POLITEKNIK MALAYSIA
BANTING

DEPARTMENT OF MECHANICAL ENGINEERING

FINAL YEAR'S PROJECT REPORT

MINI FORKLIFT CONTROL SYSTEM IN PBS

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This report is submitted to the department of mechanical engineering as fulfilling part of the conditions of the award Diploma of mechanical engineering.

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In front us,

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……

APPRECIATION

Assalamualaikum and greetings, Alhamdulillah we were able to complete the mini forklift control project and report on time. This projects represent not just the culmination of we academic journey but also a testament to passion, resilience, and ingenuity. With the blessings, hard work and cooperation of our group members, the project was successfully completed.

Firstly, we wanted to extend my heartfelt appreciation for the outstanding lectures Puan Zalaida Bt Talib have delivered during our Final Year Project. Your dedication, expertise, and passion for the subject matter have made a significant impact on our learning journey, and I am truly grateful for the knowledge and insights you've shared with us.

Thank you once again for your outstanding contributions to our learning experience. You have made a lasting impact, and I feel fortunate to have had the opportunity to learn from someone as passionate, knowledgeable, and dedicated as you.

In closing, I want to express my sincere appreciation to everyone involved in making these projects a reality. To the students, faculty, mentors, families, and supporters, thank you for your dedication, passion, and belief in the power of education. Let us continue to celebrate and support each other as we move forward, knowing that the best is yet to come.

Thank you.

ABSTRACT

In today's life , there is a wide variety of forklift ,from the large heavy loading truck to the one that work among narrow aisles. Forklift have become one of the basic transportation tools we use in our lives. We find that there are some improvements that can be made to bring the forklift to a better performance.

Leveraging advanced sensor technology, precise actuation mechanisms, and intelligent control algorithms, the system enables seamless navigation, obstacle avoidance, and cargo manipulation in constrained environments. By
harnessing the power of automation, the mini forklift not only streamlines material handling tasks but also reduces the risk of accidents and enhances productivity.

This papers present design of mini four wheel . Currently, in warehouse storage systems are mainly still done in a traditional way using human operator to store and pick goods into specified location. This project is intended to construct an automated forklift using controller (Arduino system). It's also equip with electric hoist for lifting mechanism , using battery supply to flow the electricity with help of power inverter. This purpose vision is to encountered moving and lifting problem that happened to our industries.

TABLE OF CONTENT

CHAPTER 1 : INTRODUCTION

1.0 INTRODUCTION

Mini forklifts are compact and versatile material handling equipment that are designed for use in tight spaces and narrow aisles. These smaller forklifts offer the manoeuvrability and agility required for efficient operations in warehouses, distribution centres, manufacturing facilities, and other industrial settings where space is limited. The control system of a mini forklift plays a crucial role in its functionality and performance. It encompasses various components and technologies that enable operators to effectively navigate the forklift, handle loads with precision, and ensure safety during operations. Overall, the control system of a mini forklift plays a critical role in ensuring smooth, safe, and efficient material handling operations in confined spaces. Advancements in control technologies continue to enhance the capabilities and performance of mini forklifts, making them indispensable assets in modern industrial environments**. (F. Hella et al.) (Analysis of eye movements in different tasks related to the use of lift trucks Appl. Ergonom.)(1991)**

1.1 BACKGROUND OF STUDY

The background of study for a forklift controller involves understanding the challenges and requirements of forklift operation, as well as the technological advancements driving the development of sophisticated control systems. Key areas of focus include, firstly is Forklift Operation, we can understand the dynamics of forklift movement, including acceleration, deceleration, turning, and lifting operations. Recognizing the importance of precision, safety, and efficiency in forklift operation. Next is safety regulations, we must familiarize with industry standards and regulations governing forklift operation and safety protocols. Ensuring compliance with guidelines set by organizations such as OSHA (Occupational Safety and Health Administration) and ANSI (American National Standards Institute). Besides that, is control systems we can explore various control systems used in forklifts, ranging from basic manual controls to advanced electronic systems. Studying the principles of feedback control, actuator control for precise manoeuvring and load handling. Furthermore, is human - machine interaction, we must examine the ergonomic design of forklift controls and interfaces to ensure ease of operation and operator comfort. Considering factors such as display layout, control layout, and feedback mechanisms to enhance user experience and safety. Lastly is energy efficiency, we can research techniques for optimizing energy consumption in forklifts, such as regenerative braking, idle shutdown, and power management strategies. Balancing the need for performance with the desire to minimize environmental impact and operational costs.

By delving into these areas of study, researchers and engineers can gain valuable insights into the design and implementation of advanced forklift controllers that meet the evolving needs of the industry.

1.2 PROBLEM STATEMENT

Students and staff at Polytechnics Banting Selangor face significant challenges in managing the eco-friendly club, including securing adequate funding and resources, raising awareness and engagement, addressing logistical issues and infrastructure limitations, providing education and training, improving coordination and communication, and ensuring the long-term sustainability of initiatives.

The eco-friendly club at Polytechnics Banting Selangor faces a significant challenge in distribution as members encounter difficulties in lifting and moving the recycled items collected. This challenge arises from the physical nature of handling these items, requiring substantial effort and coordination to ensure efficient distribution processes.

Additionally, the health and well-being of both students and staff involved in the eco-friendly club are a concern, as many Malaysians, regardless of age, experience low back pain. This prevalent health issue can impact their ability to participate fully in the club's activities, especially those involving the manual handling and transportation of recycled materials. It highlights the importance of implementing ergonomic practices and providing support to mitigate the risk of injuries and promote a safer environment within the club.

1.3 PROJECT OBJECTIVES

- To design the mini forklift control to save more human energy.
- To develop semi auto mini forklift control the facilitate and lift object.

1.4 SCOPE PROJECT

This project is aimed :

- The weight limit of objects that can be lifted by a mini forklift is 20 - 30 kg
- Can be used by Banting Polytechnic students and lectures from Kelab Mesra Alam to manage recyclables.
- Can move on flat ground and also in the gardening area.
- Can move by using Bluetooth controller on phone.

CHAPTER 2 : LITERATURE REVIEWS

2.1 GENERAL LITERATURE REVIEW

2.1.1 Introduction

Forklift is an industrial vehicle which can carry tons of load and move from one place to another. It is very similar to a mini truck. The main objective of constructing a forklift is to carry goods anywhere at any time. Because of its efficiency and easy design, forklift has now become an essential body of an industry.

2.2 EXISTING PRODUCT

2.2.1 A Mini Forklift Control

A mini forklift robot that can store and pick up object. Using Radio Frequency Identification Devices (RFID) technology to find the coordinates of targeted storage slot and goods identification.

Figure 2.2.1

Figure 2.1.1 is Mini forklift robot that can store and pick up object to specified storage to a base using line follower and RFID. The mini forklift store and pick goods at specified location The robot can recognize two sides (A and B), 128 lines, 16 columns and 16 rows cabinets. Total success 100%.**(Institute of Electrical and Electronics Engineer (IEEE). Gyeongju, Korea (South).**

2.2.2 IoT (Arduino)

Arduino is an open-source electronics platform, offering flexibility, affordability, and compatibility with various sensors and actuators.

Figure 2.2.2 Arduino Board

Arduino was initially introduced in 2005 by (Massimo Banzi and David Cuartielles) as a tool to support interactive projects. Since then, it has grown into a comprehensive ecosystem, including hardware boards, an Integrated Development Environment (IDE), and a vast community offering extensive resources.

2.2.3 Electric Hoists

Electric hoists are lifting devices that utilize electric motors to facilitate the movement of heavy loads vertically or horizontally.

Figure 2.2.3 Electric Hoists

The electric hoist, a product of engineering and innovation, emerged during the industrial revolution with the invention of electric motors. William George Armstrong, a 19th-century inventor, is often credited with laying the groundwork for modern hoisting technologies. Electric hoists consist of an electric motor, drum and wire rope/chain, brake system, and control systems like pendant controls, wireless remotes, and smart control systems. Electric hoists have safety features like overload protection, emergency stop mechanisms, and anti-sway systems to prevent accidents. Regular maintenance, operator training, and OSHA guidelines are crucial.

2.2.4 Motor Power Window

A power window motor is a compact electric motor used to control the movement of car windows in vehicles with power window systems. These motors are typically small, efficient, and reliable, designed to lift or lower the window glass smoothly with minimal noise and effort.

Figure 2.2.4 Motor Power Window

Power window systems typically use a DC motor, which is easily controlled with a switch or microcontroller. The motor rotates a worm gear, driving a mechanism that raises or lowers the window glass. These motors are primarily used in automotive systems but can also be used in DIY robotics or automation projects. To interface them, use a power window motor, motor driver, external power supply, Arduino board, and push buttons.

2.2.5 Programming Apps (Arduino IDE)

Arduino IDE is an open-source software for writing, uploading, and managing code for Arduino microcontroller boards, offering syntax highlighting, auto-completion, board support, and debugging capabilities.

Figure 2.2.5 Programming Apps (Arduino IDE)

Arduino IDE is used in educational applications, IoT and automation, and research and industry prototyping. However, it faces challenges like user barriers, resource constraints, and compatibility issues with non-standard boards or complex peripherals. Contributions from the community, enabling specific hardware or protocols like Wi-Fi, Bluetooth, or sensor integration. This is all from the book "Programming Arduino" by Simon Monk.

2.2.6 Programming Command

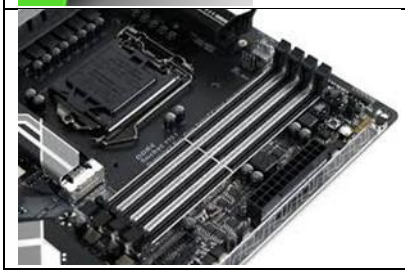
This review explores programming the Arduino Uno, a popular microcontroller board for electronics prototyping and embedded systems programming, focusing on its tools, methodologies, and applications.

```
  const int motorB_ENAL     = 2;
  const int motorB_PWMR     = 6;
  const int motorB_PWML     = 5;

 const int relay  = 7;
 ;
//Useful Variables
  int state;
  int vSpeed=200;     // Default speed, from 0 to 255

void setup() {
    // Set pins as outputs:
    pinMode(motorA_ENAR, OUTPUT);
    pinMode(motorA_ENAL, OUTPUT);
    pinMode(motorB_ENAR, OUTPUT);
    pinMode(motorB_ENAL, OUTPUT);
    pinMode(motorA_PWMR, OUTPUT);
    pinMode(motorA_PWML, OUTPUT);
    pinMode(motorB_PWMR, OUTPUT);
    pinMode(motorB_PWML, OUTPUT);
    pinMode(relay, OUTPUT);

   digitalWrite(relay,LOW);

    // Initialize serial communication at 9600 bits per second:
    Serial.begin(9600);
}
```

Figure 2.2.6 Programming Command

This Arduino code controls a motor driver (like the BTS7960 H-bridge motor controller) and a relay for a motorized vehicle, such as a robot car. The code allows controlling the vehicle's movement via serial commands.

2.3 COMPONENT-COMPONENT IN THE PRODUCT

IMAGE	NAME	FUNCTION
	Lithium battery	A type of rechargeable battery that uses the reversible intercalation of Li+ ions into electronically conducting solids to store energy.
	Laser obstacle sensor	Used for detecting objects, by passing the laser light on the object and detecting the reflected laser
	Traction rods	For ensuring stability and smooth movement.
	Wheel	Wheel To be able to move the product.
	Motherboard & Programming	Mother board and programming is a component to steer the forklift to move forward, backward, left and right.

CHAPTER 3: RESEARCH METHODOLOGY

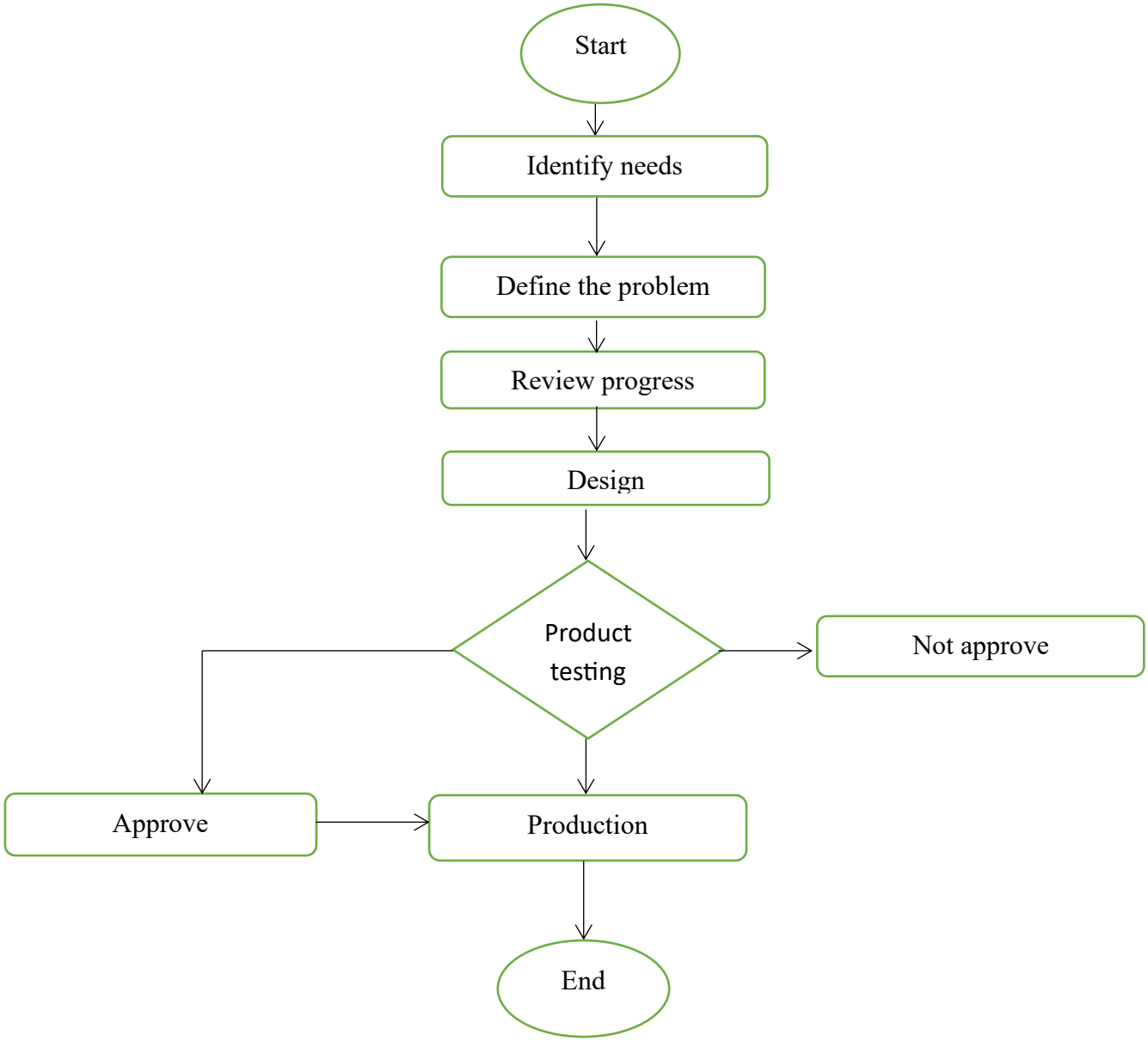
3.1 Product Description

3.1.1 Product Objective / Purpose of Product

The objective of this product is definitely to ease the community, student or lecture from Alam Sekitar Club at Banting Selangor polytechnic which is often experiences difficulties and challenges while doing the lifting work.

There for, Mini Forklift Control is able to help the student and lecture in implementing the integration of work easier and quickly without facing any challenging.

3.2 Flow Chart /Process flow.



3.3 Selection Of concept and Design

At the initial stage, there are four design proposals mini forklift control for developed. Figures 3.3.1, 3.3.2 ,3.3.3 and 3.3.4 show drawings isometric of the two designs.

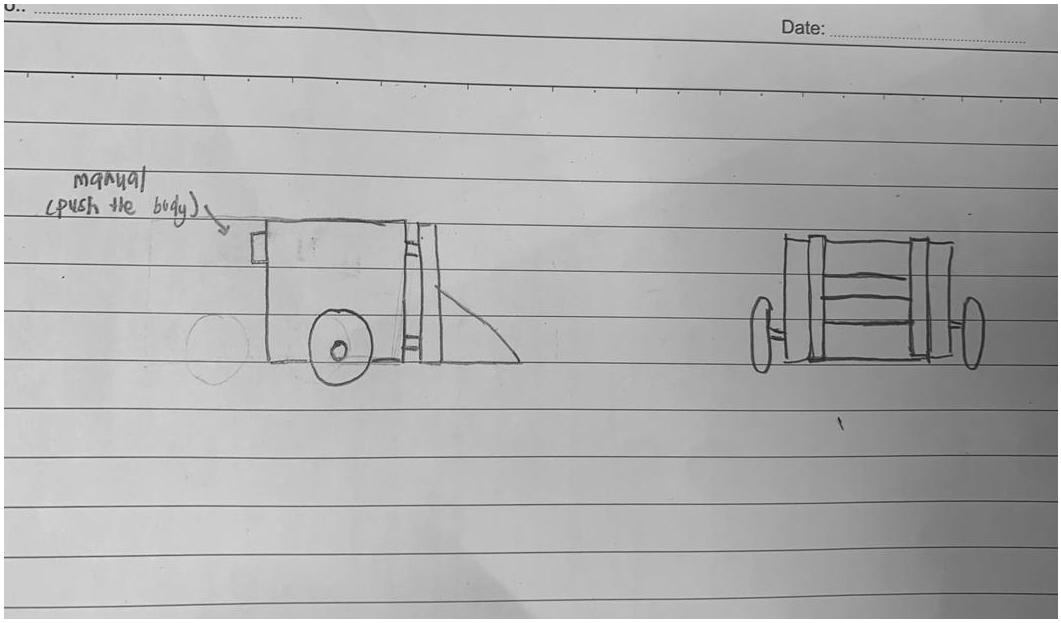


Figure 3.3.1 (First drawing)

Figure 3.3.1 shows the first drawing of a mini forkift control that uses mild steel and galvaninezed iron sheet .This design uses a manual control method to push the body. This design does not using controller .

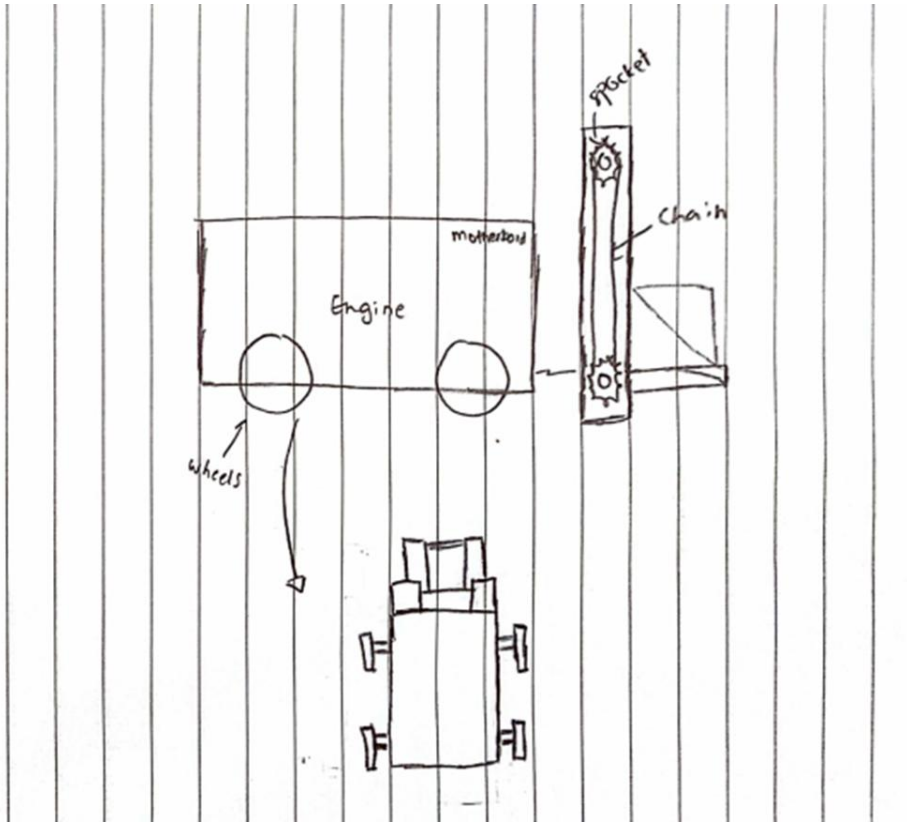


Figure 3.3.2 (Second Drawing)

Design 2 has almost identical to design 1,but start to use chain and gear to move the scope up and down. Other than that, using an engine to move the forklift.

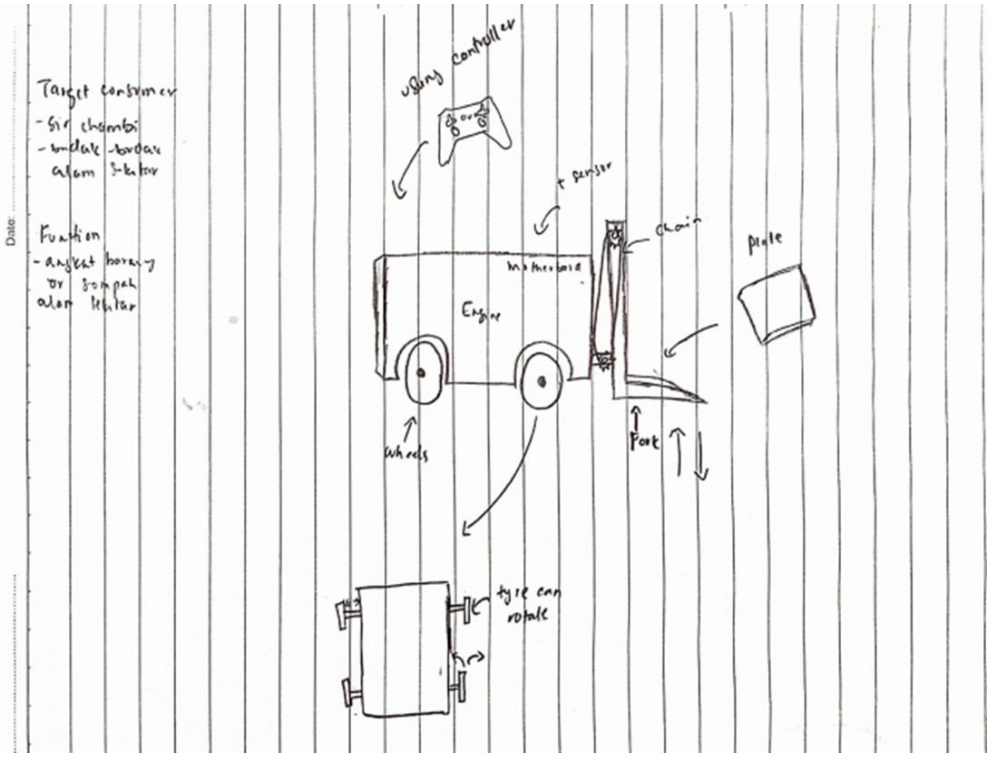


Figure 3.3.3 (Third drawing)

Design 3 is modified to use semi-automation move by controller. Figure 3.3.3 shows the proposed design the third. The wheel can move 90 degrees and still using chain and gear to move the scope up and down same as design 2.

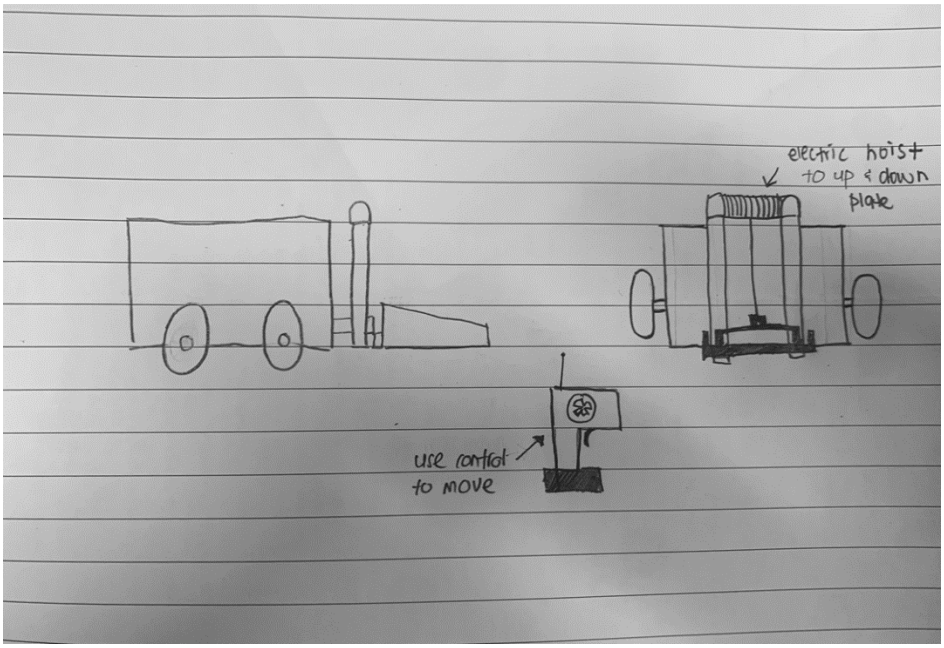


Figure 3.3.4 (Fourth drawing)

Figure 3.3.4 is a finale drawing, this design more stable than previous design. Other than that, this design use semi-automation which can move by controller with coding programming and use electric hoist to move the scope up and down. Lastly, use a automotive battery compare to others design.

Table 3.1 : Summary of all designs

IDEA	Features and advantages	Deficiencies
IDEA 1	-	i. Used manually
IDEA 2	i. Loading and unloading recycled items. ii. Scope can move up and down with chain and gear. iii. Move with engine by controller.	i. Wheel only move forward and backward. ii. Items will fall because there is no support on the edge of the scope.
IDEA 3	i. Semi automation move by controller with engine. ii. Loading and unloading recycle item. iii. Scope can move up and down by chain and gear. iv. Wheel can move 90 degrees.	i. Noise pollution due to loud engine noise.
IDEA 4	i. Semi automation move by controller with coding programming. ii. Can load and unload items. iii. Scope can move up and down by electric hoist. iv. Wheel can move 90 degrees. v. Use automotive battery.	

3.4 Technical Drawings

Computer-aided design Design, CAD and (Computer-Aided Manufacturing, CAM) is the use of computer technology for help design, process, optimize and especially sketching (technical drawings and engineering drawing) of a part or product, including the entire design.

Figures 3.4.1, 3.4.2 and 3.4.3 show the technical drawings of the Mini Forklift Control Design Project.

3.4.1 Complete Drawing

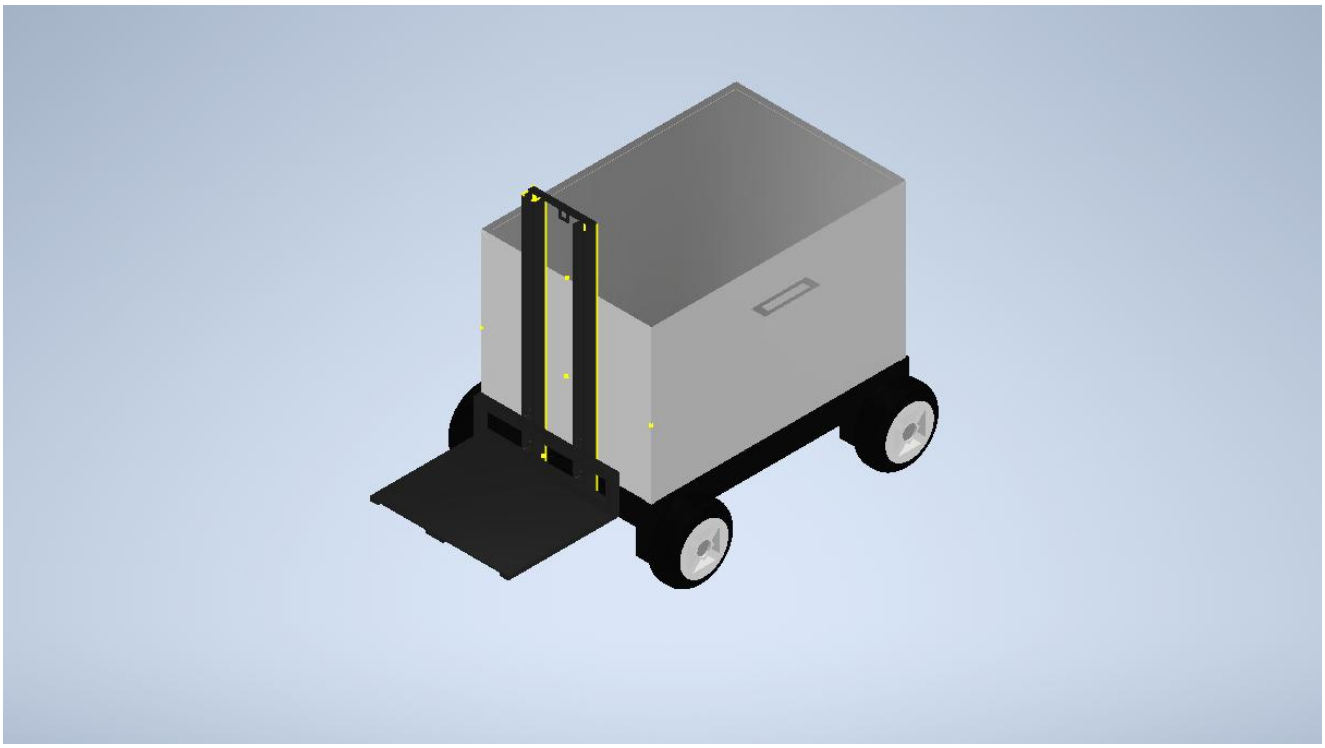


Figure 3.4.1

This project works by controlling the movement of a mini forklift using a remote - control device. In addition, this project can lift items using an electric hoist by pressing the button that comes with the electric hoist. The electric hoist used has no problem in supporting large weights.

3.4.2 Installation Drawings and Bill of Materials

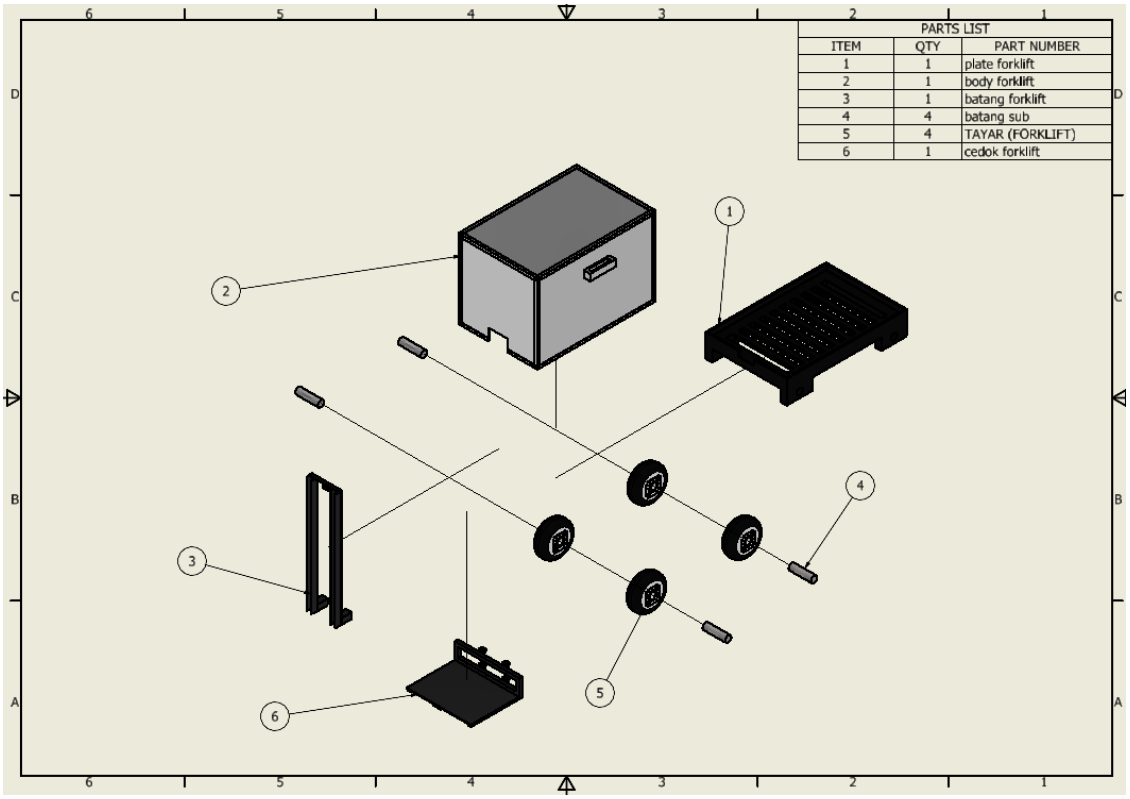


Figure 3.4.2

Figure 3.4.2 shows the assembly drawing along with the bill of material that displays the resolution of each component. The first part shows the body structure that uses mild steel. In addition, the body part is connected by the sub rod and then connected to the tire. the front part that holds the scope will be placed on the front of the body and connect directly to the scope. The iron used on the front is mild steel while the electric hoist will be on top of the iron that holds the scope. Other items such as the battery and motor will be stored inside the body to balance this product.

3.4.3 Part Drawing

a) Mini Electric Hoist

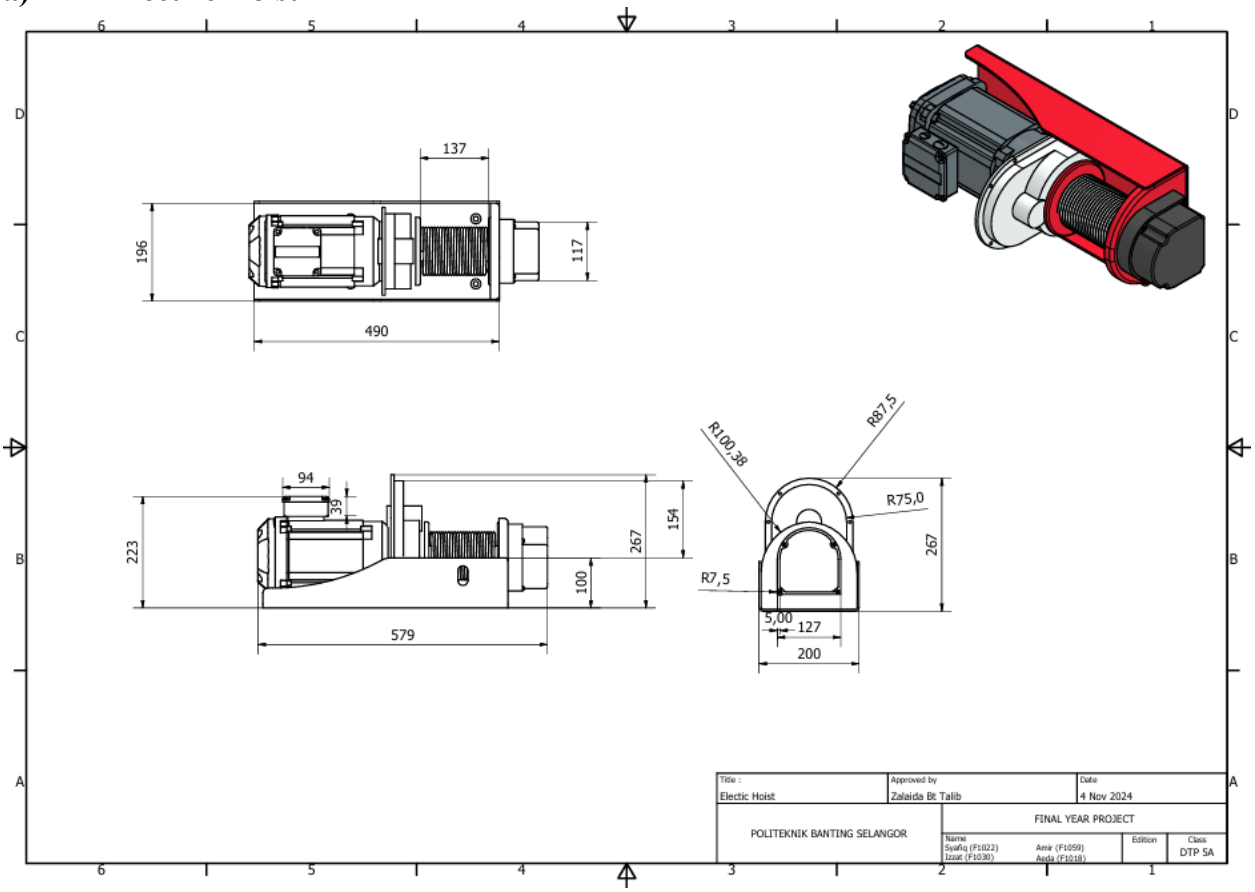


Figure 3.4.3 (a)

b) Handle Scope Forklift

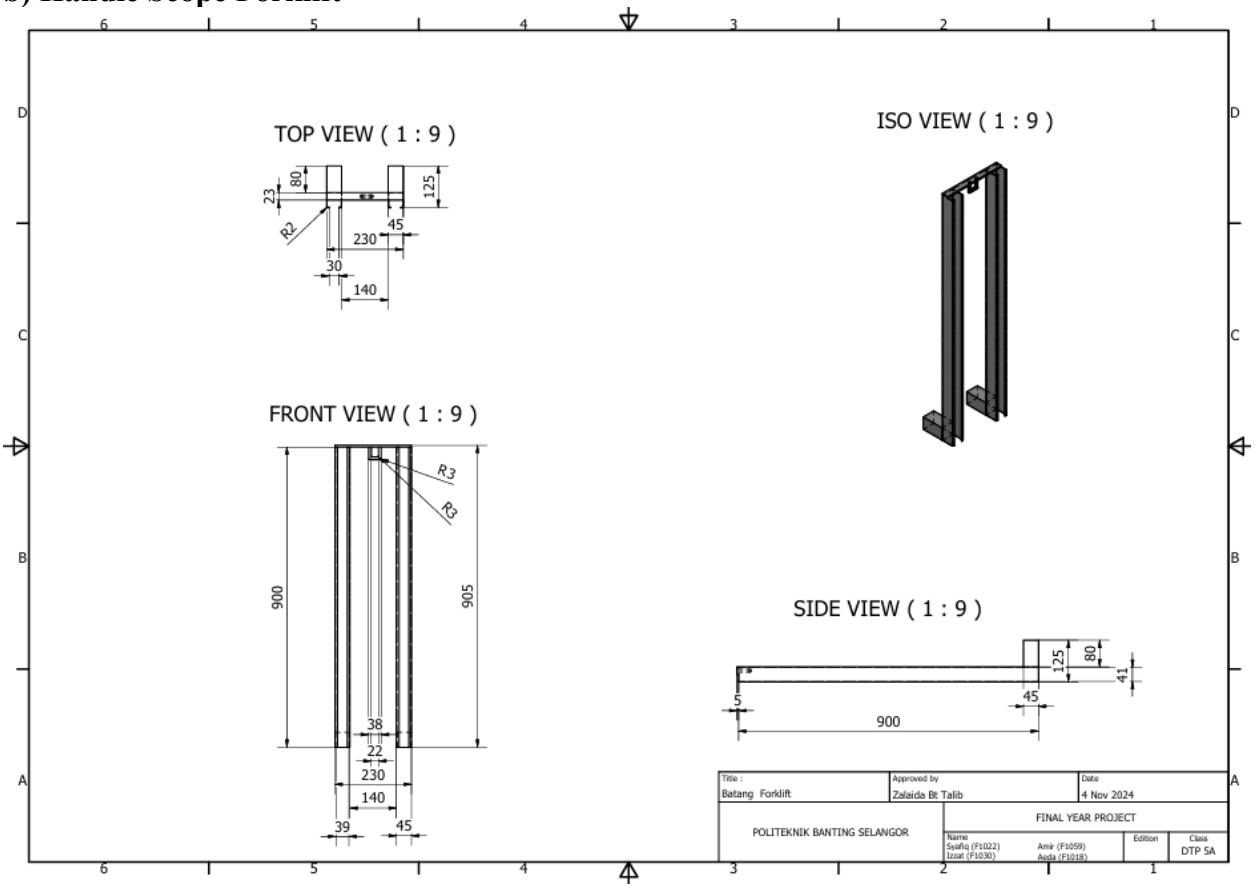


Figure 3.4.3 (b)

c) Body Structure

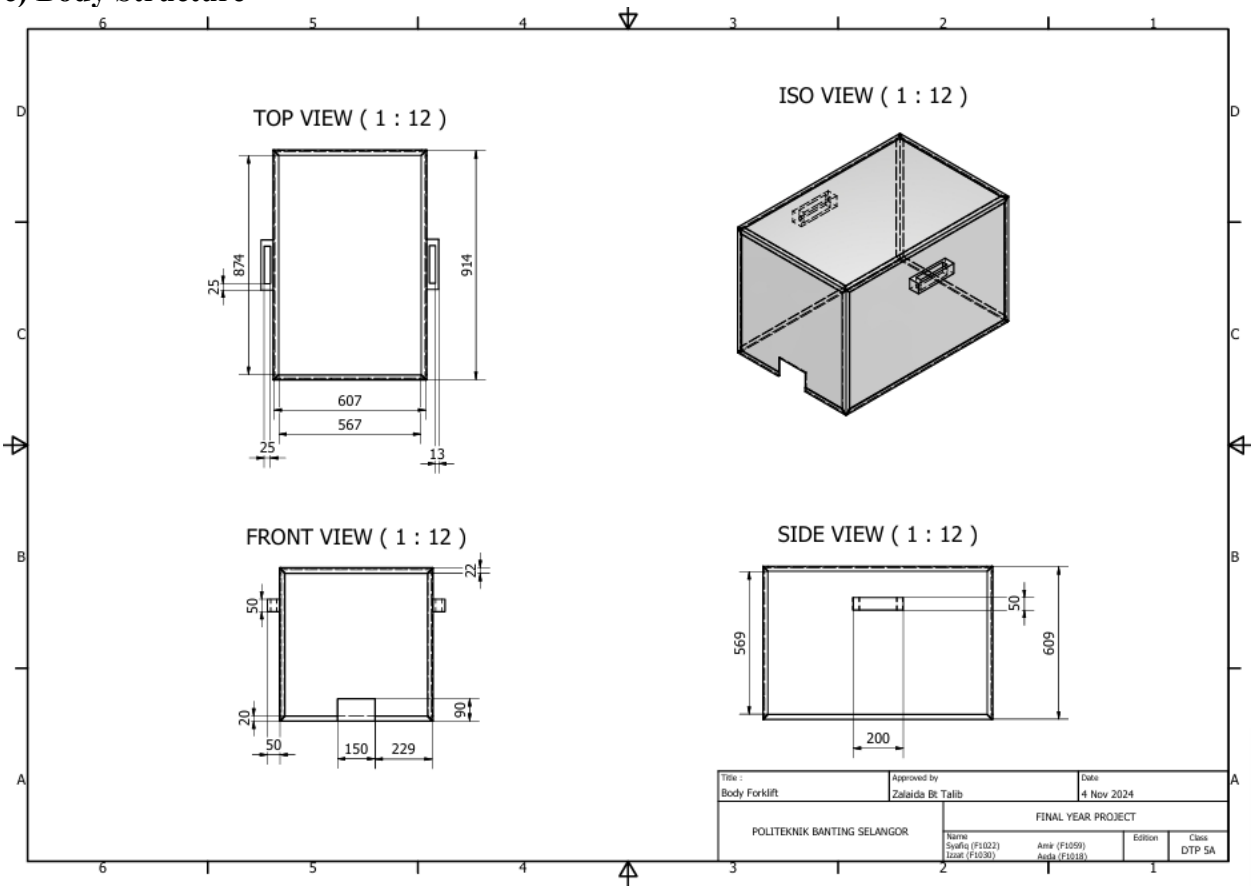


Figure 3.4.3 (c)

d) Base Structure

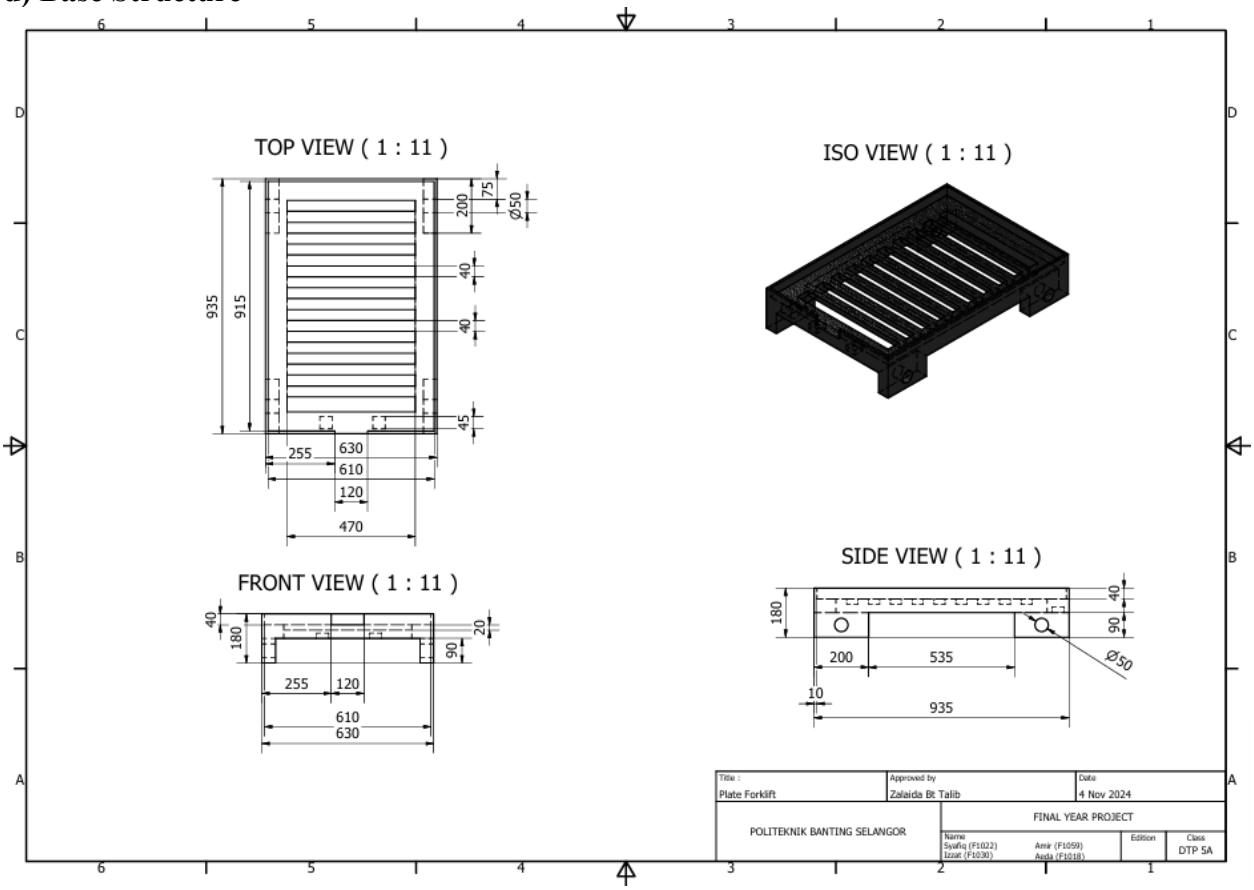


Figure 3.4.3 (d)

e) Scope Structure

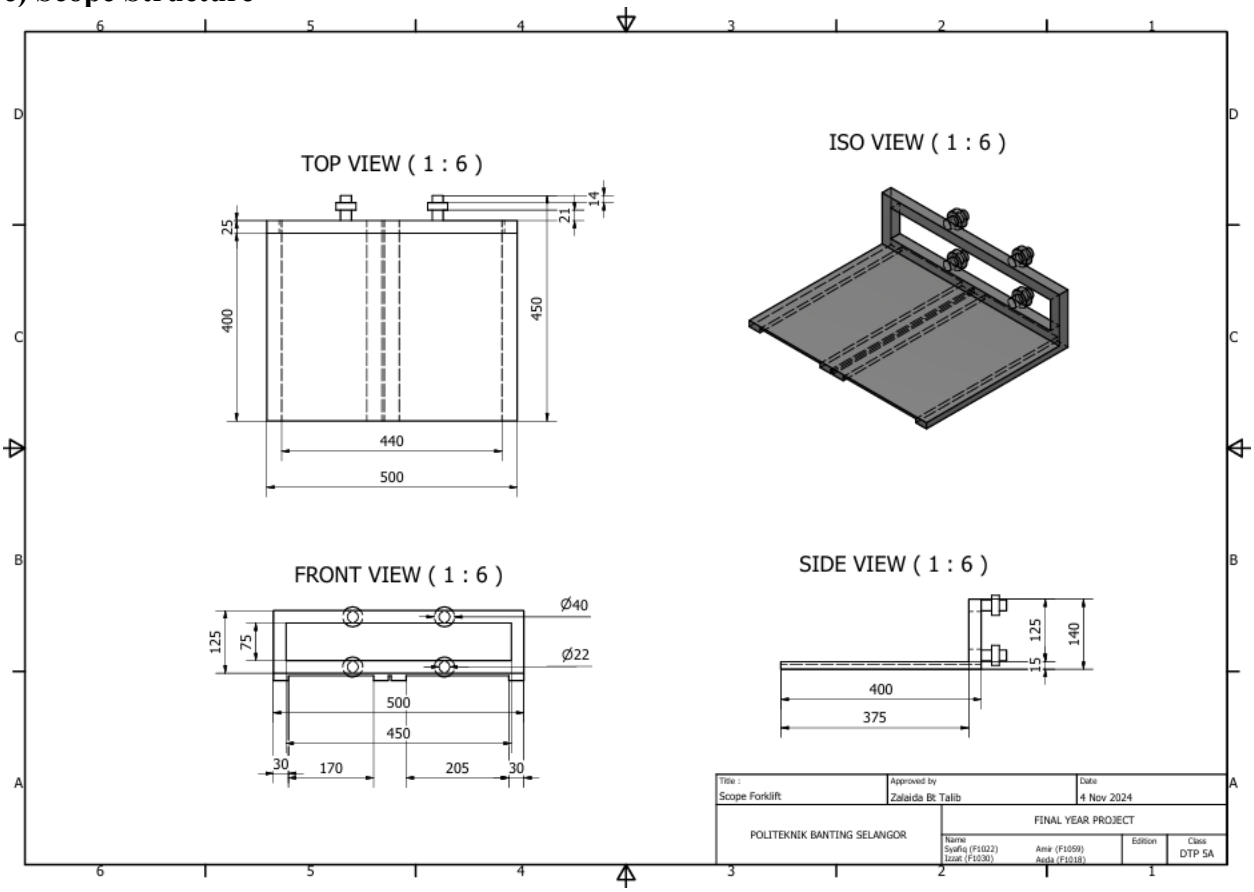


Figure 3.4.3 (e)

f) Arduino UNO

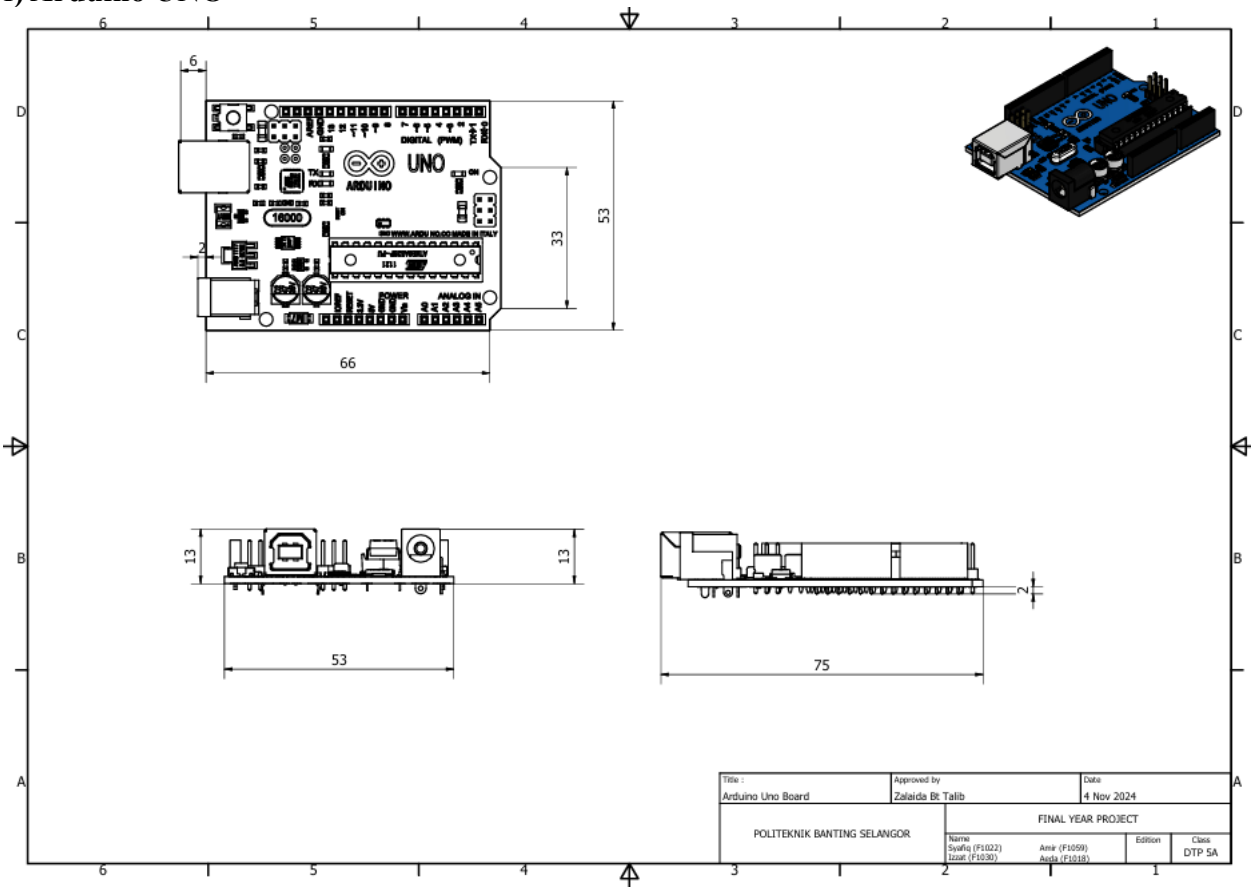


Figure 3.4.3 (f)

g) Wheel

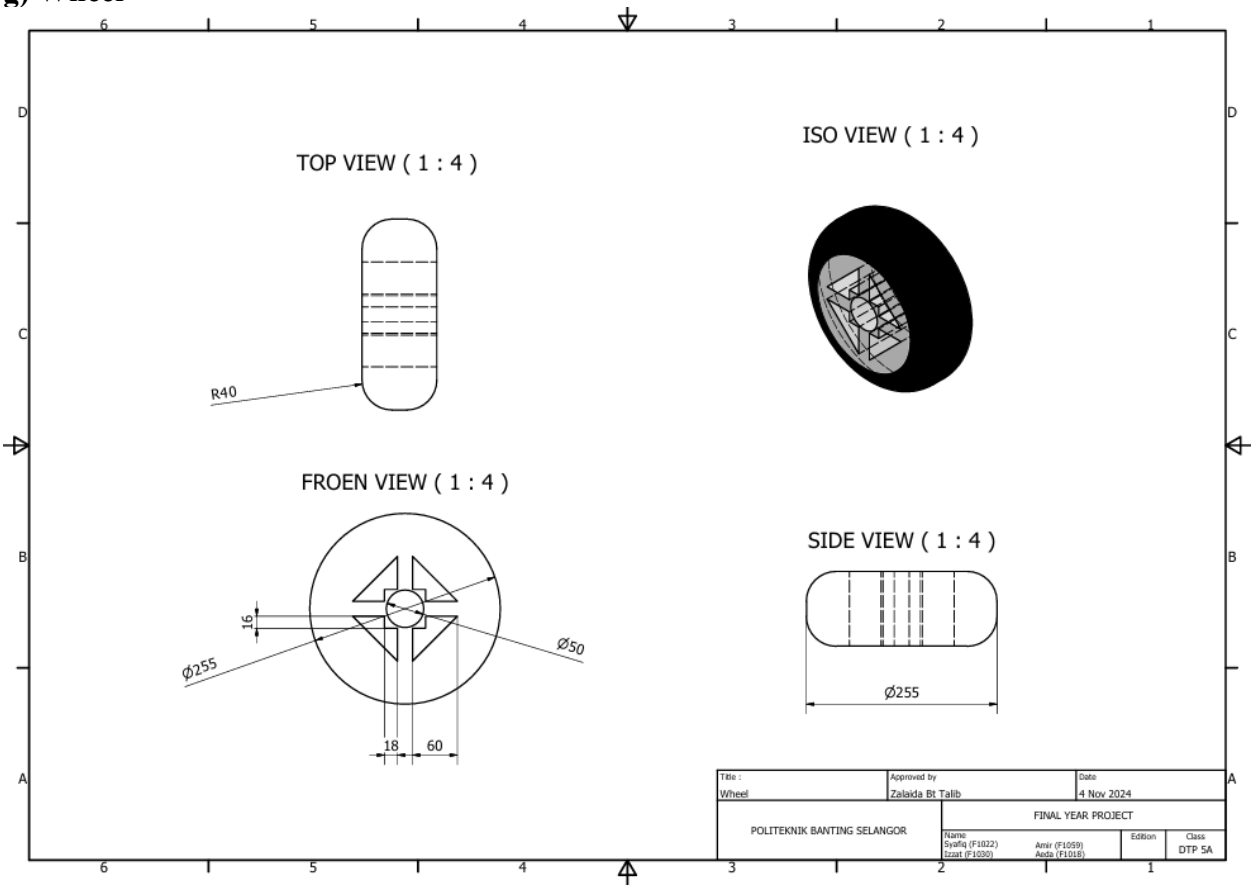


Figure 3.4.3 (g)

3.4.4 Isometric drawing

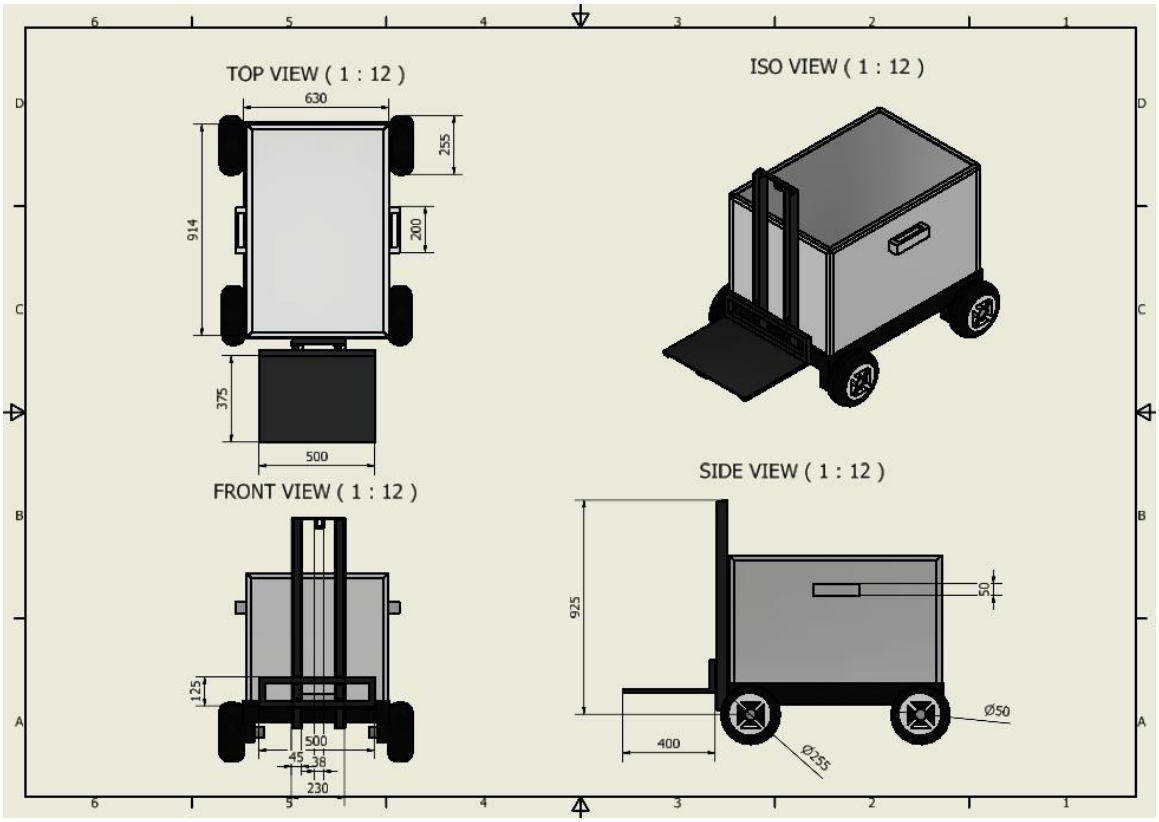


Figure 3.4.3

Figure 3.4.2 shows an isometric drawing which top, front and side views of the project. Through view on the project can be seen measurements for thickness and length of each material. High size the entire project and length can be known also through this angle .

3.5 Selection of Materials and Components

3.5.1 Introduction

The material selection process is very important to control expenses to minimize production cost.The selection of materials should be according to the specifications required to avoid project failure works. Tables 3.4.1 list the materials and the main components used to prepare Mini Forklift Control.

Table 3.5.1 shows Material and Components

IMAGE	NAME	FUNCTION
	Mild Steel	Mild steel is used for the body part.
	Galvanized Iron Sheet	Galvanized iron sheet is used as apart to close the battery & mother board compartment.
	Mini Electric Hoist	Mini electric hoist is used to replace the hydraulic parts that use for lifting on the actual forklift.
	Automotive Battery	Is to provide an electric current to the electric-powered.
	Arduino Programming	The Arduino project began in 2005 as a tool for students at the Interaction Design Institute Ivrea, Italy, aiming to provide a low-cost and easy way for novices and professionals to create devices that interact with their environment using sensors and actuators.

3.6 Fabrication/ Programming Process

The MINI FORKLIFT CONTROL fabrication process has been made at Project Workshop, Department of Mechanical Engineering, Banting Selangor Polytechnic, to guarantee the smoothness of the process, each member of the group is given a scope their respective tasks. This chapter will explain detail each task rule and steps fabrication that has been carried out.

1. Design Planning :

All group members collaborate to create detailed plans for the mini forklift, including specifications for size, weight capacity, power source, and controller programming.

2. Frame Fabrication :

Skilled welders fabricate the frame of the mini forklift according to the design specifications. Precision welding techniques are used to ensure structural integrity and stability.

3. Component Assembly :

Various components such as the mini electric hoist , battery, wheels, and controls are assembled according to the design plans. Each component is carefully installed and connected to ensure proper functionality.

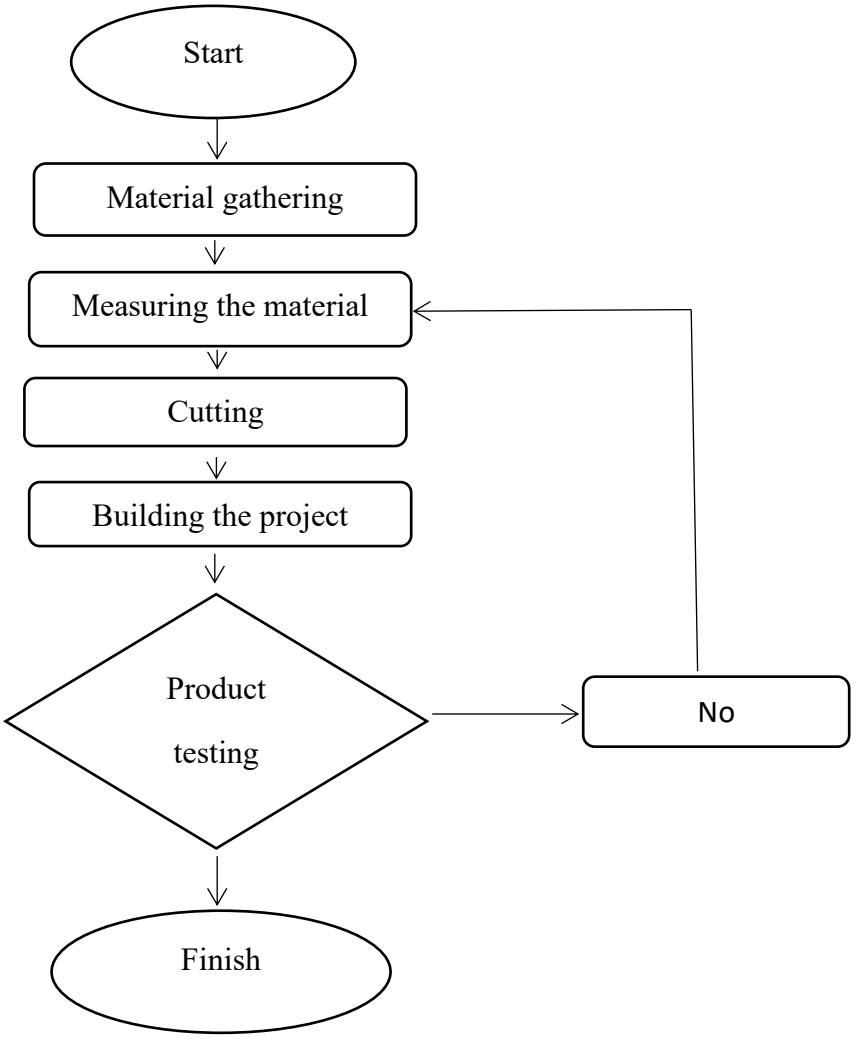
4. Testing and Calibration :

Once the mini forklift is fully assembled, it undergoes rigorous testing to verify its performance and safety. The mini electric hoist is calibrated to ensure smooth lifting and lowering of loads, and the controls are tested for responsiveness and accuracy.0

5. Painting and Finishing :

The mini forklift is painted and finished according to the client's specifications. Protective coatings may be applied to ensure durability and resistance to corrosion

3.7 Installation Process



The installation process for mini forklift controls is a crucial step in ensuring the safe and efficient operation of industrial vehicles. By following a systematic approach, including measuring the material, cutting, installing control components, and conducting thorough testing and calibration, the student and lecturer can effectively integrate the control system into the mini forklift.

Additionally, emphasis on safety checks, operator training, and documentation is essential to ensure compliance with regulatory standards and best practices. Proper installation and maintenance of control systems not only enhance productivity and performance but also contribute to a safer working environment for student and lecture.

3.8 Project Schedule (Gantt Chart) – Planning and Action

Figure 3.8.1 and 3.8.2 shows the Gantt chart of the entire activity and the process of designing a Mini Forklift Control starts from idea search, title selection, project fabrication, testing, data analysis until the project is fully completed.

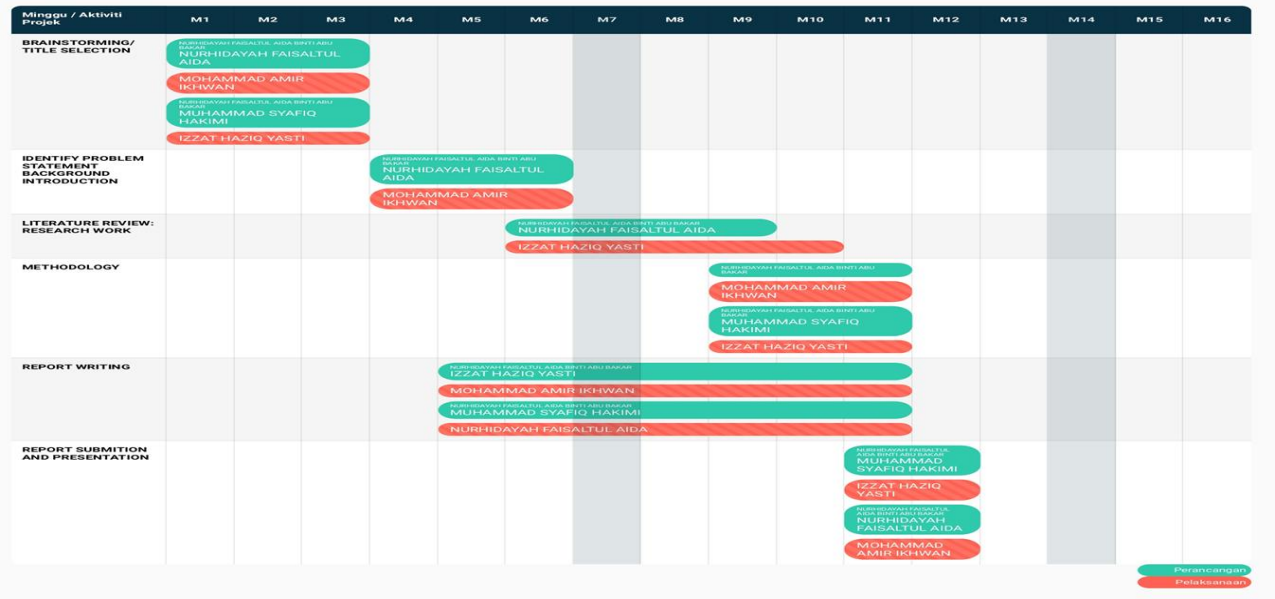


Figure 3.8.1

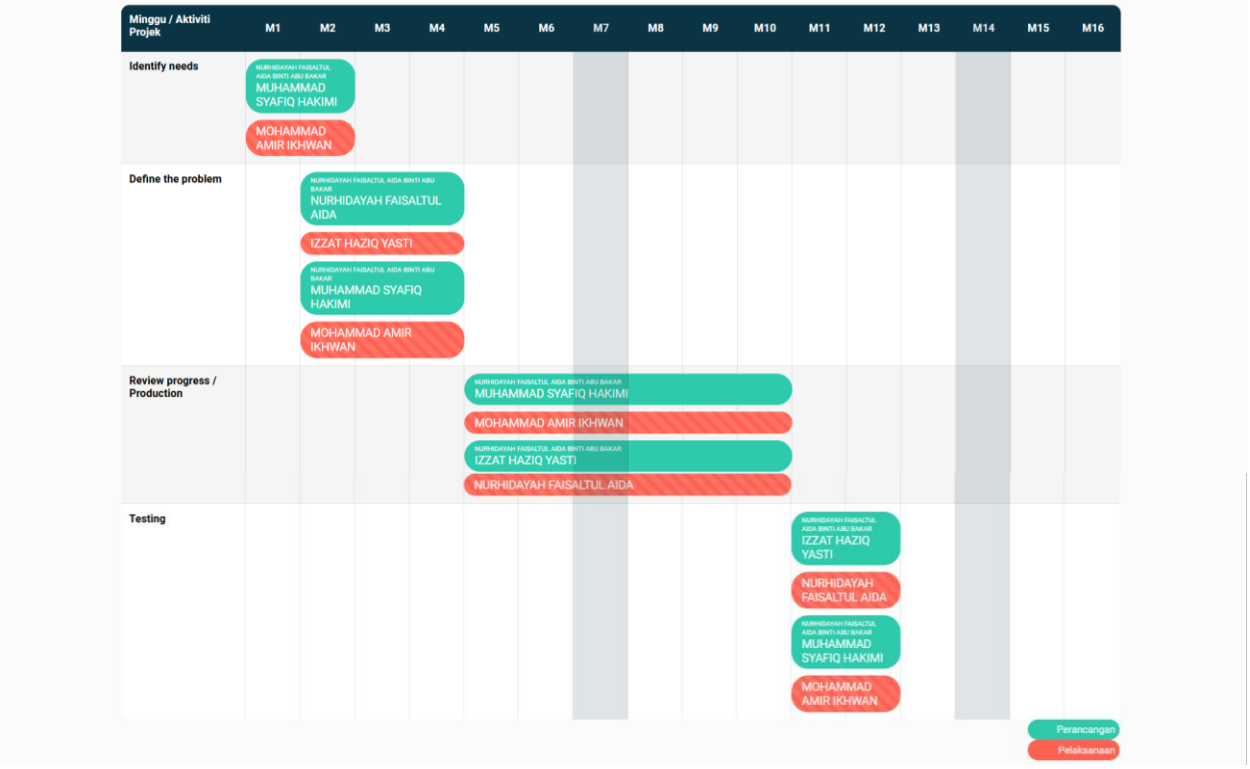


Figure 3.8.2

CHAPTER 4: DATA AND ANALYSIS

4.0 Introduction

This chapter discusses the development and testing of our mini forklift control system, designed to enhance material handling efficiency. The system incorporates automation to reduce the physical effort required from operators, promoting safer and more effective operations.

To evaluate the performance of the mini forklift, we conducted a series of tests focusing on key aspects such as ease of use, lifting capacity, and operational efficiency. We measured how effectively the forklift handles various loads, ensuring optimal performance under different conditions.

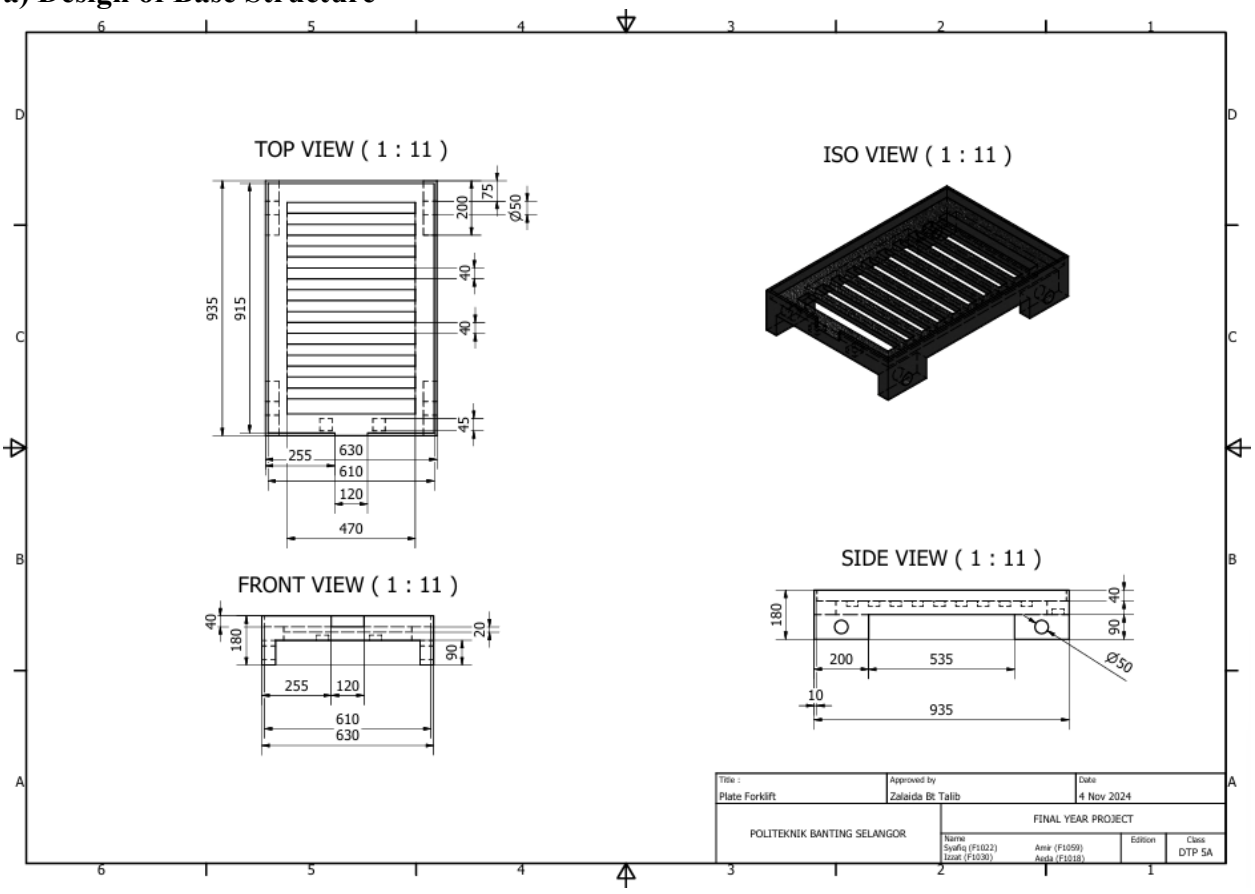
The results from these tests demonstrate the potential of our mini forklift control system to improve workplace productivity and safety, making it an essential tool in environments where material handling is critical.

4.1 Building the prototype and product

This chapter present how to build up the prototype and product.This involved 4 section which lower part body structure , Upper body structure, Front fork structure and arduino coding.

4.1.1 Base Structure

a) Design of Base Structure



b) Fabrication of Base Structure

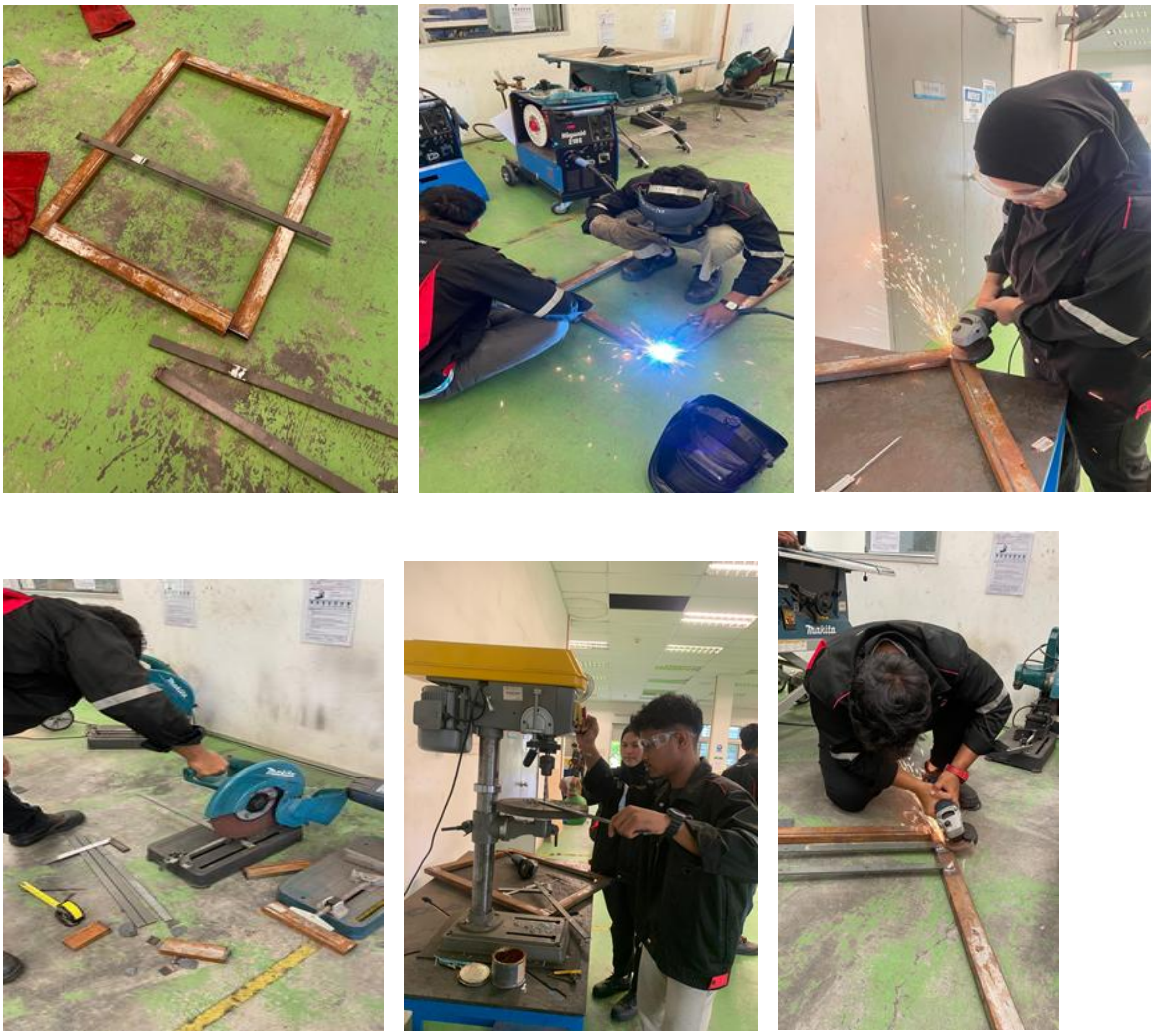


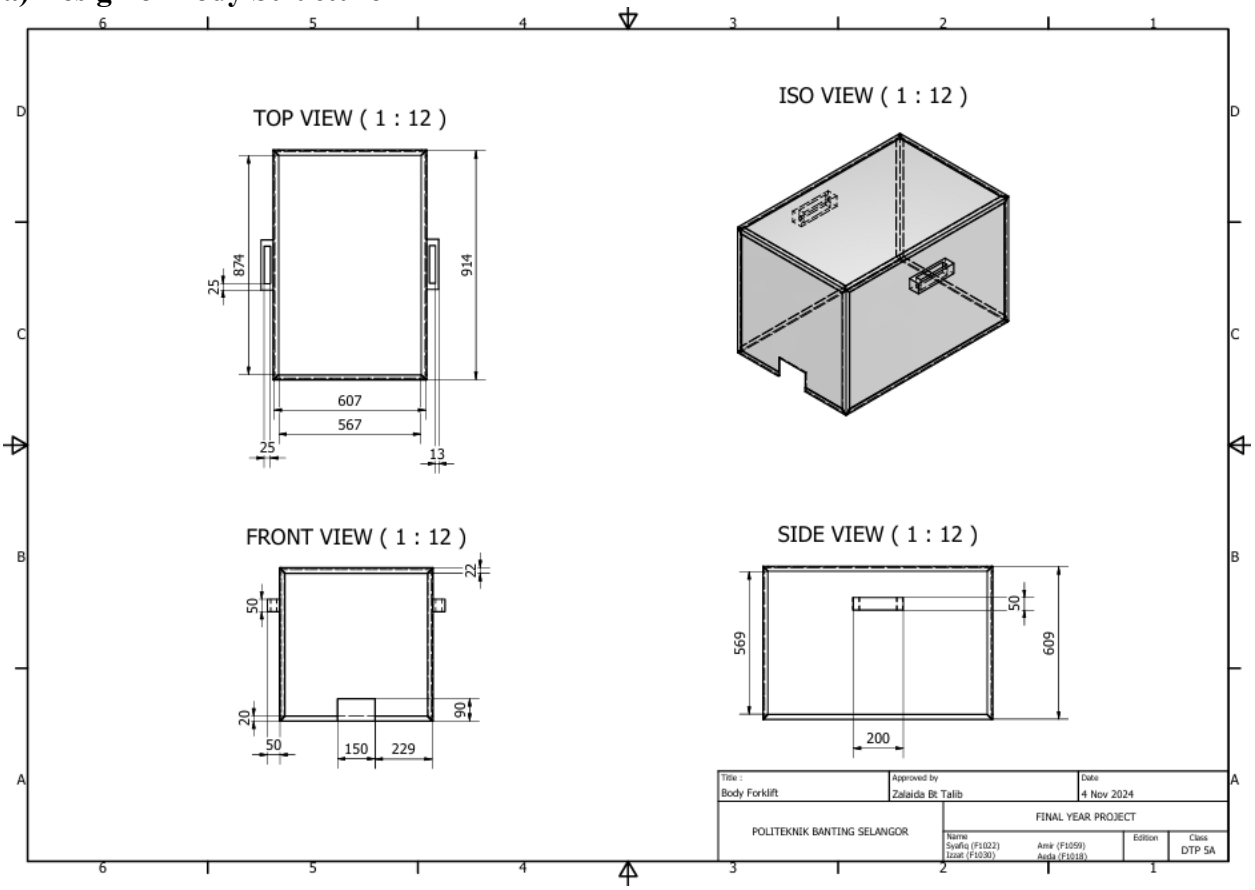
Figure 4.1.1

Figure 4.1.1 show the progress to produce lower part body structure by cutting , grinding and welding the structure.

This structure is function as a base or body of the mini forklift control to place the component such as battery, Arduino coding, electric hoist and welding the tyre.

4.1.2 Body Structure

a) Design of Body Structure



b) Fabrication of Body Structure

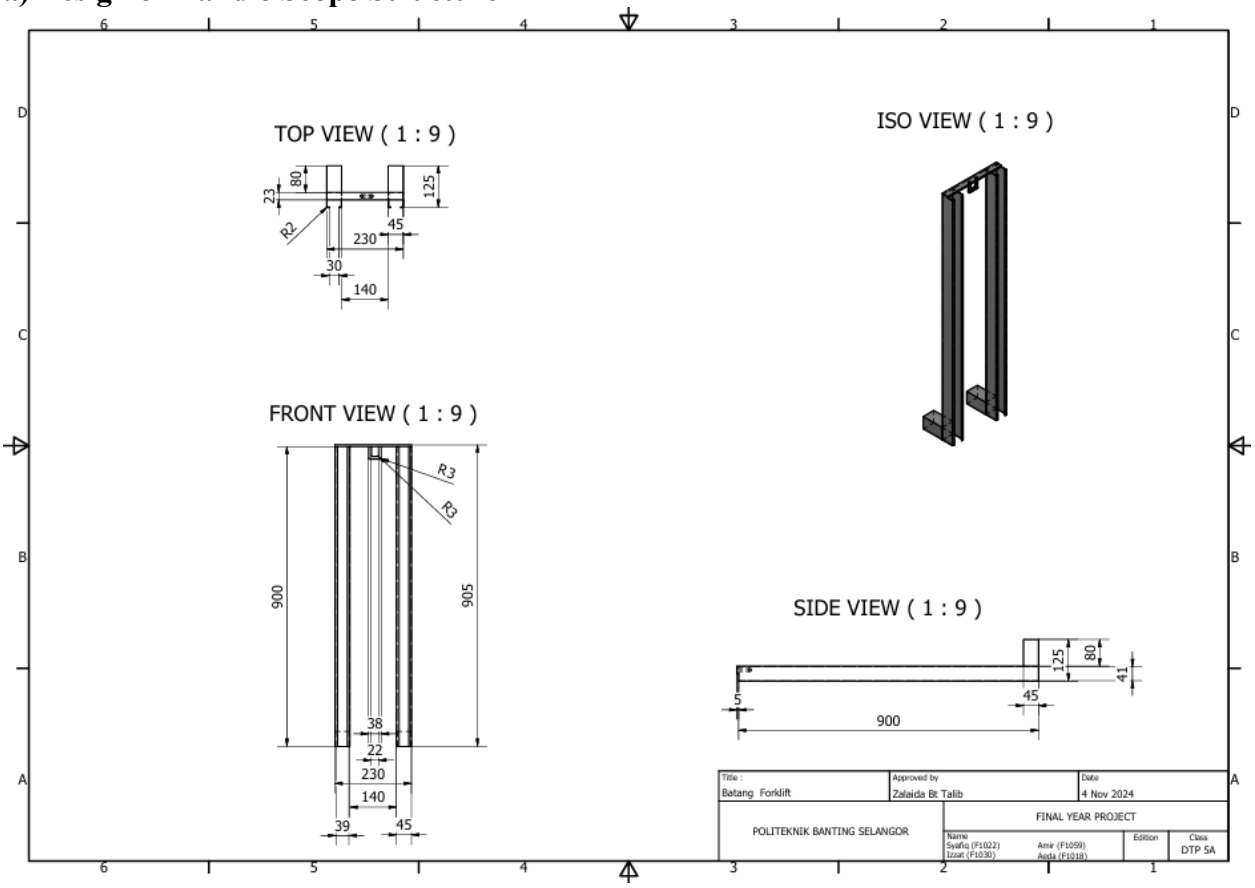
Figure 4.1.2

Figure 4.1.2 Show the process to produce upper body structure Cut the materials follow the measurement based on our design specifications. Assemble the lower body structure, ensuring that all joints are secure and aligned properly.

This structure is serves as a top cover all the component inside the mini forklift control.

4.1.3 Handle Scope Structure

a) Design of Handle Scope Structure



b) Fabrication of Handle Scope Structure

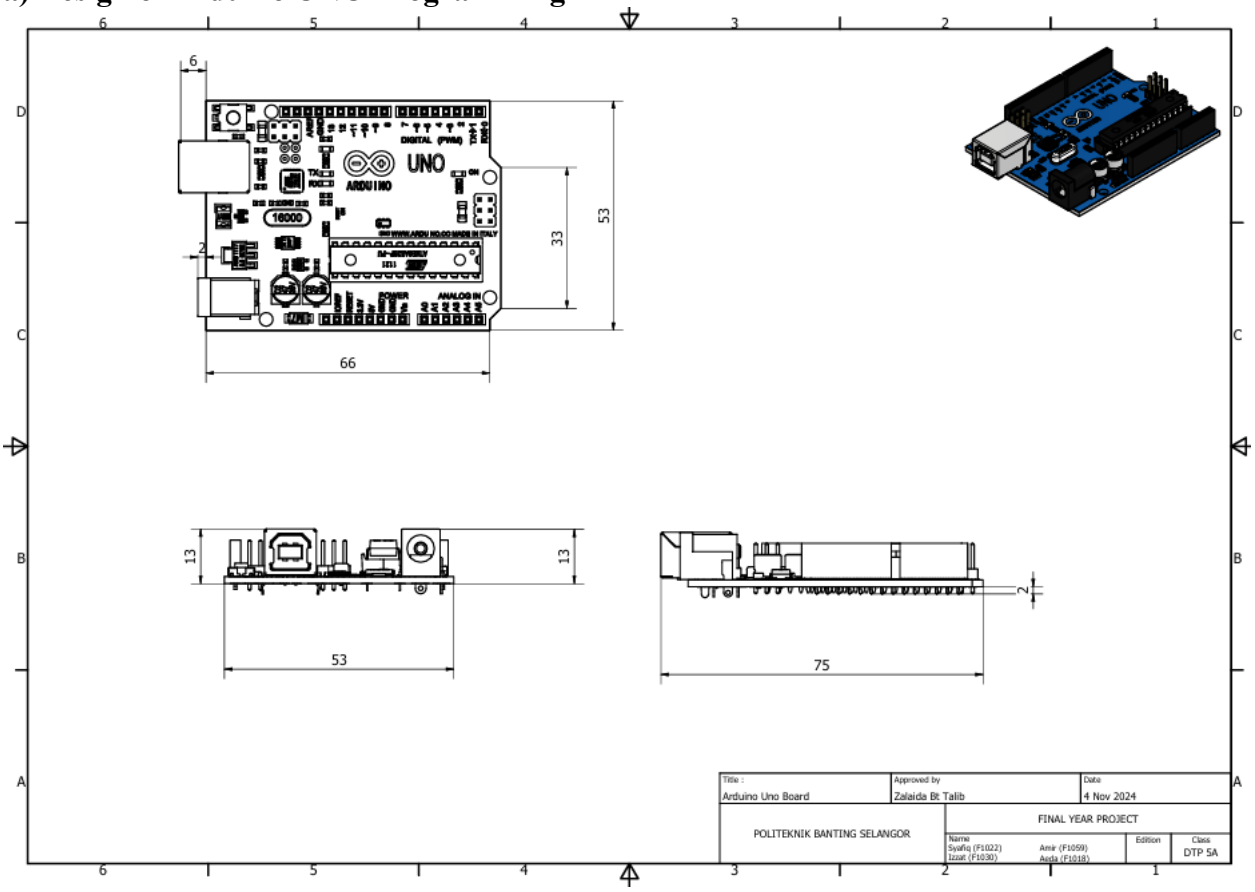
Figure 4.1.3

Figure 4.1.3 is produce front fork structure. Cutting the plate is reinforced to handle loads without bending. Use additional metal or support structures as needed. Welding the Forks Securely attach the forks to the front plate.

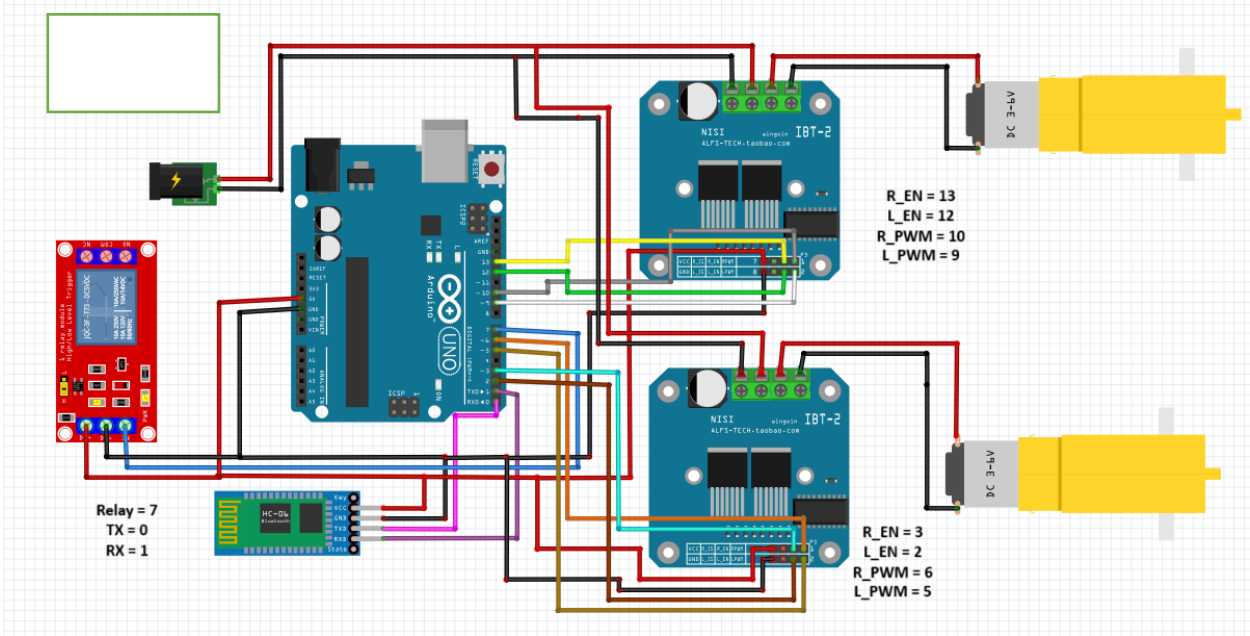
This structure is the function as front fork of mini forklift control to place and lift the item need to be lift.

4.1.4 Codding System

a) Design of Arduino UNO Programming



Circuit Block / Diagram



Programming Command

```
#include <SoftwareSerial.h>

//BTS7960 Connection
  const int motorA_ENAR     = 13;
  const int motorA_ENAL     = 12;
  const int motorA_PWMR     = 10;
  const int motorA_PWML     = 9;
  const int motorB_ENAR     = 3;
  const int motorB_ENAL     = 2;
  const int motorB_PWMR     = 6;
  const int motorB_PWML     = 5;

 const int relay  = 7;
 ;
//Useful Variables
  int state;
  int vSpeed=200;     // Default speed, from 0 to 255

void setup() {
    // Set pins as outputs:
    pinMode(motorA_ENAR, OUTPUT);
    pinMode(motorA_ENAL, OUTPUT);
    pinMode(motorB_ENAR, OUTPUT);
    pinMode(motorB_ENAL, OUTPUT);
    pinMode(motorA_PWMR, OUTPUT);
    pinMode(motorA_PWML, OUTPUT);
    pinMode(motorB_PWMR, OUTPUT);
    pinMode(motorB_PWML, OUTPUT);
    pinMode(relay, OUTPUT);

   digitalWrite(relay,LOW);

    // Initialize serial communication at 9600 bits per second:
    Serial.begin(9600);
}

void loop() {

    while(Serial.available() > 0){
      state = Serial.read();
    }
   Serial.println(state);
```

```
  //Change speed if state is equal from 0 to 4. Values must be from 0 to 255
(PWM)
    if (state == '0'){
      vSpeed=0;}
    else if (state == '1'){
      vSpeed=25;}
    else if (state == '2'){
      vSpeed=51;}
    else if (state == '3'){
      vSpeed=76;}
    else if (state == '4'){
      vSpeed=102;}
    else if (state == '5'){
      vSpeed=127;}
    else if (state == '6'){
      vSpeed=153;}
    else if (state == '7'){
      vSpeed=178;}
    else if (state == '8'){
      vSpeed=204;}
    else if (state == '9'){
      vSpeed=229;}
    else if (state == 'q'){
      vSpeed=255;}

  /**********************Forward***************************/
  //If state is equal with letter 'F', car will go forward!
    if (state == 'F') {
  digitalWrite (motorA_ENAR,LOW);
  delay(1);
  digitalWrite (motorA_ENAL,HIGH);
  delay(1);

  digitalWrite (motorB_ENAR,HIGH);
  delay(1);
  digitalWrite (motorB_ENAL,HIGH);

  analogWrite (motorA_PWMR, 0);
  analogWrite (motorA_PWML, vSpeed);
  analogWrite (motorB_PWMR, vSpeed);
  analogWrite (motorB_PWML, 0);
  }
  /**********************Forward Left************************/
```

```
//If state is equal with letter 'I', car will go forward left
  else if (state == 'I') {
digitalWrite (motorA_ENAR,LOW);
delay(1);
digitalWrite(motorA_ENAL,LOW);
delay(1);

digitalWrite (motorB_ENAR,HIGH);
delay(1);
digitalWrite(motorB_ENAL,HIGH);

analogWrite (motorA_PWMR, 0);
analogWrite (motorA_PWML, 0);
analogWrite (motorB_PWMR, vSpeed);
analogWrite (motorB_PWML, 0);
  }
/**********************Forward Right************************/
//If state is equal with letter 'G', car will go forward right
  else if (state == 'G') {
digitalWrite (motorA_ENAR,HIGH);
delay(1);
digitalWrite(motorA_ENAL,HIGH);
delay(1);

digitalWrite (motorB_ENAR,LOW);
delay(1);
digitalWrite(motorB_ENAL,LOW);

analogWrite (motorA_PWMR, 0);
analogWrite (motorA_PWML, vSpeed);
analogWrite (motorB_PWMR, 0);
analogWrite (motorB_PWML, 0);
  }
/**********************Backward*****************************/
//If state is equal with letter 'B', car will go backward
  else if (state == 'B') {
digitalWrite (motorA_ENAR,HIGH);
delay(1);
digitalWrite(motorA_ENAL,HIGH);
delay(1);

digitalWrite (motorB_ENAR,HIGH);
delay(1);
```

```
digitalWrite(motorB_ENAL,HIGH);

analogWrite (motorA_PWMR, vSpeed);
analogWrite (motorA_PWML, 0);
analogWrite (motorB_PWMR, 0);
analogWrite (motorB_PWML, vSpeed);
  }
/*********************Backward Left***********************/
//If state is equal with letter 'J', car will go backward left
  else if (state == 'J') {
digitalWrite (motorA_ENAR,HIGH);
delay(1);
digitalWrite(motorA_ENAL,HIGH);
delay(1);

digitalWrite (motorB_ENAR,LOW);
delay(1);
digitalWrite(motorB_ENAL,LOW);

analogWrite (motorA_PWMR, vSpeed);
analogWrite (motorA_PWML, 0);
analogWrite (motorB_PWMR, 0);
analogWrite (motorB_PWML, 0);
  }
/*********************Backward Right**********************/
//If state is equal with letter 'H', car will go backward right
  else if (state == 'H') {
digitalWrite (motorA_ENAR,LOW);
delay(1);
digitalWrite(motorA_ENAL,LOW);
delay(1);

digitalWrite (motorB_ENAR,HIGH);
delay(1);
digitalWrite(motorB_ENAL,HIGH);

analogWrite (motorA_PWMR, 0);
analogWrite (motorA_PWML, 0);
analogWrite (motorB_PWMR, 0);
analogWrite (motorB_PWML, vSpeed);
  }
/*************************Left*****************************/
//If state is equal with letter 'L', wheels will turn left
```

```
    else if (state == 'L') {
  digitalWrite (motorA_ENAR,HIGH);
  delay(1);
  digitalWrite(motorA_ENAL,HIGH);
  delay(1);

  digitalWrite (motorB_ENAR,HIGH);
  delay(1);
  digitalWrite(motorB_ENAL,HIGH);

  analogWrite (motorA_PWMR, 0);
  analogWrite (motorA_PWML, vSpeed);
  analogWrite (motorB_PWMR, 0);
  analogWrite (motorB_PWML, vSpeed);
    }
  /*************************Right*****************************/
  //If state is equal with letter 'R', wheels will turn right
    else if (state == 'R') {
  digitalWrite (motorA_ENAR,HIGH);
  delay(1);
  digitalWrite(motorA_ENAL,HIGH);
  delay(1);

  digitalWrite (motorB_ENAR,HIGH);
  delay(1);
  digitalWrite(motorB_ENAL,HIGH);

  analogWrite (motorA_PWMR, vSpeed);
  analogWrite (motorA_PWML, 0);
  analogWrite (motorB_PWMR, vSpeed);
  analogWrite (motorB_PWML, 0);
    }

else if (state == 'x') {
  digitalWrite(relay,LOW);
  delay(1);
}
else if (state == 'X') {
  digitalWrite(relay,HIGH);
  delay(1);
}

    /*********************Stop*****************************/
```

```
  //If state is equal with letter 'S', stop the car
    else if (state == 'S'){
  digitalWrite (motorA_ENAR,LOW);
  digitalWrite (motorA_ENAL,LOW);
  digitalWrite (motorB_ENAR,LOW);
  digitalWrite (motorB_ENAL,LOW);
    }


}
```

Movement Commands:

These commands control the **direction** the vehicle moves:

- 'F': Move **forward**.
- 'I': Move **forward left** (turn left while going forward).
- 'G': Move **forward right** (turn right while going forward).
- 'B': Move **backward**.
- 'J': Move **backward left** (turn left while going backward).
- 'H': Move **backward right** (turn right while going backward).
- 'L': Turn the wheels **left** (without moving forward or backward).
- 'R': Turn the wheels **right** (without moving forward or backward).
- 'S': **Stop** the vehicle.

b) Fabrication for Codding System

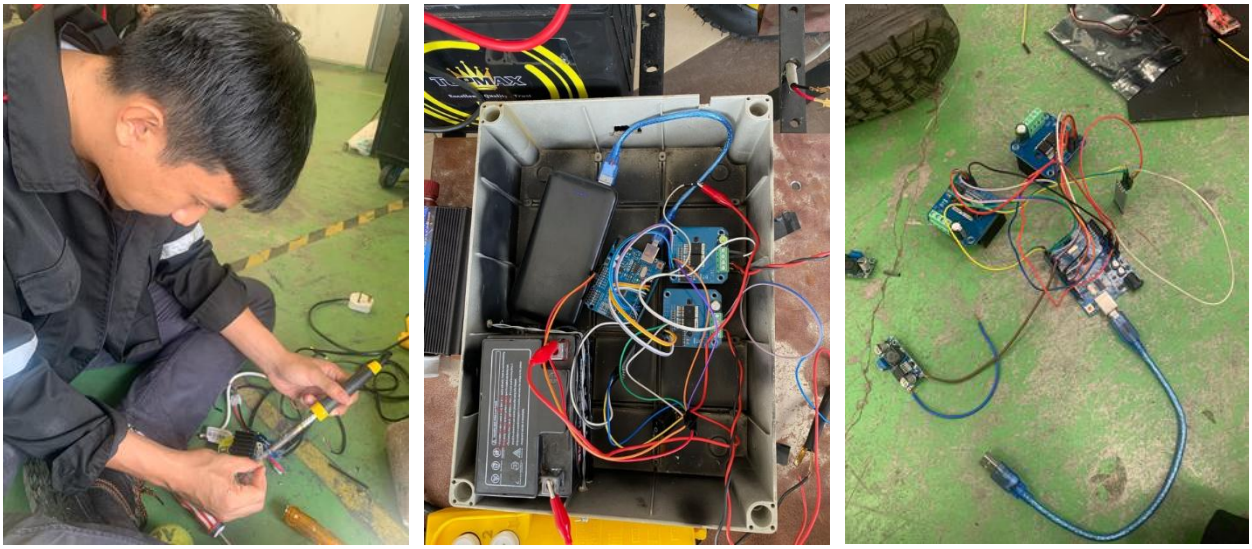


Figure 4.1.4

Figure 4.1.3 is applied arduino coding system. Arduino coding for controlling the system. the code to control the forklift's movements, including lifting, lowering, and navigation.

Coding system is the main components to move the product. The system can move the product and motor by using the arduino app in the telephone.

4.2 Mathematical Calculations in Product Design

The project to be developed is a mini forklift control to help users to move and lift recycle item The parameters that need to be analysed are:

1. **Adjustable body specification such as weight, width, height**

Calculation :

- Length (L) : 914 mm = 0.914 m
- Width (W) : 630 mm = 0.630 m
- Height (H) : 925 mm = 0.925 m
- Thickness (T) = 3 mm = 0.003 m

Surface Area calculation ;

Front / Back Area : $H \times W = 0.925\ m \times 0.630\ m = 0.58275\ m^2$

Side Area : $H \times L = 0.925\ m \times 0.914\ m = 0.84545$

Top / Bottom Area : $L \times W = 0.914\ m \times 0.630\ m = 0.57582\ m^2$

Total surface Area:

$$\begin{aligned} \text{Surface Area} &= 2 \times (H \times W + H \times L + L \times W) \\ &= 2 \times (0.58275 + 0.84545 + 0.57582) \\ &= 2 \times 2.00342 \\ &= 4.00684\ m^2 \end{aligned}$$

Volume of the steel:

Volume = Surface Area × Thickness = $4.00684 m2 \times 0.003m = 0.01202052 m^3$

Using the density of steel ($7850\ kg/m^3$):
Mass = Volume × Density
= 0.01202052 m3 × 7850 kg/m3 = 94.36kg

Approximate weight of the forklift body : 94.36 kg

4.3 Project Testing Analysis for Mini Forklift Control System

This chapter demonstrates the testing in different aspects to determine the most effective Mini Forklift Control that has been produced. Table 4.3 shows the testing data conducted on the Mini Forklift Control.

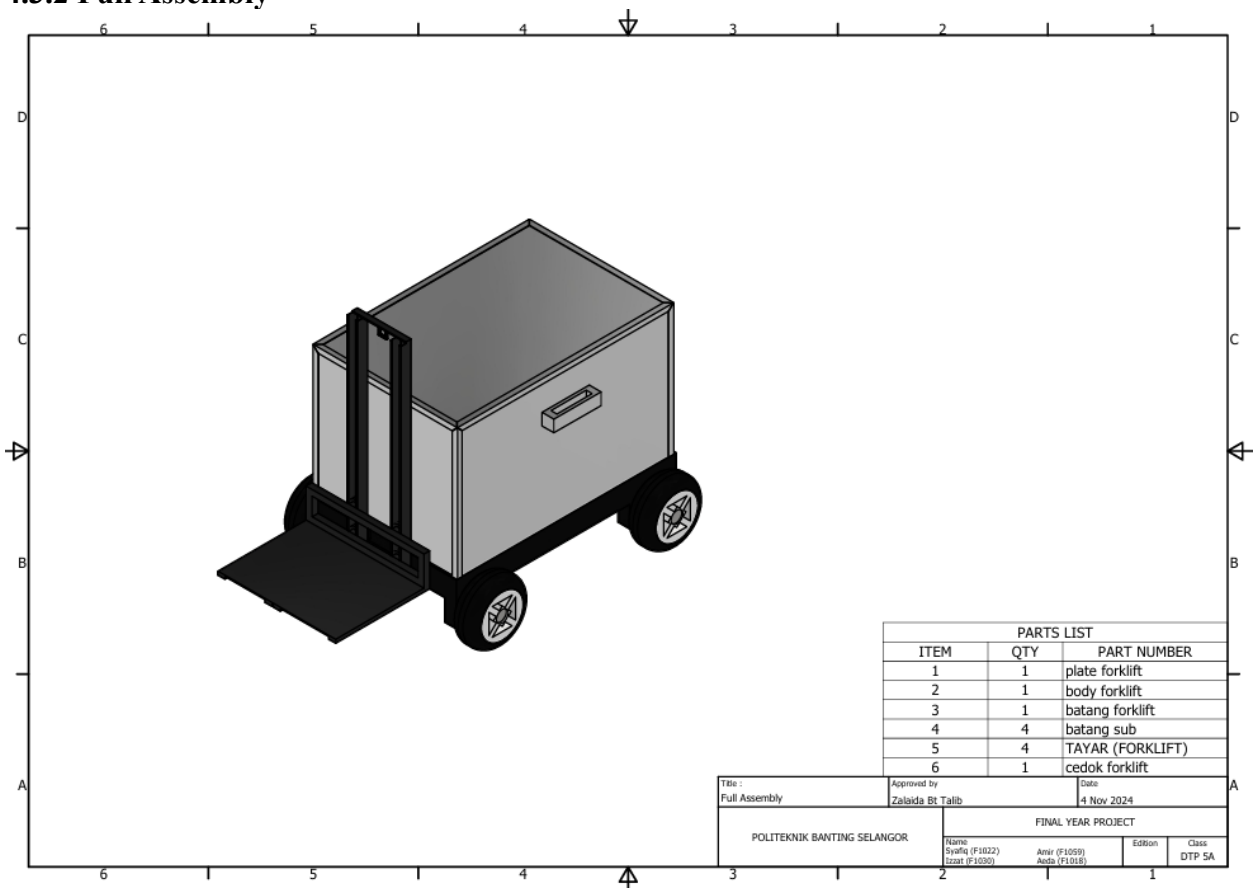
Table 4.3 Testing Data

Test Aspect / Repetition	Lifting Capacity	Operational Efficiency	Stability
10 kg	/	/	/
20 kg	/	/	/
30 kg	/	/	/
40 kg	x	x	/
50 kg	x	x	/

This data above demonstrates the testing in different aspects to determine the most effective Mini Forklift Control that has been produced. The first aspect is lifting capacity. Follow with the testing data, our mini forklift control can lifting an item until 30kg. Second aspect is operational efficiency, since these forklift weights are limit, the forklift can handle the load of items until 30kg .Lastly , for stability aspect. These mini forklift control can be stable to moving and lifting the items start from 10kg until 50kg .However, you should still ensure that the load is properly centred on the forks and not imbalanced. Lighter loads often get misaligned or don't sit properly on the forks, which can cause inefficiency and even accidents. The purpose of this design is to be moving and lifting items.

4.3.1 Real Product

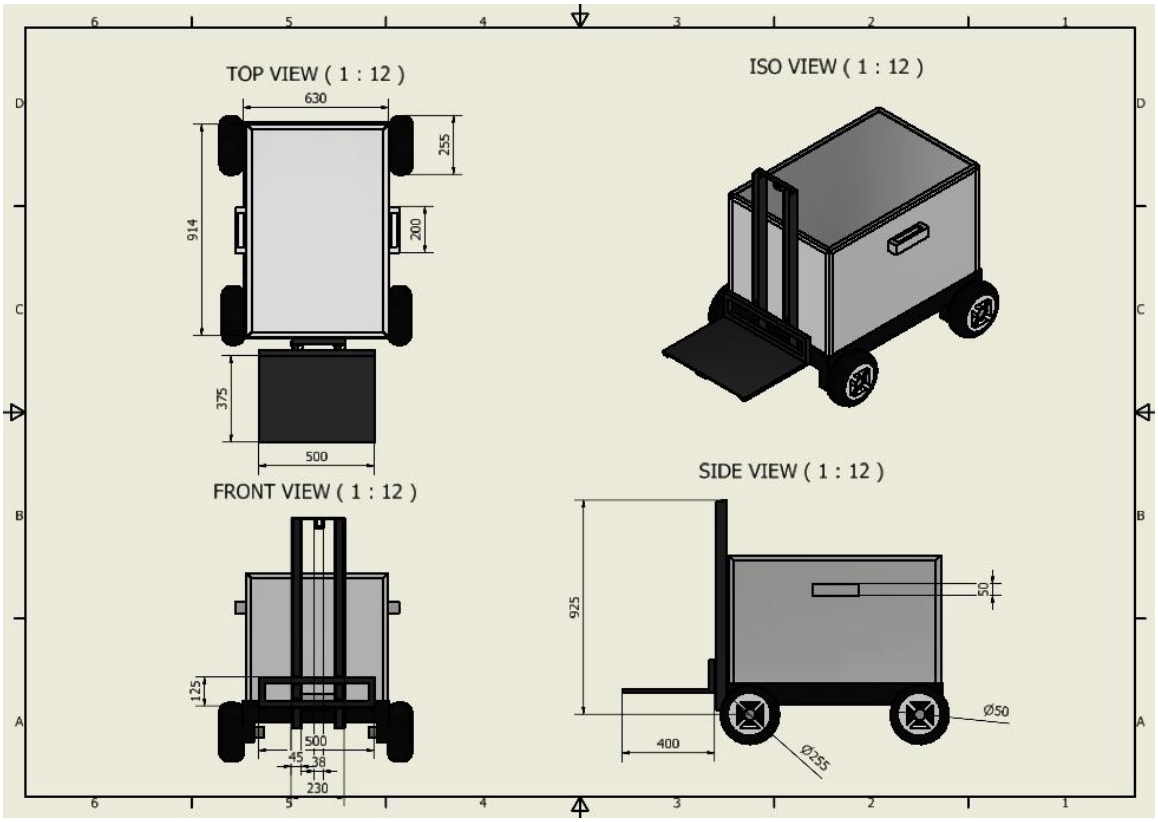
4.3.2 Full Assembly



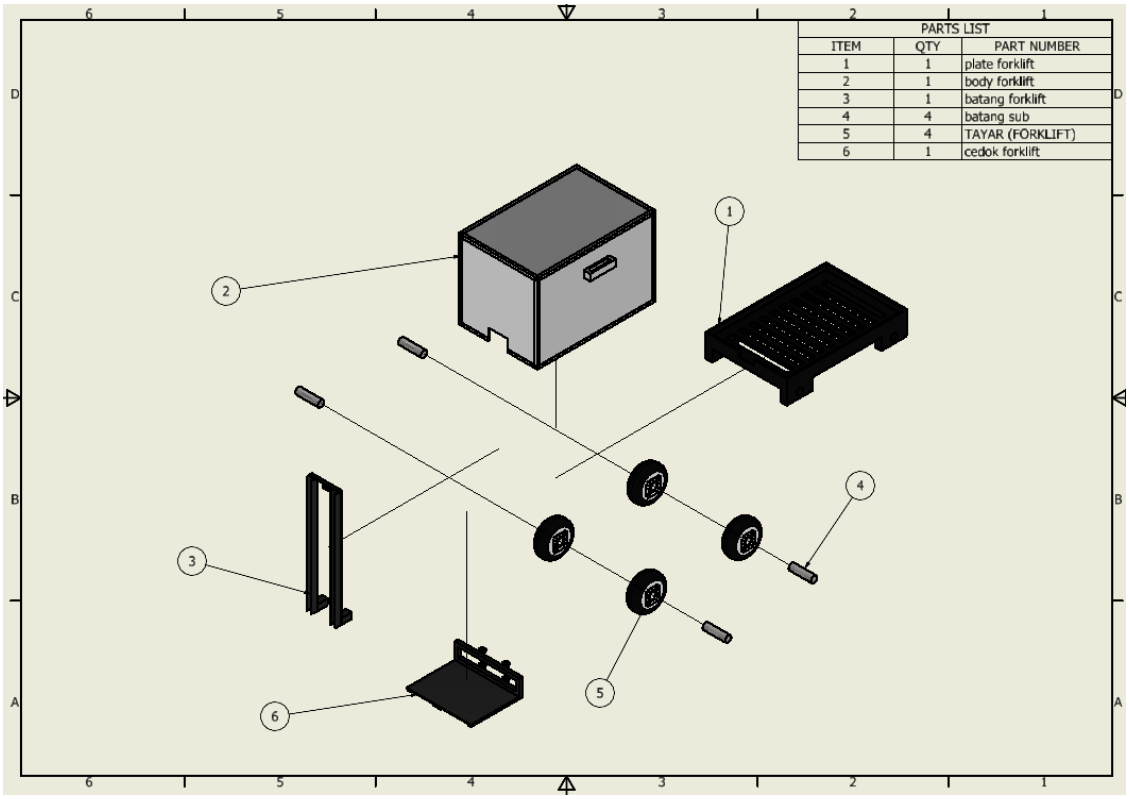
PARTS LIST		
ITEM	QTY	PART NUMBER
1	1	plate forklift
2	1	body forklift
3	1	batang forklift
4	4	batang sub
5	4	TAYAR (FORKLIFT)
6	1	cedok forklift

Title : Full Assembly	Approved by Zalaida Bt Talib	Date 4 Nov 2024
POLITEKNIK BANTING SELANGOR	FINAL YEAR PROJECT	
	Name Syafiq (F1022) Amir (F1059) Izzat (F1030) Aeda (F1018)	Edition
		Class DTP 5A

4.3.3 Assembly with Autographic



4.3.4 Exploded with Bill of Materials



4.3.5 Function of Product

Designing a mini forklift control system using an Arduino platform involves interfacing the Arduino with various components that control the forklift's movements, safety features, and load handling. The Arduino will act as the central controller, coordinating the operation of motors, sensors and other devices. The mini forklift needs to move forward, backward, left, and right. This can be accomplished by controlling the motors via the Arduino. For lifting can be control using an electric hoist that connects to power inverter.

4.3.6 Project Finding

Table 4.3.1 shows the detailed experiment conducted on the Mini Forklift Control.

Table 4.3.1: Experiment Detail

Test Aspect	Measurement/Criteria	Analysis
Lifting Capacity	Maximum 40kg weight lifted.	The mini forklift was able to lift up to 30 kg without any problems. However, it fails at 40 kg which means it cannot safely or reliably handle weights over 30 kg.
Operational Efficiency	Energy-efficient than their internal combustion counterparts. Low power consumption leads to reduced operational costs.	The forklift is operationally efficient up to loads of 30 kg . At 40 kg, the forklift's operational efficiency begins to fall. At 50 kg, it is bound to face further efficiency loss, marking it unsuitable to carry the load at this level.
Stability	Load stability test.	The various checks across the table indicate that stability remains acceptable across the weights tested, even including 50kg. It would, therefore, appear that while the forklift may, of course, stay physically stable under heavier loads, beyond 40kgs, it becomes problematic as far as lifting and operation efficiency is concerned.

Accordingly, the Mini Forklift Control System is most effective and efficient at lifting up to 30 kg. It can only lift up to 40 kg but starts losing operation efficiency. At 50 kg, it fails by both lifting capacity and operational efficiency even though it is stable. Thus, its ideal operational range would fall within handling loads from 10 – 30 kg.

4.4 Cost Analysis

Cost analysis is includes the cost of purchase materials/components, and other costs related.

4.4.1 Materials/ component Cost

Bil.	Component Name	Price per unit (RM)	Quantity	Total Price (RM)
1	Mild Steel Square	RM 9 / 2 ft	8ft	RM 36
2	Mild Steel Plate	RM 400 / 4 x 8 ft	1	RM 400
3	Round Bar Steel Rod Metal	RM 20 / 12m	1	RM 20
4	Mini Electric Hoist	RM 240 / unit	1	RM 240
5	Rubber Pneumatic Wheelbarrow	RM 50 / unit	4	RM 150
6	Power inverter	RM 60 / unit	1	RM 60
7	Arduino Programming	RM 135	1 set	RM 135
Total				RM 1041

4.5 Safety Risk

Every product design must comply with safety specifications either during the development or operation process.

Table 4.5 shows the security risks when operate the Mini Forklift Control.

Bil.	Risk	Preventive Measure
1	Mechanical Failures	• **Regular Maintenance :** Schedule routine inspections and maintenance of all mechanical parts. • **Quality Materials** : Use high-quality, durable materials for all components. • **Stress Testing :** Perform stress tests on critical parts to ensure they can handle expected loads.
2	User Errors	• **Training Programs :** Provide comprehensive training for all operators on safe usage and controls. • **Clear Instructions :** Create user manuals and quick reference guides detailing operational procedures.
3	Overloading	• **Weight Sensors :** Install weight sensors to monitor load and prevent overloading. • **Load Limits :** Clearly mark load limits on the forklift and in training materials. • **Safety Alarms :** Implement alarms or alerts when approaching weight limits.

CHAPTER 5: CONCLUSION AND RECOMMENDATIONS

5.1 CONCLUSION

It follows that development and testing of the mini forklift control system have found to highlight a number of advantages over traditional manual material handling methods. Comprehensive tests according to the development indicated that the mini forklift is able to effectively reduce physical effort for operators while improving operational efficiency. Data analysis according to results showed it can lift and transport loads with remarkable speed and precision to enhance productivity in various environments.

The ease of use of the system combined with its very low power consumption makes it one of the better options for companies looking to automate material handling. Proven lifting capacity and robust safety features make the mini forklift control system unparalleled as a workplace tool for advancing efficiency and safety.

However, several issues were identified during testing: the battery voltage was insufficient to support the Arduino coding, causing the motor to fail to operate. Additionally, the front fork experienced a sudden inability to lift and lower properly.

In summary, this project would be targeting confirmation that indeed the mini forklift control system, besides streamlining operations, contributes to a much safer and productive working environment despite the challenges faced.

5.2 RECOMMENDATIONS

Recommendations for Mini Forklift Control System :

1. Battery Upgrade

Recommendation: Use a higher-capacity battery-one that will be able to provide ample voltage to the Arduino and other components.

2. Power Management System

Recommendation: The power management system will be implemented for monitoring the health of the battery and voltage.

3. Motor Compatibility

Recommendation: Motors shall also be chosen with due consideration to compatibility issues of the control system and load.

4. System Testing and Simulation

Recommendation: Conduct thorough testing and simulation of the control system under various loads and conditions before deployment.

LIST OF APPENDICE

TABLE NO. **Pages**

REFERENCES

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APPENDIX A: DECLARATION OF TASK SEGREGATION

SUB – CHAPTER	DESCRIPTION
NURHIDAYAH FAISALTUL AIDA BINTI ABU BAKAR	
1.0	INTRODUCTION
1.1	BACKGROUND OF STUDY
1.2	PROBLEM STATEMENT
1.3	PROJECT OBJECTIVE
1.4	SCOPE PROJECT
3.8	Project Schedule (Gantt Chart) - Planning and Action
4.0	Introduction
4.1	Building Prototype and Product
4.1.1	a) Fabrication of Base Structure
4.1.2	b) Fabrication of Body Structure
4.1.3	c) Fabrication of Handle Scope Structure
4.2	Mathematical Calculation in Product Design
4.3.1	Project Finding
4.3.5	Function of Product
4.5	Safety Risk
5.1	CONCLUSION
5.2	RECOMMENDATION
IZZAT HAZIQ YASTI BIN YASSIN	
2.1	General Literature Review
2.1.1	Introduction
2.2	Existing Product
2.2.1	Mini Forklift Control
2.2.2	IoT (Arduino)
2.2.3	Electric Hoist
2.2.4	Motor Power Window
2.2.5	Programming Apps (Arduino IDE)
2.2.6	Programming Command
2.3	Component – component in the Product
3.6	Fabrication and Programming Process
3.7	Installation Process
4.1.4	Coding System a) Design b) Circuit Block c) Programming Command e) Movement Command Fabrication
4.4	Cost Analysis
	References
MUHAMMAD SYAFIQ HAKIMI BIN ANIZAN	
3.4	Technical drawing
3.4.1	Complete Drawing

3.4.2	Installation Drawing and Bill of Materials
3.4.3	Part Drawing a) Mini Electric Hoist b) Handle Scope Forklift c) Body Structure d) Base Structure e) Scope Structure f) Arduino UNO g) Wheel
3.4.4	Isometric Drawing
3.7	Installation Process
4.1.1	Base Structure a) Design
4.1.2	Upper Body Structure a) Design
4.1.3	Handle Scope Structure a) Design
4.3	Project Testing Analysis For Mini forklift Control System
4.3.2	Full Assembly
4.3.3	Assembly with Orthographic
4.3.4	Exploded with Bill of Materials
	List of Appendices
MOHAMMAD AMIR IKHWAN BIN OTHMAN	
3.1	Product Description
3.1.1	Product Objective / Purpose Product
3.2	Flow Chart / Process Flow
3.3	Selection of Concept and Design
3.5	Selection of Material and component
3.5.1	Introduction
3.6	Fabrication and Programming Process
4.4	Cost Analysis
4.4.1	Material / Component Cost
4.3.1	Real Product
5.2	Recommendation
	As A Leader in The Workshop to Finish The Project

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