DEVELOPMENT WATER PUMP

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ABSTRACT

Bicycle powered water pump is a water pumping system that instead of using electric powered, it will used the human power to rotate the pump so it can pumping the water. The main objective of this project is to develop the bicycle powered water pump. Basically the current water pump did not compete with a best future which is meeting the ergonomic and economic requirement. It is to fulfil the requirement base on farmers and human activity at third world countries that difficult to get the water supply and did not have electric supply. Design of bicycle powered water pump selected based on Pugh concept selection that includes concept design base on adaptation, pump selection, driving mechanism, and stand design selection. The best concept is fabricated and assembled with bicycle. The bicycle powered water pump is tested on pumping water with different water head, different gearing system, and with different human categories. From the experiment, it can conclude that 6^{th} gear on the bicycle can produce larger flow rate with 20 l/min 0 elevation of head and on human categories, the athlete leading in producing the water flow rate from others with average 14 to 15 l/min at 0 elevations of head of 3^{rd} gear.

ABSTRAK

Basikal pengepam air ialah satu system pengepam air daripada menggunakan tenaga elektrik, ia akan menggunakan tenaga manusia untuk memusingkan pam supaya ia dapat mengepam air. Objektif utama di dalam projek ini ialah untuk membangunkan suatu sistem pengepam air iaitu pengepam air menggunakan basikal. Secara amnya, pam air yang sedia ada di pasaran tidak dapat memenuhi ciri-ciri yang di kehendaki anatranya ialah keperluan ergonomik dan ekonomi. Ianya adalah untuk memenuhi keperluan dan kehendak berdasarkan pada pekebun dan aktiviti manusia di komuniti ketiga dalam sesebuah Negara yang susah untuk mendapatkan bekalan air dan tidak mempunyai bekalan elektrik. Reka bentuk basikal pengepam air ini di pilih berdasarkan jadual konsep Pugh yang merangkumi konsep rekabentuk berdasarkan adaptasi yang sesuai, pemilihan pam air, mekanisma penggerak, dan pemilihan reka bentuk tongkat. Pemilihan terbaik akan di bangunkan dan akan di gabung bersama basikal. Basikal pam air ini akan di uji dengan pelbagai dan berbeza ketinggian air, berbeza sistem gear, dan berbeza kategori manusia. Daripada eksperimen yang di jalankan, dapat di simpulkan yang gear ke 6pada basikal menghasilakan jumlah kadir aliran air yang paling tinggi dengan 20 l/min pada ketinggian yang sama dengan pam air. Dan pada jenis manuisa yang berbeza, atlet mendahului penghasilan kadir aliran air daripada yang lain dengan kadar aliran purata 14 hingga 15 l/min pada ketinggian air yang sama dengan pam pada gear yang ke 3.

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INTRODUCTION

1.1 PROJECT BACKGROUND

Basically the target people community in this project is more at rural area which to indigenous people or called as "Orang Asli". There are estimated 300 to 350 million indigenous peoples worldwide or about 6percent of the total world population with at least 5000 distinct indigenous group in over 72 countries. In Malaysia, they constitute a minority group making up approximately 0.6percent of the total population of Malaysia (22.2 million in 2000). (Chupil and Joseph; Pusat Komas, 2003)

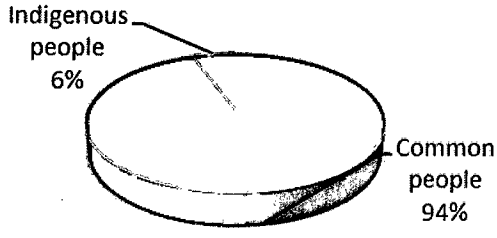


Figure 1.1: Percentage of worldwide indigenous people to the total world population
Source: (Chupil and Joseph; Pusat Komas, 2003)

Among Orang Asli communities, there are exists a lot variation in living condition. Those near urban centre tend to be more equipped with facilities and exposed to modern living. In remote location where accessibility posed a problem, livelihood and life remain traditional, living by subsistence farming, hunting and gathering of jungle products.

Despite proactive socioeconomic development initiated by the Malaysian Government in upgrading the quality of life of the Orang Asli communities since 1978, they still remained poor with a current poverty rate of 76.9percent. Poverty exacerbates the health problems faced by these communities which include malnourishment, high incidences of infectious diseases (eg. tuberculosis, leprosy, malaria) and the perpetual problem with intestinal parasitic infections. Basically, clean water supply is one of the major problems in the orang asli community beside poor education system, poverty and others. The orang asli is unwilling to accept the development by government.

The latest technology in orang asli community nowadays is water pumping system with treatment plant that conduct by government is the best for the orang asli community now. Consumption of such water leads to major health affecting diseases - and as a chain reaction to less productivity, less income, less education for children and so on. Remote villages of orang asli are concerned of this problem.

The orang asli live in the jungle of Malaysia and have no access to clean drinking water supply and due to that, this government project is needed to fulfil the needs of orang asli. But this project only covered around 170 villages only in Malaysia. There is still having community that needs this kind of facilities. (Nurul Huda Jamaluddin;July 26, 2010)

Water resource is critically lacking in third world country even in a local community. Current pumps do not meet economic and ergonomic requirement of famers and human activity. Bicycle is prevalent and relatively ergonomic mode of transportation. Bicycle powered water pump answer water need is proposed for this project. Using water pump and bicycle, standard bicycle fits into universal stand power taken of rear wheel with roller transmit power via chain to crank shaft. A crank shaft powers positive displacement bellows pump to transmit water from the source.

Nowadays, the current water pump did not compete with a best future which is meeting the ergonomic and economic requirement. It is to fulfil the requirement base on farmers and human activity at third world countries that difficult to get the water supply.

Besides that, the development of bicycle powered water pump is due to the place that unavailable and unpractical electric power supply.

1.2 PROJECT OBJECTIVE

The main objective of this project is to develop the bicycle powered water pump. Basically the development of the bicycle powered water pump consist of the designing process, fabrication, and lastly will come out with analysis base on the gearing system and power of the pump itself to produce maximum output.

1.3 PROBLEM STATEMENT

Nowadays, the current water pump did not compete with a best future which is meeting the ergonomic and economic requirement. It is to fulfil the requirement base on farmers and human activity at third world countries that difficult to get the water supply. Besides that, the development of bicycle powered water pump is due to the place that unavailable and unpractical electricity power supply.

1.4 PROJECT SCOPE

Basically the scope of the project is functioning as a guidance to achieve the objective. The scopes of project are listed such as below;

- Design bicycle powered water pump system
- Fabricate support system and assemble between bicycle and water pump
- Test the result on pumping water with different water head, different gearing size, and different human categories

1.5 FLOW CHART

Based on the Figure 1.2, it is shown the flow chart for the final year project 1. After that it is followed by getting the objective of the project, the scope including in this project and come out with project background.

After come out with all the necessary point, the second week will go through with find the literature review which is take it from article or journal that cover all related information about this title project. It also covers with reading all the raw material before take the only most related point.

The finding and reading is important to get the maximum understanding about this title. If still do not get the understanding about this title, go through back at previous step which is finding and reading.

If yes, go through with the next step which is try to come out with concept or design and make a Pugh concept to decide which are the most best concept. After finalize the all concept that come out from the brain storming, propose a methodology to develop the project.

1.6 GANTT CHART

1.6.1 Final year project 1

Table 1.1 shows the Gantt chart for the Final Year Project 1 from first week until 14th week and base on the project activities. Basically it is dividing with two sections which are in blue colour presenting with planning and in red colour representing for actual progress. The progress project on the first week it is start with get the title and the log book for noting progress each week. The first week also start with finding the literature which is related with this title project. It will be held until 3rd week.

The planning carries on with ideas to come out the project background, objective and the scope of the project. Basically all the information is important at the early stage of the project because the information is help to clearly what is to do. This progress will cover 2nd week and 3rd week.

After that, the progress of the project is continue on the 3rd week and 4th week which is make the Pugh concept, Gantt chart, and flow chart. Basically the Pugh concept is come out from the idea concept in design. The design are dividing with three categories concept which is included overall design concept, designing the driving mechanism, and designing the stand of attachment. The Gantt chart and flow chart come out to show the way in overall view of this project.

From week 2 until week 9, the literature reading takes as a planning progress. The reading must be done in continuously because the information can be taken here. The progress report planning continue with report writing on week 10 until week 13 and the final presentation of this project will be held on week 14.

1.6.2 Final year project 2

Table 1.2 shows the Gantt chart for Final Year Project 2 from first week until week 14. There is nothing happen on the first week but only come out with the planning which is discussing with supervisor what the next step. Basically, the final year project 2 is a continue work from the final year project 1. After make a final decision on the bicycle powered water pump design, the work carry on with purchasing and getting all the material needs. It will be held from the 1st week until 3rd week.

The fabrication process is started on 2nd week and ending on 7th week. The fabrication process covered on the bicycle stand fabrication, water pump modified, and water pump casing. After done all the fabrication process, the experiment takes over. The experiment forced to start 2 weeks late from the planning because of long duration on fabrication process.

The initial result gets on the week 9 and week 10. The final year project 2 is continuing with writing the report. It is start from 5th week until 12th week. The writing report covered from working editing the previous final year project 1 report and report for final year project 2. After done all the writing report, make the final slide presentation that will present on the week 14.

Table 1.1: Gantt chart for Final Year Project 1

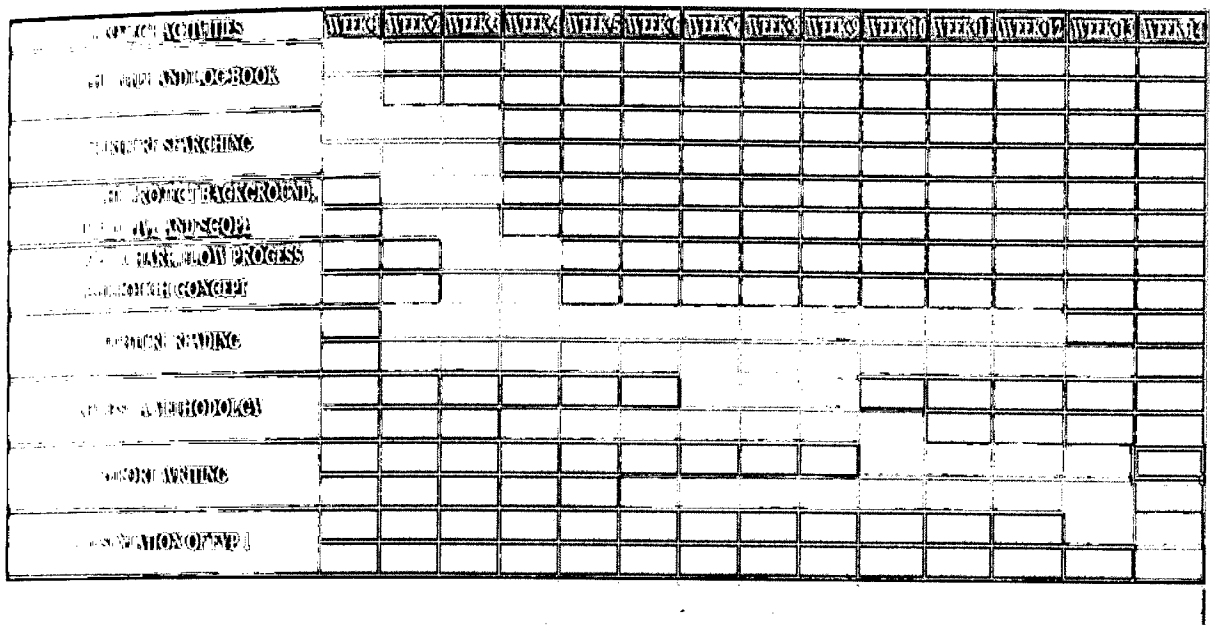
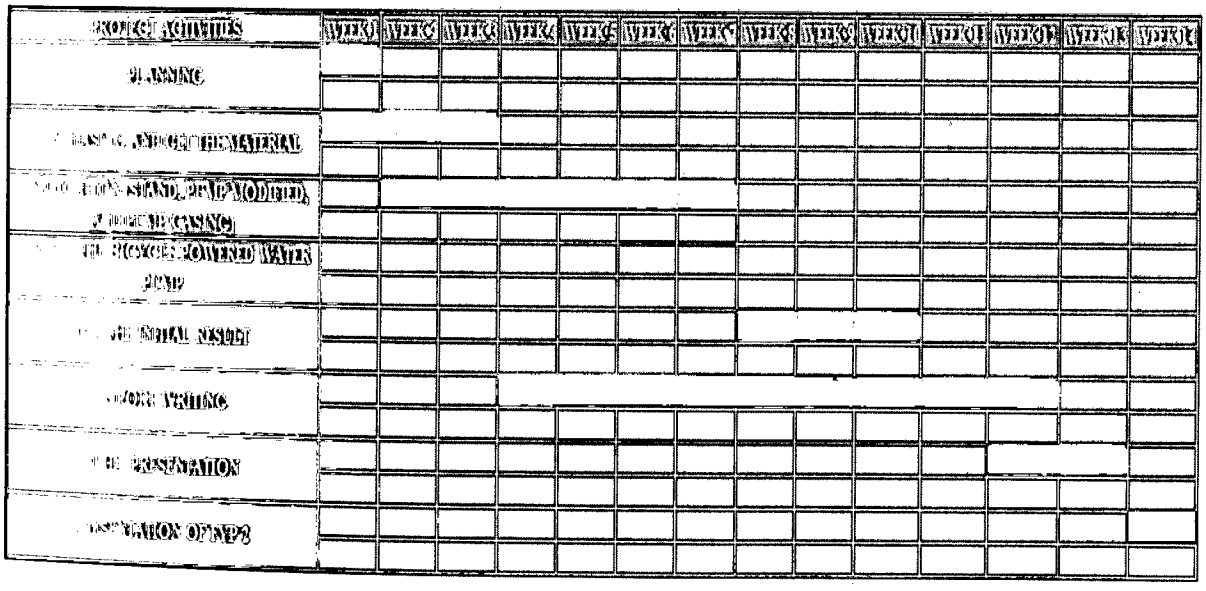


Table 1.2: Gantt chart for Final Year Project 2



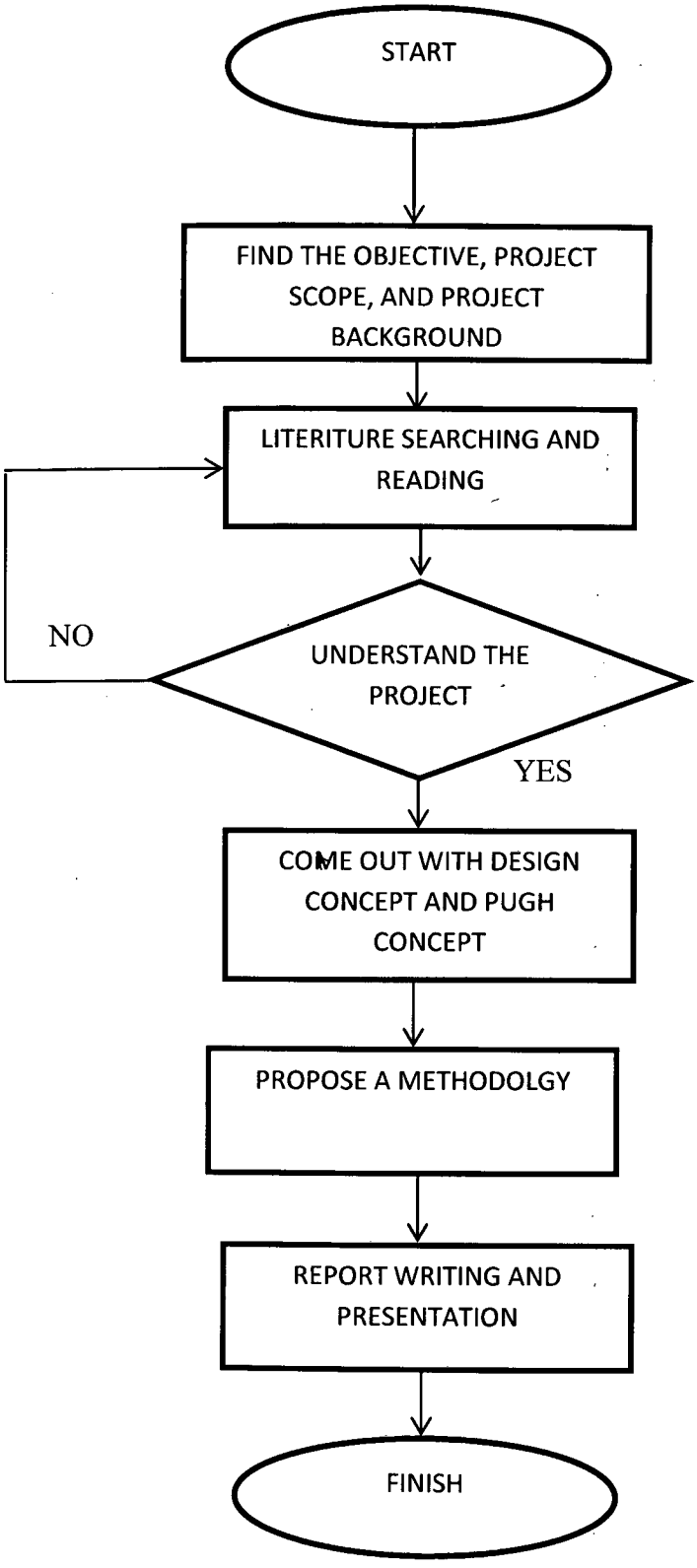


Figure 1.2: Project flow chart for FYP

CHAPTER 2

LITERITURE REVIEW

2.1 WATER DISTRIBUTION PUMP

Water-lifting devices fall into two main sub-categories depending on where the water is being lifted from:

- Groundwater – Rainfall seeps into the ground and collects in an underground reservoir. The upper limit of the reservoir is known as the water-table and can be just below the surface (as with a spring or oasis) or much deeper. The only way to get at this water is via a natural spring or to dig/drill down and use a water lifting device to bring the water to the surface.
- Surface Water – Water from a lake, river or well may need to be transported to where it is required. Water-lifting devices can be used to make the water more accessible for purposes such as irrigation, drinking or bathing.

2.2 PRINCIPLE OF LIFTING AND MOVING WATER

Water may be lifted by any one of the following mechanical principle;

- Direct lift which is involve physical lifting water in a container
- Atmospheric pressure where the water is lifted by atmospheric pressure by creating a vacuum in a chamber which sucks water up to a maximum pressure head of one atm pressure (approximate 10 m)

- Positive displacement with involve pushing or displacement of water from a lower to a higher level
- Creating a velocity head which is the momentum created by propelling or rotating water at high speed is utilized to create a flow or pressure
- Using the buoyancy of a gas where the air bubbled through water will cause movement of columns of water due to the difference in specific gravity
- Using the impulse (water hammer) effect which is water hammer effect result in sudden sharp rise in water pressure to carry a small part of the supply up to a considerably higher level.

Base on the list of the principle lifting and moving water above, bicycle powered water pump is one of the positive displacements with involve pushing or displacement of water from a lower to a higher level. Here, the centrifugal pump inner the modifying electric water pump will be rotate by the rear wheel of bicycle to pump the water. The water will transfer from some level to other level of water head.

2.3 EXISTING BICYCLE POWERED WATER PUMP

2.3.1 Piston pump and belting concept bicycle powered water pump

Figure 2.1 shows the existing of bicycle powered water pump that used belting as a thing to transmit power of human to rotating the pump. It will use piston pump where the piston pump oscillates by rotational energy of bike. When piston goes down, vacuum is created which pulls in water. When piston goes up, water is pushed out.

After done the experiment, the result of this type bicycle powered water pump shows that this piton pump type was able to pump at maximum of 7.0104 meter only. At desired height of 5.4864 meter, the pump pumped at rate 9.46353 l/min.

Figure 2.1: Bicycle powered water pump used belting concept
Source: Boby Hudgkinson, et al (2002)

2.3.2 Rope Pump bicycle powered water pump

Figure 2.2 shows the picture of bicycle powered water pump that used rope pump as the adaptation to pump the water at underground water level. Basically this type of bicycle powered water pump can pumps at 18.92 until 37.85 from wells and boreholes up to 30 meter depth. Compare to the electric pump that only pump around 12 deep. It is can provides irrigation and drinking water where the electricity is not available.

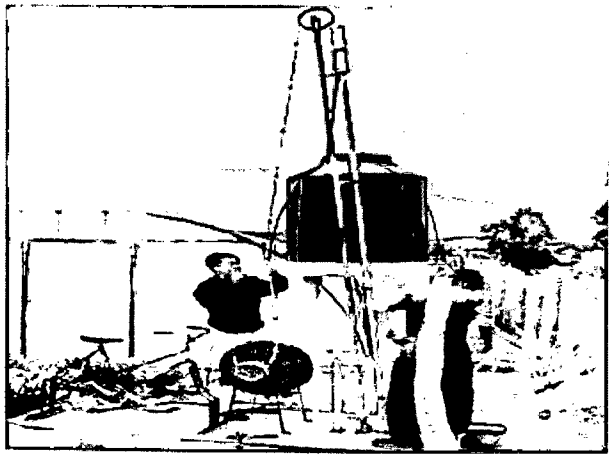


Figure 2.2: Bicycle powered water pump used rope pump concept
Source: Carlos Marroquin; Henry Godfrey (2010)

The components that needs in development of this type bicycle powered water pump includes bicycle, wheels removed, attached to strong angle upright, set in

concrete base. The flywheel is made from a bicycle wheel with side wall from a car tire attached with wire. The concrete give the fly wheel weight.

2.3.3 Turbo cycler – The human powered water pump

According to the Figure 2.3, is shows the picture of the next existing technology of bicycle powered water pump which is turbo cycler. This model is designed to assist farmers and other users in rural and no electrified areas in their agricultural and non-agricultural uses. In addition to being a mean of transportation, the human-powered water pump is used for water pumping purposes.

It is able to pump water to an elevation of 2.5 m (8 feet) at 12 l/min (3 gallons per minute) by pedalling at normal running speed. Water is pumped through a 3/8 inch pipe to the desired elevation and then flows through a water wheel chained to an electricity generator that lights an LED lamp with no use of grid electricity.

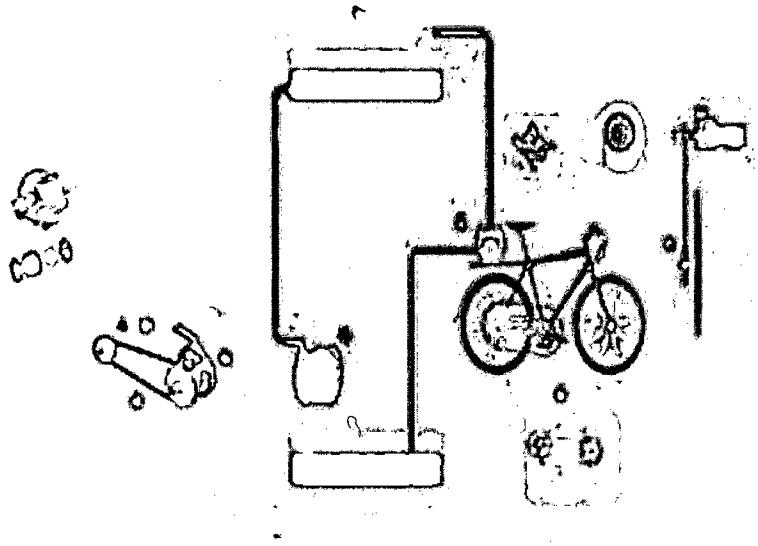


Figure 2.3: Turbo cycler – The human powered water pump

2.4 EXISTING TECHNOLOGY OF WATER PUMP

Basically in order to create a bicycle powered water pump, it is must be significant which is can give a more advantages compare with previous technology or

existing technology. Below are listed two types of pump that commonly used as a water transit.

2.4.1 Treadle Pump

Basically this treadle pump installing with a single or double piston body which is the water will draw through it use a stair-stepping motion. This pump can pump the water with 90 l/min of maximum flow rate with 13 m of water head. But one of the disadvantages it has makes it as importable pump which is 20 kg of weight. It is make the people difficult to transport this pump.

2.4.2 Rope Pump

The rope pump is one of the famous pumps during Chinese civilization with designing around over 1000 years ago. It is installing with chain, sprocket, and bucket to carry the water. Rope pumps are widely used throughout the world, particularly in Central America where 20,000 have been installed in Nicaragua alone since 1990. They have been used to transport water up to 50 m vertically and are generally used to retrieve groundwater from deep wells.

2.5 HUMAN BEING AS POWER SOURCE

Basically human work capability is about 250 watt-hours per day. Human being has an overall efficiency of 7 to 11 percentage for converting food energy to mechanical energy. However the efficiency of the muscles for short effort can be as high as 20 to 30 percentages. Base on the Table 2.1 below, it is shown the human capabilities base on the age.

The actual useful output from a person depends greatly on the way the water lifting device work the ergonomic of the design water pump. The most powerful muscles of a human being are the leg and back muscle. The arms relatively are weak. Hand pump are less effective in manual operation than pedal operated water lift. The leg muscle will allow weight behind the effort threw in order to add the pedal pressure.

Pumps are used for water supply, the efficiency the human is not a major concern where the pump also preferred as lighter, smaller and easy to install.

Table 2.1: Human power capabilities

	Human power by duration effort, watts					
Age (years)	5min	10 min	15min	30min	60min	180min
20	220	210	200	180	160	90
35	210	200	180	160	135	75
60	180	160	150	130	110	60

Source: Tamara Dean (2008)

Besides that, the electric water pump head are design to work optimally at the specific input power that is normally produced by the pump's electric motor. So, it is important to find are closely match between the powers that can generate by human to peddling the bicycle with power that can generate by an electric motor to pump the water. Based on the Figure 2.4 below, it is shown the graph of the power that can produce of human in a period time that have several of fitness level. In this project, the healthy men curve will use to find the power can be generated.

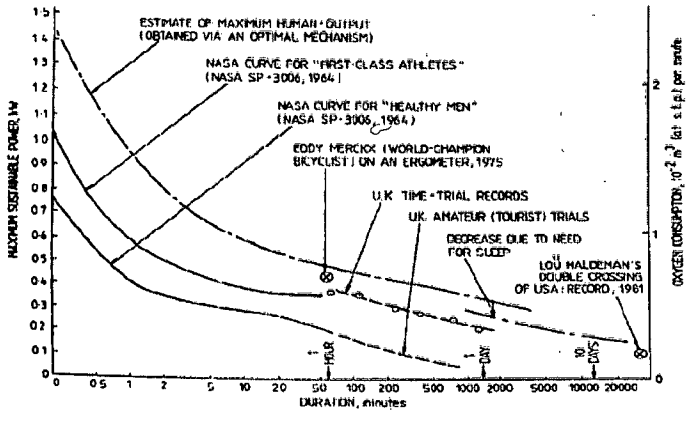


Figure 2.4: Power versus duration of various human categories

Source: Jonathan Leary (2008)