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Design and Development of An Automatic Wireless Water Pump Controller with Level Indicator: A Case of Marine Service Company Limited, Mwanza

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ABSTRACT

In marine vessels including such as ship and small vessel like boat, pump is mechanical devices which is used on board a vessel such as ship or an offshore platform that used to move fluid like liquid or gas by mechanical action, typically converted from electrical energy into hydraulic energy. A resident‟s water pump then pumps the water to a water tank on board, when the water level in the storage tanks becomes too low, the pump siphons air and shutdown, requiring a resident to manually prime the water pump to get it running again. Residents struggle to monitor the water level of the tank effectively and keep the pump running properly. To remedy the issue, this project is about design and development of automatic wireless water pump controller with level indicator for water supply at marine industry in Tanzania, that help crews and other people at marine industry to get water on time in preventing the drawbacks of the existing wastage of time during fetching water. This report involves background, literature review, methodology, data collection, data analysis, conclusion and recommendation. Literature review was carried out through reading different books, journals, paper work and internet browsing. Data were collected from different areas including Police Marine, Dar es Salaam and Tanzania port Authority.

The collected Data were critically analyzed to establish the optimal design from which the automatic wireless water pump controller with level indicator is designed accordingly, and selection of the best design alternative in first phase was done. The design and development of automatic wireless water pump controller with level indicator for water supply at marine industry (MSCL) in Tanzania will help in improving pumping efficiency hence increase innovation in marine industry found in Tanzania.

CHAPTER ONE INTRODUCTION

1.1 Background

In this project, development of the circuit of wireless water pump controller. Water pump controller is a device that senses the water level in a tank and drives the water pump. Its basic function is to manage water flow and improves the performance. This circuit is completely programmed and once you do its initial setting, it will serve for a long time. It can automatically switch ON and OFF the water pump set depending on the tank water level. You can implement this motor driver circuit at your home or college and in ships using less costly components. The main advantage of this water level controller circuit is that it automatically controls the water pump. The automatic pump controller eliminates the need for any manual switching of pumps installed for the purpose of pumping water from a reservoir to an overhead

tank. Wireless Water Pump controller with Level Indicator based on Arduino is an amazing and very useful project. The objective of this project is to notify the user the amount of water that is present in the overhead water tank. This project can be further enhanced to control the water level in the tank by turning it ON, when the water level is LOW, and turning it OFF when the water level is HIGH. Thus, the water level indicator helps in preventing wastage of water in overhead tank. This project is wireless so, it is easy to install (Anyanwu, 2012).

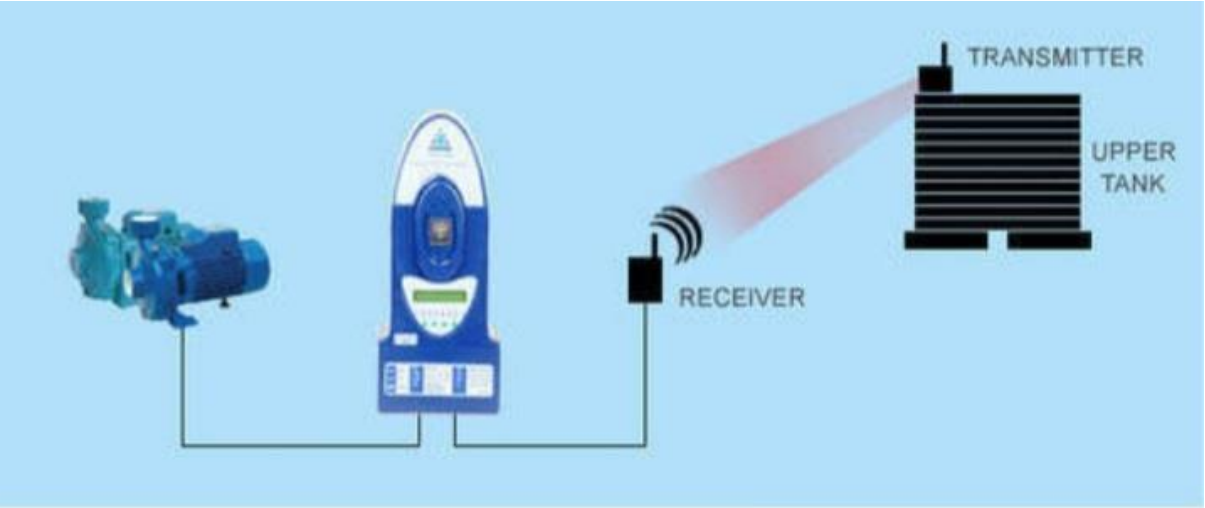


Figure 1.1 Automatic wireless water pump controller with level indicator

The project "automatic wireless water pump controller with level Indicator" is design to monitor the level of liquid in the tank. The system has an automatic pumping system attached to it so as to refill the tank once the liquid gets to the lower threshold, while offing the pump once the liquid gets to the higher threshold. Water is commonly used in marine industry such as ship and boat for different purposes like ballast system, cooling machinery and domestic consumption.

Therefore, efficient use and water monitoring are potential constraint onboard. Moreover, the common method of level control for ship appliance is simply to start the feed pump at a low level and allow it to run until a higher water level is reached in the tank. This water level control, controls monitor, maintain the water level in the overhead tank on ship, and ensures the continuous flow of water round the clock without the stress of going to switch the pump ON or OFF thereby saving time, energy, water and prevent the pump from overworking. Besides this liquid level control system is commonly used to ensure water sustainability is actually being reached with disbursement linked to sensing and automation such as programmatic approach entails microcontroller based automated water level sensing and controlling with wireless level indicator. The block diagram for automatic water pump controller as shown below (Jimenez and Ramirez, 2018).

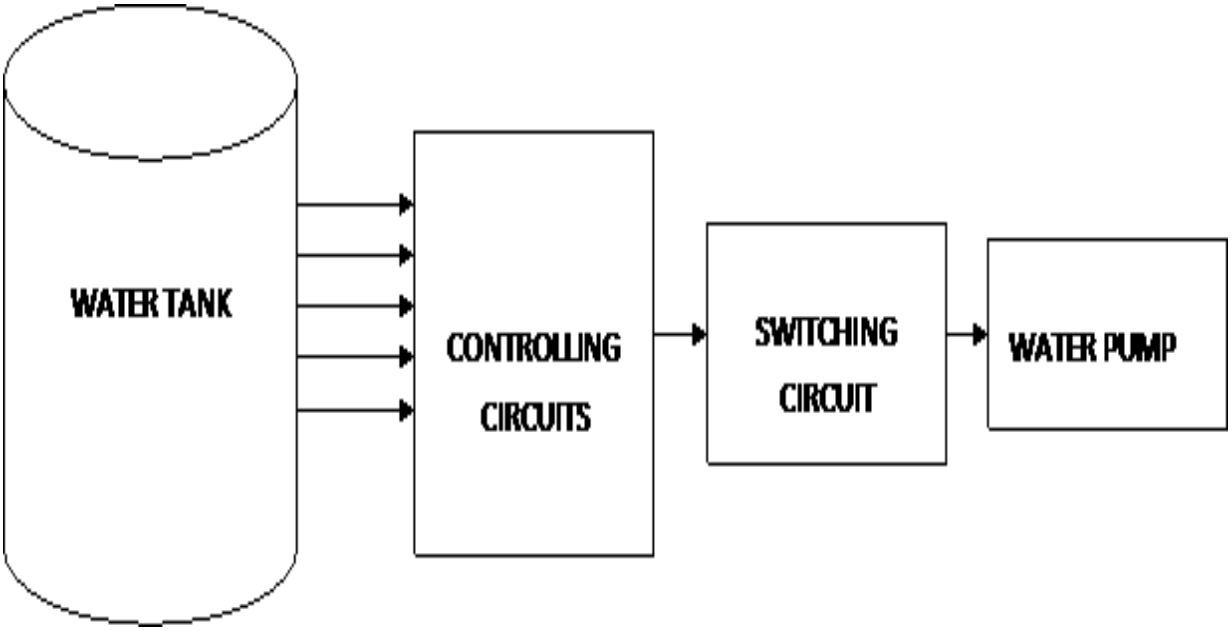


Figure 1.2 Block diagram of automatic water pump controller

1.2 Statement of the problem

The main drawback of hand-starting water pump or mechanical operated water pump used to pump water on local ships found in Tanzania for different purposes like ballast system, Cooling system is; the water pump is heavy load during starting which result in muscular disorder and crew are affected from direct shortage of water on board. Also, the hand-starting water pump results in wastage of time during starting it. The main problem with the existing hand-starting water pump are slow rate of discharging water in or out of tanks and requires a lot of man power to start and its pumping efficiency is too low. Hence this project will help crews to overcome these problems (Omolola, 2010).

Figure 1.3 Empty tanks at police marine, Dar es Salaam

1.3 Project Objectives

1.3.1 Main Objective

The main objective of this project is to design and development of an automatic wireless water pump controller with level indicator for water supply at marine industry in Tanzania

1.3.2 Specific Objectives

1. To design an automatic water monitoring system
2. To incorporate an interactive medium between the end user and the machine
3. To prevent over crew of the pumping machine
4. To prevent crew from getting injury
5. To avoid wastage of time
6. To save energy since the demand of fuel is very high

1.4 Research Questions

1. What is an automatic water monitoring system?
2. How the incorporate an interactive medium between the end user and machine?
3. What are the impacts to crew from over pumping machine?
4. What are the effects to crew from getting bad during operation of water pump?
5. What are the impacts onboard due to the wastage of water?

1.5 The scope of the project

This project is focusing on ensure constant reserve of water is available on board especially in tanks. The scope of the design is kept concise and simple to in other not to introduce unnecessary complexities and render it generally uncomfortable

1.6 Limitation of the project

Water sensors used are built with conductive material, which means that they are subject to rusting or corrosion. When corrosion occurred, the sensors will stop conducting thereby causing this device will stop working and another limitation of this project, not completed for construction it ended with design of circuit using a computer followed by simulation

Also, it is significant to know that this design is limited to 12v, 5A electric pump and cannot be used to control industrial water pump above 5A (Omolola, 2010).

1.7 Significance of the project

The completion of this project "An automatic wireless water pump controller with level indicator for water supply in marine industry at Tanzania" will result in the following significances

1. ***Suitability***: these water level controllers are ideally suited for normal water as well as for ultra-low conductivity water with less than 1micro/moh
2. ***Easy to operate***: these systems come fitted with sensitivity setting which can be provided externally on a dial or with internal settings
3. ***Settings***: It is equipped with technology which works on low or high sensitivity setting on the same machine and saves costs of buying and using two different machines
4. ***Materials of construction***: this water control system is protected against corrosion
5. ***Safety***: This system is highly insulated leakage proof and works without creating any noise.
6. ***Save water***: The system ensures no overflows or dry running of pump
7. ***Save electricity*:** consume very little energy ideal for continuous operation

1.8 Brief organization of the project proposal

The various stages involved in development of this project have been properly put into five chapters to enhance comprehensive and concise reading. In this project thesis, the project is organized sequentially as follows

Chapter one of this works is on the introduction to project. In this chapter, the background, statement of problem, general objective, specific objectives, research questions, scope of the study, limitation of the study, significance of the study and brief organization of the research proposal

Chapter two is on literature review. In this chapter, all the literature pertaining to this work was reviewed

Chapter three is on design methodology. In this chapter all the method involved during the design and construction were discussed

Chapter four is on testing analysis. All testing that result accurate functionality was analyzed. Chapter five is on conclusion, recommendation and references

CHAPTER TWO LITERATURE REVIEW

2.1 Introduction

This chapter describes the features, principle of operations and limitation of the existing machines and circuit. It gives description about how the existing system works advantages and its limitations that lead to the design and development of the proposed project and basic explanation on an Automatic wireless water pump controller with level indicator for water supply at marine industry in Tanzania

2.2 Water pump controller

According to Denizen (2013) said a controller is an instrument used for controlling a process variable (measurement). It‟s continuously monitors the error signal and gives a corrective output to the final controller element. Measurement variable: It is the demand variable measured and controlled. Desired variable: It is the demand signal or set point to which the process variable is controlled. Deviation is the error signal caused by the difference between the measurement and the demand signal. Output is the corrective signal from the controller to the final control element

2.3 Different Types of water pump controller

According to Denizen (2013) said the most important goal in the application of controllers in marine industry is to get uniform monitoring of machinery parameters during operation. There are many types of water pump controller such as liquid level pump controller, pressure controller and float level controller

2.3.1 Liquid level pump controller

This type of water pump controller is designed to maintain a predetermined level of water in storage tanks onboard. A liquid level pump controller has the following components; tank, pump, solenoid valve, piping, power source, float switch and support frame

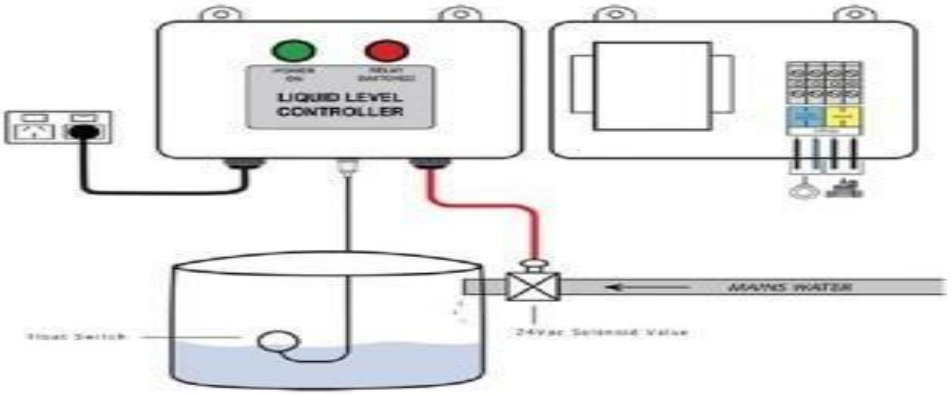


Figure 2.1: Liquid level pump controller

Specifications

1. Tank capacity: 20L
2. Model Number: R-12985
3. Voltage: 240 volts
4. Float length: 10m float switch

Merits

Merits of liquid level pump controller are:

1. power saver
2. Money saver
3. Water maximization
4. Easy installation with LED monitoring

Demerits

Demerits of liquid level pump controller are:

1. Water level controls need to be replaced every 3 years.
2. The rust, foul and deteriorate
3. Electronics are usually built separately

2.3.2 Pressure pump controller

High quality water pump pressure controller for the automatic control of pressure pumps, to maintain constant pressure supply. This Reef PC15-QP pressure controller with a quick connection socket has a cut in pressure at 150kPa (32PSI) and is suitable for a wide range of pumps up to 1.1kW, 10 amps and has 25mm connection

Figure 2.2: pressure pump controller

Specification

1. Model Number: PC10P

2. Inlet/Outlet size: 25mm
3. Voltage: 240 volts
4. Packaging Size (cm): 18 x 23 x 25cm
5. Packaging Weight (kg): 1.5kg

Merits

Merits of pressure pump controller are:

1. Low maintenance
2. low cost
3. compact and good design
4. Fully automatic
5. .saver water
6. Saver energy
7. Increase pump life

Demerits

Demerits of pressure pump controller are:

1. It may not be able to handle power
2. Components used in this are sensitive and may damage easily
3. We need to insert the wire in accordance with the level of water

2.3.3 Float level controller.

A submersible pump float switch will turn a pump on and off automatically. When water tank is full, the float switch rises and cuts off the electrical signal, shutting off the pump. As the water level falls, the float switch reconnects with the circuit, turning the pump back on to re- fill tank.

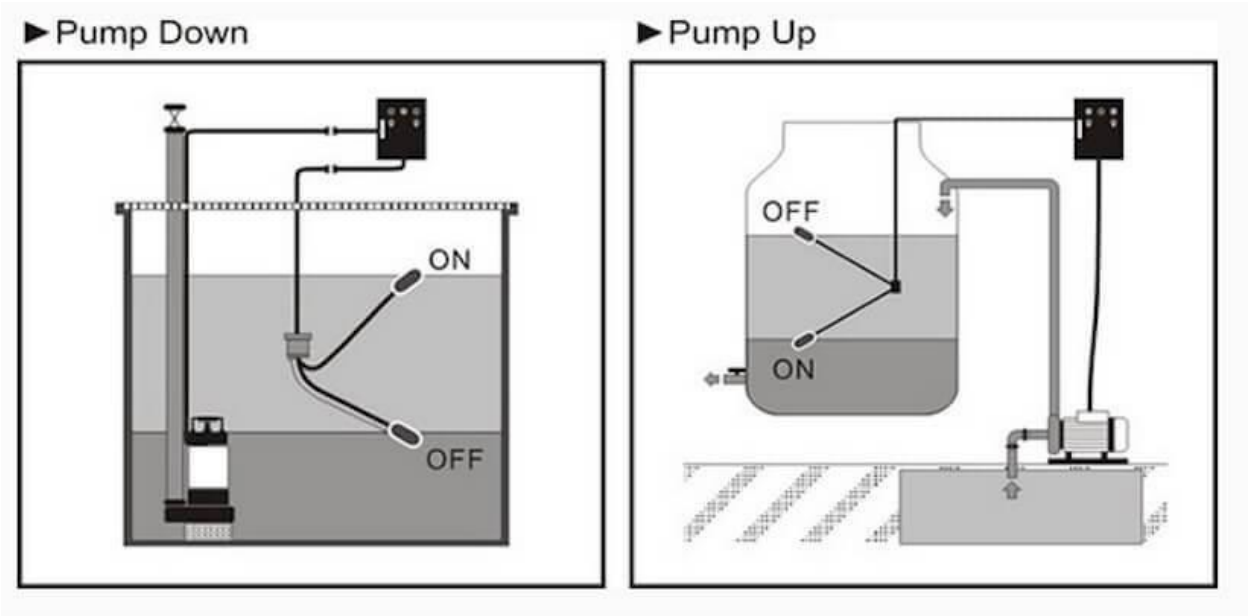


Figure.2.3 float pump level controller

Specification

1. Model Number: PC8A2M
2. Amp draw: 10 amp
3. Voltage: 240 volt

4. Float length: 2 meters
5. Working temperature range: 0-80 degrees Celsius

Merits

Merits of float level pump controller are:

1. Cheapest type of liquid level switch
2. Simple design and construction
3. Not sensitive to changes in SG & density
4. Some types do not require power to operate

Demerits

Demerits of float level pump controller are:

1. Moving parts vulnerable to clogging, wear and tear, and damage
2. Fouling can cause unreliable movement or seizure of float actuation
3. Float actuation relies on liquid contact
4. Turbulence in the fluid may cause the float to Move

2.4 Design of an Automatic Water Pump Controller

According to Abang (2013) said this part will review the realization of a concept or idea into a configuration, drawing, model, mould, pattern, plan or specification (on which the actual or commercial production of an item is based) and which help to achieve the item‟s designated objective.

2.4.1 Design concept

According to Hurst (1999) said from principles of Engineering design is the total activity necessary to establish and define solutions to problems not solved before or new solution to problems which have previously been solved in a different way. The engineering designer uses intellectual ability to apply scientific knowledge and ensures the product satisfies an agreed market need and product design specification whilst permitting manufacture by the optimum method. The design activity is not complete until the resulting product is in use providing an acceptable level of performance and with clearly identified method of disposal.

According to Adegboye (2017) said design is the creation of a plan or convention for the construction of an object, system or measurable human interaction. The parts of the paste making machine or circuit will be designed according to the criteria and specification, safety, performance (the degree to which the design meets or exceeds the design objectives) , reliability (a high probability that the machine will reach or exceed its design life), ease of manufacture, ease of service or replacement of components, ease of operation, low initial cost, low operating and maintenance costs, small size and low weight, low noise and vibration and smooth operation

2.4.2 Types of Design

Original design

This is also called innovative design. Original design is the form of design is at the top of the hierarchy. It employs an original, innovative concept to achieve a need. Sometimes, but rarely, the need itself may be original. A truly original design involves invention.

Adaptive design

This form of design occurs when the design team adapts a known solution to satisfy a different need to produce a novel application. Adaptive design involves synthesis and is relatively common in design.

Redesign

Much more frequently, engineering design is employed to improve an existing design. The task may be redesign a component in a product that is failing in service or to redesign a component so as to reduce its cost of manufacture. Often redesign is accomplished without any change in the working principle or concept of the original design. For example, the shape may be changed to reduce a stress concentration, or a new material substituted to reduce weight or cost. When redesign is achieved by changing some of the design parameters, it is often called variant design (Adegboye, 2017).

Selection design

Most designs employ standard components such as bearing, small motors, or pumps that are supplied by vendors specializing in their manufacture and sale. Therefore, in this case the design task consists of selecting the components with the needed performance, quality and cost from the catalogues of potential vendors.

Industrial design

This form of design deals with improving the appeal of a product to the human senses, especially its visual appeal. While this type of design is more artistic than engineering, it is a vital aspect of many kinds of design. Also encompassed by industrial design is a consideration of how the human user can best interfaces with the product (Adegboye, 2017).

2.4.3 Characteristics of Design

According to Adegboye (2017), there are four types‟ characteristics of design.

Creativity: Require creation of something that has not existed before or has not existed in the designer‟s mind before.

Complexity: Requires decision on many variables and parameters Choice Require making choices between many possible solutions at all levels from basic concept to small detail of shape

Compromising: Requires balancing multiple and sometimes conflicting requirements

2.4.4 Procedures of Machine and circuit Design

Solving a design problem is a contingent process and the solution is subject to unforeseen complications and changes as it develops.

The basic five steps used for solving design problems are:

1. Define the problem
2. Gather patent information
3. Generate multiple solutions
4. Analyze and select a solution
5. Test and implement the solution

2.4.5 Design Features

The following points are to be considered (Khurmi, 2005)

1. The design should be simple and the construction should be at minimum cost.
2. Power requirement to operate the equipment should be minimal. This is to be achieved by providing means for efficient power utilization.
3. The component parts should be easily replaceable in case of any damage.

2.4.6 Preparation of Engineering Drawing Introduction

In order for anyone to be able to understand exactly what a drawing represents, sets of precise rules and conventions have to be followed, much like a language British Standard Institution; BS 8888(Superseded BS 308) and American National Standards Institute set the drawing rules.

Abbreviations of drawings are used to save time and space. They are the same singular or plural, full stops are only used where word may be confusing.

(a) Sections

To show the inside details of a component it is imagined to be cut or sectioned along a plane, the cutting plane. Cutting planes are designated with capital letters (Bird, 2010).

Sectional views are produced to;

1. Clarify detail
2. Show internal features clearly
3. Reduce number of hidden detail lines required
4. Aid dimensioning
5. Show cross-section shape
6. Clarify an assembly

2.4.7 Dimensions

A drawing from which a component is to be manufactured must communicate all of the required information. The design engineer should have a good understanding of projection methods, dimensioning methods and the manufacturing method to be used.

Types of dimensions

Types of dimensioning can be broadly classified as:

1. Size dimensions: Used to describe heights, widths, diameters, etc.
2. Location dimensions. Used to place various features of a component relative to each other, such as a whole center line to a reference surface.
3. Mating dimensions. Used for parts that fit together requiring a certain degree of accuracy.

General rules

All drawing rules should be properly done so as to have the product with all required specifications.

Dimension tolerances

If a dimension is specified, in millimeters, as 10 ± 0.02, the part will be acceptable if the dimension is manufactured to an actual size between 9.98 and 10.02

2.4.8 Assembly Drawings

An assembly drawing is a drawing of an entire machine or system with all of its components located and identified. So, we need it to know how to put the machine together.

2.4.9 Detail Drawings

It is a drawing of an individual part, which includes an orthographical projection and dimensions.

2.4.10 3D CAD & Solid Modeling

Computer Aided Design offers several methods of representing the design model: 2D Lines and text, similar to conventional drawing board. CAD, CAE are the mechanical computer aided engineering software.

2.4.10a. Representing the Design

Part modeling: You can create 3D solid part models of your designs, such as this corned. The dimensions that define the model are related to each other and can be change and controlled.

Orthographic drawing: rom the 3D model you can also create a detailed orthographic projection drawing, you can easily modify the design.

2.4.10b. Analyzing your Design

Having created a 3D solid model of a component, the geometry can then be used to predict how it may

behave in real life.

2.4.11 Design of Various Parts

The design of an automatic water pump controller has involved materials with the, needed performance, quality, and cost in order to fulfill the requirements of shipping industry such as ship.

The table below show the component of automatic water pump controller with level indicator with the quantity and value as shown below (Zhao, 2014)

Table 1: The Component of Automatic Controller.

S.no	Component	Value	Quantity
1	Input supply DC	12V	1
2	Motor	-	1
3	Resistor	1.5K,100 ohm	2,1
4	Pump	-	1
5	IC	LM7809	1
6	Relay	12V, 20A	1
7	Diode	1N4007	1
8	Transistor	BC547	5

2.5 Manufacture of an automatic water pump controller

Manufacturing is the process of converting raw materials or semi-finished products into finished products that have value in the market place. This process involves the contribution of labor, equipment, energy, and information (Ogata, 2002)

2.5.1 Aims of Manufacturing Process

The aims of manufacturing process are the following:

1. Ability to reproduce constant quality during mass production
2. Meeting performance requirements (i.e. Tolerances, strength, weight etc.)
3. Meeting cost of production requirements

2.5.2 Manufacturing Process of Parts Involved

Tank: This is a standard tank available for display the level when is full or low with water and has a probe which start or off the automatic water pump when the tank is low or full with water. It has been made of high-density polyethylene plastic (Roy, 2016).

Cables or wires: These are the standard wires being used for this project for joining the whole circuit of automatic water pump controller with level indicator.

2.6 Testing an Automatic Water Pump Controller with Level Indicator

This part used by the designer to identify, if the machine is either running or not running and meet the measurements, standards and objectives.

CHAPTER THREE METHODOLOGY

3.1 Introduction

For the main objective of this project namely, design and development of an automatic wireless water pump controller with level indictor for water supply at marine industry (MSCL) in Tanzania to be achieved, different methods and procedures will be employed to collect data that is relevant for

successful completion of this project. Below are those methods and procedures;

3.2 Literature Review

Literature Review gives an opportunity to refer the related topics similar to this project, and thus the other existing types of automatic water pump controller to gain familiarity of what is done in types of automatic water pump controller existing, and thereafter to know what remains undone. It is referred to a main framework of the project. It gives the information on the progress of the various types of the existing controller technology, machines and mechanism employed. This information is mainly obtained through browsing in internet search engines, and reading related engineering books, so that the information obtained reveals the gap that is to be bridged.

3.3 Data Collection

The purpose of data collection is to know the various types of automatic water pump controller, their characteristics, challenges being faced, need of new technology and opinions on what factors should be considered in the modification.

3.3 Data Analysis

The purpose of data analysis is to know the size of each component and material suitable, production rate, and other requirements for the automatic wireless water pump controller with level indicator for water supply at marine industry in Tanzania. The following facts will be critically analyzed during analysis:

3.3.1 Construction Methodology

There are many methods of designing an automatic wireless water level control with switching device but all these methodologies require human assistance. In this project automatic wireless water pump controller with level indicator. Need of capacitor, timer IC. A Voltage Regulator IC, Some Resistors and Some NPN Transistors, Diode, LED and Relay used in this Circuit. Connect the all Components as shown in circuit diagram below. The Value of resistors are should not more than 390K and not less than 1K and should not more than 390K. If all values are the same as I recommend then circuit working will 100% successfully.

3.3.2 Circuit Diagram

In this project, development of the circuit of wireless water pump controller. A water pump controller is a device that senses the water level in a tank and drives the water pump. The basic function of a water level controller is to manage water flow and improves the “system performance”. This circuit is completely programmed and once you do its initial settings, it will serve for a long time. It can remotely turn ON a water pump when the water tank is vacant and switch it off remotely when the tank is full. The circuit will likewise deal with a significant distance (Zhao, 2014).

3.3.3 Circuit Description

Hardware components, there are two main parts for making the wireless water pump controllers are transmitter and receiver. The circuit diagram below is the circuit of wireless water pump controller transmitter and receiver (Bird, 2010).

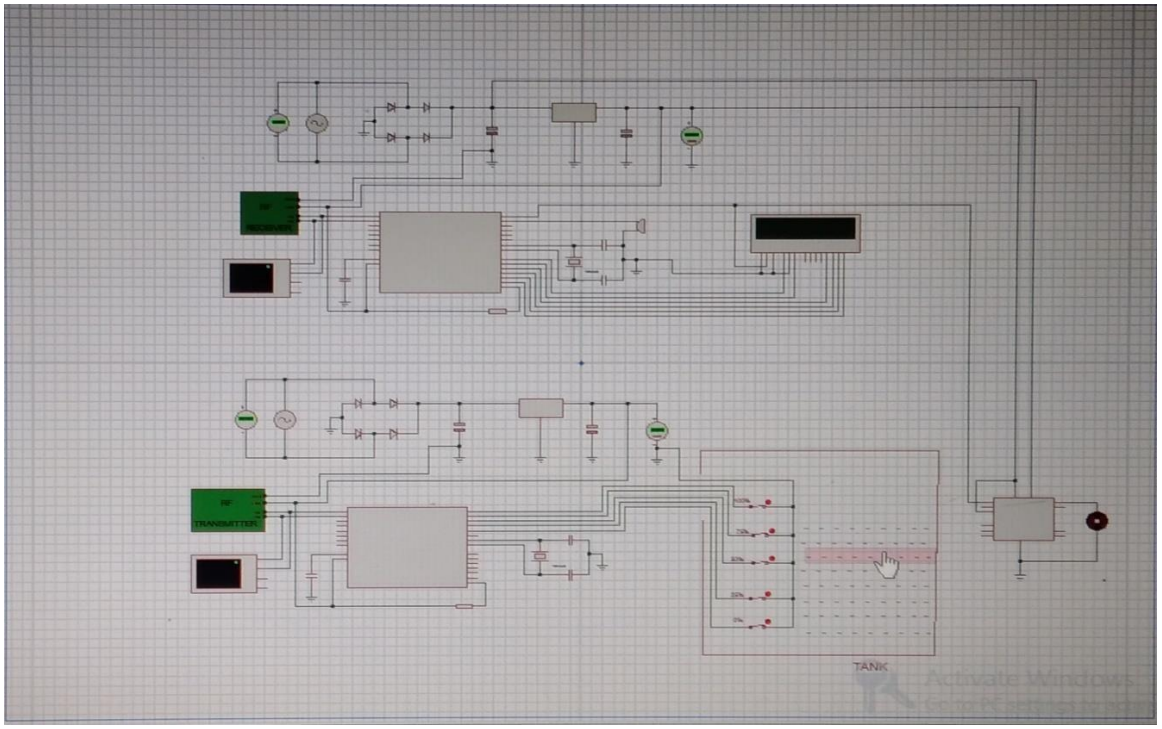


Figure 3.1 automatic wireless water pump controller receiver and transmitter circuit

3.3.4 Working Principle of the Automatic wireless Water Pump Controller

In this project, two circuits are used, first is the transmitter, and second is the receiver. The circuit contains two sections, which are a transmitter part and a receiver part. The transmitter part has two functions, first, it will detect the water level in the tank and second, it will impart or send a signal to the receiver circuit.

The receiver gets the signal and switches ON the relay because of which the water motor associated with the relay will likewise become switch ON and level water will be displayed on LCD in term of percentage level. At the point when the receiver got another signal from the transmitter, it will turn OFF the relay and subsequently the motor will likewise be switched OFF.

3.3.5 Components Used

The following are the components used for design and construction of an automatic water pump controller with level indicator as follows:

Table 2; Components Used for Design Transmitter and Receiver Circuit

s/no	Components	Value	Quantity
1	Adapter	12DC	2
2	DIODE	1N4007	2
3	VOLTAGE REGULATOR	LM7805	2
4	HEAT SINK	TO-220	2
5	CAPACITOR	1000uF,25V	2
6	CRYSTAL OSCILLATOR	16MHz	2
7	MICRO CONTROLLER	ATMEGA328P	2

8	BUZZER	5V	1
9	GSM MODULES	SIM800	1
10	RF MODULES	NRF24O1L	1
11	DISPLAY	16X2LCD	1
12	POTENTIOMETER	10K	1
13	MOTOR DRIVER	L293	1
14	PUMP	12V DC	1
15	CIRCUIT BOARD	PRINTED	1
16	PROTOTYPE FRAME		1

3.3.6 Power Supply Unit

This project of an automatic water pump controller with level indicator for water supply on ship use power supply of input supply DC but in some case, AC may be used.

CHAPTER FOUR
RESULTS, DISCUSSION AND FINDINGS

4.1 Introduction

Data were collected from various sources through: literature review, interview, and observations. Data collected were important and useful for the modification, and hence, design and development of automatic wireless water pump controller with level indicator for water supply at marine industry in Tanzania. One of the greatest goal of Data Collection is to look for Product Design Specifications (PDS), that will meet need of the marine industry in need, in terms of capacity, cost, durability and working environments, user ergonomics, etc. Through Interview and Observation, information was obtained in Songoro Marine Transport Limited and from workers of police Marine at Dar es Salaam. Through literature review, information was obtained in different books for designing, and through internet.

4.2 Interviews

Through Interviews some of the questions used to collect data were; What are the types of water pump controller do you know?
How they work?
Which specification they have? How much do they cost?

Table 3: Data from in Songoro Marine Transport Limited

Questions	Answers
What are the types of water pump controller do you know?	Three types of water pump controller which are float, pressure and liquid level control
How they work?	They operation depend on area of application
Which specification they have?	240V and 10A

Table 4: Data from Police Marine at Dar es Salaam.

Questions	Answers
Types of pump used in marine industry do you know?	Two types of pump used in marine industry such as Positive displacement and dynamic pump.
Which is more popular used?	Centrifugal pumps
Why automatic operated?	To avoid delay of time on starting
Challenges of using this type of pump?	Leakages and corrosion
Is there any need of improving it?	Yes

4.3 Availability of Materials

Through interview different shops (hardware and Argo vet) and material suppliers at Gerezani-Kariakoo in Dar es salaam. The following data was obtained.

4.3.1 Automatic water pump controller

Table 5: Data from Gerezani-Kariakoo shops

Name	Weight(kg)	Material	Value	Cost (TZS)	Quantity	Capacity
Resistor			1.5k,100ohm	5500	9,2	
Transistor			BC547	5000	5	
Diode			1N4007	2000	2	
Relay			12V, 12A	10000	1	
IC			LM7809	3000	1	
Motor pump			DC motor	25000	1	
Tank, pipe				5000	1,1	20Litre

4.3.2 Pump

Pump types commonly used in marine industry include;

1. Positive Displacement pumps
2. Dynamic pressure pumps

4.3.3 Parts of an automatic water pump controller

After studying the existing water pump controller, the following are proposed materials for different parts of automatic water pump controller with level indicator.

Table 6: Parts and Proposed Materials

Description	Materials/Specification
DC Motor	Power:84W, Voltage:12V, current:7A
DC Pump	Speed=3600rpm, Power=3.5w
Pipes	PVC
Tank	PVC ,20Lit

4.4 Data analysis

The data analysis explains much the procedures which will be taken to choose the best alternative while

keeping in consideration the data collected and the literature review covered in chapters above so as to achieve the project objectives.

4.4.1 Design consideration and installation of the complete design

There are some factors that should be met to get an optimal pump design, based on the following;

1. The pump should be relatively cheap such that people in small industry can afford to buy.
2. The pump should be able to work as per specification (i.e. PDS).
3. The pump should be made with readily available materials.
4. It should reduce the labor input effort (intense) so that the problems of fatigue, risk of injuries and health hazardous are eliminated.
5. The performance of flow rate pump should be as higher as compared to the method of using hand or other.

4.4.2 Conceptual Development

The optimal design can be obtained by considering the automatic wireless water pump controller with level indicator into the following features:

- Mechanisms of testing automatic water pump controller with level indicator.
- Portability of the device in shifting from one place to another
- Efficiency of the device in testing.
- Sources of power to drive the device
- Complexity of device for maintenance purpose.

4.4.3 Selection of Best Alternative Table 7: Design Alternatives

The design alternatives are as follows

SN	ALTERNATIVE DESIGN	TYPE
1	Manually water pump testing mechanism	A
2	Electrical motor pump testing mechanism	B
3	Diaphragm water pump testing mechanism	C

4.4.3.1 Alternative A

Manually water pump testing mechanism Working Principle

Sometimes known as manual devices, these are possibly one of the cheapest forms of hand device. Basically, they are similar in principle to the piston device, plunger pump and are positive displacement, they use human power and mechanical advantage to move fluid from one place to another having suction and delivery valves. See figure 4.1

When the handle is pushed to the left, the „space“ on the left between the fixed valve and moving vane is being compressed. Water must therefore flow out, as lower valve will be pressed „closed“ meanwhile, the right-hand „space“ is being enlarged, so that a reduced pressure is being created. This partial vacuum „sucks“ the delivery valve tightly closed, and pull open the lower suction valve, causing a flow of water into that right hand „space“.

Once the limit of travel of the handle is reached, it is pulled back to right, and the right hand „space“ now changes from „vacuum“, and the process outlined above is repeated on the other side of the device.

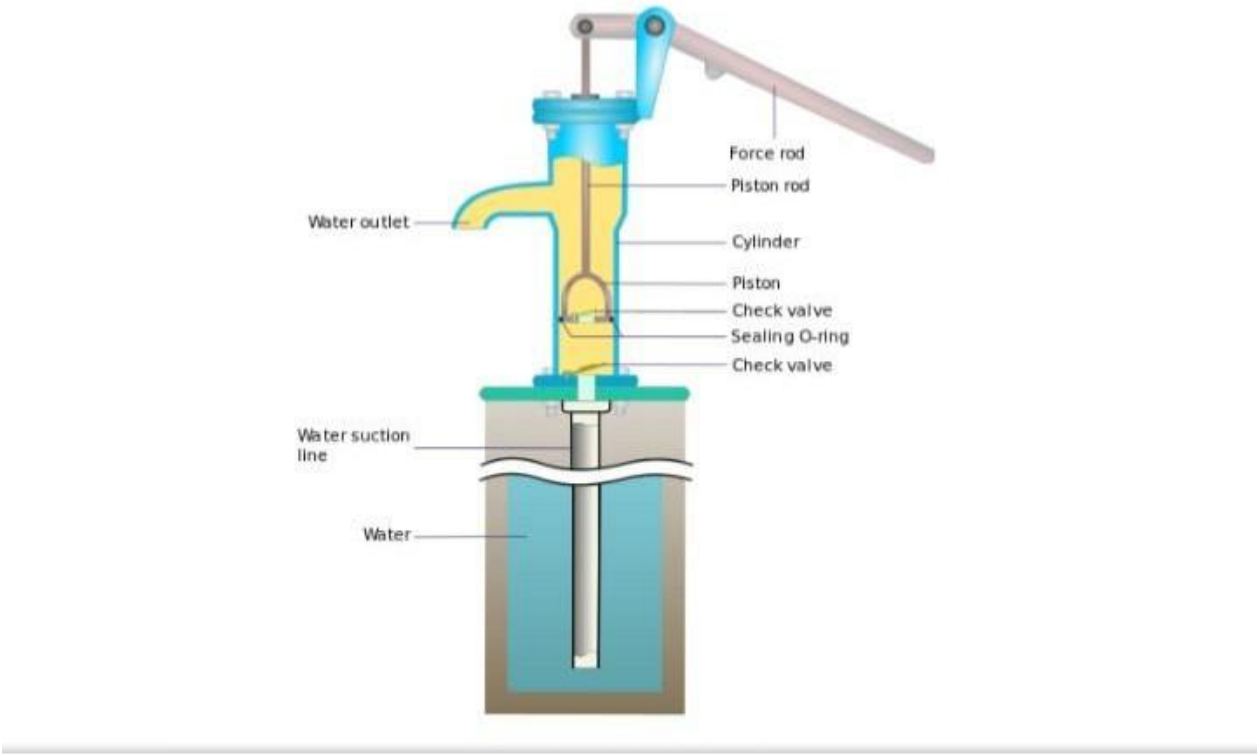


Figure 4.1: Manually water pump testing mechanism

4.4.3.1 A Advantages of manually water pump testing mechanism

1. Vibrating straight low energy consumption, high energy kind of testing
2. Simple structure, operation, and easy maintenance
3. vibrating screen is designed with straight-closed structure completely
4. Low performance, great durability.

4.4.3.1 b Disadvantages of manually water pump testing mechanism.

1. Poor stability of the device
2. Hand overload
3. High manufacturing cost

Table 8 Average marks for Alternative A

judges	complexity	testing efficiency	Compatibility	Device portability	Cost
1	1	5	3	4	2
2	4	3	4	4	1
3	5	2	4	3	2
4	4	2	4	4	1
5	3	2	4	4	1
Average	3.4	2.8	3.8	3.8	1.4

4.4.3.2 Alternative B

Electrical motor pump testing mechanism Working Principle

The working principle of a water pump mainly depends upon the positive displacement principle as well

as kinetic energy to push the water. These pumps use AC power otherwise DC power for energizing the motor of the water pump. The water pump is a portable device and can be applied in several household applications. These pumps are used for pumping the huge amount of water from one place to another. The main purpose of a water is versatile. A quality pump which can be selected carefully may be perfect for draining water from a low flooded region.

The collection of water pumps is very large, therefore while selecting a strong and consistent one, one should think about the requirement. See figure below

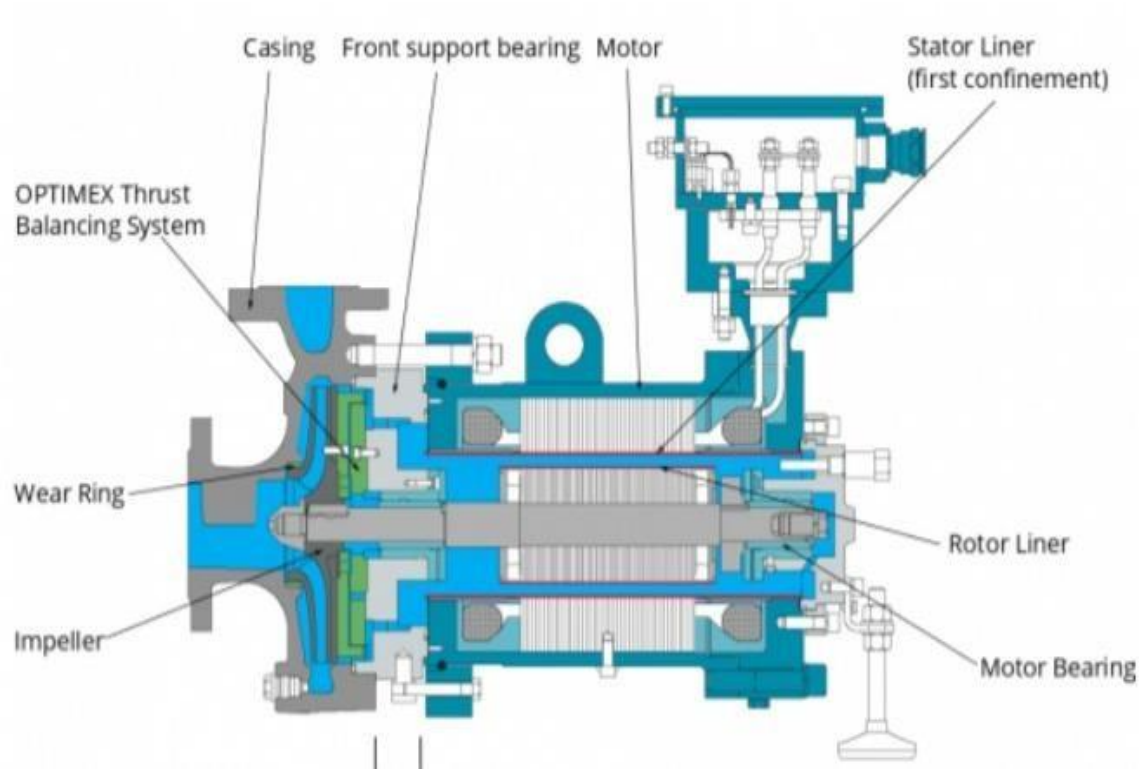


Figure 5.2: Electrical motor pump testing mechanism

4.4.3.2 A Advantages of Electrical Motor Pump Testing Mechanism

1. High testing efficiency
2. Easy maintenance
3. Simple to operate

4.4.3.2b Disadvantages of Electrical Motor Pump Testing Mechanism

1. Long process in manufacture and assembly
2. Testing mechanism increase the weight of the device

Table 9 Average marks for Alternative B

judges	complexity	Testing Efficiency	compatibility	Device portability	Cost
1	4	4	5	4	4
2	3	5	4	3	5
3	5	4	5	5	4
4	4	4	4	4	4

5	5	4	4	4	4
Average	4.2	4.2	4.4	4.0	4.2

4.4.3.3 Alternative C

Diaphragm water pump testing mechanism Working Principle A double diaphragm pump uses two bendable diaphragms that respond back and forward to make a temporary hall, where both receives and ejects water through this pump. The working principle of the pump is on air displacement principle which is like a separation partition among the air as well as the water. See figure below

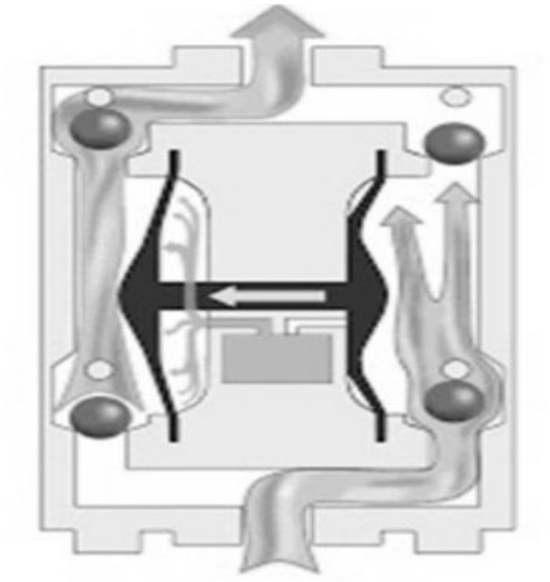


Figure 5.3: Diaphragm water pump testing mechanism

4.4.3.3 a Advantages of Diaphragm Water Pump Testing Mechanism

1. The testing mechanism is easy
2. Reduce weight of the device
3. Maintenance can be easily carried out.
4. Low manufacturing cost.
5. Increases the portability of the device

4.4.3.3b Disadvantages of Diaphragm Water Pump Testing Mechanism

1. Low testing efficiency
2. Not simple to operate compared to electrical motor pump.

Table 10: Average marks for Alternative C

judges	complexity	testing efficiency	compatibility	Portability	Cost
1	5	2	4	3	4
2	4	3	4	4	3
3	5	2	4	3	2
4	4	2	4	4	2
5	3	2	4	4	3
Average	4.2	2.2	4	3.6	2.8

4.5 Determination of the weight factor

This was done by interview different people based on the objective of the project to determine the weight of each pre-selected factors.

Table 11: Weight factors

judges	Complexity	Testing Efficiency	compatibility	portability	Cost	Total(x)
1	3	4	5	4	3	
2	5	4	4	3	4	
3	4	5	4	3	4	
4	4	5	5	4	3	
5	3	4	5	5	3	
Total(y)	19	22	23	19	17	100
Weight factor (F)	0.19	0.22	0.23	0.19	0.17	

Where; Weight factor (F) = $\frac{y}{x}$

Table 12: Ranking the Design Alternative

Alternatives		Factors					Total weight	Rank order
		Complexity	testing efficiency	compatibility	portability	Cost		
	Weighting Factors	0.19	0.22	0.23	0.19	0.17		
A	Weight	3.4	2.8	3.8	3.8	1.4		
	Score	0.646	0.616	0.874	0.722	0.238	3.096	3
B	Weight	4.2	4.2	4.4	4.0	4.2		
	Score	0.798	0.924	1.012	0.76	0.714	4.208	1
C	Weight	4.2	2.2	4	3.6	2.8		
	Score	0.798	0.484	0.92	0.684	0.476	3.362	2

Therefore, from the table above the best alternative is ALTERNATIVE B which is Electrical motor pump testing device.

4.6 Designing Calculations

Having selected the best alternative ;(i.e. alternative B), It is necessary to perform design calculations for proper selection of the sizes of the various components of this circuit and pump. The designed pump and circuit consist of the following components namely:

1. Flow water sensor
2. Motor Pump
3. Control circuit

4.6.1 Main technical specification

From the data collection after complete installation of an automatic water pump controller with level indicator, water is required to be pressurized to 1 bar to 2 bars after 15 minutes for complete full water tank.

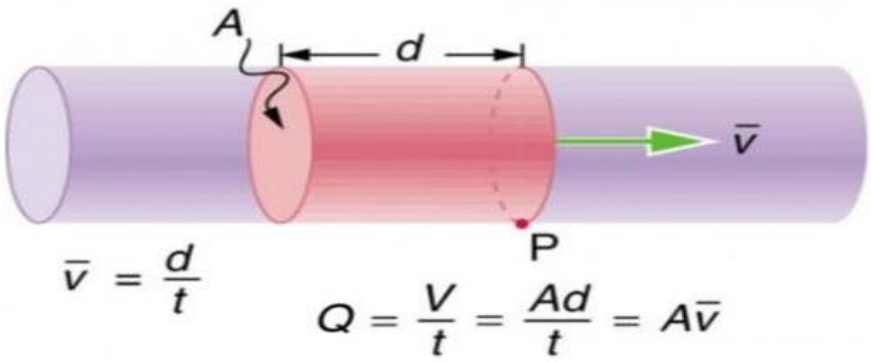
Assumptions:

Hydraulic is concerned with the flow of a fluid (water) down a pipe. Flow is a loose term that generally has three distinct meaning;

- Volumetric flow is used to measure volume of water passing a point per unit time and is the most common measurement process control.
- Mass flow measure the mass of fluid.
- Velocity of flow measure the linear speed.
- Based on the principle of Bernoulli"s which state that „Within a horizontal flow of fluid, points of higher fluid speed will have less pressure than points of slower fluid speed" and the relationship above, the device output (flow rate Q) is 3.925 x 10^{-3} m^3/s for one litter which takes 4 seconds with head 1m.

4.6.2 Determination of the flow rates (Q) of the water required to flow through the pipe

Flow rate (Q) is defined to be the volume of fluid passing by some location through an area during a period of time. The SI unit for flow rate is m^3/s, see figure 5.4 below.



Where: Q = Volume flow rate (m^3/s) V = Volume (m^3).

A = Cross section area of the pipe (m^2). t = Then elapsed time. (s)

d = Distance of the pipe (m).

Now consider the diameter of the pipe be 20mm, length of the pipe be 50m, and it"s time for water to flow from one point to another is 80 seconds to complete 20 litters fully tank.

From, Q= Ad/t

= $(20x10^{-3})^2$ x3.14 x 50m / (4x80)

=1.9625x 10^{-4} m^3/s

Therefore, the flow rate of the water through the pipe is 1.9625x$10^{-4}m^3/s$

4.6.3 Determination of the power required to run motor pump

Consider, the power that can be delivered to a motor is up to 5 watts.

From

P =QH/76×100/E (horsepower), Where: P = power requirement in hp

Q = volume flow rate (m3/s) H = head in m

E = efficiency
The hydraulic efficiency of motor pumps is usually taken as 84% for power calculations. Now P = $(1.9625x10^{-4}\times20)/76\times100/84$
P = 0.355 hp
P = 0.355 Watts
Therefore, the net minimum power requirement to drive the device would be 0.355 Watts.

4.6.4 Determination of force that required to push water to flow through a pipe

The tank is supported at 20m head hence force must exceed weight of tank 15N for comfort ability of supports
From

$$P = \frac{workdone}{time} = \frac{Force \times displacement}{time}$$

$$P = \frac{F \times S}{t}$$

Assuming displacement, s = 20 m

$$\text{Now; } F = \frac{Pt}{S} \quad \text{.....(5.2)}$$

Let time taken to complete 20 liters in a fully tank is 80 seconds.

$$F = \frac{0.355 \times 80}{20}$$

$$F = 1.42 \text{ N}$$

Therefore force required to push water to flow through a pipe to complete is 1.42 N.

4.6.5 Determination of Pressure offered by water on tank during delivery

$p=\rho gh$.....(5.3)
Where by
ρ =Density of water h=head
p=1000 × 9.81 × 20
=196200N/m^2
The resisting pressure on water is19620N/m^2

4.6.6 Determination of diameter of the pipe required

Determined by relation of force required to push water to flow through a tank and pressure resisting this force.
From

$$\text{Pressure (p)} = \frac{Force(F)}{Area(A)}$$

$$\text{And Area} = \frac{\pi d^2}{4} \quad (5.4)$$

Where, d = pipe diameter

$$\text{Now } A = \frac{F}{p}$$

$$= \frac{1.42}{19620}$$

$$= 7.24\times 10^{-5}\ m^2$$

$$d^2 = \frac{4\times 7.24\times 10^{-5}}{\pi} = 9.21\times 10^{-5}$$

$$d = 9.6\text{x } 10^{-3}\ m \text{ or } 9.6mm$$

Therefore diameter of the pipe is 9.6 mm.
With these size determined the material discussed and selected is stainless steel.

4.7 The sequential Manufacturing operation

The device of an automatic water pump controller with level indicator constructed by parallel turning, step turning, cutting small pipes, installing electronic components to PCB, making complete circuit by 3x3 PCB tool and finally testing it operations. It takes 16 hours (two days)
Delivery port include parallel and step turning (British standard), cutting and fusion of pipes arc welding. It takes eight hours
Installation of components include DC pump, connecting pipes, water flow sensor and testing. It takes 8 hours.

Table 13: **Manufacturing Operations**

OPERATION No.	OPERATION	TOOLING	TIME SPENT
1	Drawing a wireless water pump controller circuit	Computer, proteus 8.11 software program	2hrs
2	Connecting all electronic components to the PCB	Tester, Multimeter	8hrs
3	Making an assembling of all components and finally testing the device	Tap measure, electronic welding and Multimeter	6hrs

CHAPTER FIVE CONCLUSION AND RECOMMENDATION

5.1 Conclusion

The design of an automatic wireless water pump controller with level indicator for water supply in marine industry such as marine service company limited found in Tanzania, device is completed. During the designing, different factors such as compatibility, device portability, complexity of the mechanisms, testing efficiency and the cost of manufacturing the device were properly analyzed from which the optimum design was selected. Base on the optimum design selected, all parts of the device were designed to contribute on making an automatic water pump controller with level indicator device. Different parts were designed involving calculations and other parts were designed on basis of shape and size of device so as to reach the optimal design of the device. Also some of the part like pressure gauge was selected as per factors of standards; hence, such parts were mathematically proved in accordance of specifications of engineering discipline. The technical drawings for each part were prepared to help in manufacturing of the device. The prototype of an automatic water pump controller device was manufactured and tested.

5.2 Recommendation

In order to ensure a good performance of the device; during testing the water flow rate should be around1.9625x $10^{-4}m^3/s$. By maintaining the flow rate at this level, mechanical damage can be avoided. The flexible hose can be long as it can easily reach the tank. If the test are not in appropriate flow rate, occurrence of mechanical damage may occur to an extent of 48 per cent. Also pumping of the device should be controlled to avoid the water missing flow and lead to wastage of power.

Further development of the project especially in testing mechanism and financial support is welcomed. Anyone can start from where it ended, so as to increase the testing efficiency and ensures that all parameters of good wireless water pump controller is considered and achieved by the testing mechanism of the device.

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