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Multilevel Shoe Rack

Muhammad Aizat Zulkarnain Sabaruddin[1], Muhammad Aleef Aiman Suhaimi[1], Wan Nuralya Afrina Rosdi[1], Mahmod Abd Hakim Mohamad[1], Ahmad Faiz Mat Zian @ Mat Zin[1,2], Muhammad Hanafi Asril Rajo Mantari[*1,2]

[1] *Department of Mechanical Engineering, Centre for Diploma Studies, Universiti Tun Hussein Onn Malaysia, Higher Education Hub, 84600, Pagoh, Johor, MALAYSIA*
[2] *Product Research and Development Group (ProReD), Centre for Diploma Studies, Universiti Tun Hussein Onn Malaysia, Pagoh Higher Education Hub, 84600, Pagoh, Johor, MALAYSIA*

*Corresponding Author: mhanafi@uthm.edu.my
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Abstract

A shoe rack is essential furniture for organizing footwear at home or in the workplace. The Multilevel Shoe Rack was developed to address the difficulties faced by individuals with osteoarthritis when wearing shoes. The main objective of this project is to design and fabricate a multipurpose shoe rack that can store up to 12 pairs of shoes while also serving as a seating bench. Constructed primarily from chipboard for its affordability and adequate strength, the rack features a three-layer flip frame hinge system, creating three storage sections. To enhance comfort, faux leather and sponge are used as a seat cover. Test results demonstrated that the rack not only accommodates 12 pairs of shoes neatly but also supports the weight of two adults sitting simultaneously.

1. Introduction

A shoe rack is a piece of furniture or a storage solution designed specifically for organizing and storing shoes [1]. It typically consists of shelves or compartments to place shoes neatly and keep them organized and easily accessible. It is also a common household storage unit and can be categorized as a type of furniture [2]. Shoe rack also has become a necessity in the household or at the workplace. It is because of the increase in the number of shoes a person owns and to create an organized environment without having the shoes scattered all over the floor. Therefore, it comes in various sizes, styles, and materials so that it can be placed depending on the storage needs and available space. Shoe racks are also available in materials like wood, metal, plastic, or fabric depending on personal preferences for the styles and decor.

In general, people will use a shoe rack with the minimum circumstance twice a day, to retrieve and store shoes [3]. Repetitive exposure to bending and stooping will cause back-related injuries and leg-related injuries. This happened because of using a shoe rack that is low to the ground or placed in a way that requires bending or stooping to access shoes. Moreover, the overloading of shoe racks is also one of the common problems. The added weight of too many pairs of shoes or heavy objects being placed on top of it can create a risk of overexertion when trying to retrieve shoes. Furthermore, customers often face difficulties in finding a shoe rack that fits the available space in their homes, especially when they have small entryways [4].

Other than that, there are many varieties of shoe rack that are available in marketplace such as an open shoe rack, pull-out modern shoe rack, and many others are effective also may contribute to uncomfortable and cause injuries to the users like some materials that has rough surface, and the angle was too sharp. Due to usability issues in existing shoe rack designs, many designers have investigated the development of ergonomic shoe racks to maintain the structure of shoe rack to stop from been damaged or misshapen. However, there appear to be several possible flaws that still exist in these ergonomic shoe rack designs such as the cost and space

requirement.

The idea of this project is a Multilevel Shoe Rack. This project is about innovating the previous shoe rack in the market according to customer requirements. The main purpose of this product is to make a shoe rack that is a convenient and versatile storage solution for organizing and storing shoes. It is to make the shoe rack multipurpose by doing innovation in the design and functionality of it. Next, it is designed to be collapsible, which is easy to fold it down for compact storage when not in use. The primary advantage is its space-saving design which makes it ideal for small apartments, dorm rooms, or closets with limited space. Other than that, the shoe rack is aesthetic because of its unique style. Moreover, it will help to protect shoes from dust or dirt. Furthermore, it has a seat for the user to wear shoes without bending down or sitting on the floor. Lastly, sustainability and minimalism encourage users to own fewer, higher-quality shoes and store them more efficiently.

1.1 Literature Review

A shoe rack can be defined as a place or area that can keep the shoes organized and neatly arranged. It is also part of the furniture that needs to be placed correctly so that the house looks tidy and not messed up.[5] Nowadays, we can observe that there are varieties of shoe racks in the marketplace in many shapes, sizes, and colour that match add shoe rack, pull out or fold modern shoe rack and shoe rack with a bench.

The shoe rack had been used for centuries but the first shoe rack that was founded in history was in 1937 invented by William A Cicero who consumed the shoe rack pattern. Known that the material used for his shoe rack is made from wood. A decade later, a well-known shopping mall named IKEA sold so many shoe racks that it showed that the shoe rack had been an important piece of furniture for people during that time.[6]

After several years, some shoe racks have been created by some well-known designers such as Gunnar Bollin (Sweden). The shoe rack had grown much better during the 19th to 20th centuries, and the product was becoming much creative and variable along with the modern development in this age.[7] Fig. 1 showed the evolution of shoe rack design from 1937 until now.

Fig. 1 *The evolution of shoe racks* [8][9]

Not only does the shoe rack's history, but it also can include some materials about the history of its pair which are the shoes themselves. Roughly around 40,000 years ago, people were wearing footwear with large soles, as evidenced by changes in toe strength and foot shape. In addition, 9,000 years ago the first known specimen of genuine footwear—a pair of sandals discovered in California, U.S.A. [10]

Besides that, in Europe during the 17th century, boots were typically worn. Shoes featured quite tall heels and were frequently embellished with sizable lace and ribbon rosettes. Both men and women in America wore sturdy leather shoes with modest heel. Real or fake gemstones and buckles made of gold and silver were used to adorn shoes during the 18th century.[10] But it wasn't until the 19th century—with the invention of contemporary tools like the sewing machine— that shoes could be produced efficiently and affordably. Shoes were created in a plethora of styles, colours, and designs in the 20th century.[10]

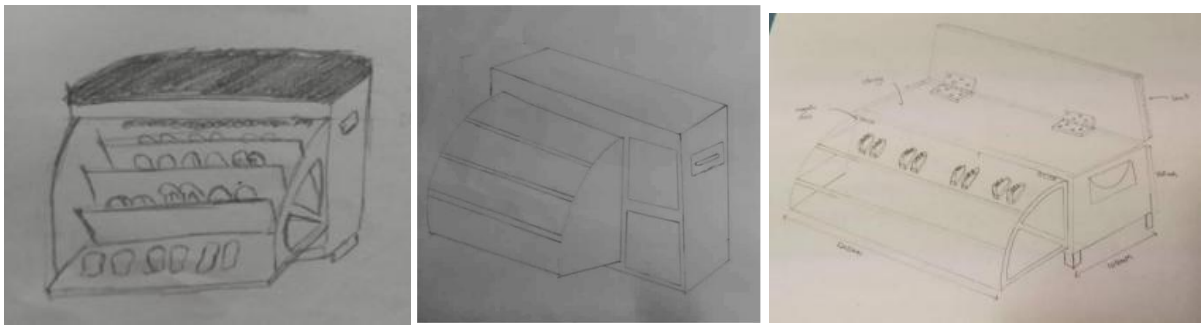
2. Methodology

The methodology is flow of a process needed to achieve the project's objectives. In this case, the methodology of this process is all about improving the current shoe rack by adding flip frames mechanism, a storage area and seat.

2.1 Design

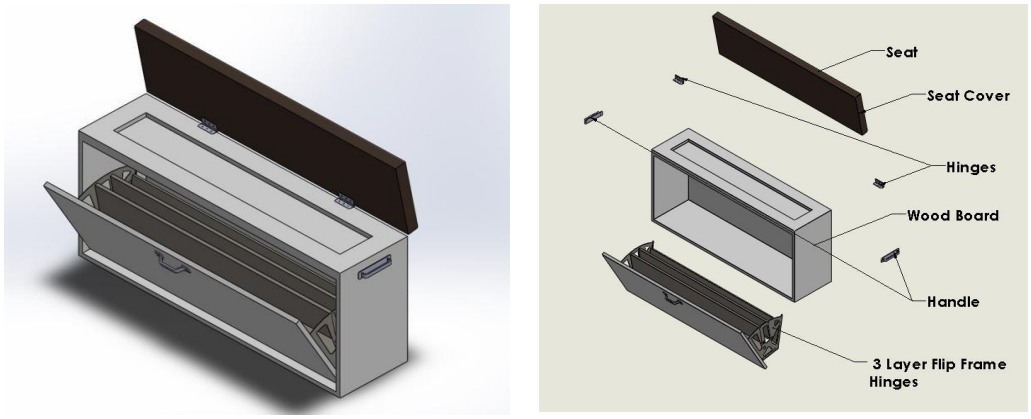
Design start with sketch. Three different sketch was produced in Fig. 2 and the selection was done by comparison between each design according to the advantages and and the convenience to use. Fig. 3(a) shows

the 3D modelling and Fig. 3(b) shows the exploded view of 3D modeling created by using 3D CAD Design Software which is SolidWorks for the final product.



(a) (b) (c)

Fig. 2 *Shows the concept design of shoe rack (a)Design 1; (b) Design 2; (c) Design 3*



(a) **(b)**

Fig. 3 *Modelling and exploded view of Multilevel Shoe Rack (a)3D modelling; (b) Exploded view*

2.2 Materials

The shoe rack has undergone development and design phases. This project's primary methodology is reviewing the literature on the products that are sold online. Every product is assessed and contrasted based on its components, strengths, weaknesses, mechanism, and cost.

Table 1 *List of main components with materials*

No.	Main Components	Materials	Comment
1.	3 Layer Flip Frame Hinges	Stainless Steel	• Resistant to rusting and corrosion.
2.	Wood boards	Chipboard and Medium Density Fiberboard (MDF)	• Smooth surface and affordable • Versatile
3.	Seat cover	Faux Leather	• Has a lower price • Easy to afford • Aesthetic value
4.	Seat	Sponge	• Soft surface • Decrease pressure on hip
5.	Hinges	Steel	• Resistant to rusting and corrosion

From Table 1, the main material in this product is using chipboard because it has a smooth surface and environmentally sustainability. Furthermore, other components use stainless steel because it is resistant to rusting and corrosion. So, these materials are suitable for this product.

2.3 Fabrication

Fig. 4 presents the fabrication process flow of the Multilevel Shoe Rack. These activities involve measuring, cutting, drilling, and screwing.

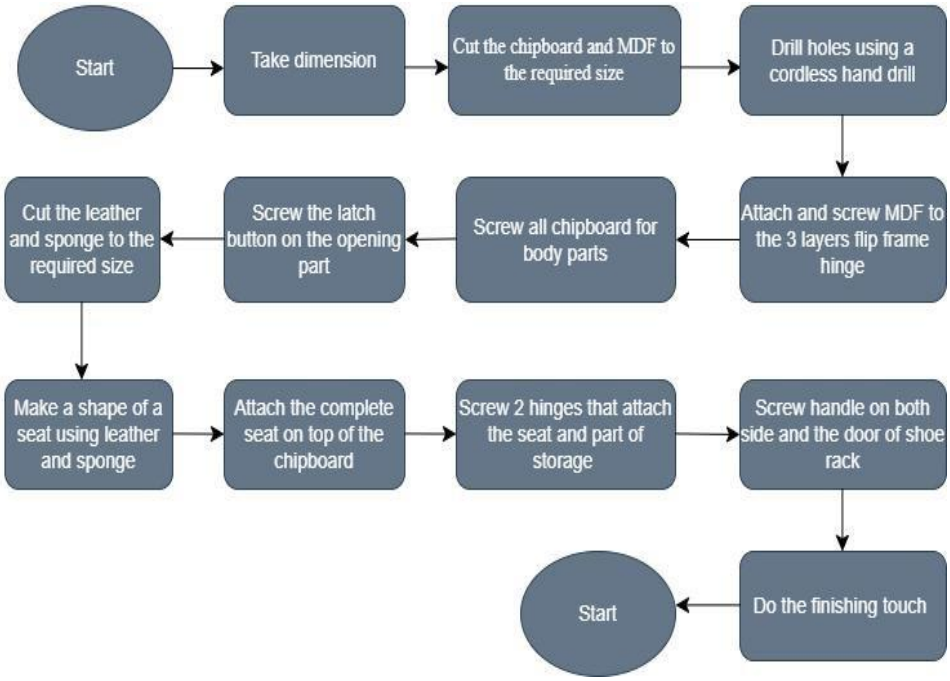


Fig. 4 *Fabrication process of Multilevel Shoe Rack*

3. Result and Discussion

After the fabrication process was completed, the product underwent a test run to evaluate its functionality and ensure it performed according to the intended design.

3.1 Test Run Result

Fig. 5 illustrates the project's outcome, demonstrating the arrangement of various types of shoes as well as the strength test conducted when two adults sat on the shoe rack. Fig. 5(a) shows the storage of 12 pairs of various types of shoes using the three-layer flip frame, with each layer accommodating up to 5 pairs. Additionally, small belongings such as a mobile phone and bracelet can be stored beneath the seat. The Multilevel Shoe Rack is also capable of holding more than 12 pairs, with a maximum capacity of 15 pairs. Fig. 5(b) demonstrates the rack's strength, as it successfully supports the weight of two adults sitting on it. This result confirms that the product meets its objective of functioning both as a shoe organizer and as a sturdy seating bench.

(a) **(b)**

Fig 5 *Test Run for the Multi-Level Shoe Rack (a) 12 pairs of various shoes; (b) 2 adults sit on the shoe rack*

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3.2 Cost Estimation

These are some costs and prices for all the items and components that were involved during this project's innovation.

Table 2 *Cost of Project*

No.	Component	Quantity (unit)	Cost per Unit (RM)	Total Cost (RM)
1.	3 Layers Flip Frame Hinges	1 pair	24.90	24.90
2.	Cabinet Handle with Screw	2 sets	9.80	19.6
3.	Chipboard	1 set	350	350
4.	Medium Density Fiberboard (MDF)	1 set	300	300
5.	70 x 200 cm Leather Patch	1 set	26.99	26.99
6.	1.5 Inch 28, 60 x 60 cm High Density Seat Sponge	2 sets	24.99	49.98
7.	Door Handle MD-4'	1 set	1.79	1.79
8.	Magnetic Door Latch	1 set	2.70	2.70
9.	4" Steel Hinges	2 sets	3.50	7.00
10.	5/8 x 6 Self Tapping Screws	1 pack	2.00	2.00
11.	Self-Tapping Screws	1 pack	2.00	2.00
12.	Self-Tapping Screws	1 pack	2.00	2.00
13.	Brass Plated Screw	1 pack	2.00	2.00
			Total	790.96

Table 2 presents the detailed costs of all components used in the construction of this product, with the total amounting to approximately RM 790.96. The project was designed not only as a shoe rack but also as a multifunctional unit that combines storage and seating. It accommodates up to 12 pairs of shoes, provides a small storage compartment beneath the seat for personal belongings, and offers a sturdy seat for users to sit on while wearing their shoes.

4. Conclusion

In conclusion, this study is successful because it has achieved the desired objectives of identifying a multipurpose shoe rack. A test had been conducted to check the functionality and strength of the shoe rack. The results have been evaluated. The development of the shoe rack involves design stages and fabrication process. The total cost for this shoe rack development is RM 790.96. The shoe is design to be a multipurpose shoe rack that capable to store 12 pairs of various shoes and load of a person. From the results, the shoe rack gets to solve the problems most of consumers having with the previous shoe rack. However, the handle on both sides of shoe rack is screw on the body and not on the frame. Therefore, for future recommendations, the most suitable and have a long-term use must be added for better functionality and improvement.

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Conflict of Interest

The authors declare that there is no conflict of interest regarding the publication of the paper.

Author Contribution

The authors have contributed to this past of the paper as follows: ***study conception and desig****n: Muhammad Aizat Zulkarnain Sabaruddin, Muhammad Aleef Aiman Suhaimi;* ***data collection****: Wan Nuralya Afrina Rosdi;* ***analysis and interpretation of results****: Muhammad Aizat Zulkarnain Sabaruddin, Muhammad Aleef Aiman Suhaimi, Wan Nuralya Afrina Rosdi;* ***draft manuscript preparation****: Muhammad Hanafi Asril Rajo Mantari, Muhammad Aleef Aiman Suhaimi, Wan Nuralya Afrina Rosdi. All authors reviewed the results and approved the final version of the manuscript*

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