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KEMENTERIAN PENDIDIKAN TINGGI
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POLITEKNIK MALAYSIA

SMART MINI CLOSET

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DEPARTMENT : MECHANICAL ENGINEERING DEPARTMENT

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SESSION: I 2024/2025

"This report is submitted to the Department of Mechanical Engineering to fulfill the requirements for the award of a Diploma in Mechanical Engineering."

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CONFIRMATION OF THE PROJECT

Project report title "**SMART MINI CLOSET"**

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APPRECIATION

We, the members of Smart Mini Closet, would like to extend our deepest gratitude to everyone who contributed to this project. This journey has been one of collaboration, learning and mutual support culminating in this project.

First and fore most thanks to the Almighty because with all the bounty and his grace that has been given whole this project can be implemented successfully as we planned before and meet the requirements of the Course DJJ 40182 and DJJ50193. We would like to express our big thanks especially to our supervisor of our project Sir Mohd Azizee Bin Sukor who have cooperated and guidance in completing this project report. Without him we would not be able to complete this project successfully. His enthusiasm, patience, insightful remarks, valuable information and idea have greatly aided us during our project. I also sincerely thank for the time he spent proofreading and correcting our many mistakes for our report and presentation slide. We are very grateful for his willingness to sharing information and help us to do this report. I would also like to acknowledge with much appreciation for our presentation panel Sir Mohd Nasiruddin Bin Hushim, Sir Shaiful Amri Bin Khudzari and Sir Zulkarnain Bin Jamak for giving suggestions to improve our product for our project. Their word of encouragement made us more enthusiastic to carry out this project. Not forget to give a big thanks for all group members that play their role for giving idea and suggestion. The teamwork spirit shown by all has helped to completed this project successfully. All the time that we have been sacrificed, all the efforts that we have been contributed finally paid off.

Ones again we take this opportunity to give infinite love and thanks for the cooperation from all parties involved throughout the process of completing this project until its complete.

ABSTRAK

Almari merupakan salah satu perabot yang hampir setiap kediaman memilikinya,antaranya ialah asrama ataupun kolej kediaman . Almari mempunyai ruang yang berfungsi sebagai tempat untuk menyimpan baju, kasut, barang-barangan berharga dan sebagainya. Terdapat pelbagai jenis almari yang berada dipasaran dan mempunyai pelbagai reka bentuk tersendiri. Namun terdapat beberapa kekurangan pada almari yang sudah sedia ada di asrama dan juga kolej-kolej kediaman. Antara kekurangan yang terdapat pada almari di kolej kediaman adalah tiada ciri keselamatan pada almari . Ini mengakibatkan bertambahnya kes kehilangan dan kecurian barang-barang pribadi di asrama dan kolej kediaman. Selain itu untuk mengunci almari ini memerlukan kunci mangga yang dibeli sendiri . Smart Mini Closet adalah projek inovasi yang bertujuan untuk menambah baik almari yang beradada di kolej dan asrama dengan memperkukuhkan lagi ciri keselamatan pada almari dan pada masa yang sama untuk mengurangkan kes kecurian yang terjadi di asrama. Bahan utama yang diggunakan untuk membangunkan *Smart Mini Closet* ini adalah plat aluminium tahan karat untuk dijadikan sebagai rangka almari, pengimbas cap jari, penggerak hidraulik dan juga sensor. Pengujian operasi yang dibincangkan membuktikan almari ini dapat memudahkan pelajar dalam masa yang sama keselamatan barang-barang dapat dijamin. Ini kerana *Smart Mini Closet* ini menggunakan pengimbas cap jari sebagai ciri keselamatan dan hanya dapat dibuka oleh pelajar tersebut sahaja. Pelajar tidak perlu bimbang jika terlupa untuk menutup almari .Ini kerana almari ini mempunyi gabungan sensor dan juga penggerak hidraulik yang dapat membuka dan menutup pintu secara automatik . Almari ini akan tertutup dengan automatik jika mengesan tiada orang yang berada dihadapanya.Dapatan ini membuktikan Smart Mini Closet ini dapat mengurangkan kadar kes kecurian yang berlaku dan juga dapat memudahkan pelajar berbanding dengan almari sedia ada .

Kata kunci: *Smart Mini Closet*, projek inovasi

ABSTRACT

A wardrobe is one of the pieces of furniture that almost every home has, including dormitories or residential colleges. The wardrobe has a space that functions as a place to store clothes, shoes, valuables and so on. There are many types of wardrobes on the market and they have different designs. However, there are some shortcomings in the closets that are already in the dormitories and also residential colleges. Among the shortcomings found in the closet in the residential college is that there is no safety feature on the closet. This has led to an increase in the loss and theft of personal belongings in hostels and residential colleges. In addition, to lock this closet, you need a key that you bought yourself. Smart Mini Closet is an innovation project that aims to improve the closets in colleges and dormitories by strengthening the security features on the closets and at the same time to reduce thefts that occur in the dormitories. The main material used to develop this Smart Mini Closet is a stainless aluminum plate to be used as a wardrobe frame, a fingerprint scanner, a hydraulic actuator and also a sensor. The operational testing discussed proves that this cupboard can make it easier for students at the same time the safety of the items can be guaranteed. This is because this Smart Mini Closet uses a fingerprint scanner as a security feature and can only be opened by the student. Students don't have to worry if they forget to close the cupboard. This is because this cupboard combines a sensor and also a hydraulic actuator that can open and close the door automatically. This closet will close automatically if it detects that no one is in front of it. This finding proves that this Smart Mini Closet can reduce the rate of theft cases and also make it easier for students compared to existing closets.

Keywords: Smart Mini Closet, innovation project

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CHAPTER 1: INTRODUCTION

1.1 Introduction

Overall crime rate is calculated by dividing the total number of reported crimes of any kind by the total population, then multiplying the result by 100,000 (because crime rate is typically reported as X number of crimes per 100,000 people). Crime rates vary greatly from country to country and are influenced by many factors. For example, high poverty levels and unemployment tend to inflate a country's crime rate(Hooghe et al., 2011). Conversely, strict police enforcement and severe sentences tend to reduce crime rates. There is also a strong correlation between age and crime, with most crimes, especially violent crimes, being committed by those ages 20-30 years old.(Crime Rate by Country 2024, 2024.)

The overall crime rate in the United States is 47.70(Lachlan Montgomery, 2012.). The violent crime rate in the United States has decreased sharply over the past 25 years. Crimes rates vary significantly between the states, with states with such as Alaska, New Mexico, and Tennessee experiencing much higher crime rates than states such as Maine, New Hampshire, and Vermont(Harries, 1971). Some of the world's lowest crime rates are seen in Switzerland, Denmark, Norway, Japan, and New Zealand. Each of these countries has very effective law enforcement, and Denmark, Norway, and Japan have some of the most restrictive gun laws in the world. Figure 1.1 show countries with highest crime rate:

Country	Crime Index (Numbeo)
Venezuela	82.1
Papua New Guinea	80.4
Afghanistan	78.4
Haiti	78.3
South Africa	75.5
Honduras	74.3
Trinidad and Tobago	70.8
Syria	69.1
Guyana	68.8
Peru	67.5

Figure 1.1: Countries with Highest Crime Rate

Property crimes such as burglary, vehicle theft, looting and other thefts. In 2021, vehicle theft recorded the highest decrease of 37.8 percent to 13,342 cases compared to 21,579 cases in 2020, followed by burglary & theft (19.1%) and other theft (0.2%).(Statistic of Crime Index in Malaysia - Penelurusan Google, 2011).

1.2 Background and Problem Statement

1.2.1 Background

Most of the closets in the dorms or at home do not have their own locks. Therefore, personal items stored in the closet are easily lost or stolen due to negligence. By improving security features, people no longer have to fear the loss or theft of personal items.

1.2.2 Problem Statement

The current theft cases that occur around Malaysia cause people feel insecure about their environment until causing them to feel wary of the people around them(Arifianto, 2009). In addition, the problem of theft that often occurs in dormitories or at home when the closet are not closed tightly causes most items to be lost or stolen(Popkin, 2000). In addition, the problem is due to the closet not being locked and the materials used against the closet is not good(Brown, 2005). As a result, it can cause the closet to be easily broken into by foreigners because the materials used are not good. The loss of important items causes the owner to feel insecure to the people around.

1.3 The objective of this project is:

In Malaysia, addressing theft cases requires a multifaceted approach. The safety closet should be adaptable to the specific needs and risks of its environment. For example, a safety closet in a home may have valuable item such as money , laptop , or self-medication. Firstly , knowing the safety features utilized on closets can significantly contribute to theft prevention efforts. Moreover, to curb theft cases and provide enhanced security to the community, there's a pressing need for innovative solutions. Fabricating a safety closet involves several key steps to ensure it meets the needs of its intended environment and complies with safety regulations. Firstly, determining the purpose and scope of the safety closet is essential. This includes identifying the types of emergencies it will address and the specific supplies needed. Next, designing the layout and structure of the safety closet is crucial. Considerations such as size, shelving, compartments, and accessibility should be taken into account to optimize storage space and ease of use. The closet should be located in a convenient yet secure area, easily accessible to occupants in case of emergencies. This closet use the high quality material such

as high carbon steel for the entire body. Besides that, adding a fingerprint for the main security system will increase the safety features of the closet. Some people may be more careless that forget to close the closet door and this will give the theft the opportunity to steeling. We adding the movement sensor that connected to the actuator for make sure the closet door close tightly by automatically. So the user will not have to worry about forget to close the closet door because of this smart feature that have been installed will keep the item in safety care.

1.4 The scope for this project is:

The closet's dimensions are constrained to 135cm x 80cm x 60cm, scaled at 1:2 from the original size. Despite its compact size, it incorporates advanced security features such as a fingerprint scanner for accessing the closet door, ensuring only authorized individuals can gain entry. Additionally, the closet boasts a sensor mechanism for automatic door opening and closing, enhancing convenience and further fortifying security measures. These innovative features not only optimize space utilization but also prioritize user safety and convenience, making the closet an ideal solution for modern living spaces.

1.5 Expected project results

At the end of this study it is hoped to be able to produce a closet that has fingerprint scanner controls to open and sensors to open and close the closet door automatically. The user of our product will not be worry about missing item.

CHAPTER 2: LITERATURE REVIEWS

2.1 Introduction

In today's era, there are various designs of security closets that have been improved but still robberies happen because they are easily accessible and directly can be opened easily(Stimmel, 2015). This chapter will use the types of closet security that have been developed before including operating mechanisms, design and manufacturing costs. As shown in Table 2.1 and Table 2.2 comparison table below:

 1	 2	 3

Table 2.1: Types of Closet

Type Of Closet	Closet Size	Material	Advantage	Disadvantage	Price
1	185x90x45cm	Metal	Fingerprint	Less of compartment	**RM249**
2	185x90x45cm	Steel	Many compartment	Low safety feature	**RM289**
3	45x40x60cm	Metal	Fingerprint and Alarm	Small compartment	**RM367**

Table 2.2: Comparison table

2.2 Components in the closet

The main components that are going to be discuss in the closet are:

a) Safety lock
b) The material
c) The compartment
d) Alarm sensor
e) Fingerprint device

Safety Lock

Having a safety lock on a closet is essential, especially if it contains valuable items or potentially dangerous objects like firearms or chemicals. A sturdy lock can prevent unauthorized access, keeping belongings secure and out of reach from children or intruders. Additionally, it provides peace of mind knowing that sensitive or confidential items are safely stored away(Yannakakis, 1982). Figure 2.2.1 show example of safety lock:

Figure 2.2.1

The Material

The material of a closet greatly affects its durability, aesthetics, and functionality. Common materials include wood, metal, plastic, and composite materials. Each material has its advantages and drawbacks. For instance, wood offers a classic, elegant look but may be susceptible to warping or damage from moisture(Reinprecht, 2016). Metal closets are sturdy and resistant to wear and tear but can be prone to rust if not properly maintained(Shah Ali et al., 2012). Plastic closets are lightweight and easy to clean but may lack the durability of other

materials(Brydson, 1999). Choosing the right material depends on factors such as budget, design preference, and intended use(Johnston et al., 2017). Figure 2.2.2 show example of material that a use to making closet:

Figure 2.2.2

The Compartment

Incorporating compartments within a closet enhances organization and maximizes storage space(Essential Storage Spaces for Your Home, 2019.). Dividers, shelves, drawers, and hanging rods are common compartmentalization options. They allow for categorizing items based on size, type, or frequency of use, making it easier to locate items and maintain orderliness. Compartmentalization also helps prevent clutter and optimize the available space within the closet, promoting efficiency and convenience(Miller et al., 2014). Figure 2.2.3 show example of compartment in closet:

Figure 2.2.3

Alarm Sensor

Installing an alarm sensor in a closet adds an extra layer of security, particularly in situations where valuable or sensitive items are stored. These sensors can detect unauthorized entry or tampering, triggering an alarm system to alert homeowners or security personnel(Sayem et al., 2023). Alarm sensors come in various types, including motion sensors, door/window sensors, and vibration sensors(Hill et al., 2004). Integrating such technology not only deters potential burglars but also provides peace of mind, especially when away from home for extended periods. However, false alarms should be minimized through proper calibration and placement of the sensors. Figure 2.2.4 show example of alarm sensor:

Figure 2.2.4

Fingerprint device

Basically, fingerprint locks operate by scanning and converting your fingerprint data into a numerical template(Song et al., 2007). Once you place your finger onto the scanner for the first time the conversion into numerical data takes place, and the fingerprint template is saved(Zhang et al., 2012). This process is then repeated every time you want to grant someone access. The next time someone places his/her finger on the sensor, it matches the data obtained through the finger with the pre-saved values(Rajput et al., n.d.). If a match is found, access is granted and the door opens. On the other hand, if its someone else trying to get through, access is not allowed and the door remains locked. Figure 2.2.5 show example of fingerprint sensor:

Figure 2.2.5

2.3 Concept selection

The selection of this design was made based on the specifications of Smart Mini Closet and existing closet design. This design also takes into account the initial features that have been set, namely:

1. Manufacturing cost

2. Safety features

3. Manufacturing and installation procedures

4. Ability and success

5. Ideas and principles of work.

Once all the requirements have been met, the most suitable idea for the design of the Smart Mini Closet has been selected. Specifications determine the rating, which will meet the needs of the user.

2.4 Design selection

The design that has been selected must meet the information requirements the use of materials and how to build them carefully to produce a product can affect consumers. The design made should be competitive with the product available on the market and does not mark the environment or have the ability to give benefit to private and corporate users. AK Hosking MP Harris (1981) explains the design. is an action that uses engineering, mathematics, graphics and scientific principles in an effort to create research that may lead to supervising and contributing to technical requests.

2.4.1 Design method

According to G Ullman (1992) the design process is divided into four (4) parts as follows:

i. Identify the problem that needs to be solved

ii. Understand the problem

iii. Make appropriate recommendations to solve problems concerned

iv. Choose a good proposal While RD. Cullum (1991) states that there are seven (7) steps that need to be emphasized in each design before a creation :

i. Identify existing problems

ii. Forming a study of existing problems and translation in the form that easy to understand

iii. According to the existing problem

iv. Analyse the design in order to meet the requirements to implement it

v. Selection and evaluation

vi. Implement the selected solution

2.4.2 Design concept

The design of this Smart Mini Closet is produced using materials from aluminium plate because it is compatible with the design in terms of its use, safety, cost, facilities, equipment, machines to help in building the design and also user requests.

A design needs to go through a process of analysis, study and imagination about how to realize the project to be built. In addition to the literature review and the field is done to get thoughtful feedback from friends as well as the working conditions of the environment about matters related to the design suitable before the construction process is carried out.

CHAPTER 3: METHODOLOGY

3.1 Introduction

The design, fabrication, installation and testing processes of product are conducted at welding workshop involving process of cutting, welding and drilling. The process started with finding the problem statement of the existing product. After that the best design will be chosen only can proceeds to selection of materials. The fabrication process comprises of cutting parts for the smart mini closet and welding the parts needed. After cutting the parts of the smart mini closet and welding is assembled according to the specification. Finishing is added accordingly. The finished prototype is then tested and adjustments and administered as needed. Only then the end product is deemed suitable to use. Figure 3.1. shows the flowchart for the methodology:

3.1.1 Flowchart

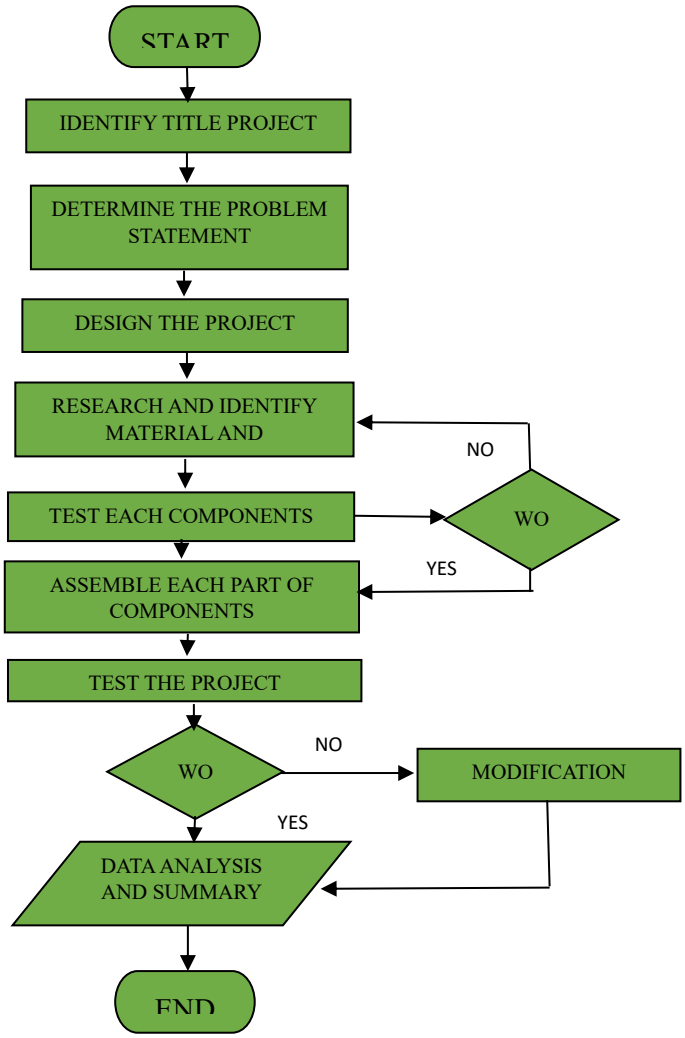


Figure 3.1.

3.1.2 Gantt chart

Table 3.1: Gantt Chart Project 1

WEEK/PROJECT ACTIVITY	W 1	W 2	W 3	W 4	W 5	W 6	W 7	W 8	W 9	W 10	W 11	W 12	W 13	W 14
SUPERVISIOR SELECTION														
PRODUCT INTRODUCTION														
GROUP DISCUSSION AND TITLE SELECTION														
MEETING WITH SUPERVISIOR														
GROUP ACTIVITY														
PROPOSAL PREPARATION														
PROJECT ANALYSIS														
SKECTHED AND SELECT PROJECT FROM DISCUSSION														
DISCUSSION OF PROJECT IDEAS														
PROJECT SKECTH IN INVENTOR														
DISCUSSION OF PROJECT COMPONENTS														
PREPARATION OF PRESENTATION														
PRESENTATION OF SEM 4 PROPOSAL														

WEEK/ PROJECT ACTIVITIES	W1	W2	W3	W4	W5	W6	W7	W8	W9	W10	W11	W12	W13	W14
MEET WITH SUPERVISIOR														
PURCHASES PROJECT STEEL PLATES														
PURCHASES PROJECT COMPONENT														
ASSEMBLE FRAME AND PLATE														
ASSEMBLE ELECTRIC COMPONENT														
ASSEMBLE THE ANCHOR STEEL TO MAKE FRAME														
MAKE HOLES AT STEEL PLATE SURFACES														
TEST COMPONENT FUNCTIONALLY														
MAKE DOORS FOR THE MINI CLOSET														
TEST RUN PROJECT														
UPDATING PROJECT REPORT														
MAKE BANNER & PRESENT														
FINAL PRESENTATION														

REPORT CORRECTION														
SUBMITTING REPORT														

Table 3.2: Gantt Chart Project 2

3.2 Design project

The detailed Smart Mini Closet design drawing will explain more clearly the layout of the parts or components of this design. Even the location or place of each component on this Smart Mini closet can be identified based on the size of the component and the suitability where the component is connected and placed. Here the initial design planning is done before the selection is made:

3.2.1 First design

For the first design, there is 2 compartments and 2 electric actuator for the door to open and close automatically. Therefore, it is a simple design and most common design closet in industry but it is easier to make. As figure 3.2.1 shown:

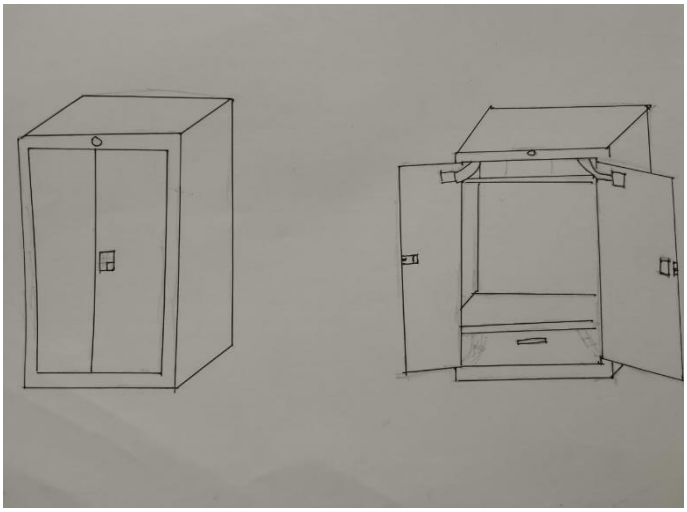


Figure 3.2.1: First design

3.2.2 Second design

The second design, there is single door only and contain 3 compartments with just only single actuator to open and close the door automatically. Therefore, it will reduce the space of the closet. As figure 3.2.2 shown:

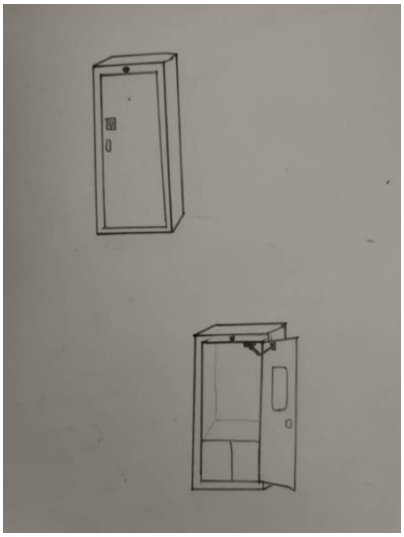


Figure 3.2.2: Second design

3.2.3 Third design

The third design, contain more compartments than the other design and the door design with folding door. Therefore, the actuator for the door is difficult to make and take times. Other than that, must create and weld part by part because it contained more compartment than the others. As shown in figure 3.2.3:

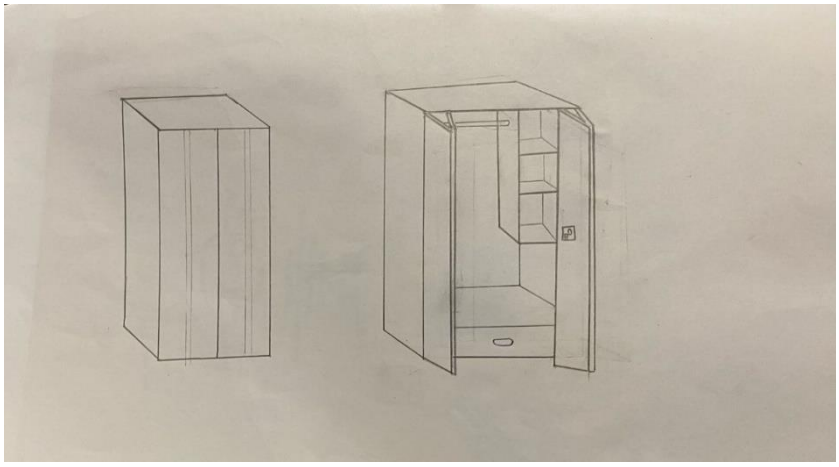


Figure 3.2.3: Third design

3.2.4 Idea comparison

Decision will be taken by reference from the table below and choose one of the best designed of project that will be developed. After making a thorough consideration with taking into account the established criteria, recommendations design 1 was chosen to be developed. As shown in Table 3.3:

DESIGN	COMPARTMENT	ACTUATOR DEVICE	DOOR	SENSOR	TOTAL
1	2	1	2	1	6
2	3	1	1	1	6
3	4	2	2	1	9

Table 3.3

3.3 Computer-aided design drawing

Computer-Aided Design (CAD) and (Computer-Aided Manufacturing, CAM) is the use of computer technology to help design, process, optimize and specially make sketches (technical drawings and engineering drawings) of a part or product including the entire project design. Figure 3.3, 3.4 and 3.5 show the technical drawings of the Smart Mini Closet Design Project.

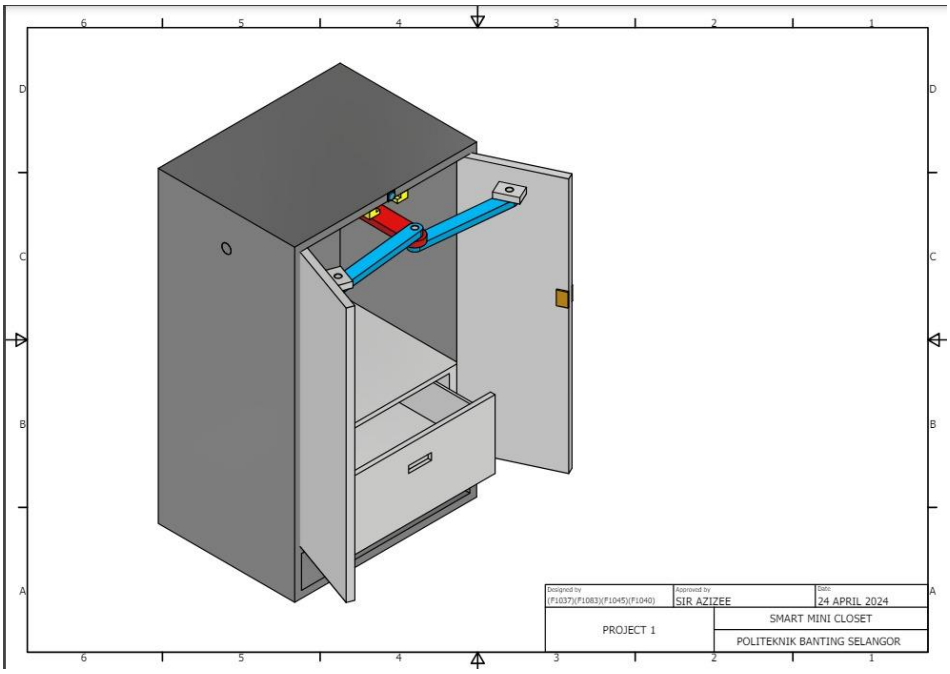


Figure 3.3: Isometric

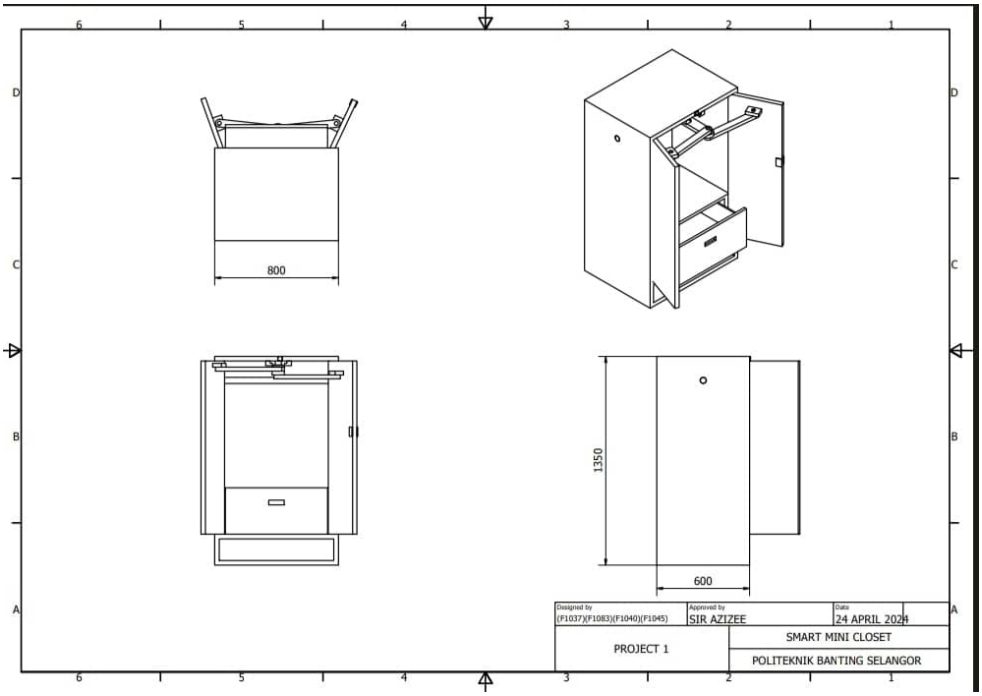


Figure 3.4: Orthographic and Isometric

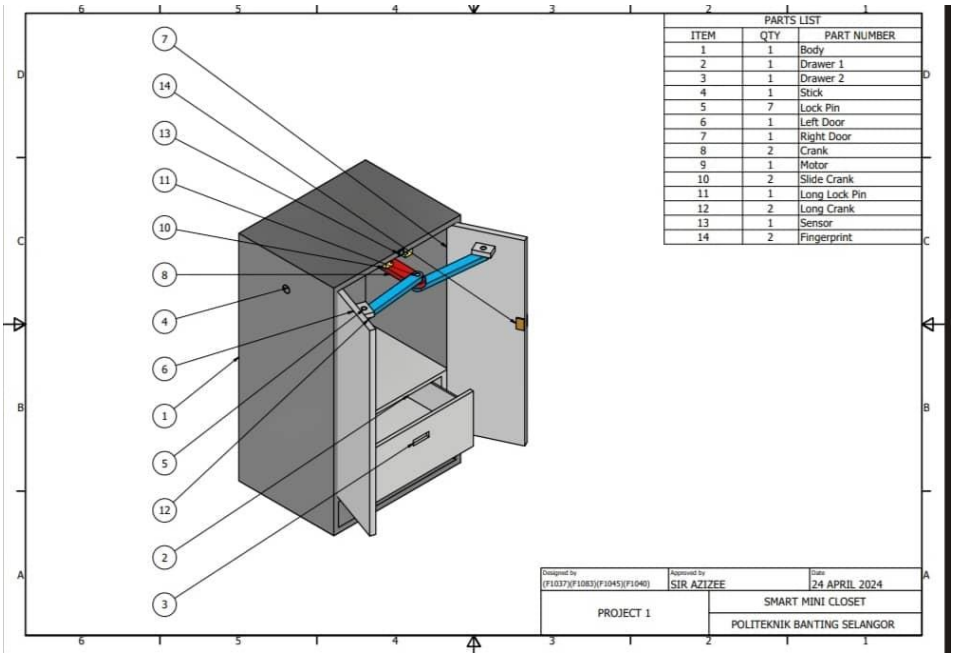


Figure 3.5: Isometric with balloon

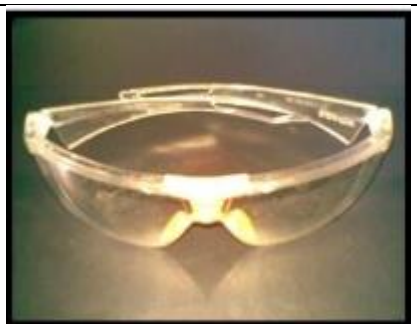
3.4 Project cost estimate

In any manufacturing process, cost is a factor that cannot be taken lightly, especially for trade. Failure to analyse and calculate costs will cause the company to suffer losses. The cost of production must be taken into account correctly and accurately. In this section, all costs involved will be listed. The costs involved are the materials to build the Smart Mini Closet and the cost of consumables. Table 3.4 show a project cost estimate of our project:

MATERIAL	UNIT	PRICE PER UNIT	PRICE
ACTUATOR 12V 150N	1	RM 235	RM 235
FINGERPRINT SCANNER	1	RM 58.90	RM 58.90
ARDUINO UNO	1	RM 49.90	RM 49.90
HIGH CURRENT MOTOR	1	RM 55.50	RM 55.50
RELAY MODULE	1	RM 21.60	RM 21.60
AC CABLE	1	RM 3	RM 3
POWER SUPPLY 12V 10A	1	RM 30.90	RM 30.90
PIN HEADER	1	RM 0.80	RM 0.80
MILD STEEL PLATE (4 X 8) FEET	2	RM 140	RM 280
ULTRASONIC SENSOR	1	RM 7.50	RM 7.50
ANGLE BAR	2	RM 18.30	RM 36.60
		TOTAL PRICE	**RM 779.70**

Table 3.4

3.5 List of equipment used

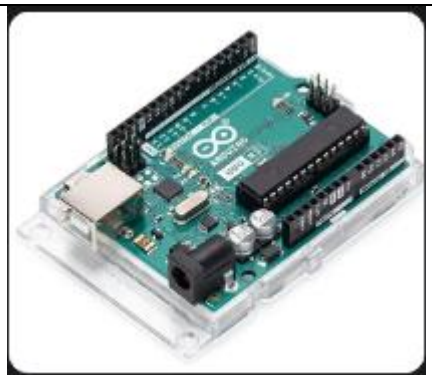
Bil	Equipment	Specification	Picture
1.	Hard chalk	Used to mark size	
2.	Leather glove	Used to protect hands from sharp and hot objects.	
3.	Goggle	Used to protect the eyes from sparks and sparks while drilling and drilling.	
4.	Head shield	Used to protect eyes and face while welding.	

5.	Centre punch	Used to mark before punching/drilling holes.	
6.	Steel rule	Used to measure and make parallel lines	
7.	Screw driver	Used to install and remove screws.	
8.	Measuring tape	Used for measuring work.	

3.6 List of machines used

Bil	Equipment	Specification	Picture
1.	Mig welding	Used to weld all parts of the aluminium plate.	
2.	Metal cutting machine	To cut, shape, and remove material from a workpiece.	
3.	Drill	Used to drill holes in aluminium plates.	
4.	Grinder	Removing material from a workpiece to shape, smooth, or finish workpieces through grinding.	

3.7 List of components used

Bil	Equipment	Specification	Picture
1.	Fingerprint sensor	To unlock the door.	
2.	Arduino uno	Connect to fingerprint and solenoid.	
3.	Linear solenoid	To lock the door	
4.	Power supply	To supply energy	

5.	Ultrasonic Sensor	To detect movement	
6.	Relay module	To connect the wiring	
7.	Actuator	Helps it to achieve physical movements by converting energy, often electrical, air, or hydraulic, into mechanical force to open the door.	

3.8 List of material

Bil	Equipment	Specification	Picture
1.	Mild steel plate	Lightweight, anti-corrosion	

3.9 Safety when using machines and equipment

When working with certain machines or tools then how much important things should be followed such as:

1) Knowing how to operate equipment and machines when using them.

Choose the right tool according to the work to be done.

- If you do not know how to use the machine, do not turn on the machine.
- Refer to the manual guidebook that has been prepared.
- Discuss with the lecturer about the equipment and how to use it.
- Using the right equipment according to the work to be done.

2) Operate equipment according to safety measures was prepared.

- Always follow the machine and equipment S.O.P when operating the machine.
- Comply with safety rules in the workshop.
- Always refer to the manual guidebook that has been prepared.
- Discuss with other lecturers about safety and methods its use.

3) Machines and equipment in good condition.

- Make sure the machines and equipment are in good condition.
- Make sure the machines and equipment are working properly.
- If there is damage to the machine or equipment, it needs to be maintained or repaired before use.

3.10 Process fabrication

3.10.1 Making a measurement

To measure and mark a large-sized metal sheet, first of all, one needs to arrange a clean and stable workspace with sufficient lighting. The required tools are a ruler or a measuring tape, marking tools like chalk or a permanent marker, and any personal safety gear like gloves and safety glasses. Place the metal flat and lay the ruler long with the line where the measurement is required, ensuring that accurate alignment has been achieved. Hold the ruler firmly so that it does not move but stays firmly in place and provides perfect measurements by marking the points on the sheet as necessary. Mark explicitly on the sheet with a bright marker, and where each measurement is being taken, recheck before marking in case one commits an error. Finally, re-measure after marking all the measurements for adjustment, if any. Once done, take the tools off from the metal sheet. Ensure the cleanup of the workplace and have it organized and safe for other fabrication steps. As shows in figure 3.6:

Figure 3.6: Making measurement

3.10.2 Cutting plate

First, the machine parameters are aligned, with the type and thickness of the steel in mind, by adjusting blade pressure and speed if that is what is called for. If the plate has not been measured and marked for cutting, this must be done now. Power the machine on and bring it up to operational speed. One employee controls the machine while other workers feed the plate towards the cut area, holding it stable and aligned properly. Workers oversee the cutting

carefully to avoid misalignment and/or jamming during the operation. Once the cut has been accomplished, power to the machine is turned off, and the steel plate is removed only after all moving parts have come to a complete stop. The edge is checked for smoothness and accuracy, and the area is marked for additional grinding, if needed. This plate is then lifted carefully and stacked in the stacking area or placed with finished pieces.

Preparation and execution of safety checks are the initial procedures to be followed when cutting a steel plate by machine. The required personal protection gear should be worn by each of the workers: gloves, safety eyewear, hearing protection, and steel-toed shoes to avoid injury. A quick look at the cutting machine should be made to ensure it is in good condition. This inspection should include an emergency stop button and any other part that can easily loosen up. The workspace is to be freed from all impediments and can demarcate safety zones away from the cutting area. Workers lift the steel plate together onto the feed table of the cutting machine, lowering it with care to lie flat and be aligned with the cutting guide for precision. If the machine had clamps or supports, then the plate is securely fastened to prevent movement during cutting.

Finally, cleaning up from the area any metal scraps, workers get the workplace ready for the next job. Sometimes, routine maintenance can also be performed on the machine itself, such as cleaning out any metal shavings or adjusting a blade. This indicates that proper documentation of the cutting process, with supplementary notes on the machine's performance, any problems that occurred, will further enable a follow-through and reference in the future. During the entire process, communication is an utmost requirement among workers, especially during lifting and aligning, so that accidents can be avoided. Workers should know the emergency stops and other safety concerns on the machine, and frequent training by the regular user of the machine on how to use it and safety precautions in general maintains a secure environment for work. As shows in figure 3.6.1:

Figure 3.6.1

3.10.3 Drill a hole at the plate

Drilling in a steel plate is a process that calls for good preparation, selection of tools, and safety measures. First, inspect the steel plate for any abnormalities; after, select the appropriate drill bit for doing metal work-commonly high-speed steel, cobalt, or carbide. Use a vise or clamps to hold down the plate securely in place and prevent it from slipping out unexpectedly. Make a mark on the spot where the drilling should be done with a centre punch to hold the bit steady. Wear proper personal protective equipment; this will include eye protection, ear protection, and cut-resistant gloves. Note: Gloves should not be worn when drilling because of the high risk of glove entanglement. Wear a dust mask if needed.

Set the drill to the correct revolutions per minute for the thickness of the material being used. If possible, use a drill press to enhance control. Cutting fluid may be applied to reduce friction and overheating. Start with low speeds and light pressure; let the drill bit do the work without forcing it through, which can cause breakage or kickback. Frequent coolant and occasionally clean out the metal shavings with a brush to prevent jamming. Once the hole is complete, switch the drill off, wait for it to stop, then deburr the edges to be smooth. Clean up the area, removing metal shavings, and then turn the power off. Put away the tools after use, turn the lights off, and close the windows for safety and order in the workshop. As shows in figure 3.6.2:

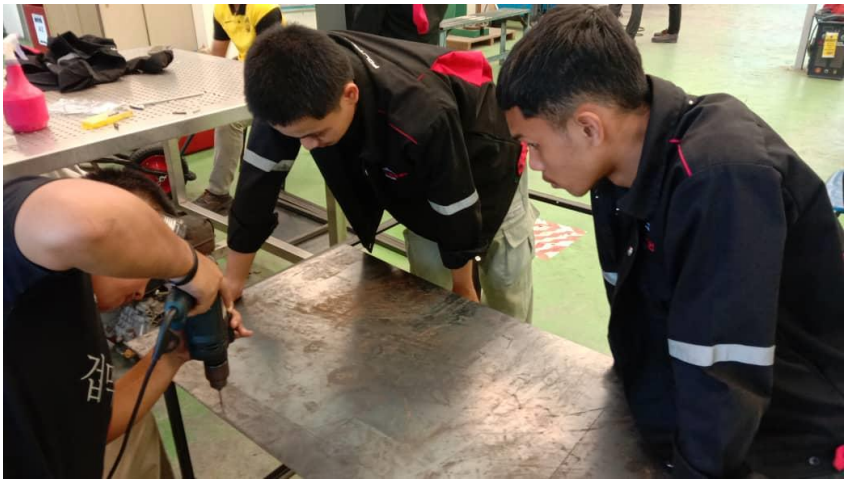


Figure 3.6.2

3.10.4 Weld the anchor steel

Care will be undertaken when welding an anchor steel to a framework to ensure that the anchor is well prepared and aligned with safe steel. Begin by inspecting the anchor steel and the frame for any defects, rust, or contaminants that will affect the weldability. Cleaning of the surfaces to be welded by use of a wire brush or grinder will remove grease, rust, and debris. Mark the places of welding to both anchor and frame, having in mind good alignment according to the design. Place the anchor steel in its place with the help of clamps or magnetic holders to hold its position unmoving during the time of welding and check accuracy by measuring tools, tape measure, or level.

Apply tack welds to hold anchor steel in place temporarily at several critical points. After tacking, continue to make the complete weld, using the proper welding technique: MIG, TIG, or Stick, based on the materials involved and the strength required. Make even, continuous welds along the edges, while controlling heat to avoid warping or distortion in larger anchors; several passes may be needed for a strong, consistent weld. Allow the joint to air cool; do not rapidly cool the joint with water or compressed air to avoid heat stress or cracking of the joint.

When cooled, visually inspect the weld for defects in the form of cracks or voids. The weld bead can be ground or wire brushed for appearance. Slag and debris should be cleaned from the weld area before a final check is made to ensure the anchor is attached securely. Wear the proper PPE throughout the process, including a welding helmet, gloves, flame-resistant clothing, and hearing protection. Keep a fire extinguisher nearby to handle any sparks or molten metal and make sure that the area is safe and well-vented during welding. This would be the

step-by-step process to ensure safety and strength in the connection between the anchor steel and the frame. As shows in figure 3.6.3:

Figure 3.6.3

3.10.5 Test the body alignment

Testing the alignment and stability of a frame is essential to ensure its structural integrity and proper functioning. The process begins with a visual inspection to identify any obvious misalignments, warping, or defects in the frame. Next, check the squareness by measuring the diagonals of the frame; if the frame is square, both diagonal measurements should be equal. Use a spirit or laser level to verify that the frame is level, checking multiple points along both horizontal and vertical planes. For vertical alignment, use a plumb bob or laser plumb tool to ensure the frame is perfectly vertical. Measure the angles of the frame using a protractor to confirm that all joints form the required 90-degree angles. To assess the frame's stability under load, apply a small test load and observe for any bending, shifting, or wobbling. Additionally, check for rigidity by pressing on different sections of the frame to ensure it does not flex or shift. If any misalignment or instability is detected, make the necessary adjustments, such as repositioning, tightening bolts, or correcting welds. Finally, document the results of the alignment tests and any adjustments made for future reference. These steps ensure that the frame is properly aligned, stable, and ready for use. As shows in figure 3.6.4

Figure 3.6.4

3.10.6 Assemble the plate

The main steps to be followed to assemble a steel plate with bolts and nuts to a frame involve checking for defects in both the steel plate and the frame, cleaning the surfaces at which the bolts will be inserted into the frame clear of all debris and contaminants. Mount the steel plate to the frame according to the specifications in the drawing while ensuring that it is aligned through an instrument such as a tape measure, a square, or a level. Mark the position of the bolt holes on the steel plate and frame. Afterwards, drill the marked positions with a drill bit matching the size of the bolts. Debur the edges of the holes to get rid of sharp edges after drilling.

Pass the bolts through the aligned holes in the steel plate and frame. You can take washers on either side of the bolt for load sharing, if needed. Secure the bolts by placing nuts on the threaded ends and hand-tightening them to hold everything in place. Then, with the use of a wrench or socket, perform tightening in a crisscross pattern to evenly distribute the pressure across the connection. Apply the correct torque with a torque wrench based on what the design calls for in order not to over-tighten or under-tighten the connection, which may weaken it. Check that after the tightening, all bolts are securely fastened, and verify the alignment of the steel plate; the plate should also be flush with the frame. Finally, clean up all the areas where

the assembly was done to free them from any metal shavings or debris and store the remaining materials in their right storage conditions. Such steps will ensure the proper tightness and fitting of the steel plate to the frame to provide a comfortable, long-lasting connection. As shows in figure 3.6.5:

Figure 3.6.5

3.10.7 Remove an interfering screw

Removing an interfering screw by grinding involves a step-by-step process to achieve a neat and accurate cut. Wear appropriate safety attire, including gloves, goggles, and a face shield, because grinding tends to generate sparks and fragments. Hold the workpiece firmly by clamping the material around it in such a manner that it will not move during the process. Select the right grinder for the work to be done, along with the proper type of grinding wheel. Use either a handheld angle grinder or bench grinder fitted with a metal cutting disc. Position the grinder's cutting wheel over top of the redundant screw applying light, constant pressure while cutting the screw to the desired length in the process. Be careful and avoid overheating the screw that will cause damage to the threads. After having removed the extra screw, check the cut for being smooth and flush, smoothening out any rough edges with a file or a deburring tool. Clean up the work area, get rid of the metal shavings, and safely put away the grinder. This will ensure that the cut will be clean and controlled for a very accurate and safe result. As shows in figure 3.6.6:

Figure 3.6.6

3.10.8 Smooth the surfaces

Therefore, this grinding process for cutting excess iron plate has some major steps that must be followed to have a neat and accurate cut of the iron plate. First, wear all your necessary safety gear like gloves, goggles, face shields, and hearing protection because grinding involves sparks, flying debris, and loud noise. Firmly clamp the iron plate into position, using a vise or heavy-duty clamps to ensure that it will not move during the grinding process. Mark on the plate where you would want to cut using chalk or a marker. Follow the line with the appropriate grinding tool, such as an angle grinder fitted with a metal cutting disc. Next, proceed to grind by applying a steady, light pressure and letting the grinder cut through the iron plate. Do not force the tool, as it can make it overheat or produce an uneven cut. Be very mindful of the temperature to prevent warping of the metal, and stop every so often to let the metal cool if necessary. Once excess material is removed from both sides, inspect the cut for smoothness and accuracy. Take the grinder or a file to it if there are rough edges or burrs that need to be smoothed. Finally, clean the workplace, safely dispose of the chaff or small pieces of metal resulting from the cutting process, and then verify whether the cut made in the iron plate is appropriate and ready for further use. As shows in figure 3.6.7:

Figure 3.6.7

3.10.9 Weld a crack part

Welding a cracked part is a process that involves stages that are all critical for the success of a repair. Safety first: put on the appropriate protective gear, including gloves, welding helmet, and flame-resistant clothes to protect against sparks, burns, and fumes. Then, inspect the crack-size, depth, and severity-to determine the best course of repair. Cleaning will be done to remove all impurities around the crack, such as rust, oil, and dirt, so that the material can form proper bonding in welding. Sometimes, preheating of the part is called for to minimize the chances of thermal shock and prevent it from further cracking. Where necessary, the crack is widened or beveled to achieve better groove access by the weld and therefore assure deeper penetration and a much stronger bond. The actual process of welding involves using proper welding techniques to lay molten filler material in the crack, such as MIG, TIG, or Stick welding. Normally, the finished weld is given PWHT for residual stresses to avoid future cracking, while in-service applications may require additional non-destructive testing. Thereafter, it is examined for defects like porosity or incomplete fusion, and further non-destructive testing is performed if the application is critical. Slag, spatter, or oxidation are then cleaned off, and the part is carefully checked to see that the repair is sound and ready for use. The overall function of this process is to restore structural integrity of the part to safety and functionality for continued operation. As shows in figure 3.6.8:

Figure 3.6.8

3.10.10 Making a measurement for actuator

First, measure the width, depth, and height of a closet to determine how much total space is available inside it, whether the actuator fits or not. Second, take the dimensions of the actuator: length, width, height, stroke length. Make sure that the actuator will suit the space properly. Verify also that there is adequate clearance around the moving parts of the actuator for full extension and retraction. Measure the mount points for installing the actuator to confirm proper alignment and installation points securely fastened. Be aware of other obstructions-shelves, rods, and such items-that the operation of the actuator will run into. If the actuator requires electrical connections, plan for the routing of wiring. Make sure that space is available to install wiring safely and neatly. Lastly, confirm all measurements to ensure proper fit of the actuator, along with free travel without interference from other installed components. This would allow careful planning and measurement such that the actuator will be installed securely and work reliably within the given closet space. As shows in figure 3.6.9:

Figure 3.6.9

3.10.11 Smoothening the hole

Smoothening of the Hole Surface for Actuator Position Using Chisel First, prepare the area around the hole by eliminating any form of obstruction. Don appropriate gear that protects you from injury, such as gloves and safety glasses. Mark out, with guidance in mind, the area around the hole which one wants to level. Select a chisel that fits the material you will be working with, caring to choose a width and shape that works for you. Take your chisel and lightly score the surface with shallow marks to help keep your work precise. Now start removing small portions of the material, tapping the chisel with a hammer frequently checking if the surface is level. Once the surface has been leveled, take the flat side of the chisel and smooth out the rough edges; finish the surface with a file or sandpaper if needed. Finally, use a level to double-check that the hole is just level and make adjustments if necessary. This ensures the actuator will fit snugly in place and minimize any interference in operation. As shows in figure 3.6.10:

Figure 3.6.10

3.10.12 Making a mechanism for the door

To adjust the stainless-steel bar that will be assembled on the actuator, first measure and cut to the length required within the system's range of motion. After cutting, verify that the bar is in alignment with the actuator-parallel and straight to the actuator's axis. This alignment is important in ensuring that there will be smooth and even movements without causing unnecessary strain or wear. Next, mark and drill holes in the stainless-steel bar to mount it to the actuator. Fasten it with the appropriate fastener, whether bolt or pin, which will provide a solid connection. Once the bar is properly mounted, lubricate contact points to minimize friction and ensure smooth operation. Further, there should be ample clearance of the bar around surrounding parts to avoid interference with movement. Now that the assembly is installed, take the actuator for a test run by running the bar through its full travel without any binds. Lastly, secure all the fasteners and re-check the alignment to ensure everything is tight and in its place to promote long-term reliability and effective performance of the actuator-stainless steel bar system. As shows in figure 3.6.11:

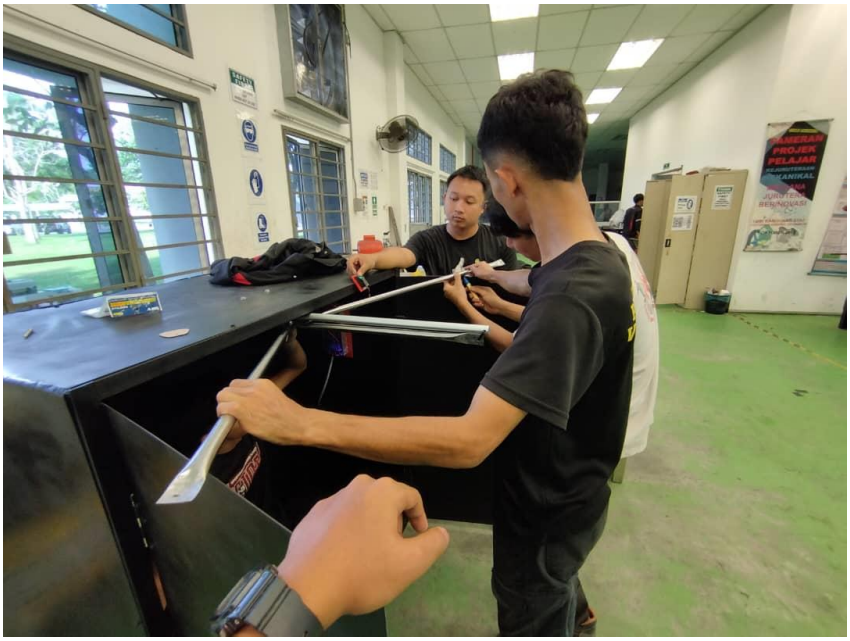


Figure 3.6.11

3.10.13 Attach the component parts

Setting up components within a closet starts with planning and preparation. First, one needs to look at the space made available and to know what he or she intends to store in it, whether clothes, shoes, or accessories. From here, design the basic layout in the most helpful way so that as much space can be saved as possible. Take all measurements to see the components-shelves, rods, and organizers-all fit comfortably and do not interfere with doors or any other structures. Gather necessary materials and tools, such as shelves, rods, brackets, screws, a drill, screwdriver, level, and measuring tape.

Attach vertical supports and brackets for the shelves and rods. Carefully measure and mark their positions, making sure they are level before screwing them into place. Install the shelves next, align them carefully, and screw them tightly into place. If you have adjustable shelves, make extra sure they are level before setting them in their final position. Install the rods for hanging clothes at the right height, ensuring they are level and can bear the weight of whatever will hang on them. If drawers or bins form part of the setup, install frames that house either drawers or organizers and secure them where needed with anchorage.

When everything is installed, do a final check to make sure everything is level, secure, and operates properly. Next, load the shelves, rods, and drawers with what is expected to be carried in terms of weight. Arrange the items by type or use to provide maximum use of the closet

space, and make necessary adjustments. Lastly, add finishing touches such as hooks, lighting, or any ornamental touch one desires. Following a final clean of the closet space to remove any installation mess, your closet will be ready to go, organized to suit your specific storage needs. As shows in figure 3.6.12:

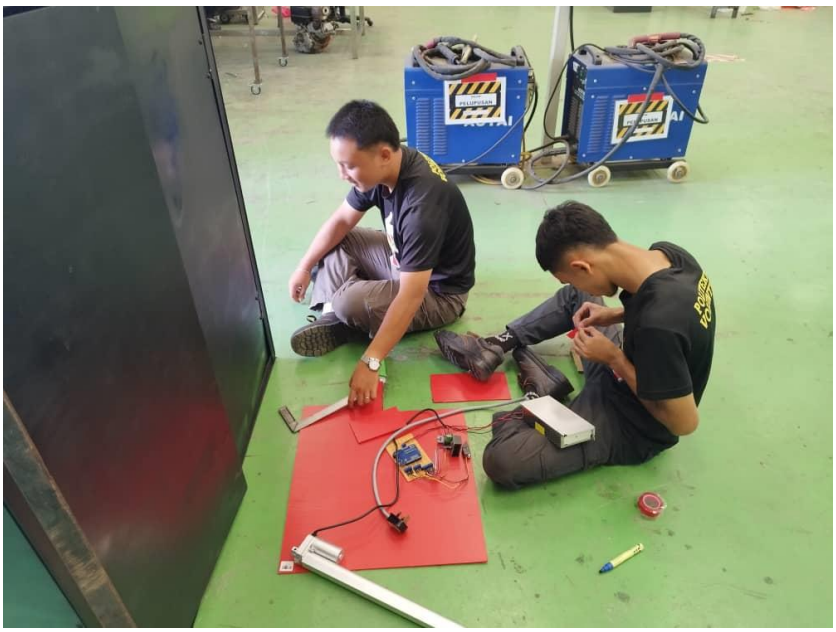


Figure 3.6.12

3.10.14 Spray paint

In completing the installation by painting, the surface should be cleaned to remove dust, dirt, or grease from the surface. Light sanding may be important for better paint adhesion. Following this, mask off areas you do not want paint to get on, such as moldings or hardware, with painter's tape, and put down a drop cloth to catch any drips on the floor. If necessary, use a coat of primer to create an even surface from which paint can adhere. Once the primer is dry, use either a paintbrush or roller to spread the first coat from top to bottom. Once the first coat is dry, repeat with a second coat for an equal cover of the second coat. After the final coat has dried, carefully remove the painter's tape and clean your painting tools. Finally, check the painted surfaces for any imperfections-touch them up where needed-so that you will have professional, smooth finishes. In this process, the closet will be left with a hardy and pleasingly painted surface. As shows in figure 3.6.13:

Figure 3.6.13

CHAPTER 4

PROJECT DISCOVERY AND ANALYSIS

4.1 Introduction

This chapter discusses the results of the studies concerning the testing of the project that has been carried out. This could not have been put into implementation if the final project had not been in full completion. This chapter will also be discussing the study and the result that the project carried out. Every project that spends money has to be tested for the success of its objectives. This has been stated by members of the group by proving the project works well and successfully or otherwise, which is the deep objective. This smart mini closet project is able to help people who are living in residential areas, dormitories, and workshops. It also guarantees the safety of personal and valuable items from theft cases in Malaysia.

4.2 Test result

After the development of the project, testing has been done by making a comparison with other closet that doesn't have safety features. After testing, it appears that this smart mini closet can be seen as a project that is able to guarantee the safety of the valuables and personal belongings of the user. The method is a good thing when compared with another closet.

Moreover, the power consumption of this intelligent mini closet is based upon the supply of power, so it is at this minimum rate since the consumption of this project is only at a minimum rate.

Next, the risk of damage is also at a minimum level. This is because when the user is using this smart mini closet in a correct manner, then the risk of damage is less. The maintenance level of this smart mini closet will be done once every 3 months to ensure that the smart mini closet works in good condition. and to guarantee a long period of time.

4.3 Types Of Tests Without Hassle

I. Door strength test.

II. Component functional test.

III. Fingerprint effectiveness test.

IV. Sensor distance test.

V. Moving actuator smoothness test.

4.3.1 Visual inspection

First of all, visual inspection is the first step in troubleshooting, it involves looking at the system visually, if possibles to identify obvious problems. This will provide evidence of damage or other issue. One can look physical signs of damage, such as cracks, corrosion and loose connections. Connection mush be checked for looseness or disconnection, as though can cause sounds, though not strictly visual, can also provide clues about internal issues.

4.4 Code and standard that used

4.4.1. Arc welding

Arc welding is a welding process that is used to join metal to metal by using electricity to create enough heat to melt metal, and the melted metals, when cool, result in a binding of the metals. It is a type of welding that use welding power supply to create an electric arc between a metal stick known as electrode and the base material to melt the metals at the point of contact. Arc welding power supplies can deliver either direct (DC) or alternating (AC) current to the work, while consumable or non-consumable electrodes are used.

The welding area is usually protected by some type of shielding gas (e.g. an inert gas), vapor, or slag. Arc welding processes may be manual, semi-automatic, or fully automated. First developed in the late part of the 19th century, arc welding became commercially important in shipbuilding during the Second World War. Today it remains an important process for the fabrication of steel structures and vehicles.

4.4.2 How ARC Welding can be related with Smart Mini Closet?

The following project is a smart mini closet project that includes welding connections. Within the connection process, there are connections showing arc welding. Arc welding references involve only non-critical connections. One can see it at every corner of the connection in this project. Corner connection for this smart mini closet connection plays an important role as each joint of a connection has excess space, and using this arc welding will cover the extra space and can give good results based on the training done before manufacture.

4.5 Analysis project

Every project that is implemented and carried out must have its own advantages and disadvantages. After completing the manufacturing process and testing this project, it was found that there are several advantages and disadvantages of this smart mini closet. One of the benefits that this smart mini closet can guarantee is the safety of the user's valuables and personal belongings. Once the door of this smart mini closet has been closed, it will be quite hard to open, meaning one cannot easily misplace the item.

One of the weaknesses of this smart mini closet is that when there is no power supply or there is a current trip, the user cannot use it, and it will not work. Afterward, during an emergency, the time taken to access the user's fingerprint is long. If it happens, it will make it difficult for the user in that situation.

4.5.1 Analysis data

For our project, we used Google Forms as the survey method, and we received a total of 20 responses. The chart indicates that most respondents (70%) are from the DKM department, with the Family category making up the next largest group at 20%. The remaining departments (DTP, DAM, and JMSK) each have minimal representation at 5% each. As shows in figure 4.1.

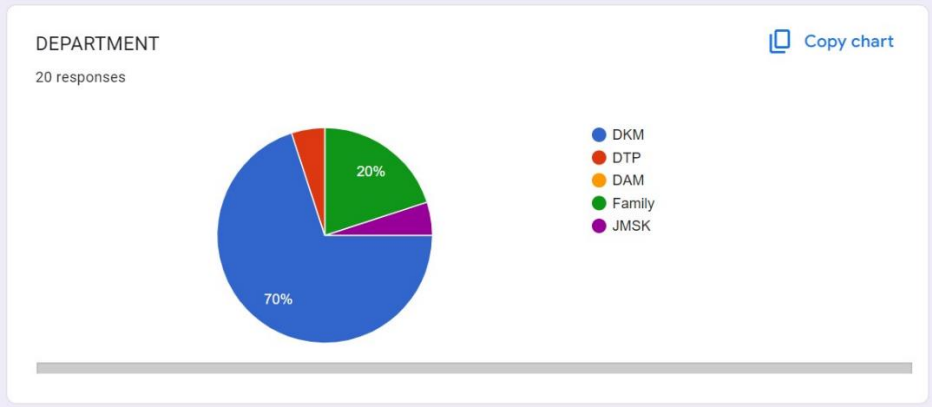


Figure 4.1

The bar chart illustrates the effectiveness of the "Smart Mini Closet" based on feedback from 20 respondents. As shows in figure 4.2. It evaluates four aspects:

1. High-security system: The most highly rated feature, with 15 respondents (75%) acknowledging its effectiveness.

2. Reduction of theft cases in hostels and residential areas: 14 respondents (70%) believe this feature contributes significantly to reducing theft.

3. Strong material: 9 respondents (45%) find the material quality effective, indicating moderate confidence in its durability.

4. All components working successfully: Only 5 respondents (25%) agree that all components of the closet function as intended, suggesting room for improvement in this area.

Overall, the Smart Mini Closet is appreciated for its security and theft-reduction capabilities, while material strength and component functionality receive less unanimous support.

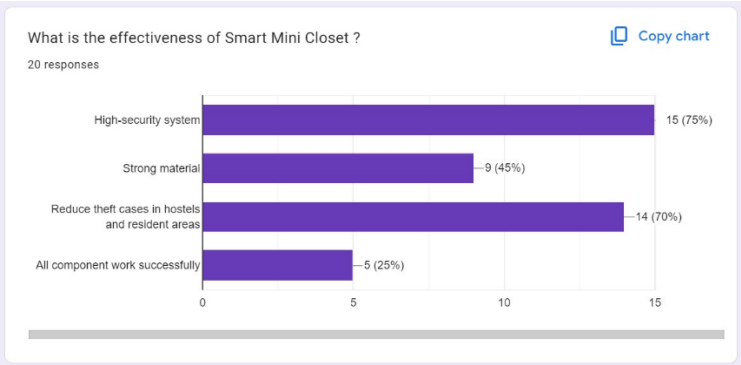


Figure 4.2

4.5.2 Schematic diagram

The figure 4.3 shows the wiring configuration for a smart mini closet system that integrates various components, including a fingerprint sensor, ultrasonic sensor, motor driver, linear actuator, and an Arduino Uno as the main control unit. Here's a breakdown of each component and its function in the circuit:

1. Fingerprint Sensor

- This sensor is used to authenticate users. It is connected to the Arduino, allowing the system to recognize authorized fingerprints. Once a recognized fingerprint is scanned, it signals the Arduino to open the closet.
- The wiring connections from the fingerprint sensor to the Arduino likely include power (5V and GND) and communication lines (TX and RX) for data transmission.

2. Ultrasonic Sensor (HC-SR04)

- This sensor detects the distance of objects, likely used to sense if there is an obstruction in the closet's path or to confirm the door's position.
- The ultrasonic sensor has four pins: VCC (power), GND, Trigger, and Echo. The Trigger and Echo pins connect to the Arduino for distance measurement, where the Arduino calculates the time taken for a signal to bounce back from an object to determine distance.

3. Arduino Uno

- The Arduino Uno acts as the central control unit for the system, receiving inputs from the fingerprint and ultrasonic sensors, processing the information, and controlling the motor driver.
- It outputs signals to the motor driver to control the linear actuator based on the conditions detected by the sensors.

4. BTS Motor Driver

- The BTS motor driver is used to control the linear actuator, which is responsible for opening and closing the closet door. It regulates the direction and speed of the actuator.
- Connections:
  - Pins 4, 5, 6, and 7 on the motor driver are connected to the Arduino, providing control signals.
  - The motor driver receives 12V power from the power supply unit to operate the linear actuator.
  - It also has connections for the 5V and GND lines to power the motor driver and establish a common ground with the Arduino.

5. 12V Linear Actuator

- The linear actuator, powered by the motor driver, physically opens and closes the closet door. It extends or retracts based on the signals received from the motor driver.
- The motor driver controls the actuator’s extension and retraction according to the user's fingerprint authentication and obstacle detection.

6. 12V 10A Power Supply Unit

- This power supply provides 12V DC power to the motor driver and the linear actuator, supplying sufficient current (10A) to handle the load.
- It is connected to a 3-pin plug, enabling the system to be powered through an AC mains outlet.

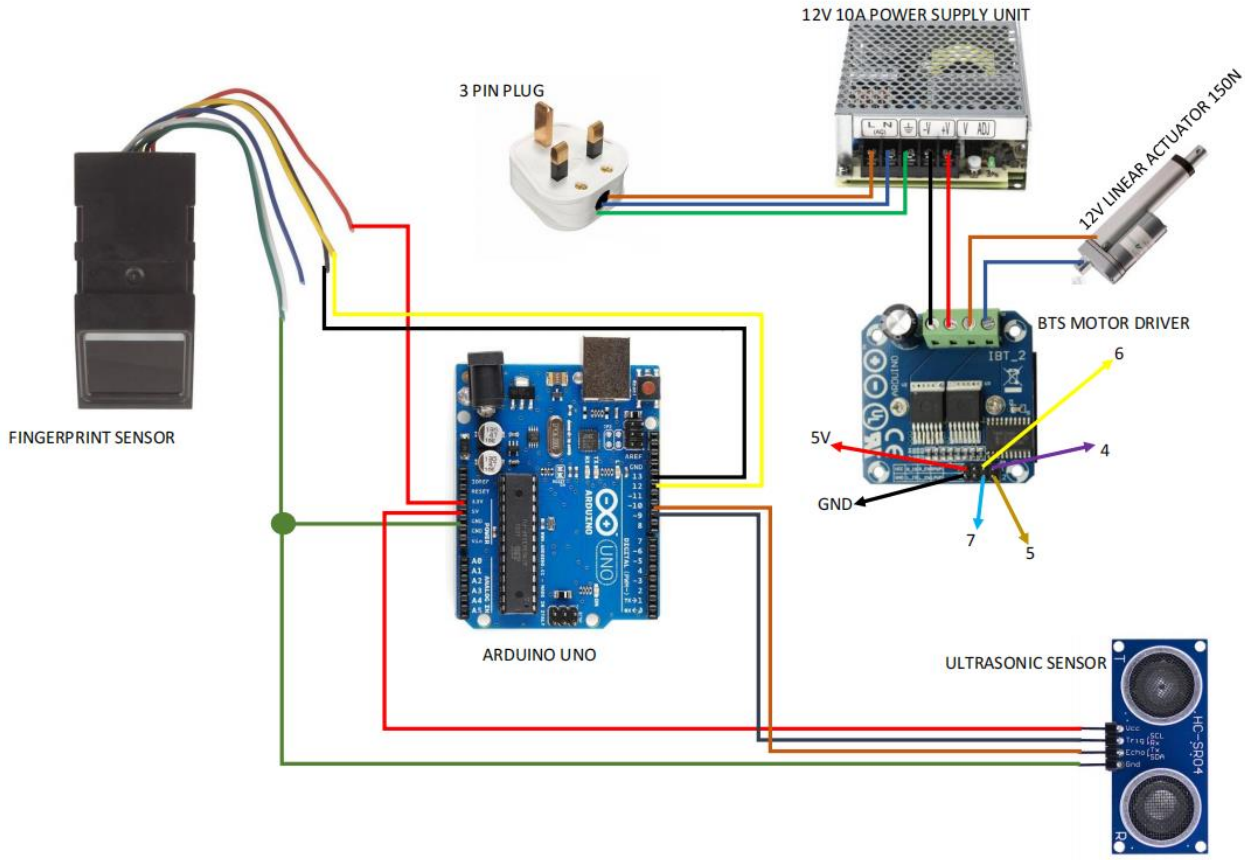


Figure 4.3

4.5.3 Coding

```
/*
  Ultrasonic Sensor HC-SR04 and Arduino Tutorial

  by Dejan Nedelkovski,
  www.HowToMechatronics.com

*/
// defines pins numbers
#include <Adafruit_Fingerprint.h>

#if (defined(__AVR__) || defined(ESP8266)) && !defined(__AVR_ATmega2560__)
// For UNO and others without hardware serial, we must use software serial...
// pin #2 is IN from sensor (GREEN wire)
// pin #3 is OUT from arduino  (WHITE wire)
// Set up the serial port to use softwareserial..
SoftwareSerial mySerial(13, 12);

#else
// On Leonardo/M0/etc, others with hardware serial, use hardware serial!
// #0 is green wire, #1 is white
#define mySerial Serial1

#endif


Adafruit_Fingerprint finger = Adafruit_Fingerprint(&mySerial);


int user1 = 0;
int user2 = 0;
int user3 = 0;
int user4 = 0;
int user5 = 0;
int permission = 0;
```

```
int MR1 = 4;
int ML1 = 5;
int ENR1 = 6;
int ENL1 = 7;

int point = 0;

int count = 0;

const int trigPin = 9;
const int echoPin = 10;
// defines variables
long duration;
int distance;   // in cm
int ideal = 50; // in cm
void setup() {
  Serial.begin(9600); // Starts the serial communication
  pinMode(trigPin, OUTPUT); // Sets the trigPin as an Output
  pinMode(echoPin, INPUT); // Sets the echoPin as an Input
  ////////////////////////////////////////////////////////////
  pinMode(MR1, OUTPUT);
  pinMode(ML1, OUTPUT);
  pinMode(ENR1, OUTPUT);
  pinMode(ENL1, OUTPUT);

  digitalWrite(ENR1, HIGH);
  digitalWrite(ENL1, HIGH);

  ////////STOP
  analogWrite(MR1, 0);
  analogWrite(ML1, 0);

  ////////////////////////////////////////////////////////////
  while (!Serial);  // For Yun/Leo/Micro/Zero/...
```

```
//////////////////////////////////////////////////////////
while (!Serial);  // For Yun/Leo/Micro/Zero/...
delay(100);
Serial.println("\n\nAdafruit finger detect test");

// set the data rate for the sensor serial port
finger.begin(57600);
delay(5);
if (finger.verifyPassword()) {
  Serial.println("Found fingerprint sensor!");
} else {
  Serial.println("Did not find fingerprint sensor :(");
  while (1) {
    delay(1);
  }
}

Serial.println(F("Reading sensor parameters"));
finger.getParameters();
Serial.print(F("Status: 0x")); Serial.println(finger.status_reg, HEX);
Serial.print(F("Sys ID: 0x")); Serial.println(finger.system_id, HEX);
Serial.print(F("Capacity: ")); Serial.println(finger.capacity);
Serial.print(F("Security level: ")); Serial.println(finger.security_level);
Serial.print(F("Device address: ")); Serial.println(finger.device_addr, HEX);
Serial.print(F("Packet len: ")); Serial.println(finger.packet_len);
Serial.print(F("Baud rate: ")); Serial.println(finger.baud_rate);

finger.getTemplateCount();

if (finger.templateCount == 0) {
  Serial.print("Sensor doesn't contain any fingerprint data. Please run the 'enroll' example.");
}
else {
  Serial.println("Waiting for valid finger...");
```

```
    Serial.println("Waiting for valid finger...");
    Serial.print("Sensor contains "); Serial.print(finger.templateCount); Serial.println(" templates");
  }

}
void loop() {
  getFingerprintID();
  delay(50);            //don't ned to run this at full speed.
  // Clears the trigPin
  digitalWrite(trigPin, LOW);
  delayMicroseconds(2);
  // Sets the trigPin on HIGH state for 10 micro seconds
  digitalWrite(trigPin, HIGH);
  delayMicroseconds(10);
  digitalWrite(trigPin, LOW);
  // Reads the echoPin, returns the sound wave travel time in microseconds
  duration = pulseIn(echoPin, HIGH);
  // Calculating the distance
  distance = duration * 0.034 / 2;
  // Prints the distance on the Serial Monitor
  Serial.print("Distance: ");
  Serial.println(distance);

  if (distance <= ideal) {
    if (permission == 1) {
      Serial.print("PERMISSION GRANTED");
      Serial.println("forward");
      analogWrite(MR1, 255);
      analogWrite(ML1, 0);
    }
    else {
      Serial.print("ACCESS DENIED");
      Serial.println("backward");
      analogWrite(MR1, 0);
```

```
      analogWrite(MR1, 0);
      analogWrite(ML1, 255);
    }
  }
  else {
    permission = 0;
    Serial.println("backward");
    analogWrite(MR1, 0);
    analogWrite(ML1, 255);
  }

  Serial.print("count: ");
  Serial.println(count);
  delay(1000);
}
////////////////////////////////////////////////////
////////////////////////////////////////////////////
////////////////////////////////////////////////////
uint8_t getFingerprintID() {
  uint8_t p = finger.getImage();
  switch (p) {
    case FINGERPRINT_OK:
      Serial.println("Image taken");
      break;
    case FINGERPRINT_NOFINGER:
      Serial.println("No finger detected");
      return p;
    case FINGERPRINT_PACKETRECIEVEERR:
      Serial.println("Communication error");
      return p;
    case FINGERPRINT_IMAGEFAIL:
      Serial.println("Imaging error");
      return p;
    default:
      Serial.println("Unknown error");
```

```
    default:
      Serial.println("Unknown error");
      return p;
  }

  // OK success!

  p = finger.image2Tz();
  switch (p) {
    case FINGERPRINT_OK:
      Serial.println("Image converted");
      break;
    case FINGERPRINT_IMAGEMESS:
      Serial.println("Image too messy");
      return p;
    case FINGERPRINT_PACKETRECIEVEERR:
      Serial.println("Communication error");
      return p;
    case FINGERPRINT_FEATUREFAIL:
      Serial.println("Could not find fingerprint features");
      return p;
    case FINGERPRINT_INVALIDIMAGE:
      Serial.println("Could not find fingerprint features");
      return p;
    default:
      Serial.println("Unknown error");
      return p;
  }

  // OK converted!
  p = finger.fingerSearch();
  if (p == FINGERPRINT_OK) {
    Serial.println("Found a print match!");
  } else if (p == FINGERPRINT_PACKETRECIEVEERR) {
```

```
  if (p == FINGERPRINT_OK) {
    Serial.println("Found a print match!");
  } else if (p == FINGERPRINT_PACKETRECIEVEERR) {
    Serial.println("Communication error");
    return p;
  } else if (p == FINGERPRINT_NOTFOUND) {
    Serial.println("Did not find a match");
    permission = 0;
    return p;
  } else {
    Serial.println("Unknown error");
    return p;
  }

  // found a match!
  Serial.print("Found ID #"); Serial.print(finger.fingerID);
  Serial.print(" with confidence of "); Serial.println(finger.confidence);

  if (finger.fingerID == 1 || finger.fingerID == 2 || finger.fingerID == 3 || finger.fingerID == 4 || finger.fingerID == 5) {
    permission = 1;
  }
  else {
    permission = 0;
  }


  return finger.fingerID;
}

// returns -1 if failed, otherwise returns ID #
int getFingerprintIDez() {
  uint8_t p = finger.getImage();
  if (p != FINGERPRINT_OK)  return -1;

  p = finger.image2Tz();
```

```
  // found a match!
  Serial.print("Found ID #"); Serial.print(finger.fingerID);
  Serial.print(" with confidence of "); Serial.println(finger.confidence);

  if (finger.fingerID == 1 || finger.fingerID == 2 || finger.fingerID == 3 || finger.fingerID == 4 || finger.fingerID == 5) {
    permission = 1;
  }
  else {
    permission = 0;
  }


  return finger.fingerID;
}

// returns -1 if failed, otherwise returns ID #
int getFingerprintIDez() {
  uint8_t p = finger.getImage();
  if (p != FINGERPRINT_OK)  return -1;

  p = finger.image2Tz();
  if (p != FINGERPRINT_OK)  return -1;

  p = finger.fingerFastSearch();
  if (p != FINGERPRINT_OK)  return -1;

  // found a match!
  Serial.print("Found ID #"); Serial.print(finger.fingerID);
  Serial.print(" with confidence of "); Serial.println(finger.confidence);
  return finger.fingerID;
}
```

4.6 Summary

As a summary at the end of this chapter, this chapter has explained the findings and analysis of the smart mini project. There are several analyse that have been described in this chapter. With the analysis done on this smart mini closet, it has advantages and disadvantages as well as improvements that have been made able to complete this project successfully.

CHAPTER 5

RECOMMENDATION AND CONCLUSION

5.1 Conclusion

Smart mini closet is an innovative solution aimed at enhancing and strengthening the security features of a closet. At the same time, it helps reduce theft incidents.

Several durability tests have been conducted to compare the security features between the smart mini closet and traditional closets available in the market. Data analysis has shown that the smart mini closet is equipped with a fingerprint scanner, allowing only authorized users to open it, whereas traditional closets use keys that are easy to clone.

Furthermore, the smart mini closet helps reduce theft due to user negligence in closing the closet doors. This is because the smart mini closet has sensors to detect the presence of a user and will automatically close the door if no movement is detected.

Overall, the smart mini closet proves to be a robust and secure solution with the potential for further optimization based on usage data and environmental conditions.

5.2 Study finding

The results of interviews and spontaneous or 'in situ' questions with lecturers and several students who have used the Smart Mini Closet indicated that the equipment is very easy to operate. Overall, after the Smart Mini Closet was completed and used, it was found that all the research objectives stated in Chapter I were successfully achieved.

5.3 Recommendation

Recommendation for improve Smart Mini Closet t is by adding an additional door as a backup in case of power failure or battery depletion. Additionally, improving the actuator system and adding lights inside the closet.

5.4 Study summary

This is the study summary of our SMART MINI CLOSET which is designing a secure, smart safety closet involves careful consideration of its purpose, materials, security features, layout, and placement. First, it's essential to determine the closet's specific needs based on the valuables it will store, such as money, electronics, or medications, and the environmental risks, like theft, in places such as homes or offices. High-quality materials, like high-carbon steel, are chosen for their durability and resistance to tampering, ensuring that the closet is sturdy and long-lasting. Security features are critical, with a biometric fingerprint scanner as the primary access method to limit entry to authorized users. Additionally, an automated door closure system with a motion sensor connected to an actuator addresses the risk of human error, if the door is left open, it closes automatically, providing continuous security without the need for constant monitoring. Inside, shelves and compartments are customized to suit the stored items, ensuring everything is easily accessible and organized for emergencies. The closet should be placed in a secure but accessible location close enough for quick access yet out of high-traffic areas to prevent attracting unwanted attention. Altogether, this design offers a comprehensive solution for storing valuables safely, integrating strong construction and advanced technology to reduce the risk of theft and improve usability.

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