

# **SMART PARCEL LOCKER SYSTEM**

**18MT810 - Project**

Submitted by

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*in partial fulfillment of the requirements for B.E. degree in Mechatronics  
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**MADURAI-625 015**

**APRIL 2023**

# THIAGARAJAR COLLEGE OF ENGINEERING

(A Govt. Aided Autonomous Institution Affiliated to Anna University)

**MADURAI-625 015**



## BONAFIDE CERTIFICATE

Certified that this is a bonafide record of the 18MT810 Project done by **Mr. Manojkumar M (19F025)** and **Mr. Pranave Karthik A (19F030)** of Eighth Semester B.E. (Mechatronics Engineering) during the year 2022 – 2023.

Signature of the Guide

Signature of HDMCT

Station: Madurai

Date:

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Submitted for Viva-voce Examination held at Thiagarajar College of Engineering, Madurai – 625 015, on\_\_\_\_\_.

INTERNAL EXAMINER

EXTERNAL EXAMINER

HDMCT

## **CERTIFICATE**

This is to certify that the 18MT810 Project Report entitled “**SMART PARCEL LOCKER SYSTEM**”, being submitted by **Mr. Manojkumar M (19F025)** and **Mr. Pranave Karthik A (19F030)** in partial fulfillment of the requirement for **Bachelor of Engineering Degree in Mechatronics Engineering**, is a record of bonafide work. The results embodied in this report have not been submitted to any other university or institute for the award of any degree or diploma.

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## **ABSTRACT**

A smart parcel locker is a secure, automated storage system designed for package delivery. It allows customers to receive parcels at any time of the day, without the need for face-to-face interaction with a delivery person.

Smart parcel lockers typically consist of individual lockers of varying sizes, controlled by a central computer system. When a package is delivered to the locker, the recipient receives a notification with a unique code that allows them to open the designated locker and retrieve their package. The recipient use the unique code generated for retrieving the package. The customer can pick up their package at any time that is convenient for them, and the locker system keeps the package secure until it is retrieved.

Smart parcel lockers are increasingly being used by delivery companies, retailers, and property managers as a convenient and secure solution for package delivery and pick-up. They are especially useful for apartment buildings, office buildings, and other locations where traditional package delivery methods may be inconvenient or not possible. Smart parcel lockers can also help reduce package theft and improve the overall delivery experience for customers.

# **CHAPTER 1**

## **INTRODUCTION**

### **1.1. INTRODUCTION**

In recent years, with the rise of e-commerce and online shopping, parcel delivery has become an integral part of our daily lives. However, the traditional method of doorstep delivery is not always convenient or secure, especially when recipients are not available to receive the package or live in areas with high package theft rates. This is where smart parcel lockers come in - a secure, convenient and accessible way to receive packages.

Smart parcel lockers are automated self-service units that are typically located in public places such as apartment complexes, office buildings, and shopping malls. They offer a secure and convenient way for package delivery and pick-up by allowing recipients to collect their parcels at any time, regardless of whether they are at home or not. Additionally, smart parcel lockers provide an efficient way for delivery companies to manage packages, as they eliminate the need for repeated delivery attempts.

However, to ensure maximum security, it is essential to implement smart parcel locker system. The system requires users to provide a unique code of identification before gaining access to the locker, thereby preventing unauthorized access and reducing the risk of theft or tampering. Common forms of locker system include the use of a fingerprint and an authentication token such as a mobile phone.

This report aims to provide an in-depth analysis on the implementation smart parcel locker system. It will discuss the advantages and disadvantages of different authentication methods and how they impact the user experience. Additionally, the report will cover the technical aspects of implementing smart parcel locker, including hardware and software requirements. Finally, the report will discuss the potential

impact of smart parcel locker on the security and accessibility of smart parcel lockers, and its potential to revolutionize the parcel delivery industry.

## **1.2. Features of Smart Parcel Locker**

A smart parcel locker is a versatile solution that offers various features, including:

- **Automated System:** The system is fully automated, allowing users to access the locker with ease.
- **One-factor Authentication:** The locker uses one -factor authentication, which involves the use of a unique code sent to the user's registered phone number to open the locker.
- **Real-time Updates:** The system sends real-time updates to the user's phone, providing information about the status of their parcel.
- **Secure Storage:** The locker is designed to provide a secure storage solution for parcels, ensuring that they are protected from theft or damage.
- **Multi-User Access:** The locker can be used by multiple users, making it an ideal solution for workplaces, residential areas, and public locations.

## **1.3 Advantages of Smart Parcel Locker**

- The use of smart parcel locker system offers several benefits, including:
  - **Convenience:** The system allows users to collect their parcels at any time, without having to wait for delivery.
  - **Enhanced Security:** The authentication system provides an added layer of security, making it difficult for unauthorized persons to access the locker.
  - **Reduced Costs:** The use of smart parcel lockers reduces delivery costs for businesses, as there is no need to deliver parcels to individual addresses.
  - **Increased Efficiency:** The system is designed to improve the efficiency of parcel collection and delivery, reducing the workload of delivery personnel.
  - **24/7 Access:** The locker can be accessed at any time, making it a convenient solution for users who have busy schedules.

In short, a smart parcel locker offers a secure, convenient, and cost-effective solution for parcel collection and delivery. The system's automated features and real-time updates provide an efficient and reliable service, making it an ideal solution for residential areas, workplaces, and public locations.

## **CHAPTER 2**

### **LITERATURE REVIEW**

#### **2.1. INTRODUCTION**

Smart parcel lockers are a relatively new technology-driven solution for parcel delivery and collection. With the rise of online shopping, the need for secure and efficient parcel delivery services has increased. One of the ways smart parcel lockers address this need is through the use of-factor authentication. This literature report aims to review the current research and literature available on smart parcel lockers system.

- **Security in Smart Parcel Lockers:**

The use of two-factor authentication is a critical feature of smart parcel lockers. A study conducted by Tang et al. (2021) found that two-factor authentication is an effective way to secure smart parcel lockers. The study suggested that the use of two-factor authentication, along with other security measures such as CCTV cameras and motion sensors, significantly reduced the likelihood of theft and unauthorized access to the lockers.[2]

- **Convenience and Efficiency:**

Smart parcel lockers offer a convenient and efficient solution for parcel delivery and collection. According to a report by Kim (2020), the use of smart parcel lockers can reduce the cost of last-mile delivery by up to 50%. The report also found that smart parcel lockers could improve delivery efficiency and reduce the number of missed deliveries, which are a significant problem for both customers and delivery companies.[9]

- **Multi-User Access:**

Smart parcel lockers with two-factor authentication offer multi-user access, making them an ideal solution for workplaces, residential areas, and public locations. A study by S. Balakrishnan et al. (2021) found that multi-user access

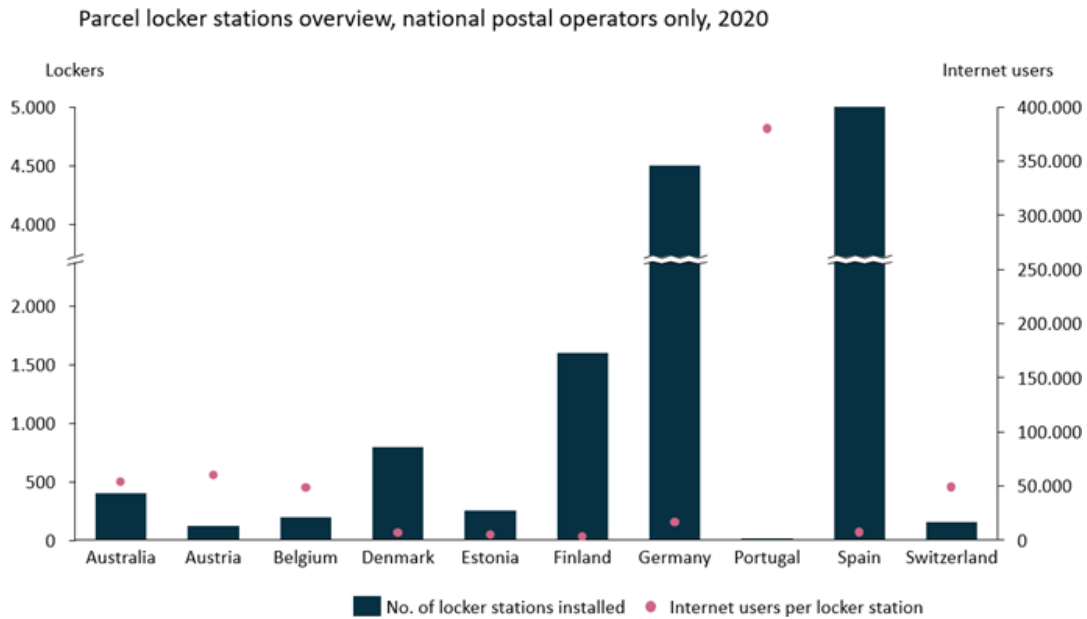
to smart parcel lockers improved the efficiency of parcel delivery and collection, reducing the workload of delivery personnel.

- User Experience:

The user experience of smart parcel lockers is also an important aspect to consider. A study by A. Garg and Zhang et al. (2020) found that the user experience of smart parcel lockers was positive, with users reporting convenience, ease of use, and satisfaction with the security features of the lockers. The study suggested that the use of two-factor authentication enhanced the user experience, as it provided an added layer of security and peace of mind.[10]

## **2.2. DETAILED ANALYSIS**

Smart parcel lockers are a relatively new technology that has gained popularity in recent years. There has been a significant amount of research done on the topic of smart parcel lockers, with many studies focusing on the benefits and challenges of implementing this technology in different contexts. One study by Farhoomand and Li (2017) examined the adoption of smart parcel lockers in the logistics industry in Hong Kong. The authors found that while there were several benefits to using smart parcel lockers, such as increased security and convenience, there were also several challenges, such as high installation costs and the need for a reliable and efficient IT system. Another study by Feng, Zhang, and Yang (2018) examined the use of smart parcel lockers in the context of e-commerce in China. The authors found that smart parcel lockers could help reduce delivery costs and improve the overall delivery experience for customers, but that there were also challenges related to locker placement and management. A study by Kim and Jeon (2020) examined the impact of smart parcel lockers on last-mile delivery in the context of urban logistics in Korea. The authors found that smart parcel lockers could help reduce delivery times and improve the efficiency of last-mile delivery, but that there were challenges related to locker placement, capacity, and maintenance.



**Figure 2.1 Graph depicting the number of Lockers installed vs the Internet users**

Overall, the literature suggests that smart parcel lockers have the potential to offer several benefits in terms of increased security, convenience, and efficiency for package delivery and pick-up. However, there are also challenges related to installation, IT systems, locker placement, and management that need to be addressed in order for this technology to be successful. Future research could focus on the development of more efficient and cost-effective smart parcel locker systems, as well as the evaluation of their impact on different aspects of the logistics industry.

Operator	Name of smart locker solution	Market	Capabilities
Deutsche Post And DHL	Packstation Source: <a href="https://www.logistik-watchblog.de/">https://www.logistik-watchblog.de/</a>	Germany Finland Austria	"Deutsche Post DHL's Packstation locker network in Germany is the oldest and most successful parcel locker network in the world. It is also the largest locker network in Europe" (Apex Insight, 2019). The Packstation service was first introduced in German in 2003 and now consists of 4,000 Packstations and 24,000 postal outlets or DHL parcel shops", serves 12 million online shoppers (DHL, 2019)
SF Express Co., Ltd.	Hive box Source: <a href="http://www.chinamoneynetwork.com">www.chinamoneynetwork.com</a>	China	HiveBox, the largest smart locker network in promoting efficiency of the last-mile delivery system in China, operates more than 150,000 parcel lockers with 12,000,000 boxes in communities/ business-buildings/ schools/ government-units, located in more than 100 cities, and delivers more than 9,000,000 parcels per day (Dongxiao et al., 2019).
Amazon	Amazon-locker Source: <a href="https://commons.wikimedia.org">commons.wikimedia.org</a>	Multiple countries	Amazon is rapidly expanding its lockers location networks, as well as its parcel locker networks in the US, Europe, Japan, and India. Its locker network locations in the US and the UK have increased by 50% (Apex Insight, 2019). At present, Amazon has had nearly 10000 lockers in the US and about 300 lockers in the UK (Rubin, 2019)
InPost	Inpost Source: <a href="http://www.saga.co.uk">www.saga.co.uk</a>	Multiple countries	InPost has provided service and parcel lockers to operators in Poland, France, United Arab Emirates, Estonia, Lithuania, Latvia, Czech Republic, Slovakia, Slovenia, Iceland, Ireland, Colombia, Brazil, Austria (2006) Australia, Malaysia (2015), and the UK (Post & Parcel, 2019)

**Figure 2.2 Companies that operate smart parcel locker around the world**

In a whole, the literature and research available on smart parcel locker system indicate that they offer a secure, convenient, and efficient solution for parcel delivery and collection. The use of smart parcel locker system along with other security measures, significantly reduces the likelihood of theft and unauthorized access to the lockers. Smart parcel lockers also offer multi-user access and an improved user experience, making them an ideal solution for workplaces, residential areas, and public locations.

## **2.3. KEY FEATURES FROM LITERATURE REVIEW**

Smart parcel lockers are automated storage systems that allow users to pick up or drop off packages at their convenience without the need for face-to-face interaction. They are becoming increasingly popular in urban areas where traditional parcel delivery methods are often inconvenient or unreliable.

Some key findings from recent literature on smart parcel locker systems:

Convenience and security are the top benefits of smart parcel lockers. According to a study by Accenture, 60% of consumers said they would be willing to use smart lockers for package delivery because of the convenience they offer. In addition, smart lockers offer greater security for packages, as they require a unique code or key to open.

Smart parcel lockers can improve last-mile delivery efficiency. Last-mile delivery is the final stage of the delivery process, from a transportation hub to the final destination. This stage is often the most expensive and time-consuming part of the delivery process. Smart lockers can help reduce the cost and time of last-mile delivery by consolidating multiple deliveries to a single location.

Smart parcel lockers can be used for a variety of applications. While package delivery is the most common use case for smart lockers, they can also be used for a range of other applications. For example, they can be used for click-and-collect retail, grocery pickup, and even as a secure bike locker.



Adoption of smart parcel lockers is still in its early stages. While smart parcel lockers have been available for several years, adoption has been slow in some areas. This may be due to concerns about security or the cost of installing and maintaining the lockers. Integration with other technologies can enhance the functionality of smart parcel lockers. For example, integration with GPS tracking systems can provide real-time tracking of packages, while integration with mobile apps can allow users to receive notifications when their package is ready for pickup.

Smart parcel lockers can benefit both consumers and carriers. Consumers appreciate the convenience and security of smart lockers, while carriers benefit from the efficiency and cost savings of consolidating multiple deliveries to a single location. According to a report by Research And Markets, the global smart parcel locker market is expected to grow at a compound annual growth rate of over 12% from 2021 to 2026, indicating the increasing adoption of these systems by carriers and consumers alike. Smart parcel lockers can help reduce carbon emissions. By consolidating multiple deliveries to a single location, smart lockers can help reduce the number of delivery trucks on the road, resulting in lower carbon emissions. According to a study by the University of Washington, smart lockers can reduce carbon emissions by up to 78% compared to traditional delivery methods.

Privacy concerns may hinder the adoption of smart parcel lockers. Some consumers may be hesitant to use smart lockers due to concerns about privacy and security. For example, they may be worried about their personal information being stored in the system or the risk of theft. To address these concerns, smart locker providers need to implement robust security measures and transparent privacy policies. Integration with artificial intelligence (AI) can enhance the functionality of smart parcel lockers. AI can be used to optimize locker placement, predict demand, and improve the overall user experience. For example, AI can analyze user behavior to determine the most convenient locker location and predict delivery times based on traffic and weather conditions.

Smart parcel lockers can benefit small and medium-sized businesses. Small and medium-sized businesses can use smart lockers to offer more flexible delivery options to their customers without the need for their own physical storefront. This can help level the playing field with larger retailers who have more resources for traditional delivery methods. In summary, smart parcel locker systems offer a range of benefits, including convenience, security, and improved last-mile delivery efficiency. While adoption of these systems is still in its early stages, they have the potential to be used for a range of applications beyond package delivery. Integration with other technologies, such as GPS tracking and AI, can enhance the functionality of smart lockers and improve the overall user experience.

## **CHAPTER 3**

### **PROBLEM STATEMENT**

The rise of online shopping has led to an increase in the demand for parcel delivery and collection services. However, traditional delivery methods are often inefficient and costly, resulting in missed deliveries, lost packages, and frustrated customers. Additionally, there is a significant concern about the security of parcels, as theft and unauthorized access to packages are significant problems. To address these challenges, there is a need for a secure, convenient, and efficient parcel delivery and collection system that can be operated by the user irrespective of the parcel delivery company. A smart parcel locker system can provide a solution to these challenges. Therefore, the problem statement is to develop a smart parcel locker system which is a secure, convenient, and efficient solution for parcel delivery and collection.

## **CHAPTER 4**

### **METHODOLOGY**

Parcel delivery has become an integral part of the modern world due to the increase in online shopping and e-commerce. As a result, parcel delivery methods have evolved to keep up with the changing needs of consumers. While smart parcel locker system is gaining popularity, there are several existing methods for parcel delivery that are widely used. This section aims to provide an overview of the existing methods for parcel delivery other than smart parcel locker system.

The existing methods for parcel delivery other than smart parcel locker system can be classified into four categories:

- traditional delivery methods
- courier services
- postal services
- and on-demand delivery services.

#### **4.1. TRADITIONAL DELIVERY METHODS**

The traditional delivery methods include delivering parcels to the recipient's address using a delivery truck. The parcel is usually handed over to the recipient or left at the doorstep if the recipient is not available. This method is the most common method of parcel delivery and is used by companies such as UPS, FedEx, and DHL.



**Figure 4.1 Traditional Parcel Delivery Companies**

## **4.2. COURIER SERVICES**

Courier services are companies that specialize in delivering parcels and packages. They operate on a similar basis to traditional delivery methods, but with a few differences. Courier services usually offer faster delivery times, same-day delivery, and door-to-door delivery. Examples of courier services include TNT, DPD, and Hermes.



**Figure 4.2 Courier parcels**

Top 10 courier companies in India				
Courier	Serviceable Pincodes	Shipping Charges	COD Facility	Reverse Pickup
	17,677	As per weight	✓	✓
	17,500	As per weight	✓	✓
	19,000	As per weight	✓	✓
	10,000	As per weight	✓	✓
	220+ Countries	As per weight	✓	✓
	19,000	As per weight	✓	✓
	11,400	As per weight	✓	✓
	7,000	As per weight	✓	✓
	25,000	As per weight	✓	✓
	8,451	As per weight	✓	✓

iThink Logistics

**Table 4.1 Top 10 Courier companies in the world**

### 4.3. POSTAL SERVICES

Postal services are government-owned or privately-owned companies that provide mail and parcel delivery services. They offer standard delivery times and often have a fixed delivery schedule. Postal services also offer additional services such as registered mail and express delivery. Examples of postal services include USPS, Royal Mail, and Canada Post.

Distance	Weight			
	Up to 50 grams	51 to 200 grams	201 to 500 grams	Additional 500 grams or part thereof
Local	₹ 15	₹ 25	₹ 30	₹ 10
Up to 200 Kilometres	₹ 35	₹ 35	₹ 50	₹ 15
201 to 1000 Kilometres	₹ 35	₹ 40	₹ 60	₹ 30
1001 to 2000 Kilometres	₹ 35	₹ 60	₹ 80	₹ 40
More than 2000 Kilometres	₹ 35	₹ 70	₹ 90	₹ 50

(Source: India Post website:- <https://www.indiapost.gov.in>, 2020)

\* Tariff does not include taxes, as notified by the Central Government of India from time to time.

\* Proof of Delivery charges is ₹10.00 per article along with the Speed Post charges.

*Key Differences*

**Table 4.2 Postal service rates in India (2020)**



**Figure 4.3 Indian Postal Service**

#### **4.4. ON-DEMAND DELIVERY SERVICES**

On-demand delivery services are companies that specialize in delivering parcels and packages on the same day or within a few hours. These services are typically accessed through mobile apps, and the delivery is usually made by independent contractors. Examples of on-demand delivery services include Uber Eats, Postmates, and Deliv.

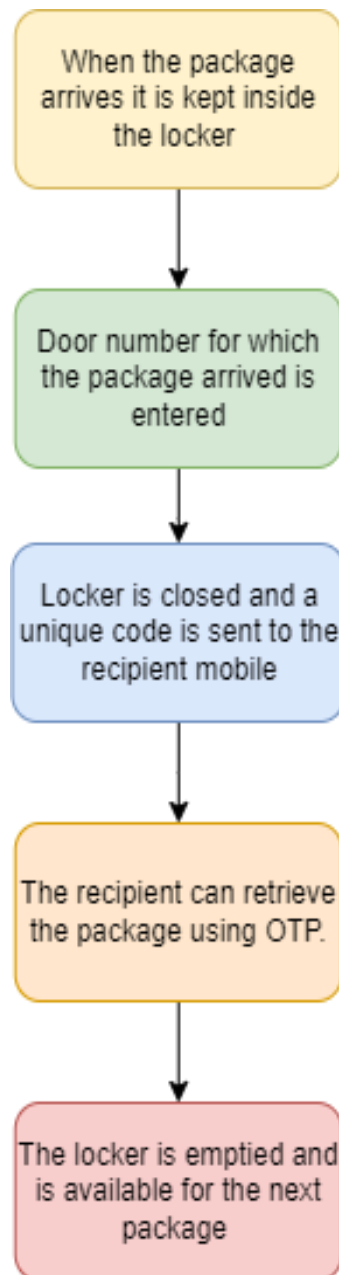


**Figure 4.4 On demand parcel service**

#### **4.5. COMPARISON OF DIFFERENT METHODS**

- The existing methods for parcel delivery vary in terms of delivery times, cost, convenience, and security. Traditional delivery methods and courier services offer a high level of security and reliability but may be more expensive than postal services or on-demand delivery services. Postal services offer a fixed delivery schedule and are often the most cost-effective option but may have longer delivery times. On-demand delivery services offer the convenience of same-day delivery but may not be as secure or reliable as traditional delivery methods.
- In conclusion, there are several existing methods for parcel delivery other than smart parcel locker system. Each method has its own advantages and disadvantages, and the choice of method depends on the specific requirements of the sender and recipient. As technology continues to evolve, it is likely that new methods for parcel delivery will emerge in the future.





**Figure 4.5 Block diagram of our depicting our model**

## CHAPTER 5

### IMPLEMENTATION

Smart parcel lockers with one-factor authentication are an innovative solution to the problem of secure and convenient parcel delivery. This technology uses a combination of advanced electronics, software, and hardware to provide a secure, automated, and self-service parcel delivery solution. In this section, we will discuss the implementation of smart parcel locker system.

#### **Steps for Implementation:**

The implementation of smart parcel locker system involves the following steps:

- **Define the Requirements:**

The first step is to define the requirements of the system. This includes the number of lockers, the size and capacity of each locker, the type of authentication required, and the communication protocols between the lockers and the server.

- **Hardware and Software Selection:**

The next step is to select the appropriate hardware and software components. This includes selecting the locker hardware, the sensors, the communication devices, the control unit, and the software platform.

- **Locker Installation:**

Once the hardware and software components are selected, the lockers are installed at the designated location. The installation process involves the physical installation of the lockers and the configuration of the control unit and communication devices.

- **Authentication and Authorization:**

The next step is to configure the authentication and authorization mechanism. This includes setting up the user accounts, defining the access levels, and configuring the locker system. The authentication system can use a combination of methods such as biometric verification, OTP verification, or smart card authentication.

- **Parcel Delivery:**

Once the lockers are installed and the authentication system is configured, the lockers are ready to use. The user can select the appropriate locker and enter the authentication credentials to open the locker. Once the locker is open, the user can place the parcel inside and close the locker. The locker sends a confirmation message to the user's account, and the recipient is notified of the parcel delivery.

- **Monitoring and Maintenance:**

The final step is to monitor the system performance and ensure regular maintenance. The system should be monitored for any malfunctions, errors, or security breaches. Regular maintenance and software updates should be performed to ensure the system's smooth operation.

## **5.1 REQUIREMENTS**

The requirements of a smart parcel locker system can vary based on the specific use case and application. However, some common requirements include:

- **Locker Size and Capacity:** The locker should be of appropriate size and capacity to accommodate different types and sizes of parcels.
- **Secure Storage:** The locker should provide secure and tamper-proof storage for parcels to prevent theft or damage.
- **Communication and Connectivity:** The locker should be connected to a server or cloud-based platform to enable real-time communication and monitoring.

- **Authentication and Authorization:** The locker should have a robust authentication and authorization system to ensure secure access to the lockers by authorized users only.
- **One-Factor Authentication:** The locker should have a one-factor authentication system that requires users to provide OTP for verification.
- **User Interface:** The locker should have a user-friendly interface that allows users to easily select and open the appropriate locker.
- **Monitoring and Maintenance:** The locker should be equipped with sensors and monitoring systems that provide real-time information about the locker's status and any malfunctions. The locker should also be designed for easy maintenance and repairs.
- **Integration with Delivery Services:** The locker should be integrated with delivery services to enable seamless parcel delivery and tracking.

#### **5.1.1. Components Required and Budget**

- Arduino Nano.
- 4x4 Keypad Module
- Solenoid Lock
- LCD
- Sim800I GSM Module
- MOSFET.
- Diodes and Resistors.
- LM2596 DC-DC(Buck)

## **5.2 HARDWARE AND SOFTWARE SELECTION**

Hardware and software selection for smart parcel locker system is a crucial step in the implementation process. The selection should be based on the specific requirements of the system and the available budget. Here are some hardware and software components that can be considered:

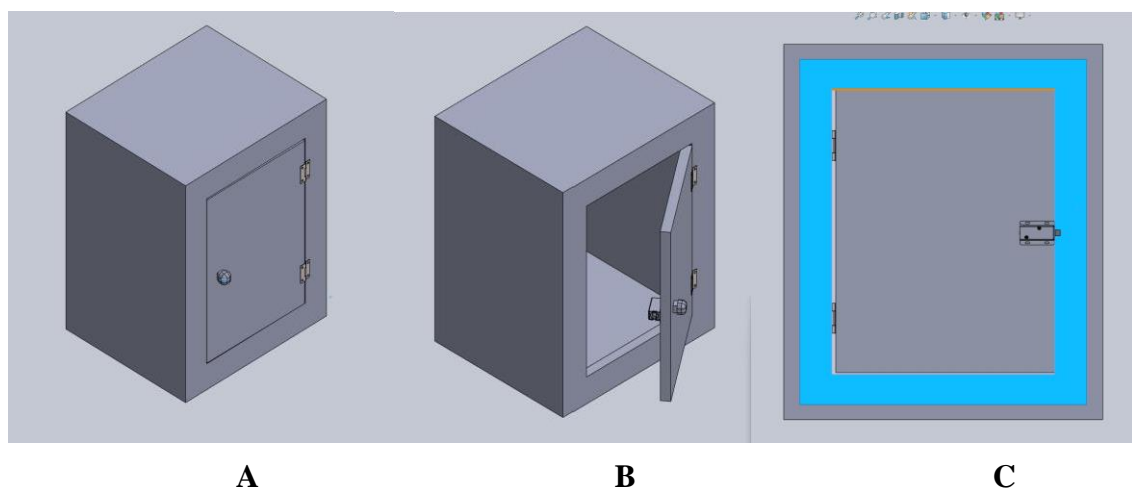
COMPONENTS	PRICE
Arduino Nano	450
4x4 Keypad Module	75
Solenoid Lock	350
LCD	120
Sim800I	450
Buck Module	50

**Table 5.1 Components and their prices**

### 5.2.1. Hardware Selection

#### 1. Locker Hardware:

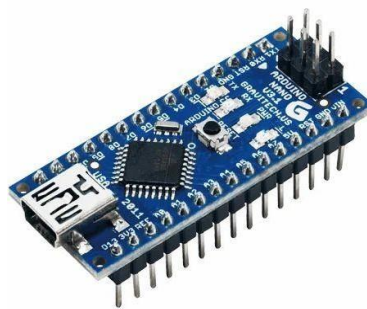
The locker hardware should be of high quality and durable. It should be designed to withstand harsh weather conditions and physical tampering. So, we go in with steel locker which can withstand any rugged environment.



**Figure 5.1 Different views of Locker a) Closed b) Open c) Inside view of the locker**

## 2. Control Unit:

The control unit is the brain of the locker system, and it should be powerful enough to handle multiple transactions simultaneously. Here we are going with Arduino nano microcontroller which has ATmega32P as the core processor. The Arduino Nano is equipped with 30 male I/O headers, in a DIP-30-like configuration, which can be programmed using the Arduino Software integrated development environment (IDE), which is common to all Arduino boards and running both online and offline. The board can be powered through a type-B mini-USB cable or from a 9 V battery. It has 14 digital input/output pins, six of which can be used as PWM outputs, and eight analog inputs. It also has a built-in voltage regulator, which allows it to be powered with a range of input voltages. The board has a built-in voltage regulator that can provide a stable 5V output to power external components. The board is of size 18mm x 45mm. It can be programmed using the Arduino IDE, which supports various programming languages such as C, C++, and Python. The Nano is compatible with a wide range of shields and modules, making it easy to expand its capabilities. Finally the Nano is relatively inexpensive compared to other microcontroller boards, making it an affordable option.



**Figure 5.2 Arduino Nano**

### 3. Communication Devices:

The locker should be connected to a network or a cloud-based platform, and communication devices such as Wi-Fi, Bluetooth, or cellular networks can be used to enable communication. Here we are using SIM800I for communication purpose. The SIM800 is a cellular communication module that can make calls, send email and SMS texts, and even connect to the internet.

Some of the key features of the SIM800I module include:

- Quad-band support: The module supports four GSM bands (850/900/1800/1900MHz), making it compatible with most cellular networks worldwide.
- GPRS data transfer: The module supports GPRS class 10 data transfer, allowing devices to transfer data over the cellular network at speeds of up to 85.6 kbps.
- Voice support: The module supports voice calls over the cellular network using a standard 3.5mm audio jack and microphone.

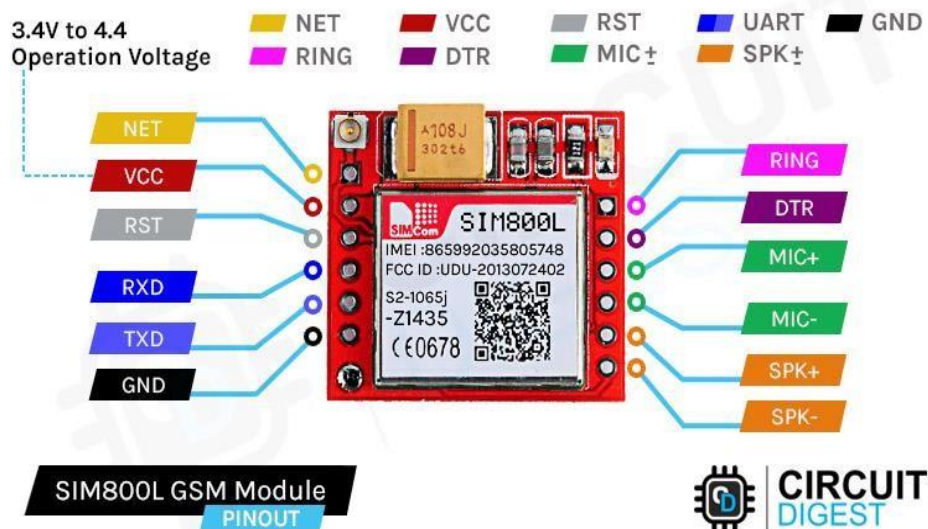


Figure 5.3 SIM800 GSM Module Pinouts

#### 4. Authentication Devices:

The locker should have devices that enable authentication such as biometric scanners, OTP generators, or smart card readers. Here we are using 4x4 keypad for entering authentication unique code. A keypad is a block or pad of buttons set with an arrangement of digits, symbols, or alphabetical letters. Pads mostly containing numbers and used with computers are numeric keypads.



**Figure 5.4 4x4 Keypad Module**

#### 5.2.2. Software Selection:

##### 1. Operating System:

The operating system should be secure, stable, and compatible with the hardware components. Some examples of operating systems that can be used include Linux, Windows, or Android. Here as we are using Arduino nano it has its own IDE and own set of libraries which helps in taking necessary decisions based on the user inputs.

##### 2. Server Software:

The server software should be designed to handle multiple transactions and provide real-time communication between the lockers and the server. Here as



we are using SIM800 it takes care of the server side thus enabling us in sending the SMS to the recipient without any fuss.

### **3.Database Management:**

The database management software is used to store and manage user data, access levels, and locker status. Some examples of database management software include MySQL, Oracle, or Microsoft SQL Server. Here we have used the Arduino nano memory to store the details of the recipients. The Arduino has the capacity to store more than 100 data's of in a synchronized manner without need for any specific database software.

### **4.Authentication and Authorization Software:**

The authentication and authorization software should be designed to enable one-factor authentication and provide a high level of security. Some examples of authentication and authorization software include Auth0, Okta, or Microsoft Azure. Here the Arduino nano takes care of checking the credibility of the entered credential by the user. Thus, properly maintain the objective.

### **5.User Interface Software:**

The user interface software should be user-friendly and intuitive. It should enable users to easily select and open the appropriate locker. Some examples of user interface software include React, Angular, or Vue. Here we use the Liquid Crystal Display for the user interface. LCD is a device that is used to display data and the message is known as LCD 16×2. As the name suggests, it includes 16 Columns & 2 Rows so it can display 32 characters ( $16 \times 2 = 32$ ) in total & every character will be made with  $5 \times 8$  (40) Pixel Dots.

## **CHAPTER 6**

### **RESULT AND DISCUSSION**

Smart parcel locker systems have been increasingly implemented in various settings, including residential buildings, offices, and public spaces. These systems offer a secure and convenient way for people to receive and send packages, particularly in the context of the growing e-commerce industry. In this discussion, we will explore the results and implications of implementing a smart parcel locker system.

- **Increased convenience:** Smart parcel lockers offer a more convenient way for people to receive and send packages. Instead of having to wait at home for a delivery or go to a post office to send a package, individuals can use the locker system at their own convenience.
- **Improved security:** Smart parcel lockers provide a secure way to receive and send packages. With features such as unique access codes and surveillance cameras, individuals can have peace of mind knowing that their packages are safe.
- **Reduced delivery costs:** Smart parcel lockers can also help reduce delivery costs for businesses. By consolidating multiple deliveries into one location, delivery companies can save time and money on transportation costs.
- **Increased efficiency:** Smart parcel lockers can also increase efficiency in package delivery. Instead of having to wait for individuals to be present to receive a package, delivery companies can simply drop off packages at the locker system, and individuals can retrieve their packages at their convenience.

The implementation of a smart parcel locker system has several implications for different stakeholders. For individuals, it offers a convenient and secure way to receive and send packages. For businesses, it can reduce delivery costs and increase efficiency. For property managers, it can be a valuable amenity for tenants and a way to increase property value.



**Arduino Nano:** Arduino nano is the control unit that manages the locker system. It is typically a microcontroller that controls the sensors, actuators, and communication devices.

**12 V Solenoid valve acts as the Actuators:** The actuators are devices that physically control the locker, such as the lock mechanism. These devices are controlled by the control unit based on input from the sensors and user interactions. Here we are using 12V Solenoid valve which disconnects as soon the device is powered on.



**Figure 6.2 12V Solenoid Lock**



**Figure 6.3 LM2675 DC-DC converter**

## **SIM800 GSM Module**

acts as the Communication devices in the locker system. These communication devices enable the locker system to transmit and receive data from the cloud-based platform or user interface. The SIM800i is a quad-band GSM/GPRS module that enables embedded devices to connect to the cellular network. It is manufactured by SIMCOM and is widely used in a variety of applications, including remote monitoring, tracking, and control systems. The SIM800i module supports both voice and data communications, and it has a built-in TCP/IP stack, which allows it to connect to the internet. It also has an onboard microcontroller, which provides flexibility in controlling the module's functions and features.

### **Power Supply:**

The locker system requires a power supply to operate, and this can be achieved using an AC/DC adapter, battery backup, or solar panels, depending on the specific requirements and location of the system. Here we are using 12V power adapter which powers the entire locker system. We are also using buck converter for powering the Arduino nano.

LM2675 which is widely used in power supply applications. It is a high-efficiency, step-down switching regulator that can handle an input voltage range from 8V to 40V and deliver a regulated output voltage from 1.23V to 35V with a maximum output current of 1A. It also features thermal shutdown and current limit protection, making it a popular choice for various power supply designs.

### **Circuit Protection:**

The locker system should be protected from electrical surges, short circuits, and other electrical hazards. This can be achieved using circuit protection devices such as free wheeling diodes, resistor in order limit the amount damages to the other components on system. In conclusion, the circuitry for a smart parcel locker system mainly consists of control unit, sensors, actuators, communication devices, power supply, and circuit protection are some of the essential components that are required for such a system to operate reliably and securely.

## 6.2 PCB DESIGN AND LAYOUT

### Layout 1:

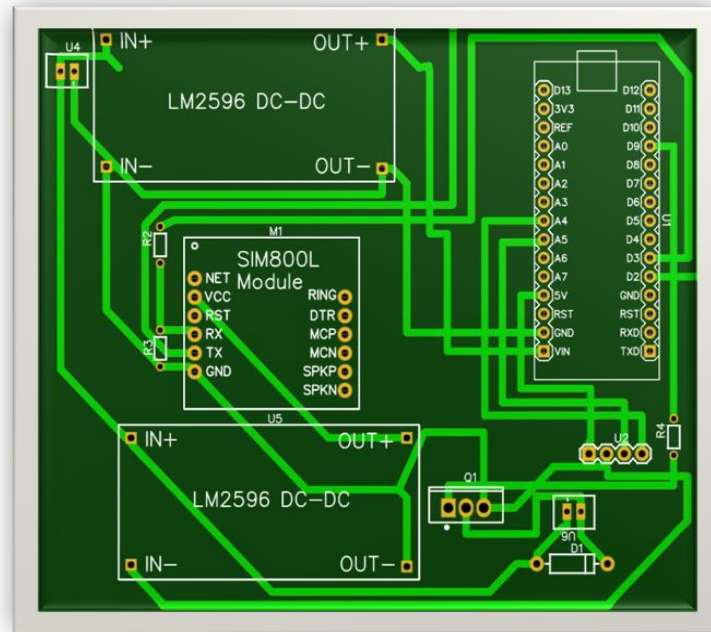


Figure 6.4 Front side of PCB

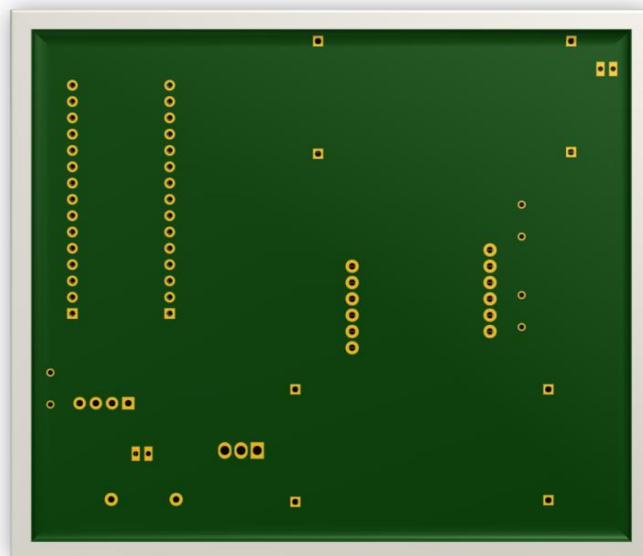
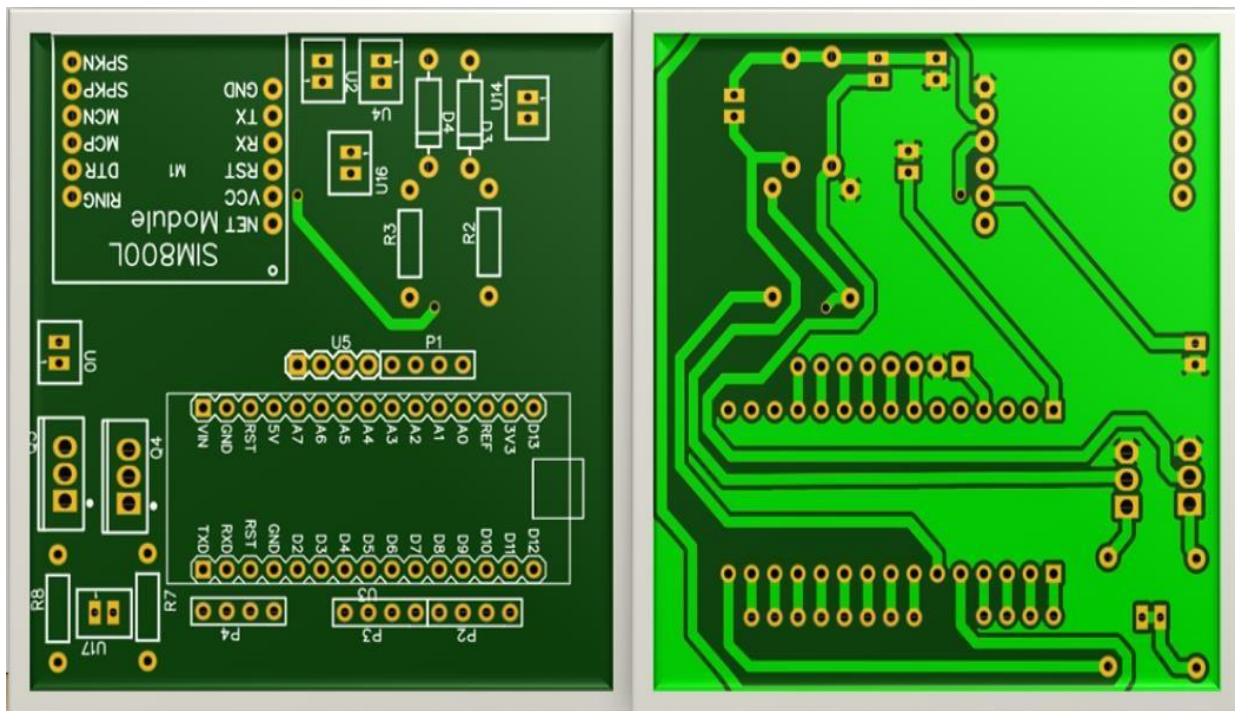


Figure 6.5 Back side of PCB

This was the first design we made for implementing the smart parcel locker system. Here you can see the we are using Arduino nano, SIM800 GSM Module, Buck converters (LM2596 DC-DC), freewheeling diodes, transistors and resistors. The PCB Board was of dimensions 85x95mm.

The drawback of this design was that the there were lot components to be soldered to the board which would take lot timing and also wastage resources and money. The components such as LM2596 DC – DC were modules which can be easily kept away from the PCB Board as they we modules and we can use jumper wires to connect the modules to the PCB Boards. This would in turn reduce the soldering time as the size of the PCB Board thus reducing money and energy used.

## Layout 2:

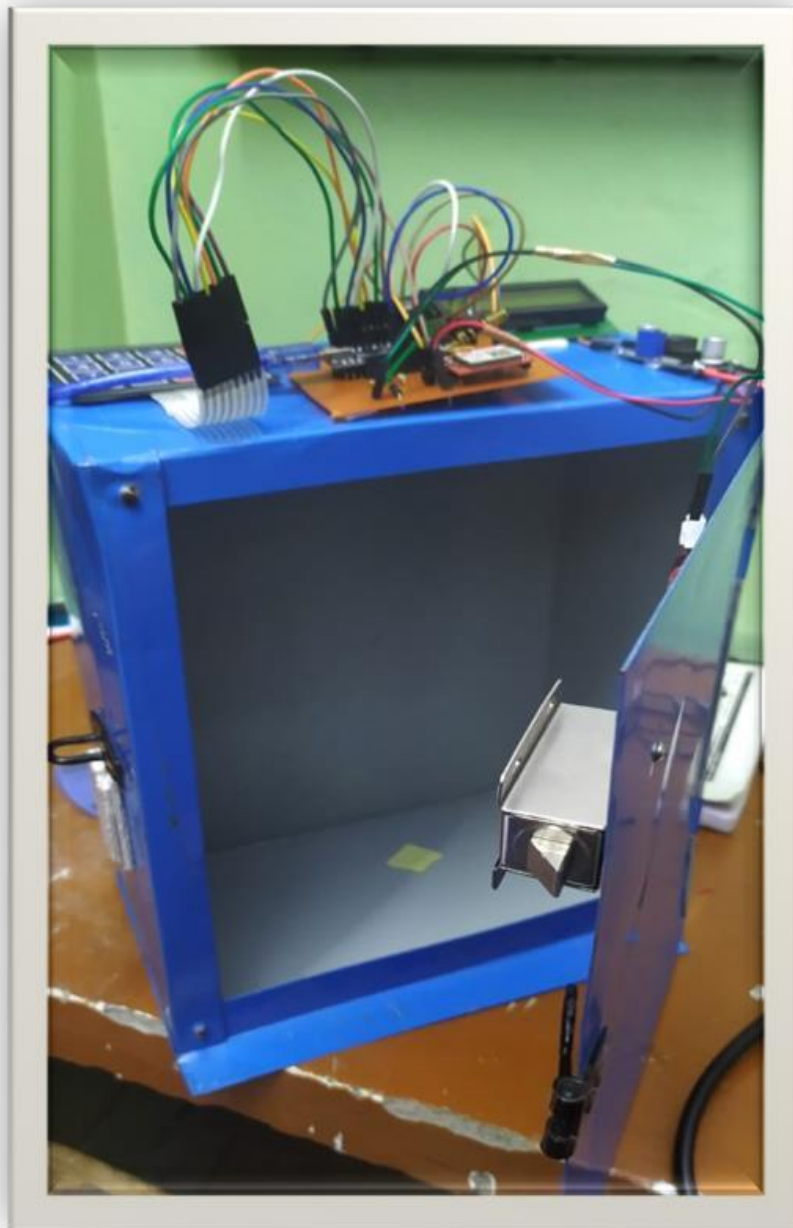


**Figure 6.6 Front and Back of PCB Module**

This PCB was of dimension 65x65 mm. This design eliminated the shortcomings of the previously mentioned layout 1 as the dimension were considerably reduced and only the

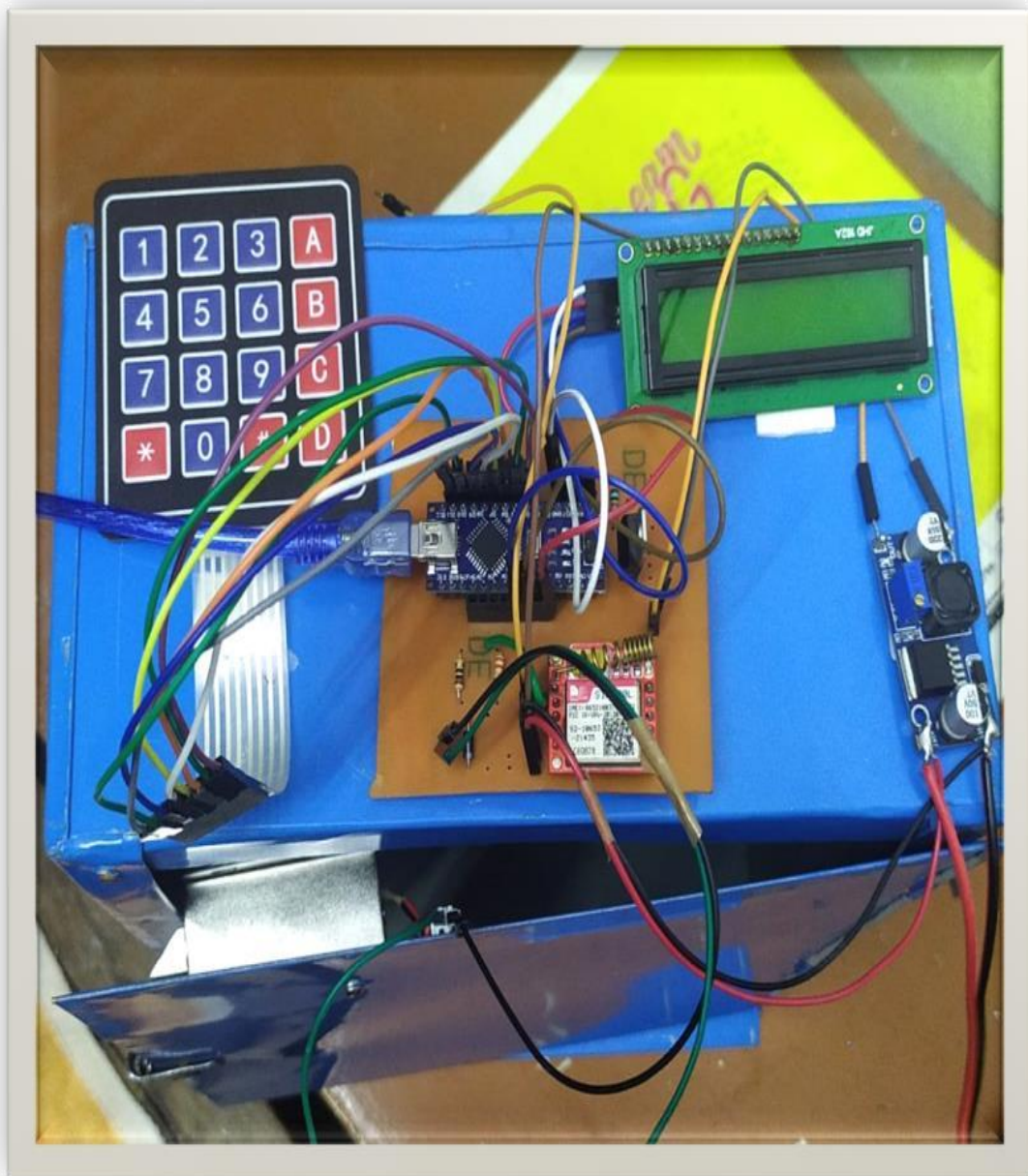
more important components were embedded into PCB thus reducing the size as well as the soldering time.

### **6.3 FINAL OUTPUT**



**Figure 6.7 Front view of Locker**





**Figure 6.8 Top view of Locker**

## **CHAPTER 7**

### **CONCLUSION**

Smart parcel locker systems are becoming increasingly popular as a secure and convenient way for individuals and businesses to send and receive packages. These lockers are automated, accessible 24/7, and offer a contactless solution for package deliveries, reducing the risk of theft and the need for in-person interactions.

One of the key benefits of smart parcel lockers is the convenience they offer to customers. Users can pick up their packages at a time that is most convenient for them, without worrying about missed deliveries or having to wait for a courier to arrive. Additionally, these lockers can be placed in locations that are easily accessible, such as near public transportation hubs, grocery stores, or residential complexes.

Another advantage of smart parcel locker systems is the increased security they provide. Packages are stored in locked compartments, which can only be accessed by authorized individuals with a unique code or key. This reduces the risk of theft, as packages are not left unattended on porches or in common areas.

Overall, the use of smart parcel locker systems is a smart and practical solution for businesses and individuals who want a secure and convenient way to send and receive packages. As technology continues to evolve, we can expect to see even more advanced features and capabilities integrated into these systems, making them an even more attractive option for package delivery and pickup. In conclusion, the smart parcel locker system is an effective and promising solution for organizations looking to improve their parcel delivery process while enhancing security measures. With careful consideration of the specific requirements of the system, organizations can implement a well-designed and efficient smart parcel locker system that can offer long-term benefits to both the organization and its customers. The system provides increased security, enhanced efficiency, and improved customer satisfaction, making it an excellent investment for organizations that require a secure and efficient parcel delivery process.

Some of the benefits of smart parcel locker systems.

- **Convenience:** Smart parcel lockers are accessible 24/7, which means that individuals can pick up their packages at any time that is convenient for them, without having to worry about the delivery times of courier services. These lockers are located in strategic locations, such as near residential complexes, public transportation hubs, and commercial areas, making them easily accessible to users.
- **Reduced Costs:** Smart parcel lockers can significantly reduce the costs associated with package deliveries. With these lockers, there is no need for couriers to make multiple attempts at delivery or for businesses to hire staff to receive and manage packages. This can result in significant savings for businesses, particularly those that receive a high volume of packages.
- **Increased Security:** Smart parcel lockers provide a high level of security for packages. Packages are stored in locked compartments that can only be accessed by authorized individuals using unique codes or keys. This significantly reduces the risk of package theft or loss, as packages are not left unattended in common areas or on porches.
- **Contactless Delivery:** In the wake of the COVID-19 pandemic, contactless delivery has become a necessity for many individuals and businesses. Smart parcel lockers offer a contactless solution for package deliveries, eliminating the need for in-person interactions between couriers and recipients.
- **Automated Management:** Smart parcel locker systems are automated, which means that packages can be stored, managed, and retrieved without the need for human intervention. This reduces the likelihood of errors or delays in package management and ensures that packages are processed quickly and efficiently.
- **Improved Customer Experience:** Smart parcel locker systems can improve the overall customer experience for businesses and individuals. With these lockers, customers can track their packages in real-time and receive notifications when their packages are ready for pickup. This ensures that customers are always informed about the status of their packages and can plan their pickups accordingly.

Overall, smart parcel locker systems offer numerous benefits and advantages for businesses and individuals who want a secure, convenient, and cost-effective way to send and receive packages. With their advanced features and capabilities, these lockers are becoming an increasingly popular option for package delivery and pickup, and we can expect to see continued growth in their adoption in the future.

Some potential future work for smart parcel lockers system includes:

- **Integration with other technologies:** As technology continues to evolve, there may be new opportunities to integrate the smart parcel locker system with other technologies. For example, integrating with blockchain technology could further enhance the security of the system, providing even greater protection against theft and unauthorized access.
- **Enhanced customization:** As more organizations adopt smart parcel lockers, there may be a need for greater customization to meet the specific needs of different industries. For example, a healthcare facility may require a specialized locker system to store and deliver sensitive medical equipment or medication.
- **Expansion of delivery services:** Smart parcel locker system could also be integrated with more delivery services, including drones or autonomous vehicles, to further streamline the delivery process and reduce the need for manual intervention.
- **Development of advanced analytics:** The smart parcel locker system generates a significant amount of data, which could be used to develop advanced analytics to identify trends, improve operational efficiency, and enhance customer satisfaction.

## CHAPTER 8

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## CHAPTER 9

## APPENDIX

```
#include <LiquidCrystal_I2C.h>
#include <Keypad.h>
#include <Wire.h>
#include <LiquidCrystal_I2C.h>
#include <SoftwareSerial.h>
#include <Servo.h>
#define rxPin 2
#define txPin 3
SoftwareSerial sim800L(rxPin,txPin);
int pos = 30;
const byte ROWS = 4; /* four rows */
const byte COLS = 4; /* four columns */
const int solenoid =12 ;
/* define the symbols on the buttons of the keypads */
char hexaKeys[ROWS][COLS] = {
  {'1','2','3','A'},
  {'4','5','6','B'},
  {'7','8','9','C'},
  {'*','0','#','D'}
};
byte rowPins[ROWS] = {11,10,9,8}; /* connect to the row pinouts of the keypad */
byte colPins[COLS] = {7,6,5,4}; /* connect to the column pinouts of the keypad */

int otp;
String otpstring = "";
int i = 0;
/* initialize an instance of class NewKeypad */
Keypad customKeypad = Keypad( makeKeymap(hexaKeys), rowPins, colPins, ROWS, COLS);
LiquidCrystal_I2C lcd_1(0x27, 16, 2); //SDA=A4 SCL=A5
void setup() {
  pinMode(solenoid, OUTPUT);
  Serial.begin(9600);
  sim800L.begin(9600);
  sim800L.println("AT");
  waitForResponse();
  sim800L.println("ATE1");
  waitForResponse();
  sim800L.println("AT+CMGF=1");
  waitForResponse();
  sim800L.print("AT+CSMP=17,167,0,0\r");
  waitForResponse();
  sim800L.println("AT+CNMI=1,2,0,0,0");
  waitForResponse();
  lcd_1.begin();
  randomSeed(analogRead(0));
```

```

}

void loop()
{
    digitalWrite(solenoid, HIGH);
    set_otp();
    int num=get_no();
    lcd_1.setCursor(0, 0);
    lcd_1.clear();
    Serial.print("OTP is ");
    delay(100);+
    Serial.println(otpstring);
    if(num=='1')
        send_sms();
    else
        send_sms1();
    delay(100);
    getotp(num);
}

void set_otp()
{
    otp = random(1000, 9999);

    otpstring = String(otp);
}

char get_no()
{
    Serial.println("Enter door no:");
    lcd_1.clear();
    lcd_1.print("Enter door no:");
    int a=0;
    while (a==0)
    {
        char n= customKeypad.getKey();
        if(
        {
            lcd_1.print(n);
            delay(100);
            digitalWrite(solenoid, LOW);
            return n;
            a=1;
        }
    }
}

void send_sms()

```



```

void send_sms()
{
    sim800L.print("AT+CMGS=\"+918220991113\\r\\n\");
    waitForResponse();
    sim800L.print("Your OTP is: ");
    sim800L.print(otpstring);
    sim800L.write(0x1A);
    waitForResponse();
}

void send_sms1()
{
    sim800L.print("AT+CMGS=\"+918903248902\\r\\n\");
    waitForResponse();
    sim800L.print("Your OTP is: ");
    sim800L.print(otpstring);
    sim800L.write(0x1A);
    waitForResponse();
}

void getotp(int num)
{
    String y = "";

void getotp(int num)
{
    String y = "";
    int a = y.length();
    lcd_1.setCursor(0, 0);
    lcd_1.clear();
    lcd_1.print("Enter otp:");
    while (a < 4)
    {
        char customKey = customKeypad.getKey();
        if (customKey=='#') {
            lcd_1.clear();
            lcd_1.print("Otp sent again");
            delay(2000);
            lcd_1.clear();
            set_otp();
            Serial.println(otpstring);
            if(num=='1')
                send_sms();
            else
                send_sms1();
        }
    }
}

```

---

```

        delay(100);
        lcd_1.print("Enter otp:");
    }
    else
    if (customKey) {
        y = y + customKey;
        Serial.println(y);
        lcd_1.print(customKey);
        a = y.length();
    }
}
Serial.print("Entered OTP is ");
Serial.println(y);
if (otpstring == y)
{
    lcd_1.clear();
    Serial.println("Unlocked");
    lcd_1.print("Unlocked");
    digitalWrite(solenoid, HIGH);
    delay(3000);
}
else
{
    Serial.println("Access Failed");
    lcd_1.clear();
    lcd_1.print("Access Failed");
    Serial.println("Try Again !!!");
    getotp(num);
}
}
void waitForResponse() {
    delay(1000);
    while(sim800L.available()) {
        Serial.println(sim800L.readString());
    }
    sim800L.read();
}
}

```