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Design and Fabrication of 6 Meter Fiberglass Boat for Coastal Water Tourism in Batam

Hendra Saputra[1], Danang Cahyagi[2,*], Veryawan Nanda Perkasa[3], Dedi Purnama[4], Oxa Nurmannsyah[5], Rangga Saputra[6], Regita Ferari[7], Faaza Ibnu Al Fauzy[8], Muhammad Fadillah[9]
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***Abstract*— A tourist boat is one of the amenities frequently utilized in coastal water tourism activities in Batam. Boats used for tourism are frequently used for fishing or simply to take in the beauty of marine tourism. Thus, one of the requirements that must be developed for local tourism is the availability of boats for water tourism. The goal of this research is to create a design and prototype for a six-meter water tourism boat that can serve as a public reference within the same case study. Because of its advantages in terms of cost and readily available materials, fiberglass was selected as a material for design and fabrication. Because of its benefit of being a simple fabrication process, the fiber-reinforced plastic method was also selected for use in the process. A six-meter fiberglass boat prototype was created through a multi-phase process that began with design, moved on to hydrostatic and power requirement prediction analyses, and ended with mold-based fabrication. The study concludes that 40 horsepower (29.5 kW) is needed to power a 6-meter fiberglass boat that can accommodate five people and reach a maximum speed of 25 kN. Five to seven layers of fiberglass were used to successfully complete the ship fabrication process.**

Keywords— tourism boat, coastal water, fiberglass, tourism boat design, tourism boat fabrication

I. INTRODUCTION

Indonesian government has focused on a number of areas, including tourism development, in an effort to enhance the economic growth, improve people's welfare, end poverty and unemployment, protect the environment and natural resources, and promote culture [1], [2].

As an industrial and maritime city consisting of a group of islands, Batam is one of the cities that has a high demand for ships in various segments of community activities. In order of importance are the needs for trade, transportation, fishing, and tourism. There were 9,217 ships registered in Batam as community ships, according to data specifically for ships used for tourism and fishing. Out of all the vessels, fishing boats under 5GT (2063 units, 44%), motorboats without motors (1836 units, 39%), and outboard motorboats (498 units, 10%) make up the majority of the vessel types. These boats are typically constructed of fiberglass and wood.

Due to its distinct topography and multi-island nature, Batam is a highly desirable site for investments in lodging, coastal water tourism, and travel-related services, all of which have an influence on the growth of marine tourism. Ships that support Batam's tourism industry are still imported, despite the high demand; this is partly due to the low level of domestic industry participation.

With the availability and cost of wood as a basic material for boat-buildings, the production of wooden ships is decreasing over time. As the use of wood as a prodution material decreases, people typically turn to fiberglass materials [3], [4]. Because the raw materials are less expensive and the manufacturing process is simpler than for metal ships, fiberglass is a substitute material for boat manufacturing.

Several studies on fiberglass vessels in a range of ship sizes and industrial sectors have been carried out over the past ten years by researchers from various Indonesian universities. A 6-meter fiberglass boat was produced at a Surabaya university by Indartono & Sudarso (2012) in an effort to raise awareness of the industry and provide students with a useful knowledge [5]. As an alternative material that can be used to get around the limitations of wooden materials for fishermen, Romadhoni et al., (2015) and Pardi & Afriantoni, (2017) also produced fiberglass boats in Bengkalis [6], [7].

Research on making fiberglass boats for fishermen was also carried out by Ardhy et al., (2019), Ariesta et al., (2018), Marzuki et al., (2017), Boesono et al., (2018), Pambudi et al., (2021), and Ranteallo et al., (2022) [3], [4], [8], [9], [10], [11]. Marzuki et al (2017) focused their research on the application of classification

Hendra Saputra, Naval Construction Engineering Technology, Politeknik Negeri Batam, Batam, 29461, Indonesia. e-mail : hendrasaputra@polibatam.ac.id
Danang Cahyagi, Naval Construction Engineering Technology, Politeknik Negeri Batam, Batam, 29461, Indonesia. e-mail : cahyagi@polibatam.ac.id
Veryawan Nanda Perkasa, Naval Construction Engineering Technology, Politeknik Negeri Batam, Batam, 29461, Indonesia. e-mail : veryawan@polibatam.ac.id
Dedi Purnama, Naval Construction Engineering Technology, Politeknik Negeri Batam, Batam, 29461, Indonesia. e-mail : ddiprnama@gmail.com
Oxa Nurmannsyah, Naval Construction Engineering Technology, Politeknik Negeri Batam, Batam, 29461, Indonesia. e-mail : oxanew203@gmail.com
Rangga Saputra, Naval Construction Engineering Technology, Politeknik Negeri Batam, Batam, 29461, Indonesia. e-mail : ranggasyaputra204@gmail.com
Regita Ferari, Naval Construction Engineering Technology, Politeknik Negeri Batam, Batam, 29461, Indonesia. e-mail : regitaferari003@gmail.com
Faaza Ibnu Al Fauzy, Naval Construction Engineering Technology, Politeknik Negeri Batam, Batam, 29461, Indonesia. e-mail : Faaza.ibnu05@students.polibatam.ac.id
Muhammad Fadillah, Naval Construction Engineering Technology, Politeknik Negeri Batam, Batam, 29461, Indonesia. e-mail : adiltaktaudie@gmail.com

regulations to the hull construction of 3GT fiberglass fishing boats carried out at several shipyards in Cilacap [8]. Based on their research, Marzuki et al (2017) found that several shipyards surveyed had implemented these classification regulations.

Putra et al., (2022) conducted a survey in Benoa, Bali, regarding the application of classification regulations in 2022. 10% of activities were included in the category of not conforming, 20% were included in the category of appropriate, and 70% of activities in shipyards were included in the category of very appropriate, according to the results of standardizing part 3 of volume B Guidance for Certification of FRP Fishing Vessels less than 12 m [12].

Ariesta et al. (2018) conducted a comparative economic analysis of fiberglass and wooden boats in Randuboto Village, Gresik, East Java, and discovered that fiberglass boats were more profitable than wooden boats from an economic standpoint [4]. Pambudi et al. (2021) in Bayuwangi, East Java, manufactured fiberglass boats to support the fishing and the tourism industry in Sumberasri Village, Purwoharjo District [10]. The purpose of this project is to teach the community how to build fiber boats. Pambudi et al. (2021) claim that fiberglass is a more cost-effective material for small boats than metal or wood. Following the training and mentorship, the participants demonstrated strong hand lay-up technical skills and material knowledge, according to the evaluation results [10].

Ranteallo et al. (2022) taught the residents of Membramo Raya Regency how to make fiberglass motorboats in Membramo Raya, Papua. The purpose of this research is to equip Membramo Raya residents with the knowledge and abilities needed to build fiberglass boats and ships. The training method involves presenting theoretical knowledge initially, followed by the introduction of tools and materials, the preparation of tools and materials, and the stages of building a boat or motorboat until completion [11]. Boesono et al. (2018) concentrated their research in Jepara, Central Java, to determine the amount of polyurethane foam required to float a five-meter-tall ship [9]. Boesono et al. (2018) discovered that 45 kg of polyurethane foam is required to keep a 5 GT fiber fishing boat floating.

Apart from fishing activities, fiberglass boats are also made for tourism sector activities and campus operational vessels. The manufacture of fiberglass boats for tourism sector activities was carried out by Sulasminingsih et al., (2017) and Ariesta et al (2018) [4], [13]. Sulasminingsih et al (2017) conducted an economic study of techniques for making bottom glass outrigger boats from fiber glass for marine tourism in Banten Village, Kasemen District, Serang City, Banten Province. Meanwhile, Ariesta et al (2018) compared wooden boats and fiber glass boats in Gresik.

The economy of the people in Batam can be greatly bolstered by the use of fiberglass boats. They make it easier to trade and exchange goods by facilitating the efficient movement of people and goods between small islands. Additionally, by providing access to stunning beaches and other tourist destinations on small islands, these ships help the tourism industry, which in turn can boost local economies and job prospects. Therefore, the local population's economy benefits greatly from the use of fiberglass boats as a mode of transportation in Batam. They not only successfully address the geographical difficulties small islands face, but they also make it possible for these places to experience competitive and sustainable economic growth.

There isn't much research on fiberglass boat building in Batam, despite the fact that it has been extensively studied in a number of Indonesian regions, including the Province of the Riau Islands. Research on fiberglass materials on tourism boat was done in number studies by Satoto et al., (2020) and Muvariz et al., (2019) [14], [15]. Small businesses and the local community in Batam typically construct fiber boats for fishing and inter-island transportation.

Fiberglass boats have a long history that began with important advancements in the middle of the 20th century. When Ray Greene unveiled the first polyester-fiberglass boat in 1942, boatbuilding underwent a sea change [16]. Later, in 1957, improvements were made to the molding process for boats by employing glass fibers bonded with synthetic resin, which improved the production process. [17]. By 1968, methods for creating glass-fiber laminate boat sections had been developed, highlighting the fiberglass boats' structural integrity. [18]. Fiberglass fishing boats with wear-resistant layers and protective bars for increased longevity and durability are the result of these advancements. [19]. All things considered, the development of fiberglass boats in the middle of the 20th century transformed the marine industry with their strong, lightweight, and effective designs. [18], [19].

The purpose of this study is to design and build a tourism boat that meets the needs of Batam's coastal water tourism. The public should be able to use this study as a guide when building fiberglass boats for tourism. Because of its advantages in terms of material availability in the community, ease of material formation, and relatively lower production costs, fiberglass was selected as the basic material for making tourism boats.

II. METHOD

The first step in this research is to identify the characteristics of coastal tourism activities in Batam. Some of the identification is related to the activities that tourists typically engage in to enjoy the beauty of the coastal water tourism area. The tourism boat's speed during operation is one of the factors used to determine how much power should be provided on board the tourism boat. Identification is also performed on collecting coastal water characteristics which are then used to modelling and analysis process.

Surveys conducted in Kasu Island, Batam City, have also revealed community-based boat production. The purpose of the survey is to learn about the most recent advancements in community shipbuilding as well as the methods used to construct fiberglass ships. According to the survey, people in Batam City are currently beginning to make fiberglass boats instead of wooden ones since the materials are more readily available, the process of

making them is simpler, and the cost is generally less.

Following the identification of tourism boat design parameters, the research moves on to designing the tourism boat. Tourism boat design involves determining the dimensions of the tourism boat to be built, which include length, width, height, and the number of passengers that can be carried. The tourism boat's dimensions are then defined in the specification data. Line plans were the first technical drawings created to represent the shape of a tourism boat both above and below water. The tourism boat's underwater shape will be a distribution parameter that determines the tourism boat's hydrodynamic characteristics and thus affects its stability.

This study uses tourism boat resistance calculation modeling with Maxsurf® to determine the tourism boat power required to move the tourism boat at the designed speed. The resistance calculation modeling was performed using 3D modeling to determine the shape of the tourism boat underwater. Savitsky planning became the reference method because this tourism boat was taller. The output parameters from the resistance calculation modeling are estimates of the resistance and power values required to move the tourism boat at a specific speed.

The free surface running modeling approach is also used in this research to determine the free surface movement characteristics of the tourism boat while traveling at a specific speed. Free surface running modeling was also performed using Maxsurf®.

After the tourism boat design process has been completed. The research continued with making a 6 meter fiber glass boat prototype with the following stages:

1. Prepare the mold: The mold that will be used to form the tourism boat's structure must be made once the tourism boat's design is finished. Polystyrene, wood, and other resilient materials that can take on the required shape can be used to create this mold.
2. Material preparation: The primary ingredient needed to make fiberglass boats is glass fiber, which can be found as a mat or cloth. In addition, polyester or epoxy resin are required as an adhesive. Prior to the commencement of the manufacturing process, these ingredients need to be prepared in the appropriate amounts and quality.
3. Resin application: Resin is applied to the surface of the mold using a brush or other tool. After that, layers of glass fiber are placed on top of the resin in the specified order. This process is repeated to create several layers that form a strong structure that is resistant to the pressure and force of ocean waves.
4. Drying and hardening: The process of drying and hardening the resin comes next after the tourism boat structure has been formed. Several days or longer are typically needed for this process to complete, depending on the type of resin and the surrounding circumstances.
5. Cutting and finishing: The fiberglass boat can be polished and cut to take on the final shape and appearance that is desired after it has fully solidified. Other components like windows, doors, and navigation systems can then be installed.

III. Results and Discussion

One of the coastal tourist locations in Batam is Nongsa tourism which is also recognized by the Ministry of Tourism and Creative Economy (Kemenparekraf). According to the Ministry of Tourism and Creative Economy, this location has a marina which can be a docking location for tourists using yachts. This resort is also equipped with other amenities such as an international standard golf course. Figure 1 shows coastal water tourism in Nongsa.

A six-meter fiberglass tourism boat's design specifications include having a length of 6.11 meters, a width of 1.58 meters, and a draft of 0.26 meters. The intended speed of this tourism boat is 20 knots. It needs 29.5 KW of power. Table 1 displays the specifications for the 6-meter fiberglass tourism boat.

Figure 1. Coastal water tourism in Nongsa, Batam
Source: Setiawan Documentation on Kemenparekraf (2021)

TABLE 1.
SPECIFICATION OF 6 METER TOURISM BOAT

No.	Parameters	Values
1	LOA	6.11 m
2	LWL	5.3 m
3	Beam	1.58 m
4	Height	0.84 m
5	Draft	0.26 m
6	Displacement	574 kg
7	Speed	25 kN
8	Power	29.5 kW
9	Capacity	5 Person

Source: Personal Data (2023)

The first step in production a 6-meter fiberglass boat is designing the tourism boat's line plan using the given parameters. The Fiberglass tourism boat's intended line plan is depicted in Figure 2. The monohull type was chosen as the hull form because the fabrication process is simple and has lower manufacturing costs.

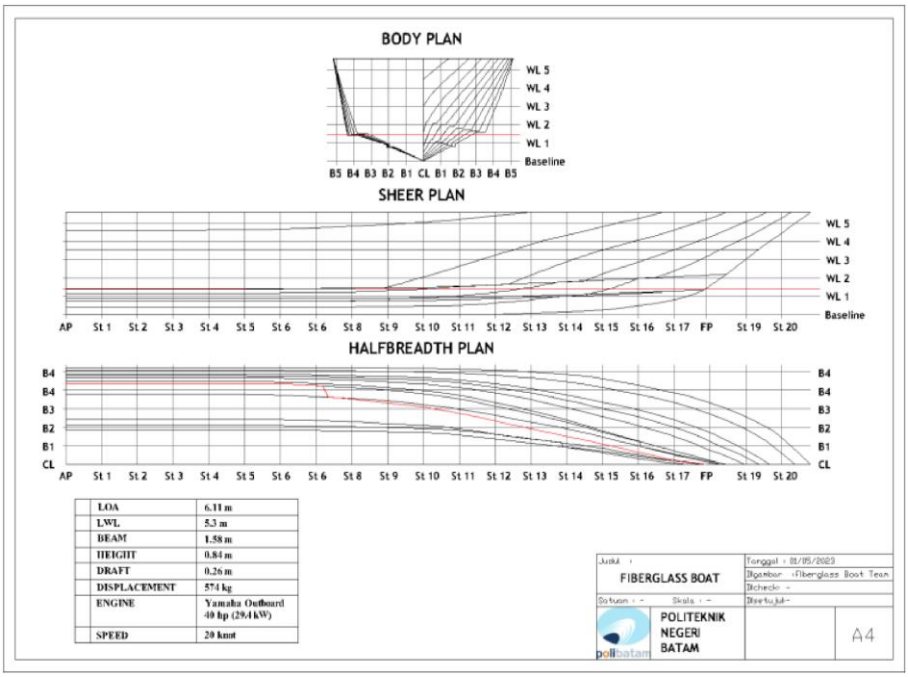

Figure 2. 6 Meter Tourism Boat's Linesplan
Source: Personal Documentation (2023)

Tourism boat modeling was begin to support the power prediction process for a six-meter fiberglass tourism boat. In order to complete this modeling, the tourism boat's three-dimensional shape is represented in accordance with the original plan. Three-dimensional modeling is also used to analyze the resistance and power requirements required by tourism boats. Tourism boat modeling for power prediction is shown in Figure 3.

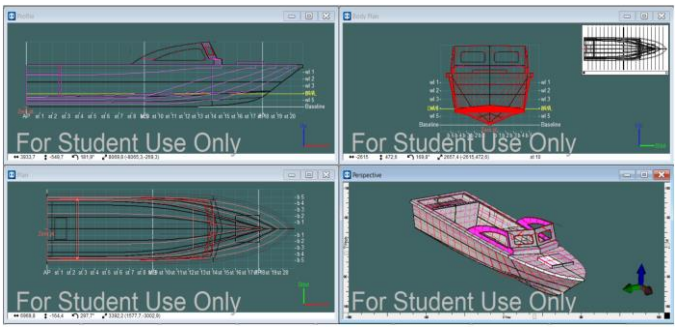

Figure 3. Tourism boat modelling for power prediction
Source: Personal Documentation (2023)

The availability of hydrostatic charts aims to provide information about the characteristics of a tourism boat's hull while submerged. This will describe the hull characteristics for each tourism boat's draft. Figure 4

depicts the results of modeling the hydrostatic characteristics of a 6-meter touring boat.

The hydrostatic graph provides information on several parameters, including displasmen, wetted area, water plan area, longitudinal center of bouyancy (LCB), longitudinal center of floatation (LCF), Keel-Bouyancy (KB) number, and tonnes per centimeter immersion (TPc). According to hydrostatic analysis results, at a draft of 0.26 meters, the tourism boat's displacement value is 0.57 tons, and the tourism boat's LCB value is 2.55 meters from stern of the boat. Figure 4 shows the detailed hydrostatic characteristics of the 6-meter tourism boat.

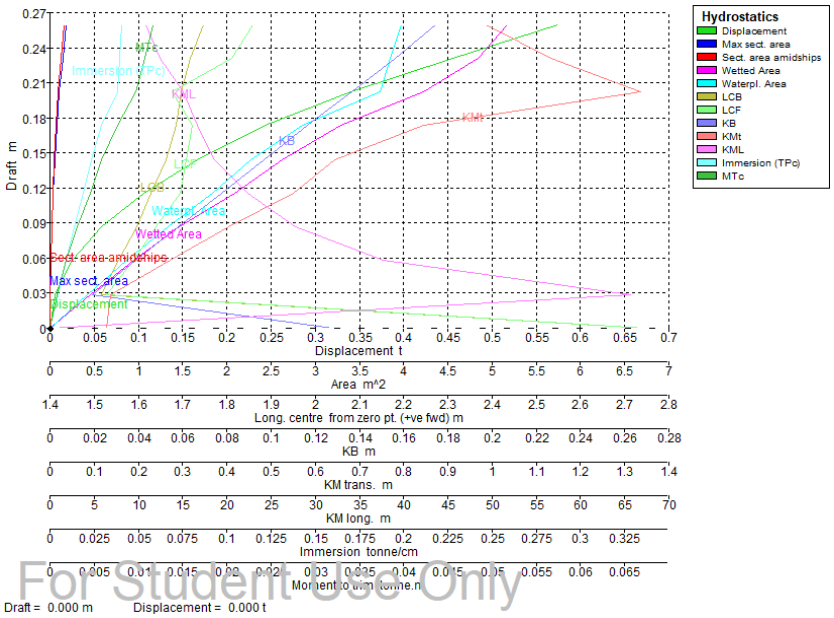

Figure 4. Hydrostatic result of 6 meter tourism boat
Source: Personal Documentation (2023)

The power prediction analysis of a 6-meter fiberglass tourist tourism boat using tourism boat modeling is shown in Figure 5. The analysis's findings indicate that in order to achieve a maximum speed of 25 km/h, 40 hp of power are required; this information will be utilized to choose the engine.

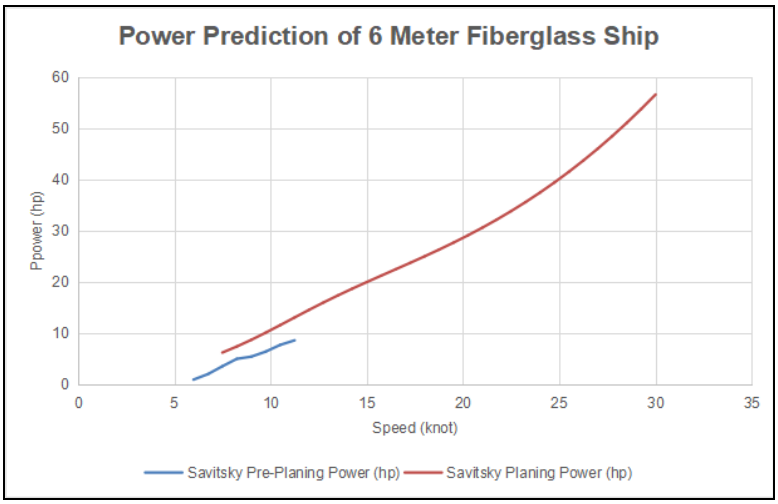

Figure 5. Power prediction of 6 meter tourism boat
Source: Personal Documentation (2023)

Free surface modeling was also done through modeling in order to ascertain the operational characteristics when the tourism boat is used in this study. The findings of a free surface modeling analysis on a six-meter fiberglass tourist boat are displayed in Figure 6. Based on the results of the free surface running analysis, it is known that the movement of the tourism boat while traveling at the planned speed meets the standards.

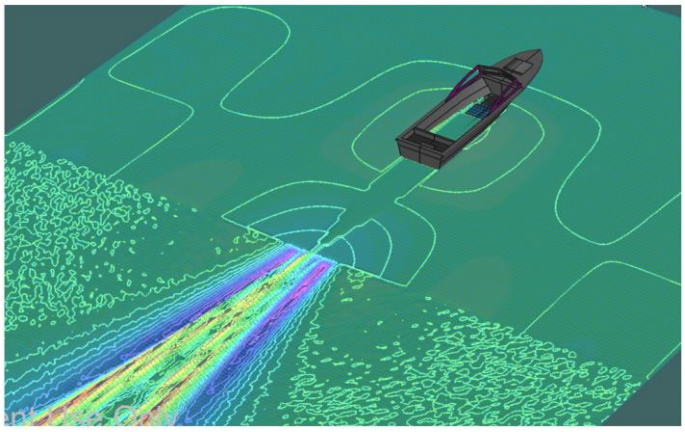

Figure 6. Free surface modelling
Source: Personal Documentation (2023)

Following the successful completion of the 6-meter fiberglass tourist boat's design and modeling, the study moved on to the boat's fabrication. Preparing the tourism boat mold fit the intended tourism boat shape is the first step in the tourism boat fabrication process. The section of the tourism boat can be adjusted to change the overall length of the vessel.

The tourism boat's hull is coated with lamination or gelcoat to prevent the fiber fluid from adhering to it. Laminated white plywood is used in the construction of the tourism boat's floor plate to create a flat fiber plate with a consistent thickness. Five to seven layers of fiber are used in the tourism boat's fiber lamination process. The strongest part of the tourism boat is its keel, which has seven layers of fiber. Five layers of fiber covering the lower floor and hull. On the superstructure and deck, two coats. The manufacturing process for tourism boat structure and lamination is depicted in Figure 7.

Figure 7. Manufacturing process of tourism boat
Source: Personal Documentation (2023)

In the next stage, the fiberglass laminate is released from the hull master mold to continue the tourism boat fabrication process. To facilitate an easy removal procedure, fresh water is poured into the space between the mold master and the fiber layer. Figure 7 shows the mold removal process of tourism boat. After hull fabrication is finished, the superstructure is begun to be constructed. All the components of the superstructure are cut by hand, and the entire structure is covered in fiber. Installation of tourism boat engines. This tourism boat has a front rudder and an electric starter to power its 2-stroke outboard engine, which produces 40hp (29.5 kW). Figure 8 shows the engine installation and finishing process of tourism boat.

Figure 8. Engine installation and finisihing process of tourism boat
Source: Personal Documentation (2023)

Based on the design and construction of fiberglass tourism boats intended for coastal tourism that it is quite achievable for this kind of tourism boat to be manufactured in the country. This is reinforced by the expertise of the instructors, students, and community members engaged in the shipbuilding process, as well as by the accessibility of supplies and machinery that aid in the building process. Nonetheless, the quality of built tourism boats must be adapted to imported tourism boats that are currently in service in a number of Batam tourist destinations. The goal of this is to raise the standard of fiber boat manufacturing so that it can fulfill the necessary requirements.

IV. Conclusion

In Batam, tourism boats have a specific place in the demands of marine tourism activities. Typically, people use tourism boats for fishing or to take in the beautiful views of the seas. The purpose of this study is to design a tourism boat and build a prototype out of fiber glass material that will be suitable for public use as a guide for tourism boat manufacturing. Since the fiberglass material is more readily available in society and is less expensive, it was selected as the material of choice. Fiber reinforced plastic has advantages in material formation, it is also used as a fabrication method. Based on linesplan design and three dimentional modelling, the findings led to the conclusion that 40 horsepower (29.5 kW) is needed to power a six-meter tourist boat that can accommodate five people and travel at 25 knots. The longitudinal center of bow of this ship is 2.55 meters from the boat's stern, according to hydrostatic analysis. Based on fabrication activities, five to seven layers are needed to complete the fiberglass manufacturing process using a mold. In order to ascertain the actual performance of the tourism boat with respect to the hull and machinery, this study will be extended through sea trial testing.

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