

Hand Pedal Powered Washing Machine

Nurmina Abdullah^{1,2*}, Mohd Amien Rais Shahadan¹, Mohamad Razif Abu Bakar¹, Muhammad Harris Daniel Abdullah¹

¹ Department of Mechanical Engineering, Center for Diploma Studies,

Universiti Tun Hussein Onn Malaysia, Pagoh Higher Education Hub, 84600 Pagoh, Johor, MALAYSIA

² Vehicle Control and Robotics Engineering (VeCaRE), Centre for Diploma Studies,

Universiti Tun Hussein Onn Malaysia, Pagoh Higher Education Hub, 84600 Pagoh, Johor, MALAYSIA

*Corresponding Author: nurmina@uthm.edu.my

DOI: <https://doi.org/10.30880/mari.2024.05.02.019>

Article Info

Received: 01 December 2023

Accepted: 30 April 2024

Available online: 30 June 2024

Keywords

Washing Machine, Hand Pedal, Eco-friendly

Abstract

The Hand Pedal Powered Washing Machine is an eco-friendly alternative to electric washing machines, operated manually through a pedal mechanism. This project is specially made for students who live in the hostel. By harnessing human power, it eliminates the need for electricity, making it an ideal solution for areas with limited access to power or those aiming to reduce their carbon footprint. Modern washing machines come in large sizes and draw a lot of electricity. By times, students that stay in hostel will choose to wash their clothes with their own hands. As a result, this project was started to create a small-sized washing machine that doesn't require electricity, specifically to address the issue for students living in hostel. During FYP 1, activities such as choosing and creating design concepts, three-dimensional painting, and more was happening to make sure FYP 2 going smoothly. In the end, this project demonstrates how washing and rinsing clothes can be done quick and easy in comparison to other washing machines.

1. Introduction

A washing machine is a machine that is used to wash various types of clothing without requiring any physical effort. With a washing machine, the user does not have to rub or compress the garments to remove the water. The washer is often known as a clothes washer or just the washer. The washing machine will automatically wash without needing to supervise its operation. Simply place the garments in the washing machine and pick the wash mode. The washing machine automatically measures the amount of water and detergent needed and sets the timer for washing, rinsing, and drying according to the mode selected and the number of clothing [1].

Washing machines are further classed as half automated washing machines or completely automatic washing machines based on the total automation functions provided in the machine. Washing machine, semi-automatic: The washer and dryer are housed in separate tubs or vessels. Setting washing and drying times is possible using two independent timers [2]. To wash the garments, place them in the washing machine, add appropriate water and detergent, and then set the timer. The washing machine will shut down after the stated period. You can either take the clothes and dry them in the sun, or you can partially dry them in the drier vessel by choosing the appropriate time [3].

Several studies had been carried out by researchers, the first study was about how much students wash their clothes in the laundry and the second study is how many students wash their clothes manually, i.e., washing by hand. According to the findings, the percentage of students who wash their clothes by hand is higher than the number of students who use laundry.

Researchers also receive the reasons given by the students. Students who choose to wash their clothes manually say that they are not fit to carry their clothes down and up the stairs if they want to go to the laundry. Students also said that if they want to wash in a laundromat, they must spend money and wait a long time for the clothes to be washed. Meanwhile, the reason for students who wash in this laundry is that they are too lazy to wash manually and think that washing manually is an old-fashioned way because machines have been prepared.

The primary goal of the research on this washing machine is to make it easier for users to wash their clothes. Some objectives are provided to guarantee that this aim is accomplished and attained. The first objective is to produce washing machines that are economical, affordable, and easy to build and maintain. The second objective is to save students savings on laundry costs and electricity consumption costs as well as repair costs in the event of damage. The last objective is to learn fabrication skills when we are working on this project.

The work scopes are the work route phases that must be completed on this washing machine. Some work scopes have been mentioned below to help better understand this work scope. The first scope is to create a 3D model of this hand pedal washing machine using Solidworks Software. Second, researchers would perform installation simulations and load calculations for this hand pedal washing machine reconstruction. And for the last, to create a model of the hand pedal washing machine's dependability especially for student.

This tool can help all groups, regardless of gender, especially students [4]. This tool can also reduce time and use only a little force to wash clothes. In addition, with the presence of this washing machine, it can reduce the cost that should be used to pay for laundry. Because the parts of this tool are mostly made of strong iron and plastic, hence more durable and suitable for their function.

2. Material and Methodology

There are various types of washing machines available now, regardless of whether they are on the market or online. The differences that exist between all these products are in terms of design, durability, how to use them, and price. Fig. 1 below shows the automatic and semiautomatic washing machines available on the market. Washing machines like this are less suitable for students who live in dormitories due to several reasons, such as high costs [5]. Students need a washing machine that is lightweight, easy to use, effective, and saves money. Therefore, we produced this Hand Pedal Washing Machine to meet the needs of the students.



(a)



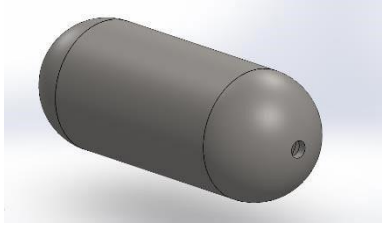
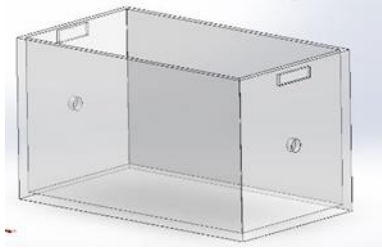

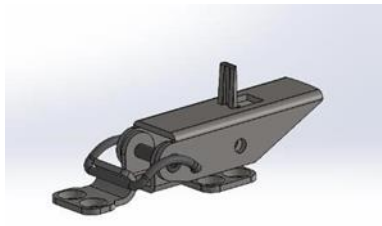
(b)

Fig. 1 Two types of washing machine (a) Semi-automatic; (b) Fully automatic

2.1 Materials

In developing a product, the use of materials is the most important thing to ensure that the product produced can be used well and last long [6].

Table 1 Materials specifications and characteristics

Component	Characteristics	Material / Type
<p>Drum</p> 	Carbon steel	Hardy, high-quality metals anti-rust
<p>Box</p> 	Plastic	Lightweight, strong and ductile, anti-rust
<p>Pedal</p> 	Carbon steel	Hardy, high-quality metals anti-rust
<p>Clip</p> 	Stainless steel	Long lasting, high tensile stress, corrosion resistant

In this research, there are four main components to be used which are the drum, box, pedal, and clip. Each component has its own advantages to make sure that the product can function accordingly. The characteristics of all the components used have been shown as in Table 1 above.

3. Methodology

The manufacturer of the Hand Pedal Powered Washing Machine needs to follow the necessary processes and fabrication before proceeding to the project test.

3.1 Project Design Concept

This washing machine aims to make it easier for the students staying in the dormitory to wash their clothes [7]. The selection of materials and equipment that are suitable for this situation is very important and should be emphasized so that this project can be well perfected without any problems during the fabrication process of the project design. There are various types of washing machine designs that have their own characteristics. However, the characteristics of this washing machine are its small size, ease of use, and effectiveness [8]. Therefore, each of these characteristics needs to be applied to this washing machine.

The main materials used to produce this washing machine are the drum, the box, the pedal, and the clamp. Other washing machine project materials can be referred to in the picture below, Fig. 2(a) showing the Final Drawing Project of the Hand Pedal Washing Machine. Each part chosen to fabricate this project has a desired

function. To achieve the desired function is to require materials that correspond to the specified function [9]. Therefore, the selection and determination of suitable materials are important to ensure the project objectives can be met. Fig. 2(b) shows the Bill of Exploded (BOM) view, of the drawing.

The tools and materials chosen must have safety features that do not harm the user. The size of this washing machine, which is small, simple, and mobile, is very suitable for the users, especially students in the water room of their dormitory. In conclusion, the selection and criteria of our tools and materials are chosen to produce the best washing machine.

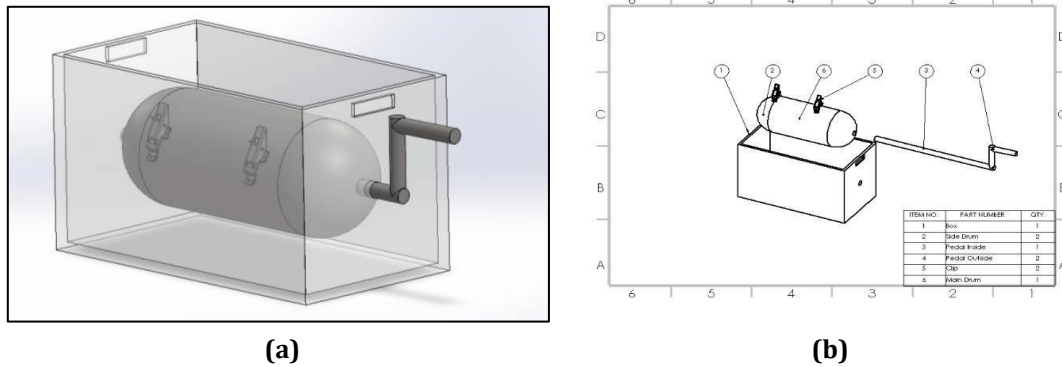


Fig. 2 Drawing project using SolidWorks (a) Final project drawing; (b) BOM project

3.2 Specifications

The studies that were produced during the problem statement activity at the start of this product's implementation process were used to determine the design of this product. Determined by the data and information gathered, a good washing machine's specification can be found.

Table 2 Specifications and Characteristics

No.	Specifications	Characteristics
1	Weight	Less than 10 KG
2	Size	Length, height, and width is no more than 0.5m, 0.3m, and 0.4m
3	Material	Strong and Hard
4	Maintenance	Quick and Simple
5	Ergonomics	Easy to handle
6	Force / Energy	Less force than washing with hands

The specifications and factors listed in Table 2 above should be considered when choosing a socket design.

4. Decisions and Discussions

Hand Pedal Powered Washing Machine will be tested with several types of tests to see and assess the capabilities of the machine. the first test carried out is to test how many clothes this washing machine is capable to wash, while the second test is to test the durability of the machine when rotated at high rate.

4.1 Working Principle

A hand pedal-powered washing machine operates by harnessing human energy to wash clothes [9]. It consists of a drum or tub where the clothes are placed, an agitation mechanism for moving the clothes, a water supply and drainage system, and a pedal mechanism. The user fills the drum with water and detergent, adds the clothes into the drum, and starts pedaling. The pedaling motion from the pedal is transferring the energy or rotation straight to the drum, which the user can move back and forth or in a circular motion, agitating the clothes and removing dirt and stains.

After the washing cycle, the dirty water is manually drained, and fresh water is poured for rinsing. Pedaling again agitates the clothes in clean water to remove detergent residues. Finally, the clothes can be wrung out by hand and dried using other means. This Hand Pedal Powered Washing Machine also can be used as drier. User just needs to drain the water out of the tub, then spin the pedal as fast as possible. Make sure to close the tub with its cover.

One of the key advantages of a hand pedal-powered washing machine is its eco-friendly nature, as it does not require electricity and therefore reduces energy consumption and carbon emissions [10]. It is particularly useful in areas with limited or unreliable access to electricity. Additionally, these Hand Powered Washing Machine is

portable and lightweight, making them ideal for camping trips, off-grid living, or situations where conventional washing machines are not available. They also offer cost savings since they do not rely on electricity or require maintenance.

Furthermore, hand pedal-powered washing machines provide a form of exercise as the user pedals, promoting physical activity and a healthier lifestyle [11]. In summary, these machines offer a sustainable, portable, cost-effective, and physically active solution for washing clothes.

4.2 Machine Testing

In this washing activity test, the washing machine is tested with a huge amount of clothes. Additionally, the machine is tested with a pedal stroke at its maximum speed. This test requires quite paddling power to work on the washing machine.

Fig. 3(a) and Fig. 3(b) below shows the activity of testing the washing machine project. Both activities were done to test the effectiveness of the machine as well as the durability of the project. Through these activities, in the first test, we found that the clothes to be washed are only in half quantities for the better washing quality. The type of fabric also affects the quantity of clothes to be washed. Next, for the second test, the speed of rotation of the engine pedal is not too fast and not too slow. The best and most effective way to pedal is to alternate between fast pedaling and slow pedaling so that the water can get in and out of the drum properly.

Users will be able to operate this washing machine effectively once the test is complete because we are already aware of its benefits and drawbacks. Considering that this washing machine project was created especially for boarding students and that it was installed in a water room. It can be used by students, but not exclusively. This washing machine will break down and become damaged if it is used roughly. To preserve safety and achieve the best possible washing results, the washing machine must be used correctly. Aside from machine damage, it is crucial to prevent machine failure.



Fig. 3 Testing on washing machine (a) Putting all the clothes inside the drum; (b) Spin the machine manually

4.3 Impact of Design and Materials used on the Environment and Sustainability

This washing machine is made in accordance with the design depicted in Fig. 4 and is manufactured without the use of electricity or non-renewable fuel in order to prevent environmental contamination. Iron is the sole sort of material employed, which is both recyclable and environmentally benign. Because this Hand Pedal Powered Washing Machine is manufactured from environmentally friendly components, its production will never impact the environment.



Fig 4 Hand Pedal Powered Washing Machine

5. Decisions and Discussions

Our focus is on Hand Pedal Powered Washing Machine to make a simple, effective, and affordable washing machine for students who live in hostel. This is happening because we wanted to build a washing machine that is easy to use, quick, and cost-effective. Not only students, but anybody can also use this washing machine, anywhere. The hand pedal-powered washing machine offers a viable and sustainable solution for washing clothes.

The hand pedal-powered washing machine offers a viable and sustainable solution for washing clothes. By harnessing human energy through pedaling, it eliminates the need for electricity, reducing energy consumption and carbon emission [10]. This eco-friendly feature makes it particularly advantageous in areas with limited or unreliable access to electricity. Furthermore, its portability and lightweight design make it suitable for various situations, such as camping trips, off-grid living, or areas where conventional washing machines are unavailable. The cost savings associated with not relying on electricity and the minimal maintenance requirements add to its appeal [12]. Additionally, the physical activity involved in pedaling provides a dual benefit of exercising while accomplishing the task of washing clothes.

Overall, the hand pedal-powered washing machine combines practicality, sustainability, and physical activity, making it an innovative and advantageous solution for efficient and environmentally friendly clothes washing. Finally, after the test that we held to this machine, we reached our main objective, which is to produce washing machines that are economical, affordable, and easy to build and maintain. Plus, this washing machine saves a lot of cost on laundry and electricity consumption costs as well as repair costs in the event of damage, because people wash clothes every day. Finally, we are also able to learn fabrication skills during our last two semesters planning and creating this Hand Pedal Powered Washing Machine.

6. Suggestions

Some weaknesses of this project were identified after the test was conducted, particularly regarding the use of an iron drum. There is a risk of the drum rusting, despite being painted, which can contaminate the water and affect the clothes. Consequently, this project may not be suitable for long-term use.

A valuable suggestion that our group and the supervisor came up with is to replace the iron drum with a plastic one. By using a plastic drum, the probability of rusting is eliminated entirely, addressing the issue, and enhancing the project's durability, also can be used for a long time.

Acknowledgement

The authors would like to thank Center for Diploma Studies, Universiti Tun Hussein Onn Malaysia for its support.

Conflict of Interest

Authors declare that there is no conflict of interests regarding the publication of the paper.

Author Contribution

*The authors acknowledge the contributions to this paper as follows: **conception and design of the study:** Mohd Amien Rais Shahadan, Mohamad Razif Abu Bakar, Muhammad Harris Daniel Abdullah; **data collection:** Mohd Amien Rais Shahadan, Mohamad Razif Abu Bakar, Muhammad Harris Daniel Abdullah; **analysis and interpretation of results:** Nurmina Abdullah, Mohd Amien Rais Shahadan, Mohamad Razif Abu Bakar, Muhammad Harris Daniel Abdullah; **manuscript draft preparation:** Nurmina Abdullah, Mohd Amien Rais Shahadan, Mohamad Razif Abu Bakar, Muhammad Harris Daniel Abdullah. All authors reviewed the results and approved the final version of the manuscript.*

References

- [1] H. Sakidin, P. Sudhakaran, M. S. Saad, S. S. Rozali, A. H. Nasarudin, and A. A. Almashhor, "Development of eco-friendly washing machine," in MATEC Web of Conferences, EDP Sciences, Oct. 2017. doi: 10.1051/mateconf/201713104015
- [2] O. A. Mandavkar, T. P. Komawar, D. R. Gawad, S. V. Gupta, and S. A. Bari, "Foot Operated Washing Machine," Int J Res Appl Sci Eng Technol, vol. 10, no. 4, pp. 489-494, Apr. 2022, doi: 10.22214/ijraset.2022.41296
- [3] P. Cumber, "Visualising mechanics: washing machine dynamics," International Journal of Mathematical Education in Science and Technology, vol. 52, no. 4. Taylor and Francis Ltd., pp. 626-652, 2021. doi: 10.1080/0020739X.2020.1794070
- [4] M. A. Bajet, Jr., N. A. Bajet, and O. T. Tolentino, "Converting Malfunctioned Fully Automatic (Electro-Mechanical Driven) to Semiautomatic Washing Machine," JPAIR Multidisciplinary Research, vol. 12, no. 1, pp. 101-115, Mar. 2013, doi: 10.7719/jpair.v12i1.216

- [5] Z. ElNashar, O. Cherkaoui, Z. Zlatev, and E. ElNashar, "Laundry Washing Machine For Consumption Of Clothing, Water And Energy In Egypt," *Applied Researches in Technics, Technologies and Education*, vol. 16, no. 2, pp. 121–130, 2018, doi: 10.15547/artte.2018.02.007
- [6] M. A. Fajobi, E. Y. Salawu, J. Azeta, J. O. Dirisu, O. O. Ajayi, and P. Onwordi, "Development of a Human Powered Pedal Washing MACHINE," in *IOP Conference Series: Materials Science and Engineering*, Institute of Physics Publishing, May 2020. doi: 10.1088/1757-899X/811/1/012035
- [7] A. Wisnujati, W. Kaliman, and R. A. Himarosa, "Analysis The Strength Of Mild Steel Material On A Handcycle Bike Frame," 2021. [Online]. Available: <http://ojs.pnb.ac.id/index.php/LOGIC>
- [8] A. A. Adenowo, A. I. Yussuff, S. O. Adetona, O. M. Ogunleye, O. K. Abioye, and C. G. Ahubelem, "Automatic Washing Machine with Direct Current Power Backup," *Engineering and Technology Research Journal*, vol. 4, no. 2, pp. 7–16, Sep. 2019, doi: 10.47545/etrj.2019.4.2.051
- [9] H. Pham, A. P. Bandaru, P. Bellannagari, S. Zaidi, and V. Viswanathan, "Getting Fit in a Sustainable Way: Design and Optimization of a Low-Cost Regenerative Exercise Bicycle," *Designs (Basel)*, vol. 6, no. 3, Jun. 2022, doi: 10.3390/designs6030059
- [10] W. J. Chung, Y. J. Park, C. Choi, and S. C. Kim, "Effects of manufacturing errors of gear macro-geometry on gear performance," *Sci Rep*, vol. 13, no. 1, Dec. 2023, doi: 10.1038/s41598-022-27204-9
- [11] P. H. Sahare, T. Madavi, B. S. Kamble, M. J. Kajliwale, A. Demir, and M. Ataram, "Study for The Manufacturing of Manually Operated Washing Machine," *International Journal of Analytical, Experimental and Finite Element Analysis (IJAEFEA)*, vol. 7, no. 4, Dec. 2020, doi: 10.26706/ijaefea.4.7.20200809
- [12] S. Radhakrishnan, Y. T. T. Lee, S. Rachuri, and S. Kamarthi, "Complexity and entropy representation for machine component diagnostics," *PLoS One*, vol. 14, no. 7, Jul. 2019, doi: 10.1371/journal.pone.0217919