

Smart Parcel Receiver Box

Nursyafieqa Abu Zarin¹, Siti Zaharah Kunchi Mon^{1*}

¹ Department of Mechanical Engineering Technology

Faculty of Engineering Technology, Universiti Tun Hussein Onn Malaysia, Pagoh, Johor, 84600, MALAYSIA

*Corresponding Author: zahara@uthm.edu.my

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Abstract

The Smart Parcel Receiver Box is designed to address issues with traditional package delivery systems at UTHM Pagoh Residential College. Previously, packages were left in vulnerable paper boxes with no proper storage, leading to theft or damage by weather conditions. The new smart parcel box prototype aims to enhance security and organization. When a package is delivered, it can be unlocked and locked inside the smart parcel box, preventing theft. The recipient verifies ownership by scanning a QR code on the package, and the system updates the database with the receipt time to prevent unauthorized access. A website complements the solution, allowing users to monitor incoming and received parcels easily. The system enhances security by restricting the use of QR codes to one scan, discouraging repeated attempts at theft.

1. Introduction

The eCommerce market in Malaysia is set to grow by 13.26% by 2027, reaching \$8.75 billion by the end of 2023. Digital customers, constituting 90% of internet users, are a significant driver. Malaysia's internet usage is high at 96.8%, with a 54.7% mobile transaction rate and 90% smartphone penetration. Q1 2023 saw a 10% revenue increase in eCommerce compared to 6% in 2022. Online sales in 2022 reached \$9.08 billion, favoring toys, fashion, and electronics over furniture. Shopee leads with 42.8 million monthly visits, displacing Lazada. Projections anticipate a 15–25% eCommerce growth in the SEA region. Malaysia projects eCommerce payments to rise from \$22.23 billion in 2023 to \$41.74 billion in 2027, with a 13.6% annual growth rate. Factors driving growth include technology advancements, increased education, and a consumption-focused middle class, aligning with the World Bank's forecast of Malaysia becoming a high-income country between 2024 and 2028. [1]

In Malaysia, the current practice of leaving oversized packages outside the buyer's residence, when they don't fit in the letterbox, poses significant risks. This unattended delivery method increases the likelihood of packages being lost, stolen, or damaged due to exposure to the elements. Factors such as inadequate security measures and lack of supervision contribute to the vulnerability of packages. The absence of proper monitoring tools, like CCTV systems or security personnel, in insecure locations makes it easier for thieves to take advantage of unattended packages. This situation not only provides opportunities for theft but also complicates investigations in case of loss or tampering, hindering efforts to track down missing items or identify perpetrators.

This article addresses the worsening state of courier services in Malaysia, citing an incident involving Mohd. Suzairi Ali Hassan whose wife's cosmetics were not only significantly delayed but also arrived opened with the item missing, resulting in a RM70 loss. Similar complaints surfaced on Facebook during the Covid-19 pandemic, with users expressing dissatisfaction over incorrect package contents. A delivery firm employee

attributed the decline in service to personnel shortages and increased parcel volumes during the Movement Control Order (MCO). The Malaysian Communications and Multimedia Commission (MCMC) reported a substantial decline in courier service quality from late 2019 to the previous year, with 86% of complaints related to poor service, late deliveries, and lost items. In response, MCMC is implementing initiatives such as the National Post and Courier Industry Laboratory (NPCIL) and the National Courier Accelerator Plan to enhance the courier industry. [2]

To prevent package theft, especially during the holidays when millions of packages are stolen annually, several strategies can be employed. Scheduling deliveries for times when someone is home, installing front door security cameras, and providing delivery instructions during online orders are effective measures. Additionally, investing in a lockable parcel box at home, easily accessible to delivery personnel, can enhance security. Recognizing the importance of secure drop boxes and considering security cameras and large wall-mounted post boxes further discourages theft and addresses the ongoing challenge of package security [3].

The article titled "Singapore goes all out in out-of-home" as shown in Figure 1 discusses Singapore's substantial investments in advancing its out-of-home (OOH) advertising infrastructure. In Singapore, innovative projects like the "Orchard Road Media Wall" and digital screens in transportation hubs highlight the city's use of advanced technologies and creative concepts in advertising. The integration of data analytics and automation, along with collaborations between advertisers, technology providers, and government agencies, drives innovation in out-of-home (OOH) advertising. Singapore's commitment to urban transformation underscores its dedication to providing advertisers with inventive opportunities to engage consumers beyond their homes. On the other hand, Malaysia exhibits a lower adoption of lockable parcel boxes, indicating a need for the development of smart parcel boxes for community use [4].



Fig. 1 The article titled "Singapore goes all out in out-of-home."

UTHM students reside in UTHM Pagoh Residence College encounter issues of losing or damage parcels after delivery. There is no proper system or storage for the parcel. The parcels were normally left in a paper box at the collection point as shown in Figure 2. This has resulted in packages being stolen, damaged due to rain or other circumstances, and the parcel location looks messy, and it is difficult to find the parcel as shown in Figure 3. Therefore, Smart Parcel Receiver Box is proposed to address the issue of unmanageable and disorganization of parcel receiving system at UTHM Pagoh Residence College.



Fig. 2 Paper boxes at the parcel collection point



Fig. 3 The parcel left unorganized.

1.1 Patent Search

A patent search, frequently referred to as a patentability search, is the process of looking through already issued patents and documents that are accessible to the public in order to find related inventions or technologies. Even if the invention has never been commercially sold, a patent search may reveal that it has already been manufactured.

Patent 1: Intelligent Parcel Box Lease Management and Logistics Management System and Control Method

Figure 2.1 displays an intelligent parcel box lease management and logistics management system and control method patented by Zhuang Xiubao on August 31, 2021 (Patent number: CN107491917B). It involves a control technique and an intelligent parcel box leasing and logistics management system. This system comprises an intelligent parcel box, a cloud administration platform, a sorting center, a leasing end, a mobile communication terminal, and an intelligent parcel box. Users can register and query logistics information through a mobile communication terminal interfacing with the cloud management platform and the intelligent parcel box. Each intelligent parcel box has a unique identification number for leasing through the leasing end. The sorting center and recovery end facilitate the sorting, sending, and retrieval of intelligent package boxes. [5]

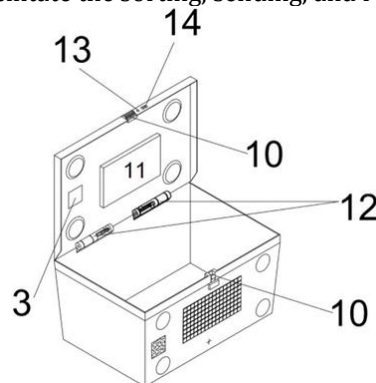


Fig. 4 Patent 1

Patent 2: Parcel Box

Figure 2.2 displays a parcel box patented by Curtis R. Richardson Thomas D. Smith on October 27, 2020 (Patent number: US10817824B2). The parcel box is a flexible storage solution with a user interface, cameras, and solar panels. It is customizable in different sizes to fit various parcel dimensions and features a modular design for adding or removing storage compartments without duplicating components. The box can be assembled from foldable panels for efficient shipping and storage. The plastic components are produced using various molding techniques, including injection molding, blow molding, compression molding, gas assist molding, rotational molding, structural foam molding, and thermoforming. [6]

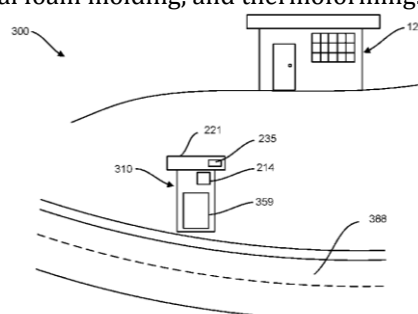


Fig. 5 Patent 2

Patent 3: Smart Parcel Safe

A smart parcel safe patented by Rebecca Romanucci on August 9, 2018 (Patent number: US10039401B1) in Figure 6. The smart parcel safe is designed to securely receive and protect packages delivered by courier services. It consists of an owner-container with an electronically controlled locking mechanism and a smart temperature control refrigeration unit. The locking mechanism can be remotely managed through mobile apps on the delivery service and owner's devices. The temperature control unit, operable through the apps or an on/off switch, allows for heating or cooling as needed. This technology ensures secure package delivery by providing remote locking and temperature control through mobile devices. [7]

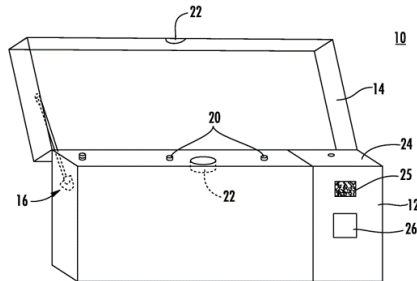


Fig. 6 Patent 3

Patent 4: Systems and Methods for Control of Electronic Parcel Lockers

Figure 7 displays a system and methods for control of electronic parcel locker by Donald Eugene Irwin on September 22, 2020 (Patent number: US10783486B2). The embodiment is a control unit designed for use with a storage unit, devoid of storage receptacles. It features a versatile screen, with options such as CRT, plasma, LCD, and others, capable of displaying information to the user. The screen may have touch capabilities and additional output features like speakers. When paired with input devices like touchscreens, keypads, or microphones, it facilitates electronic signature capture and user input. The adaptability of this control unit makes it suitable for diverse scenarios involving information display and user interactions [8].

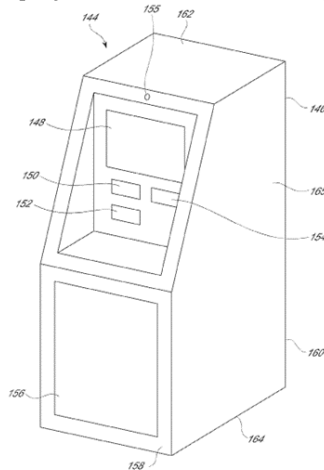


Fig. 7 Patent 4

1.2 Current parcel box invention

Product A: Clever Made Parcel Lock Box S100 Series

A parcel box as shown in Figure 8 was designed for protecting important products. The Lock Box is made of heavy-duty and durable reinforced steel. Furthermore, it has hydraulic struts for smooth opening and closing, an illuminating, programmable digital lock plus manual key, four pieces of AAA Alkaline batteries included, and can be accessed via a programmable digital lock that can also be opened manually with the key set provided. A hydraulic strut is added to assist in the creation of a secure container closing. It can generate codes and enter shipping instructions for all major carriers online [9].



Figure 8: Product A

Product B: 2 in 1 Parcel Delivery Box

2 in 1 Parcel Delivery Box was constructed with galvanized steel and coating finishing, durable, heavy-duty, and sustainable as shown in Figure 8. Its tamper-avoid drop slot and lockable front retrieval door provide more security and convenience. It can mount the parcel box to the wall or stand it in the yard with mounting hardware included. This box is ideal for receiving mail and packages on the home porch, offices, business buildings, etc. The parcel box has a key lock with two keys included and all the necessary fixings required [10].



Fig. 9 Product B

Product C: Letterbox Medium Front Access Blue Smart Parcel Box

The parcel box as shown in Figure 9, Letterbox Medium Front Access Blue Smart Parcel Box is meant to be built into a wall. This parcel box also can choose to stand this model up like a regular parcel box. Do however note that the roof is not slanted, so it will need to choose a covered location for it to prevent rain pooling on the top. As this parcel box is extra-large, it allows us to accept many deliveries at any time of the day or night. A 3-pin combination lock ensures only one can access the parcels, keeping any unwanted hands well away from them [11].



Fig. 10 Product C

1.3 Comparison between patents and products based on different criteria.

Table 1 compares patents and products based on different criteria, such as size, capacity, barcode or lock, material and water resistance level. The comparison shows that Patent 3 was chosen as the reference for the designed product in terms of size, Patent 4 was chosen for capacity and Patent 3 was chosen for type of barcode or lock. Similarly, Product A was chosen as the reference for the designed product in terms of size and capacity. The larger the size of parcel box, the more parcels can be placed in the parcel box. Furthermore, Product C was chosen for barcode or lock. The selection using barcode due to simple and easy to use with little or no training required. Last but not least, the chosen type of material used is galvanized steel and the product is water resistant. The study concludes that these patents and products are the best fit for the designed product based on the evaluation criteria.

Table 1 Comparison between patents and products based on different criteria.

	Patent Chosen				Product Chosen		
	1	2	3	4	A	B	C
Size	Specific size	Not stated	Variety and particular size	Specific size	444.5mm x 444.5mm x 571.5mm	350.5mm x 444.5mm x 59mm	430mm x 530mm x 1000mm
Capacity	Limited	Not stated	Limited	Limited	Maximum 35 cm x 36.8 cm x 50.8 cm	Maximum 27 cm x 37.5 cm	Maximum 32 cm x 20 cm x 12 cm
Barcode or Lock	Barcode	Barcode	Lock	Barcode	Lock	Lock	Lock
Material	-	-	-	-	Alloy Steel	Galvanized Steel	Galvanized Steel

2. Methodology

The design idea was created by choosing suitable materials, running programming using the Arduino IDE after completing procedure for the design and development of the Smart Parcel Receiver Box. Designs are selected and prepared for manufacturing if coding is accepted. After the fabrication stage, the product is subjected to testing. If any issues arise during the fabrication stage, the product needs to be redesigned to achieve the desired level of quality. Finally, the research for the project is recorded to complete the final year project.

2.1 Pre and Post Survey

A pre-survey is a research process that involves sending surveys to respondents to gather information before product fabrication. It is conducted before the design phase to understand user needs. The collected survey data is statistically analyzed to draw meaningful study results and aims to determine the frequency of online shopping among respondents and gather feedback on issues like stolen or missing packages. Post Survey was conducted to get the feedback of the students who used the Smart Parcel Receiver Box. It was carried out concurrently to gather feedback from students who utilized the Smart Parcel Receiver Box. This implies that the survey aimed to assess the students' experiences and opinions after they had interacted with or made use of the mentioned Smart Parcel Receiver Box.

2.2 Design Prototype using Sketch.

In Figure 9, the area for scanning the QR Code and the door to take out of the parcel is at front are illustrated in Figure 9(a) and 9(b). Both doors to take out the parcel is differently position which is at the front. As sketched in Figure 9(c) the area for scanning the QR Code is to the right of the Smart Receiver Parcel Box while the position of the door to put and to take out the parcel is at the front. Figure 9(d) the door to put the package is at the top of the Smart Receiver Parcel Box while the area for scanning the QR Code on the left side and the door to take out the parcel is at the front and the design was acceptable to being a prototype.

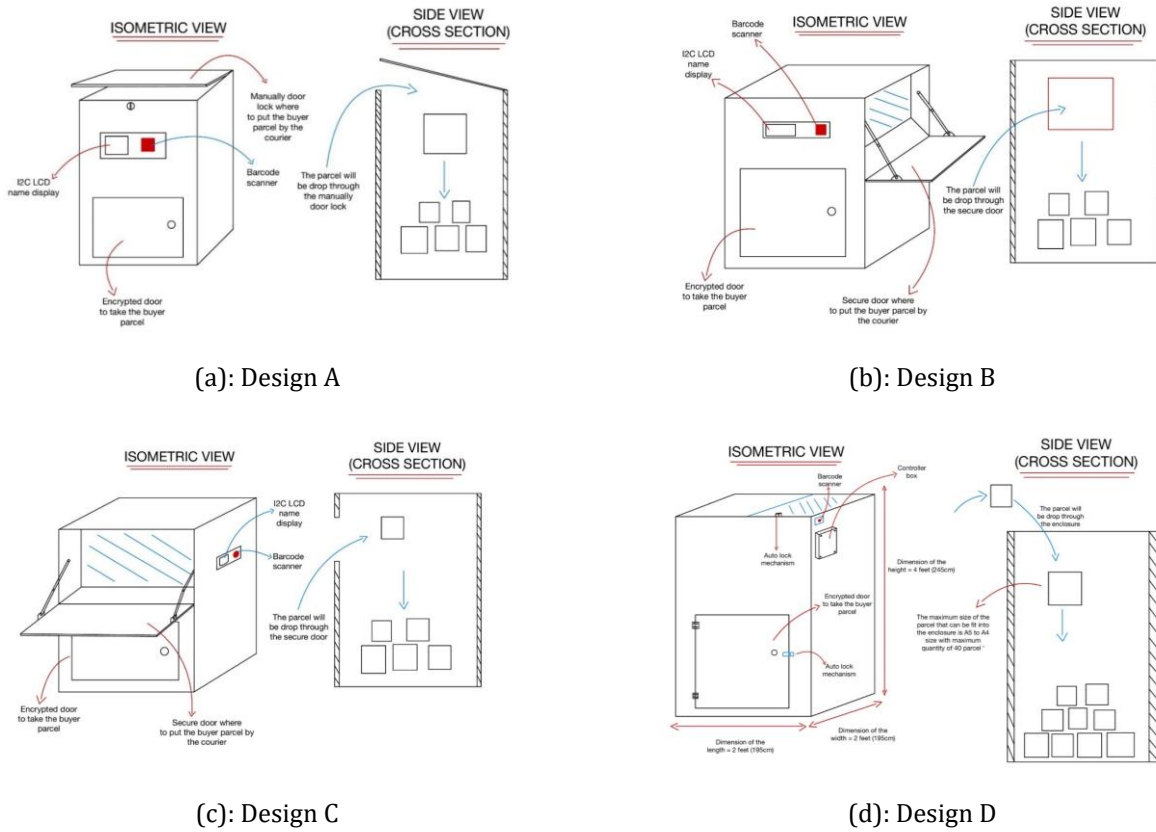


Fig. 11 Design Prototype using Sketch

2.3 Evaluation

This phase is intended to discover if the design really satisfies the needs, and to select the appropriate concept to meet the design objective [12]. Design specifications, which are characteristics determined during problem definition, can be used to determine evaluation criteria. The selection of criteria, on the other hand, must be done with caution, as some of the criteria chosen can be extremely difficult to access. Table 2 shows the chosen evaluation criteria for smart parcel receiver box.

Table 2 Chosen evaluation criteria	
EVALUATION CRITERIA	• Size and capacity
	• Locking mechanism
	• Integration with delivery service
	• Remote access log

For the size and capacity, it to hold a variety of package sizes that are frequently sent in the area. However, the locking mechanism has the ability to assess its own dependability and strength. It ought to be sufficiently safe to thwart unwanted access. Integration with Delivery Services is also included. QR codes may be scanned by intelligent package boxes to facilitate simple tracking and delivery confirmation. Lastly, log access. It requires mobile applications to support it. Its delivery and pickup log should be kept for security and tracking reasons.

2.4 Hardware

The Arduino IDE (Integrated Development Environment) and the Arduino UNO board are essential parts of the Arduino platform that are needed to develop projects. The Arduino programming language is similar to C/C++, and the IDE is the software interface used to create, upload, and monitor code written in that language [13].

Users use USB to connect their computers to the Arduino UNO, which enables the IDE to upload code that has been compiled to the board. This tight integration highlights a seamless interface between hardware and software during development by guaranteeing compatibility between the development environment and different Arduino board variations.

2.5 Software

The project utilizes QR Scanner software, designed to read and interpret QR codes. This tool captures an image of a QR code with a camera or image sensor, decoding the information contained in the code. To use the QR scanner, users need to launch the app on their device, aim the camera at the QR code, and wait for the scanner to detect and decode the data [14]. Google Firebase in Figure 10 is a platform built by Google for the development of online and mobile apps. It enables developers to save and sync data in real time. It is also frequently used to create real-time collaborative apps, and it is intended to make the development process easier [15].

3. Result and Analysis

3.1 Parametric Design

In terms of parametric design, Design D was chosen to be fabricated. The main reason for the chosen of design D is because of the position of the doors. The door for courier to insert the parcels was set at the top of the box. The location at the top makes it easier for parcels to be inserted. While the door to pick up parcels is located at front of the box to makes it easier for students to find and pick up the items. In addition, the USB QR Scanner is placed on the right of the prototype to make it easier for the courier scan and insert the parcels. The location of the USB QR Scanner is located at the side of the box to make it more orderly and systematic. The size of Smart Parcel Receiver Box was set to 60 x 60 x 122 cm and can fit approximately 80 parcels with range size of 20 x 20 cm.

3.2 Design using SolidWorks.

After finalizing the design, the designer moves on to the presentation phase for the smart parcel receiver box, utilizing 3D modeling and detailed drawings. The 3D model offers a comprehensive representation, and detailed drawings, generated from SolidWorks software, provide dimensions through isometric views as shown in Figure 11. These outputs are crucial for manufacturing and are shared with manufacturers. The designer then presents the product to customers, gathering feedback. Positive feedback indicates success, while negative feedback prompts the designer to make recommendations for improvement.

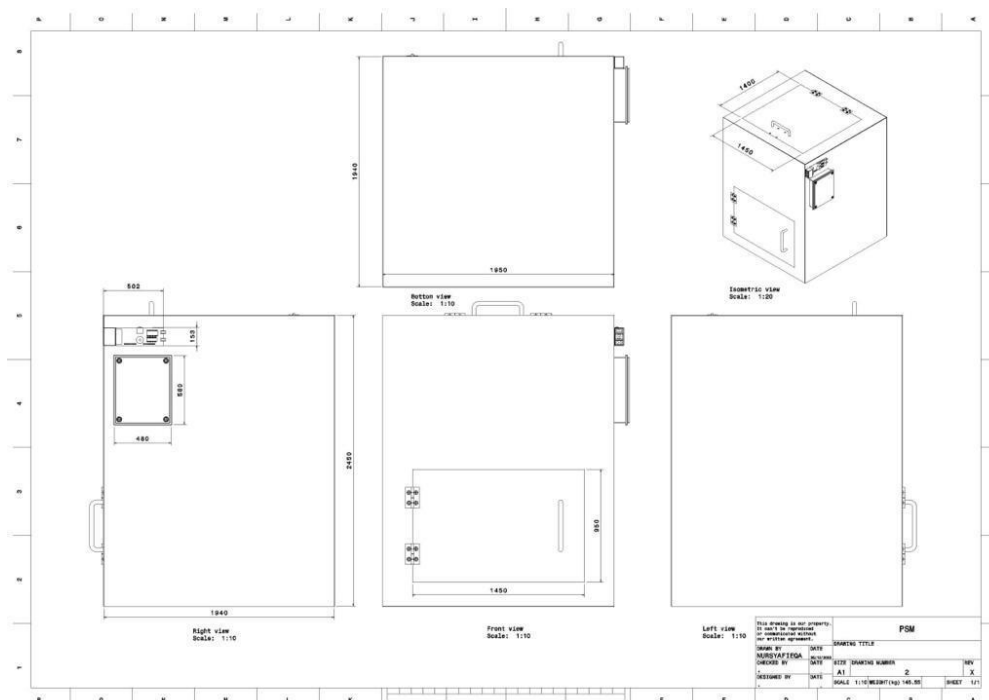


Fig. 12 Design using SolidWork

3.3 Fabrication

Creating a prototype for a Smart Parcel Receiver Box involves integrating diverse technologies to establish a secure and efficient package management system as shown in Figure 12. Acrylic is chosen for its excellent optical clarity, making it suitable for applications requiring transparency. Additionally, acrylic is lightweight, possesses good weather resistance, and is less prone to yellowing or degradation in sunlight compared to other plastics. To assemble this prototype, it uses acrylic glue. This is due to the acrylic texture that breaks easily when tapped or nailed.



Fig. 13 *Prototype of Smart Parcel Receiver Box*

3.4 Circuit of Monitoring

The schematic diagram using Fritzing for the Smart Parcel Receiver Box prototype is illustrated in Figure 13. Highlighting key components including Arduino, USB QR Scanner, Nodemcu, and Solenoid Lock. The USB QR Scanner scans package QR barcodes, and the Solenoid Lock secures or permits the door latch to open without latch withdrawal. The Arduino and Nodemcu sensors are connected, establishing a link with the USB QR Scanner through generated barcodes for scanning.

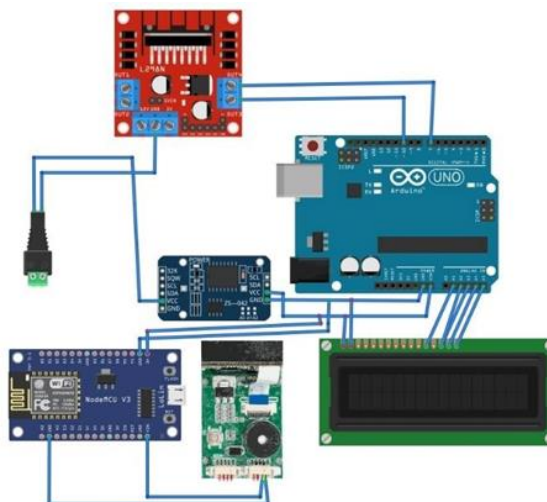


Fig. 14 *Circuit Monitoring Smart Parcel Receiver Box*

3.5 Final Prototype of Smart Parcel Receiver Box

Figure 14 shows the final prototype of Smart Parcel Receiver Box.



Fig. 15 Final Prototype of Smart Parcel Receiver Box.

4. Conclusion

The fabrication of the Smart Box Receiver Box was executed successfully based on the four types of designs produced. The systems employed for this project were Arduino Uno and Arduino IDE. A comprehensive test was conducted involving 40 students over a period of three days. The results revealed that 31 of the respondents, accounting for 78%, expressed satisfaction with the production of this prototype.

The Smart Parcel Box is designed to securely receive and store parcels by implementing a verification function for intended recipients. This innovative solution aims to address challenges like parcel theft at UTHM Pagoh Residential College, offering a convenient and secure way for recipients to receive packages without being physically present. The prototype, made of acrylic, is intended to test durability and practicality. Overall, the Smart Parcel Receiver Box represents a significant advancement in improving the security and convenience of parcel deliveries through cutting-edge technology and user-friendly features, including real-time tracking, secure authentication, and user notifications.

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Conflict of Interest

Authors declare that there is no conflict of interests regarding the publication of the paper.

Author Contribution

The authors confirm contribution to the paper as follows: **study conception and design:** Nursyafieqa Binti Abu Zarin; **data collection:** Nursyafieqa Binti Abu Zarin; **analysis and interpretation of results:** Nursyafieqa Binti Abu Zarin; **draft manuscript preparation:** Nursyafieqa Binti Abu Zarin, Siti Zaharah Binti Kunchi Mon. All authors reviewed the results and approved the final version of the manuscript.

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https://www.amazon.com/Yoocabinet-Delivery-Galvanized-Anti-Theft-Black-BG002B/dp/B0BR568NYM/ref=zg_bs_17572893011_sccl_1/134-1665109-8334826?th=1
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