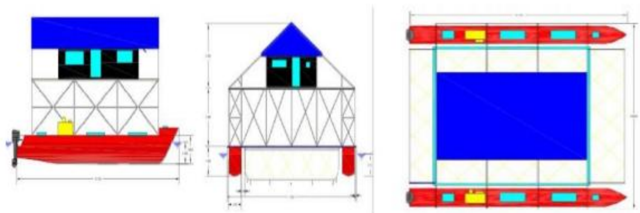

Figure 4. Mobile fish platform (Hetharia et al., 2021)

In Figure 4, you can see examples of current vessels whose function is to function as fishing vessels. The following is a decrease in production, especially for grouper, the most

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popular type of export fish (Hidayah et al., 2020).

From Table 1, it can be seen that the decline is very high. This is influenced by the exploratory value, especially in the type of grouper fish. Seeing the existing conditions and supporting the government program, an innovation is needed in the form of a mini aquatic mobilize. This research aims to pour in the form of a general plan of the ship. The general plan is a 2D drawing to show the location and placement of equipment on a ship.

Table 1. The production value and volume of grouper nurseries (KKP, n.d.)

Year	Production Volume	Production Value
2017	3,417.267	468,110,903
2018	1,562.729	165,965,597
2019	1,606.023	265,905,655
2020	2,050.393	239,626,178
2021	129.541	10,230,900

Figure 5 is a design from previous research that functions as a tourism and fishing boat. By looking at the existing conditions, the main dimensions were chosen from the last study with the ships' main sizes, which can be seen in Table 2. So, in this research, a design modification was carried out so that the facility was more effective and could save fuel costs through the addition of solar cell technology, and ship hulls use High-Density Polyethylene (HDPE) material, which is environmentally friendly, resistant to sharp objects, and lightweight. The main measures above are selected based on the regression results from previous assessments, which are adjusted to the conditions in Sampang Regency.

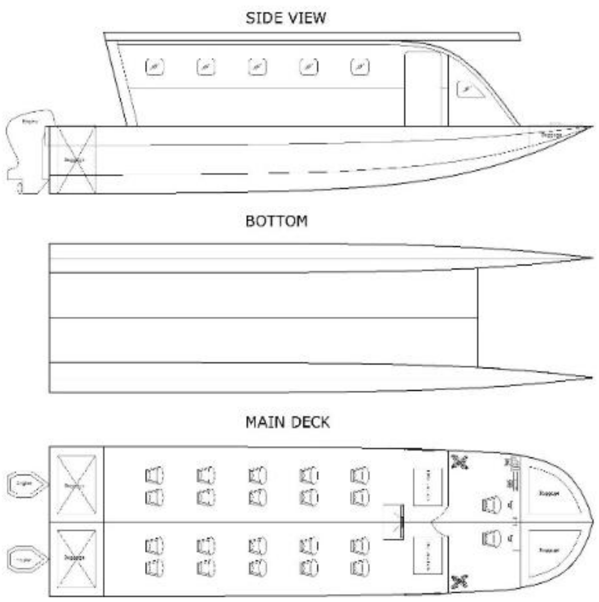

Figure 5. Design ship waterbus (Awwalin et al., 2022)

Table 2. Main dimension of the ship (Awwalin et al., 2022)

Dimension	Symbol	Value	Unit
Length	L	15.00	m
Breadth	B	4.00	m
Height	H	1.71	m
Draft	T	0.86	m

METHOD

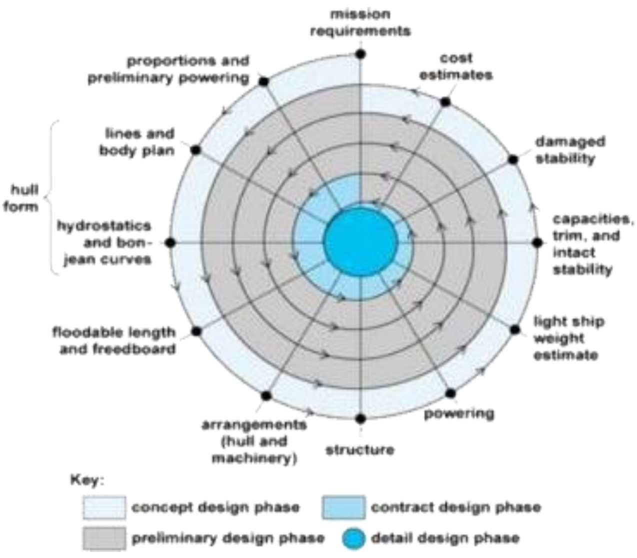

Figure 6. Spiral design (Satoto et al., 2022)

The method in this study uses the main measurements from previous research, and then the design is modified with solar panel technology to save fuel (Awwalin et al., 2022). The spiral design is a stage in the ship design process, starting from determining the main size until the ship is built and returning to the starting point, namely the review of the main size of the ship. Meanwhile, for ships made of HDPE, which is a material other than steel or fibre, using the rules according to IMO (1994), Figure 6 is a sequence of spiral design.

Concept Design

Concept design or design concept is the main stage in the ship design process. Where the ship owner (owner requirement) provides ship data in the form of the primary size, ship tonnage, ship type, shipping area, and type of cargo, it will later be translated by the ship designer (drafter) in the form of a concept.

Preliminary Design

Preliminary design is the second stage after the design concept. After the designer gets conceptual data from the ship owner, further technical efforts will provide more details obtained in the spiral diagram. Preliminary design can also be interpreted as the second literacy on the spiral diagram. An explanation will significantly impact the ship, including an initial approach to the costs required.

Contract Design

Contract design is an advanced stage after preliminary Design. This phase aims to create a ship document contract that the owner and ship designer will make and agree upon. In the contract design, there will be a more detailed ship design development stage, allowing the ship design to determine the overall estimated cost needed to build the ship.

Detail Design

Detail design is the last step of the spiral design or shipbuilding stage. Detail design can also be called final design, which includes all plans or calculations needed for the construction and operational processes of the ship, such as ship drawings or essential plans, ship support equipment, and machinery. The detailed design must determine even the place of shipbuilding or shipyard.

RESULTS AND DISCUSSION

Lines Plan

Lines plan, or line plan depicts the shape of the pieces of the ship's body projected on the front, side, and top views length-wise and transversely. This line plan drawing will later become a reference for the next ship drawing, and the ship's characteristics, shipload, and parent motor power will be calculated according to the designed mileage (Syarifuddin et al., 2022). The following terms are used in the depiction of lines plan according to (Iqbal & Aryawan, 2019):

- LOA (Length Overall) is the overall length measured from the bow end to the stern end of the ship;
- LPP (Length Perpendicular) is the length of the ship measured from AP to FP or from the stern, upright line to the bow upright line at the full load water line;
- LWL (Length of Water Line) is the length of the ship's water line that intersects with the bow and stern perpendicular lines;
- B (Breadth) is the width of the ship measured

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from the outer side of the ship;
- T (Draft) is the ladder of the ship measured from the baseline to the total load water line;
- H (Height) is the height of the ship measured from the baseline to the main deck.

General Arrangement

After drawing the line plan, the next step is to make a general design drawing to plan and determine the space requirements on board, such as loading space and accommodation space (superstructure). General design can be referred to as available room planning according to the ship's function. The general plan also calculates the ship's resistance, calculates the ship's motor power, and determines the number of crew (Sugianto & Buana, 2018).

Solar Panel Requirements for Fish Farming

a. Solar Panel

Solar panels are solar cells that absorb solar energy channelled to the battery. The resulting energy can be used to meet electricity needs for electronic devices (Satoto & Ariyanto, 2019). In the market, solar panels are divided into two types, namely:
- Monocrystalline. This type has material specifications from thin silica, has a panel efficiency of 17-22%, and an average of 320 watts of electricity that can be generated.
- Polycrystalline. This type is different from Monocrystaline even though it is made of silica but is heavier, has a panel efficiency of 15-17%, and the average electricity generated is 240-300 watts.

Furthermore, the panel has a maximum or maximum power that can be absorbed. This can be adjusted to the needs. Currently, there are several sizes, namely 10, 20, 80, 100, 200, and 300-watt peak (wp) (Sardi et al., 2020).

b. Battery

The battery is essential to the solar cell circuit because it stores electrical energy (Setiawan et al., 2015). Generally, batteries are divided into two types, namely:
- The premier battery is a type that cannot be recharged or energized examples of alkaline batteries;
- Secondary batteries are types of batteries that can be recharged. Examples of Accu, power banks, etc.

Batteries have two types of electric current, namely:
- AC is changing or unstable, which is unsuitable for electronic devices;
- DC is a current that tends to be stable, so it is suitable for electronic devices.

c. Selection of Lights for Deck

Electricity needs on the deck require the calculation of the room index to provide adequate average light flux for a square-shaped room and not a sphere. The following is the relationship between the room and shape indexes (Ubaidillah et al., 2021). Equation (1) to Equation (6) is a formula to determine the amount of light flux needed.

$$\text{Area formula} = \text{p x l} \quad (1)$$

$$k = \frac{(\text{p x l})}{(\text{h x (p+l)})} \quad (2)$$

(Interpolation Efficiency /ɳ)

$$\eta = \frac{\eta_1((k-k_1)x\eta_2-\eta_1)}{(k_2-k_1)} \quad (3)$$

$$\eta = \text{U x M} \quad (4)$$

$$\text{Light flux} = \frac{(\text{E x A})}{\eta} \quad (5)$$

$$\text{Number of armature} = \frac{\text{light flux}}{\text{armature flux}} \quad (6)$$

p = room length (m); l = room width (m); k = room index; h= distance of the lamp to the workpiece (m); k = reflection factor; ɳ = factor; U = illumination rate; M = faktor maintenance (0.75); E = wattage capacity (watt); A = area (m^2); ɳ = illumination rate.

The following are guidelines for light illumination intensity for determining lights on board. In Table 3, the guidelines for light illumination intensity are for the type of match, work, road, and traffic decks 20 to 40 lux.

d. Selection of Lights for Cultivation and Fish Luring

The following is the determination of the number of lights in terms of the Gross Ton (GT) value of the ship and the comparison of light intensity in several types of fishing gear (Hamidi et al., 2017).

Based on Table 4, the determination of lights and wattage must be adjusted to the GT of the ship and the target or target catch of fishermen. This study uses it to attract squid; the ship weighs 12 GT. So, the lights for squid use a range of 100-1,000 watts, and the number of lights on 12 GT is 3 (15 watts; 130 volts) lights with a distance of 6 meters and height of 2.8 meters.

Table 3. Solar panel requirements

Equipment	Quantity	Unit power (watt)	Total power (watt)
Deck lighting	2	20	40
Floodlights	2	500	1,000
Fish attractor light	12	15	180
		Power requirement	1,220

Table 4. Distance of lights to GT of the ship (Baskoro & Suherman, 2007)

GT (ton)	∑ hood (piece)	Bulp/piece (watt)	Wattage (kW)	Distance between hoods (m)	Lamp height (m)	Volt
10-20	3	500	15	6	2.8	130
20-30	5	500	20	4	2.8	114

The following are the results of calculating lamp, panel, and battery requirements for cultivation.

1. Panel Calculation for Fish Farming

Based on the facts in the field, the number of solar cells needed refers to the power used.

- Power requirement

$$\text{Power requirement} = 1{,}220 \text{ x } 5 \text{ hours}$$
$$= 6{,}100 \text{ Wh}$$

- Solar panel requirement

$$\text{wp} = \frac{6{,}100}{7 \text{ hours}} = 871 \text{ wp}$$

- Battery quantity
  a. If using 12V / 50 Ah

$$\text{Battery} = \frac{\left(\frac{871}{12}\right)}{50} = 1.5 \text{ (2 batteries)}$$

  b. If using 12V / 80 Ah

$$\text{Battery} = \frac{\left(\frac{871}{12}\right)}{80} = 0.9 \text{ (1 battery)}$$

- Total number of panels
  a. If using 100 wp monocrystalline

$$\text{Panels} = \frac{871}{100} = 8.7 \text{ (9 panels)}$$

  b. If using 200 wp monocrystalline

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$$\text{Panels} = \frac{871}{200} = 4.3 \text{ (5 panels)}$$

The next panel and battery specifications were selected based on the above calculations: 200 wp monocrystalline panels with five panels (requires an area = 9.6 m^2 and weighs 87 kg).

2. Calculation of the Number of Passengers

Equation (7) is used to determine the number of passengers that can be accommodated by the ship (D'Arcangelo, 1969):

$$Z_C = C_{st}\left[C_{eng} \text{ x } \left(\frac{PB}{10^5}\right)^{\frac{1}{3}} + C_{dk}\text{x } \left(Lpp \text{ x } B \text{ x } H \text{ x } \frac{35}{10^5}\right)^{\frac{1}{6}} + \text{Cadets}\right] \quad (7)$$

C_{st} = steward deck coefficient (1.2-1.3); taken C_{st} = 1.2. C_{dk} = deck department coefficient (11.5-14.5); taken C_{dk} = 11.5. C_{eng} = engine department coefficient (8.5-11.0); taken C_{eng} = 8.5. PB = engine power; taken PB = 500 Hp = 670 kW. Cadets = additional officers / guests; taken Cadets = 1 people. Zc = number of passengers (people).

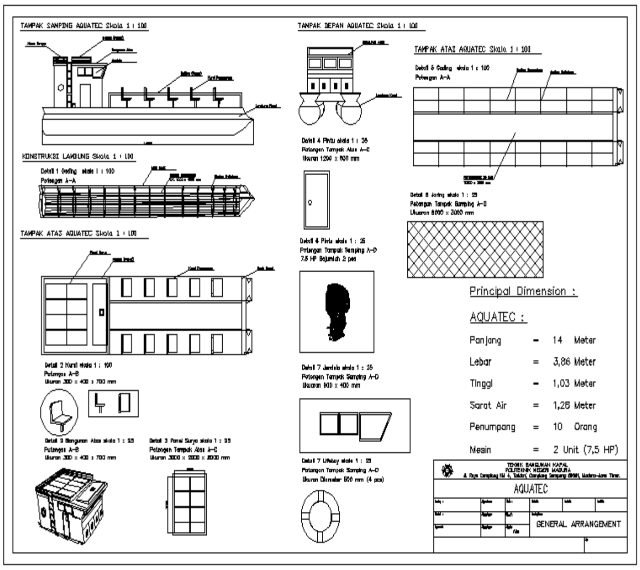

Figure 7. General plan design

Based on the above calculations, the maximum number of passengers is 12, with a full load of 75 kg per person. Determining the maximum number of passengers to maintain passenger safety.

3. General Plan Design

Figure 7 is a general plan drawing designed using application assistance. The general plan is designed to mobilize facilities to facilitate fishermen in the fishing process. Other equipment such as solar panels, power generation energy on Lacuba, and spotlights can optimize free energy from sunlight. Furthermore, 3D modelling can be seen in Figure 8.

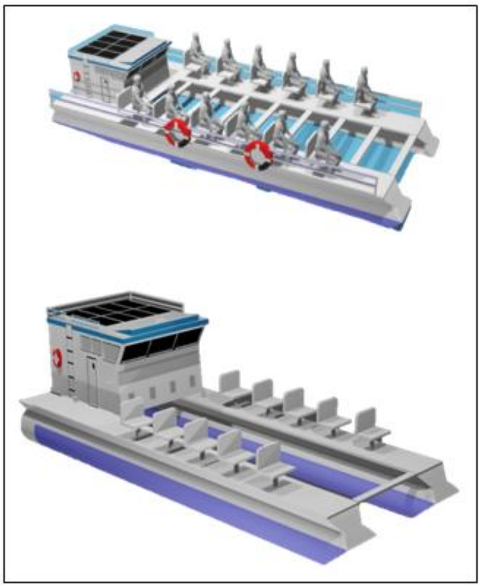

Figure 8. 3D design

CONCLUSION

The above explanation concludes that a general plan drawing is obtained with the primary size of the ship L = 15.00 m, B = 4.00 m, H = 1.71 m, and T = 0.86 m. The number of panels needed for cultivation is as follows:

- Number of solar panels: 5 panels (200 wp);
- Number of batteries: 1 piece (12V/80 Ah);
- Number of deck lights: 2 (20 watts);
- Number of spotlights: 2 (500 watts);
- Number of Lacuba (Underwater Dip Lamp) lights 12 (15 watts);
- Max number of passengers: 12 passengers (max 75 kg).

In the following research, stability calculations will be carried out according to IMO (1994), and resistance will be used using the Fung method.

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