UNIVERSITI TEKNIKAL MALAYSIA MELAKA

DESIGN AND FABRICATION OF WATER BIKE NAVIGATION AND PROPULSION SYSTEM

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BACHELOR OF MECHANICAL ENGINEERING TECHNOLOGY (AUTOMOTIVE TECHNOLOGY) WITH HONOURS

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Faculty of Mechanical Technology and Engineering

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A thesis submitted in fulfillment of the requirements for the degree of Bachelor of Mechanical Engineering Technology (Automotive Technology) with Honours

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BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA MUDA

TAJUK: **Design And Fabrication Of Water Bike Navigation And Propulsion System**

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APPROVAL

I hereby declare that I have checked this thesis and in my opinion, this thesis is adequate in terms of scope and quality for the award of the Bachelor of XXX Engineering Technology (specialisation) with Honours.

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Supervisor Name : IR. TS. DR. MOHAMAD HAFIZ BIN HARUN

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DEDICATION

This dedication is for the pillars of support and inspiration in my life to my beloved parents and family. It is my deepest appreciation for their everlasting love, wisdom, and support, which has enabled me to continue pursuing my studies to this day. Their constant support and belief in me have served as a guiding light throughout difficult times. Thank you to my supporting lecturer, Ir. Ts. Dr. Mohamad Hafiz Bin Harun, for your dedication to imparting knowledge, challenging my brain, and nurturing my development. Your mentorship has impacted my thoughts and fueled my desire to study.

Finally, I'd like to thank my family for their unwavering love and my supportive friends for their encouragement and support in my studies. Without your assistance, I would not have made it this far. I'd like to commend myself for continuing to strive for my best despite a difficult academic career. I am proud of myself since I have done my absolute best to obtain what I have now.

ABSTRACT

In rural areas where geographical barriers such as water bodies hinder access to education, unsafe or inefficient transportation methods contribute to high dropout rates among students. This research aims to design, develop, and evaluate a human-powered water bicycle to provide safe and reliable transportation while improving access to education. The design process involved conceptualizing a propulsion system with a three-blade propeller (220 mm in diameter) and a navigation system utilizing a rudder connected to handlebars for precise control. We conducted flow simulations to guide the construction phase. The prototype was fabricated and tested for performance, focusing on propulsion efficiency, durability, and user experience. The propeller achieved an efficiency of 4.59%, consistent with the typical range of 5% to 15% for human-powered watercraft (Fuglsang et al., 2017). This efficiency was attributed to the use of a dynamo-powered grass cutter shaft, which, although not specifically optimized for water propulsion, demonstrated effective power transmission. Field tests indicated sufficient thrust for smooth and stable motion across water with minimal energy loss. Steering was responsive, and durability tests confirmed the resilience of key components under various conditions.The results validate the feasibility and efficiency of the water bicycle, demonstrating its potential to overcome geographical barriers and enhance access to education in rural areas.

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ABSTRAK

Di kawasan luar bandar di mana halangan geografi seperti badan air menghalang akses kepada pendidikan, kaedah pengangkutan yang tidak selamat atau tidak cekap menyumbang kepada kadar keciciran yang tinggi dalam kalangan pelajar. Penyelidikan ini bertujuan untuk mereka bentuk, membangunkan, dan menilai basikal air berkuasa manusia untuk menyediakan pengangkutan yang selamat dan boleh dipercayai, sekali gus meningkatkan akses kepada pendidikan.Proses reka bentuk melibatkan konsep sistem pendorongan dengan kipas tiga bilah (berdiameter 220 mm) dan sistem navigasi yang menggunakan kemudi yang disambungkan kepada pemegang untuk kawalan yang tepat. Simulasi aliran telah dijalankan untuk membimbing fasa pembinaan. Prototaip telah dibina dan diuji untuk prestasi, dengan memberi tumpuan kepada kecekapan pendorongan, ketahanan, dan pengalaman pengguna.Kipas mencapai kecekapan sebanyak 4.59%, yang konsisten dengan julat biasa 5% hingga 15% untuk kenderaan air berkuasa manusia. Kecekapan ini disebabkan penggunaan batang pemotong rumput berkuasa dinamo, yang walaupun tidak dioptimumkan secara khusus untuk pendorongan air, menunjukkan penghantaran kuasa yang berkesan. Ujian lapangan menunjukkan daya tujahan yang mencukupi untuk pergerakan yang lancar dan stabil merentasi air dengan kehilangan tenaga yang minimum. Sistem stereng responsif, dan ujian ketahanan mengesahkan keteguhan komponen utama dalam pelbagai keadaan. Keputusan ini mengesahkan kebolehgunaan dan kecekapan basikal air, menunjukkan potensinya untuk mengatasi halangan geografi dan meningkatkan akses kepada pendidikan di kawasan luar bandar.

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To all those mentioned above, as well as anyone else who has contributed in any way to the creation of this research study, I'm extend my heartfelt appreciation. Your contributions have been invaluable, and I'm truly appreciate your support.

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LIST OF SYMBOLS AND ABBREVIATIONS

ECSM	-	Electronic control steering mechanisms
SBW	-	Steer-by-wire
MHSM	-	Manual Hydraulic Steering Mechanism
CAD	-	Computer Aided Design
3D	-	Three(3) Dimension
2D	-	Two(2) Dimension
UTeM	-	Universiti Teknikal Malaysia Melaka
RPM	-	Revolution per minute
ANSYS	-	Analysis Software
ω	-	Angular velocity
m/s	-	Meter per second
kg/m³	-	Kilogram per meter cube
RPM	-	Revolution per minit
P_output	-	Power output
F_thrust	-	Force thrust
V_outlet	-	Velocity outlet
V_inlet	-	Velocity inlet
Rad/min	-	Radian per minit
Nm	-	Newton meter
η	-	Efficiency
mm	-	Milimeter
N	-	Newton
W	-	Watt
%	-	Percent

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CHAPTER 1

INTRODUCTION

1.1 Background

Water bicycles, or hydrobikes, are innovative watercraft that combine cycling and boating, providing a fun and eco-friendly way to navigate water bodies. Their propulsion system, which includes a pedal mechanism and a propeller, efficiently turns pedalling into motion. The navigation system integrates handlebars with a rudder to enhance balance in turbulent waters. Water bicycles are popular for recreation and fitness and have a low environmental impact. They are accessible and sustainable, focusing on user experience and eco-friendliness.

This project focuses on developing a water bicycle propulsion and navigation system to help students in rural areas get to school more easily. Many rural communities are located near rivers or other waterways, but these areas often lack reliable and affordable transportation options for students. Traditional boats are often expensive and complex in their design, which is unsuitable for everyday use by students.

This project aims to create a water bicycle that is easy to maneuver, affordable, and environmentally friendly for short water trips. The project specifically aims to design an effective and unique model that will facilitate the transportation of students in rural regions to school.. This will help enhance their quality of life and academic achievement.

1.2 Problem Statement

The issue that is focused on in this study is the transportation issues that students in rural areas require in order to go to school. Therefore, based on the issues of transportation affecting students in rural areas, especially in areas with water bodies, this study is centred on the design of water bicycles as a viable solution. Unlike other means of transport, water bicycles add value to crossing bodies of water and reduce the time, energy, and costs of travelling to school for students in rural areas. As a result, this study focuses on assessing the readiness of the propulsion system and the navigation system of water bicycles to support school transport.

The technology used to drive water bicycles is vital when it comes to the performance of the bicycles when in the water. Comparing and evaluating pedal-assist electric, paddle wheel, and jet propulsion will help in determining the best propulsion method for use when traversing challenging and changing water terrain in rural regions. For that reason, the assessment of navigation system components such as the spade or balanced rudder and ship wheel steering are significant factors required to enhance precise control and safety during transportation.

In light of this, this study seeks to establish the extent to which water bicycles can effectively address the challenges of transport for students in rural areas by assessing their propulsion and navigation systems. The knowledge of the technical characteristics of water bicycles has the potential to promote the practical application of sustainable transport, which may greatly enhance school attendance and the effectiveness of education for children in rural schools.

1.3 Research Objective

The main aim of this research is to **DESIGN AND FABRICATION OF WATER BICYCLE NAVIGATION AND PROPULSION SYSTEM**. Specifically, the objectives are as follows:

a) To Develop water bicycle propulsion system and navigation system

b) To fabricate water bicycle propulsion and navigation system

1.4 Scope of Research

The scope of this research are as follows:

a) Proposed the concept of water bicycle propulsion system and navigation system.

b) Design propulsion system and navigation system using CATIA V5R21.

c) Analysed the propulsion system design using Ansys.

d) Fabricated water bicycle propulsion system and navigation system

e) Install the propulsion system and navigation system on water bicycle

f) Test the performance of propulsion systems and navigation system in the water

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Literature review includes study and research of published material like journals, thesis, case studies, technical document, book and online library. Generally, the purpose of their view is to analyze critically a segment of a published body of knowledge through summary, classification, approach used in their project, and any technique that used in their study, review of literature and theoretical articles.

This chapter will describe topics that related of conceptual design, Optimization, Design Process and other relevant topic for this project. These chapters to carry out any approach that can use in water bicycle navigation and propulsion system. This topic also describes about type of amphibious vehicle to know how that vehicle work using navigation system and propulsion system.

2.2 Amphibious vehicle

An amphibious vehicle is a kind of transportation that can travel on land, water, and even underwater. It is also known as Amphibian. Amphibious vehicles are vehicles that can be used in a variety of ways. It can be put forward for commercialization purposes with respect to numerous applications, such as the field of military and rescue operations(MGawande & Mali, 2016).

Designing a great amphibious vehicle entails carefully balancing engineering considerations for both land and water movement. This includes shaping the hull for efficient water navigation, designing propulsion systems for both land and water, and ensuring tight seals to keep water out during transitions. Modern amphibious vehicles provide better performance and versatility as materials and technology evolve.

Amphibious vehicles come in various types, each designed for specific purposes and environments. Among these types are amphicar, amphibious buses, amphibious trucks, Amphibious ATVs and water bike. Amphibious vehicles enable recreational users to explore unusual landscapes and waterways that are inaccessible to conventional vehicles. While the notion of amphibious vehicles has existed for centuries, advances in materials, propulsion technology, and design have resulted in increasingly powerful and flexible vehicles. Despite the constraints given by the dual land-water environment, continued research and development are pushing the boundaries of amphibious mobility.

2.2.1 Amphicar

The Amphicar is the first non-military amphibious vehicle ever commercially constructed. Because of the numerous rules and regulations governing road and water vehicles, it is highly improbable that another car-based amphibian would be built. Amphicar can reach over 70 mph on the road and 8 knots in the water. It is comfortable enough to travel 500 miles per day; road behavior is equivalent to an excellent 1960s European saloon car or a 1980s American automobile (Shirsath et al., n.d.-a).

The Unique features of Amphicar is Road clearance, 2 inches greater than a Jeep, make it an ideal off-road vehicle; a low first gear also contributes to its off-road capabilities. The Amphicar's amphibious functionality was achieved through the use of twin propellers mounted at the rear, providing propulsion in water, while the wheels acted as rudders for steering. The Amphicar demonstrates the possibilities of dual-mode mobility, inspiring inspiration and excitement among individuals who are captivated by its amphibious characteristics.

Figure 2.1 : Ampicar in water (Shirsath et al., n.d.-b)

2.2.2 Amphibious buses

Amphibious buses, sometimes known as swimming buses, are a versatile means of transportation that could be used in tourism, military operations, and rescue missions. Recent breakthroughs include the creation of a 45-passenger self-driving amphibious bus with a by-wire system, autonomous operation, and navigation software(Watabe et al., 2022). These developments demonstrate the potential for amphibious buses to address transportation issues in both urban and rural settings.

Typically, an amphibious bus looks like a regular bus but has amphibious elements including a watertight hull, marine propulsion system, and buoyancy control devices. On land, it operates like a regular bus, utilizing its conventional wheels and road-based propulsion system. When it becomes necessary to move across water, the bus converts into a waterborne mode by activating its amphibious parts. Depending on the bus's design, these could be retractable wheels, water-jet propulsion systems, or paddle wheels.

Amphibious buses are mostly utilized for tourism, providing passengers with a unique opportunity to visit both land-based sites and waterfront attractions. They serve practical uses in locations with little road infrastructure, such as providing shuttle services, transporting tourists to islands or waterfront resorts, and even assisting in emergency evacuations in flood-prone areas.

Overall, amphibious buses are a creative transportation solution that crosses the divide between land and water, providing passengers with a one-of-a-kind travel experience while solving a variety of urban mobility needs and issues.

Figure 2.2 : amphibious bus cross river (*This Is Germany's First Amphibious Bus And It's Used For Hamburg City Tours | Carscoops*, n.d.)

2.2.3 Amphibious trucks

Amphibious trucks are vehicles that can function on land and in water, combining the characteristics of conventional trucks with amphibious qualities. These vehicles are designed to travel a variety of terrains, including roadways, off-road terrain, and bodies of water including rivers, lakes, and coastal locations. Amphibious vehicles are diverse modes of transportation, with uses in military, rescue, and commercial use (Shirsath et al., n.d.-b).

The Vietnam War, which lasted from 1955 to 1975, saw the development of many unique amphibian military carrier designs. In the aftermath of World War II, the British also designed the Sherman (named after Civil War general William Sherman), also known as the "Duplex Drive," which featured a rubberized screen that soldiers opened before entering the water for added buoyancy. It used propellers for propulsion. The design issue was that the firearms were rendered ineffective while afloat due to screen coverage (Majumder* & Chowdhury, 2021).

Amphibious Design Equipped amphibious trucks feature a robust amphibious design with watertight hulls or buoyant pontoons, allowing them to float and navigate through water bodies such as rivers, lakes, or coastal areas. They are equipped with marine-grade propulsion systems, such as water jets or propellers, for efficient propulsion in water.

Equipped amphibious vehicles provide versatility, mobility, and efficiency in a wide range of industries and applications, including transportation, forestry, disaster response, and military activities. These trucks are essential assets in tackling complex operational difficulties and meeting project objectives because of their ability to smoothly shift between land and marine settings, as well as their capacity to operate in harsh situations.

2.2.4 Amphibian ATVs

The Amphibious ATV (equivalent to small non-air-cushioned amphibious vehicles. These were fairly mainstream in North America in the 1960s and mid 1970s. An amphibious ATV (AATV) is a small, lightweight off-road vehicle with six (or sometimes eight) wheels that has been manufactured since the 1960s. Constructed from an integrated hard plastic or fiberglass body tub(Suraj et al., 2017).

Amphibious ATvs are typically equipped with floats or airtight hulls that enable the vehicle to float in water. Those transportation craft include propulsion systems like water jets or propellers intended to work in an aquatic environment. This sled is an amphibian ATV, capable of traversing both land and water. They can move from one terrain to another seamlessly, which makes low-range vehicles prosper in remote areas not reachable to conventional cars.

In conclusion, amphibian ATVs offer a perfect combination of mobility, versatility and utility, and are valuable assets for any outdoor enthusiasts, professionals, and organizations who need to go through different terrains. In the absence of an army of carriers, the Amphibian ATVs provides the opportunity to explore, play and work in some of the most extreme and remote locations of the globe due to its near universal traction on land and water.

Figure 2.3 : Amphibious ATVs (Suraj et al., 2017).

2.2.5 Water bike

Water bikes are a type of watercraft used as transportation, fishing, and recreation in (water) tourism areas such as Ulee Lheue and Waduk Tempuran. These are good for eco-friendly travel, as they can be either human-powered or electric, unofficially making them the ninjas of the water. Water biking features stability for the fisherman so that the water bike can take him to his favorite fishing spot. The boating options in the tourism destinations are divided into guided tours or rentals based on local regulation, allowing individuals to calmly soak in delightful coastlines and tranquil seascapes. In general water bikes are a fun and green channel to enjoy the potential of magnificent aquatic observing (Pitana et al., 2022).

Water bikes are designed to be suitable for both recreational and sports activities, with different models that come with the time. Still, the design of water bikes has changed over time, from the first water bikes till now (Imran Bin Anuar et al., 2024). Pontoons are the vital parts of water bikes, which lift them up and keep them afloat on water surfaces, moreover, the design of these pontoons is based on factors that help to maintain the stability of the water bikes when they are in use(Flynn et al., n.d.).

Water bikes give lifesaving duties to the swimmers some easy means of transportation, which is lightweight, easy to transform, and high performance objectives, such as, speed and maneuverability (Flynn et al., n.d.). Better paddle design is the key to achieving maximum efficiency of propulsion, reducing the drag forces, and increasing the overall performance in the water environments (Imran Bin Anuar et al., 2024).

Water bicycles have evolved from older versions with large tricycle wheels used as buoyancy devices to more sophisticated designs with gearing systems and catamaran-like constructions(Imran Bin Anuar et al., 2024). Water bikes are designed to meet certain performance goals including as speed, stability, and easy configuration transitions, catering to the demands of both lifeguards and recreationnal riders. Numerous future milestones could be in the field of improving paddle design with the goal of increasing propulsion efficiency and, as a result, the overall efficacy of operating in water conditions (Flynn et al., n.d.).

Figure 2.4 : Water Bike (Pitana et al., 2022)

2.2.6 Summary of Amphibious Vehicle

Amphibious vehicles are adaptable forms of transportation that can be used for a variety of purposes, including emergency services, military use, and leisure travel on land or in the water. Two examples of amphibious vehicles are amphibious buses, which are used for city tours in river or coastal locations, and the Amphicar, a 1960s civilian vehicle that converts from a car to a boat. Amphibian ATVs are designed for off-roading, hunting and exploration, the Military and emergency services instead use amphibious trucks for the logistics and transportation between the hills and the valleys. Water bikes with attached pontoons or hydrofoils propel different ideas related to activities or leisures.

The main benefit of amphibian vehicles is that they are flexible, allowing them to transition easily from land to water. Making them suitable for hilly terrains and for easy access to remote locations or areas devastated by floods. The vehicles erase the need for different types of vehicles, which helps to reduce operating costs for the military and emergency services. They also contribute to tourism because they provide special experiences. There are disadvantages to this however, costing more money and is more complex and compromises in both performance settings, and requires higher upkeep due to exposure of other nature elements. These barriers include complex and changing regulatory frameworks and ensuring public health and safety with respect to land and water use.

Finally, answers to the challenges of mobility are creatively met with amphibious vehicles across the board. Excellent availability and variety, yet they carry maintenance, costs and legal considerations with them as well. Summing upThese are only a few examples of tactical wheeled vehicles, and as their technology improves, their capabilities and special purpose and civilian uses will only expand.

2.3 Propulsion System

Water propulsion system is an device important for the production of thrust or propelling force to propel marine boats through the water. The systems are categorised into three types, conventional propellers, water jets, and paddle wheels, with a specific set of characteristics and application.

Marine propulsion is the mechanism or system used to generate thrust and the power used to move a maritime vessel across water. A power-generating engine (e.g. diesel engine, gas turbine, or electric motor) From this comes the propulsion power which drives the ship forward and this power is provided to the propellers or water jets. Engine speed, thrust direction and vessel course are controlled by control systems, comprising throttle controls, steering systems and navigation technology. The control systems, such as rudders and thrusters, help the ship steer (Samoilescu et al., 2018).

A range of factors, such as design, engine power, hull configuration, and operational conditions, influence the power and efficiency of water propulsion systems. Continued development aims to optimise efficiency, reduce emissions, and improve maneuverability. These systems are an enabling technology for marine transportation and are responsible for the safe, efficient, and sustainable transits of vessels across waterways.(Imran Bin Anuar et al., 2024) .

2.3.1 Pedal-Assist Electric

Pedal-assist electrical systems, typically found in e-bikes and water bikes, work by combining human pedal power with an electrical engine to improve propelling. Hybrid systems are designed to help enhance the rider's pedal efforts, making it easier to cover long distances, ascend terrains, and traverse difficult terrain or water.(DESIGN OF WATER BIKE FOR UMP PEKAN LAKE CHANG CHUN KIT UNIVERSITI MALAYSIA PAHANG, n.d.).

Pedal-assist electric systems that automatically adjust the digitally delivered electric support power to the speed and power of the rider pedaling enhance riding experience. Depending at the rider's pedaling frequency and force, these systems offer specific, managed quantities of electric assistance. This technology helps to boost speed, minimize tiredness, and prolong the bike's range. Sensors determine how quickly and hard the user is pedaling, and the system gives the appropriate amount of help, making riding more comfortable and efficient.

This makes riding more accessible and pleasurable for everyone, including seniors, persons with physical impairments, and those who wish to commute or ride for fun without becoming weary. Overall, pedal-assist systems enhance the riding experience by providing a convenient and efficient mode of transportation(DESIGN OF WATER BIKE FOR UMP PEKAN LAKE CHANG CHUN KIT UNIVERSITI MALAYSIA PAHANG, n.d..

Figure 2.5 : Water bike Pedal-Assist Electric (*Hydrofoiler XE-1 Is an Electric Bike That Offers Biblical Bliss Riding on Water | The Australian*, n.d.)

2.3.2 Jet Propulsion

Jet propulsion in marine vessels is the process of converting energy into mechanical power in order to push the ship effectively through water. Water-jet propulsion systems are methodically built for various power levels, with a variety of designs and components such as intakes, impellers, and nozzles. These systems operate by pulling water into the intake, accelerating it via the impeller, then releasing it at high velocity out the nozzle to create thrust and push the vessel forward.

On the other hand, the AZIPOD thruster systems in a way share same principle but higher power ranges, changing the conventional propulsion arrangements by eliminating parts like longshafts and controllable pitch propellers. This increment has a significant contribution for better efficiency of movement, which is crucial to many marine operations (Samoilescu et al., 2018). When deciding on what to propeller a vessel with, always take into account the cost, consumption, manning, and safety characteristics.

Although some technologies, such as water-jet propulsion, may have higher upfront costs, they deliver payback in efficiency.

Low cost of operation is alluring, and fuel-efficient solutions like those offered by AZIPOD thrusters can be tempting. From a cost and safety perspective the staff is likely specialized on complex systems. In conclusion, a thorough consideration of these variables will ensure the best choice of propulsion system in order to ensure the highest level of performance, economy and safety associated with the operation of a vessel (Samoilescu et al., 2018).

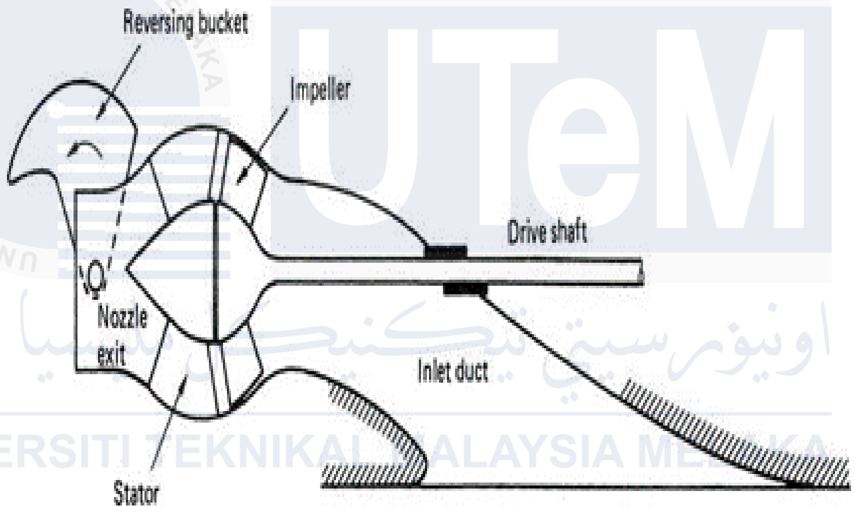


Figure 2.6 : Water Jet System Configuration (Dwi SUSANTO et al., n.d.)

2.3.3 Paddle Wheel

Paddle Wheel is commonly seen traditional propelling system in water bikes. They're paddles fixed to a giant wheel that spins when you pedal. As the wheel revolves, the paddles press against the water, producing force and driving the water bike ahead. this is a method driven by the pedalling action of the rider, using the energy from the pedalling to move forth the propulsion system and simply flow through water (Flynn et al., n.d.).

Paddle wheel design allows it to be custom made to fit nearly any type of water bike. The size and shape and location of the paddles could be adjusted to performance and efficiency optimally as the rider like, water conditions or the will to how the bike is going to be used on the water. A rubbery paddle wheel system is also durable, long lasting, and requires minimal maintenance, so is appropriate for a range of scenarios and environments (Flynn et al., n.d.).

In conclusion, the paddle wheel remains a popular water bike propulsion due to low complexity, high performance, and versatility. It brings with it a trusted and accessible means of engaging in calm, leisurely rides or performance-based water sports.

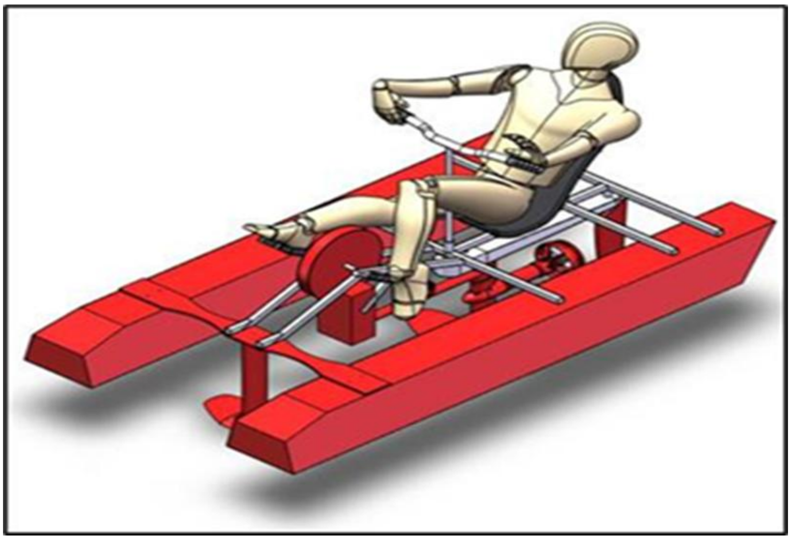


Figure 2.7 : The Human-Powered Water Bike (Imran Bin Anuar et al., 2024)

2.3.4 Pedal-Powered

Water bikes are modern watercraft with pedal-powered device, which makes them move forth by converting the human power of the edge driver into mechanical energy. This technology is driven, not only to save fuel but to contribute to environmental programs such as the 'GO GREEN' project. Water bikes offer sustainable transportation by utilizing human pedaling force. Pedal generated energy could be stored and used in the energy storage device which can result in further enhancing sustainability without the use of fossil fuel and lessening the carbon emissions (Choi & Kim, 2013).

Pedal-Powered Water Bikes with optimized power transmission system for efficiency and performance. These consist of pedals, a chain, gears and a mechanism to move the gears. As the cyclist pedals, the chain and gear system transfer mechanical energy into driving the bike. The gears make transmissions more energy-efficient, which allow submarines to more easily turn energy created by a nuclear reactor into using props through the water. It also makes the bike, as a whole, perform better, enabling higher speeds and quicker maneuverability just by using less power (DESIGN OF WATER BIKE FOR UMP PEKAN LAKE CHANG CHUN KIT UNIVERSITI MALAYSIA PAHANG, n.d.).

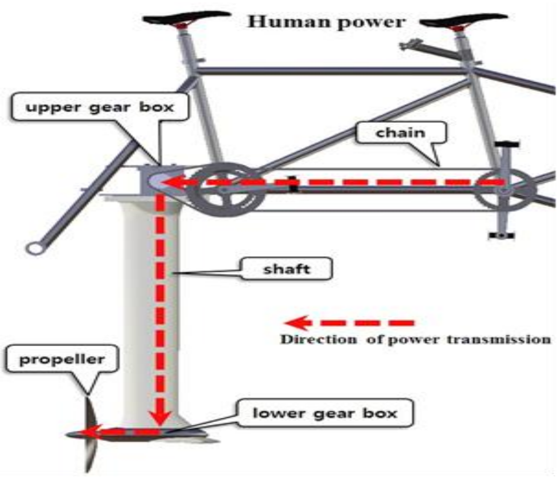


Figure 2.8 : Power Transmission System Of A Water Bike(Choi & Kim, 2013)

The pedal-powered water bikes are made from the use of strong factory material which provides them with the best quality to endure all the environmental element. Usually the frame and pedal unit is made of stainless steel, anodized aluminium or carbon fiber. Stainless steel for strength and corrosion resistance, or anodized aluminum for lightweight affordance and durability, or even a carbon fiber option if you need a high strength to weight ratio. These materials reduce weight and durability, so bicycles can survive harsh aquatic conditions while serving as a reliable, long-term transportation (DESIGN OF WATER BIKE FOR UMP PEKAN LAKE CHANG CHUN KIT UNIVERSITI MALAYSIA PAHANG, n.d.).

In summary, pedal-powered water bikes combine human-powered propulsion with cutting-edge engineering and high-quality material to create an efficient vessel. These water bikes contribute to sustainability efforts by transforming pedal force into mechanical energy, using a complex power transmission system, and using lasting materials. They also provide a practical and pleasurable mode of transportation on water.

2.3.5 Summary of Propulsion System

Propulsion systems play a crucial role in determining the efficiency and adaptability of vehicles in various conditions. There are four most used propulsion systems, namely electric pedal-assisted, jet propulsion, pedal wheel and pedal powered. Each of these systems has its specific pros and cons.

Pedal-Assist electric systems connect human pedalling to an electric motor, providing propulsion with greater speed and efficiency at much lower effort levels. Yet their reliance on battery life does offer limitations regarding distance, alongside higher capital expenditures and maintenance requirements.

The Jet Propulsion utilizes high-speed water jets as its propelling force, offering peak velocity and maneuverability over water surfaces, operability in confined spaces, and prevents propeller breakage. However, these devices require significant energy to operate and are less effective in shallow seas.

A paddle wheel system uses paddles to impart force to the water to generate propulsion. That design has its own simplicities, durabilities and lower speed manoeuvrabilities. Nevertheless, it has some limitations as it is inefficient and bulky, taking more power to operate at higher speeds.

Pedal-powered systems, where only pedaling of humans is used for propulsion, are cost-effective, environmentally graceful, and health facilitating. However, they are constrained by their restricted speed and range, dependence on physical stamina, and diminished effectiveness in unfavourable conditions.

Every propulsion system has its own set of advantages and disadvantages, which are tailored to specific purposes. Selecting the optimal system requires evaluating performance, cost, and user experience in order to effectively meet certain requirements.

2.4 Navigation system

A navigation system in a water vehicle involves many element and part of technology and mechanics used to guide the ship or the water vehicle in it's operation on water (Ikeda et al., 2016). The primary steering mechanism is the rudder system, which is controlled by the captain using a steering wheel or tiller. Some of the large ships might have even used hydraulic or electric power so as to maneuver and steer the ship as one could easily imagine(IKEDA et al., 2011).

Modern navigation systems in watercraft now often include electronic control steering mechanisms (ECSM) with steer-by-wire (SBW) technology, which enhances operability and maneuverability, especially for inexperienced captains. ECSM dispenses with the regular mechanical connections since it involves the use of electronic mechanisms for making these changes and thus providing smooth transitions(Ikeda et al., 2016).

These systems are assessed through maneuvering simulators where factors such as speed, rudder angles, and hydrodynamic forces are used to determine the most desirable result. For enhanced control of these systems and safety, these simulators mimic conditions in the external environment to fine-tune the settings of the ECSM. Using of the SBW technology causes the better control of the vessel, safety measures and interface, which provide the captains with safer navigation(Ikeda et al., 2016).

2.4.1 Spade or Balanced Rudder

A spade rudder is a balanced rudder with high taper ratio that is the ratio of the root chord that is the wider of the two at the side near the ship hull to the tip chord that is the slender at the bottom. This design is exclusively tailored in order to minimize the levels of rudder drag, however the rudder may be designed and configured in a manner so as to provide thrust.

Conventional spade rudders are easier to use than unbalanced rudders; therefore, the investment costs in motors and actuators are low, as well as the fuel consumption of the steering gear. Generally, looking at the hydrodynamic and cavitation standpoint, spade rudders are thought to be better than semi-skeg rudders due to better power gain and lesser maintenance. Semi skeg rudders which are also balanced are an improvement from the fully skegged rudders mainly because of differences in lift and drag coefficients due to the rudder horn(Liu & Hekkenberg, 2017).

Spade rudders are located in various boats; however, they are particularly common in those with long-distance and accurate encoding in water. Some of the recommended guidelines for the use of spade rudders include that on seagoing boats, they should have efficient profiles through enhancing maneuverability, improving fuel use, and eradicating cavitation. Ship owners and operators prefer spade rudders on account of the fact that they are efficient, exhibit a lower power requirement, and have lower competitive running costs (Liu & Hekkenberg, 2017).

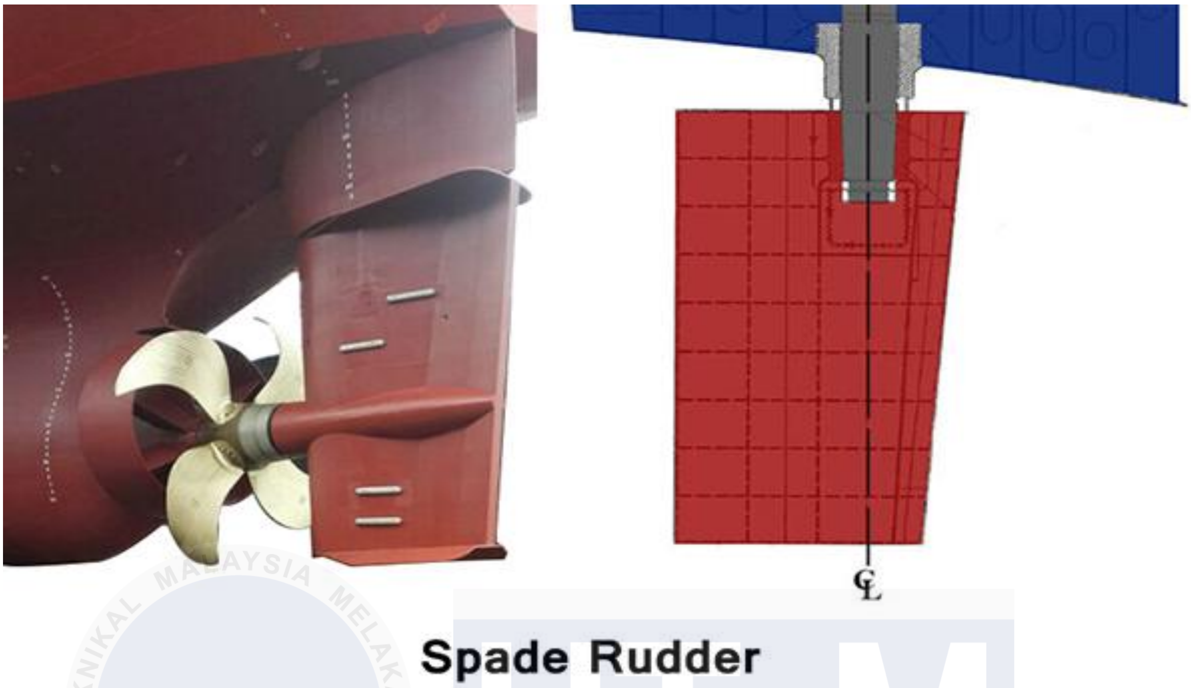


Figure 2.9 : Spade Rudder Ship (*Spade Rudder - Marine Rudder Blade - Hi-Sea*, n.d.)

2.4.2 Ship wheel steering

Among the various types of steering, wheel steering is one of the most widely used in boats and other forms of small watercraft where steering is actually managed by a wheel. As it is commonly found in cars, it is situated in the bridge or cockpit of the vessel and switched to regulate the rudder or the steering mechanism below. Every time you turn the wheel, it pushes extra switches, which then cause the vessel's rudder to start moving.

Through this system, the captains get the real feeling and sense that they have over control of the vessel, hence better control of the movement and direction of the vessel. Compared to the vessel's deck, it is not very large; however, it might require more frequent maintenance, and it takes some space on the deck of the vessel. Nevertheless, wheel steering is still widely used due to the effectiveness of the technology and its utility, particularly in pleasure crafts and small ships. (*Understanding Steering Gear in Ships*, n.d.).

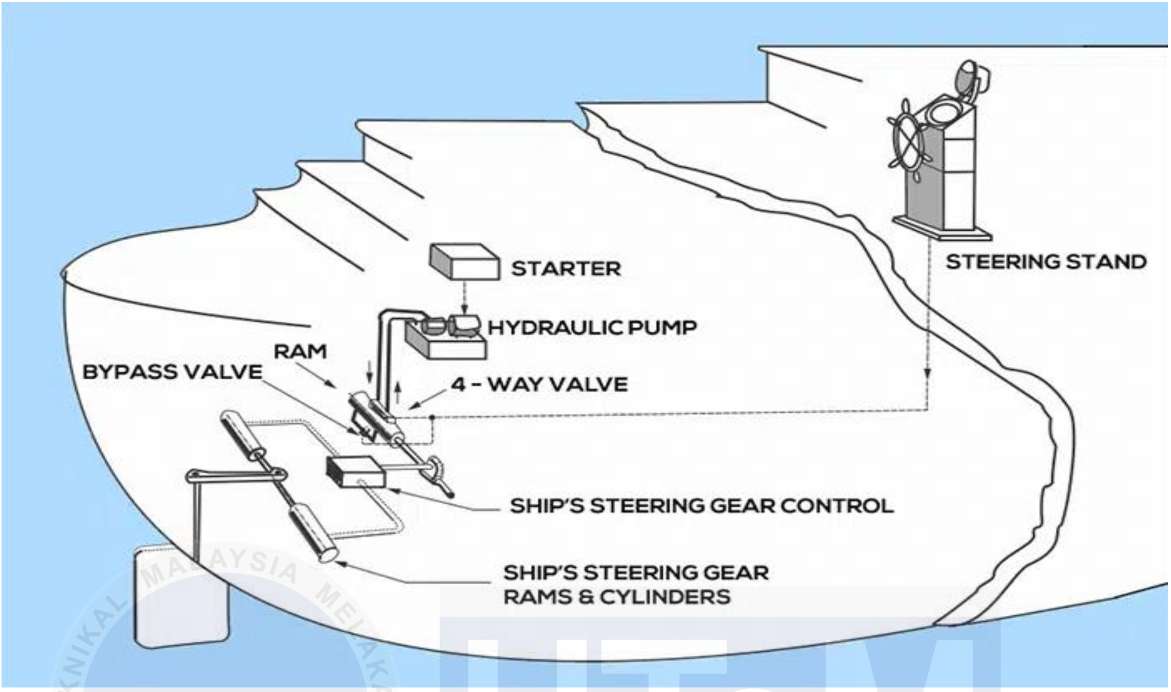


Figure 2.10 : Representative image of Steering Gear arrangement in a ship(*Understanding Steering Gear in Ships*, n.d.)

2.4.2.1 Manual Hydraulic Steering Mechanism (MHSM)

The Manual Hydraulic Steering Mechanism (MHSM) is a type of steering that is largely used in marine vessels, with the steering wheel being linked to a helm pump. This pump pressurises hydraulic fluid, which in turn operates the movements of vessels' rudders. Even though the MHSM is one of the most commonly implemented systems, it is usually criticised for its low operability. Another challenge that arises with the MHSM is the centre position of the steering wheel.

It also causes imprecise steering, and it may be very hard to keep the vehicle on a straight path. Furthermore, translating the movements of the steering wheel to the rotation of the hull of the vehicle can at times be somewhat tricky for those operating the vehicle, especially if they are beginners. Such factors cause a reduction in the ability to manoeuvre the vessel and may have a negative impact on its safety. Nevertheless, due to the reliability of the MHSM and its increased use in marine applications, the MHSM remains in use(Ikeda et al., 2016).

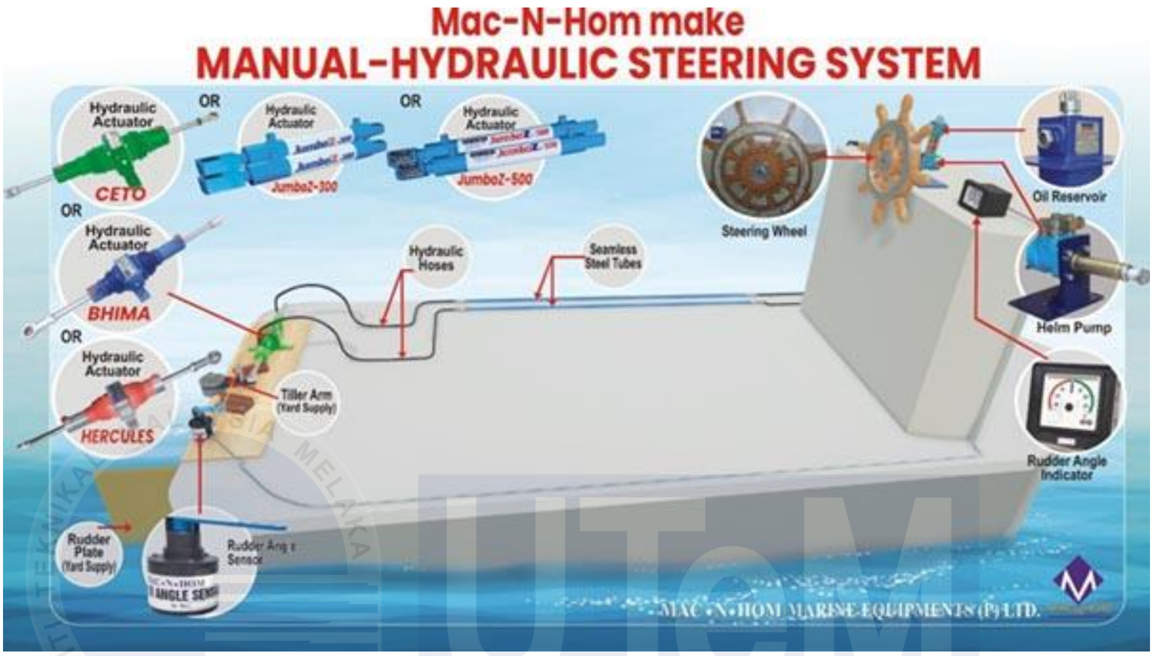


Figure 2.11: Manual hydraulic steering system working principle (*MacN Hom Systems - Hydraulic Boat Steering Equipment in India*, n.d.)

2.4.2 Electronic Control Steering Mechanism (ECSM)

The Electronic Control Steering Mechanism (ECSM) is a sophisticated steering technique that replaces mechanical hydraulic steering mechanisms such as the Manual Hydraulic Steering Mechanism through the steer-by-wire (SBW) system. ECSM measures the steering wheel angles and converts them into rudder movements through a digital signal control system without the use of hydraulic oil (Ikeda et al., 2016).

This innovation enhances the control and accuracy of the output when it concerns the steering, especially by novice captains, by providing a smoother motion and, at the same time, creating feedback torque on the steering wheel. With the inclusion of SBW technology, ECSM will be able to fine-tune its steering rates and overall performance with the goal of delivering safer and more organic-like manoeuvres (IKEDA et al., 2011).

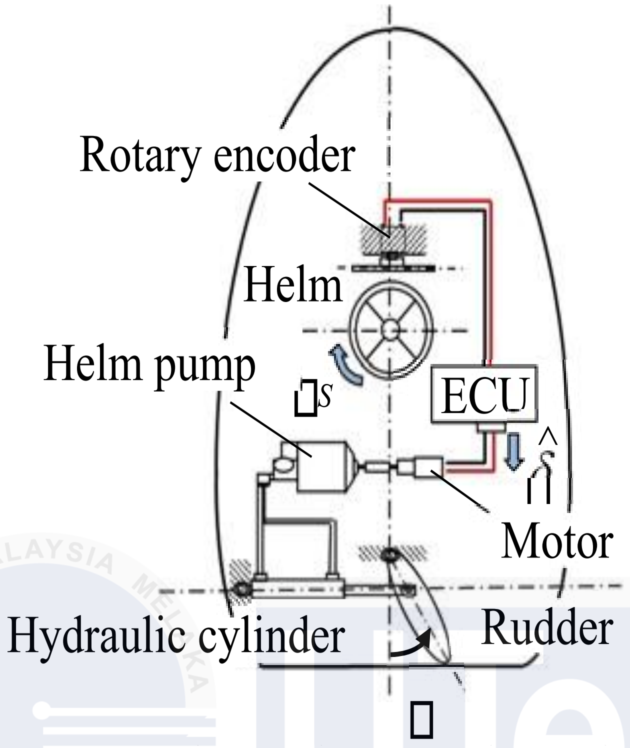


Figure 2.12: Steering mechanism of pleasure boats (Ikeda et al., 2016)

2.4.3 Summary of Navigation System

Navigation systems are essential for guiding water vehicle and ensuring effective control and maneuverability. The most common steering systems are the Spade or Balanced Rudder system, and the Ship Wheel Steering system. It is a type of steering mechanism that includes the manual hydraulic steering mechanism and also the electronic control steering mechanism. Every system has its benefits and disadvantages.

The spade, or balanced rudder system has a rudder hung so the pivot point is half way along the blade. The whole setup is designed to enhance efficiency and response, providing a more responsive performance, less drag and faster responses to helm orders. While it is simple to apply and nearly maintenance free, it may suffer at high speed and be associated with high initial capital and damage risk.

Verstile ship wheel steering, which uses both manual hydraulic control systems and electrical. As the manual hydraulic structure provides hydraulic assistance and reliability, it is the least expensive price alternative, but for a system of this nature, accuracy is invariably low and it requires frequent maintenance. While electronic control steering systems provide accurate control, versatility, and user friendly environment they require a more complicated system, they are dependent on electricity, and higher cost.

Choosing a suitable navigation system needs a careful study of variables like manoeuvrability, dependability, maintenance requirements, and cost to ensure secure and effective vessel operation.

CHAPTER 3

METHODOLOGY

3.1 Introduction

This part explains in detail the process followed to design and build the propulsion and navigation systems of water bicycle. These are include the component selection, the prototype design, the working principle, and the propeller design concept to meet the set objectives. the selection of materials for the propulsion system and navigation system, which includes the dynamo, flexible cable, propeller, and clamp for the water bicycle's for forward motion was conducted.

The concept design of the propeller entails measuring the propeller and the use of computer-aided design software known as CATIA in designing the propeller. This step enabled accurate representation and design of the propeller, as shown in the figure below. Therefore, it was deemed relevant to develop a raw prototype design. This prototype was used to show the relative location of parts at specific sites and explain the operation on which the design was based.

Furthermore, the use of ANSYS software helped to simulate and develop the propeller's structure, making it efficient and safe. This was the foundation upon which an effective propulsion and navigation system for water bicycles could be exclusively developed.

In addition to the design, the fabrication of the prototype was also carried out. This included dynamo mounting, propeller shaft fabrication, mounting the aluminum tube drive shaft, and navigation system fabrication.

3.2 Flowchart

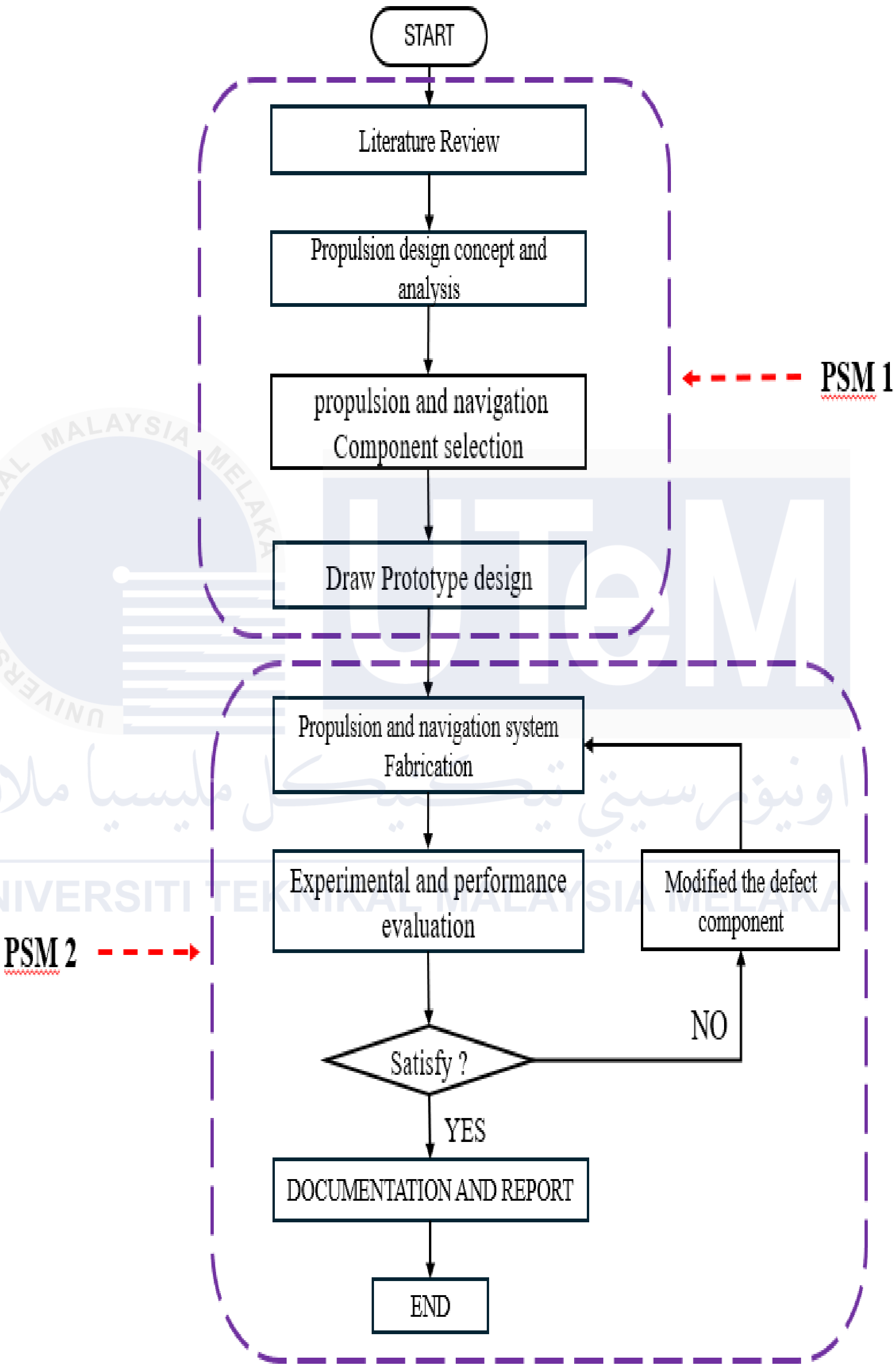


Figure 3.1: Flowchart

3.3 Component selection

Its movement techniques can be described as the product of several parts of the water bicycle that enable movement and control. This, among others, includes pedals, chains, propeller paddle wheels, and possibly electric motors. The various parts used in the propulsion and navigation of a water bicycle are as follows the materials chosen must be hard-wearing, energy-efficient, lightweight, resistant to corrosion, and cheap.

Some of the commonly applied substances include stainless steel, aluminum, composites, and high-grade polymers to enhance the durability of the devices. The components of the navigation system have to be accurate, durable, and built to withstand the elements of water with protective and performance materials such as metals where necessary. Designs that incorporate these factors could result in the creation of a water bicycle that has excellent performance, durability, efficiency, greater reliability, and ease of control.

3.3.1 Dynamo

Dynamo lighting is a system that uses the mechanical energy of a revolving wheel, such as those seen on bicycles, to create electricity to power lights. This technology is environmentally safe and efficient, delivering continuous lighting without the use of batteries. Dynamo lighting works on the basis of electromagnetic induction. A magnet passes past a coil of wire, causing an electrical current to flow through it. The electricity can then be utilized to power a light.

There are several types of dynamo lighting systems commonly used, such as hub dynamo, bottle dynamo, roller dynamo, and contactless dynamo. Bottle dynamo highly recommended for water bicycle to generate energy based on table below. A bottle dynamo is a small generator mounted on a bicycle that generates energy as it contacts rider's pedalling powers. This generates thrust, which propels the water bicycle ahead by turning a motor that spins the propeller. Bottle dynamo also affordable and easy to install, but less efficient and requires regular maintenance.

Table 3.1 : advantage and disadvantages specific type of dynamo

Type of dynamo	Advantage	disadvantage
Hub Dynamo	• Low maintenance • Consistent power output • Low maintenace	• Higher initial cost • Add weight to the bicycle • Installation complexity
Bottle Dynamo	• Easy installation • Easy installation	• Less efficient • Higher maintenance • Causes tire wear
Roller Dynamo	• More efficient than bottle dynamos • Easy installation	• Requires maintenance • Can cause tire wear
Contactless Dynamo	• Low maintenance • Minimal tire wear	• Higher cost • Compatibility issues • Less widely available

3.3.2 Flexible cable

In a water bicycle, the flexible cable serves as a mechanical transmit between the pedal-powered dynamo and the propeller, assisting the transfer of rotational energy underwater. Its operation is based on energy transmission, flexibility, and torque transmission. Firstly, the flexible cable simply transmits the rotational movement created by the pedalling on the water bicycle down to the propeller that is located under the water. The energy transference theory actually works this way, when the pedals turn the dynamo and this energy becomes directional to the drive shaft that turns the propeller.

In addition, the flexibility of the cable itself sets it apart from rigid alternatives, enabling it to handle obstacles and curves inside the water bicycle's frame. Such flexibility is crucial for seamless operation and improving thrust efficiency. Finally, the flexible wire needs to tolerate the torque that the pedal-powered dynamo will transfer, while transferring this energy onto the propeller without deforming or failing.

This is critical practice to maintain the integrity of the transmission system and ensure reliable propulsion of water bicycle. The flexible shaft is essential in a water bicycle, as it efficiently transfers power, accommodates the unique geometry of the bike, and maintains consistent torque delivery, enabling smooth and effective underwater propulsion.

Figure 3.2: flexible cable grass cutter machine

3.3.3 Grass cutter head

Grass cutter head is one of the key elements to adapt the propulsion system for the hydro bike. It serves in this capacity in its original form, housing the rotating mechanism shaft and a blade powered by a motor or an engine. As its a water propulsion system its function is redesigned.

The propulsion of the water bicycle for the grass cutter head requires that a mechanical interface exists between the head of the pedalling mechanism and the propeller. It is transferring the output energy that is generated through human pedalling via a flexible cable into the propeller of the implemented arrangement so as to be able to provide an optimal standard of alignment, stability and efficiency. The grass cutter head used in this system converts it into a high-speed, lightweight and efficient propulsion method due to its compact and heavy structure.

Figure 3.3 : Grass cutter head

3.3.4 Drive shaft aluminum tube

An aluminium drive shaft tube from a grass cutter is an appropriate part for adapting the propulsion system of a water bike because of its lightweight, strong, and efficient design. In this application, the tube provides a casing for the rotating drive shaft, transmitting mechanical energy developed by human pedalling onto a custom-designed propeller. The primary purpose of its design is to keep the driveshaft aligned, providing fluid, consistent rotation while guarding the driveshaft from outer environmental elements.

The aluminium makeup here is lightweight and resistant to rust a perfect fit for usage underwater, where weight needs to be at an absolute minimum and rust control is important. The tube provides structural support to the propulsion system, allowing it to be securely attached to the water bike frame and reducing vibrations for a smoother operation.

At the lower end, the shaft inside the tube is connected to the propeller, which converts rotational motion into thrust to propel the bike forward. The slim, compact design of the aluminium tube minimises drag in the water while its strength provides reliable performance under varying loads. Integration produces an efficient and robust system for watercraft propulsion powered by human effort.

3.3.5 Propeller

In order to improve performance and user experience, this study focuses on selecting a suitable propeller for one of these vehicles known as water bicycles. It needs to translate the energy of peddling into forward motion while minimizing drag, providing just enough force to work against the water and current. Reduced vibration ensures a smooth and quick ride, but high stability and control are needed to handle turbulent water. It has to be cost-effective and durable.

The table below recommends three-blade propellers for water bikes. They offer a satisfactory balance of efficiency and smoothness, making them suitable for riders aiming for improved performance and better stability. These propellers provide reduced vibration and better thrust control, which enhances maneuverability and ensures smooth rides even in variable water conditions.

Despite slightly higher drag and cost compared to two-blade designs, the superior balance between thrust and efficiency makes them ideal for an optimized waterbike experience.

Table 3.2 : advantage and disadvantages specific Type of propeller blade

Type of propeller blade	Advantage	disadvantage
Two-Blade Propellers	• Highly efficient • cost-effective • lightweight	• More vibration • less stability and control • noisier
Three-Blade Propellers	• Good balance of efficiency and smoothness • reduced vibration • better thrust and control.	• Slightly more drag • more expensive
Four-Blade Propellers	• Very smooth • better thrust and control • quieter operation	• Increased drag • Heavier • more expensive
Five-Blade Propellers	• Excellent thrust • very smooth and quiet • enhanced control	• High drag • very heavy • expensive
Six or More-Blade Propellers	• Ultimate smoothness • maximum thrust and control.	• Least efficient • very heavy • costly

3.3.6 Navigation Fin

The fin is an integral part of the water bike navigation system, as it ensures stability, maneuverability, and proper control of the bike's movement in the water. It works a bit like a rudder on a boat, giving new motorcycle riders directional control, and allowing the bike to keep on a-forthright path. Different kinds of fin although can be used for a water bike depending on what type of performance you want and what is the level of stability or maneuverability that you want.

Water bikes come with various fin types that have their respective functions. Flat fins are the most stable, best for the rest of the boat, but not so much for catching waves. Rudder fins are whatallow for precise steering for tighter turns. Fins with a shaped or curved shape can provide more control and less drag, increasing maneuverability. Hydrofoil fins help the bike skim above the surface for added speed. Twin fins provide additional stability and control, especially while feeding through making sharp turns. And adjustable fins allow riders to change the angle or depth of the fin based on water conditions. Ultimately, the choice of fin is based on the rider's expectations for speed, stability and maneuverability.

As illustrated in the figure 3.4 below, a water bike's curved fin enhances control and stability. The curvature allows the bike to glide smoothly through the water by reducing drag and creating lift. This design makes steering easier, helps navigate currents, and facilitates sharper turns. Additionally, it aids in maintaining balance, prevents the bike from tipping over, and boosts overall performance, resulting in a faster and more responsive ride.

Figure 3. 4:Fin

3.4 Prototype Design Raw

The objective of this concept design is to developt and fabricate the water bicycle propulsion system and navigation system. A water bicycle is similar to a normal bicycle but is built to be ridden over water. When you cycle, your movement rotates a propeller or blades fully immersed in water. These rotate and push water backward, in this way moving the bicycle forward. The propeller or the paddles which are installed on the front part of the bike provide the force required to push this bike forward in water.

Handlebars that are used in a water bicycle work similarly to the handlebars of every regular bicycle. They are attached to a system that runs a rudder on the water level. Turning the handle bars to the left or right also affects the rudder to turn the cycle in the corresponding direction too. It allows the rider perform flowing and effective movements in water to make efficient response to the task.

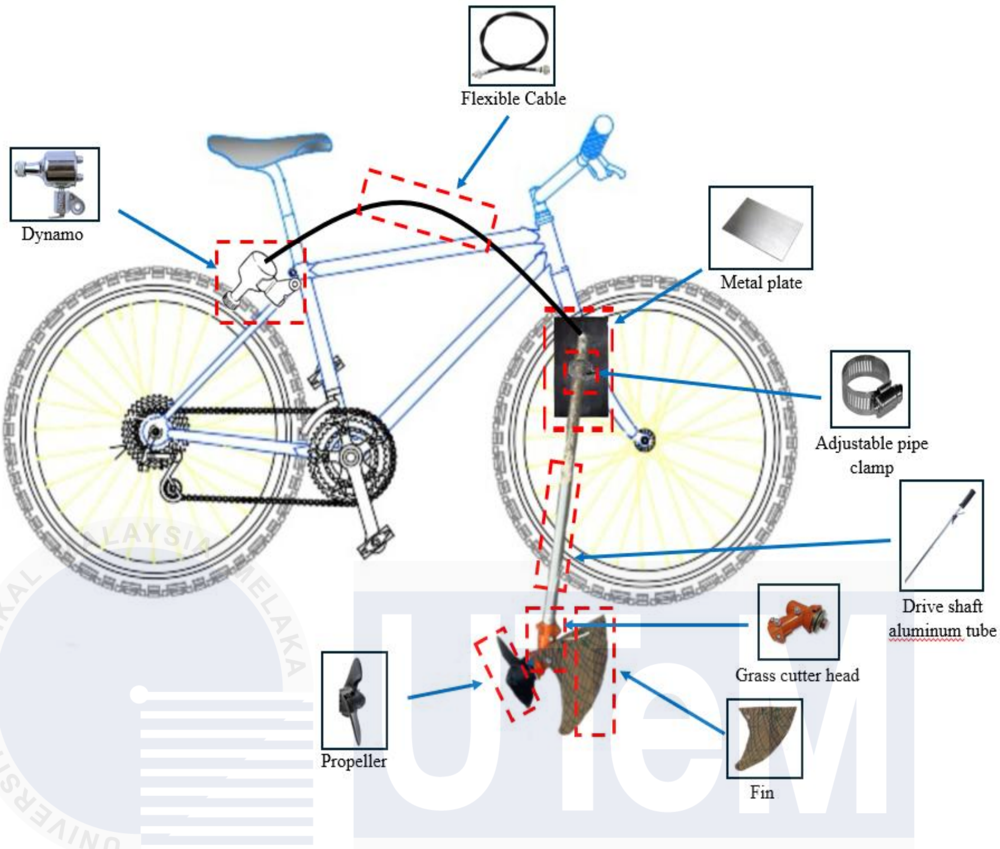


Figure 3.5: Specific Prototype Design

3.5 Working principle

The propulsion system and navigation system of a water bike are two systems that allow the water bike to move on the water bodies safely and effectively. The working principle of propulsion system and navigation system water bike is based on multiple components and design strategies to generate the mechanical power needed to move the bicycle forward.

The propulsion mechanism of a water bicycle, also known as a pedal boat, turns the rider's pedaling action into forward movement through water. From the design concept dynamo lighting are used to generate energy as the bicycle wheel rotates for move the propeller. The mechanical energy generated by the rider's pedaling powers from dynamo lighting system, and a flexible cable transfers that energy to grasscutter shaft for the propulsion system. This generates thrust, which propels the water bicycle ahead by turning a motor that spins the propeller.

The direction of travel over water on a water bicycle is determined by its navigation system, which is controlled by the bicycle handlebar. When the rider twists the handlebar to the left or right, the front wheel or paddle mechanism changes orientation, effectively controlling the water bicycle. This fundamental technology enables riders to steer their water bicycle easily and intuitively, simply by turning the handlebar whenever they want to change direction.

The propulsion system creates power to push the water bike forward, and the navigation system allows the driver to handle and control the vehicle. Together, these technologies facilitate swift travel between bodies of water and make it a multitasking exercise for riders at any skill level.

3.6 Propeller design concept

There are some basic principles to consider when designing a propeller for a water bicycle to create the best possible performance, efficiency and embodiment. As they pass over water, the propeller blades are designed to minimize drag using optimal profiles, thereby improving thrust efficiency

Blades, typically flexed like airplane wings, create pressure differentials resulting in forward thrust. Thrust and efficiency both depend directly on the number of blades. Increasing the number of blades results in greater thrust but reduced efficiency, whilst decreasing the number of blades leads to improved efficiency but lower thrust.

The propeller pitch determines how much water is displaced with each spin and can be modified to produce the desired speed and power output. Aluminium alloys, stainless steel, and composites are chosen for their lightweight, high strength, and corrosion resistance, all of which have a substantial impact on performance and longevity.

Efficient operation and avoidance of cycling interference are achieved by seamlessly integrating into the bicycle's structure, taking shaft alignment and placement into consideration. By taking these elements into account, a water bicycle with a two-blade propeller design can improve efficiency, performance, and overall riding pleasure, making it a great choice for activities on the water.

3.6.1 Propeller measurement

During the CAD design of the propeller water bicycle, the correct measurement of the propeller should be taken in order to have the required features of a propeller. This diameter measurement is crucial in determining the size of the propeller and where it must be inserted in the body of the water bicycle. With the help of measuring tape as shown in figure 3.6, start measuring from one blade extremity up to the other blade passing through the center of the propeller shaft.

Another important measurement that needs to be taken is to measure the length of each blade from the hub to the tip in order to have a balanced design. This angle is done using a pitch gauge or a protractor to determine the angle made by the blade with ref. plane which is perpendicular to the propeller shaft. Another important dimension that is required is the diameter of the hub of the propeller since it has to be fitted in the propulsion system of the water bicycle.

Knowing the material used for the propeller determines the choice for appropriate manufacturing procedures to ensure durability and efficiency in the water. Once accurate dimensions are obtained, a detailed drawing in CAD of the water bicycle's propeller is made. After that, CAD design applies this data to maintain the precise proportion, geometry, and orientation of the propeller blade as well as the total structure of the propeller.

Figure 3.6 : Measurement Propeller Size

3.6.2 CAD 3D Design

CATIA is a well-known CAD tool that helps in the generation and creation of 3D parts and assemblies that finds application in different domains. They consist of drawing, modeling, simulation, and drafting tools that facilitate perfect designing of the product. The following are the main steps to be followed in order to develop a propeller water bicycle in CATIA. Start with making a new task/project and check if measurement units are consistent with the corresponding measurements. Draw 2D representations of components, for example, the propeller blade and hub and cross-sections of the same.

After that, develop these 2D drawings into 3D models using extrusion and revolution techniques The Pad (Extrude) tool is used for simple shapes such as blade profiles while the Revolve tool can handle more complex shapes like the hub and the bicycle frames. Some degree of optimization is required which is done by providing mounting holes or cutouts and by rounding the edges with fillets or chamfers. Depending on the simulation of each part's physical characteristics, the correct material gets assigned to it.

Lastly, prepare detailed working drawings that contain dimensions, tolerances and requirements for materials. Also, develop assembly instructions with an exploded view to facilitate production as suggested. This process helps to ensure that all parts are modelled correctly and none of them move immediately into the production phase.

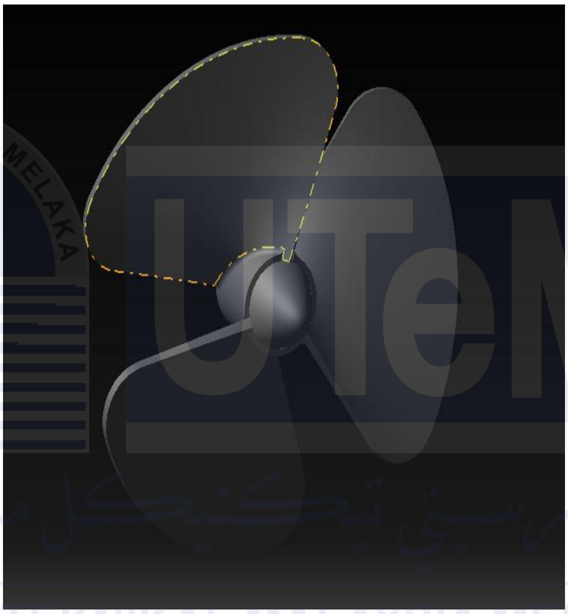


Figure 3.7 : Propeller CAD 3D design

3.7 ANSYS

The ANSYS programme is a series of tools that the designer can input before developing the final concrete form. It enables implying of simulation models which contain such data as structural stiffness, thermal conductivity, fluid flow, electromagnetic and their corresponding responses. One of the advantages of using Ansys is that it allows testing different loadings and conditions of wind, heat, pressure, etc. to find out what works best and the performance level of the design in question.

ANSYS is a versatile software package that also includes features for the design and modeling of fatigue life in order to fulfill performance demands or meet certain rules or regulations. As a result, ANSYS helps designers reduce the cost of building physical prototypes and save on expensive design modifications. ANSYS also translates into a shorter time to market and lower product development costs. In the context of this project application, this section will describe the steps and procedures necessary to compute the analysis of a Fluid Dynamics propeller.

3.7.1 Pre-Processing

In ANSYS, meshing is important when analyzing the flow of fluid around a propeller on a water bicycle. It is the process of dividing the simulation domain to small cells beginning with data import and cleaning of the 3D propeller model. The smaller components are in area around propeller while the relatively large components are at a larger distance from the propeller.

The tetrahedral elements are effective where there is complex geometry, hexahedral is effective in regions of structures and prismatic one is effective in boundary layers. Quality checks are made to ensure that all the parts are of standard quality and that there is no exaggeration towards the upper end of the scale. These are elaborative steps that increase the accuracy of the simulation and the propeller's performance efficiency.

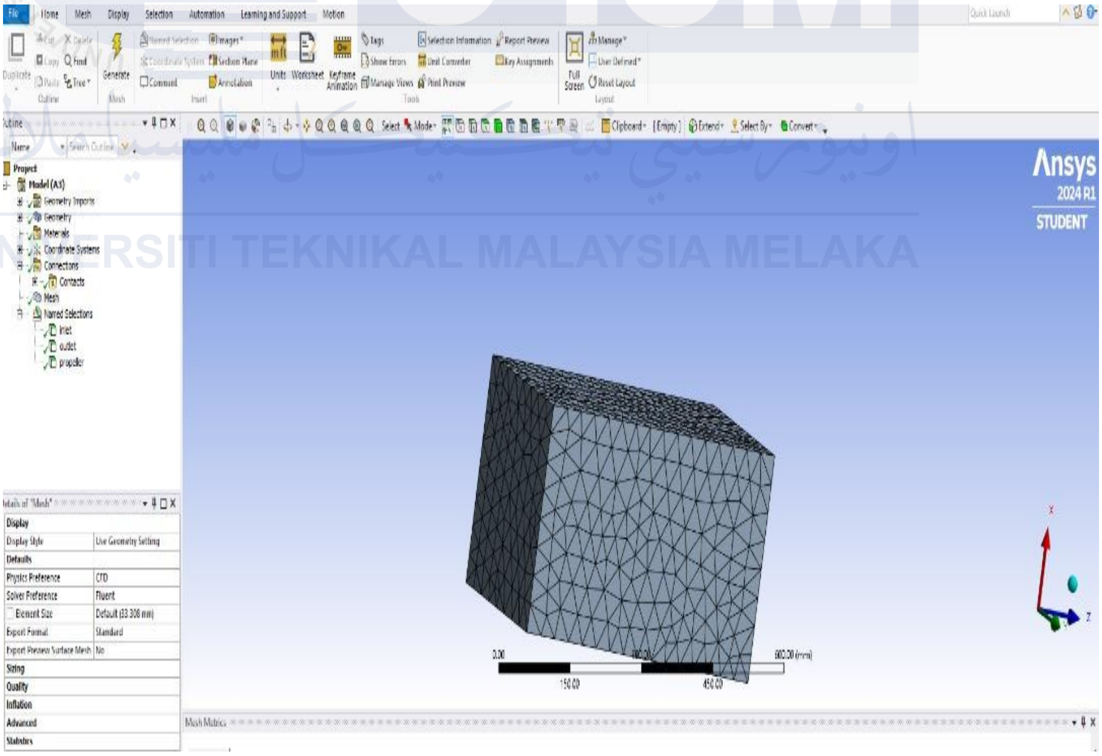


Figure 3.8 : Hyper Mesh Process

3.7.2 Solution

Solution methods in ANSYS are very important when it comes to how a propeller on a water bicycle operates. These methods assist in ascertaining how the software deals with the fluids flow, which plays a critical role in achieving precision in the simulations made. The water flow around the propeller is analyzed for laminar viscous model in ANSYS. It divides the water into small volumes to solve the flow equations.

These boundary conditions include the desired rotational speed of the propeller in water, these have to be chosen such that the simulation is as close to real life as possible. ANSYS uses these methods to find out more accurately how the propeller will perform during its use and so it can make the improvements necessary as to the efficiency and safety of the structure.

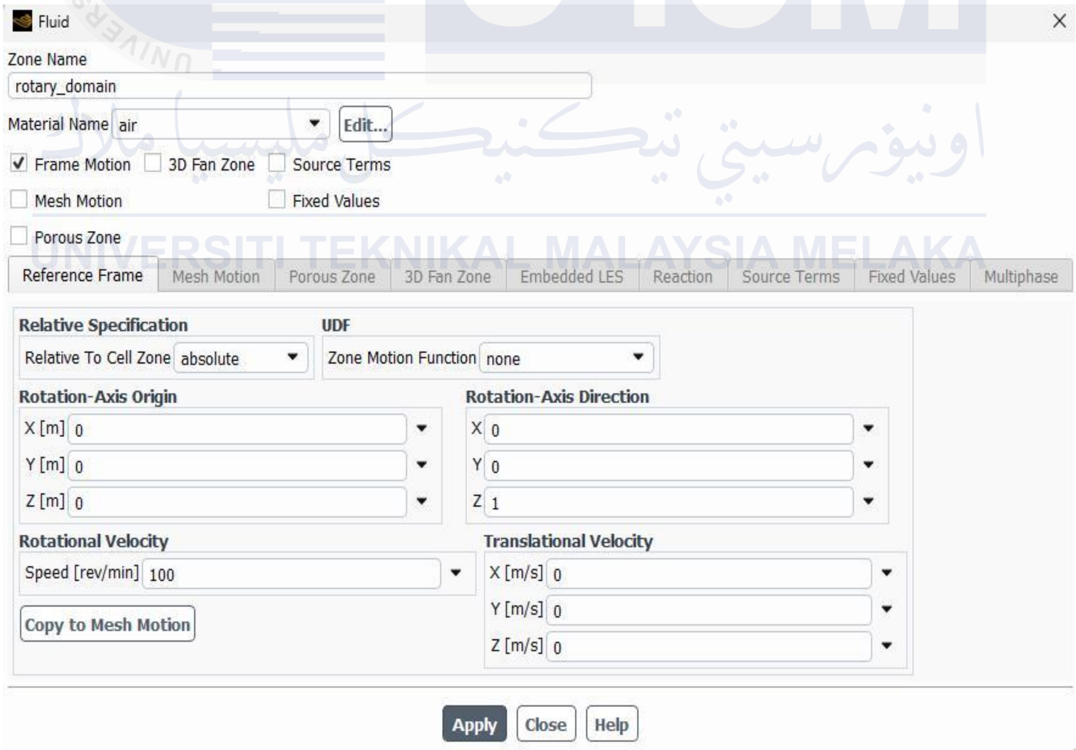


Figure 3.9 : Fluid Boundary Setting

3.7.3 Post-Processing

To support designers, the post-processing procedure is also important, since the results of the simulation come as graphs, animated views and contour plots. This visualisation is helpful to quickly understand the behaviour of simulation models and spot the most important factors that influence performance, which is crucial to take optimal decisions in systems with conditions.

Moreover, post-processing also plays an integral part of the validation and verification as designers can validate the findings received from the simulation with experimental data acquired to ensure the model is valid. It also assists in design improvement, where it provides users what required an upgrade what are the instructions to grow the design. Generally, post-processing is important to improve the simulation solutions in order to effectively address design issues and more efficiently cover the design potential of ANSYS.

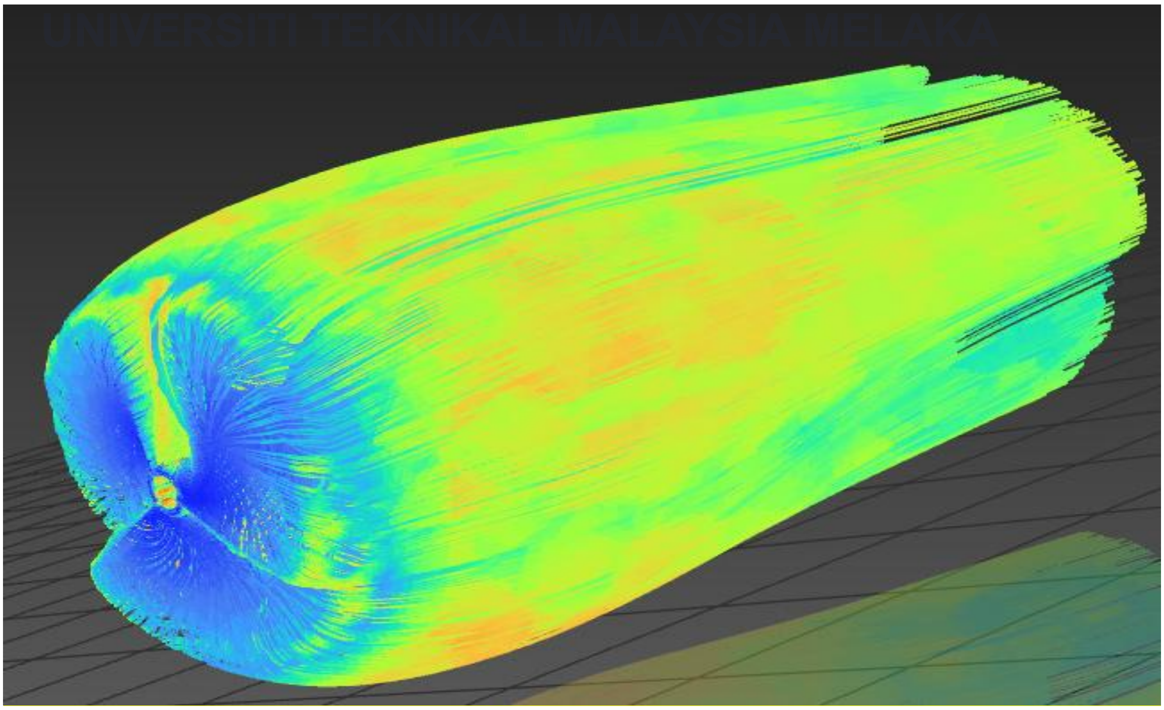


Figure 3.10 : Post-Processing Result

3.8 Prototype Fabrication

The fabrication of a water bike navigation and propulsion system involves developing an innovative and efficient mechanism for aquatic mobility. The propulsion system for this water bike utilizes a three-blade plastic propeller, purchased online, known for its lightweight and durable properties. This propeller design ensures optimal thrust and stability in water.

The system is powered by a dynamo, which is mechanically linked to the rear tire of the bike. This setup transfers rotational energy from the tire directly to the propeller, providing a seamless and efficient propulsion mechanism. By combining readily available components and simple engineering principles, this fabrication aims to create a cost-effective and functional water bike for recreational or practical use.

3.8.1 Dynamo Mounting

The dynamo that powers the propeller was mounted over the bike frame using a clamping bracket as shown figure 3.11. A custom bracket was fabricated to hold the dynamo at a very secure place without drilling. This bracket was designed to wrap around the bike frame and then tightened up with screws or with bolts. The clamping method thus provides a non-invasive and adjustable manner of mounting while preserving alignment required to efficiently transfer power from the tire to the dynamo.

Figure 3.11: Mounted dynamo at bicycle frame

3.8.2 Propeller Shaft Fabrication

The fabrication of a propulsion system comprised certain significant steps in integrating the custom shaft with the grass cutter machine shaft. First, this custom shaft was then cut (a) according to the required length exactly using a cutting tool to make perfect dimensions necessary for the system.

Subsequently, the shaft was ground (b) to give smooth edges and ensure precision in a clean surface for the subsequent welding operation. Grinding was also beneficial to fit the custom shaft with an existing grass cutter machine shaft. After making the coupling strong and stable, it was welded (c) to the grass cutter machine shaft after properly preparing the custom shaft. This had the added benefit of keeping the two in close alignment and also enabled the efficient transfer of the rotational power created by the dynamo to the propeller.

A flexible cable was then fixed to transmit energy from the dynamo to the shaft and facilitate vibration absorption while reducing mechanical stress. Finally, the propeller was fixed to the shaft to establish the system by these. Cutting, grinding, and welding were crucial steps that held all components integrated and aligned securely to make the propulsion system operate effectively and reliably.

(a) (b) (c)

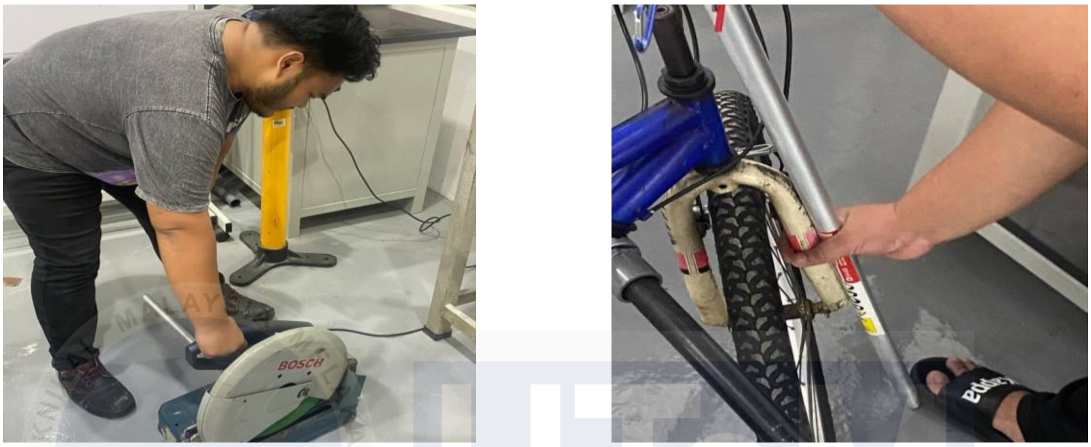
Figure 3.12: Fabrication process

3.8.3 Mount aluminium tube drive shaft

To create a mount for attaching an aluminium tube drive shaft to a water bike propulsion system using adjustable pipe clamps, start with the (a) cutting process. Cut the aluminium tube to the desired length using a chop saw, then smooth the edges to eliminate any burrs. Next, (b) mark and position the mount at the bicycle fork, ensuring it provides a strong and stable attachment point for the drive shaft. This placement is essential for proper alignment with the propulsion system's impeller or paddle mechanism.

After fabricating all components, dry-fit the tube to the frame and secure it with the adjustable pipe clamps at the fork. These clamps offer flexibility in adjusting the tube's angles and distances, allowing for fine-tuning to achieve optimal propulsion performance. The adjustable pipe clamps are crucial in maintaining the correct alignment of the drive shaft with the propulsion system.

Afterward, secure the assembly with the clamps, which fasten the drive shaft to the fork without damaging the frame. It can easily adjust these clamps to fit various water bike frame sizes or propulsion setups. To enhance strength and distribute the load evenly, consider adding reinforcement with gussets or metal plates, especially if the propulsion system will face significant forces during operation. This approach results in a sturdy, adjustable, and efficient mount for the aluminium tube drive shaft, securely positioned at the bicycle fork for dependable propulsion.



(a) (b)

Figure 3.13: Mounted fabrication process

3.8.4 Navigation fabrication

To attach a plastic fin to a grass cutter head for a water bike propulsion system, the process starts with designing the fin to fit on the head and provide the stability and maneuverability needed. It has to be designed in such a way that it interacts smoothly with the cutting mechanism, enhancing the overall performance of the propulsion system in water.

After the design is finalised, the (a) shaping process is initiated by cutting the plastic into the wanted shape using a CNC machine. It is then finished; the edges are sanded and smoothed to ensure minimum drag with the best water flow. Lastly, the fin is glued with bolts onto the grass cutter head. Holes are drilled in both the fin and the cutter head to align with the bolt placement for secure attachment. Attach the fin using the bolts, allowing for adjustments in positioning that provide optimum performance.

The last step involves (b) testing and adjustments to check the performance of the fin in the water. It is then adjusted based on findings in its angle, position, or attachment to meet the best efficiency for the propulsion system and better maneuvers. The end product is a plastic fin bolted onto the grass cutter head, enhancing the navigation and propulsion of the water bike.

(a) (b)

Figure 3.14: Navigation fin fabrication

3.9 Prototype testing

Based in the figure 3.15 above, Prototype testing focused on assessing the performance and durability of the water bike's propulsion and navigation systems. The pedal-driven propeller was tested for thrust and efficiency, while the rudder-based navigation system was evaluated for steering control and stability in different water conditions. Durability tests were conducted on key components to ensure reliability under repeated use. The results confirmed the water bike’s efficiency, ease of use, and robustness, validating it as a reliable transportation solution for rural areas.

Figure 3.15: Prototype testing

3.9 Summary

This chapter describes and explains briefly the proposed method for developing a propulsion and navigation system for a water bicycle. In pursuit of the project's overall objective, this chapter recommends the following improvements, all of which require effective implementation. This chapter also discusses component selection, which was used in the project's realization. Furthermore, the project's workings are shown in the flowchart and block diagram, which explain the procedures in detail.

This working principle entails understanding how pedaling action is converted into rotary motion to drive the propeller, as well as improving energy transfer efficiency. Handlebar for control and direction are some of the functions implemented in the navigation system's design. This chapter also discusses propeller design concepts that employ computer-aided design, commonly referred to as CAD, three-dimensional design, and Ansys.

This structured methodology includes a flow chart, component selection, prototype design, working principles, and precise propeller design using CATIA and ANSYS software simulation. Additionally, the prototype fabrication phase includes key tasks such as dynamo mounting, propeller shaft fabrication, aluminum tube drive shaft mounting, and navigation system fabrication. These steps ensure that every aspect of the design is carefully planned, fabricated, and tested to achieve optimal functionality and efficiency.

CHAPTER 4

RESULTS & DISCUSSION

4.1 Introduction

This chapter explores the evaluation and validation of the water bicycle's propulsion and navigation systems. It highlights the use of fluid dynamics analysis to examine how water flows around the propeller, ensuring that it performs efficiently by generating sufficient thrust with minimal energy loss. The chapter also details the calculations used to measure the propeller's performance and optimize its design.

It also tested the prototype to ensure the smooth operation of its propulsion and steering mechanisms. These tests confirmed that the system is both functional and reliable. The insights gained from the analysis and testing were instrumental in refining the design, ensuring it is practical, efficient, and ready for real-world application..

4.2 Analysis Result

The purpose of using fluid dynamics analysis for a water bicycle’s propeller in ANSYS is to show and explain the flow of water to the propeller’s blades for improved performance.. From the figure 4.1 below, The streamlines shown by the colored lines show smooth, even flow movement around and behind the propeller. it can see the velocity transitions nicely from high speed (red) at the blade tips to medium speed (green) in the wake. The green lines spreading out evenly behind the propeller indicate good momentum transfer to the water without excessive turbulence or energy waste.

The flow is symmetrical across all three blades, meaning it will provide balanced thrust. There are minimal blue areas (low-speed regions) except near the hub, which suggests the propeller is efficiently moving water with little unwanted drag or separation.

In simple terms - the smooth, organized patterns and even color distribution suggest this propeller should provide good thrust while being energy efficient, which is exactly what you want for a water bike application.

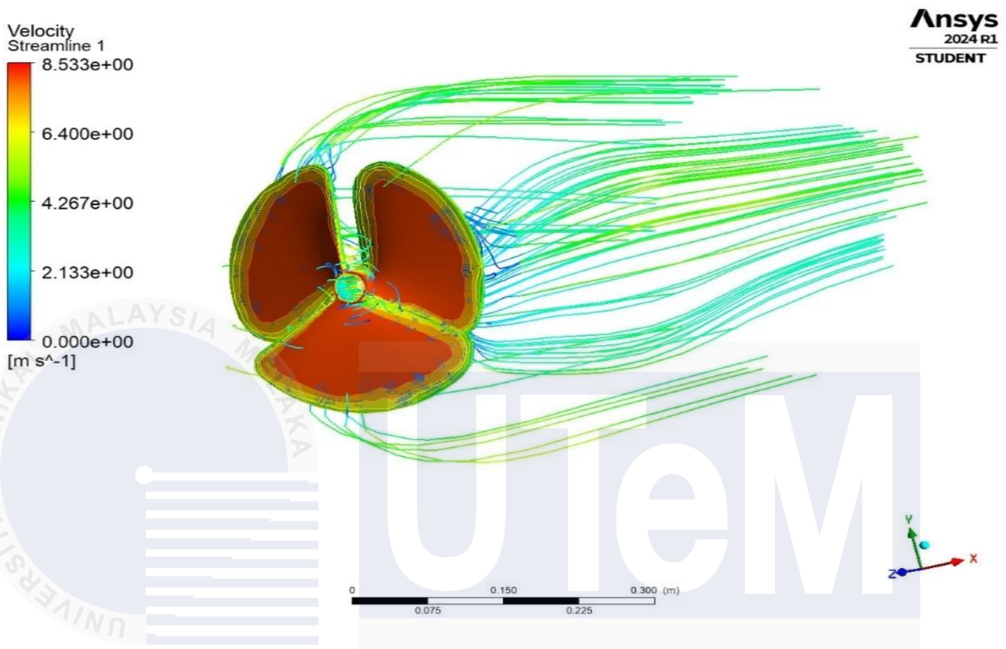


Figure 4.1 : Velocity streamline result

The figure 4.2 below shown the ANSYS flow visualization analysis demonstrates that the water bike propeller performs effectively. The velocity plot shows water being accelerated from inlet speeds of 0-2 m/s (blue) to 4-6 m/s (green), indicating strong momentum transfer. A stable cylindrical wake with smooth color transitions from blue to green/yellow confirms efficient thrust generation and minimal turbulence, contributing to good propulsive efficiency. The coherent wake pattern downstream highlights effective power conversion, though minor flow variations suggest small opportunities for further optimization. Overall, the propeller design successfully meets the objective of efficient propulsion.

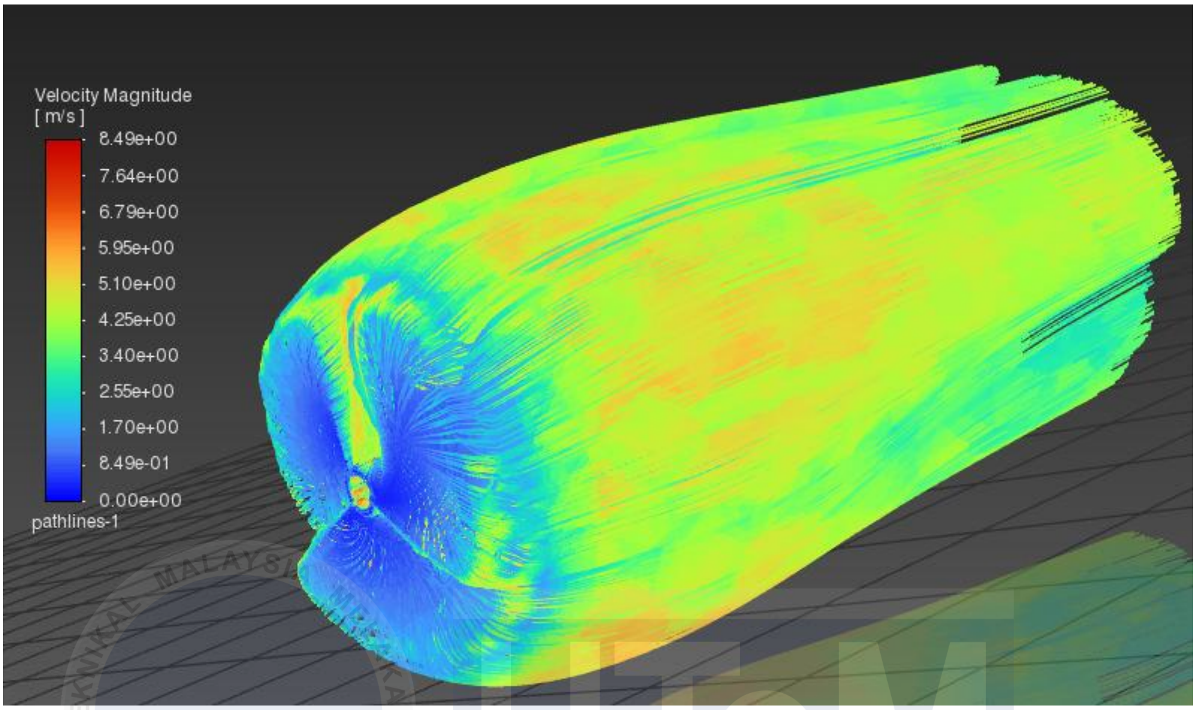


Figure 4.2: Velocity Magnitude Result

The CFD analysis not only provided detailed insight into the flow dynamics and performance characteristics of the propeller but also provided a critical foundation for prototype development. Knowledge of the velocity magnitude, streamline patterns, and flow separation helped in informing the design modifications that were required to enhance efficiency and performance. This also guided the process of design based on important knowledge like refinement in blade profile and optimisation of the blade angle-rotational speed for dealing with regions of flow separation.

4.2.1 Analysis calculation

Calculating the water bike propeller's performance and using ANSYS analysis helps ensure it generates enough thrust, operates efficiently, and remains durable. The analysis allows you to optimize the propeller's design for maximum power, speed, and energy efficiency while identifying potential weaknesses. It also helps in selecting the right materials and reduces the need for costly and time-consuming physical testing, ensuring a reliable and effective design.

Table 4.1: Data of calculation

Data	Value
Thrust Force (T)	1.8368 N
Drag Force (D)	1.8383 N
Inlet Velocity (V_inlet)	2.0 m/s
Outlet Velocity (V_outlet)	5.0 m/s
Density of Water (ρ)	1000 kg/m³
Propeller diameter	0.22 m
Average RPM	75 rpm (human pedalling 50 rpm -100 rpm)
Pitch of the Propeller (θ)	120 degrees

Calculation:

Propeller area (A) = $\frac{\pi D^2}{4}$

$$A = \frac{\pi (0.22)^2}{4} = \frac{3.14.6 X 0.0484}{4} = 0.038\, m^2 \qquad (1)$$

P_{output}=F_{thrust} x V_{outlet}

P_{output} = 1.8368 x 5.0 = 9.184 W (2)

Torque (T)

(ω) angular velocity $\omega = \frac{2\pi X 75}{60} = 7.85\, rad/s$ (3)

T = $\frac{P_{output}}{\omega} = \frac{9.184}{7.85} = 1.17\, Nm$ (4)

Efficiency (η)

For human pedaling power, consider 200W (Yamamoto et al., 2010)

P_{input} = 200W:

$$\eta = \frac{P_{output}}{P_{input}} = \frac{9.184}{200} = 0.0459 \ or \ 4.59\ \% \qquad (5)$$

Based on the calculation, the efficiency propeller got 4.59%. it is because the propeller system uses mechanical power from dynamo connected to a grasscutter shaft to drive the propeller. Human-powered watercraft system typically have efficiencies between 5% and 15% (Fuglsang et al., 2017),and my setup falls within a reasonable range considering the mechanical components used. The use of a grasscutter shaft, although not optimized for water propulsion, still contributes effectively to the overall performance. With further design optimizations, such as reducing friction and enhancing power transfer, it could improve the efficiency, but it current result shows a solid foundation.

The result was directly channelled into making the prototype with a view to ensuring that the propeller designed would indeed prove efficient and effective under actual conditions. It also validated the feasibility of the design in advance of physical production, thereby limiting trial-and-error iterations and greatly reducing time and resources during the prototype development phase.

4.3 Outcome result

The figure below shows the outcome results of the propulsion and navigation systems after analysis. The water bike's propulsion relies on a propeller driven by the rider's pedalling. This propeller is designed with precise attention to blade size, angle, and rotational speed to optimise thrust generation, ensuring smooth motion through the water.

For navigation, the handlebars are linked to a fin, which acts as a steering mechanism. Turning the handlebars in a certain direction pivots the fin, allowing the bike to turn in that direction. The result is responsive and stable navigation control, allowing for easy manoeuvring of the water bike in all sorts of aquatic conditions.

Figure 4.3: Fabrication Result

4.3.1 Propeller specification

Table 4.2: Data of Specification Propeller

Specification	Description/Details
Number of Blades	3
Propeller Material	Plastic
Blade Diameter	220 mm
Hub Diameter	15 mm
Length of Each Blade	120 mm
Weight	500 grams
Design Speed Range	75 RPM (average human pedalling)
Thrust force	1.8368 N
Power output	9.184 W
Power input	200 W (human pedalling)
Propeller efficiency	4.59%

Table 4.2 shown the propeller specifications prioritize efficiency, practicality, and compatibility with human-powered water bicycles. A three-blade plastic propeller is chosen for its lightweight, durability, and cost-effectiveness. With a blade diameter of 220 mm and a hub diameter of 15 mm, it provides adequate thrust while remaining compact and simple to fabricate. Operating at 70 RPM, the average pedalling speed, the propeller generates a thrust force of 1.8368 N and a power output of 9.184 W from a 200 W human input, resulting in an efficiency of 4.59%. These specifications balance performance and feasibility, making them ideal for the project.

4.3.2 Working mechanism

The system uses a bicycle to generate propulsion by pedaling. It transfers energy from the rear wheel through a dynamo. The grasscutter shaft connects a flexible cable to the dynamo, which drives a propeller to produce thrust. Turning the handlebars achieves steering, controlling the propeller's direction and enabling navigation. The setup combines human-powered input with a simple mechanical system for efficient propulsion and control.

Figure 4. 4: Working Mechanism of Propeller

4.3.3 Testing Result

The prototype water bike test shows that the system operates efficiently with minimum energy loss during the transmission process, proving that the dynamo and flexible cable sufficiently transmit power to the grass cutter shaft for smooth operation. The propeller generates sufficient thrust, allowing the bike to reach satisfactory speeds and maintain steady forward motion with the rider’s pedalling.

Steering proves to be precise and responsive, with the handlebars and rudder working seamlessly for simple and controlled navigation on water. Durability tests reveal that key components like the cable, dynamo, and propeller are resistant to wear and can withstand various water conditions without significant degradation. These positive outcomes suggest that the waterbike is a functional, efficient, and user-friendly prototype with the potential for further refinement and optimization.

Figure 4.5: testing result

4.4 Summary

This chapter presents the analysis, design, and testing results of the propulsion and navigation systems for a water bicycle. Using computational fluid dynamics (CFD) in ANSYS, the flow dynamics around the propeller were studied, revealing smooth and symmetrical water flow, efficient momentum transfer, and minimal turbulence. These results validated the propeller's efficiency, which achieved a thrust force of 1.8368 N and a power output of 9.184 W at 70 RPM, with an overall efficiency of 4.59%. While the efficiency aligns with typical human-powered systems, it highlights opportunities for further optimisation in mechanical power transfer and design.

These calculations are essential to evaluate performance parameters like thrust force, drag force, torque, and efficiency. This analysis provided valuable insight into the performance of the propeller and allowed for design refinements, reducing the amount of physical testing required and the resources consumed as prototypes developed.

The propulsion system of the water bike operates on the principle of energy transmission through the dynamo, flexible cable, and grass cutter shaft to drive the propeller. Navigation is in the hands of steerable handlebars attached to a rudder, allowing for sharp and smooth movement. It has been tested and confirmed to work well, with enough thrust for steady motion, responsive navigation and components that withstand wear. Even so, the ergonomic aspects keep the rider comfortable, making the prototype quite practical.

In summary, this chapter demonstrates the successful integration of analysis, design, and testing in developing a functional, efficient, and user-friendly water bicycle prototype, with promising results for future refinement and optimisation.

CONCLUSION

5.1 Conclusion

The development and fabrication of the water bicycle propulsion and navigation system have successfully met the objectives outlined for the project. It has carefully designed and analyzed a suitable propulsion system, selecting a three-blade plastic propeller with 70 rpm and a diameter of 0.22 m. The system leverages mechanical power from a dynamo connected to a grasscutter shaft, effectively powering the propeller and generating thrust.

The navigation system, designed to complement the propulsion system, ensures effective maneuverability and stability. The calculated efficiency of the propeller system, approximately 4.59%, aligns with typical performance expectations for human-powered watercraft systems, which often range from 5% to 15%. While the current setup demonstrates a functional and efficient design, future improvements in power transfer and friction reduction are expected to further enhance performance.

Overall, this project lays a solid foundation for future optimizations and improvements in water bike propulsion and navigation systems, contributing to the development of efficient and sustainable human-powered watercraft.

5.2 Recommendation

Future designs can take several practical steps to improve the propulsion and navigation system of the water bicycle. For the propulsion system, focusing on better power transmission from the dynamo to the propeller is essential. Reducing friction losses and utilizing more efficient connection mechanisms, like precision gears or direct-drive systems specifically designed for water-based propulsion, can achieve this.

Additionally, improving the propeller’s design by testing different blade shapes, materials, and pitch angles can increase thrust and reduce water resistance. We could evaluate these changes without extensive physical prototyping by using simulations like computational fluid dynamics (CFD).

When it comes to navigation, upgrading the steering mechanism to make it more adjustable and smoother will enhance control. A well-designed rudder or fin system can stabilize the bicycle’s direction, especially under varying water conditions. Adding features like a rudder position indicator or a simple electronic steering assist system could further improve accuracy and ease of handling. By implementing these refinements, the water bicycle's propulsion and navigation systems would become more efficient, reliable, and user-friendly, making the overall experience more enjoyable and effective.

REFERENCES

Choi, J.-K., & Kim, H.-T. (2013). Design of Power Transmission System of a Water Bike. *Journal of the Society of Naval Architects of Korea*, *50*(3), 153–159. https://doi.org/10.3744/snak.2013.50.3.153

DESIGN OF WATER BIKE FOR UMP PEKAN LAKE CHANG CHUN KIT UNIVERSITI MALAYSIA PAHANG. (n.d.).

Dwi SUSANTO, A., Prihanto, U., Suharyo, O. S., & Bandono, A. (n.d.). *STUDY OF WATER JET PROPULSION SYSTEM DESIGN FOR FAST PATROL BOAT (FPB-60)*.

Flynn, E., Grindel, P., Payne, N., Allin, R., Flynn, R., Grindel, E., & Payne, P. (n.d.). *MEMS 411: The Water Bike MEMS 411: The Water Bike Recommended Citation Recommended Citation FL21 MEMS 411 Mechanical Engineering Design Project WATER BIKE*. https://openscholarship.wustl.edu/mems411https://openscholarship.wustl.edu/mems411/158

Fuglsang, T., Padulo, J., Spoladore, M., Dalla Piazza, M., & Ardigò, L. P. (2017). Development and testing of a novel arm cranking-powered watercraft. *Frontiers in Physiology*, *8*(AUG). https://doi.org/10.3389/fphys.2017.00635

Hydrofoiler XE-1 is an electric bike that offers biblical bliss riding on water | The Australian. (n.d.). Retrieved May 18, 2024, from https://www.theaustralian.com.au/business/technology/hydrofoiler-xe1-offers-biblical-bliss-riding-on-water/news-story/2ff34113d2cdef1408d444ceaddefa4f

Ikeda, F., Toyama, S., Ishiduki, S., & Seta, H. (2016). A study of a steering system algorithm for pleasure boats based on stability analysis of a human-machine system model. *Journal of Physics: Conference Series*, *744*(1). https://doi.org/10.1088/1742-6596/744/1/012032

IKEDA, F., TOYAMA, S., SETA, H., & EZAKI, N. (2011). Improvement of Steering Feeling on Maneuverability for Pleasure Boat. *Journal of System Design and Dynamics*, *5*(5), 1119–1126. https://doi.org/10.1299/jsdd.5.1119

Imran Bin Anuar, M., Azwir, M., & Azlan, B. (2024). Journal of Design for Sustainable and Environment Improvement in the Design of a Water Bike for Recreational and Sports Purposes. *JDSE Journal of Design for Sustainable and Environment*, *6*(1), 54–59. http://www.fazpublishing.com/jdse

Liu, J., & Hekkenberg, R. (2017). Sixty years of research on ship rudders: effects of design choices on rudder performance. *Ships and Offshore Structures*, *12*(4), 495–512. https://doi.org/10.1080/17445302.2016.1178205

MacN Hom Systems - Hydraulic Boat Steering Equipment in India. (n.d.). Retrieved May 23, 2024, from https://www.macnhomsystems.com/

Majumder*, D., & Chowdhury, Dr. A. (2021). CAD Based Analysis for Feasibility of Design of an Amphibious Vehicle for Recreation. *International Journal of Innovative Technology and Exploring Engineering*, *10*(10), 45–50. https://doi.org/10.35940/ijitee.J9428.08101021

MGawande, P., & Mali, M. P. (2016). Amphibious Vehicle. *International Research Journal of Engineering and Technology*. www.irjet.net

Pitana, T., Santoso, A., Cahyono, B., Iswantoro, A., Siswantoro, N., & Nugroho, D. O. W. (2022). Pembuatan Water Bike untuk Mendukung Wisata Air di

Ecowisata Waduk Tempuran Blora. *Sewagati*, *7*(1). https://doi.org/10.12962/j26139960.v7i1.462
Samoilescu, G., Iorgulescu, D., Mitrea, R., & Cizer, L. D. (2018). Propulsion Systems in Marine Navigation. *International Conference KNOWLEDGE-BASED ORGANIZATION*, *24*(3), 78–82. https://doi.org/10.1515/kbo-2018-0140
Shirsath, P. S., Hajare, M. S., Sonawane, G. D., Kuwar, A., & Gunjal, S. U. (n.d.-a). *A REVIEW ON DESIGN AND ANALYSIS OF AMPHIBIOUS VEHICLE*. www.ijstm.com
Shirsath, P. S., Hajare, M. S., Sonawane, G. D., Kuwar, A., & Gunjal, S. U. (n.d.-b). *A REVIEW ON DESIGN AND ANALYSIS OF AMPHIBIOUS VEHICLE*. www.ijstm.com
Spade Rudder - Marine Rudder Blade - Hi-sea. (n.d.). Retrieved May 23, 2024, from http://www.cqhisea.com/Spade-Rudder-530-5970-1.html
Suraj, M., Singh, K., Bande, A. V, Nandekar, S. D., & Verma, A. (2017). FABRICATION OF TWO STROKE ENGINE OPERATED AMPHIBIOUS VEHICLE. *International Research Journal of Engineering and Technology*. www.irjet.net
This Is Germany's First Amphibious Bus And It's Used For Hamburg City Tours | Carscoops. (n.d.). Retrieved May 22, 2024, from https://www.carscoops.com/2016/09/this-is-germanys-first-amphibious-bus/
Understanding Steering Gear in Ships. (n.d.). Retrieved May 23, 2024, from https://www.marineinsight.com/naval-architecture/understanding-steering-gear-ships/
Watabe, D., Wada, M., Shimizu, N., & Ohkubo, T. (2022). World's first self-driving amphibious bus. *International Robotics & Automation Journal*, *9*(1), 1–6. https://doi.org/10.15406/iratj.2023.09.00254
Yamamoto, L. M., Klau, J. F., Casa, D. J., Kraemer, W. J., Armstrong, L. E., & Maresh, C. M. (2010). The effects of resistance training on road cycling performance among highly trained cyclists: A systematic review. *Journal of Strength and Conditioning Research*, *24*(2), 560–566. https://doi.org/10.1519/JSC.0b013e3181c86583
Fuglsang, T., Padulo, J., Spoladore, M., Dalla Piazza, M., & Ardigò, L. P. (2017). Development and testing of a novel arm cranking-powered watercraft. Frontiers in Physiology, 8(AUG). https://doi.org/10.3389/fphys.2017.00635

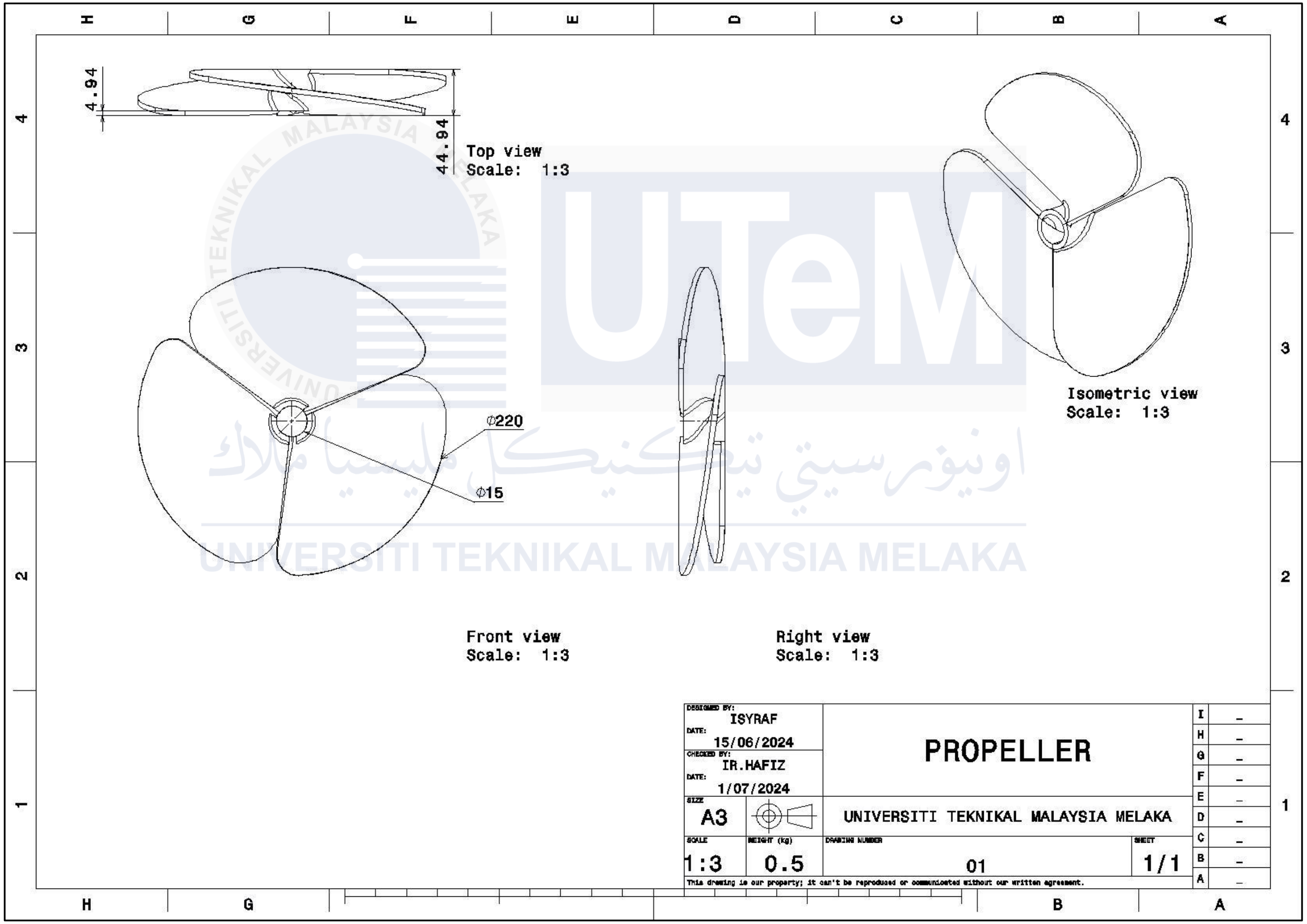
APPENDICES

APPENDIX A: Gantt Chart

PSM 1														
	March			April				Mei				June		
Task	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9	Week 10	Week 11	Week 12	Week 13	Week 14
Literature review finding (journal, article, paper)														
Start Literature review writing														
Propulsion design concept and analysis														
Propulsion and navigation system component selection														
Draw prototype design														
Report writing														
Psm 1 report submission														
Psm 1 presentation														
PSM 2														
	Month 1			Month 2				Month 3				Month 4		
	October			November				December				January		
Propulsion and navigation system fabrication														
Experimental and performance evaluation														
Documentation and report														

PLANNING Actual

APPENDIX B: Propeller Design Drafting



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step  flow-time thrust_force   flow-time  drag_force
  97  1.4550e+00 -1.8383e+00  1.4550e+00 -1.8383e+00
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