POLITEKNIK BANTING SELANGOR

TOOLBOX SENSOR

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MECHANICAL ENGINEERING DEPARTMENT

SESSION 2 : 2023/2024

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Are students of fourth semester of Diploma Mechanical Engineering at Politeknik Banting Selangor.

1. We acknowledge that the project is above, and the intellectual property therein are our original works / innovations without taking or imitating any property of other parties.
2. We also concur to relinquish copyright ownership of the project to any purpose of Polytechnic in order to meet the requirements for the Diploma of Mechanical Engineering.

ACKNOWLEDGEMENT

In this section, we would like to take the opportunity to express our gratitude and appreciation to everyone who involve directly or indirectly in helping us to embody and realizing our project from the early stage of proposing idea to the success of our finished product.

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Finally, hear felt appreciation is expressed towards each member of this group as each of us has given all our efforts and time to complete and present this project as best as we could. This project would not complete and work functionally without the cooperation and coordination from each member.

ABSTRACT

A variety of tools that have various kinds of function was undeniably has help its user to ease their daily work. Hence, the toolbox was invented to carry, protect and the organizing the tools inside it. Although, there a lot of innovation and improvement on the existing toolbox, yet the missing tool was still being one of the biggest issues for the toolbox owner. Research has been done also state that in 1990 American Demographics report that we spend 16 minutes per day looking for lost items. Other estimates range as high as 31-55 minutes per day. As to fulfil the vision of Industrial Revolution 4.0, the idea was triggered to innovate and redesign the existing toolbox into a smart toolbox. Toolbox sensor requires a matrix card or NFC card to open the toolbox door and the user's name will be entered into the data of the toolbox user list in the computer of the lecturer or keeper of the workshop items. By the creation of this smart toolbox, the missing tool of toolbox owner can be preventing from happen more frequent in the future and the user can enjoy using the smart and efficient toolbox to improve their daily working life. Plus, the Arduino software also will be more acknowledge by the public and specifically the toolbox's owner since this smart toolbox was programmed using Arduino software.

CONTENT

CHAPTER 1

INTRODUCTION

1.1 RESEARCH BACKGROUND

Nowadays, there are still many employment sectors out there that are still using and utilizing hand tools in their day-to-day work despite the rapidly increasing technological advances. The tool itself refers to an object used to extend the ability of an individual to modify features of the surrounding environment. Hence, a toolbox was invented to protect, organize and carry the tool inside it. Although there was a lot of innovation and improvement on the existing toolbox, the missing tool was still one of the biggest issues for the toolbox owner. Not to mention that if the owner isn't able to find their tool, then not only can't they proceed with their work, but they also must buy the new one. Plus, the missing tool can be hazardous for those who weren't aware of the present of the missing tool. Moreover, it is a part of human nature to naturally forget something. Forgetfulness is part of adult life for many reasons, including being preoccupied, under stress, fatigue or possibly health issues like depression, hypothyroidism or worse, dementia.

However, throughout this project the existing toolbox can be improved to smart, efficient and convenient toolbox that can be applied by various users and different kinds of industrial field. Besides, the smart toolbox also can detect the absence of each tool inside it. One of the main components that make this concept work effectively is LDR sensor. A photo resistor or lightdependent resistor LDR is an active component that decreases resistance with respect to receiving luminosity (light) on the component's sensitive surface. The resistance of a photo resistor decreases with increase in incident light intensity, in other words, it exhibits photoconductivity [Photo resistor-light dependent resistor LDR, (19 April 2018), resistor guide, retrieved from https://en.wikipedia.org/wiki/Photoresistor]. There are many applications of LDR sensor such as camera light meters, outdoor clocks, and solar road studs. Besides, the smart toolbox applying an Arduino software into its system to make it as relevance as the Industrial Revolution 4.0 where smart connectivity is the important part.

1.2 PROBLEM STATEMENT

- Heavy to carry if the toolbox is full
- Hard to carry anywhere
- The risk of self-injury is high
- Can’t find the tools if the tools missing

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1.3 PROJECT OBJECTIVE

- to design and develop an ergonomic toolbox
- to show the functionality of security sensor of toolbox
- to solve problem of missing hand tools by collecting that data from users who use the toolbox

1.4 SIGNIFICANCE

Firstly, the primary users for this project are the workers that work at the workshop, factory, institute for any course that have a workshop in the syllabus such as in politeknik for engineering course in workshop subject. The design is made for much better security it is to make sure that the tool is not going missing, we also can identify who opens the toolbox since to open it you must have a card design to open the toolbox and only the workers can have it for much better security. Compare to other toolbox this one is smaller and can save space but it is compact with tool and only can put the tool that are useful for the workshop it is also can bring anywhere which less man power since there no need to carry it because the design has a wheel and a handle to bring it to another place with less energy.

1.5 SCOPE OF PROJECT

- Student of Polytechnic Banting Selangor
- Fitting workshop Polytechnic Banting Selangor
- To ensure user-friendly design material integration without compromising toolbox usability.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

In this chapter, will be shown about the innovation of the existing toolbox to the smart and convenient toolbox. Before continuing to further in this topic, a toolbox also called toolkit, tool chest or workbox is a box to organize, carry, and protect the owner's tools. They could be used for trade, a hobby or DIY, and their contents vary with the craft of the owner. A toolbox could refer to several types of storage to hold tools. It could mean a small portable box that can carry a few tools to a project location, or a large storage system set on casters.

Early in mankind, people would find objects that they could use to do other things. For example, one might find a rock with a nice flat spot on it to use as a hammer. As these early tools were being found and made, people needed some place to store them. People utilized cloth bags, stone, or clay jars to hold their tools. Once wood became more available, people started making wooden toolboxes. As wood became more available for homes and tools were created to work wood, toolboxes were created from wood. Wood was the material of choice for toolboxes-built beginning in the early 19th century (Unique Truck Accessories,2015).

Overtime as building designs change, tools and toolboxes must evolve. People who worked in construction, repair, and general labors. Oftentimes they need to carry their tools to the work site with them. Portable toolboxes were typically made from wood, steel, and plastic. Steel toolboxes are known to be stronger, withstand abuse, and support the weight of many tools. Steel toolboxes tend to rust. Plastic toolboxes are known to be lightweight. Plastic toolboxes loaded with tools can oftentimes be just as heavy as an empty steel toolbox. Modern toolboxes are predominantly metal or plastic.

DESIGN	MATERIALS	YEAR	ADVANTAGES	DISADVANTAGES
 WOODEN TOOLBOX	-Wood	-19th Century	-Wooden toolboxes can be more environmentally friendly	-Don't have secure lock -Need regular maintenance to protect against moisture and pests
 CANTILEVER TOOLBOX	-Steel -Aluminum	-20th Century	-Multiple trays or compartment -Quick access (time searching for specific items)	-Heavy -More expensive - Restricting the types of tools that can be stored (larger tool may not fit comfortably)
TOOLCART 	-Steel -Aluminum -Stainless steel	-21st Century	-Ease of movement Multiple drawer and shelves -Larger storage capacity	-Higher price -Regular maintenance required to ensure the wheels function -Heavy when loaded

Figure 2.1: Comparison of existing toolbox

2.2 PREVIOUS STUDIES/REVIEWS/INVESTIGATION

2.2.1 Project research

A toolbox is a box to organize, carry and protect the owner's tools. This existing toolbox comes in many shapes, different of secure lock safety and have their own design, which is in the form of boxes, cantilever toolbox, simple wooden toolbox, portable toolbox and moulded toolbox. However, it has been common behavior for humans to not be able to place back the tool that has been used, which will cause many hand tools in the workshop to be lost. Additionally, a toolbox that does not have a secure safety lock will cause hand tools in the workshop to decrease. Thus, to prevent this happening, there are come out with several ideas to improve the existing toolbox to become more convenient and comfortable to use.

Besides, the existing toolbox cannot detect the user who uses the hand tools during workshop classes. Therefore, in terms of the research being done, the toolbox will detect who uses the hand tools by scanning their matrix card before opening the toolbox. Hereby, students or lecturers who use hand tools will be more alert to returning hand tools after use because the sensor of the toolbox can extract data on who is using them if there is a loss of hand tools in the workshop. This is to prevent a project that needs to be done in the workshop from becoming slow due to a lack of hand tools and having to share hand tools in turn with others.

2.2.2 Statistic case

We have made feedback form to students Polytechnic Banting through the google form platform to get data about the problems in the fitting workshops.

a

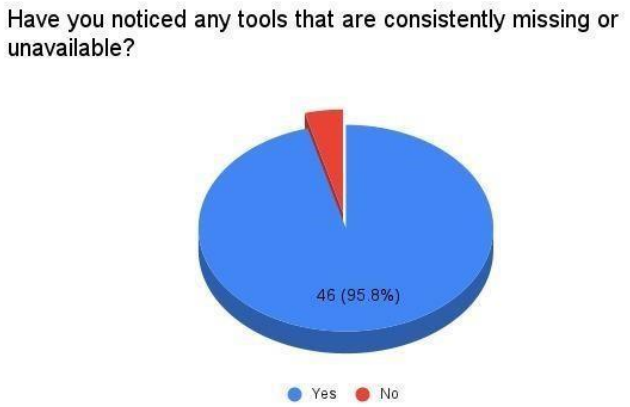

Figure 2.2

Based on the figure 2.2 pie chart above, it shows that 95.8% students say there's a lot of hand tools missing in the fitting workshop.

b)

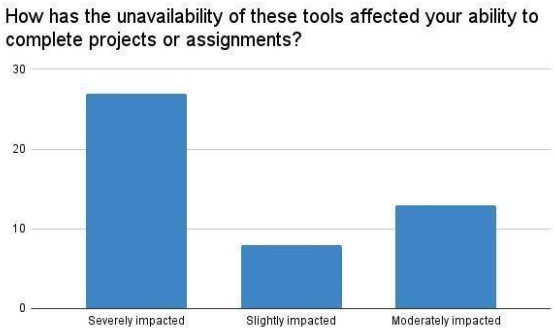

Figure 2.3

With the data that we got in figure 2.3, most students are very affected to complete the task in the workshop due to a lack of workshop tools.

The conclusion of the data is that the loss of tools in the workshop has a very bad impact on students in making activities in workshops. With the presence of the toolbox sensor, it can reduce the problem of loss of hand tools in the workshops.

2.3 OVERVIEW OF THE MATERIAL, TOOLS AND EQUIPMENT

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

a) Material

b) Handle

c) Safety lock / latches

d) Compartments and Trays

Material

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Figure 2.3.1

Figure 2.3.1 show example of materials that are used for making a toolbox. The materials commonly used for making toolboxes each have unique characteristics that make them suitable for different uses. First, using steel as a material for making toolboxes can support heavy tools without bending or breaking. Second, by using plastic material generally more affordable for hand carry toolbox and easy to handle. However, making a toolbox from wood material can be easily customized or modified for specific needs but the weight is typically heavier than plastic but lighter than steel. Each material brings different benefits, such as durability, weight, resistance to elements, and cost.

Handle

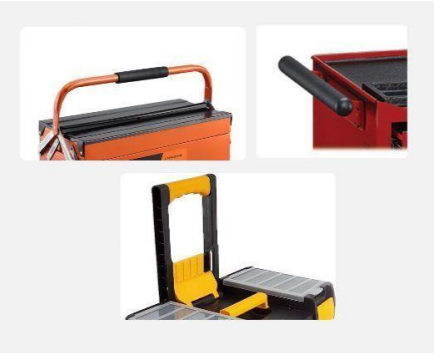


Figure 2.3.2

Figure 2.3.2 shows the difference types of handle use in the toolbox, the handle is a crucial component of a toolbox, designed to ensure easy and comfortable portability. Handle in every toolbox shaped to fit the natural contours of the hand, reducing fatigue during transport. In addition, handle design greatly impacts the functionality and comfort of the toolbox, making it an essential consideration in toolbox construction.

Safety lock / latches

Figure 2.3.3

Figure 2.3.3 shows the latches as a safety lock that is used in toolbox,latches are essential components of a toolbox, ensuring that the lid or compartments remain securely closed during transport and storage. It's designed for ease of use, with shapes that are easy to grip and operate. Some latches come with built-in locks or allow for padlock attachment for added security. Certain latches allow for tension adjustment to ensure a tight fit over time as parts wear.

Compartment and Trays

Figure 2.3.4

Figure 2.3.4 shows the difference of compartment and trays used in toolbox, compartments and trays are essential components of a toolbox, designed to organize and separate tools for easy access and efficient storage. The compartment has many types, which is fixed compartment provided specific places for each type of tool, adjustable compartment that can repositioned to create custom sized compartments, and removable compartment can be taken out to the toolbox for easy access. However, the trays also have many types such as lift-out trays that can be easily lifted out to access tools and sliding trays that provide easy access to tools without removing the tray that useful for frequently used items.

2.4 SUMMARY

The literature review on our sensor toolbox is our toolbox provided sensor technologies into toolboxes significantly enhances tool management, security, and operational efficiency. While RFID Arduino systems are popular for their ease of use and cost-effectiveness, wireless sensor networks and technologies offer advanced monitoring and connectivity options. Effective power management and robust software integration are essential to maximize the benefits of these sensor systems. Overall, sensor-equipped toolboxes represent a significant advancement in tool management, providing substantial benefits in various professional and educational settings.

CHAPTER 3

METHODOLOGY

3.1 Introduction

This chapter focuses on the manufacturing process of the Toolbox Sensor. Overall, the flow chart showing the manufacturing process is shown in figure 3.1.

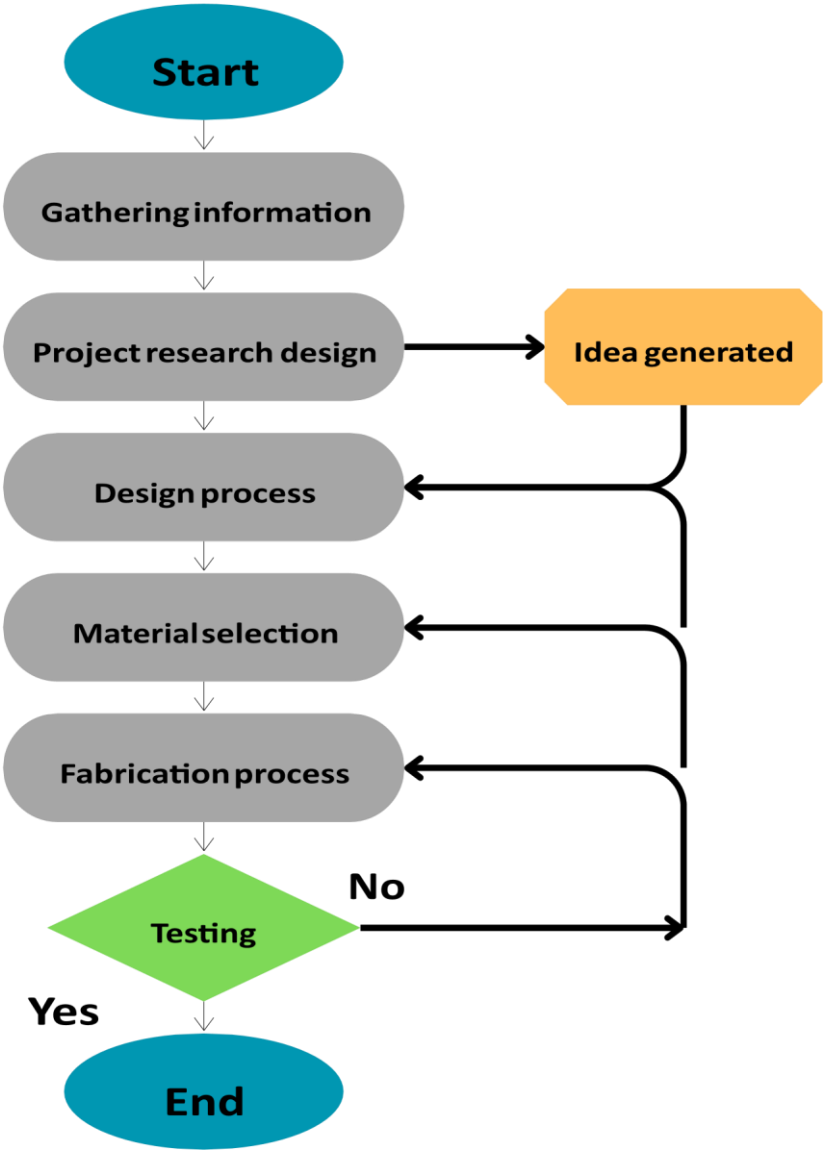


Figure 3.1

3.2 Selection of Concept and Design of Toolbox Sensor

In the initial stages, there are four proposed toolbox sensor designs that have the potential to be developed. Figures 3.2, 3.3, 3.4 and 3.5 show isometric drawings of the three designs.

Figure 3.2 shown design toolbox that has a common toolbox design where it has a compartment that has a square body and can be opened at the top of it to put tools that can be hung such as a hand saw, and can be used if the tool is still being used and instead of putting it at work place where it can be disturb when working the hanger hook can be used to hang the tool for a moment. It also has a set of 2 wheels at the base of the toolbox so that it can move easier by pushing the handle that is at the side of the toolbox, plus with an Arduino at the door so that it will ensure safety of being stolen from happening.

Then, the materials that are being used are stainless steel for the body, 2 sets of rubber wheels, hanger hook, Arduino and an aluminium for the handle.

Figure 3.2

For this 2nd design it has a unique design since it came from the impression of an old suitcase bag where the design is like that that has a square shape design and, inside, it has a 2 set of tools that the toolbox can carry. It is made so that it can be easier to carry anywhere even outside of the workshop, it is an easy way to say that this toolbox is portable and allows for easy transport of tools to different job sites or areas within a workspace. The set of tools being compact in this toolbox is neat.

Figure 3.3 shows that proposal of the 2nd design. Then the material that is being used is curved for the body since it is lightweight, scratch resistant and resistant to extreme temperatures. The

handle is made of rubber so that the grip will be better and will not be painful at the finger while carrying. Additionally, silicone is used inside the toolbox to make a specific shape so that only a specific shape of tool can be put in it.

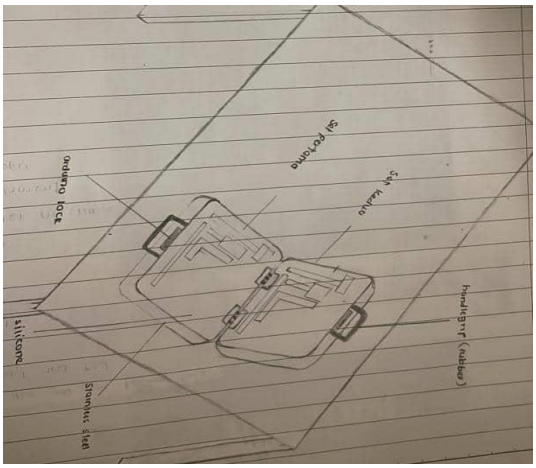


Figure 3.3

For this 3rd design is different from any other toolbox and are trying to achieve a unique design of toolbox where it can catch the attention of the society, with the addition of Arduino so the safety will be superior, have a wheel and a telescopic handle so that it can move easier rather than carrying it. A door that has to slide to open it with a 4 drawer and a 4 set of tools in it, plus with a set of med kit at the top of the toolbox that can be opened by sliding the top of the toolbox.

Figure 3.4 shows the proposal of the 3rd design. Then, the material that is being used is plywood for the body, hollow aluminum for the telescopic handle, rubber wheels for a better grip. The drawers frame that kept the tools is made of plastic acrylic and has silicone to make a shape that only a specific tool can be put not a random tool. An Arduino with a card to make sure that only a specific user can open the toolbox and guarantee safety from the tools being stolen.

With this cost of material, the cost that to make this toolbox is inexpensive and the toolbox needs to be taken care of carefully rather than rough it is to make sure that the toolbox can last longer-term and being useful since the body made of plywood and a battery check to the Arduino so it doesn't run out.

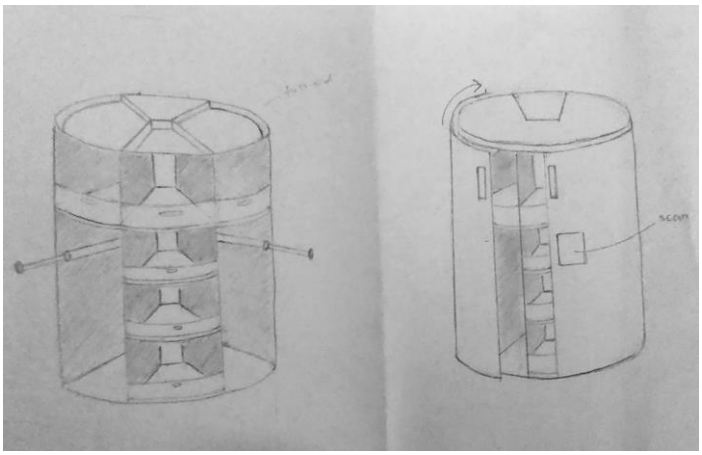


Figure 3.4

For this 4th design it has the same idea as the 3rd design but has a chance for the design where it doesn't take much space since it is compact with tool and smaller than first design, easier to move with the set of handle and wheels so that it will take less energy to move, with 3 sets of tools at the lower door and set of med kit at the top of the toolbox, with the wheels also have a brake so that I will not rolled away if the user want it to be static at one place.

Figure 3.5 shown that the proposal Then the used materials are also good where it is for a long-lasting term if it is properly maintained and not being vandalism, with the Arduino being added it also increases the safety for this toolbox so that the tool for this toolbox will not get stolen and only a specific user can open. Plus, good protection helps protect tools from damage, dust, and moisture, prolonging their lifespan.

The materials that are being used for the body are mild steel, the telescopic handle is hollow aluminum, the wheels are rubber wheels, so the grip is better than plastic. Secondly the drawers where the tool is being kept is plastic acrylic for the frame, silicone to make a specific tool that can only be put and also Arduino.

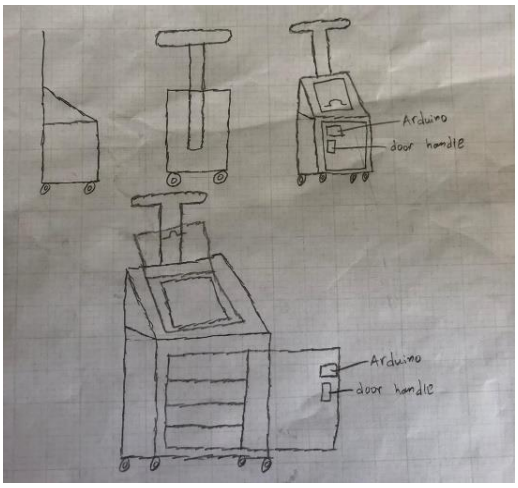


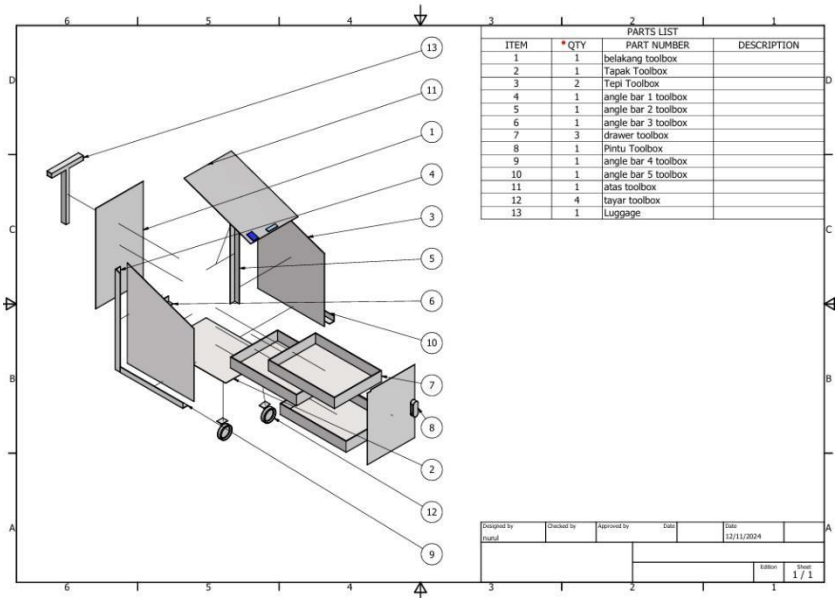
Figure 3.5

3.3 TECHNICAL DRAWING

Figures 3.6, 3.7 and 3.8 show the technical drawing of design project Toolbox Sensor.

i. Installation drawing and Bil of Material

Figure 3.6 shows the assembly drawing along with the bill of material that displays the resolution of each component. The first part is the body of the project, which uses mild steel. After that, the second part has a plastic wheel with brakes on it. The third part is the drawer that we use acrylic sheet. Then, use silicone for the hand tool position. Next, the fourth part is suitcase luggage handle for the handle of toolbox. For the fifth part, still use mild steel for medical kit for toolbox.



PARTS LIST

ITEM	QTY	PART NUMBER	DESCRIPTION
1	1	belakang toolbox	
2	1	Tapak Toolbox	
3	2	Tepi Toolbox	
4	1	angle bar 1 toolbox	
5	1	angle bar 2 toolbox	
6	1	angle bar 3 toolbox	
7	3	drawer toolbox	
8	1	Pintu Toolbox	
9	1	angle bar 4 toolbox	
10	1	angle bar 5 toolbox	
11	1	atas toolbox	
12	4	tayar toolbox	
13	1	Luggage	

Figure 3.6

ii. Isometric drawing

Figure 3.7 shows isometric drawing which is top, font and side views of the project. Through the top view of the project can be seen the measurement for the thickness and length of each material. The height of the entire project and length can also be known through the side view and front view can see each part and entire project.

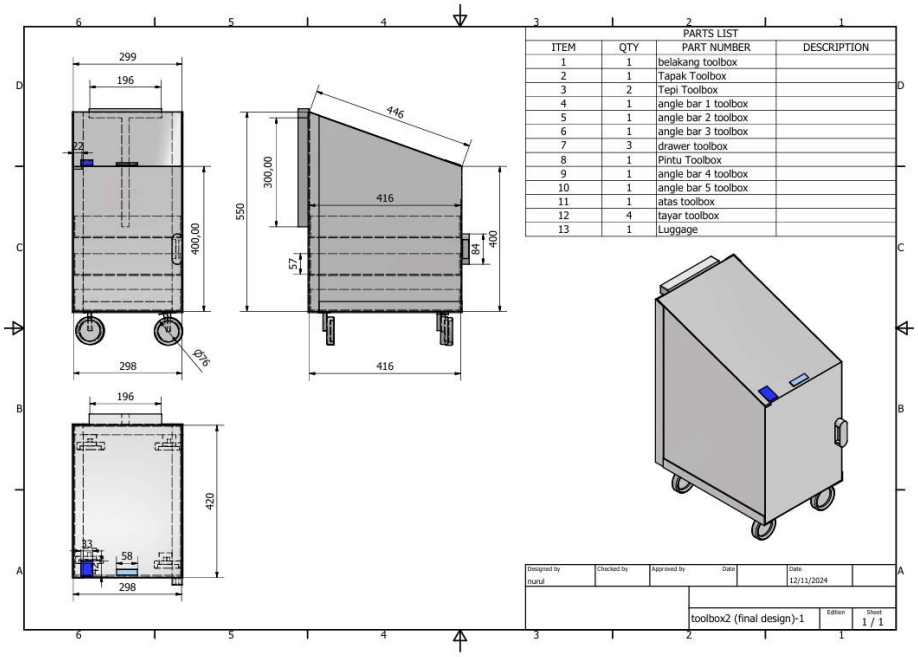


Figure 3.7

iii. Entire project drawing

Figure 3.8 shows a sketch of the whole toolbox sensor where each component has been joined into one toolbox. The first part is the body of the project produced using mild still measuring 28 inch wide, 38 inch long and 44-inch height. The second part is the drawer of the toolbox made using measuring 24 inch in width and 34 in length. The third and fourth are the medical box of the toolbox and using measuring 16 inch in height, 38 inch in length and 20 inch in width.

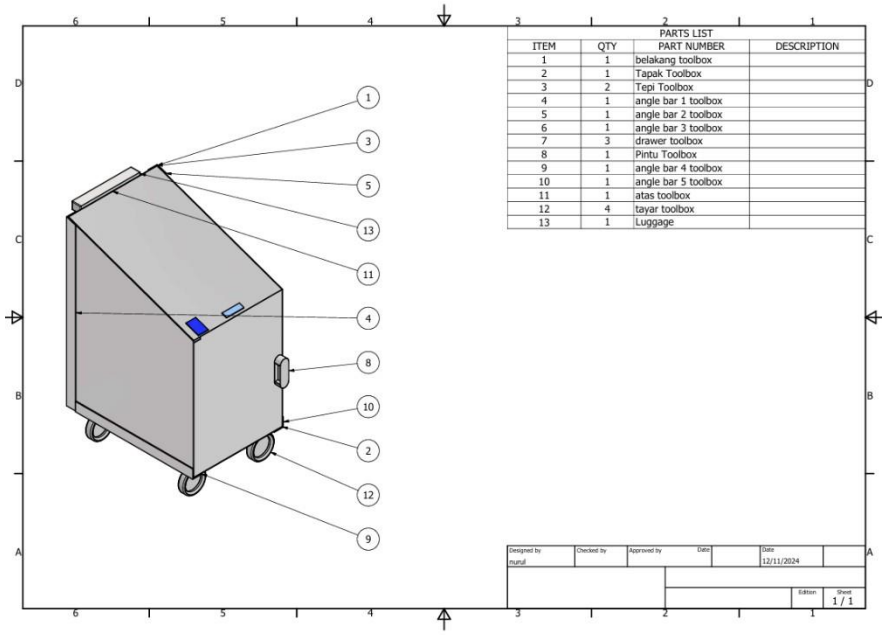
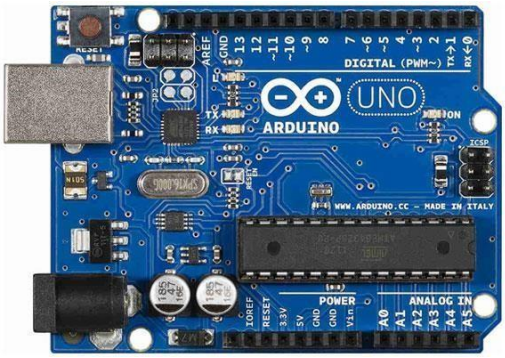


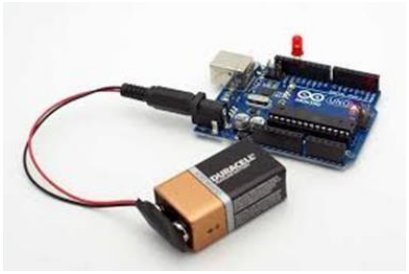
Figure 3.8

3.4 MATERIAL AND COMPONENTS SELECTION

The material selection process is very important to control expenses to minimize the production costs. The selection of materials should be according to the specifications required to avoid project failure works. Table 3.1 is the list of main material and components used to complete the Toolbox Sensor project.

Material	Function
 Suitcase luggage handle	A suitcase luggage handle made of aluminum that has excellent durability is used as a toolbox handle. The toolbox handle that is on in the back of the toolbox is used to make it easier for the user to pull the toolbox in any direction comfortably.

 Plastic wheel	Plastic wheel is used to make it easier for users to move the toolbox without using a lot of energy. These plastic wheels have a long lifespan and are easy to maintain.
 Arduino System	Arduino is an open-source electronic platform that consists of hardware and software design to make sure microcontroller programming more accessible to various circles. Arduino is used on Toolbox Sensor to allow lecturers or maintainers to identify users in the event of damage or loss of workshop equipment.

 NFC card	Polytechnic Banting Selangor student's matrix card has an RFID chip that is used to record exit or entry into Polytechnic Banting Selangor. With the help of the Arduino system on the Toolbox Sensor, users can be recorded by touching their matrix card to the Arduino sensor for unlock it.
 Arduino's battery	The battery used in the Arduino Toolbox Sensor system is a 9v battery type. This is because it is easy to find and durable and can be connected by using the barrel jack connector on the Arduino uno board that is on the Toolbox Sensor.

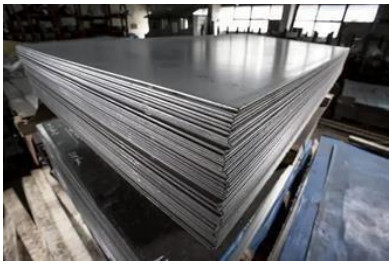
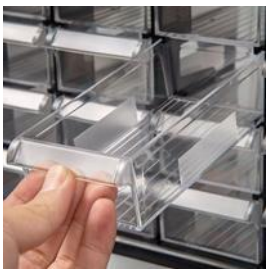
 Mild steel	Mild steel is used on the outside or better known as the body. This is because mild steel is easy to form to build the Toolbox Sensor's body without many problems. In addition, mild steel also has good enough durability and is cheaper.
 Plastic acrylic	Acrylic plastic material is used on the Toolbox Sensor's drawer. This is because acrylic plastic is clear and easy to form, making it easier for users to see the workshop tools to be taken.
 Foam Tools	This tools foam solution is designed to precisely shape and secure your tools within drawer toolboxes, ensuring easy access, protection, and efficient workspace management. However, the foams are easily cut and shape the foam to fit any tool configuration. It's available in various thicknesses to accommodate different tool sizes and drawer depths.

Table 3.1

3.5 FABRICATION PROCESS

No	Activities	Description
1	 	-Marking and measurement. The mild steel, drawer foam, acrylic sheet and angle steel bars were measured to prepare them for constructing the toolbox.
2	 	-Cutting After marking and measuring, the steel bars were cut according to the outlined measurements.
3	 	-Welding Following the cutting process, the steel pieces were aligned and welded together to form the toolbox body.
4		- Drilling Used the drilling machine to drill holes in the angle steel bar for rivet installation.
5	 	-Rivet Used a rivets process to assemble the angle steel bar with mild steel for the body of the toolbox.

6			Performed the wiring for the Arduino and mounted it on the toolbox door.

Table 3.2

3.6 GANTT CHART

Table 3.3 below shows the Gantt chart as process to our project activity of toolbox sensor.

Table 3.3: Gantt Chart project 1

Table 3.4: Gantt Chart project 2

CHAPTER 4
RESULTS AND ANALYSIS

4.1 INTRODUCTION

This chapter will include the impact of our product, its advantages, and disadvantages, as well as the challenges throughout the process of developing the product and finally product testing. This data and analysis are very important for this project to achieve the objectives and scope of the project. This data indicates the successful results of the materials testing. After getting all of this data, we analyze every single possible to make it perfect.

4.2 DATA ANALYSIS AND STATISTICS

In order to determine the success of the "*Toolbox Sensor*" to all communities, we collected the statistics and data shown below from users using the Google Forms platform.

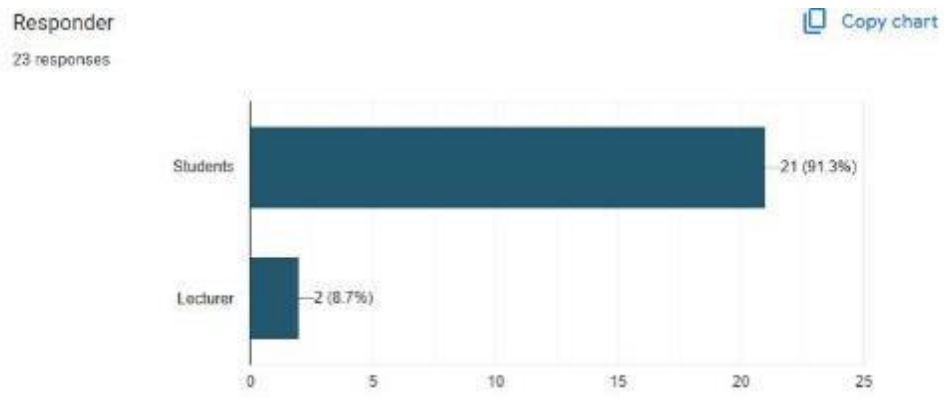


Figure 4.1 Feedback from the Google Forms

Based on the chart provided, the Toolbox Sensor project has received responses from two groups: students and lecturers, and highlights a clear difference in participation between them. Out of the 23 people who responded, 21 were students, making up 91.3% of the responses, while only 2 responses came from lecturers, which is just 8.7%. The results suggest that students were far more engaged or interested in sharing their thoughts or feedback, perhaps because the topic was more relevant to them or they felt a stronger connection to it. On the other hand, lecturers contributed only a small portion of the responses, which might reflect a difference in interest,

availability, or perceived relevance. This split in responses gives us insight into who is most invested in this topic, with students showing a much stronger presence.

Overall, this feedback reflects a high level of student involvement, with some contributions from lecturers in evaluating the performance of this Toolbox Sensor.

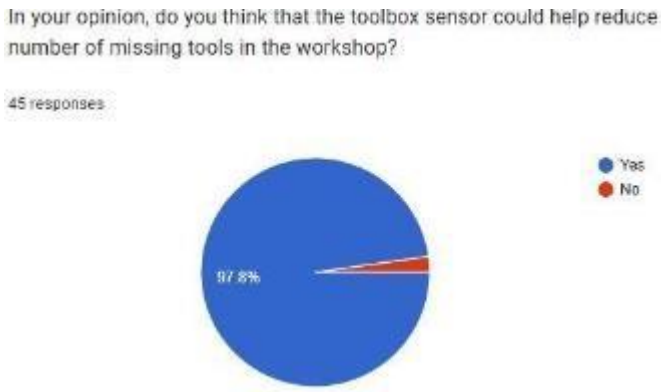


Figure 4.2 Feedback about the effectiveness of the objective

This chart reveals a strong consensus among respondents regarding the potential of a Toolbox Sensor to reduce missing tools in the workshop. Out of 45 people who shared their opinions, an overwhelming 97.8% almost everyone believes that adding a sensor system could really help keep track of tools and prevent them from disappearing. This high level of confidence shows that most people feel the sensor could make a meaningful difference in maintaining accountability in the workshop.

Only a small group, making up just 2.2% of respondents, felt otherwise. These few may have doubts about the sensor's impact or might feel there are other factors at play that the sensor alone won't address. Their perspective suggests they might be considering practical limitations or the possibility that some issues go beyond what technology alone can solve.

Overall, the response reflects a shared sense of optimism about the Toolbox Sensor, with the vast majority feeling it could offer a practical solution to a common problem. It's clear that

missing tools are an issue people care about, and they see this sensor as a step toward a more organized and reliable workshop environment.

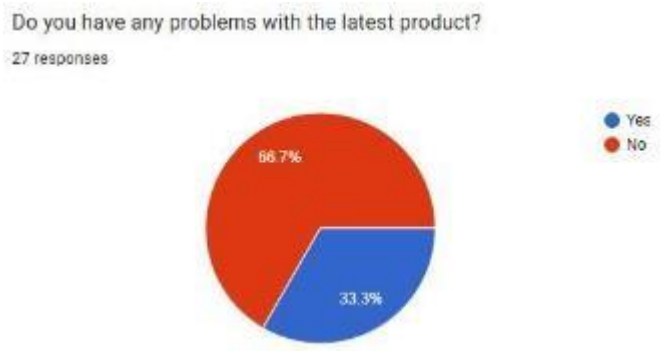


Figure 4.3 Feedback about if the responded have any problem with the latest product

This chart reflects how users feel about the latest product and whether they're encountering any issues. Out of 27 people who responded, most—66.7%—said they're not facing any problems, shown in red. This is a promising sign, suggesting that the product is meeting expectations for the majority and likely performing well in areas that matter most to users.

However, about a third of respondents, or 33.3%, answered "Yes" to having issues, represented by the blue section. Although this group is smaller, it's still a noticeable portion of users who are experiencing some challenges or frustrations with the product. This feedback suggests there may be specific areas that could be improved, whether in functionality, ease of use, or quality.

In general, while most users seem happy with the product, the feedback from those experiencing issues provides valuable insights. By addressing the concerns of this group, it may be possible to enhance the product experience further and ensure that more users are fully satisfied.

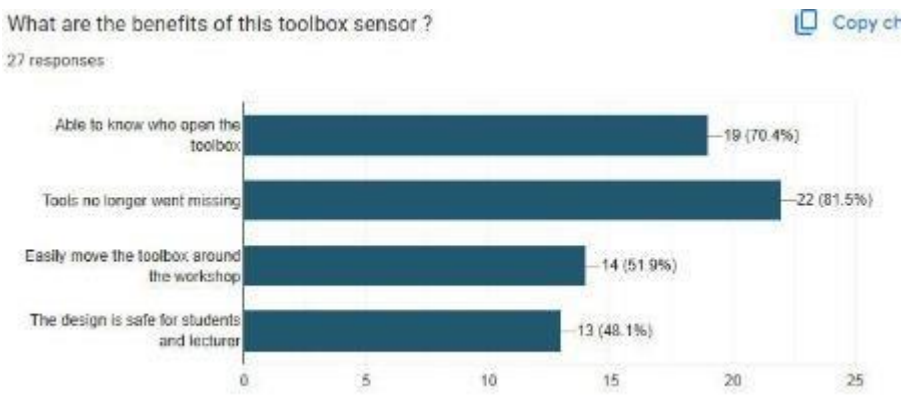


Figure 4.4 Feedback about the benefits of this Toolbox Sensor

This chart captures what 27 people think about the benefits of using a toolbox sensor in a workshop environment. It turns out the biggest advantage, according to 81.5% of respondents, is that tools no longer go missing. This suggests the sensor does a great job of keeping track of tools, ensuring that they're always where they should be when needed.

The second key benefit, noted by 70.4% of respondents, is the ability to know who opened the toolbox. This feature seems to make a big difference in terms of accountability, especially in a shared space like a workshop or classroom. Knowing who accessed the tools can help create a sense of responsibility among users, reducing the chances of misplaced items.

Additionally, 51.9% of participants mentioned that the sensor makes it easier to move the toolbox around the workshop. This indicates that the toolbox is not only practical but also easy to handle and transport, which can be a significant convenience when working on multiple projects or in larger spaces.

Safety also stands out as a meaningful benefit. Nearly half the respondents (48.1%) pointed out that the toolbox sensor is designed with safety in mind, making it a good fit for environments involving both students and instructors. This focus on safety underscores the importance of creating a secure and user-friendly workshop space.

In summary, the toolbox sensor is seen as a helpful tool that brings order, accountability, convenience, and safety to a busy workshop, making it a popular choice for those who value both practicality and security in their workspaces.

4.3 PROJECT OUTCOME

This is the picture of our project that we were able to complete over the course of 14 weeks as well as our last project:

Figure 4.5

4.4 COSTING OF THE PRODUCT

ITEM	QUANTITY	EACH PRICE	TOTAL
Angle steel bar	1	RM19	RM19
Mild steel	1	RM80	RM80
Acrylic sheet	8	RM9.90	RM7
Drawer foam	3	RM12	RM36
Drawer slider	3	RM17	RM51
Handle luggage	1	RM30.21	RM30.21
Arduino	1	RM83.38	RM83.38
Door handle	1	RM1.75	RM1.75
Arduino coding	1	RM490	RM490
Rivet	4	RM1.90	RM7.60

Bolt and nut	1	RM20	RM20
Hinge door	1	RM2.10	RM2.10
Wheel	1	RM8	RM8
TOTAL			RM908.24

4.5 PROJECT TESTING AND PERFORMANCE ANALYSIS

FIRST ATTEMPT	
Concept	The concept of using wood as a body for the toolbox, card matrix students as a card that need to open the toolbox
Weight	Light
Material	Plywood
Durability	Moderate
Percentage of safety for toolbox cannot be break	40%

SECOND ATTEMPT	
Concept	The concept of using mild steel as a body for the toolbox, RFID card as a card that need to open the toolbox
Weight	Moderate
Material	Mild Steel
Durability	High
Percentage of safety for toolbox cannot be break	90%

4.6 DISCUSSION

The Toolbox Sensor design shared a similar concept for the body but one that have a low durability and the other have higher durability, and through research toolbox that made from wood less resistant to impact forces when dropped, possibly resulting in catastrophic failure. So, by changing it to Mild steel that is much stronger and more durable, also able to withstand heavy impacts and rough handling.

At first thought, the toolbox where plan to made from wood because it is cheaper, but the quality will drop so planning to changing it to stainless steel, but the cost will be expensive after thought of this through the result have been made to make the Toolbox Sensor from mild steel that are more costeffective than many other materials also versatility where mild steel is easy to cut, shape, and weld into various forms. Lastly, the Resistance to environmental factors where mild steel is resistant to varying weather conditions, making it suitable for both indoor and outdoor use.

CHAPTER 5
CONCLUSION

5.1 INTRODUCTION

This chapter is the last chapter in this study and in general this chapter will briefly discuss all discussions in more depth about the results of the study that have been analyzed in chapter 4. The results of these findings are supported by various opinions that can further strengthen the results of the analysis of the study. After going through the phases that have been discussed and the strategy also runs smoothly along with it. Researchers have successfully improved the quality and safety level of the TOOLBOX SENSOR project.

5.2 ACHIEVEMENT OF AIMS AND OBJECTIVE OF RESEARCH

With all the research and information gathering now we can conclude that the goal and objectives presented at the beginning of the research were successfully achieved. The purpose of the creation of this Toolbox Sensor has shown satisfactory performance.

1. Objective: To design and develop an ergonomic toolbox

- Development of a handle design that minimizes strain and allows for comfortable, extended use.
- Design of an efficient internal compartment system to accommodate various tools, ensuring they stay organized and easily accessible.
- Selection of lightweight, high strength materials such as mild steel for the toolbox's outer shell, ensuring it withstands drops, impacts, and wear.

2. Objective: To show the functionality of security sensor of toolbox

- Integration of RFID access control systems that only allow authorized users to access the toolbox, preventing tool theft or unauthorized use.
- Development of a tracking feature that records every instance of access, including who opened the toolbox and when.
- Ensuring the security sensor system is robust enough to function reliably in various environments, such as workshops, outdoor construction sites, or high dust areas.

3. To solve problem of missing hand tools by collecting that data from users who use the toolbox

- Providing user training on how to properly use the toolbox system, understanding the importance of tool return policies, and how to report issues with the system.
- Successful implementation of a system that reduces the occurrence of missing hand tools by providing clear tracking and accountability.
- Implementation of user-specific access controls using RFID cards to track who accesses the toolbox.

5.3 SUGGESTIONS AND RECOMMENDATIONS

Based on the research conducted on the toolbox sensor, here are some suggestions and recommendations to further improve its efficiency and attract more customer:

1. The RFID sensor that are used can be broken if any water touches the RFID sensor or the Arduino board, so to make it last some of the suggestions is to make the RFID sensor weatherproof and dustproofing where if the toolbox is used in harsh environments, weatherproofing the sensor and matrix card pad can increase longevity and reliability.
2. Added an ecofriendly mode where for now the toolbox sensor used a high voltage of battery and can make the battery life short. So, for suggestions is that added an ecofriendly mode or low power mode. Example is that if the toolbox sensor is not used then the sensor will go to the low power mode and the moment the user wants to use by touching the card to the RFID sensor then the system will automatically activates provide a long-life battery.
3. Solar or battery backup where if the toolbox sensor is used outside so added a solar system can be considered so there no need to change any battery if sun risen the toolbox will forever be able to use. A battery backup to ensure consistent functionality.
4. Ergonomically design for the body even if the telescopic handles are used to prevent the user for carrying heavy causing back pain, changing the body design to make it the user do not have to bend over to take the tools from the toolbox. Added a hydraulic at the bottom of toolbox where if the user put, they foot at the pedal the toolbox will go up according to the suitable height.

5. At the top of the body for this toolbox can change the design to add a door where the user can put a first aid kit so if any unexpected accident happens the user can open the top door to use the first aid.

5.4 CONCLUSION

The Sensor Toolbox project has addressed the need for a versatile and user-friendly system to streamline data collection and enhance learning experiences in technical and educational environments. By integrating advanced sensor technology with access control through matrix cards, it allows educators to monitor tool usage and track student activity. The toolbox's design prioritizes both functionality and user experience, ensuring that students can easily scan their matrix cards to access the toolbox and initiate data collection. Lastly, by creating this toolbox we can reduce injuries and can add a wider work space with a medium sized and compact toolbox.

5.5 REFERENCES

- **https://m.knightauto.com.my/index.php?ws=showproducts&products_id=4323268&cat=Tool-Storage-Tool-Boxes**
- **https://m.knightauto.com.my/index.php?ws=showproducts&products_id=4323268&cat=Tool-Storage-Tool-Boxes**

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3.4	MATERIAL AND COMPONENTS SELECTION
4.2	DATA ANALYSIS AND STATISTICS
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Pengesahan Penyelia Projek:

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Nama: