DESIGN AND FABRICATION OF A PADDLE POWERED WASHING MACHINE

A Thesis
By

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SONARGAON UNIVERSITY (SU)
SEPTEMBER 2023

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Submitted To the

DEPARTMENT OF MECHANICAL ENGINEERING
SONARGAON UNIVERSITY (SU)

In partial fulfillment of the requirements for the award of the degree
of
Bachelor of Science in Mechanical Engineering

SEPTEMBER 2023

CERTIFICATION OF APPROVAL

This is to certify that the project **"DESIGN AND FABRICATION OF A PADDLE POWERED WASHING MACHINE",** By Fazle Rabbi Mridha (ID: BME 2001020140), Md. Foysal Sikder (ID: BME 2001020141), Md. Masuar Rahman (ID: BME 2001020584), Md. Asikur Rahman (ID: BME 1802015120) and Md. Emrul Sheikh (ID: BME 2001020139) has been carried out under our supervision. The project has been carried out in practical fulfillment of the requirements of the degree of Bachelor of Science (B.Sc.) in Mechanical Engineering of years of 2023 and has beenapproved as to its style and contents.

Signature of the Supervisor

Niloy Sarkar
Assistant Professor
Department of Mechanical Engineering
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DECLARATION

We, hereby, declare that work presented in this Thesis, is the outcome of the research work performed by us under the supervision of **Niloy Sarkar,** Assistant Professor Department of Mechanical Engineering, Sonargaon University (SU). We also declare that no part of this project and thesis has been or is being submitted elsewhere for the award of any degree.

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ACKNOWLEDGEMENT

All praise and thanks to Almighty Allah who has enabled us with mercy to represent the reported study of fuel production from waste plastic.

The authors would like to express thanks to a supervisor, Niloy Sarkar, Assistant Professor, Department of Mechanical Engineering, Sonargaon University, Dhaka, for his sincere guidance, kind cooperation, supervision constant encouragement and valuable suggestions in this thesis and project work with powerful instruction. Special thanks to Prof. Md. Mostafa Hossain, Department Head, Faculty of Mechanical Engineering, Sonargaon University, Dhaka, for providing and offering valuable support as an administrator.

ABSTRACT

Pedal Powered Clothes Washer is a low cost machine made up of easily and readily available scrap parts in daily life. It is a machine which generates power through human pedaling and with the drive mechanism, converts the pedaling motion into required rotary motion of the washing drum. Its innovation lies in its simple design, use of inexpensive parts, very low repairing and maintenance cost, affordability to each member of the society and it does not affect the environment. Our team intends to directly address the problems faced in washing clothes, and thus have developed a new design for easy effort in washing, rinsing and drying clothes. The Pedal Powered Clothes Washer is a completely new concept, which in its one laundry cycle does washing, rinsing and drying of clothes similar to that of an automatic washing machine available in the market.

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CHAPTER-01

INTRODUCTION

1.1 Introduction

Washing machines are one of the most useful devices in households today. A washing machine [1] is basically a machine designed to wash or clean laundry such as towels, clothing and sheets. Generally washing machines are powered by electrical energy. This project intends to design and fabricate a washing machine which uses our energy instead. All washing machines work by using mechanical energy, chemical action, and thermal energy. Mechanical energy is transmitted to the clothes load by the rotation of the agitator or by the whirling action of the drum. In this project, rotation of the drum or agitator is caused by the rotation of the pedals. The temperature of the wash bath supplies the thermal energy. The chemical energy is supplied by the detergent. Pedal power involves transferring power from a human source by means of foot pedals and crank system. This form of transfer has been mainly used for transportation, for example bicycles are propelled by pedal power.

1.2 Objectives of the Project

The main objective of this project is to "Design and Fabrication of a Paddle Powered Washing Machine'' Project for themain purpose is to create a smart system so that we can take many benefits from one project.

- To study about washing machine mechanism.
- To design a paddle powered washing machine.
- To Fabrication a paddle powered washing machine.
- To measure the necessary component data's for better understanding.

1.3 Background of the Project

Washing laundry is one of activities that many households do daily. Basically, this is done either by our hands or by powered machines. Washing by hands involves scrubbing, beating, soaking, and rinsing the dirty clothes. This is a laborious and time-consuming task. Electric

Powered washing machines were developed to eliminate the labor and time involved in washing clothes manually. [1] In rural areas electric powered machines are not viable mainly because there is no electricity or because the machine itself is expensive. Women are mainly the ones burdened by the washing of clothes and can spend an entire day washing clothes. The project intends to solve the problem faced by so many people in their day-to-day life.

Fig-1.1: People washing in Bangladesh.

In rural areas washing laundry is a laborious and time-consuming task. Electric powered washing machines do not work because of lack of electricity and due to their high cost. The detergents used in washing clothes are chemically harmful to hands. The scrubbing process also strains muscles.

1.4 Justification

Thus, the paper has the following merits:

- The machine does not use electricity thus suitable for places where electricity is not available or is expensive.
- Saves time as compared to washing clothes manually.
- The machine will be low cost and thus affordable.
- One will also be exercising while washing.
- It's an easy to maintain machine as the components are readily available.
- Women no longer have to be in contact with soapy water which may damage hands.

It is therefore necessary to design and fabricate a pedal powered washing machine.

1.5 Need

In developing countries, rural women are among the least privileged. [4] Women are both essential to the family unit and integral to the economy, yet they rarely have equal opportunities for education, career development, or social status when compared to men. One factor behind the inequality is the long list of responsibilities that traditionally fall to women. Not only do women perform agricultural duties and care for livestock alongside men, but women are also responsible for many domestic chores. Usually, new technology improves people's efficiency, but women benefit less from new technology for several reasons. First, women's duties are neglected by technological improvement efforts because domestic chores are often seen as cultural obligations for women so little effort is expended to diminish them. Second, foreign aid in the form of appropriate technologies is unevenly distributed because women are often considered less technically competent than men. Factors like these tend to prevent the development of improved technology for women's uncompensated, time-consuming, and laborious tasks. Our team intends to directly address the plight faced by women by developing a pedal-powered washing machine.

An average woman may do two to three loads per week for a family of about five children and her husband. It generally takes at least 8 hours of washing time, not including the extra time needed to walk to the public washing reservoir or hang up clothes to dry. Additionally, while washing clothes by hand, women spend hours leaning over a concrete basin. Clothes are washed by laboriously scrubbing each section of cloth over a cement washboard with their hands immersed in detergents that are harmful to the skin. The detergents are chemically harmful to their hands, and the motion of scrubbing is straining to the muscles.

Some types of synthetic detergents still use inorganic phosphates, which are environmentally dangerous. The phosphates known as aluminosilicates cause a condition in water known as Eutrophication. This condition enables algae to grow at a rapid rate. This diminishes levels of oxygen in water, leaving the water incapable of supporting other aquatic life. Artificial colorants used in synthetic detergents are sometimes made from petroleum products. These artificial colorants are not biodegradable and, therefore, stay in the environment indefinitely. Some artificial dyes and colorants can irritate skin, eyes and cause allergic reactions in mammals and fish. Some artificial dyes are thought to be hazardous to the health of humans and possibly cause cancer. Colorants serve no useful purpose in detergents. Some synthetic detergents contain ingredients knows as optical brighteners. These synthetic chemicals do not make laundry cleaner.

These optical brighteners possibly cause reproductive and developmental problems. Synthetic ingredients in optical brighteners can cause skinsensitivity and allergic reactions as well. One of the most important things for those suffering from eczema is finding a good laundry detergent. Ironically, eczema can be caused by some detergents, so the last thing you need is something to irritate the condition even more. Watch out for laundry detergents that contain enzymes, because they can by highly irritating to eczema. Body lice, unlike head lice however, live in clothing and lay their eggs (nits) on cloth fibres. Body lice move from clothing to the skin surface to feed. Because body lice eggs are attached to clothing, these lice are generally not a concern where clothes are routinely washed. Severe outbreaks of body lice, and associated louse-borne diseases, have historically occurred during wars, in prisons, on crowded ships, and under similar crowded and unsanitary situations but are less common today.

Fig-1.2: Women Washing Clothes Manually

1.6 Motivation for Project

Pedal Powered Washing Machine is a low cost washing machine made up of easily and readily available scrap parts in daily life. It is a machine which generates power through human pedaling and with the drive mechanism, converts the pedaling motion into required rotary motion of the drum. Its innovation lies in its simple design, use of inexpensive parts, very low repairing and maintenance cost, affordability to each member of the society and it does not affect the environment. Our team intends to directly address the problems faced in washing clothes, and thus have developed a new design for easy effort in washing, rinsing and drying clothes. Pedal Powered Washing Machine is a completely new concept, which in its

one laundry cycle does washing, rinsing and drying of clothes similar to that of an automatic washing machine available in the market.

1.7 Project Management

Management of any project can be briefly disintegrated into several phases. Our project has been decomposed into the following phases:

Experimentation: This phase involved discussions regarding necessary equipment regarding the project. The study of related already existing projects, gathering required theoretical learning. It also included figuring out the coding part, by developing simple algorithms and flowcharts to design the whole process.

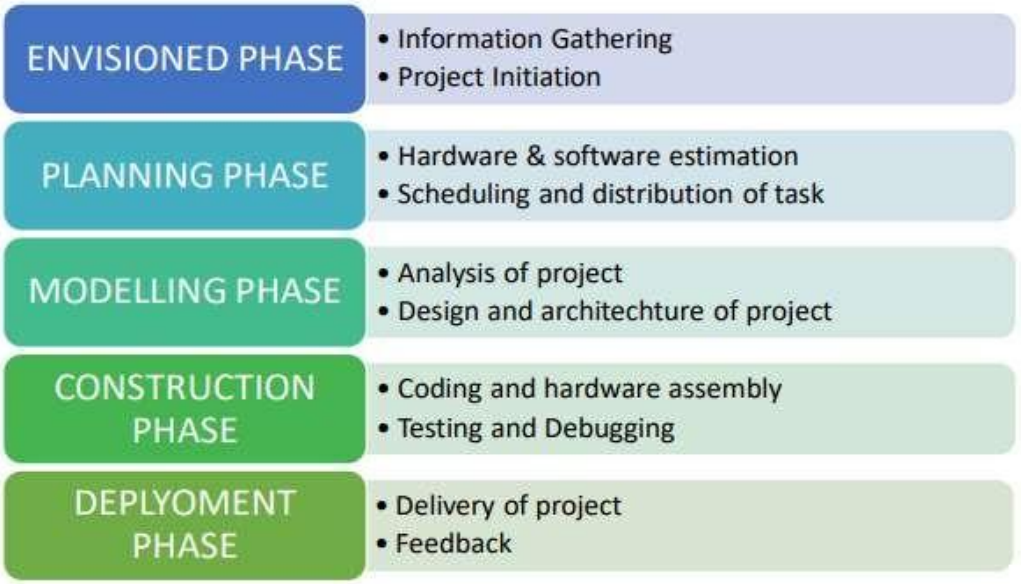

Fig-1.3: Project Management

CHAPTER-02

LITERATURE REVIEW

2.1 Introduction

Cycle based washing machine is a low cost washing machine made up easily and readily available scrap parts in daily life .It is a machine which generates force through human pedaling and with the drive mechanism, converts the pedaling motion into required rotary motion of the drum. Its innovation lies in its simple design, use of inexpensive parts, very low repairing and maintained cost, affordability to each member of the new design for easy effort in washing, rinsing and drying cloths Laundering by hand involves beating and scrubbing dirty textiles. Clothes washer technology (CWT) developed as a way to reduce the manual labor spent, providing an open basin or sealed container with paddles or fingers to automatically agitate the clothing. The earliest machines were hand operated and constructed from wood, while later machines made of metal permitted a fire to burn below the washtub, keeping the water warm throughout the day's washing (the entire process often occupied an entire day of hard work, plus drying and ironing).The earliest special-purpose washing device was the scrub board, invented in 1797.As electricity was not commonly available until at least 1930, some early washing machines were operated by a low-speed single cylinder hit and miss gasoline engine.

Because water often had to be hand carried, heated on a fire for washing, then poured into the tub, the warm soapy water was precious and would be reused, first to wash the least soiled clothing, then to wash progressively dirtier laundry. Removal of soap and water from the clothing after washing was originally a separate process. After rinsing, the soaking wet clothing would be formed into a roll and twisted by hand to extract water. To help reduce this labor, the wringer/mangle machine was developed, which used two rollers under spring tension to squeeze water out of clothing and household linen. Each laundry item would be fed through the wringer separately.

The Pedal Operated Washing Machine is a project, which is under taken to solve the problem of electric supply of people. At village, to run washing machine source of power is electricity. In Bangladesh most of village is suffering from shortage of electricity. So to overcome above problem we select the washing machine, which is operated manually. It required no power supply or diesel supply. This project is low weight & portable can be easily transported. We use simple cycling mechanism to run the washing machine shaft.

A washing machine, clothes washer, or simply washer, is a machine designed to wash laundry, such as clothing, towels and sheets. The term is mostly applied only to machines that use water as the cleaning solution, as opposed to dry cleaning (which uses alternative cleaning fluids, and is performed by specialist businesses) or even ultrasonic cleaners. All washer machines work by using mechanical energy, thermal energy, and chemical action.

Mechanical energy is imparted to the clothes load by the rotation of the agitator in top loaders, or by the tumbling action of the drum in front loaders. Thermal energy is supplied by the temperature of the wash bath. The spin speed in these machines can vary from 500 to 1600rpm. The machine ―Pedal Operated Washing Machine is innovative to manufacture and it requires skill to manufacture. The parts can be manufacture in our college. Its subcomponent price is also less, but its manufacturing requires sort of skill. This project gives us knowledge, experience skill and new ideas of manufacturing.

2.2 Types of Washing Machines

Basically washing machines are available in two main configurations. The classification depends on the way the clothes are introduced and the axis of rotation. The two main configurations are top loaded and front-loaded.

- Top Loaded
- Front Loaded

Top Loaded: This design is more common in America, Canada and some African states. Clothes are placed in a vertically mounted basket which has perforations. [1] This basket is contained within a tub which retains water.

Fig-2.1: Top Loaded Washing Machine

At the center of the clothes basket is a finned vertical axis agitator. Clothes are loaded at the top of the machine through a hinged door. During washing the water in the tub has to fully

immerse and suspend the clothes in the inner basket. As the agitator moves, water is pushed outwards between the fins towards the edges. The water then moves outward, up the sides of the basket, towards the center, and then down towards the agitator to repeat the process, in a circular pattern. The agitator direction is reversed periodically as continuous motion in one direction would lead to the water spinning around the inner basket with the agitator rather than the water being pumped in the torus-shaped motion.

Front Loaded: The front-loading design or horizontal-axis clothes washer, [5] most popular in Europe and the Middle East, mounts the inner basket and outer tub horizontally, and loadingis through a door at the front of the machine. The door often but not always contains a window. Agitation is supplied by the back-and-forth rotation of the cylinder and by gravity. The clothes are lifted up by paddles on the inside wall of the drum and then dropped. This motion flexes the weave of the fabric and forces water and detergent solution through the clothes load. Because the wash action does not require the clothing be freely suspended in water, only enough water is needed to moisten the fabric. Because less water is required, front-loaders typically use less soap, and the aggressive dropping and folding action of the tumbling can easily produce large amounts of foam.

Fig-2.2: Front Loaded Washing Machine

When the tempera inside the warehouse is lower than lower limit of the set value higher than the upper limit of the set value or higher than the upper limit of the set value the MCU will output the corresponding control signal to temperature and humidity control system and start the heating cooling or dehumidification circuit. When the temperature and humidity meet the requirement the temperature and humidity control system stop working the core work of temperature and humidity control system is to control the action of relays to achieve circuit switching part of the control circuit diagram is show in Figure.

2.3 Materials and Methods

Mechanical design is the design of objects and systems that are mechanical in nature. Examples include machines, structures, engines and engine parts and tools. In most cases mechanical design uses material science, mathematics, and mechanical science applied to engineering. Mechanical design requires one to know various engineering disciplines that include thermal and fluid sciences. For this paper, material science, mechanical science and the finite element method will be used in the design and fabrication of the components. The design of any machine should.

2.4 General Design Specifications

The most important aspect in the design of the machine is its ability to perform as a device that eases the task of washing clothes. In order to be a viable solution in rural areas, the machine should be able to deliver the same quality of washing without adding excessive overheads (in terms of water use, clothing wear, effort required to operate, etc.). Thus the design and operation of the machine should be firmly grounded in the physics of clothes washing, with a special emphasis on the mechanical aspects (since water temperature and detergent composition are likely to vary).We also identified a number of secondary goals with varying degrees of importance that could help make the machine more useful and thus more successful. The ability to spin-dry clothes would increase water economy by requiring fewer wash cycles, and could relieve the strenuous task of manually wringing the clothes before they are hung to dry. If the layout of the machine allowed the user to perform manual work (hand-craft, food preparation, etc.) while pedaling, we could further reduce the amount of time consumed by washing. A number of safety features should also to be included in order to mitigate the inherent safety issues involved in a chain-driven machine. If the machine was to be used in a home, insuring its portability of would allow it to be shared among families, transported close to a water source for operation, or used in households where space is limited. Another set of specifications for load sizing, water usage and pricing, depend on the targeted community. Since we are expecting the amount of laundry to vary between families, an initial size was selected based on existing washing machines, and designs allowing for easy re-sizing were preferred.

2.5 Literature Survey

A washing machine is a machine that is used to wash laundry, such as sheets and clothing. Usually this term is applied to machines that use water as compared to dry cleaning which uses cleaning fluids or ultrasonic cleaners. Washing clothes manually is strenuous, laborious

and time consuming. Washing machines were developed to address these challenges. The first washing machines were operated by hand and made from wood, while later machines were made of metal and made it possible to burn a fire below the washtub, keeping the water warm throughout the washing process which helps supply the required thermal energy.

Due to globalization, competition for the market has increased. This has resulted in many times of washing machines being invented. Recent designs have been getting noiseless, more and more effective, economical, less weight and their designs adapt to where you want to use them. At first, clothes were washed using hot water and soap, and the fine fabrics were kept soft. Technology began to appear in 1780 with the invention of the washing machine by Robinson Lancashire. The machine also dripped clothes. In 1855 another washing machine to wash and dry clothes was invented in Crimea's hospitals. 1880 saw the first washing machines being built. They were steam-driven. They water was heated with coal and gas. In 1888 Incola Tesla joined electronics with washing by creating a compact electric engine. In 1901, Alva Fisher invented the first washing machine by adding an electric engine which impelled a cylinder to the already existing machines. An automatic mechanism inverted the spinning sense from time to time so that the clothes did not compress, which frequently used to happen. Rollers were then added to drip clothes. This is the date when the first washing machine was born. Washing machines started selling highly in Western countries after the Second World War, in 1945. Prices for washing machines were now much cheaper than before.

2.6 Time Plan

The following tables define the main tasks in the project introduction and project itself.

T1	Project Definition	1 Week
T2	Collecting data	11 Weeks
T3	Analysis	7 Weeks
T4	Theoretical calculation	4 Weeks
T5	Documentation	10 Weeks
T6	Prepare for presentation	2 Weeks

Table- 01: Time Scheduled Table for Project Introduction

The time of the project introduction is scheduled over 16 weeks, table 2 shows how the work was scheduled over this time:

Week / Task	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
T1																
T2																
T3																
T4																
T5																
T6																

Table-02: Time Plan Table for Project Introduction

The following table defines the main tasks in the project:

T1	Collecting data	3 Week
T2	Implementation	10 Weeks
T3	Analysis	5 Weeks
T4	Building and testing the system	8 Weeks
T5	Documentation	10 Weeks
T6	Prepare for presentation	2 Weeks

Table-03: Time Scheduled Table for Project

The time of the project is scheduled over 16 weeks, table 4 shows how the work was scheduled over this time:

Week / Task	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
T1																
T2																
T3																
T4																
T5																
T6																

Table-04: Time Plan Table for Project

CHAPTER-03

DESIGN AND FABRICATION

3.1 Introduction

Cloth washing is one of the essential parts of the life but it is considered undesirable because of the involvement of efforts, time, [6] energy and cost. Nowadays a wide variety of washing machines are available in the market and there is a tough competence among the manufacturers. The cost of washing machine varying from 30,000taka to 40,000taka depending upon features and capabilities. Very costly washing machines are equipped with facility of dry cleaning too. All of the washing machines available in the market are electricpower driven and basic principle of their operation depends upon creation of the turbulent flow of detergent around the dirty clothes. Drying of the clothes is based upon rotation of wet clothes at very high rpm so that water droplets can be separated out due to centrifugal action. In our country where approximately 70% population is living with very poor economic status, those people cannot have a washing machine because of cost constraints and unavailability of electricity due to any reason. The present work is an attempt to develop a concept to make a cloth washing mechanism which can meet out the requirements of above mentioned 70% population of the nation. Working principle of this concept is no more different from available similar type of machine with a difference driving mechanism of the machine. The objective of bringing down the initial cost and operating cost of washing machine is almost achieved in present work within the limitation of work as mentioned. A washing machine (laundry machine, clothes washer, or washer) is a machine designed to wash laundry, such as clothing, towels, and sheets. The term is mostly applied only to machines that use water as the primary cleaning solution, as opposed to dry cleaning (which uses alternative cleaning fluids, and is performed by specialist businesses) or ultrasonic cleaners. Washing entails immersing, dipping, rubbing, or scrubbing in water or other liquids, usually accompanied by soap, detergent, or bleach.

3.2 Design of Wash Mechanism

The washing of clothes in front loading washing machines requires that the tub of the washing machine executes rotations in both senses i.e. clockwise for some time, then anti-clockwise for some-time and then again clockwise and so on. The shaft connected to the bicycle rotates

in one direction only so some mechanism had to be designed by which the sense of rotation could be changed [7] the power obtained from a shaft rotating in one direction had to be modified so as to execute rotation in both senses in a periodic way. Thus rack and pinion arrangement was used. In this mechanism the rack would reciprocate and a pinion would mesh with the reciprocating rack, as the direction of motion of the rack changes, the sense of rotation of the pinion would also change and the required objective shall be accomplished. The reciprocating motion of the rack from a shaft rotating in one direction could be achieved in two ways:

- Quick Return Mechanism.
- Slider Crank Mechanism.

Design of Rinse and Spin dry Mechanism: For the rinsing and spin dry the tub needs to rotate in one direction only. One of the important parameters for rinse and spin dry processes is the speed at which the tub rotates. Since there was no need for us to change the sense of rotation for rinsing and spin dry processes, it could be achieved simply by meshing of gears having the proper gear ratio. In the case of pedal powered washing machine, we required a reduction ratio of 2 for the spin and rinsing processes, so appropriate gears were made to mesh and the drive was finally sent to the tub to execute rotations at high speeds for the rinsing and spin dry processes.

Design of Drive Selector: In order to switch between the wash mode and the rinse and spin dry mode a drive selector was designed by the use of which the tub could be made to rotate in the desired mode by the user. The drive selector has a very simple design; it consists of a hollow pipe on which a gear (drive selector gear) is mounted. The hollow pipe has a hole for a bolt to pass through. This hollow pipe can move over a solid pipe which has holes in two positions where the hollow pipe can be bolted. In one of the positions, the drive selector gear meshes with the spin and rinse gear as shown in the image and in the other position it meshes with the wash gear. Accordingly the tub rotates in the desired mode.

3.3 2D Model & Hardware Specifications

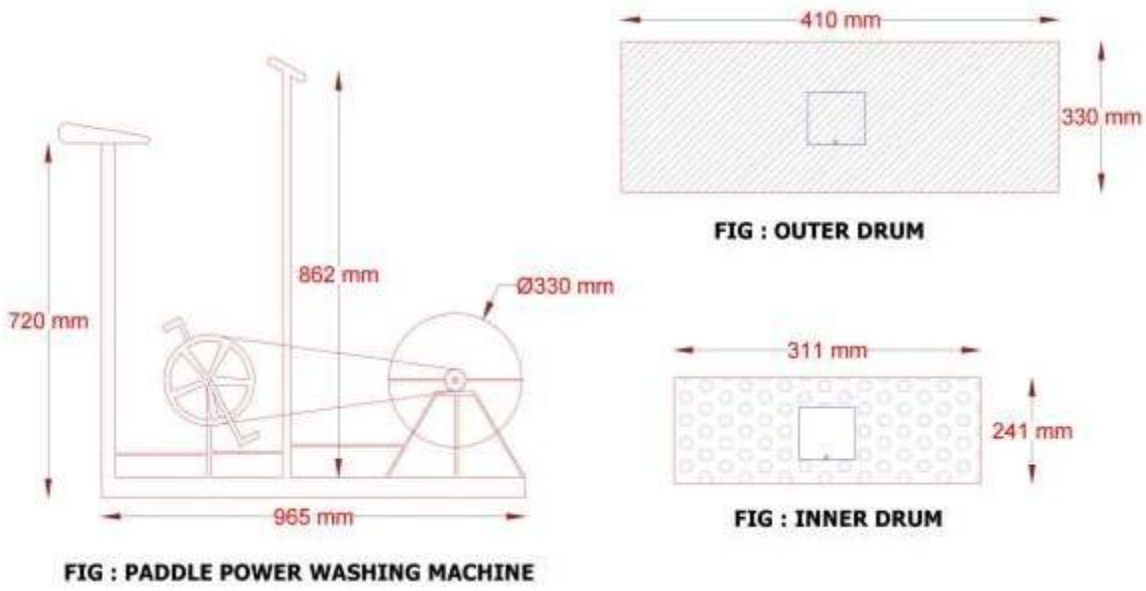

Fig-2.3: 2D Model of Paddle Power Washing Machine.

- Pedal.
- Pedal wheel.
- Gear hub.
- Shaft.
- Chain sprockets.
- Washing Inner Drum.
- Outer Drum.
- Seat.
- Handle.
- Drum Lock.

3.4 Solid works Model

Fig-3.1: Solid works Model

3.4.1 Description

Bicycle gearing is the aspect of a bicycle drive train that determines the relation between the cadence the rate at which the rider pedals, and the rate at which the drive wheel turns. On some bicycles, there is only one gear and the gear ratio is fixed. Many contemporary bicycles have multiple gears and thus multiple gear ratios. A shifting mechanism allows selection of the appropriate gear ratio for efficiency or comfort under the prevailing circumstances: for example, it may be comfortable to use a high gear when cycling downhill, a medium gear when cycling on a flat road, and a low gear when cycling uphill. Different gear ratios and gear ranges are appropriate for different people and styles of cycling. A cyclist's legs produce power optimally within a narrow pedaling speed range, or cadence. Gearing can be optimized to use this narrow range as efficiently as possible.

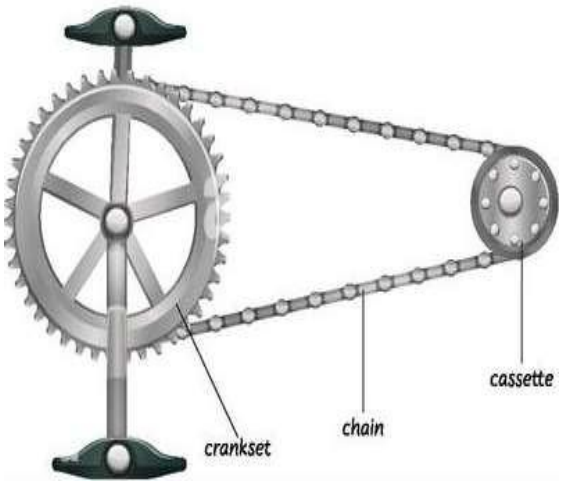

Fig-3.2: Bicycle Gearing

As in other types of transmissions, the gear ratio is closely related to the mechanical advantage of the drive train of the bicycle. On single-speed bicycles and multi-speed bicycles using derailleur gears, the gear ratio depends on the ratio of the number of teeth on the chaining to the number of teeth on the rear sprocket (cog). For bicycles equipped with hub gears, the gear ratio also depends on the internal planetary gears within the hub. For a shaft driven bicycle the gear ratio depends on the bevel gears used at each end of the shaft.

3.4.2 General Considerations

The gearing supplied by the manufacturer on a new bicycle is selected to be useful to the majority of people. Some cyclists choose to fine-tune the gearing to better suit their strength, level of fitness, and expected use. When buying from specialist cycle shops, it may be less expensive to get the gears altered before delivery rather than at some later date. Modern crank set chain rings can be swapped out, as can cog sets. While long steep hills and/or heavy loads may indicate a need for lower gearing, this can result in a very low speed. Balancing a bicycle becomes more difficult at lower speeds. For example, a bottom gear around 16 gear inches gives an effective speed of perhaps 3 miles/hour (5 km/hour) or less, at which point it might be quicker to walk.

3.4.3 Relative Gearing

As far as a cyclist's legs are concerned, when changing gears, the relative difference between two gears is more important than the absolute difference between gears. This relative change, from a lower gear to a higher gear, is normally expressed as a percentage, and is independent of what system is used to measure the gears. Cycling tends to feel more comfortable if nearly all gear changes have more or less the same percentage difference. For example, a change from a 13-tooth sprocket to a 15-tooth sprocket (15.4%) feels very similar to a change from a 20-tooth sprocket to a 23- tooth sprocket (15%), even though the latter has a larger absolute difference.

3.4.4 Usable Gears

On a bicycle with only one gear change mechanism (e.g. rear hub only or rear derailleur only), the number of possible gear ratios is the same as the number of usable gear ratios, which is also the same as the number of distinct gear ratios. On a bicycle with more than one gear change mechanism (e.g. front and rear derailleur), these three numbers can be quite

different, depending on the relative gearing steps of the various mechanisms. The number of gears for such a derailleur equipped bike is often stated simplistically, particularly in advertising, and this may be misleading. Consider a derailleur-equipped bicycle with 3 chainring and an 8-sprocket:

- The number of possible gear ratios is 24 = (3×8, this is the number usually quoted in advertisements);
- The number of usable gear ratios is 22;
- The number of distinct gear ratios is typically 16 to 18.

3.4.5 Sprockets and Chains

A sprocket is a toothed wheel upon which a chain rides. Contrary to popular opinion, a sprocket is not a gear.

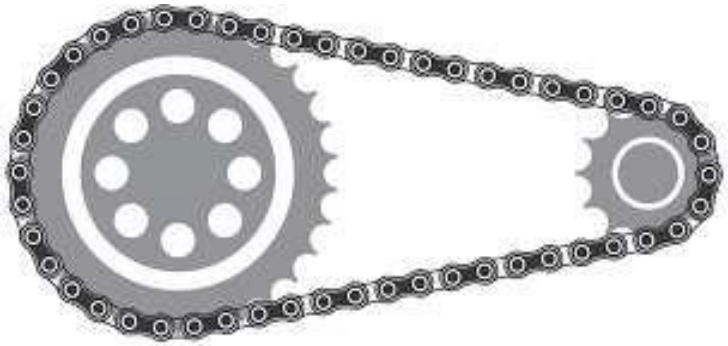

Fig-3.3: Sprockets and Chains

3.4.6 Development of Manually

There are existing solutions to the clothes washing problem, but no existing technology is both practical and affordable for people in our target community. Existing solutions are either designed for industrialized nations with running water and electricity, or they are not practical for rural setting where replacement parts are difficult to find. Commercial washing machines have existed for many years, but they are expensive and require electricity to operate. Sometimes, they are available in urban settings, but the average family cannot afford to purchase one. In rural areas, commercial washing machines are not an option because electricity may be unavailable or extremely expensive. A number of groups have modified commercial washing machines to power them with human power. They attached a pedal-drive mechanism to the washing machine drum and attached a suspension system.

3.4.7 Probable Design Alternatives

The team evaluated a number of mechanisms that could serve as the basis for the washing machine. Initial concepts were developed starting from the mechanical requirements of laundry washing, with inspiration drawn from existing and historical washing machines.

3.4.8 Horizontal-Axis Agitator

The usual washing machine found in American homes consists of two vertical axis concentric tubs. The inner tube, which holds the clothes, has densely-spaced perforations which allow the water to run in and out easily. Soap and water are kept inside the outer tub during the wash cycle. A central agitator alternating directions induces friction between the clothes to mechanically remove dirt and stains. For the spin cycle, water is emptied from the outer drum and the inner drum is spun to centrifugally extract water from the clothes.

Fig-3.4: Horizontal-Axis Agitator

3.4.9 Vertical--Axis Tumbler

Commonly used in European homes, this washer also uses two concentric tubs; however their revolution axis is horizontal.

Instead of using an agitator, the horizontal washer utilizes fins along the inner barrel that lift the clothes on the side of the drum, and let them fall back in the water on top of other clothes. Cycling the clothes through the water in this fashion eliminates the need for rapid changes in the direction of rotation of the agitator, which results in lower energy requirements. Since the drum is only filled up to one third with water, the machine realizes a sizeable water economy.

Fig-3.5: Vertical--Axis Tumbler

3.4.10 Tilted-axis Tumbler

A tub spinning at a inclined axis using a helical fin would perform the same kind of action, in a fashion similar to a cement mixer.

Fig-3.6: Tilted Axis Tumbler

The tilted design would allow for easier addition of water and clothes. No known commercial washers use this mechanism. Manufacturing of the helical fin proved to be problematic, and the other construction benefits we were hoping for in the tilted axis design did not end up materializing themselves. No conclusive cleaning experiments were performed using this design.

3.5 Final Design of Washing Machine

Our final design resembles a commercially available horizontal axis washer. The inner drum which holds the clothes is currently constructed by modifying a plastic utility tub. Tubes like these are widely available at scrapper but could easily be substituted for other types of buckets, perforated sheet metal or mesh, depending on availability The inner drum is perforated, so that spinning the drum will extract water from the garments. There are also three triangular fins inside the inner drum that agitate the clothes during the wash cycle. The main structure of the machine consists of a simple tube frame. The frame can be built by modifying an existing bicycle frame. The inner drum is mounted on one side of a pedal shaft. Rotational force turns the drum via a drive gear attached to the opposite side of the pedal shaft.

A bicycle chain connects the gear at the drum to a set of pedals mounted on the frame. The operator loads and unloads clothing from the inner drum through a cut out on the side of the outer barrel. The operator drains the soapy water and rinse water by opening a drain value at the bottom of the barrel. The operator can use her hands to do manual work like weaving while pedaling the machine. Women expressed interest in this particular feature.

CHAPTER-04

DATA ANALYSIS

4.1 Calculation :

We have assumed an overall calculations for our project. Here is the assumption in short:
Length of the shaft = 550 mm
Diameter of main shaft = 20 mm
Outer drum length = 410 mm
Outer drum diameter = 330 mm
Inner drum length = 311 mm
Inner drum diameter = 241 mm
First chain drive centre to centre distance = 500 mm
Number of teeth of small gear = 18
Diameter of small gear = 80 mm
Number of teeth of larger gear = 36
Diameter of larger gear = 150 mm

We are going to apply the following formulas for our project. [3] (As our all dimensions are assumed we could not calculated the actual calculations, as it may vary in later)

Angular velocity, $w = 2\pi N/60$

Where N= rpm
W= angular velocity.

Gear ratio, G,
Our Gear Ratio = 1:5

Torque= Force ×Radius
Power = $2\pi NT/60$
RPM generated by pedalling = 50 RPM
RPM of the main shaft = 250 RPM
As average cyclist can generate 183 watts power while running at a speed of 30.4 km/hr or 8.44 m/s,

Thus power transmitted from driving sprocket to driven sprocket,
Power = Force * Velocity
so, Force = (Power/Velocity)
= (183/8.44)
= 21.68 N

An average cyclist can generate up to 80 rpm, as we can consider 60 rpm
and our velocity ratio is 1:2

Speed of main Shaft,

Velocity ratio N1/N2

N2= 60*2 = 120 rpm

Torque = Force * Radius

As our inner drum diameter d = 241 mm

& radius r = 121 mm

Torque = (21.68*0.121) Nm

= 2.54 Nm

Power required to rotate inner drum at 180 rpm

$P = 2\pi NT/60$

= 31.92 watt.

we increase the diameter of inner drum to 600 mm

&Radius = 300 mm

= 0.30 m

Torque =(Force * Radius)Nm

=(21.68*.30) Nm

=6.504 Nm

Power require to rotate inner drum at 180 rpm

$P = 2\pi NT/60$

= 81.73 watt

We decrease the diameter of inner drum to 100 mm

Radius = 50 mm

= 0.05 m

Torque = (21.68*0.05) N.m

= 1.084 N.m

Power required to rotate at 180 rpm

$P = 2\pi NT/60$

= 13 watt

We can say that the required power is proportional to the inner drum size. If we increased the drum diameter the required power is more .

CHAPTER-05

RESULTS AND DISCUSSION

5.1 Introduction

Washing machine will be easy to use by younger and older women. After loading the machine, washing requires three cycles. [1] Between each cycle, the drum spins quickly to draw the water out of the clothing, as it drains out of the drum. In the first cycle, water anddetergent are added to the drum. The operator pedals the machine for roughly 15-20 minutes, spins, and drains the water. The next two cycles are rinse cycles. In each rinse cycle, the operator pours clean water into the machine. After the last rinse cycle, the operator spins the clothes dry and saves the slightly soapy water for the next wash cycle. Our research into existing washers and our earlier prototypes indicate that the power required for washing and spinning is relatively low.

For these experiments, we used a geared transmission from a bicycle. Both younger and older women can generate enough power for the wash and spin cycles. Estimated power generated 50-75 watts. While familiarity with pedaling in general and the machine in particular will reduce the effort expended by the user, no prior experience will be necessary for its operation. The ability to change gearing ratios will allow some level of tuning to individual users and also allow for shorter wash times with more power input or conversely less strenuous operation if the user can pedal for a longer amount of time.

Fig-4.1: Final Model Images

To operate the machine one has to follow the following steps:

- Open the outer and inner drum doors.
- Put the clothes in the inner drum and close the inner door.
- Pour about 5 to 10 litters of water and add a detergent.
- Close the outer door and sit on a comfortable chair.
- Begin to cycle starting slowly and increasing pace. Pedal for about 15-20 minutes.
- Remove the soapy water by opening drainage screw at the bottom of the outer drum. You can add rinsing water and pedal for a short time. Remove the water. Drying will require a faster pedaling rate. The heat in the drum will also help dry the clothes.
- Now remove the clothes from the machine. The machine has to be maintained at regular intervals. A preventative type of maintenance every 5 years is more suitable. The components that require replacement are the sprocket, gears and the chain. Chain has to be greased regularly.

5.2 Testing

This machine Work tested the concept by washing 2 T-Shirts and 1 Pant constituting the weight of dry cloth approximately 2Kg. The detergent used was one of the commonly recommended detergents for washing machine. Water approximately used 10 L. The washing time was 15 min after that the detergent was drained out through gravity and fresh water used to rinsed the cloth. Then clothes are dried by draining out the absorbed water for this purpose there is a need to pedal the machine at higher rpm. The capability of machine to dry out the clothes depends upon rpm. So the extent of dryness is not better than the manual squeezing of the clothes.

5.3 Results

The main objective is to provide a product with an alternative way to wash clothes when there is no electricity. It has to be understood that in rural areas, it is a very stressful and laborious task. So the product which is a pedal driven machine, it satisfies the need of rural people by giving them an alternative way of washing clothes which is quick, cost effective and eco-friendly. The product designed has zero operating cost, cost-effective, and it can be used with minimal effort.

Speed achieved

No load condition		With load (5 litters of water, 1 kg cloth, and 100 gm of detergent)	
N1 in rpm	N2 in rpm	N1 in rpm	N2 in rpm
100	210	100	183
120	274	120	200
150	308	150	230
180	380	180	300
200	417	200	350

CHAPTER-06

CONCLUSION AND RECOMMENDATIONS

6.1 Discussion

The pedal powered washing machine is quite different from the community's current method of washing clothes; the community may be reluctant to try the new machine. Achieved what we desired to build a manually driven pedal powered low cost washing machine using locally available materials and performing necessary function of washing and rinsing with ease. Our washing machine doesn't consume electricity. The washing machine can be used bythe urban people also while workout and exercises. It can serve dual purposes. While cycling, the clothes can be washed utilizing the pedaling of the human being. If the production of this washing machine is done at commercial scale then the total production cost will be less of the machine.

6.2 Advantage

There are certainly many advantages of our project and some of the major ones have been given below:

- Eco friendly and non-polluting in every way.
- The machine has low manufacturing cost. It is highly economical and affordable to all class of people.
- Less effect of chemical on the hand.
- Works without electricity so it can be an ideal machine for the people in the electricity deficient Bangladesh villages.
- Less tiring than conventional washing techniques by hand. This would greatly contribute in increasing the productivity of the manual laundries all over the world.
- Lesser chances of failure than electronic washing machine as the mechanical systems used in the machine have stood the test the time.

6.3 Application

- Home System.
- Hospital System.
- Hotel System.
- Industry

6.4 Future Scope

Many features can be added to our project in future to get better output. Below are some ofthe features in the project:

- Include the spin dry mechanism provides drying of clothes.
- Automatic water supply system.
- There should always be opportunities for continual development and improvement.

6.5 Conclusion

From the above project, it can be concluded that the “paddle powered washing machine” is a very simple yet very powerful design of washing cloth which if brought into application in the rural areas of the developing countries can aid a lot of plight and the suffering of the poor peoples who find it very difficult to wash cloth by means of hand. Thus it is used as a application keeping in mind the social welfare of the peoples of the rural areas. Also It is safe in working condition and hence it does not require any safety guards during operation. The washing machine can be used by the urban people also while workout and exercises. The cost of maintenance is a low and it has a long life.

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