POLITEKNIK MALAYSIA
MUKAH

A COMPARATIVE STUDY ON HYDROKINETIC TURBINE OF BLADE PROFILE

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This report is submitted to the Department of Mechanical Engineering in partial fulfilment of the requirements for graduation Diploma in Mechanical Engineering

PROJECT REPORT VERIFICATION

This report entitled "**A COMPARATIVE STUDY ON HYDROKINETIC TURBINE OF BLADE PROFILE**" has been submitted and reviewed as to meet the conditions and requirements of project writing.

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"We declare that this report is our own work except each piece that we have explained the source"

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ABSTRACT

The objective of this project to design a prototype of river turbine that can convert hydrokinetic energy to electric and to compare the outcome from 3 different types of blade profile. This turbine is design for river application which are using river flow stream to drive the turbine. It operate in a shallow river with the depth range from 1 meter to 1.5 meter. The turbine must be submerge to able it operate smoothly. By using this results, the highest reading of which type of blade profile by producing electricity are the most suitable to solve the problems. Blade with radius 105° shows the reading of the voltage while the first and second design show difficulties in functioning to rotate smoothly and reading the data. This studies shows the blade with radius 105° show potential and can be apply to the turbine to generate electricity. Factor such as stream velocity, water flow, blade and frame design and depth of the river is the main factor that will affect the efficiency of the blade in generate electricity. River turbine has a great future as an alternative way in generating electricity especially in off grid electricity location.

ABSTRAK

Objektif bagi kajian ini ialah untuk mereka cipta sebuah prototaip turbin sungai yang mampu untuk menukar tenaga hidrokinetik kepada tenaga elektrik dan untuk membandingkan 3 jenis bilah turbin. Turbin ini direka untuk aplikasi sungai yang menggunakan aliran sungai untuk menggerakkan turbin. Turbin in beroperasi dalam sungai yang cetek sedalam 1 meter sehingga 1.5 meter sahaja. Ianya juga perlu ditenggelamkan agar turbin itu berfungsi dengan lancar. Keputusan bacaan yang tertinggi diantara bilah turbin yang dikaji merupakan bilah yang paling sesuai untuk digunakan sebagai turbin sungai. Bilah turbin yang mempunyai radius 105° menunjukkan bacaan voltan yang tertinggi manakala bilah yang pertama dan kedua menunjukkan kesukaran untuk berfungsi untuk berputar dengan lancar dan bacaan data. Kajian ini menunjukkan bahawa bilah turbin yang ketiga menunjukkan potensi yang baik dan dapat diaplikasikan keatas turbin untuk menghasilkan elektrik. Antara faktor seperti halaju aliran, aliran sungai, reka bentuk bilah dan turbin, dan kedalaman sungai tersebut merupakan faktor-faktor yang mempengaruhi effisiensi agar bilah tersebut menghasilkan elektrik. Turbin sungai mempunyai masa hadapan yang cerah untuk dijadikan sebagai cara alternatif dalam menghasilkan elektrik khususnya kepada kawasan pedalaman yang sukar memperolehi elektrik.

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LIST OF SYMBOL

SYMBOL

Gwh	-Giga watt per hour
Sq	-square
kV	-kilo volts
rpm	-rotation per minute
km	-kilometer
mm	-millimeter
ft	-feet
m	-meter

LIST OF SHORTFORM

HEP	Hydroelectric power
VAT	Vertical Axis Turbine

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

The continuous increasing needed for electrical energy, geographic difficulties of extending electric power sources across the rural areas and extensive number of rivers are some of the reasons for encouraging the use of renewable technologies. The lack of the governmental efforts and actions of non-governmental institutions to extend electrical energy to these rural areas, the progress in this direction is extremely slowly. Among different renewable energy technologies, hydro-power generation seems to be the most suitable solution for providing electrical energy on large and small scales. Hydrokinetic or in-stream turbines have received a growing interest in many parts of the world especially in relation to river applications. Hydrokinetic turbine transforms kinematic energy of water streams acting on a turning rotor coupled to an electric generator, into electric energy.

1.2 BACKGROUND OF STUDY

Hydrokinetic turbines are renewable energy which convert the kinetic energy of rivers into electrical energy. Various studies have been conducted on horizontal axis wind turbine blade sections. However the hydrokinetic turbine blade profiles are poorly investigated for turbines. For centuries people have harnessed the power of river energy by installing water wheels. According to United Nations about 1.4 billion people or 20% of the global population still do not have access to electricity. Certain villagers in Sarawak still do not have electric power source because of the lack of the governmental efforts to extend electrical energy to these rural areas. There are a few types of flow water of river in Sarawak. These are the reason why we want to study the blade profile for river hydrokinetic turbine that are suitable for the types of river flows.

1.3 PROBLEM STATEMENT

Sustainable energy from unlimited power source is a crucial topic nowadays. Rural areas are having problem in getting electricity. It is considered too costly for an electric power to be build or brought to some rural areas especially in Sarawak. Moreover, there are no road excess mostly in rural areas especially in Sarawak which causes certain areas to be isolated from the major cities and it causes difficulties to access electricity. The people in rural areas rely on diesel generator to provide electricity but this is inefficient because the price of diesel nowadays are expensive and this gives burden to them to purchase it

1.4 OBJECTIVE

i. To design the prototype of river turbine that can convert hydrokinetic energy to electric.

ii. To compare the outcome from 3 different types of blade profile by voltage.

1.5 SCOPE

i. Use river flow stream to drive the turbine.
ii. Turbine is design for river application.
iii. This turbine only can operate in shallow river(1-1.5m)
iv. The turbine must be submerge to operate.

1.6 IMPACT OF RESEARCH

This type of hydrokinetic turbine are easier to build and brought to rural areas. This is a better alternative solution for making electricity available in rural area compared to solar energy. This is because solar energy are more expensive compare to this river turbine. It also cheaper to be built since it only use kinetic energy of water streams that turns into electrical energy. By using this river turbine, we can use the available abundant source of energy from hydrokinetic without spend costly on electricity. Besides, by using this alternative solution the villagers can reduce oil or diesel consumption in rural area. In addition, it can save the environment and can save money from buying diesel for generator because high diesel's price give burden to the villagers. From this research, people can know the most suitable blade profile for this turbine. They can choose the blades of the turbine that are suitable for settlement around river.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

Growth in energy consumption and environmental concerns over conventional power generation technologies has given rise to a need for alternative energy sources. Emerging hydro technologies consist of kinetic currents, tidal and wave applications. River kinetic hydro power is a promising technology that involves the use of underwater turbines in fast moving rivers to produce electricity. The technology differs from more conventional hydro power technologies in that it does not require a dam, or powerhouse. River kinetic hydro power is well-suited for distributed power generation. The technology has been available for decades; however despite its minimal environmental impact, commercialization has been limited. Recently, there has been a large resurgence in the interest in all forms of emerging hydro technologies (Sergergren 2005) however, the application of river kinetic hydro power is largely undocumented (Gaden 2006).

The main purpose of this thesis is to develop and evaluate a set of design tools for practical application to the development of river-kinetic hydro power. It is not intended as a rigorous academic investigation of specific flow conditions. Therefore the goal is not to obtain highly accurate results, but rather to cover a wide array of modeling techniques and obtain an understanding of their performance. Hence an emphasis will be placed more on the trends in the data rather than the exact values. Although broad in scope, important general conclusions can be drawn from these studies. In the field of fluid dynamics, three techniques are used to gain insight into the behavior of fluids: theoretical, numerical, and experimental. All these techniques have deficiencies, as theoretical and numerical solutions are both limited by our breadth of knowledge, and experimental data is limited by the errors inherent in our experiment and by the costs of test equipment. It is important to understand what useful information can be obtained from any design tools, and under what circumstances. Therefore, in this thesis, all techniques are presented, along with a detailed study of the limitations of each approach. The results in concert with the error analyses will provide the reader with an appreciation of the capabilities of the design tools available to river-kinetic turbines. It is important not to lose sight of the primary goal of this thesis: to improve our ability to extract power from kinetic flows. This thesis provides a stepping-stone to further the development of this technology. In this study, three different design of blade is use to make comparison. The comparison will make by calculate the output voltage that generate by the turbine by using analog multimeter and also by the rotation of the blade per minute.

2.2 KINETIC TURBINE

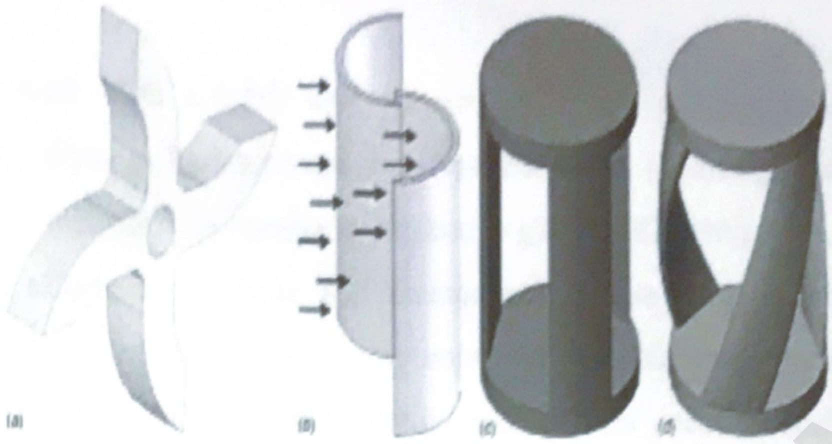


Figure 2.1 Turbine

Alternatively, a fixed anchor can be used which, unlike a cable anchor, must also withstand a moment force which is function of the height of the turbine above the river bed and the peak drag force expected during the lifetime of the turbine. This increases costs. Kinetic hydro power has no reservoir, spillway, or emissions. Therefore environmental impact is minimal, and site selection is far less restrictive compared with other hydro technologies. The initial installation cost and deployment time is relatively short as river kinetic hydropower does not require any significant infrastructure, such as dams or powerhouses. The modular nature of kinetic hydro power leads to an easily scalable energy output but with limited opportunities to decrease the capital cost per kW. Finally, river flows lead to continuous energy production, thus eliminating the need for any significant energy storage capacity, an important advantage in remote communities and of interest to utilities. This technology is intended to supplement existing hydro power generation. Installation and servicing may be complicated by dangerous river conditions, cold weather and seasonal ice floes, where applicable. The design must accommodate diverse flow conditions, including seasonal variations in the river flow rate, thus design optimization is compromised. There is no control over the upstream flow conditions or riverbed surface, therefore turbulence, silt and foreign debris are expected at the inlet. Turbulent inlet flow may lead to cavitation on the turbine blades. Finally, the technology poses an unknown risk to fish, vegetation, and other habitants of the river, a risk that must be understood before large- scale deployment is considered

2.3 HYDRO POWER STUDY

Blessed with high rainfall and an abundance of rivers, Sarawak harnesses renewable energy through hydro power development. With greater global awareness on carbon mitigation measures to combat greenhouse gas (GHG) emissions, there are now more concerted efforts to promote and encourage the use of renewables for power generation. In Malaysia, the Government approved the National Renewable Energy Policy and Action Plan on 2 April 2010.All these factors point to shifting to a more sustainable energy supply which is readily available, economical to produce, renewable and non-polluting. The push for this shift appears to come increasingly from the need for lower carbon emission in power generation. Sarawak's first foray into hydro power began in 1962 when a pre-feasibility study was conducted at Batang Ai. Follow up studies were conducted in the 1970s and construction commenced in 1981. Batang Ai HEP, with installed capacity of 108 MW, was completed in 1985. After 30 years, it continues to generate and deliver clean and renewable energy smoothly and reliably. After its first turbine was commissioned in 2014, Murum HEP was fully commissioned in June 2015. The plant delivers 944 MW of clean and reliable energy for Sarawak. Sarawak Energy also purchases the entire output from Bakun HEP (2400MW) through a power purchase agreement signed in 2011.

Sarawak Energy is pursuing the development of indigenous hydro power resources and has identified further sites as being highly promising for the construction of hydroelectric projects. In developing hydro power, the Sarawak Energy project development model - Sarawak Energy Project Model or SPM - requires projects to pass through three formal decision gates before a final investment decision is taken, namely Initiation phase which is decision to start, Concept phase and Pre-Engineering phase. This is based on the gross head measurements taken during the site survey, then we take into account head losses in channels and pipework to produce an estimated net head which is used in the hydro system performance modeling in the hydro power feasibility study.

Our sophisticated in-house modeling software also takes into account changes in the head across the site as the flow rate changes, upstream water levels rise and downstream levels back-up. It also accounts for head losses in all pipework, channels and within the turbine itself to provide a realistic estimate of how the head varies across all flow rates. Malaysia has a total land mass of 332,000 km2 and its mean elevation is about 300 m. The average rainfall is slightly more than 2,600mm per year. The total gross hydro potential is 414,000 GWh/year, of which about 85,000 GWh/year is available in Peninsular Malaysia. Hence, whilst Peninsular Malaysia has 39% of the land area, its share of hydro power resources is only slightly more than 20% .

Geographically, the peninsula is relatively narrow, and its main range of low mountains, the Titiwangsa Range, runs along the interior to form the main watershed. Thus, the river basins formed are moderately small. The largest river basin is Sg. Pahang with a drainage area of 28,500 km2. In addition, topographic features and rainfall are comparatively less favorable than Sabah and Sarawak. These are the main factors which contributes towards the limited hydro power resources in the peninsula of the 85,000 GWh/year gross potential, the utilized resources amount to 4,900 GWh/year (6%) whilst another 5,000 GWh/year (6%) has been identified. The Sg. Perak river basin is the most developed in terms of hydro- power development utilization (2,500 GWh/year), and it is reaching the limit of hydro power potential development. For Peninsular Malaysia, it has been estimated that the economic limit of hydro power utilization is unlikely to exceed 10,000 GWh/year.

2.3.1 Batang Ai Hydroelectric Plant

Figure 2.2 Pioneering Hydro power in East Malaysia

Batang Ai, Sarawak's first hydroelectric plant, commenced operations in 1985, captures the stored energy of a 90 sq km reservoir impounded by a dam 85 m high and 649 m wide. It has functioned smoothly for over 30 years, delivering up to 108 MW of power to Kuching via a purpose-built 275kV transmission line. The station is refurbished and upgraded to serve for another 30 years. The project has transformed the lives of local communities, who enjoy much better access to education and health care and to markets for their agricultural produce. Many have also become involved in ecotourism, driven by the unique culture of the local Iban people and the spectacular rain forest of the project catchment area. The local orangutan population has risen steadily since the establishment of the 120,000-hectare catchment area, which is now one of the most densely populated orangutan habitats in Borneo with more than 1.7 animals per sq km.

2.4 RIVER TURBINE

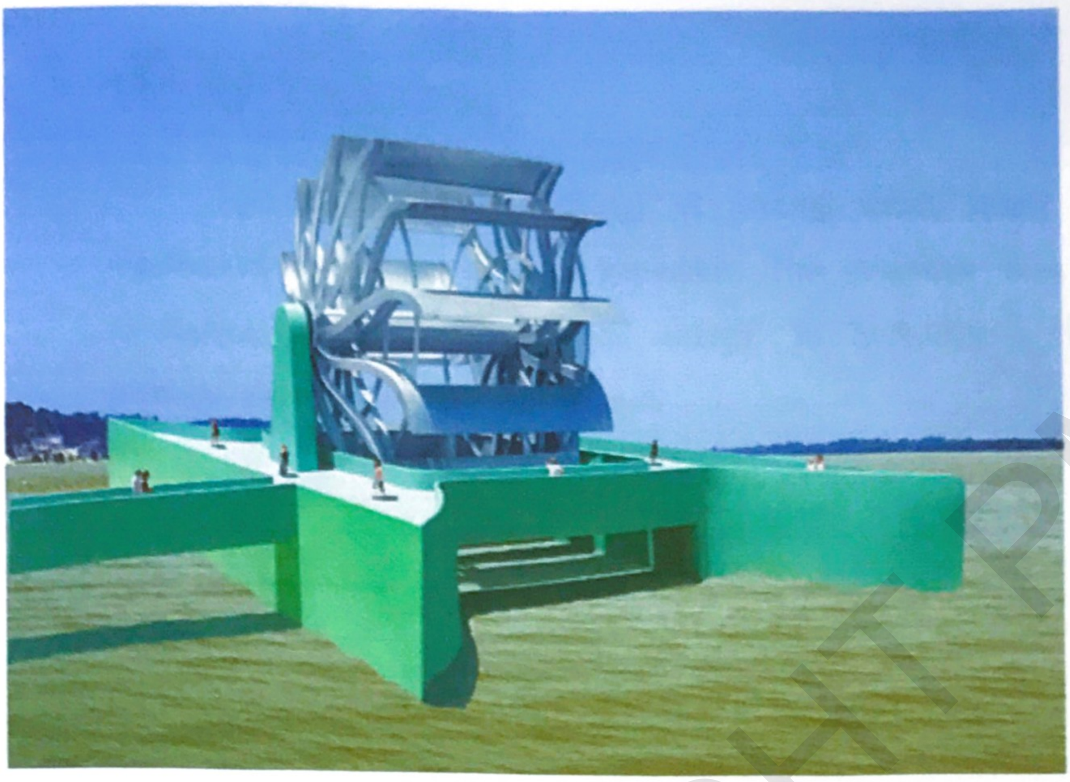


Figure 2.3 River Turbine

River turbine have been used for hundreds of years for industrial power. Their main shortcoming is size, which limits the flow rate and head that can be harnessed. The migration from water wheels to modern turbines took about one hundred years. Development occurred during the Industrial revolution, using scientific principles and methods. They also made extensive use of new materials and manufacturing methods developed at the time.

Flowing water is directed on to the blades of a turbine runner, creating a force on the blades. Since the runner is spinning, the force acts through a distance (force acting through a distance is the definition of work). In this way, energy is transferred from the water flow to the turbine. Water turbines are divided into two groups; reaction turbines and impulse turbines. The precise shape of water turbine blades is a function of the supply pressure of water, and the type of impeller selected.

2.5 CURRENT TYPE OF TURBINE

- **Turbines**

Turbines convert the energy of rushing water, steam or wind into mechanical energy to drive a generator. The generator then converts the mechanical energy into electrical energy. In hydroelectric facilities, this combination is called a generating unit.

i. Francis turbine

Figure 2.4 Francis turbine

The Francis turbine is a type of water turbine that was developed by James B. Francis in Lowell, Massachusetts. It is an inward-flow reaction turbine that combines radial and axial flow concepts. Francis turbines are the most common water turbine in use today. They operate in a water head from 40 to 600 m (130 to 2,000 ft) and are primarily used for electrical power production. The electric generators that most often use this type of turbine have a power output that generally ranges just a few kilowatts up to 800 MW, though mini-hydro installations may be lower. Penstock (input pipes) diameters are between 3 and 33 feet (0.91 and 10.06 metres). The speed range of the turbine is from 75 to 1000 rpm. A wicket gate around the outside of the turbine's rotating runner controls the rate of water flow through the turbine for different power production rates. Francis turbines are almost always mounted with the shaft vertical to isolate water from the generator. This also facilitates installation and maintenance. The most commonly used turbine in Hydro-Québec's power system. Water strikes the edge of the runner, pushes the blades and then flows toward the axis of the turbine. It escapes through the draft tube located under the turbine. It was named after James Bicheno Francis (1815-1892), the American engineer who invented the apparatus in 1849

ii. Kaplan turbine

Figure 2.5 Kaplan turbine

Austrian engineer Viktor Kaplan (1876-1934) invented this turbine. It's similar to the propeller turbine, except that its blades are adjustable; their position can be set according to the available flow. This turbine is therefore suitable for certain run-of-river generating stations where the river flow varies considerably. The Kaplan turbine was an evolution of the Francis turbine. Its invention allowed efficient power production in low-head applications that was not possible with Francis turbines. The head ranges from 10–70 meters and the output from 5 to 200 MW. Runner diameters are between 2 and 11 meters. Turbines rotate at a constant rate, which varies from facility to facility. That rate ranges from as low as 69.2 rpm (Bonneville North Powerhouse, Washington U.S.) to 429 rpm. The Kaplan turbine installation believed to generate the most power from its nominal head of 34.65 m is as of 2013 the Tocoma Dam Power Plant (Venezuela) Kaplan turbine generating 230 MW (Turbine capacity, 257MVA for generator) with each of ten 8.6 m diameter runners. Kaplan turbines are now widely used throughout world in high-flow, low-head power production

iii. Pelton turbine

Figure 2.6 Pelton turbine

Named after its American inventor, Lester Pelton (1829-1908), this turbine uses spoon-shaped buckets to harness the energy of falling water. The Pelton wheel is an impulse type water turbine. It was invented by Lester Allan Pelton in the 1870s. The Pelton wheel extracts energy from the impulse of moving water, as opposed to water's dead weight like the traditional overshot water wheel. Many variations of impulse turbines existed prior to Pelton's design, but they were less efficient than Pelton's design. Water leaving those wheels typically still had high speed, carrying away much of the dynamic energy brought to the wheels. Pelton's paddle geometry was designed so that when the rim ran at half the speed of the water jet, the water left the wheel with very little speed; thus his design extracted almost all of the water's impulse energy which allowed for a very efficient turbine.

2.6 BLADES TO STUDY

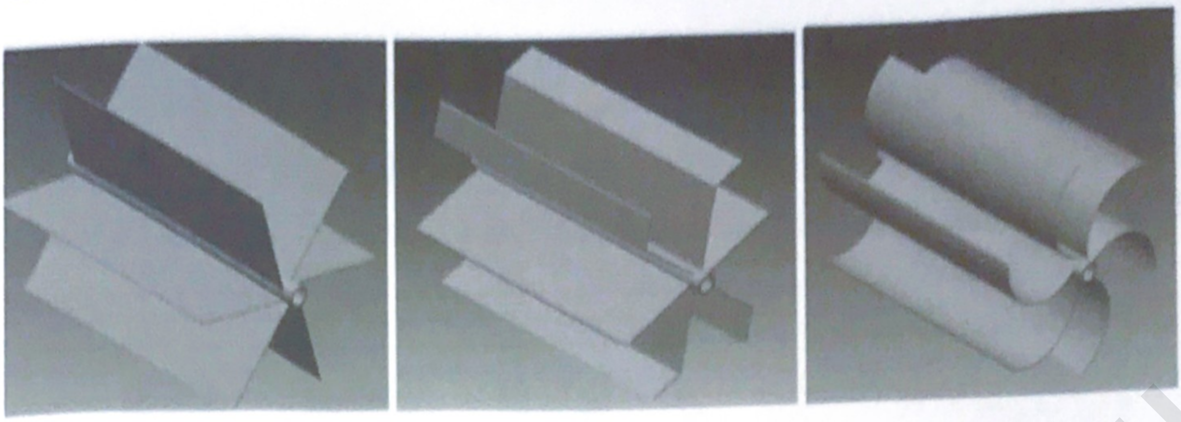


Figure 2.7 : blade to study

To study the 3 types of blades as shown on figure 2.7 above and to know which one is the best that can create or produce more electricity. A water turbine is a rotary machine that converts kinetic energy and potential energy of water into mechanical work.

Water turbines were developed in the 19th century and were widely used for industrial power prior to electrical grids. Now they are mostly used for electric power generation. Water turbines are mostly found in dams to generate electric power from water kinetic energy. But this time, we use the water stream to push then operate the turbine. Besides, this study also help us to find out which blade rotate the fastest one when the stream of the water or the kinetic energy from the water push the blade. Through this type of blades we will know which one is.

2.7 WATER STREAM STUDY

The study of flow field of river is very important to investigate various flow field parameters in water resource system, river control development works for life and works of humans, analysis of river mechanics problem, design of hydraulic structure etc. various studied has been made to analyses the river flow field with respect to earlier said working fields. In addition to computation-control parameters, certain other parameters must be defined. These principally describe the conveyance properties of the channels. Although these parameters cannot be measured directly, they can be derived from certain measured data. They depend principally upon the physical properties of the channels of the rivers. Generally the Mountain Rivers or glaciers river have very steep flow and complex bed geology. To study of the flow field for any geological and artificial structure within the flow must be analyzed and it is very important to simulate the flow field for outcome and results of that particular flow structure and parameters of river. A paper has been discussed the flow field of the ice cubes and the boulders in river through the IR scanner shown in figure 2.8. In figure 2.8 the temperature field around the ice boulder has been shown.

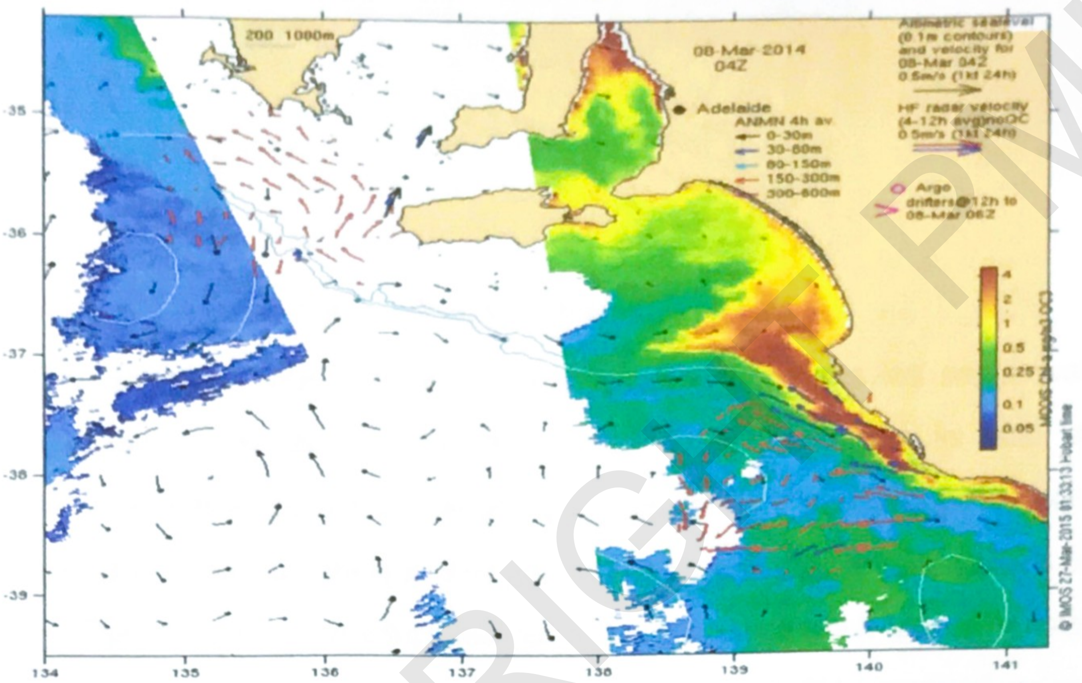


Figure 2.8 Flow patterns captured with the IR camera, using ice cubes as tracers.

As it discussed above the flow field of any flow stream or river gives the compete knowledge about the flow structure and flow behavior around any boulders or any bluff body. The flow field for river has been investigated for many geological and environmental purposes but there is a lack of study to estimate the river field to correlate the energy generation devices in river such as in stream and free flow hydrokinetic turbines. A river flow parameters also needed for water power generation through hydrokinetic turbines. In present research work, the study of flow field of selected rivers has been estimated and analyzed. And require parameters of the hydrokinetic turbine has been correlated with the river flow field model. It has been also discussed the flow pattern of the river field around the any structure such as the bluff body which is similar to the hydrokinetic turbine mainly Darrius turbine. A similar flow field study for river and bluff body assumption as hydrokinetic turbine has been done.

2.8 SELECTED FRAME FOR WATER TURBINE

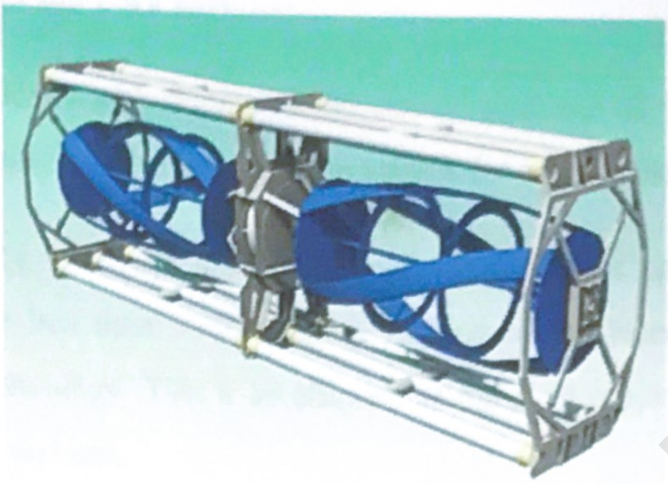


Figure 2.9 Selected frame for turbine

This turbine is very similar to the wind energy turbines we see around our countryside and out at sea. The turbine is much modified for use in water and is positioned for energy extraction on the sea bed. These devices have to cope with changes in direction of the tide, variations in strength of the tide including regular periods of zero tidal flow. They have controls which maneuver the orientation pitch angle and rotational speed to suit the conditions. These devices also have to cope with long period under water with motors, generators, actuators and electrical connections completely submerged.

The resulting high maintenance costs are, not surprisingly, causing the industry to produce low return on investments.

Vertical Axis Turbine - The efficient, low maintenance way forward

Rather than the water flowing along the axis of the rotating blades, water flows across the axis of the Vertical Axis Turbine (VAT). The turbine can be mounted vertically or horizontally.

The first operating turbine in this configuration was the Darrieus turbine and then the more recent Gorlov Helical Turbine in 1995. Both of these inventions have their problems and have therefore not been adopted by the tidal energy industry.

Blue Tidal Energy has developed a new Vertical Axis Turbine by varying the blade pitch using a simple system requiring no power of any kind.

- **Advantages of the VAT turbine:**

1. Mounted vertically with the top of the vertical shaft out of the water allowing all electrics to be above the water or near the surface for easy access.

2. The efficiency of a model variable pitch Vertical axis tidal turbine has been measured at just less than 50%, a figure verified by the Norwegian University of Science and Technology. This is as efficient as the most efficient modern wind and water axial flow turbines.

3. An efficiency of 32% to 40% has been achieved from the first test programmer without a diffuser. Turbines mounted in a diffuser can achieve much higher efficiencies.

4. Axial flow turbines have a theoretical maximum efficiency of 59% (Betz law). The VAT turbine is not limited by this condition.

5. Rotates in same direction with flow from either direction, therefore no blade orientation motors required.

6. Water turbines needs to operate from a tidal flow of zero to full flow twice a day. Our variable pitch blades have eliminated the problem with self-starting for the VAT.

7. The frontal area presented to the water flow for VAT is square or rectangular. This shape allows better use of a tidal flow than a circular shape presented by the axial flow turbine. This factor is important when operating in shallow waters in an array.

CHAPTER 3

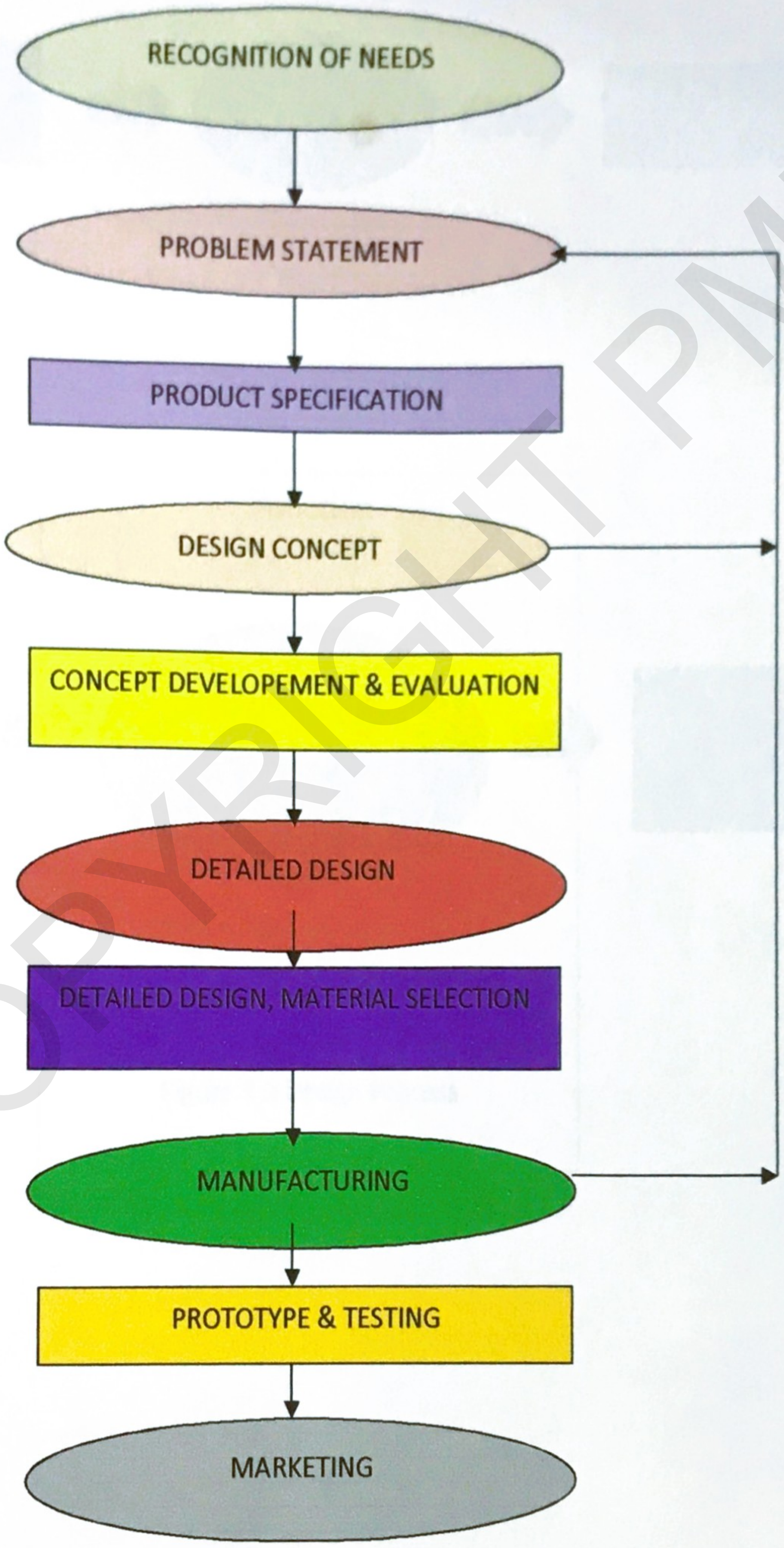
METHODOLOGY

3.1 INTRODUCTION

In this chapter, we will analyse theoretically about the methods applied in the making of our project. We will explain the variable methods that were used to make our project besides that, we will also explain our planning in doing this project, the problems that we have to endured in choosing the right materials, and last but not least the materials that were used to make this project.

3.2 PROJECT DESIGN PLANNING

3.1 Design Flow Chart



3.3 PROJECT DESIGN

3.3.1 Design flow process

Figure 3.1 Black box model

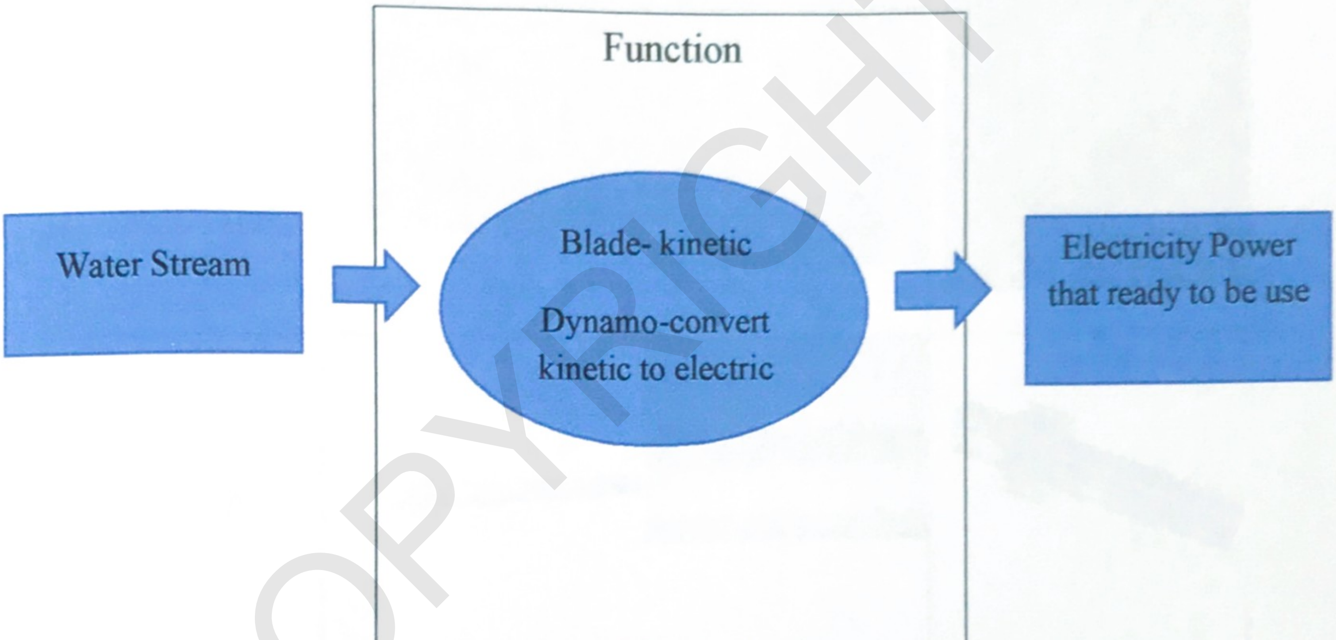
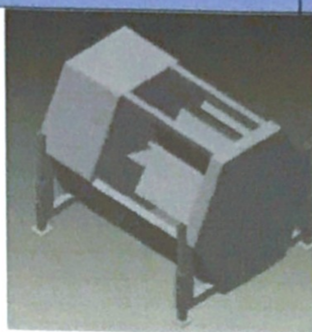
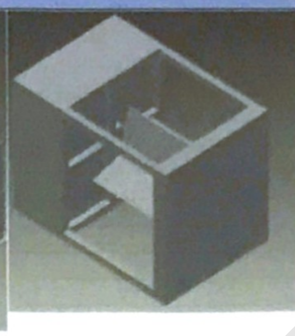
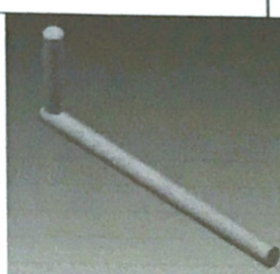
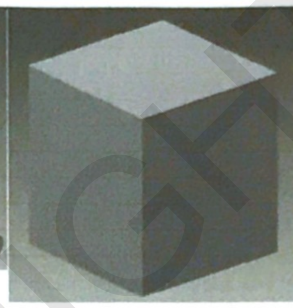
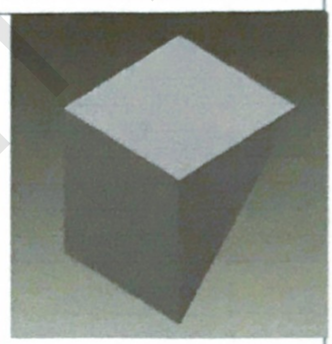
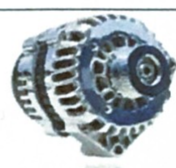


Figure 3.2 Design Process

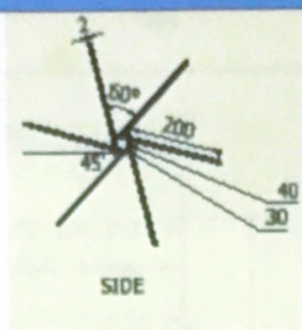
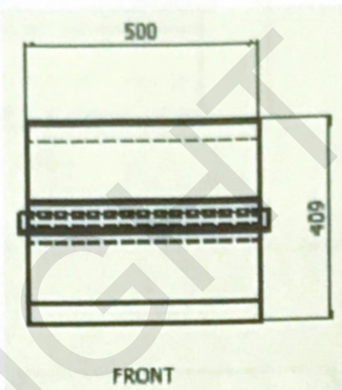
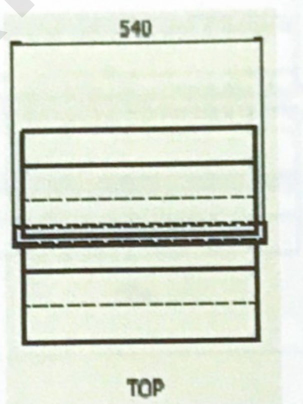
3.3.2 Concept generation

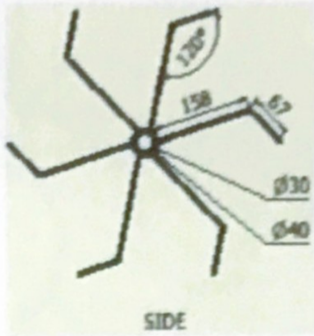
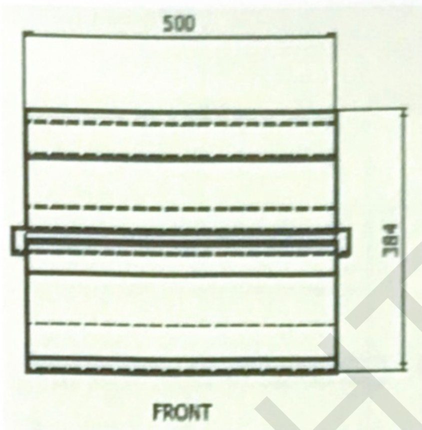
Table 3.2 Morphology Chart

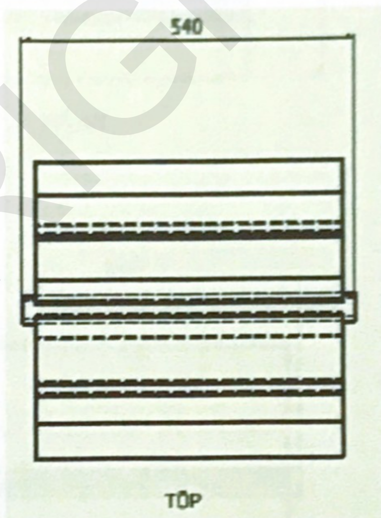
Function	**Concept1**	**Concept 2**	**Concept 3**
frame			
Weight/ancho r			
Shaft			
dynamo			
Power storage			

3.3.3 Design concept for the blade study

Table 3.3 Blade profile

Option	Design
Design 1	

<table>
<tr><td>Design 2</td><td>
</td></tr>
<tr><td></td><td>


</td></tr>
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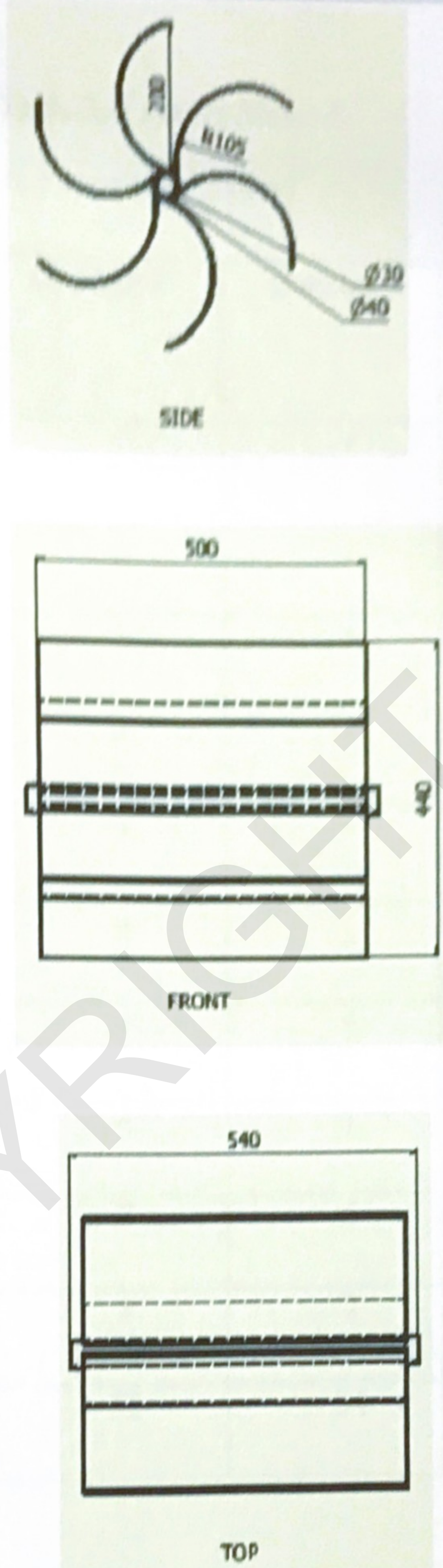
<table>
<tr><td>Design 3</td><td>
</td></tr>
</table>

3.3.4 Concept Evaluation

Table 3.4: Pugh's Method

Matrix Evaluation Method				
Evaluation Criteria	Wt.	Concept 1	Concept 2	Concept 3
1. Safety	10	+	+	+
2. Cost	5	–	–	+
3. Maintenance	8	+	+	–
4. Ease To Use	9	+	+	–
5. Resistance to corrosion	8	+	+	+
6. Easy installation	9	+	–	–
7. Long service life	6	+	+	+
8. Manufacture	7	+	+	–
Total +		7	6	4
Total -		1	2	4
Overall score		52	34	-4

Discussion

Based on concept generation, concept 1 is selected because it is the best concept compare to other concept. Concept 2 is almost similar to concept 1 but concept 1 is easier to install the blades.

3.3.5 Final Project Design

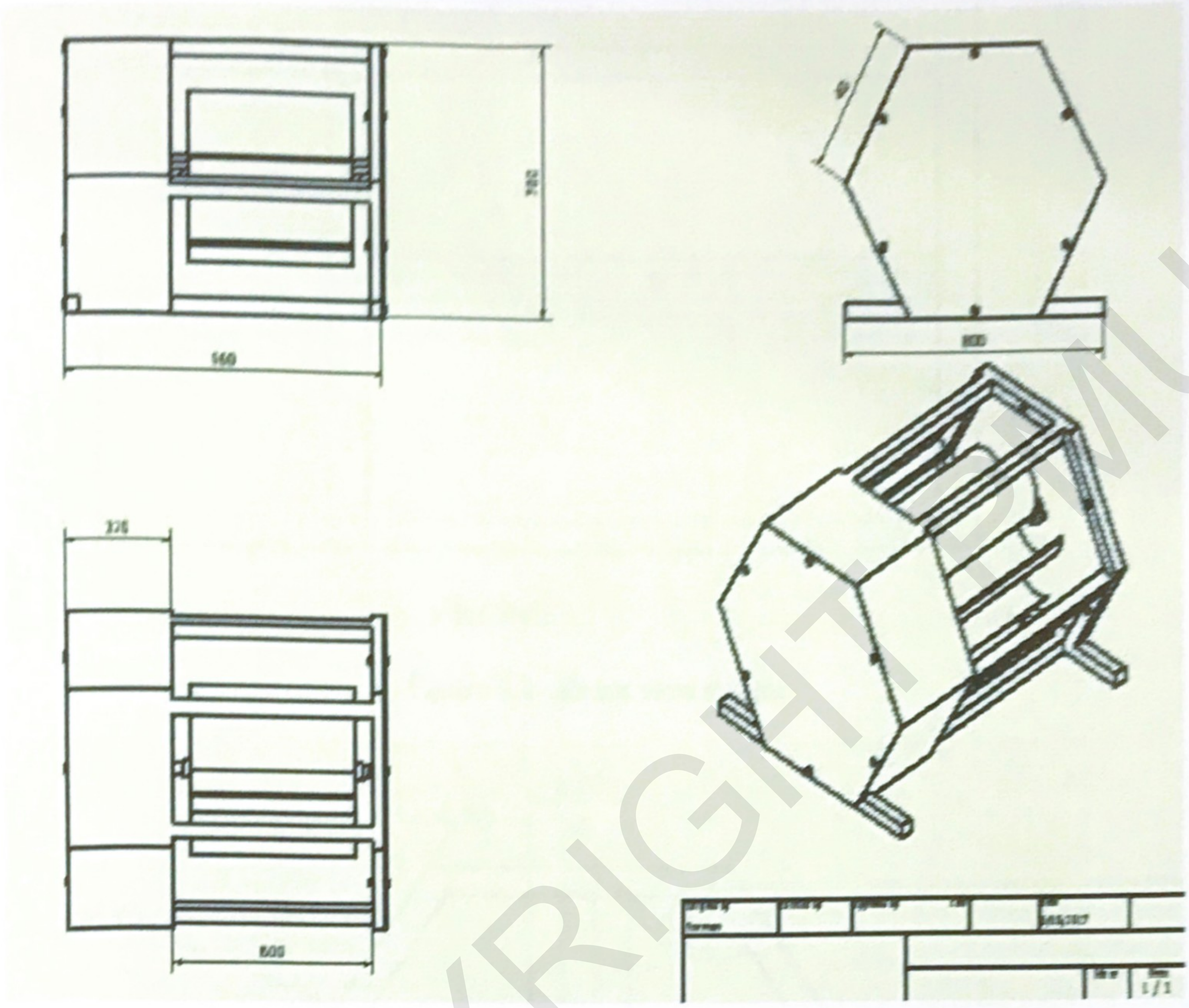


Figure 3.3 : Final design

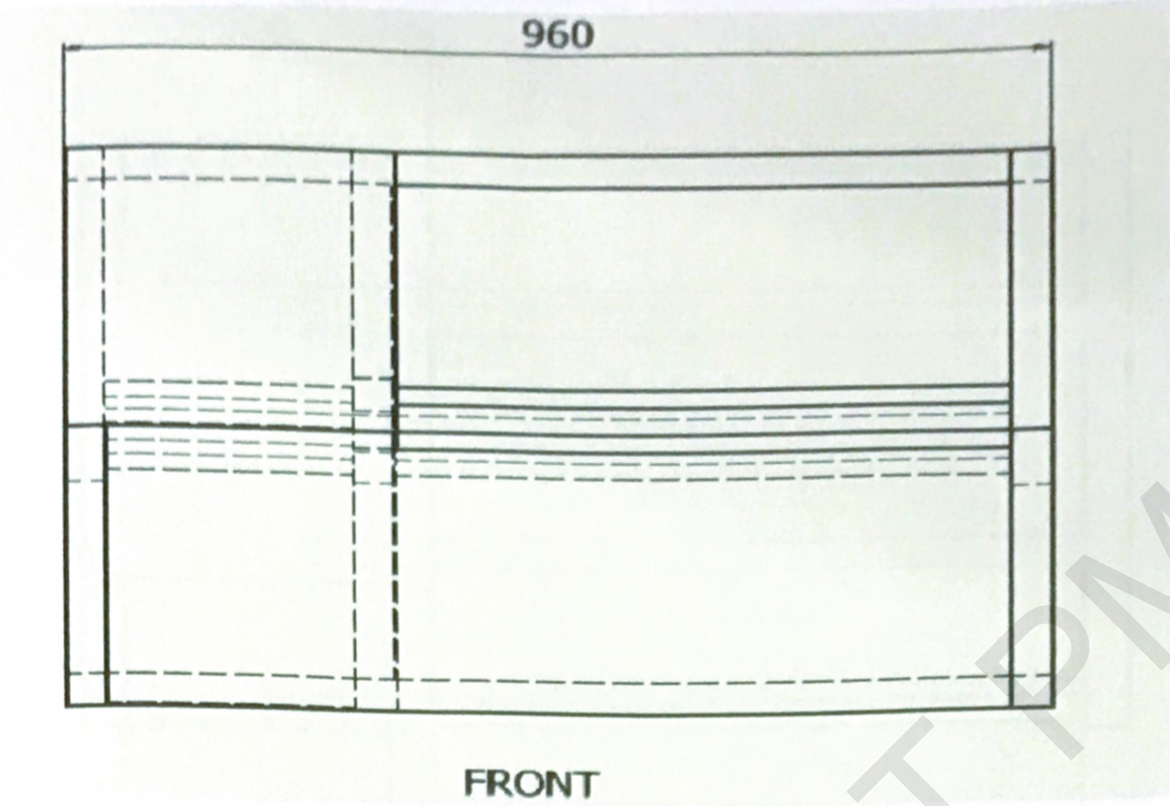


Figure 3.4 : Front view design

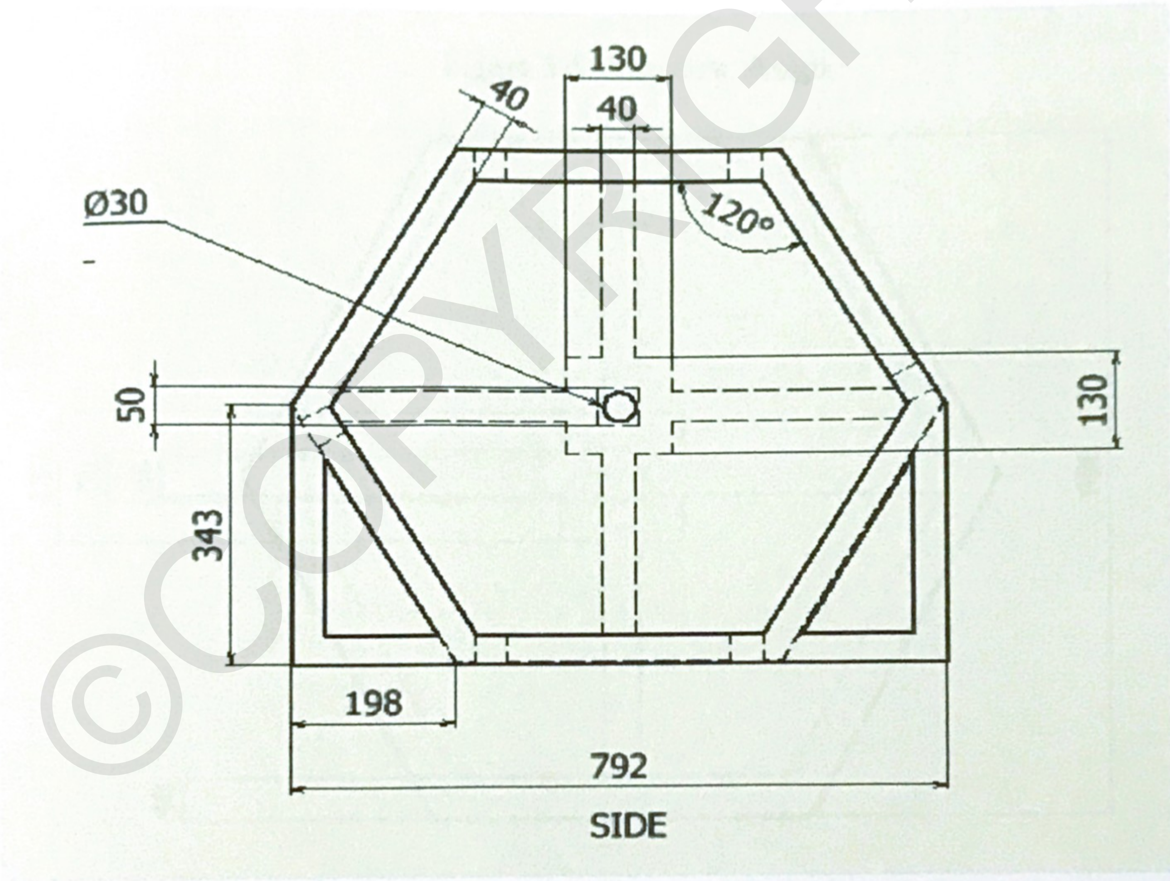


Figure 3.5 :Side view design

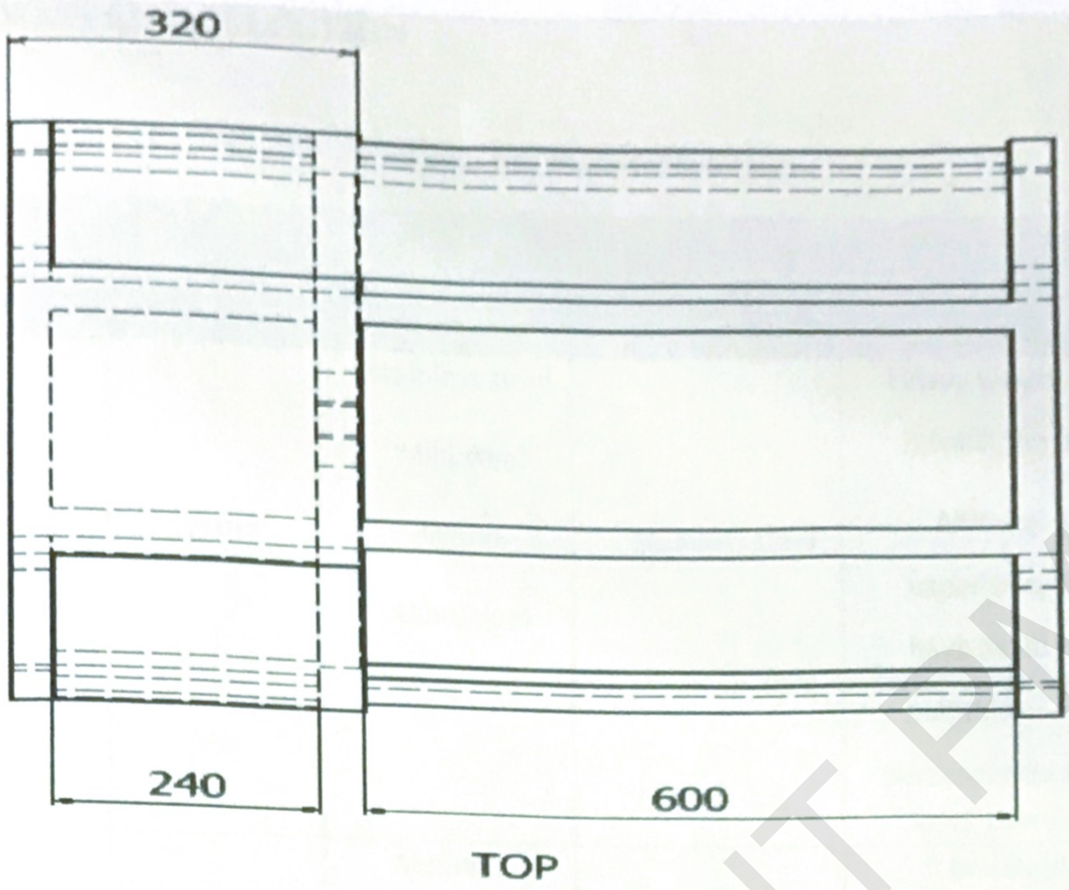


Figure 3.6 : Top view design

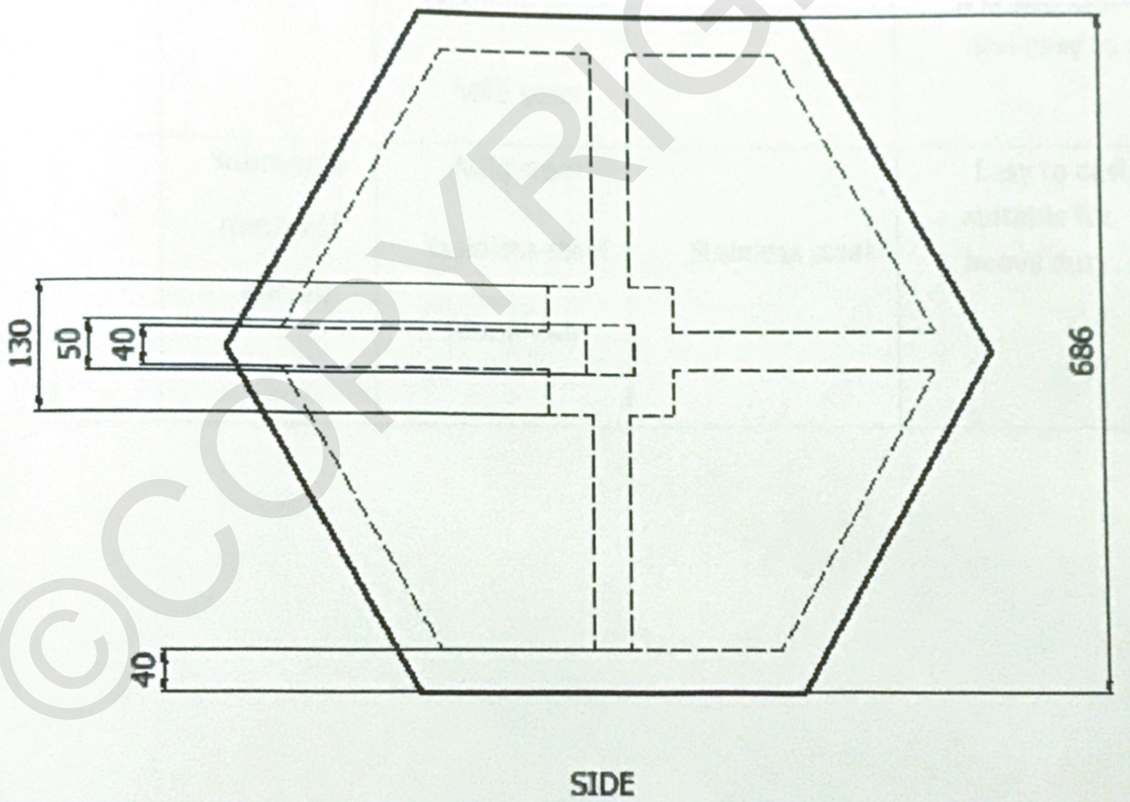


Figure 3.7 : Side view design

3.4 MATERIAL SELECTION

Table 3.5: Material Selection

NO	Part	Suggested Material	selected	Justification
1.	Frame	Stainless steel Mild steel Wood Aluminium	Stainless steel	Heavy weight which is fulfill the need. Although it is expensive, it have more suitable persepection such as anti- corrosion.
2.	Blade	Aluminium Perspex Stainless steel Mild steel	Stainless steel	It is suitable for heavy duty. It is anti-corrosion and easy to cast.
3.	Submerge method/ anchor	Mild steel Stainless steel Aluminium	Stainless steel	Easy to cast and suitable for heavy duty.

3.4.1 Bills of materials

Table 3.6: Bills of material

No.	Material description	Unit Cost	Total Cost	Quantity
1.	Stainless steel hollowed bar	RM 80.00 per 6 meter	RM 160.00	12 meter
2.	Bearing	RM 50.00	RM 150.00	3 unit
3.	Stainless steel plate	RM 150.00 per 3 meter^2	RM 300.00	6 meter^2
4.	Wire cable	RM 13.00 per 6 meter	RM 26.00	12 meter
5.	Alternator	RM 120.00	RM 120.00	1 unit
6.	Stainless steel round bar	RM 75.00 per 6 meter	RM 75.00	6 meter
7.	Sprocket	RM 30.00 per unit	RM 60.00	2 unit
8.	Wire connector	RM 40.00	RM 40.00	1 unit
9.	Bolt and Nut	RM 5.00 per unit	RM 100.00	20 unit
11.	Chain	RM 18.00 per unit	RM18.00	1 unit

	Inverter	RM 59.00	RM 59.00	1 unit
Total				RM 1108.00

3.5 Sampling techniques

Sampling method that been used for this project is by assemble the turbine with the first blade and submerge it in the 1 meter depth of river for 2 hours. Then, the voltage produce by the alternator is measured by using multimeter.

For the second blade, the first blade is remove from the turbine and change with the second blade. The turbine is submerged for 2 hours before the reading is taken.

Lastly, for the third blade. The second bade is remove from the turbine and change with the third blade. The turbine once again submerge for 2 hours before the reading is taken by using multimeter.

All the result is taken for 3 times and the average is calculated and tabulated in the final report in chapter 4.

3.6 PROCESS

3.7 DATA ANALYSIS METHOD

Table 3.7: method of volt reading

blade	Volt reading (volt)			
	1^{st}	2^{nd}	3^{rd}	average
1				
2				
3				

CHAPTER 4

RESULTS AND DATA

4.1 INTRODUCTION

This chapter presents the results of the study that have been researched in chapter 1. In this chapter, the results are being collected from the volt produced by the turbine by using different type of blade profile that has been fabricated. The objective in this research are achieved from the collecting data of this results. Data analysis are recorded by reading 3 times of the volts on each of the blade profile.

4.2 RESULTS

Table 3.8: volt reading

blade	Volt reading (volt)			
	1^{st}	2^{nd}	3^{rd}	average
1	-	-	-	0
2	-	-	-	0
3	0.5	0.6	0.5	0.5

CHAPTER 5

DISCUSSIONS, CONCLUSIONS AND RECOMMENDATIONS

5.1 INTRODUCTION

This chapter will explain the discussions that we get from the results of the research that have been collected from the previous chapter. It also includes the conclusions that stated which is the most suitable blade profile from the research of the result of data analysis. Lastly, this chapter will give the suitable suggestions to improve the research of that has been conducted.

5.2 DISCUSSION

As what has written in data analysis, it shows the result, advantages and disadvantages of the three blade and the turbine physical. The turbine shows that it can stay static in one place because of the turbine is not heavy enough to make it stay in one place. Add up with the flow of the river wave that makes the turbine can't stay in one place. The turbine should be add more weight or make an anchor to make it static in place.

For the blade, the first design with 45° angle it can rotate but not fast enough to generate the electric because of the flow of river is not strong enough to push the blade and the physical of the blade made the water trap in every angle at the back of the blade during the blade try to rotate.

The result that obtain from the second blade is not much different form the first one. The blade with 120° angle only can rotate slowly and cannot drive the alternator to produce electricity. This type of blade is not suitable for turbine.

Lastly the third blade, the 150 radius blade can rotate but not as planned. It only can drive the alternator to produce up to 0.6 volt. This blade can be upgrade to a better design so that the turbine can produce more power.

As the conclusion, the third blade is more suitable for the turbine. This design can be upgrade by changing the design of the turbine, design of the blade and adding the inlet and outlet of water flow to the turbine. This design of turbine is more suitable for fast flow river.

5.3 CONCLUSION

As the conclusion of this project, the objective is accomplished which are we able to design the prototype of river turbine that can convert hydrokinetic energy to electric and we able to compare the outcome from 3 different type of blade profile by using voltage readings. The project is not finished in time that we have been set or by following the actual planning in the Gantt chart but this research still be done before the due time.

5.4 RECOMMENDATION

Recommendation about the shape of the turbine, it is suitable and need some upgrade on the inlet and outlet of the water. Suggested that the inlet of the turbine should be one way so the blade will have enough pressure to drive it.

The blade that recommended after finishing this project is vertical so that easier to make the inlet and the outlet of the water.

The generator that suitable for this project is alternator with low rpm and low torque. The most suitable step up method is using gear because it is more rpm can be generated by gear and less space needed compare to chain and sprocket.

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1. Abdullah Muratoglu, M. Ishak Yuce, (2015), Performance Analysis of Hydrokinetic Turbine Blade Sections, Civil Engineering Department, (p 2-14)
2. Daniel B. Jones (2011), Hydrokinetic turbine blades: Design and local construction techniques for remote communities Energy for sustainable development,(223-230)
3. Kamal A.R.Ismail (2015) A comparative study on river hydrokinetic turbines blade profiles, Int. Journal of Engineering Research and Applications Vol. 5, Issue 5,(pp.01-10)
4. Saurabh Sangal, Arpit Garg, Dinesh Kumar,(2013) Review of Optimal Selection of Turbines for Hydroelectric Projects, International Journal of Emerging Technology and Advanced Engineering Website (ISSN 2250-2459, ISO 9001:2008 Certified Journal, Volume 3, Issue 3.

ATTACHMENT

Attachment A	**GANTT CHART**
Attachment B	**Picture of research project**

ATTACHMENT A

			SESSION: JUNE 2017																					
POLITEKNIK MALAYSIA MUKAH			JUNE				JULY				AUGUST						SEPTEMBER				OCTOBER			
MECHANICAL ENGINEERING DEPARTMENT			REG	W1	W2		W3	W4	W5	W6	W7	W8		W9	W10	W11	W12	W13	W14	W15	W16			
		M	5	12	19	26	3	10	17	24	31	7	14	21	28	4	11	18	25	2	9	16		
		T	6	13	20	27	4	11	18	25	1	8	15	22	29	5	12	19	26	3	10	17		
		W	7	14	21	28	5	12	19	26	2	9	16	23	30	6	13	20	27	4	11	18		
		T	8	15	22	29	6	13	20	27	3	10	17	24	31	7	14	21	28	5	12	19		
GANTT CHART		F	9	16	23	30	7	14	21	28	4	11	18	25	1	8	15	22	29	6	13	20		
CODE: DJJ6143		S	10	17	24	1	8	15	22	29	5	12	19	26	2	9	16	23	30	7	14	21		
COURSE : PROJECT 2		S	11	18	25	2	9	16	23	30	6	13	20	27	3	10	17	24	1	8	15	22		
Activities/tasks																								
1.	Registration week	planning				SPECIAL BREAK							MID SEMESTER BREAK									SPECIAL BREAK II & FINAL EXAMINATION JUNE 17/		
		actual																						
2.	Project 2 briefing	Planning																						
		Actual																						
3.	planning	Planning																						
		Actual																						
4.	Measuring the items	Planning																						
		Actual																						
5.	Cutting the items	Planning																						
		Actual																						
6.	Welding	Planning																						
		Actual																						
	I. Pentagon shape	Planning																						
		Actual																						
	II. frame	Planning																						
		Actual																						
	III. attach plate to the frame	Planning																						
		Actual																						
7.	Assemble the items	Planning																						
		Actual																						
	I. attach bearing to frame	Planning																						
		Actual																						
8.	Installation of electric	Planning																						

	component	Actual
9.	Test run	Planning
		Actual
10.	Data analysis	Planning
		Actual
11.	Writing report	Planning
		Actual
12.	Preparing presentation	Planning
		Actual
13.	Final presentation	Planning
		actual

: PLANNING

: ACTUAL/ EXECUTION