TITLE : CHAIR-LADDER : COMBINATION OF A CHAIR AND LADDER

PROJECT SUPERVISOR : ZULKARNAIN B JAMAK

NAME	NO. MATRIX
SAID RAHMAN BIN SAID AGIL	24DKM22F1047
SITI NURAIN HABIBAH BINTI ZULKEFLI	24DKM22F1062
WAN AJMAL DANISH BIN JAMAL	24DKM22F1077
NOR SALWANI BINTI AHMAD FAUZI	24DKM22F1080

DEPARTMENT : MECHANICAL ENGINEERING DEPARTMENT

POLITEKNIK BANTING SELANGOR

SESSION: I 2024/2025

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CHAIR LADDER

This report is being submitted, reviewed and endorsed to fulfill the conditions and requirement of report writing as specified

Checked by:

Supervisor's Signature

Supervisor's Stamp

Date: 5/11/2024

Endorsed by:

Project Coordinator's Signature

Project Coordinator Stamp

Date : 5/11/2024

STATEMENT OF AUTHENTICITY AND PROPRIETARY RIGHTS

CHAIR-LADDER

Made and in truth that is recognized by:

SAID RAHMAN BIN SAID AGIL

IC NUMBER: 041030140911

…….

(SAID RAHMAN)

NOR SALWANI BINTI AHMAD FAUZI

IC NUMBER: 040304101094

…….

(NOR SALWANI)

WAN AJMAL DANISH BIN JAMAL

IC NUMBER:040314-10-0087

…….

(WAN AJMAL DANISH)

SITI NURAIN HABIBAH BINTI ZULKEFLI

IC NUMBER:040409100266

…….

(SITI NURAIN HABIBAH)

In front of

ZULKARNAIN BIN JAMAK

IC NUMBER: 791129015099

As a project supervisor, on the date

ZULKARNAIN BIN JAMAK
PENSYARAH
JABATAN KEJURUTERAAN MEKANIKAL
POLITEKNIK BANTING SELANGOR

…… **……**

(DATE) : 5/11/2024 **(ZULKARNAIN)**

ACKNOWLEDGEMENT

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ABSTRACT

The Chair Ladder is a revolutionary and versatile design that ingeniously combines the dual functionalities of a chair and a ladder, offering an exceptional solution for those looking to save space and streamline their daily activities. This innovative piece of furniture incorporates an advanced automatic system that allows the chair to effortlessly transform into a fully functional ladder with minimal effort, providing the user with a seamless transition between sitting and reaching higher areas without the need for complex manual adjustments. Furthermore, the Chair Ladder is equipped with smooth, durable wheels, which make it easy to move and reposition the chair wherever needed; instead of struggling to lift and carry the chair, users can simply push or roll it to different locations, making it an ideal solution for home, office, or other environments where mobility and convenience are paramount. Designed with durability and strength in mind, the Chair Ladder is built to withstand a weight capacity of up to 100 kg, ensuring that it is not only reliable and sturdy for a wide range of everyday tasks but also capable of providing secure support and stability for users of varying sizes and weights. This thoughtful design is perfect for individuals who seek a practical, space-saving piece of furniture that doesn't compromise on functionality or ease of use.

CHAPTER 1
INTRODUCTION

1.1 INTRODUCTION

It is the intention of the present invention to provide a combination of a chair ladder that is inexpensive to produce, convenient to use as a chair and to use as a ladder to climb to heights above the usual height of a chair seat. It can save money for individuals who have limited budgets. Instead of buying 2 things that can only do 1 thing each. It can help to save space as well. Its architecture is based on the idea that at least two types of appearance and function must be involved in the chair ladder. It should have both an ordinary look and an altered appearance. Thus, by combining the chair and ladder, a Chair Ladder that can transform the ladder solved the dilemma. It's designed based on the concept that the chair ladder must involve at least two forms of appearance and function. A chair design that can be used as a ladder made of hardwood materials able to take all stress and drop test conducted to validate its safety features.

Chair Ladder is basically a chair and a ladder that had been combined into one without changing its purpose of use. The size of the chair ladder must also follow Malaysian adult body standards with height (1.5 m - 1.8 m). Thus, it must be ergonomic to avoid the user uncomfortable while using it and to avoid backpain. Next, this design should also withstand a standard weight for Malaysian adult (<150 kg) [1].

Chair Ladder is designed based on the concept that the chair ladder must involve at least two forms of appearance and function. The design is suitable to place it near the kitchen, as someone is cooking and waiting the food to be cooked. The chair ladder can transform into a ladder when someone want to take something higher above the ground. It can save cost for people who have small budgets. Instead of buying 2 items that each only can do 1 specific things, you can buy one that only has one use.

1.2 BACKGROUND AND PROBLEM STATEMENT

1.2.1 BACKGROUND

Buying two different items chairs and stairs that have a different function each item will only waste money and space. This study was done to help them save money and space by only buying one item with two different functions. Not only can they save money and space they can also save energy because these chair ladder are portable.

1.2.2 PROBLEM STATEMENT

i. Two items with different functions

Two items that have a heavy mass and a large size, which is the ladder and the chair

ii. Space limit

Its takes up a lot of space to store two different items

iii. Limited movement

It is difficult to move two items from one place to another for two different functions

1.3 OBJECTIVES

i. Combination of two items with different functions

To produce product that can eliminate the need to store or move separate chairs and stairs, reducing clutter and discomfort

ii. Save space

To design a combination of chairs and stairs into a multifunctional unit saves space, especially in smaller houses or apartments.

iii. Portable

To develop a chair ladder offers flexibility and convenience for various tasks around the house.

1.4 PROJECT SCOPE

We the primary users are workshop workers who require sturdy and reliable tools for reaching higher spaces and those whose body weight is 100 kg and below as consumers of our product. The load limit that can be accommodated by our products is 100kg and below we put a limit on our products because it is possible that our small products cannot support a load of more than 100kg. We improved the project by adding an actuator to our project to allow our chair to become a ladder automatically, this will make it easier for users to use our project.

1.5 EXPECTED PROJECT RESULTS

The expected result of this project is to help them save energy, space and money, by combining two items with different functions into one item with two functions. We are confident that combining two items with different functions into one can help those who are wise to make decisions in life. We also put actuators on our chairs to ensure our chairs can automatically become stairs to save manpower.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

The purpose of this chair was to convert a chair quickly into a step ladder. It is an excellent useful furniture to have in any place let alone a small place. The idea of innovating a chair into a ladder has been widely circulated since the 17th century. There are many designs that have been developed and they are of great benefit to the users. It is an excellent useful furniture to have in any place let alone a small place. This Chair is very helpful in saving the floor space and avoid unnecessary movement of person in the search of ladder.

2.2 EARLY RESEARCH

Appearing in the Middle Ages, ladder-back chairs had become widespread in England by the 17th century and were in common use in colonial America as well. By the middle of that century, they were also copied by fashionable furniture makers who used walnut instead of sycamore or maple and added elaborate refinements

It is sometimes claimed that these chairs were designed by Benjamin Franklin. Franklin himself preferred to sit in a step chair he designed for his own library. This chair folded in a slightly different way from the common diagonal-side-cut step chair; the seat flips up, resting against the reclined back of the chair, and forming three steps; one formerly hidden under and parallel to the seat, and two attached vertically along the seat's front edge and midline. “Library chair with folding step”. www.benfranklin300.org. The Benjamin Franklin Tercentenary (Exhibition). 1760–1780.

TABLE LITERATURE REVIEW

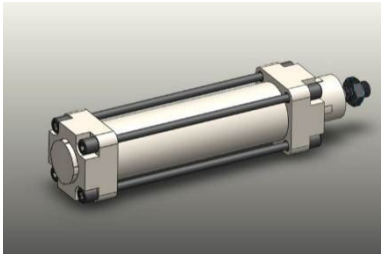
Title	Researcher	Year	Citation
Ergonomics and Accessibility Tools	A. Smith	2022	As noted by Smith in his book on ergonomics and accessibility tools, chair ladders play a significant role in improving mobility for elderly individuals
Lifting and Mobility Aids: A Comprehensive Guide	R. Johnson	2021	Johnson provides a comprehensive guide on various lifting aids, including chair ladders, used in mobility assistance
Design and usability of chair ladders for elderly care	M. Johnson and T. Lee	2023	Johnson and Lee's study demonstrates the design improvements in chair ladders aimed at elderly care
Improving accessibility through portable chair ladders	P. Harris	2022	Harris emphasizes the importance of portability and ease of use in chair ladders to improve accessibility in various settings
Developing safer chair ladders for public spaces	S. White	2021	White's paper discusses new innovations in chair ladder safety for public spaces
The benefits of chair ladders for people	J. Doe	2024	Doe outlines the key benefits of using chair ladders for individuals with mobility

with mobility challenges			challenges on the HealthTech Solutions website
What you need to know about chair ladders	L. Adams	2024	Adams provides a comprehensive overview of the different types of chair ladders and their usage on the Mobility Devices Guide website
Chair Ladder Safety and Operation Manual	XYZ Industries	2023	The chair ladder safety manual by XYZ Industries provides crucial safety instructions for both users and operators
Accessibility Tools for Aging Populations: A Guide to Safe Mobility	U.S. Department of Health and Human Services	2020	According to the U.S. Department of Health and Human Services, chair ladders are essential for improving mobility in aging populations
Chair ladders in senior living facilities: A case study	A. Patel	2024	Patel's report examines the impact of chair ladders in senior living facilities, highlighting their effectiveness in improving daily activities

Table 2.1 : Table of literature review

2.3 COMPONENT IN CHAIR LADDER

i. ACTUATOR



An actuator is a part of a device or machine that helps it to achieve physical movements by converting energy, often electrical, air, or hydraulic, into mechanical force. Simply put, it is the component in any machine that enables movement. actuators are used to ensure that the chair can automatically become a ladder

ii. HINGE

A hinge is a mechanical bearing that connects two solid objects typically allowing only a limited angle of rotation between them. Hinge is used in our project to ensure that our chair can be folded into a ladder.

iii. STAINLESS STEEL

It is known for its ability to resist rust, staining, and corrosion, making it suitable for a wide range of applications, including household appliances, cookware, cutlery, surgical instruments, industrial equipment, and architectural structures. This stainless steel is used as the frame of our chair.

iv. RUBBER WOOD

Rubber wood is a light-coloured medium-density tropical hardwood obtained from the Pará rubber tree (Hevea brasiliensis), usually from trees grown in rubber plantations. Rubber wood is commonly advertised as an "environmentally friendly" wood, as it makes use of plantation trees that have already served a useful function. This wood is placed on each step.

v. WHEELS

These wheels are used on our chairs to facilitate the movement of our chairs. Allows our chairs to move easily with the presence of wheels.These wheels will not move when a ladder or chair is used.

vi. Accumulator battery

A rechargeable battery, storage battery, or secondary cell (formally a type of energy accumulator), is a type of electrical battery which can be charged, discharged into a load, and recharged many times, as opposed to a disposable or primary battery, which is supplied fully charged and discarded after use.

CHAPTER 3
METHODOLOGY

3.1 INTRODUCTION

The flow chart as shown in Figure 2 shows the overall process for the design and development of the chair ladder. The process starting by selecting the topic for the research study and proceed with the preliminary studies which are by reviewing the previous research papers and journals, benchmarking the product in the market and make patent search that are connected to the project. After the preliminary studies, the topic selected and planned a Gantt chart to ease for the further process. After that, the design concept is made based on the material selection, calculation that are required and the simulation of the stress analysis.

3.1.1 FLOWCHART

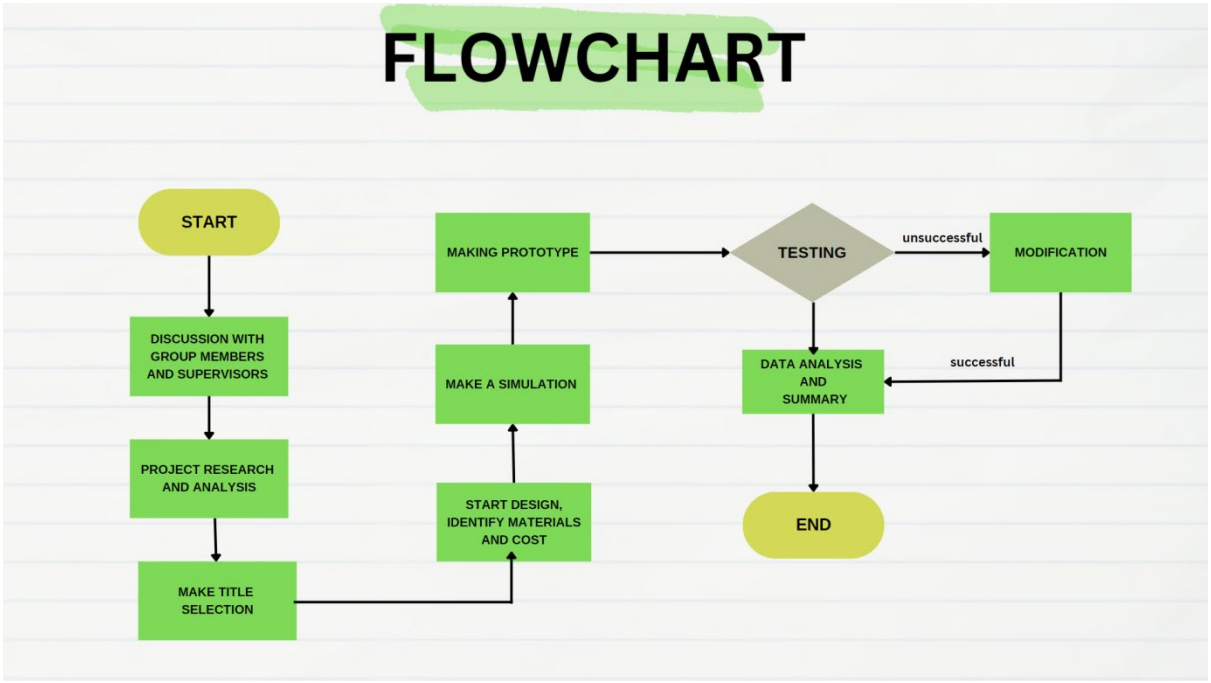


Figure 2: flowchart

3.2 CONCEPT AND DESIGN SELECTION

At the initial stage, there are three proposals for the design of the chair ladder that can be developed 3.2, 3.3 and 3.4 show isometric drawings of the three current designs as chairs and ladder

Figure 3.2 shows the design of a chair ladder that uses rubber wood. The ladder of this chair is small and can save space

Ladder **Chair**

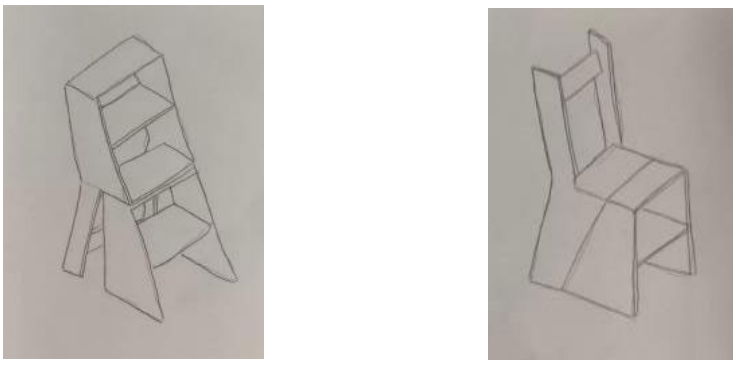
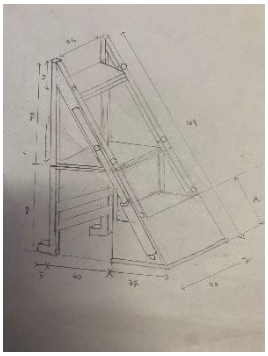


Figure 3.2: Design proposal 1

Design proposal 2 has almost the same height as design 1. But modified by adding an actuator to allow it to open automatically into a laddercase

Ladder **Chair**



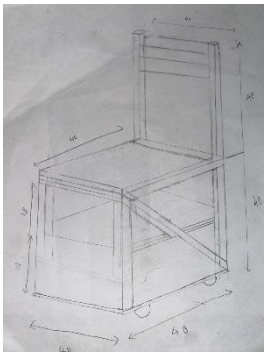
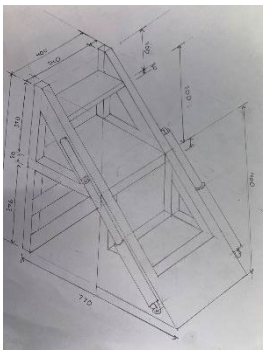


Figure 3.3: Design Proposal 2

Design proposal 3 is an improvement from design 2 by adding one more actuator, making it have two actuators on each side that allows the actuator to help make it easier to fold into a ladder. Using stainless steel and on each step using rubber wood makes it better than design 1 and design 2

Ladder **Chair**



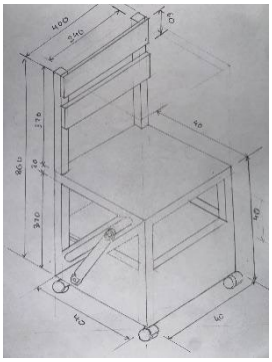


Figure 3.4: Design Proposal 3

Table 3.1 provides a summary of the three designs for comparison purposes

Idea	Features and advantages	Disadvantages
Idea 1	● save space	● hard to move
Idea 2	● save space ● automatic	● using only one actuator

Idea 3	• save space • automatic • portable	• high cost

Table 3.1 summary of the three designs

The best design will be selected based on the matrix evaluation method. There are five criteria that are taken into account to select the best design concept. Table 3.2 shows a comparison of the intended criteria.

NO	Criteria	Idea 1	Idea 2	Idea 3
1	wholeness	5	5	5
2	Automatic	1	3	4
3	Cost of materials	4	3	3
4	Space saving	5	5	5
5	Portable	1	4	4
	TOTALS	**16**	**20**	**21**

Table 3.2: idea comparison criteria

Note: Scale (1) represents very dissatisfied, scale (2) is not satisfied, scale (3) is moderate, scale (4) is satisfied and scale (5) refers to very satisfied.

After making a thorough consideration taking into account the set criteria, design proposal 3 has been selected to be developed

3.3 TECHNICAL DRAWING

i. Assembly

Figure 3.5 show that showing a complete assembly drawing of the final look of our chair ladder

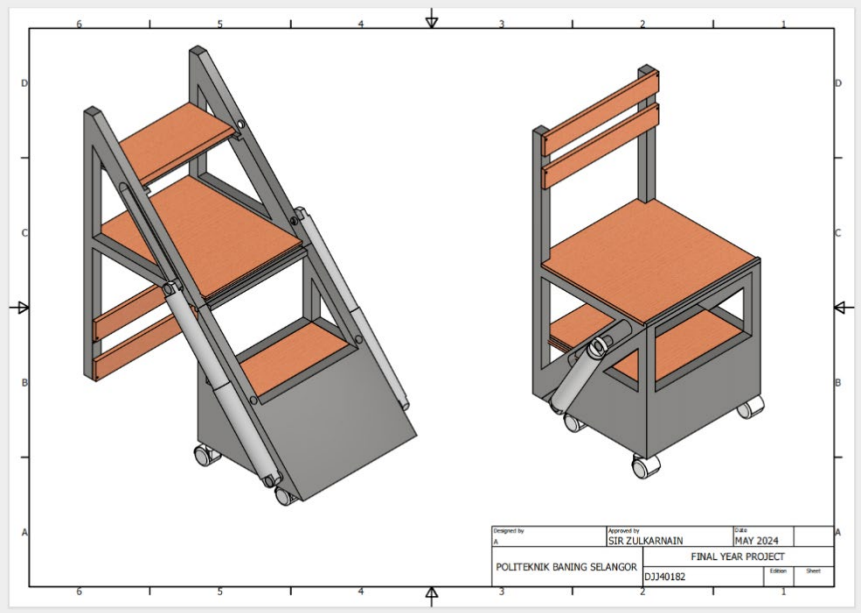


Figure3.5: assembly

ii. Orthographic

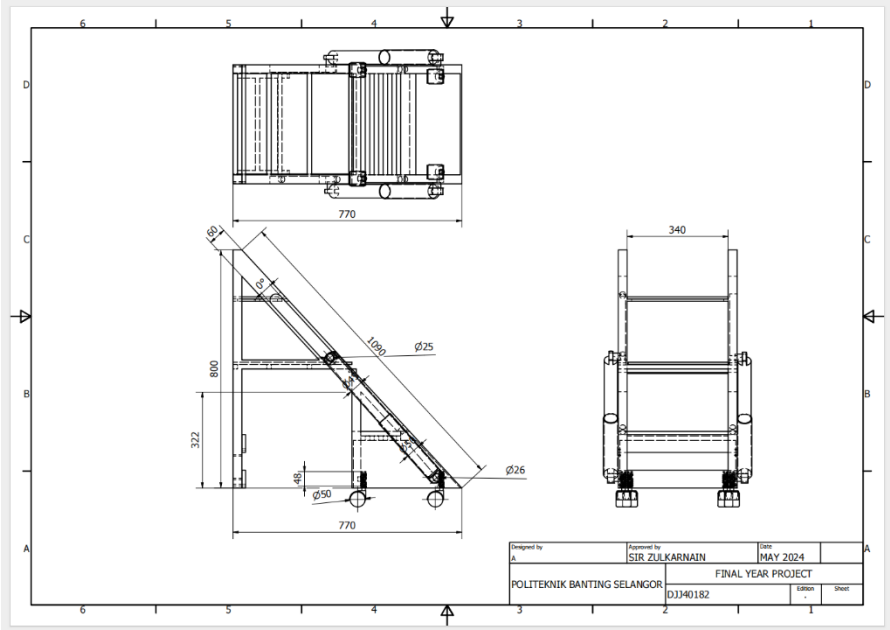


Figure 3.6: orthographic (ladder)

iii. Orthographic

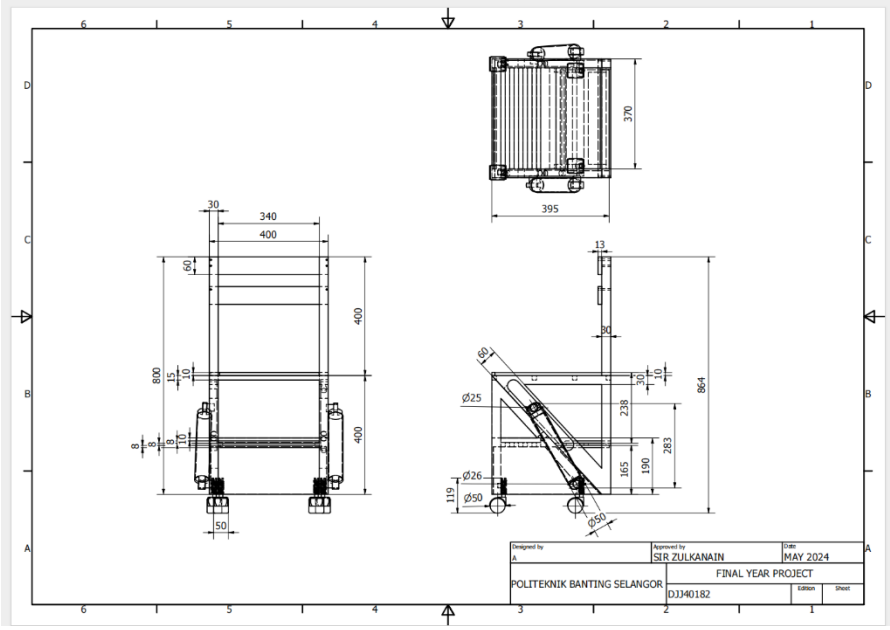


Figure 3.7: orthographic (chair)

iv. Assembly with balloon

Figure 3.8 showing the final assembly drawing along with the bill of material that displays the resolution of each component. Part one is the lower frame of the project using stainless steel. Part two is the upper frame of the project which also uses stainless steel parts three and four are the steps on the top of the stairs, the material used is rubber wood. For parts five and six there is an actuator, which is placed in the lower body for the purpose of turning the chair into a ladder automatically. parts seven and eight are pins to hold the actuator. Part nine is where the seat rests when folded into a ladder it becomes the foot of the ladder

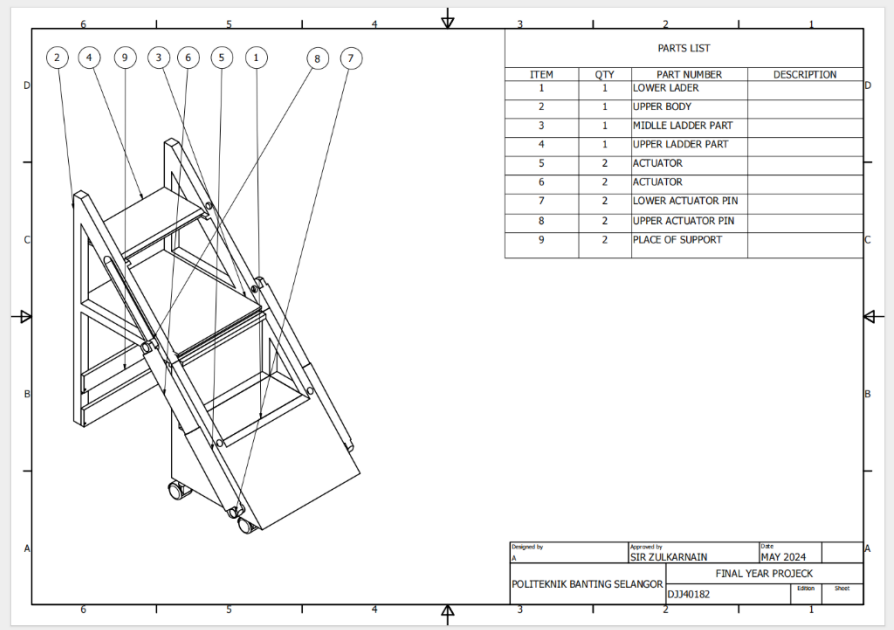
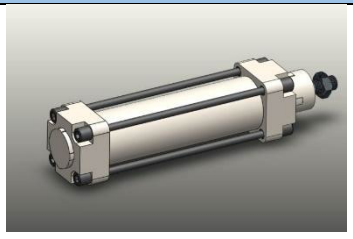


Figure 3.8: assembly with balloon

3.4 WORK MATERIAL

MATERIAL	FUNCTION
 **ACTUATOR**	The actuator is placed on the side of the chair and its function is to lift the upper part of the chair, this enables the chair to change into power automatically

 **HINGE**	By using the hinge on the chair our chair can be folded easily
 **STAINLESS STEEL**	Stainless steel is used as a frame to ensure our staircase has a quality frame
 **RUBBER WOOD**	Rubber wood is used as a staircase allowing the user to step on each staircase
 **WHEEL**	Wheels used to facilitate movement of the chair ladder
 **battery**	Battery is used as power supply for the actuator

3.5 EQUIPMENT USED IN THE PROJECT

MIG WELDING MACHINE

MIG welding machine identify the material needed for constructing the machine, such as metal sheets, tubes, bars and any other components specified in the design. Ensure that the materials are compatible with MIG welding. Proceed with the main welding process once the components are accurately positioned and secured. Appply the MIG welding technique by feeding the wedding wire continuously while maintaining an appropriate welding are length and travel speed (kah et al.,2013). Weld along the joints to create strong and durable connections (kazi et al.2015)

HAND GRINDING MACHINE

Grinding is used to finish workpieces that must show high surface quality (e.g., low surface roughness) and high accuracy of shape and dimension. As the accuracy in dimensions in grinding is of the order of 0.000025 mm, in most applications, it tends to be a finishing operation and removes comparatively little metal, about 0.25 to 0.50 mm depth. However,

there are some roughing applications in which grinding removes high volumes of metal quite rapidly. Thus, grinding is a diverse field.

HAND DRILL

A drill is a tool used for making round holes or driving fasteners. It is fitted with a bit, either a drill or driver chuck. Hand-operated types are dramatically decreasing in popularity and cordless battery-powered ones proliferating due to increased efficiency and ease of use.

3.6 THE COST OF MATERIAL IN THIS PROJECT

Based on surveying material online and going to hardware this are the actual prices for each item according to its quantity

No	Parts	Quantity	Description	Cost
1	Actuator	**1**		RM109.00
2	Hinge	**3**	4inch-1 piece	RM9.00
3	Rubber wood	**1**	(5pcs) 1.0mm*15mm	RM14.00
4	Square hollow Stainless steel	**2**	1/2” x 1/2”	RM30.00
5	Toggle Switch	**1**		RM12.00
6	Wire Copper	**1**		RM2.00

7	Wheel	**2**		RM4.50
8	battery	**1**		RM55.00
9	Screw,bolts and nuts	**1**		RM9.50
10	Coil Sheet	**1**		RM15.00
			TOTAL	**RM260.00**

3.7 GANTT CHART

3.7.2 Gantt Chart Project 1

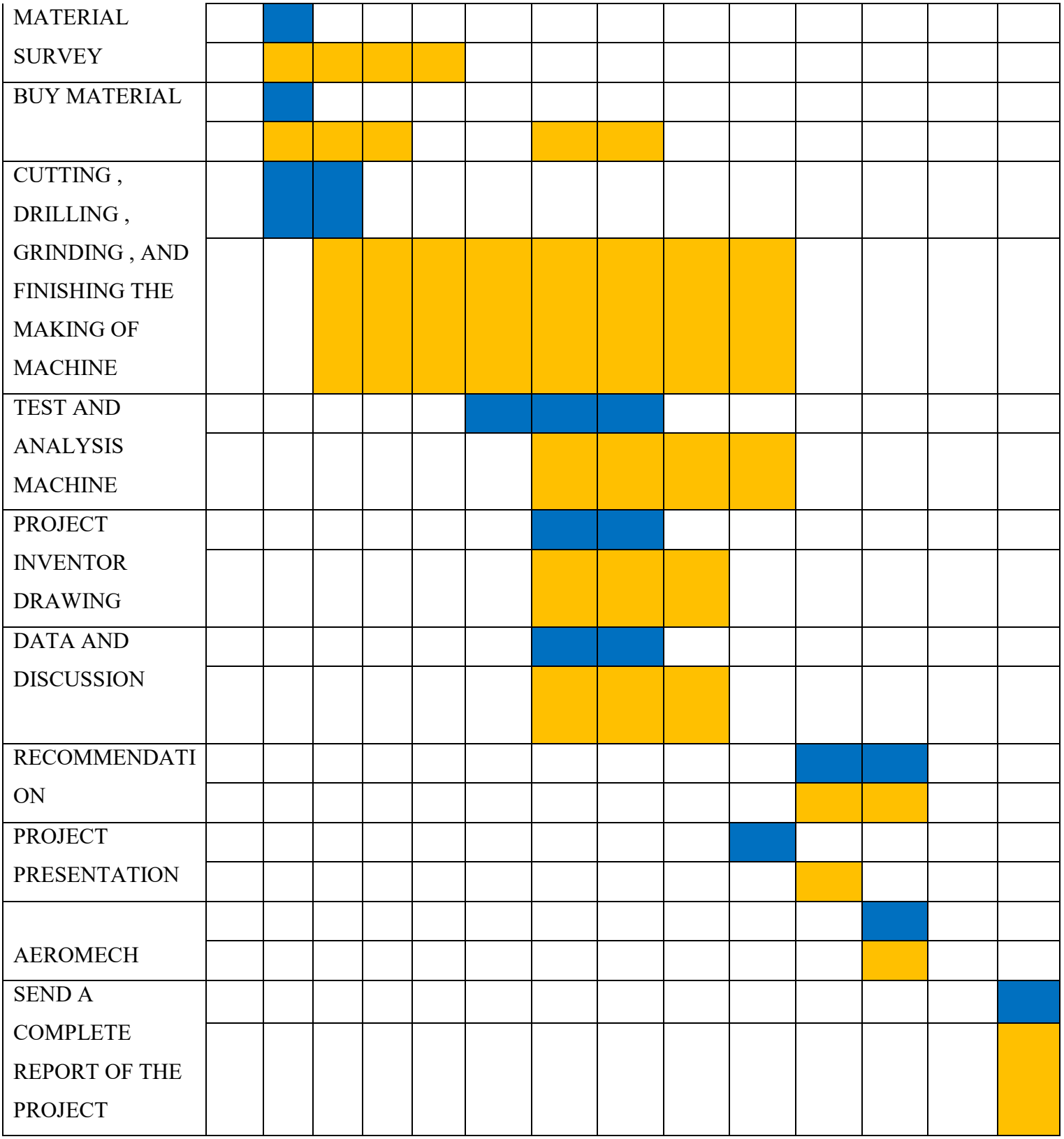
TASK	WEEK													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
GROUP MEMBER & SUPERVISOR SELECTION														
PRESENT TITLE IDEA & TITLE SELECTION														

INTRODUCTION & ABSTRACT														
OBJECTIVE & PROBLEM STATEMENT														
SCOPE PROJECT														
SUMMARY														
LITERATURE REVIEW														
METODOLOGY														
PROJECT DRAWING & DESIGN														
PRESENTATION														
SEND A COMPLETE REPORT OF THE PROJECT														

PLANNING	
PROCEED	

3.7.2 Gantt Chart Project 2

TASK	WEEK													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
DESIGN PROJECT														


MATERIAL SURVEY
BUY MATERIAL
CUTTING , DRILLING , GRINDING , AND FINISHING THE MAKING OF MACHINE
TEST AND ANALYSIS MACHINE
PROJECT INVENTOR DRAWING
DATA AND DISCUSSION
RECOMMENDATION
PROJECT PRESENTATION
AEROMECH
SEND A COMPLETE REPORT OF THE PROJECT

PLANNING	

PROCEED	

3.8 FABRICATION PROGRESS

3.8.1 Prepare tools and materials

Before starting the ladder chair construction process, which combines wood and metal, it is essential to provide the appropriate tools to ensure that the work proceeds efficiently and yields a high-quality result

Tools

- MIG welding machine
- Hand grinding machine
- Tools Kit

- Hand Drill
- Saw table machine

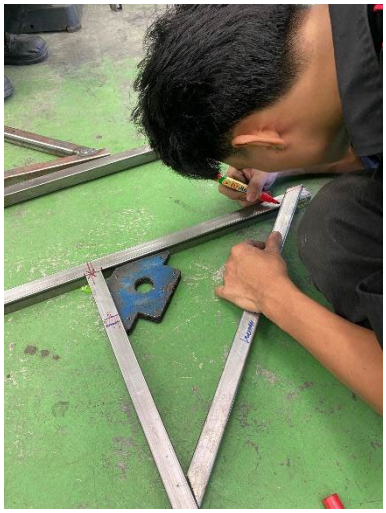
Material

- Actuator
- Hinge
- Rubberwood
- Toggle Switch
- Wire Copper
- Wheel
- Stainless steel
- Screw, bolts and nuts
- Coil Sheet
- Battery

3.8.2 Plan and Measure

- Design the chair ladder: Decide on the height and width.
- Measure the wood: Use measuring tape to mark where will cut. The chair will need:
    - Four legs

- Two side rails (to connect the legs)
- A seat
- Backrest slats
- Ladder steps



3.8.3 Cut the material.

- **Wood-**Cut the wood according to the specified size to make the seat and stairs
- **Steel-**Cut the stainless steel according to the specified size to be used as a chair frame

3.8.4 Assemble the Chair frame

- **Assemble legs**

Attach the legs to the side rails using welding technique. The two shorter legs go at the front, and the longer legs go at the back**.**

- **Attach seat**

Secure the seat on top of the frame, ensuring it's level.

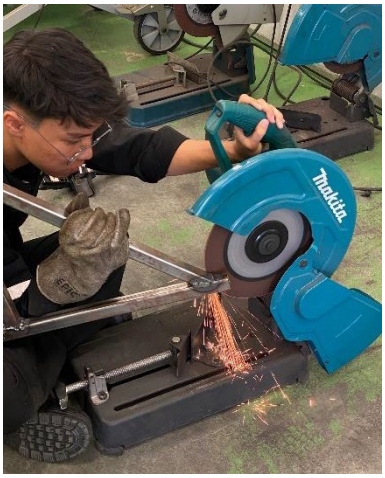
3.8.5 Grinding

- **Metal Grinding**

It smooth rough edges on metal surfaces or weld joints using grinding wheels or discs.

- **Smoothing Concrete**

Grind down uneven concrete surfaces



3.8.6 Assembly of Wood and Metal

- **Attaching Wood to the Metal Frame:**

Once welding is complete and the frame is secure, the wood is attached to the metal frame. Use appropriate screws or bolts to ensure the wood is firmly attached to the frame.

- **Install a designated holder for the battery to keep it neat and organized**

3.8.7 Attach Actuator, Battery and wheels

- Attach the actuator to the frame of the chair ladder to enable automatic movement, ensuring it is securely installed according to the instructions. Then, connect the actuator to the provided battery and ensure the battery is placed securely and is easily accessible for maintenance. Test the connections to ensure the actuator functions smoothly before use.

3.8.8 Final Inspection , Quality Check and Finish

- Quality Check: Ensure that the ladder chair is stable and sturdy. Check that the welding and screwing are secure.
- Function Testing: Test the ladder chair to confirm it functions.
- Finishing: Coat the wood surface with varnish to give it a natural shine and protect it from damage. After that, use metal spray paint on the metal frame to achieve a neater appearance

and enhance durability, providing a polished and aesthetic finishing touch to the overall ladder chair.

CHAPTER 4

DATA AND DISCUSSION

4.1 INTRODUCTION

This chapter presents an in-depth analysis of the data and outcomes derived from the development of the ChairLadder, an innovative automatic chair that seamlessly transforms into a ladder. The primary goal of this project is to design a dual-functioning piece of furniture that

can serve as both a comfortable chair and a practical ladder, providing users with a convenient solution for limited space environments. The specific objectives of this project include: designing a chair that can automatically transform into a ladder, ensuring the mechanism is safe, reliable, and user-friendly, and evaluating its potential impact on improving space utilization and accessibility.

Through the course of this project, various tests were conducted to assess the ChairLadder's performance, including its ease of transformation, stability, and overall user experience. The results of these tests are analysed through both quantitative data (such as transformation speed and load-bearing capacity) and qualitative feedback (from user trials). Additionally, strengths and weaknesses of the ChairLadder design are identified, with particular focus on the durability of the automated mechanism, comfort of the chair, and practicality of the ladder function.

The outcomes of this project show promising results, demonstrating that the ChairLadder effectively meets its objectives. It offers an innovative solution to the challenge of maximizing utility in limited spaces, while also ensuring safety and functionality. The data reveals that the ChairLadder not only provides a reliable seating option but also facilitates quick and easy access to higher spaces, making it a valuable addition to homes, offices, or other environments where versatility and space-saving are essential. Through this discussion, the success of the project will be highlighted, as well as areas for potential improvement and further development.

4.2 PROJECT FINDING

After the project was completed, tests were conducted to test Weight Capacity, battery life and wheel traceability. The first test is a weight capacity test that aims to study the weight data that can be borne during the use of the ladder. The following is a data table to study the weight that can be accommodated.

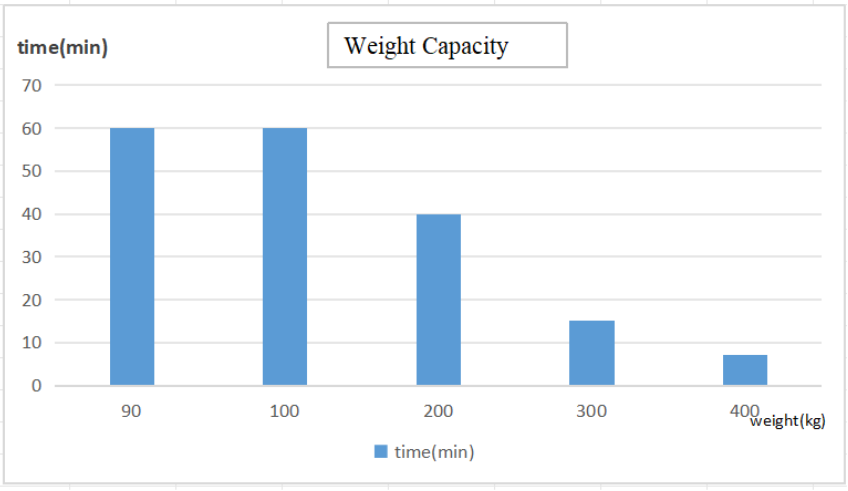
Test Parameter	Test Description	Test Result	Conclusion

Test 1: Static Load (Chair Mode)	Apply a constant weight of 100 kg directly to the chair seat to simulate regular sitting use	100 kg applied for 1 hour, no deformation or instability.	The Chair Ladder maintains stability and comfort under maximum rated load in sitting mode.
Test 2: Dynamic Load (Ladder Mode)	Simulate user stepping onto the ladder and climbing up with a weight of 100 kg. Apply a gradual load to mimic climbing.	User steps onto ladder in increments up to 100 kg. No tipping, slippage, or collapse observed.	The Chair Ladder supports dynamic movement while maintaining stability when used as a ladder.
Test 3: Overload Test	Apply a weight of 110 kg (10% over the rated capacity) to the chair in sitting mode.	110 kg applied for 10 minutes, some slight bending in the frame noticed, but no failure or collapse.	The Chair Ladder can support brief overloads but should not exceed the 100 kg limit for regular use.
Test 4: Safety Stability (Ladder Mode)	User climbs the ladder with 100 kg of weight while performing typical ladder tasks (reaching shelves).	No wobbling or instability observed. Chair Ladder remains firmly positioned while in use.	The Chair Ladder provides a stable ladder experience even under the full weight capacity.

Table 4.1 Weight Capacity Test Data

From the test the Chair Ladder successfully passed all tests, demonstrating that it can safely support its maximum rated weight of 100 kg in both chair and ladder modes. The tests confirm that the Chair Ladder is stable and secure under full load, both statically and dynamically.

weight(kg)	time(min)
90	60
100	60
200	40
300	15
400	7



This graph show that how long a weight can accommodated for 60 min

4.3 DATA ANALYSIS

It is the primary element that yields outcomes from data gathering and serves as the foundation for decision-making. Information from diverse origins is gathered, examined, and subsequently scrutinized to derive insights. Data analysis is conducted to validate the feasibility of achieving goals during project implementation. Numerous forms of data analysis can be undertaken, such as:

The data analysis of off battery life that we use

We have a **12V 7.2Ah** battery, so let's calculate its total energy capacity:

Battery capacity (wh) = Battery voltage (v) x Battery Capacity (Ah) = 12v x 7.2Ah = 86.4Wh

Total runtime = Power Consumption (W) ÷ Battery Capacity (Wh) = 24W ÷ 86.4Wh = 3.6hours

So, the battery will last for 3.6 hours of continuous operation

Test Parameter	Value	Explanation/Calculation

Battery Voltage	12V	Voltage of the battery powering the actuator.
Battery Capacity	7.2Ah	Capacity of the battery (7.2 ampere-hours).
Actuator Force	150N	Maximum force the actuator can exert to transform the Chair Ladder.
Cycle Time (Full Transformation)	3second	Weight the actuator is lifting (does not affect power consumption in this case).
Power Consumption of Actuator	24w	Estimated power consumption of the actuator.
Total Battery Capacity	86.4Wh	Calculated from 12V × 7.2Ah battery
Total Runtime of Battery	3.6 hours (216 minutes)	Total time the actuator can run before the battery is depleted

Table 4.2 Final Data Table

4.4 SECURITY RISKS

Every product design must meet safety specifications either during its development or operation to ensure the well-being of users. Table 4.3 provides a comprehensive overview of the safety risks associated with operating the Chair ladder, emphasizing the importance of addressing potential hazards and implementing appropriate safety measures throughout the design and operation phases.

No	Risk	Preventative Measurement
1	Risk slippery ladder treads can cause injury	adding anti-slip foot pads to each step
2	the switch button may be pressed while the user is climbing the ladder, this results in the user falling when using the ladder	adding a cover for the switch to prevent the switch from being touched or pressed when using the ladder
3	placing the wheel on the wrong side may result in danger during certain uses	the wheels are placed on the lower corner of the chair, and are only used if the chair is slightly tilted, and when using the ladder the wheels are on the top and do not interfere with the use of the ladder

Table 4.3 : risk

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 CONCLUSION

In conclusion, the Chair Ladder project successfully integrates the key principles of mechanical engineering that I have learned throughout the semester, including design optimization, material selection, load analysis, and human-centered design. The automatic transformation system that allows the chair to convert seamlessly into a ladder reflects the application of mechanical linkages and mechanisms. The weight capacity of up to 100 kg, coupled with the need for structural stability, required careful consideration of material properties and stress analysis, concepts that were covered in our courses on materials science and mechanics of materials. Additionally, the mobility feature of the Chair Ladder, achieved through smooth wheels, mirrors the principles of motion, friction, and the importance of designing for ease of use, which we explored in our study of mechanics and machine design.

The space-saving design emphasizes the importance of compact and efficient engineering solutions, an essential skill for mechanical engineers tasked with optimizing both functionality and space. Throughout this project, We was able to apply the knowledge We gained in areas such as CAD modelling, prototyping, and testing skills developed in our lab work and design projects. Ultimately, the Chair Ladder project provided a practical example of how engineering principles can be combined to create a product that meets real-world needs, demonstrating the importance of interdisciplinary thinking and the ability to solve complex design challenges lessons that we have developed throughout this semester as a mechanical engineering student.

5.2 RECOMMENDATION

Here are suggested improvements for Chair ladder if a similar product is developed in time front:

No	Recommendation	Reason
1.	Choose lightweight, durable materials like aluminium or high-strength composites, while balancing affordability in production	The materials used will directly impact the product's performance, durability, and cost. Lightweight materials are crucial for ensuring the Chair Ladder is easy to move, while durability ensures it can support the weight capacity without wear over time. Striking the right balance between performance and cost will allow the Chair Ladder to be both affordable and high-quality, making it accessible to a broader consumer base and ensuring long-term reliability.
2.	Design the Chair Ladder with modular components for easy repair and maintenance.	Over time, furniture experiences wear and tear. Modular components make it easier for users to replace or repair individual parts, extending the product's lifespan and improving customer satisfaction. This also makes the Chair Ladder more cost-effective for consumers in the long term, as they will be able to replace damaged parts rather than discard the entire product. Additionally, it could reduce waste, contributing to sustainability efforts
3.	Design an adjustable version of the Chair Ladder, allowing users to customize the ladder height or chair backrest position.	While the basic Chair Ladder model is functional for a wide range of users, adding adjustable features such as an extendable ladder or a reclining chair backrest would provide more versatility and cater to a broader customer base. Adjustable height ladders would be ideal for users who need different reach levels depending on the task, while an adjustable chair backrest could enhance comfort for those who plan to use the chair for longer periods. This flexibility would allow the Chair Ladder to serve in a wider variety of spaces and tasks, increasing its appeal and utility.
4.	Incorporate an integrated storage compartment or shelving in the Chair Ladder for storing	Adding a small, practical storage compartment or shelf within the Chair Ladder design could increase its appeal, particularly in home or office environments where space is at a premium. This additional feature would allow users to store tools, cleaning supplies, or office essentials within the furniture itself, enhancing the product's overall utility. This feature

	small items (e.g., tools, office supplies).	could help differentiate the Chair Ladder from competitors, making it even more valuable as a multifunctional piece of furniture that not only serves as seating and a ladder but also offers convenient storage.

REFERENCE

- A. Smith, Ergonomics and Accessibility Tools, 3rd ed., New York, NY, USA: Academic Press, 2022.

- R. Johnson, Lifting and Mobility Aids: A Comprehensive Guide, 1st ed., London, UK: HealthTech Publishing, 2021.
- M. Johnson and T. Lee, "Design and usability of chair ladders for elderly care," Journal of Assistive Technology, vol. 20, no. 4, pp. 45-56, Apr. 2023.
- P. Harris, "Improving accessibility through portable chair ladders," Journal of Ergonomics Research, vol. 28, no. 2, pp. 134-139, Feb. 2022.
- S. White, "Developing safer chair ladders for public spaces," in Proc. Int. Conf. on Safety and Mobility Aids, Berlin, Germany, 2021, pp. 101-105.
- J. Doe, "The benefits of chair ladders for people with mobility challenges," HealthTech Solutions. [Online]. Available: https://www.healthtechsolutions.com/chair-ladders. [Accessed: Nov. 7, 2024].
- L. Adams, "What you need to know about chair ladders," Mobility Devices Guide. [Online]. Available: https://www.mobilitydevices.com/guide-to-chair-ladders. [Accessed: Oct. 15, 2024].
- XYZ Industries, Chair Ladder Safety and Operation Manual, 2nd ed., San Francisco, CA, USA: XYZ Industries, 2023.
- U.S. Department of Health and Human Services, Accessibility Tools for Aging Populations: A Guide to Safe Mobility, Washington, D.C., USA: U.S. Gov. Printing Office, 2020.
- A. Patel, "Chair ladders in senior living facilities: A case study," Senior Living Innovations Report, no. 15, pp. 78-82, Oct. 2024.
- https://sites.google.com/view/projek-jkm-pbs/utama?authuser=0
- https://online.anyflip.com/lsexs/guux/mobile/index.html

APPENDIX

The effectiveness of chair ladder among workshop workers

Multifunctional chair ladder, a space-saving solution that merges comfort and convenience. This innovative product transforms from a sturdy ladder to a comfortable chair, perfect for those everyday tasks that require a little extra height. No more digging out a bulky ladder or straining on a tippy stool – the multifunctional chair ladder offers a safe and practical solution for all your low-reach needs.

NAME *

Short-answer text

DEPARTMENT *

- DKM
- DAM
- DTP
- Other...

What is the effectiveness of Chair Ladder among workshop workers ? *

Short-answer text

GENDER *

- FEMALE
- MALE

What is the recommendation to improve this product? *

Long-answer text

Have you used Chair Ladder before? *

- Yes
- No

Are you comfortable with our product design? *

- Yes
- No

Does your current chair Ladder have wheels for easy movement? *

- Yes
- No

Do you feel the Chair Ladder is durable and long-lasting? *

- Yes
- No

Is an automatic Chair Ladder more efficient than manual one? *

- Yes
- No

Have you heard about chair ladder before? *

- Yes
- No

Are you comfortable with our materials? *
1.Wood
2.Stainless steel

- Yes
- No

Have you experienced any issues related to the safety of the chair ladder? *

- Yes
- No

Do you think the chair Ladder is easy to be used without any assistance? *

- Yes
- No

Do you find it useful to have both chair and ledder combined in one product? *

- Yes
- No

What kind of improvement you would suggest to the 'chair ladder' more effective? *

- [ ] Add a storage system under the seat
- [ ] Add armrests for extra support.
- [ ] Can be folded
- [ ] Ergonomic Design

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by siti nurain habibah

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2.3	**COMPONENT IN CHAIR LADDER**
3.2	**CONCEPT AND DESIGN SELECTION**
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