National University of Computer and Emerging Sciences, Lahore

FYP Report Title

Abdullah Zahid 21L-5764 BS(SE)
Abdul Rafay 21L-6095 BS(SE)
Muzammil Hussain 21L-6051 BS(SE)

Supervisor: Dr. Zeeshan Ali Rana

Final Year Project

October 9, 2024

Anti-Plagiarism Declaration

This is to declare that the above publication was produced under the:

Title: FYP Report Title

is the sole contribution of the author(s), and no part hereof has been reproduced as it is the basis (cut and paste) that can be considered Plagiarism. All referenced parts have been used to argue the idea and cited properly. I/We will be responsible and liable for any consequence if a violation of this declaration is determined.

Date: ....

Name: ....

Signature: ....

Name: Muzammil Hussain

Signature: ....

Name: ....

Signature: ....

Author's Declaration

This states Authors' declaration that the work presented in the report is their own, and has not been submitted/presented previously to any other institution or organization.

Abstract

The incline in the usage of ecommerce globally has introduced challenges in the last mile delivery process as recipients are not available often. This affects service providers in terms of budget, time and management and customers (Sender and Receiver) in terms of availability and easy to use. **Smart Delivery** will uplift the last mile delivery process towards perfection by automating last mile delivery process. Developed countries like Japan, Sweden and Dubai have already implemented this idea and generating very positive outcomes. Amazon and Dominos got major increment in their revenue by 38% and 5% in first year after automation of delivery process. Automation will increase the annual revenue of service providers and makes delivery process easy for customers.h. Put the abstract on a separate page that follows the title page.

Executive Summary

In today's era, ecommerce is getting boosted as the availability of internet and usage of smart devices increasing. Trends of Pakistan in 2024 showed that ecommerce has evolved 12%. Most of the part in boost of ecommerce is acquired by garments and clothing side. This increases the feasibility of our solution as compartment size in delivery box is limited and can be useful for medium size products. As garments and stuff like that can easily be delivered using smart delivery boxes, this gives the hint that this solution will also work in Pakistan as it is uplifting businesses in other countries like Japan, Sweden and Dubai. Smart Delivery will provide facilities to service providers in terms of budget and time while on the other hand, it will facilitate customers on larger scale in terms of availability and time as well. Firstly, it will minimize the failed delivery attempts to negligible and will increase the revenue. Also, it will minimize the pollution caused by automobiles as failed delivery attempts has been reduced. For example, a receiver has confirmed that I will be able to receive parcel at decided time but unfortunately, he would not be able to receive parcel and delivery attempt gets failed. This happens sometimes in Pakistan that delivery attempt gets failed 1 to 2 times before successful attempt. These failed attempts go negative in revenue of service providers. By automation, failed attempts are decreasing and in return increasing the annual revenue of service providers. As a by product it is beneficial for environment because re attempting delivery will generate more pollution as well which is getting reduced now.

Secondly, it is also up swinging the customer side by making the availability of receiver flexible. Sometimes the receiver wants to change the delivery location due to some reasons, but it does not have option to change the pickup point and delivery attempt gets failed. Smart Delivery will allow receiver to pick his parcel within allowed time. It also enables receiver to change the delivery box within allowed time. Rider will place the parcel in delivery box selected by the receiver and receiver will have selected time to pick up the parcel. This will create ease if receiver does not available at some time to receive parcel.

Furthermore, it will also allow senders to send parcels using delivery boxes. Instead of going to offices of service providers, senders can simply reserve compartment in delivery box, and they can simply place their parcels into delivery box and service providers will deliver it to requested destiny.

Finally, we can say that by automating the last mile delivery process, not only the failed attempts will decrease rather it will create an ease for customers to send and receive parcels according to their schedules. It will also allow riders to directly place the parcels into lockers rather contacting and scheduling time for delivery. Senders are also able to send parcels using delivery boxes. This also increase the annual revenue of service providers which in turn play a crucial role in economic growth and environmental nourishment.

Table of Contents

List of Figures

List of Tables

Chapter 1 Introduction

With the increase of population, the traditional method of shopping, going to the physical market, has become difficult due to heavy traffic and time consumption. Fortunately, with emerging use of E-commerce, online shopping has become a necessity of life and is now becoming traditional shopping. But this also comes with its own set of problems, particularly the last mile delivery process. The Smart Delivery Process aims to solve this particular problem by automating the system and providing satisfying user experience.

1.1 Purpose of this Document

The purpose of this document is to present the design and implementation of our project, which addresses the problem with last mile delivery process. The project will focus on implementing a user-friendly web-based application for service provider and its users. The project will contain a **Smart Delivery Box** which the riders can place the parcel and sender, or receiver can send or receive the parcel using passwords shared to them with the application. This is done for the users who are not available at their homes to receive the parcel causing the rider to make several attempts to deliver the parcel.

1.2 Intended Audience

The intended audience for this document is the service providers and their users who face the problems with the last mile delivery process. In addition to this, any concerned person who wants to comprehend the system's operations can review parts of this report.

1.3 Definitions, Acronyms, and Abbreviations

Definitions:

Carbon-Neutral: A state where the net carbon dioxide emissions from a company, service, or product are zero. This is achieved by reducing emissions and offsetting the remaining emissions through sustainable practices, such as planting trees or using renewable energy.
Dynamic Customer Interfaces: Flexible and interactive platforms that allow customers to modify or control their delivery preferences (e.g., selecting delivery windows, updating delivery locations) in real time.
Self-Learning Algorithms: Machine learning algorithms that can adapt and improve their performance over time by learning from data. In logistics, they are used for optimizing routes, predicting delivery

times, and managing demand efficiently

Following are the Acronyms used

SDG: Sustainable Development Goal

SP: Service Provider

NFR: Non Functional Requirements

OTP: One Time Password

API: Application Programming Interface

QFDP: Queue of Failed Delivery Parcels

QUP: Queue of Unpicked Parcels

QIC: Queue of Initial Compartments

QFC:Queue of Final Compartments

CRUD: Create, Read, Update, Delete

EV: Electric Vehicles

CO2: Carbon Dioxide

SMS: "Short Message Service

SDB: Smart Delivery Box

1.4 Conclusion

In conclusion, our project is ready to transform the logistics industry by setting parcel lockers in different locations which will be accessible to both senders and receivers. By providing user-friendly interface, senders and receivers will be able to reserve the compartments. There they can place the parcel and receive the parcel respectively. This will be accomplished by thorough study and by taking inspiration from existing systems

Chapter 2 Project Vision

In this chapter, we dive deeper into the visionary aspects of the project **"Smart Delivery"**. This chapter will provide an overview of the project problem domain, the project statement and its elaboration, the goals and objectives, and the scope of the project. These will provide a clear perspective on the project's ambition and its potential to transform the world of delivery.

2.1 Problem Domain Overview

The project focuses on creating an application for SPs and their users that face the problems regarding last mile delivery process. Many times, the rider has to make several attempts to deliver the parcel because receiver is not available to receive the parcel. This application will solve this problem by using Smart Delivery Boxes. Countries like Japan and Sweden have already implemented their system to tackle this problem.

2.2 Problem Statement

The main issue that the project seeks to address is the problems faced when the receiver is unavailable to receive the parcel. The rider has to make several attempts to deliver the parcel. Similarly, the receiver has to make time to be home so he can receive the parcel. This makes user experience for both of them unsatisfactory.

2.3 Problem Elaboration

Although E-commerce has made lives easier, but the problem arises when the receiver is unavailable to accept the parcel during the rider's scheduled delivery. As a result, the rider is forced to make multiple attempts, wasting time and resources, while the receiver has to rearrange their schedule to ensure they are available, often interrupting their daily routine. Moreover, delayed deliveries can lead to missed deadlines, increased logistical costs, and negative experiences for customers, potentially affecting their overall satisfaction with the service. This project will solve this problem by incorporating smart delivery boxes in different locations. The rider will place the parcel in one of reserved lockers, set by the receiver or sp, while the receiver can collect the parcel in its own convenience within some time frame.

2.4 Goals and Objectives

2.4.1 Primary Goals and Objectives

The primary goals and objectives of the Smart Delivery platform are as follows:

- Automate the last-mile delivery process for delivery companies.
- Allow both the sender and receiver to track their respective parcels.
- Enable the sender to select a convenient pickup point for the delivery company.
- Provide the receiver with the option to finalize the destination box for parcel delivery.
- Securely process the transaction of information with the service provider.
- Integrate the system seamlessly with delivery companies for efficient operations.

2.5 Project Scope

The project will make a solution for the SP for the last mile delivery process using smart scheduling and allocations of delivery boxes. The project will be a web application for users to send or receive the parcels which will be developed using MERN stack. The system will allow users to

1. The sender will be the initiator of the process who will provide the receiver details.
2. After the parcel is arrived at the appropriate warehouse, the receiver will be contacted to select the location of the delivery box from where he wants to retrieve the parcel.
3. After a location is selected, the rider will unlock the box using the OTP he will receive on the web application and put the parcel in the box.
4. When the rider locks the delivery box after placing parcel, the receiver will get notified and he will receive the parcel also using an OTP. The system will ensure that delivery will be successfully done. System will manage the state of delivery boxes.

2.6 Sustainable Development Goal (SDG)

2.6.1 Industry, Innovation and Infrastructure

Our sustainable development goal is Industry, infrastructure, and Innovation. We want to revolutionize the industry of logistics which has become a necessity of today's world. We hope that our project will help the delivery companies so that there are no failed attempts or time waste. The SDG is given below in fig 2.1.

Figure 2.1: Industry, Innovation and Infrastructure

2.6.2 Decent work and Personal Growth

The other sustainable development goal is Decent work and Personal Growth as with less failed attempts, the revenue of the SPs is increasing which in turn improve the country's economy. The SDG is given below in fig 2.2.

Figure 2.2: Decent work and Personal Growth

2.6.3 Climate Action

It has also one small SDG Climate Action as less failed attempts means less use of vehicle and less exhaustion of harmful substances. In this way our product will help the environment. The SDG is given below in fig 2.3.

Figure 2.3: Industry, Innovation and Infrastructure

2.7 Constraints

There are a few constraints that we would be following, mentioned below:

1. Availability of delivery box
2. Integration of delivery box hardware with our system
3. Integration of our system with SPs(TCS)
4. Time
5. Budget

2.8 Business Opportunity

The web-application will be open-source software. Companies can use and customize it according to their requirements and use for business. As this is maintainable and extendible, more modules and functionality can be added making it more efficient.

2.9 Stakeholders Description/ User Characteristics

Senders: Individuals who send the parcel to a particular location Receivers: Individuals who receive the parcel Service Providers: Delivery Companies who deliver the parcel Project Client: Mr. Ijaz Khan external Client

2.9.1 Stakeholders Summary

The users who will use our app will be the users of the SPs who want to send and receive the parcel. Sender will send a parcel through SP and receiver will receive it. Project Client will give requirements of the project

2.9.2 Key High-Level Goals and Problems of Stakeholders

1. Automation
   (a) Automate the process of sender so that he does not need to go to SP office.
   (b) Automate the last mile delivery process so receiver does not need to be physically present to receive the parcel
2. Sending and Receiving Parcel
   (a) Allow sender to reserve a smart box to place the parcel within time limit.
   (b) Allow receiver to receive parcel from the locker within time limit
3. Tracking Parcel
   (a) Allowing sender and receiver to track the parcels

2.10 Conclusion

In conclusion, the vision of our project is to make the process of delivery easier by solving the last mile delivery process. Our project will revolutionize the process by incorporating smart delivery boxes with SPs and allowing their users to send and receive parcels. This will help both the SPs and their customers by removing failed attempts, scheduling problems and many more. Our project scope is to deliver a functional website that includes all the features already addressed.

Chapter 3 Literature Review / Related Work

3.1 Definitions, Acronyms, and Abbreviations

3.1.1 Definitions:

- Carbon-Neutral: A state where the net carbon dioxide emissions from a company, service, or product are zero. This is achieved by reducing emissions and offsetting the remaining emissions through sustainable practices, such as planting trees or using renewable energy.
- Dynamic Customer Interfaces: Flexible and interactive platforms that allow customers to modify or control their delivery preferences (e.g., selecting delivery windows, updating delivery locations) in real time.
- Self-Learning Algorithms: Machine learning algorithms that can adapt and improve their performance over time by learning from data. In logistics, they are used for optimizing routes, predicting delivery times, and managing demand efficiently.

3.2 Detailed Literature Review

3.2.1 PostNord: Innovations in Last-Mile Delivery [1]

3.2.1.1 Summary of the Research Item

PostNord, a key logistics provider in the Nordic region, specializes in postal and parcel delivery, particularly focusing on last-mile delivery services for e-commerce. Their digital innovations include real-time tracking, dynamic customer interfaces for flexible deliveries, and automated sorting systems that increase delivery speed and accuracy. These tools allow PostNord to offer a seamless last-mile delivery experience to consumers while ensuring operational efficiency. PostNord is also known for its sustainability initiatives, such as electric vehicle fleets for urban deliveries and efforts to reduce carbon emissions through more efficient delivery routes and eco-friendly packaging. As part of its strategy, PostNord provides delivery solutions for high-volume e-commerce platforms, which face growing customer demands for faster, more flexible delivery options.

3.2.1.2 Critical analysis of the research item

Strength: Excellence is in the view of the IT infrastructure in play for last-mile delivery, as it makes use of the latest real-time parcel tracking and automated sorting systems. Sustainability is also a focus, as it operates electric vehicles, and routes are optimized to cut carbon emissions. Apart from that, PostNord services on customer-oriented issues reach as far as delivery window selection and parcel lockers that increase customer satisfaction on parcel reception and their flexibility.

Weaknesses: For PostNord, delivery times are very inconsistent for peak periods as most customers report delayed deliveries. Its market leadership could only be within the Nordic region, thus minimizing its footprint within the larger European and global last-mile delivery marketplaces. Its sustainability in scaling practices, especially to thinly populated areas is also challenging.

3.2.1.3 Relation to the Proposed Research Work

Among the solutions presented, PostNord advanced last-mile delivery solutions and sustainable approaches most closely relate to a proposed research on smart delivery boxes. Implementing real-time tracking, communicating interfaces with customers, and automated logistics share a greater objective aimed toward improved last-mile efficiency in the system under development. Another, their green approach would bring greater opportunities that the smart delivery system could have with greener delivery methods such as electric vehicles and routing optimization so that the last-mile deliveries are done carbon-neutral. Expertise drawn from the battles faced by PostNord in handling the demand peaks might be applied when having to design even stronger and scalable delivery solutions for the e-commerce time smart delivery system.

Geographical Presence: Nordic countries, including Sweden, Denmark, Norway, and Finland.

3.2.2 Budbee: Optimizing Last-Mile Delivery with Consumer Convenience [2]

3.2.2.1 Summary of the Research Item

Budbee, founded in 2016 in Sweden, is a last-mile delivery company that uses advanced technology to streamline online shopping and delivery processes. Operating in Sweden, Finland, Denmark, Belgium, and the Netherlands, Budbee reaches over 40 million people through home deliveries and parcel lockers. Their system relies on smart algorithms and self-learning technology to optimize delivery efficiency and customer satisfaction. They use cost-effective and environmentally friendly means for delivering parcels by using bikes, electric vehicles, and biofuels.

3.2.2.2 Critical analysis of the research item

Strength: The last mile revolution was transformed with consumer-centric design, tremendous strength from Budbee. Self-learning algorithms and route optimisation enhance efficiency with low emissions delivery through electric vehicles and bicycles. Other than that, customer-friendly flexibility helped Budbee achieve an excellent reputation among e-commerce partners. This merger with Instabox will only add to that strength and innovation capacity.

weeknesses: It only operates from Northern and Western Europe, thus limiting its strength as a global player. However though they may seem a far from being oblivious to sustainability, scaling such an operation to bigger or more rural parts would likely sacrifice either customer service and/or technology performance. Besides, real-time technologies themselves also give way during peak times or technical failure.

3.2.2.3 Relevance of the proposed research work

To a great extent, Budbee aligned with the purpose of the proposed system of a smart delivery box, being consumer-first and technology-oriented solutions. The real-time tracking, electric vehicles, and environmentally friendly logistics to be consulted in coming up with the algorithms utilized by Budbee in optimizing its delivery route and sustainability focus. Another feature which can be added to the proposed smart delivery box system, relevant to the customer, is empowerment to choose at what time and in what manner they would want their consignments delivered. The takeover of Instabox also reveals how scaling and expansion of innovative last-mile delivery solutions could be achieved on a larger market.
Geographical Presence: Sweden, Finland, Denmark, Belgium, and the Netherlands.

3.2.3 Posti: Modernizing Last-Mile Delivery in Finland[3]

3.2.3.1 Summary of the Research Item

Posti is the national postal service of Finland. It has undergone significant transformations to modernize its logistics and delivery services. With a history spanning over 380 years, Posti has evolved from a traditional postal service into a modern logistics company. It now offers a wide range of services, including last-mile deliveries, parcel lockers, and express services to support the growing demand for e-commerce deliveries. Posti operates across Finland and other Baltic countries, delivering over 1.5 million parcels each year. Its parcel locker network allows customers to send and receive packages at their convenience.

3.2.3.2 Critical Analysis of the Research Item

Strengths: One of Posti's primary strengths is its extensive network of parcel lockers, which offers a flexible and convenient way for customers to receive packages. Their focus on sustainability, including the adoption of electric vehicles and carbon-neutral deliveries, is another key strength that aligns with global trends towards environmentally friendly logistics. Posti's long history and established infrastructure give them an advantage in terms of market penetration and customer trust.
Weaknesses: Despite its innovations, Posti faces challenges in scaling its last-mile delivery services to

rural areas where infrastructure may be less developed. Additionally, as e-commerce continues to grow, Posti must continue to enhance its digital capabilities to remain competitive with private logistics companies. Ensuring that its services are both efficient and scalable while meeting sustainability goals may present ongoing operational challenges.

3.2.3.3 Relevance of the proposed research work

Posti's innovative use of parcel lockers and commitment to sustainability are directly relevant to the proposed smart delivery box system. Their experience in optimizing last-mile delivery logistics offers valuable lessons for building an efficient, user-friendly, and environmentally sustainable delivery system. Posti's focus on real-time tracking and customer convenience can help guide the development of key features in the smart delivery box system, such as user notifications, flexible delivery options, and efficient route planning.

Geographical Presence: Finland, Baltic countries (including Estonia, Latvia, and Lithuania).

3.2.4 DHL Parcel Lockers: Contactless Delivery Innovation [4]

3.2.4.1 Summary of the Research Item

DHL has been a pioneer in using parcel lockers to enhance last-mile delivery. Their locker network, known as "Packstations," allows customers to collect packages at their convenience, offering 24/7 access to parcels. This system eliminates the need for direct contact between delivery personnel and recipients, making it especially relevant during times when contactless delivery is prioritized, such as the COVID-19 pandemic. DHL's parcel lockers are strategically located in high-traffic areas to ensure accessibility, and customers receive notifications via SMS or email when their parcels are ready for pickup.

3.2.4.2 Critical Analysis of the Research Item

The number of parcel locker networks and parcel lockers can be picked up in flexible and convenient way from the customers. Their sustainability: electric vehicles and carbon-neutrality, fits into the future-friendly logistics of the rest of the world is one of the main strengths. Further on, the long history of the company and the existing infrastructure are competitive benefits in the market to enable successful penetration and subsequent trust from customers. While creating many innovations, Posti cannot but struggle on the complexity of scale for its last-mile delivery service to rural areas where much infrastructure may be less developed. In addition, with ever-growing e-commerce, Posti has to continually upgrade its digital capabilities to remain competitive with private logistics companies. The activities have to be very efficient and scalable in support of sustainability goals while the operations are underway, and this can be an ongoing challenge.

3.2.4.3 Relevance of the proposed research work

However, parcel lockers and sustainability efforts through developed smart delivery box systems are quite applicable from Posti. Experience in last-mile delivery logistics optimization builds important learning lessons in the construction of efficient user-friendly and environmentally sustainable delivery systems. Real-time tracking and customer convenience by Posti will focus well in steering development for key features that are mostly going to be found in the smart delivery box system, including user notifications, flexible options for delivery, and effective routing plans.
Geographical Presence: Germany, with extensive parcel locker networks in many other European countries including the UK, France, and Poland.

3.2.5 Amazon Locker: Revolutionizing Parcel Pick-up [5]

3.2.5.1 Summary of the Research Item

Amazon Locker offers a self-service, 24/7 parcel delivery and pick-up service that enhances flexibility for customers by eliminating the need for at-home deliveries. Placed in high-traffic locations like shopping centers and public transport hubs, Amazon Locker integrates with Amazon's existing e-commerce platform, allowing customers to choose a locker location during checkout. Customers receive a unique code to retrieve their packages once delivered to the locker. This system is widely used in urban settings, especially in the US and Europe.

3.2.5.2 Critical analysis of the research item

Strengths: Amazon Lockers are placed strategically in accessible places and are available 24/7. This gives customers flexibility in case they are not home to receive their packages. It also reduces the percentage of failed deliveries since it is efficient and enhances customer satisfaction. In addition, Amazon Locker helps prevent environmental impacts by avoiding repeated delivery attempts.
Weekness: It is also less available and reaches fewer people because, for example, one has to proceed to a locker location that for some is inconvenient, especially in remote areas. It is more inaccessible in sparsely populated areas.

3.2.5.3 Relation to the Proposed Research Work

The self-service, secure, and flexible nature of the Amazon Locker system fits well with the concept of the new smart delivery box proposed. General insights of key importance include 24/7 availability with a seamless user interface while tracking and retrieving the parcel, informing the design and deployment of smart delivery boxes. Another lesson from Amazon Locker relates to reduction in environment impacts through fewer delivery attempts and will thus be relevant in the sustainable manner of the new smart delivery box system. **Geographical Presence:** US, UK, Germany, France, Italy, Spain, Japan.

3.2.6 InPost: Expanding Parcel Lockers Across Europe [6]

3.2.6.1 Summary of the Research Item

InPost operates a large network of self-service parcel lockers across Europe, enabling customers to pick up and drop off packages at their convenience. These lockers are strategically placed in high-traffic areas such as gas stations, shopping malls, and residential complexes. InPost offers 24/7 accessibility and integrates with its digital platform, allowing users to track parcels and receive notifications for pick-up. This system is particularly popular in Central and Eastern Europe, where it offers an alternative to traditional home deliveries, catering to the growing e-commerce market.

3.2.6.2 Critical analysis of the research item

Strength:A great advantage of InPost Lockers is that they are deployed widely, which offers 24/7 availability, thus simplifying the convenience to customers, lowers the rate of missed deliveries, and raises the effectiveness of last-mile logistics. The goal of going for fewer delivery attempts by zeroing in emissions also aligns with growing demand for sustainable logistics.
Weekness: The main limiting factor is that customers have to travel to a locker location-that's quite a problem for those who are not easily accessible. This may make lockers' coverage not so wide in rural areas, in some regions, and end-users will be few.

3.2.6.3 Relevance of the proposed research work

Useful insights the InPost parcel lockers can offer regarding the proposed smart delivery box system include scalability and customer convenience. Opening 24/7 with parcel tracking ability linked to digital platforms makes this a very useful model for the smart delivery box. The objective of reducing emissions by InPost can also be useful in bringing enlightenment on environmental sustainability for the proposed system. **Geographical Presence:**Poland, United Kingdom, France, Italy, Spain, Netherlands

3.2.7 UPS Access Point: Convenient Pick-up Locations for Last-Mile Delivery [7]

3.2.7.1 Summary of the Research Item

UPS Access Point is a network of retail locations where customers can pick up and drop off UPS packages. These points are typically located in convenience stores, supermarkets, and other local businesses, offering an alternative to traditional home deliveries. Customers can select an Access Point as their delivery location during checkout, providing them with flexibility and security. The system aims to reduce missed deliveries and optimize logistics by delivering multiple parcels to one central location, reducing both time and emissions.

3.2.7.2 Critical analysis of the research item

Strength: Easy for those whose packages are not delivered to their homes. Taking advantage of existing retail facilities, the access point helps UPS save delivery and failed attempts along with the poor environmental impact that surrounds them. Access points tend to be relatively easier to access due to their tendency to be located in more populated places.
Weakness: it demands users to move to an access point, which sometimes is inconvenient, especially for people residing in rural areas. Since the strategy relies on retail stores, it shall difficult to scale in areas where there are relatively few participating firms.

3.2.7.3 Relevance of the proposed research work

UPS Access Point's model-where retail outlets serve as a centralized pickup location-achieves some similar aims with the proposed solution. With centralization of parcel deliveries in the system being proposed, delivery times and emissions are reduced; such could be informative while setting up the logistics aspects of the proposed solution to optimize its delivery. Customer-facing flexibility of the UPS Access Point system could further inform the formulation of user-friendly features of the proposed solution. **Geographic Coverage**: US, UK, Canada, Germany, France, Italy, Spain

3.3 Literature Review Summary Table

The following is the summary table

3.4 Conclusion

The literature review explores several last-mile delivery innovations from leading logistics companies, such as PostNord, Budbee, Posti, DHL, Amazon, InPost, and UPS. These companies share common goals of enhancing delivery efficiency, sustainability, and customer satisfaction through technologies like real-time tracking, parcel lockers, electric vehicles, and route optimization. Key challenges include scaling these services, especially in rural areas, and maintaining performance during peak times. The insights gained from their models and strategies can inform the development of a smart delivery box system, focusing on efficiency, flexibility, and sustainability.

Table 3.1: Summary Table

Application	Features	Relevance	Limitations
PostNord [1]	Advanced IT infrastructure, real-time tracking, automated sorting, sustainability focus (electric vehicles, optimized routes).	Insights on real-time tracking, customer interfaces, sustainability for the proposed smart delivery system	Inconsistent delivery times during peak periods, limited geographical footprint outside the Nordic region.
BudBee [2]	Consumer-centric design, route optimization, self-learning algorithms, eco-friendly vehicles (bikes, electric, biofuels).	Lessons on consumer-first design, eco-friendly logistics, flexible customer delivery options for smart delivery boxes	Limited to Northern and Western Europe, challenges in scaling to rural areas.
Posti [3]	Consumer-centric design, route optimization, self-learning algorithms, eco-friendly vehicles (bikes, electric, biofuels).	Lessons on consumer-first design, eco-friendly logistics, flexible customer delivery options for smart delivery boxes	Limited to Northern and Western Europe, challenges in scaling to rural areas.
DHL Parcel Lockers [4]	Extensive parcel locker network, contactless delivery, carbon-neutral initiatives.	Experience with scalable parcel locker networks and contactless deliveries relevant to smart delivery system design.	Scaling challenges in rural areas, competition with private logistics companies.
Amazon Lockers [5]	24/7 self-service, reduces failed deliveries, strategically placed in high-traffic areas	Insights on self-service, secure, and flexible delivery systems; environment impact reduction.	Inconvenient for rural areas, limited geographical accessibility.
InPost [6]	24/7 availability, parcel tracking, reduces missed deliveries, lowers emissions.	Scalability, customer convenience, and emissions reduction for smart delivery box development.	Inconvenient for rural areas, limited rural coverage.
UPS Access Point [7]	Uses existing retail facilities, reduces missed deliveries and environmental impact.	Centralized delivery model and flexible pickup locations offer insights for optimizing smart delivery logistics.	Inconvenient for rural areas, scaling challenges due to reliance on retail partners.

Chapter 4 Software Requirement Specifications

The ”Smart Delivery” project’s Software Requirement Specifications (SRS) chapter explains the specific needs, functions, and design facets of the system. It makes sure that both technical and non-technical readers can understand the system’s requirements, enabling them to duplicate or improve the system based on the given information.

4.1 List of Features

The features of our software are

1. Reserve compartment for sending parcel
2. Select compartment for receiving parcel
3. Track parcel delivery
4. Cancel compartment reservation by sender
5. Edit compartment reservation by receiver
6. Receive parcel by rider
7. Receive parcel by receiver
8. Placement of Parcel by sender
9. Placement of Parcel by rider
10. Reschedule delivery
11. Add new delivery box
12. Edit details of existing delivery box
13. Remove existing delivery box

4.2 Functional Requirements

4.2.1 Admin functionality

1. The system shall allow Admin to add new delivery boxes.
2. The system shall allow Admin to remove existing delivery boxes.
3. The system shall allow Admin to edit details of existing delivery boxes.

4.2.2 Systems automated Functionality

1. This information system shall gather package details from service providers (SP).
   (a) The system shall provide API to be called by the SP to provide package details for distribution
      i. The system shall be able to refresh its list of packages to be delivered whenever SP calls API to send details.
2. The system shall prepare a list of available boxes based on the state of the boxes' compartments
   (a) The system shall process the information of categories/compartments (Large, Medium, Small) of delivery box
   (b) The system shall prepare the queue of delivery boxes with empty compartments that matches the requirements of parcel.
      i. The system shall allow only those parcel that matches dimensions and weight bearing capacity of compartments of delivery box
3. The system shall send notification to receiver to select his preferred delivery box within 5 hours.
   (a) The system shall send notification at 9am when the business day starts and will wait for 5 hours to get preference.
4. The system shall assign a delivery box after waiting for 5 hours if receiver does not send his choice within 5 hours.
   (a) The system shall revoke the right to select delivery box from receiver.
   (b) The system shall assign a delivery box that is top in queue of QFC.
5. The system shall prepare the list of reserving delivery boxes' compartments
   (a) The system shall reserve the compartment in the suggested delivery box by changing its state from empty to reserved.
   (b) The system shall add the preferred compartment to list of reserved compartments of delivery box.
6. The system shall prepare list of received parcels by sender
   (a) The system shall put information of parcel by sender in the queue of QIC after the placement of parcel in compartment of delivery box.
   (b) The system shall prepare the list of parcels to be picked by SP to deliver at the destination

delivery box.

7. The system shall cancel reservation of compartment done by sender
   (a) After 5 hours, reservation of compartment will be revoked, and sender will be notified
8. The system shall allow SP to get updated list of parcels to pick sent by sender for delivery.
   (a) The system shall provide API to be called by SP for getting updated list of parcels to deliver.
9. The system shall notify receiver when parcel will be delivered to the respective delivery box.
10. The system shall send OTP to SP, receiver and sender
    (a) The system shall send OTP to sender only if he is sending parcel through delivery box after when he will reserve the compartment for 5 hours.
    (b) The system shall send OTP to receiver only after the placement of parcel in the respective delivery box's compartment.
    (c) The system shall send OTP to SP for picking-up and delivering parcel time
        i. The system shall send OTP to SP after placement of parcel in delivery box's compartment by the sender.
        ii. The system shall send OTP to SP after the finalization of destination delivery box's compartment
11. The system shall update the state of delivery boxes after their state is changed.
12. The system shall revoke the right from receiver to take parcel from delivery box.
    (a) The system shall notify the receiver if he does not take parcel form delivery box for 2 days excluding the day when the parcel was delivered
        i. The system shall prepare the queue of unpicked parcels (QUP) (parcels not received by receiver)
13. The system shall prepare list of unpicked items by receiver
    (a) The system shall put the unpicked items' details in queue of failed delivery Parcels (QFDP) if not picked within defined time which is maximum 3 days
    (b) The SP shall handle the delivery of failed delivery parcels according to their policies.

4.2.3 Sender and Receiver Functionality

1. The system shall allow the receiver to give his preferred delivery box within 5 hours after notification received.
   (a) The system shall allow the receiver to view list of available delivery boxes.
2. The system shall allow the receiver to take his parcel by getting OTP as input.
3. The system shall allow receivers to reschedule their delivery within 1 day of revocation of delivery.
   (a) The system shall allow receivers to pick their parcels by giving 1 extra day.
   (b) The system shall not allow receivers to reschedule their delivery if they do not schedule their delivery within 1 day.
4. The system shall allow receiver to edit the reserved compartment within 1 hour of reservation.
5. The system shall allow senders to send parcels through delivery boxes
   (a) The system shall allow sender to search for available delivery boxes by entering his required details.
   (b) The system shall allow senders to temporarily reserve the required compartment in the delivery box for 5 hours.
6. The system shall allow senders to cancel the reserved compartment within 5 hours of reservation.
7. The system shall provide feature of parcel tracking to senders and receivers
   (a) The system shall show all the staying points in delivery process and shall indicate the parcel on specific point at which it will be.

4.2.4 Service Provider Functionality

1. The system shall update about selected delivery boxes to the SP warehouse
   (a) The system shall provide API to be called by SP to get list of reserved compartments of delivery boxes
2. The system shall update the SP about unpicked parcels
   (a) The system shall provide API to be called by the SP for fetching QUP
3. 15. The system shall provide API to SP to get updated list of failed attempts (QFDP

4.3 Quality Attributes

The Quality Attributes are

4.3.1 Performance

System will perform effectively so that user will not feel any issue. It will be fast and quick in response. (NFR 2)

4.3.2 Usability

System will be easy to use and understand (NFR 3)

4.3.3 Security

Crucial data of user will be protected end-to-end for security from threats and risks. (NFR 7)

4.3.4 Maintenance

There will be no issue in maintaining any module of system. User will be notified about maintenance time for that user might not be able to use system. (NFR 4)

4.3.5 Compatibility

There will be no compatibility issue for user in terms of supporting and for SPs in terms of integration. (NFR 10 and 6)

4.3.6 Responsiveness

System will be easy to navigate for all users and will be intuitive to understand. (NFR 9)

4.4 Non-Functional Requirements

This section will be discussing non-functional requirements for the different entities of our project ”Smart Delivery”

4.4.1 Availability

System shall be available on the internet for easy access in time other than maintenance time reported via notification

4.4.2 Performance

System shall response within 5-10 seconds of request

4.4.3 Usability

system shall be easy to use for anyone who can browse things easily

4.4.4 Maintainability

System shall be available within time given to user when it will go offline due to any reason

4.4.5 Testability

System shall be testable during whole phase of development

4.4.6 Compatibility

System shall be compatibility with the system of SPs

4.4.7 Security

Important data such OTP that involves risks or vulnerability shall be encrypted end-to-end.

4.4.8 Reliability

System shall not face critical failure when it is available.

4.4.9 Responsiveness

System shall be responsive for all devices including laptop, mobile, and tablet.

4.4.10 Portability

System shall be able to work on all operating systems that will support chrome, edge, or safari.

4.5 Assumptions

- The delivery box we are expecting with minimum functionalities is available in market.
- Working system of SP can be integrated with this system.
- The embedded system of delivery box can easily be integrated with this system.

- The delivery box is connected with internet 24/7.
- The users must have knowledge of browsing over the internet.
- The users will be connected to internet when using the internet.
- The sender will place the item in the locker before closing the locker.
- The receiver will take out the item before closing the locker.

4.6 Use Cases

4.6.1 Use Case 1: Reserve compartment for sending parcel

Name	Reserve compartment for sending parcel		
Actors	Sender		
Summary	The sender wants to send parcel through smart delivery, so, he wants to reserve a compartment in delivery box to start delivery process.		
Pre-Conditions	User already logged in through SP's side.		
Post-Conditions	A compartment will be reserved temporarily for 5 hours.		
Special Requirements	None		
Basic Flow			
Actor Action		**System Response**	
1	Sender clicks on smart delivery from SP's menu.	2	Menu of Smart Delivery will be displayed.
3	Sender selects send parcel from menu.	4	System displays delivery information form.
5	Sender inputs all the required data.	6	List of available delivery boxes will be displayed if box (es) is available.
7	Sender selects his preferred delivery box.	8	Notifies sender about successful reservation after reserving available compartment.
Alternative Flow			
		6-A	Notifies about no available boxes if no one is available.

4.6.2 Use Case 2: Select compartment for receiving parcel

Name	Select compartment for receiving parcel		
Actors	Receiver		
Summary	Receiver got a notification to select his preferred delivery box for delivery.		
Pre-Conditions	Parcel has been reached to SP, and user already logged in through SP's side.		
Post-Conditions	A compartment will be reserved for delivery		
Special Requirements	Receivers need to select delivery box within 2 days of notification		
Basic Flow			
Actor Action		**System Response**	
1	Receiver clicks on smart delivery from SP's menu.	2	Menu of Smart Delivery will be displayed.
3	Receiver clicks on select delivery box from menu.	4	System displays list of available delivery box (es) according to address given by sender.
5	Receiver selects his preferred delivery box.	6	System reserves preferred delivery box for delivery.
Alternative Flow			
		4-A	System will increase 6 hours in time for selecting delivery box if no delivery box available at time of selection and notifies receiver.

4.6.3 Use Case 3: Track parcel delivery

Name	Track parcel delivery		
Actors	Sender, Receiver		
Summary	Sender and receiver will be able to track their parcel delivery process of under-process delivery.		
Pre-Conditions	Sender and receiver already logged in from SP side, their delivery is under process.		
Post-Conditions	Delivery tracking details will be displayed.		
Special Requirements	None		
Basic Flow			
Actor Action		**System Response**	
1	Sender and receiver (Customer) clicks on smart delivery from SP's menu.	2	Menu of Smart Delivery will be displayed.
3	Customer selects track delivery from menu.	4	Displays list of delivery under process.
5	Customer selects delivery process he wants to track data.	6	Tracking details will be displayed.
Alternative Flow			

4.6.4 Use Case 4: Cancel compartment reservation by sender

Name	Cancel compartment reservation by sender		
Actors	Sender		
Summary	Sender wants to cancel his reservation of compartment.		
Pre-Conditions	Sender already logged in from SP side, sender has successfully reserved compartment.		
Post-Conditions	Reserved compartment will be unreserved.		
Special Requirements	Sender needs to cancel reservation within 5 hours of reservation		
Basic Flow			
Actor Action		**System Response**	
1	Sender clicks on smart delivery from SP's menu.	2	Menu of Smart Delivery will be displayed.
3	Sender selects cancel order from menu.	4	System displays list of reserved delivery boxes.
5	Sender selects list item (delivery box) for which he wants to cancel reservation	6	System will notify about cancellation after successful cancellation of reservation to sender.
Alternative Flow			

4.6.5 Use Case 5: Edit compartment reservation by receiver

Name	Edit compartment reservation by receiver		
Actors	Receiver		
Summary	Receiver wants to change the location of delivery box.		
Pre-Conditions	Receiver already logged in from SP side, receiver has already reserved delivery box for delivery.		
Post-Conditions	Receiver's selected delivery box will be changed.		
Special Requirements	Receiver needs to update his preference within 1 hour of reserving delivery box		
Basic Flow			
Actor Action		**System Response**	
1	Receiver clicks on smart delivery from SP's menu.	2	Menu of Smart Delivery will be displayed.
3	Receiver selects "edit delivery box location" from menu.	4	System displays list of reserved delivery box.
5	Receiver selects list item (delivery box) for which he wants to edit reservation.	6	System will display list of available delivery box(es) according to delivery address given by sender.
7	Receiver selects his preferred delivery box from list.	8	System notifies receiver about successful updating of delivery box preference.
Alternative Flow			
9	Receiver press cancel button.	6-A	System notifies about previously selected delivery box.

4.6.6 Use Case 6: Receive parcel by rider

Name	Receive parcel by rider		
Actors	Rider		
Summary	Rider wants to pick up the parcel placed by the sender.		
Pre-Conditions	Rider has OTP to open delivery box's compartment.		
Post-Conditions	The state of parcel will be changed to be received By SP and compartment status will be changed to empty.		
Special Requirements	Receiver needs to pick up the parcel within 2 days after delivery of parcel		
Basic Flow			
Actor Action		**System Response**	
1	Rider clicks on smart delivery from SP's menu.	2	Menu of Smart Delivery will be displayed.
3	Rider selects pick up item.	4	System will ask to input OTP.
5	Rider inputs OTP.	6	System will open the respective compartment.
Alternative Flow			
7	User inputs wrong OTP	6-A	System will ask to enter OTP again.

4.6.7 Use Case 7: Receive parcel by receiver

Name	Receive parcel by receiver		
Actors	Receiver		
Summary	Receiver wants to pick his parcel at the end of delivery.		
Pre-Conditions	Receiver has OTP to open delivery box's compartment.		
Post-Conditions	Parcel state will be changed to delivered and compartment state will be changed to empty .		
Special Requirements	Receiver needs to pick up the parcel within 2 days after delivery of parcel		
Basic Flow			
Actor Action		**System Response**	
1	Receiver clicks on smart delivery from SP's menu.	2	Menu of Smart Delivery will be displayed.
3	Receiver selects pick up item.	4	System will ask to input OTP.
5	Receiver inputs OTP.	6	System will open the respective compartment.
Alternative Flow			
7	User inputs wrong OTP	6-A	System will ask to enter OTP again.

4.6.8 Use Case 8: Placement of Parcel by sender

Name	Placement of Parcel by sender		
Actors	Sender		
Summary	Sender wants to place his parcel at the start of delivery process or rider wants to place the parcel sent by the sender.		
Pre-Conditions	Sender has OTP to open delivery box's compartment.		
Post-Conditions	Parcel status will be changed to placedBySender and compartment status will be changed to acquired .		
Special Requirements	Sender needs to place parcel within 5 hours of reservation		
Basic Flow			
Actor Action		**System Response**	
1	User clicks on smart delivery from SP's menu.	2	Menu of Smart Delivery will be displayed.
3	User selects place item.	4	System will ask to input OTP.
5	User inputs OTP.	6	System will open the respective compartment.
Alternative Flow			
7	User inputs wrong OTP	6-A	System will ask to enter OTP again.

4.6.9 Use Case 9: Placement of Parcel by rider

Name	Placement of Parcel by rider		
Actors	Rider		
Summary	Rider wants to place the parcel sent by the sender.		
Pre-Conditions	RIder has OTP to open delivery box's compartment.		
Post-Conditions	Parcel status will be changed to placedBySender and compartment status will be changed to acquired .		
Special Requirements	Rider needs to place parcel within 5 hours of reservation		
Basic Flow			
Actor Action		**System Response**	
1	User clicks on smart delivery from SP's menu.	2	Menu of Smart Delivery will be displayed.
3	User selects place item.	4	System will ask to input OTP.
5	User inputs OTP.	6	System will open the respective compartment.
Alternative Flow			
7	User inputs wrong OTP	6-A	System will ask to enter OTP again.

4.6.10 Use Case 10: Reschedule delivery

Name	Reschedule delivery		
Actors	Receiver		
Summary	Receiver did not pick his parcel from delivery box and wants to reschedule timing.		
Pre-Conditions	Receiver did not pick his parcel in allowed timing of 2 days, receiver already logged in from SP side.		
Post-Conditions	Receiver will get 1 extra day to pick his parcel.		
Special Requirements	None		
Basic Flow			
Actor Action		**System Response**	
1	Receiver clicks on smart delivery from SP's menu.	2	Menu of Smart Delivery will be displayed.
3	Receiver selects reschedule delivery.	4	Notifies receiver about extra 1 day to receive his parcel after successfully updating time limit.
Alternative Flow			

4.6.11 Use Case 11: Add new delivery box

Name	Add new delivery box		
Actors	Admin		
Summary	Admin wants to add new delivery box at required location.		
Pre-Conditions	Admin logged in from SP side.		
Post-Conditions	Details of delivery box will be added to list of delivery boxes .		
Special Requirements	None		
Basic Flow			
Actor Action		**System Response**	
1	Admin clicks on smart delivery from SP's menu.	2	Menu of Smart Delivery will be displayed.
3	Admin selects add new delivery box.	4	Detail form will be displayed.
5	Admin enters all required fields and presses add button.	6	Notify user about successful addition of delivery box.
Alternative Flow			
7	Admin presses cancel button	6-A	Smart delivery menu will be displayed

4.6.12 Use Case 12: Edit details of existing delivery box

Name	Edit details of existing delivery box		
Actors	Admin		
Summary	Admin wants to edit details of existing delivery box.		
Pre-Conditions	Admin logged in from SP side and delivery box already added in list.		
Post-Conditions	Details of delivery box will be added to list of delivery boxes .		
Special Requirements	None		
Basic Flow			
Actor Action		**System Response**	
1	Admin clicks on smart delivery from SP's menu.	2	Menu of Smart Delivery will be displayed.
3	Admin selects edit delivery box.	4	Detail form will be displayed.
5	Admin enters all required fields and presses edit button.	6	Notify user about successful editing of delivery box.
Alternative Flow			
7	Admin presses cancel button	6-A	Smart delivery menu will be displayed

4.6.13 Use Case 13: Remove existing delivery box

Name	Remove existing delivery box		
Actors	Admin		
Summary	Admin wants to remove existing delivery box.		
Pre-Conditions	Admin logged in from SP side and delivery box already added in list.		
Post-Conditions	Delivery box will be removed from list of delivery boxes .		
Special Requirements	None		
Basic Flow			
Actor Action		**System Response**	
1	Admin clicks on smart delivery from SP's menu.	2	Menu of Smart Delivery will be displayed.
3	Admin selects remove delivery box.	4	List of Delivery boxes will be displayed.
5	Admin selects the required box and presses remove button.	6	Notify user about successful deletion of delivery box.
Alternative Flow			
7	Admin presses cancel button	6-A	Smart delivery menu will be displayed

4.7 UseCase diagram

Figure 4.1: UseCase Diagram

4.8 Hardware and Software Requirements

4.8.1 Hardware Requirements

Smart Delivery box with large, medium and small compartments that connects with internet and would be controllable through internet using APIs

4.8.2 Software Requirements

APIs implemented in Node.js are required that integrate with Smart Delivery Box to control all the components of hardware Smart Delivery Box(SDB)

4.9 Graphical User Interface

4.9.1 Interface 1

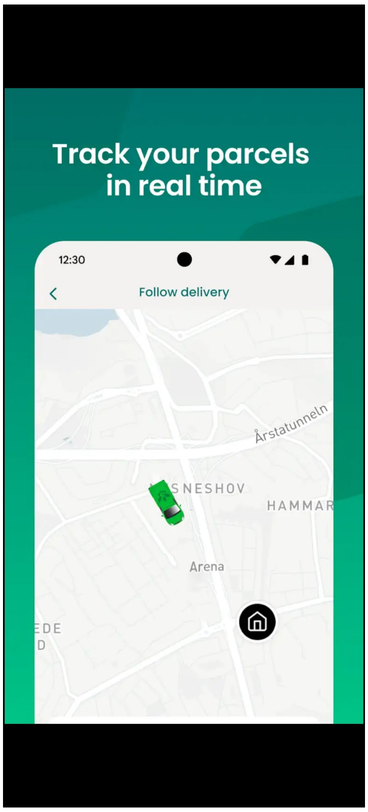

Figure 4.2: Interface 1

4.9.2 Interface 2

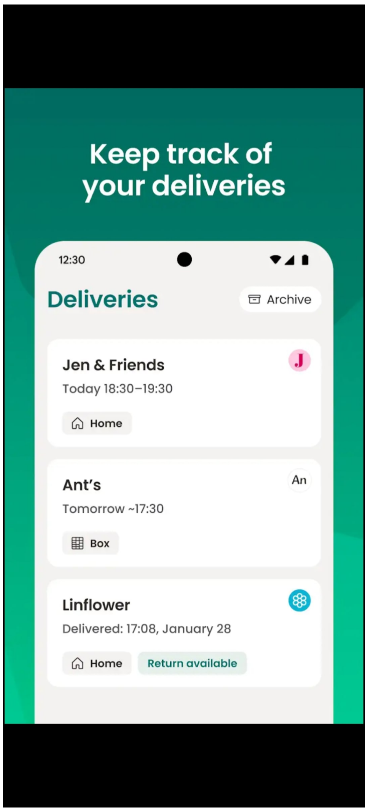

Figure 4.3: Interface 2

4.9.3 Interface 3

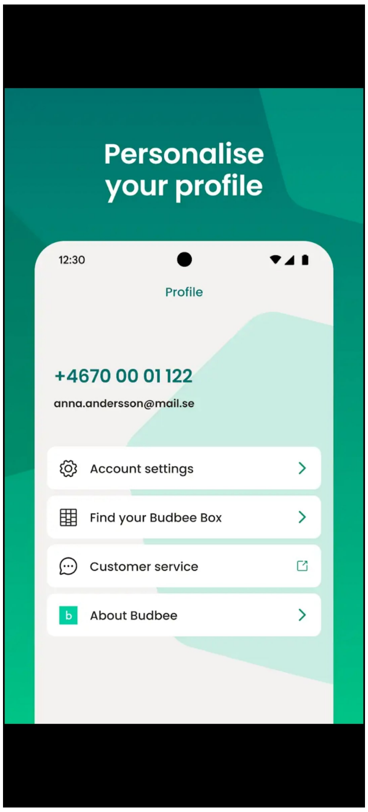

Figure 4.4: Interface 3

4.10 Database Design

4.10.1 ER Diagram

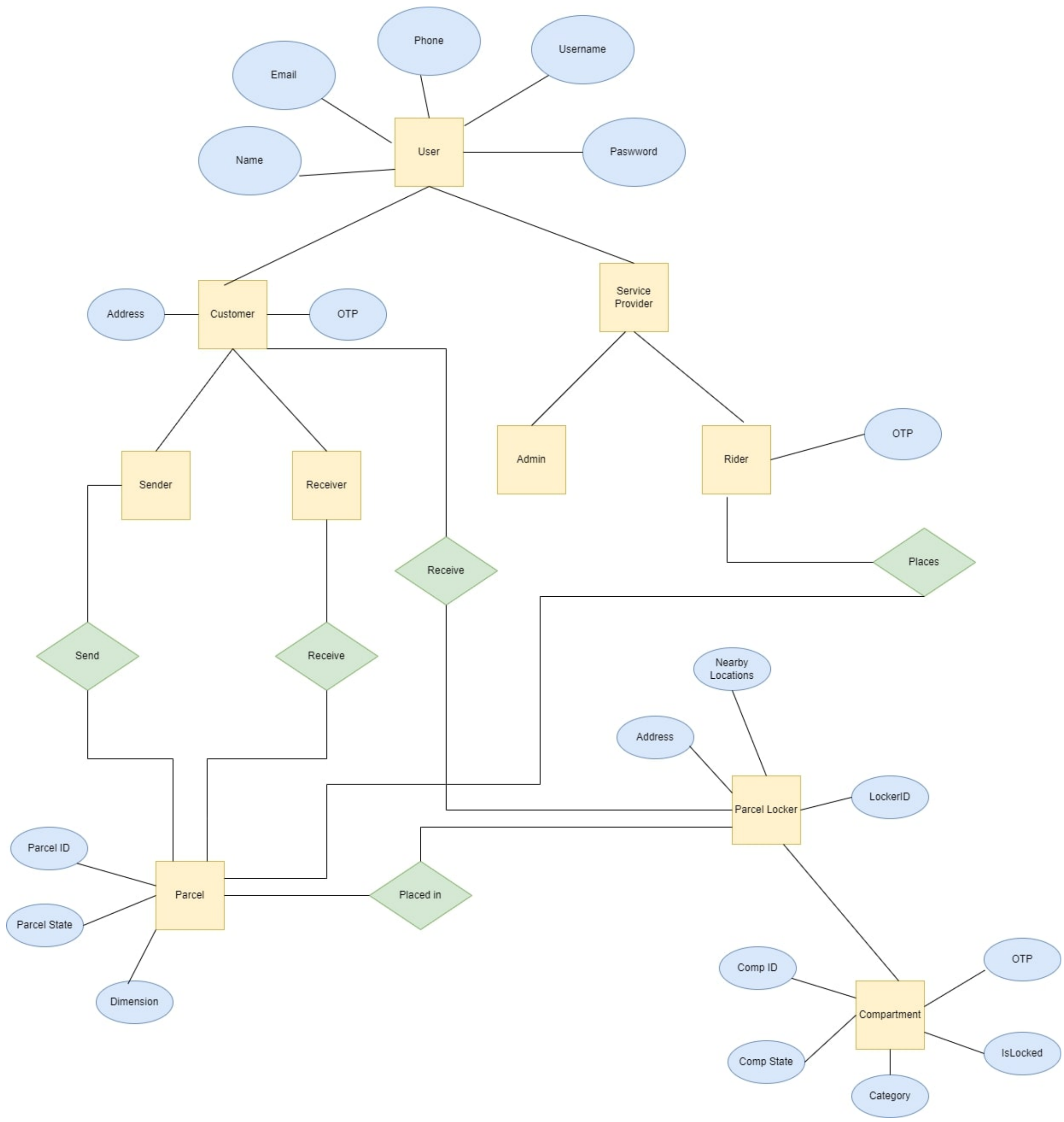

Figure 4.5: Entity Relation Diagram

4.10.2 Data Flow Diagram

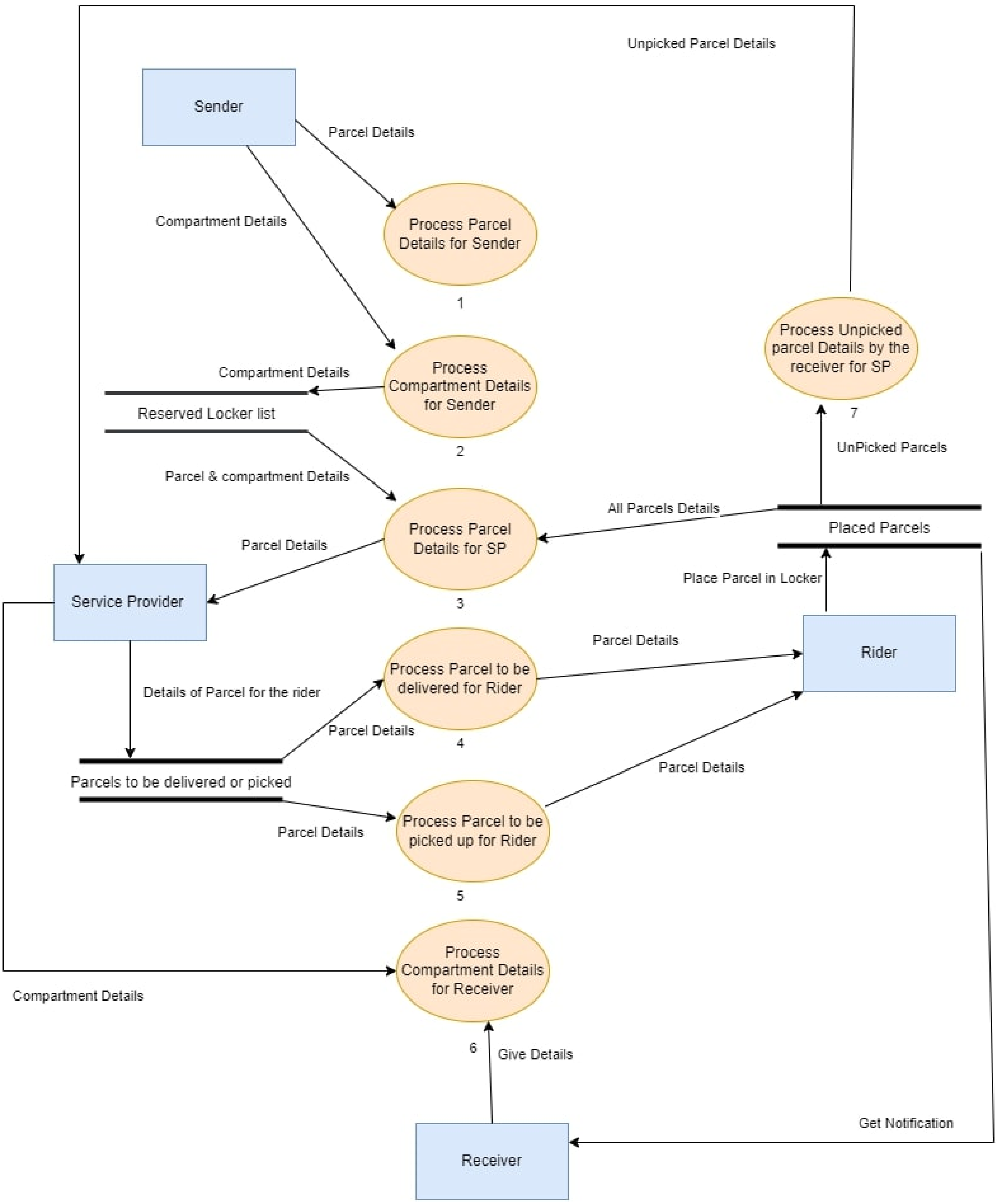

Figure 4.6: Data Flow Diagram

4.11 Risk Analysis

List and explain the risks that may be encountered during the project. For e.g.: technical risks, business risks, etc.

Chapter 5 High-Level and Low-Level Design

The high and low level design of the Smart Delivery are explored in further detail in this chapter. System architecture and flow of functionalities is shown visually using diagrams. Detailed discussions on architecture, strategy, and policy are provided for your project.

5.1 System Overview

The Smart Delivery platform aims to transform the Delivery industry by facilitating seamless interactions between clients and Service Providers. Our system software comprises the following key modules:

5.1.1 Send Parcel

The “Send Parcel” module is at the heart of the Smart Delivery system. Parcel Selection: The sender initiates the process by selecting the parcel they want to send. They choose a Smart Delivery Box from the available options. These boxes are strategically placed in convenient locations, such as near residential areas, office complexes, or public spaces. The sender can pick a box based on proximity to their location or other preferences. Parcel Drop-Off: Once the sender has chosen a Smart Delivery Box, they drop off their parcel there. The box is equipped with technology to securely store the parcel until the recipient retrieves it. This step eliminates the need for direct home delivery, reducing failed delivery attempts and ensuring efficient use of resources. Confirmation and Tracking: The system confirms the parcel drop-off and notifies the sender. Both the sender and the service provider (SP) can track the parcel’s status throughout the entire transaction. Real-time updates ensure transparency and accountability.

5.1.2 Receive Parcel

The “Receive Parcel” module focuses on the recipient’s experience: Recipient Selection: The recipient (receiver) interacts with the system to choose a Smart Delivery Box where they want to receive their parcel. They can select a box based on their convenience, whether it’s close to their home, workplace, or any other preferred location. Parcel Retrieval: When the delivery person places the parcel in the chosen box, the recipient receives a notification. The recipient can then visit the Smart Delivery Box at their convenience and the time they have selected to retrieve their parcel. This flexibility allows recipients to collect their parcels when it best suits their schedule

5.1.3 Track Parcel

The ability to track parcels is crucial for all parties involved: Sender Tracking: The sender can monitor the parcel's journey from drop-off to delivery. Real-time tracking provides peace of mind and helps manage expectations. Receiver Tracking: The recipient also has access to tracking information. They know when the parcel is ready for pickup, eliminating the need to wait at home for delivery. Service Provider (SP) Tracking: The SP can oversee the entire process, ensuring efficient delivery operations. They can optimize routes, manage resources, and address any issues promptly.

5.2 Design Considerations

For our application to be successful, we need to address a range of issues, assumptions, dependencies, and constraints to ensure a smooth user experience. This section outlines various considerations that need to be taken into account before devising a complete design solution.

5.2.1 Assumptions and Dependencies

Describe any assumptions or dependencies regarding the software and its use. These may concern such issues as:

- Related software or hardware
  - The user should have a smartphone on which he can access browser.
- Operating systems
  - The user should have a stable internet connection and the browser on which he will open the web-based app.
- End-user characteristics
  - End users should have a reliable Internet connection.
  - End users should possess the latest devices with Compatible browser versions.
  - End users should have basic knowledge of using the application.
  - Possible and/or probable changes in functionality.

5.2.2 General Constraints

- Constraints
  - Availability of delivery box.

  - Integration of delivery box hardware with our system.
  - Integration of our system with service providers (e.g., TCS).
  - Time constraints.
  - Budget constraints.
- Hardware or Software Environment
  - Internet connectivity issues.
  - Overloaded website traffic, leading to potential inaccessibility for some users.
  - Security breaches by third-party software, requiring temporary shutdowns.
  - Availability of the smart delivery box.
- End-user Environment
  - Users lacking basic internet knowledge.
  - Users lacking understanding of internet browsing.
- Availability or Volatility of Resources
  - Poor Internet connections.
  - Outdated or underpowered devices.
  - Slow loading times due to insufficient internet speed.
- Standards Compliance
  - VS Code for development.
  - MongoDB as the backend database.
  - Use of JS libraries.
- Interoperability Requirements
  - Smooth connection with the database.
  - Smooth connection with the hardware delivery box.
  - Smooth connection with the service provider.
- Interface/Protocol Requirements
  - User-friendly interfaces for easy navigation within the system.
  - Protocols for connection with the smart delivery box.

- Security Requirements
  - Crucial data should be encrypted.
- Performance Requirements
  - The system shall respond within 5-10 seconds of a request.

5.2.3 Goals and Guidelines

The design of the Smart Delivery platform should align with specific goals and guidelines to achieve its intended purpose:

5.2.3.1 User Friendly

Our system will be easy to use, with a simple and clear design. The website will be in English, making it helpful and accessible to many users.

5.2.3.2 Performance

Our system will be a high-performance system. It will not require unnecessary memory or space from the end user and will perform all operations with minimal latency.

5.2.3.3 Modifiability

Our system will be modifiable so that new features can be easily added according to future needs.

5.2.3.4 Compatibility

The system will ensure compatibility with external Service Providers (SPs) by supporting standard protocols and APIs. It will also be designed for portability across all operating systems that support Chrome, Edge, or Safari browsers, guaranteeing seamless integration and broad accessibility.

5.2.3.5 Maintainability

There will be no problems maintaining any system modules. Users will be alerted in advance of maintenance times, during which they may be unable to access the system.

5.2.3.6 Security

Crucial user data will be protected end-to-end to ensure security against threats and risks.

5.2.4 Development Methods

In the development of the Smart Delivery, we will employ the Scrum methodology, an agile development approach known for its iterative and repeatable cycles. Work will be divided into several sprints, each with set deadlines not exceeding one week. After each sprint, a 15-to-20-minute meeting will be held to review progress and make necessary schedule adjustments. Scrum's adaptability allows for changes in projects or the addition of new functionalities, making it a suitable choice for our development methodology.

5.3 System Architecture

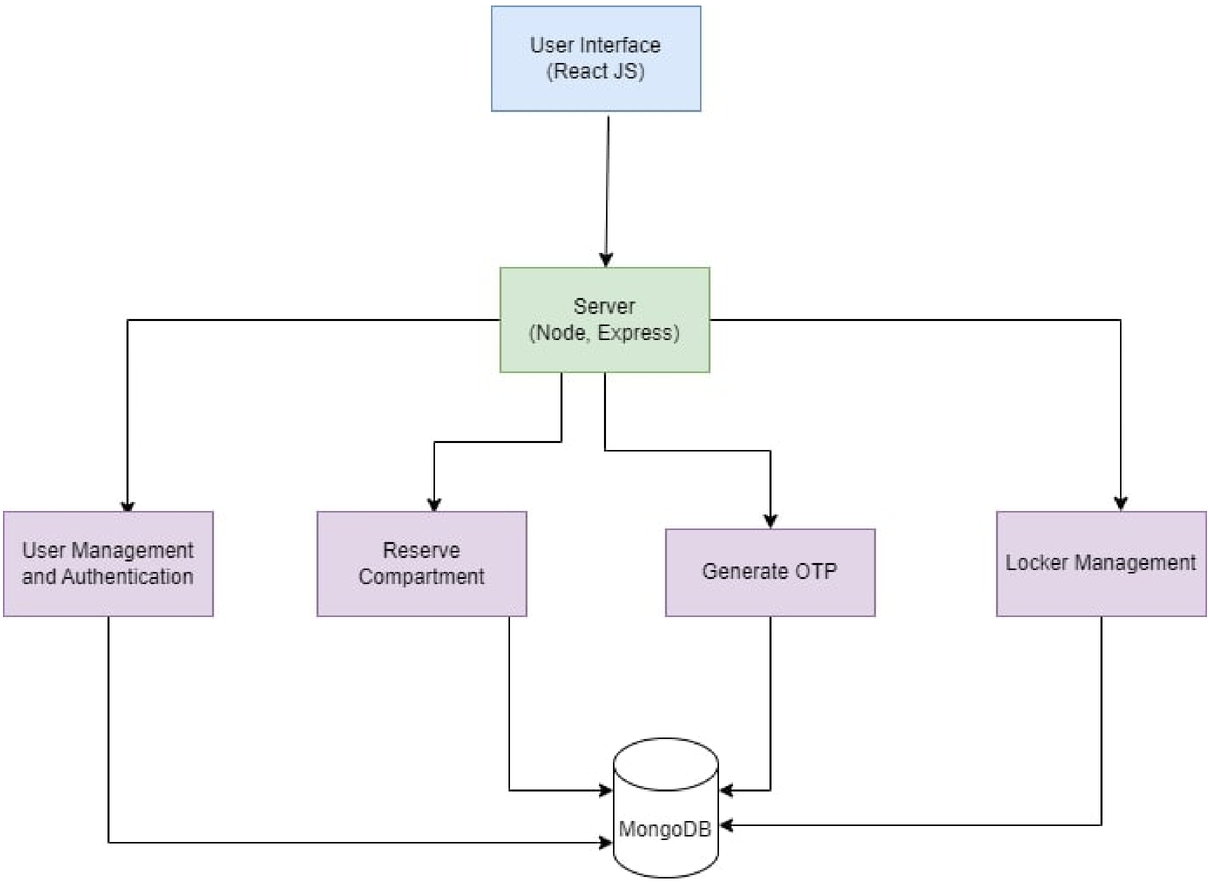

Figure 5.1: Client-Server Architecture Diagram

As this diagram shows, Our Architecture design is **Client-Server Architecture**. The users(clients) will interact with user interface built on react js. They will be able to manage users and manage lockers (Admin Responsibility). They will also be able to reserve compartments, track parcels (User functionality) using node (server). All this will be save on MongoDB cloud. **User Interface** The users will interact with the user interface that will help them make locker reservations, manage lockers and track the parcel

5.3.1 Subsystem Architecture

5.3.1.1 Admin

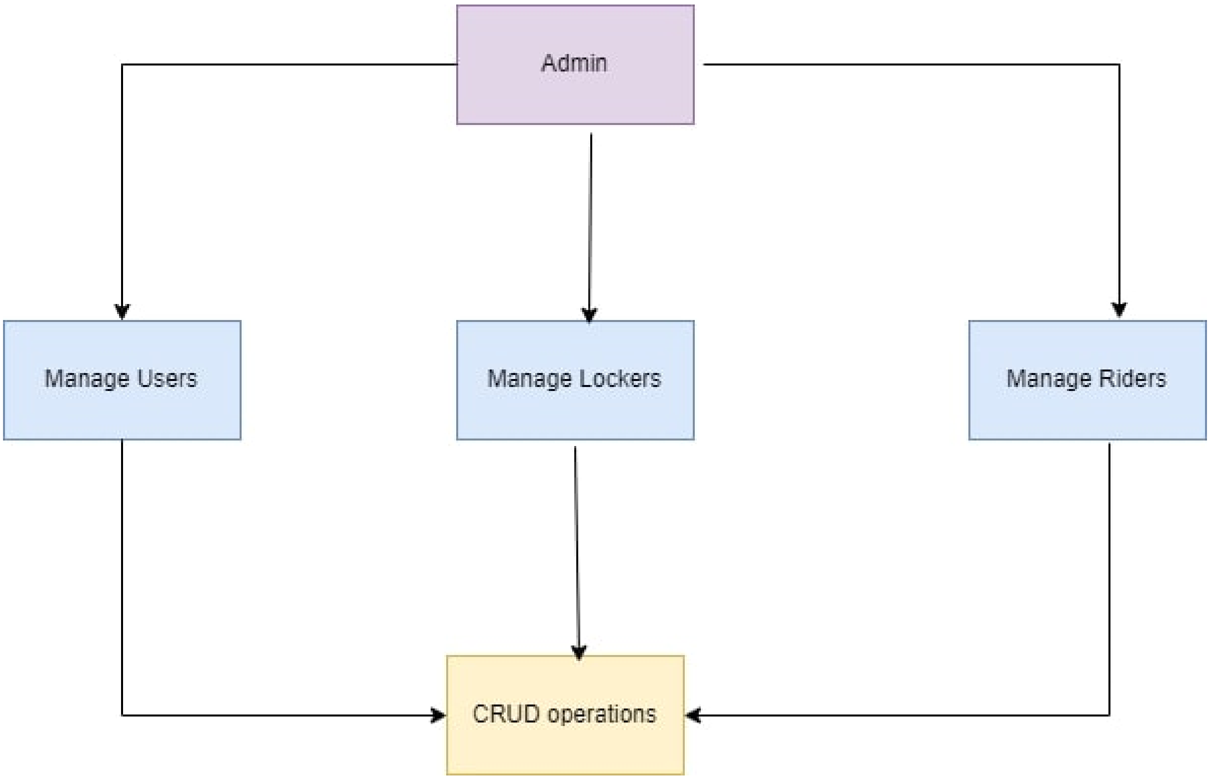

Figure 5.2: Admin Architecture Diagram

The admin will have the following features

- Manage Lockers
- Manage Riders
- Manage Users

5.3.1.2 Users

The users(Sender and Receiver) will have following features

- Reserve Compartment
- Receive Parcel
- Send Parcel

5.4 Architectural Strategies

Following are the architectural strategies we will be using for this project:

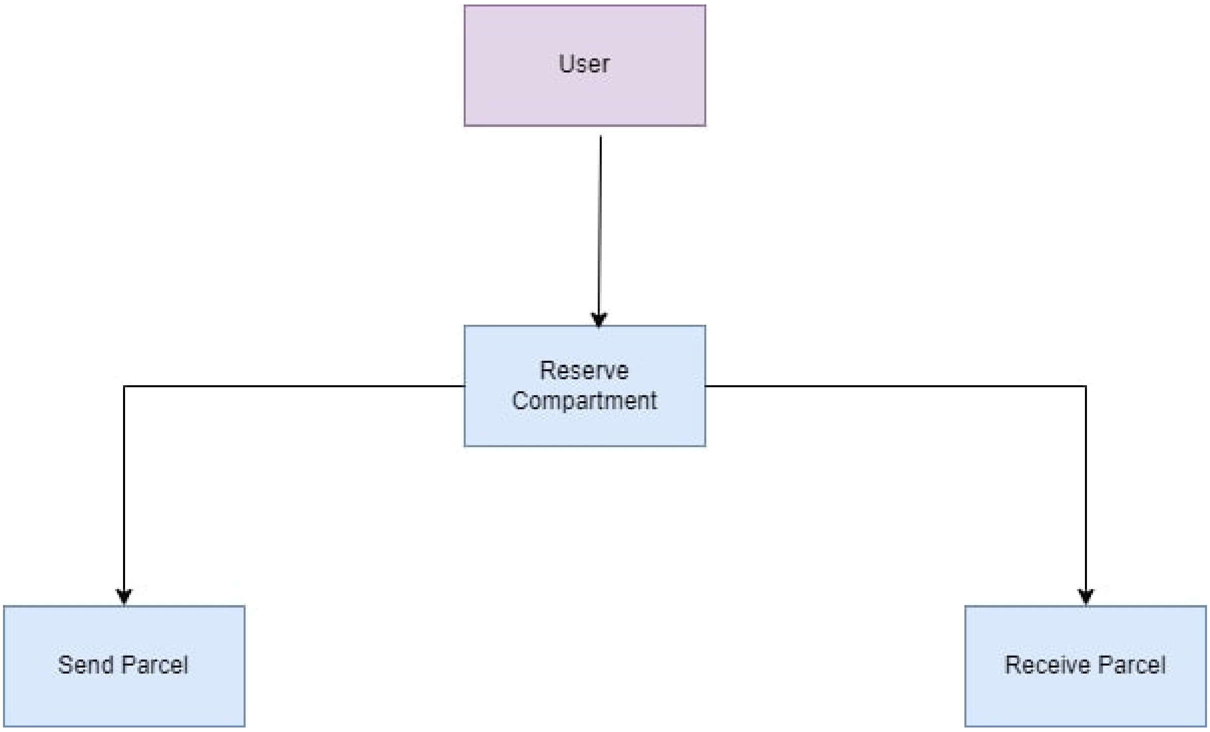

Figure 5.3: User Architecture Diagram

5.4.1 Programming Language

The system shall be using MERN stack technology. The front end will be built in React js and the back end in Node js. For the database, we will be using Mongo DB. We are using the MERN stack as it is better in terms of web development than others as it provides component-based design. It has a robust framework and a huge library collection, saving a lot of time. React js allows for rapid development.

5.4.2 Concurrency and Synchronization

Async operations will be used for back-end queries. This will enable the user to interact with the front end while the back-end system is working.

5.4.3 Error Detection and Recovery

Detecting and handling errors in both front-end and back-end will ensure that the system is reliable. Meaningful error messages will be displayed to the user. Any errors will be added to the logs for analysis.

5.4.4 Interface Paradigms

The interface employed in this system will prioritize simplicity and user-friendliness, ensuring accessibility for users of all levels of expertise. Each functionality defined will be thoughtfully crafted to provide meaningful and intuitive interactions, enhancing the overall user experience.

5.4.5 Communication Mechanism

The system uses APIs to ensure seamless communication with external systems like service providers (SPs) and delivery boxes for sending and receiving parcel data. These APIs provide compatibility and scalability, enabling integration with various third-party services.

5.5 Domain Model/Class Diagram

In this subsection, add the Class Diagram of your system. Class diagrams represent the structure design of your system.

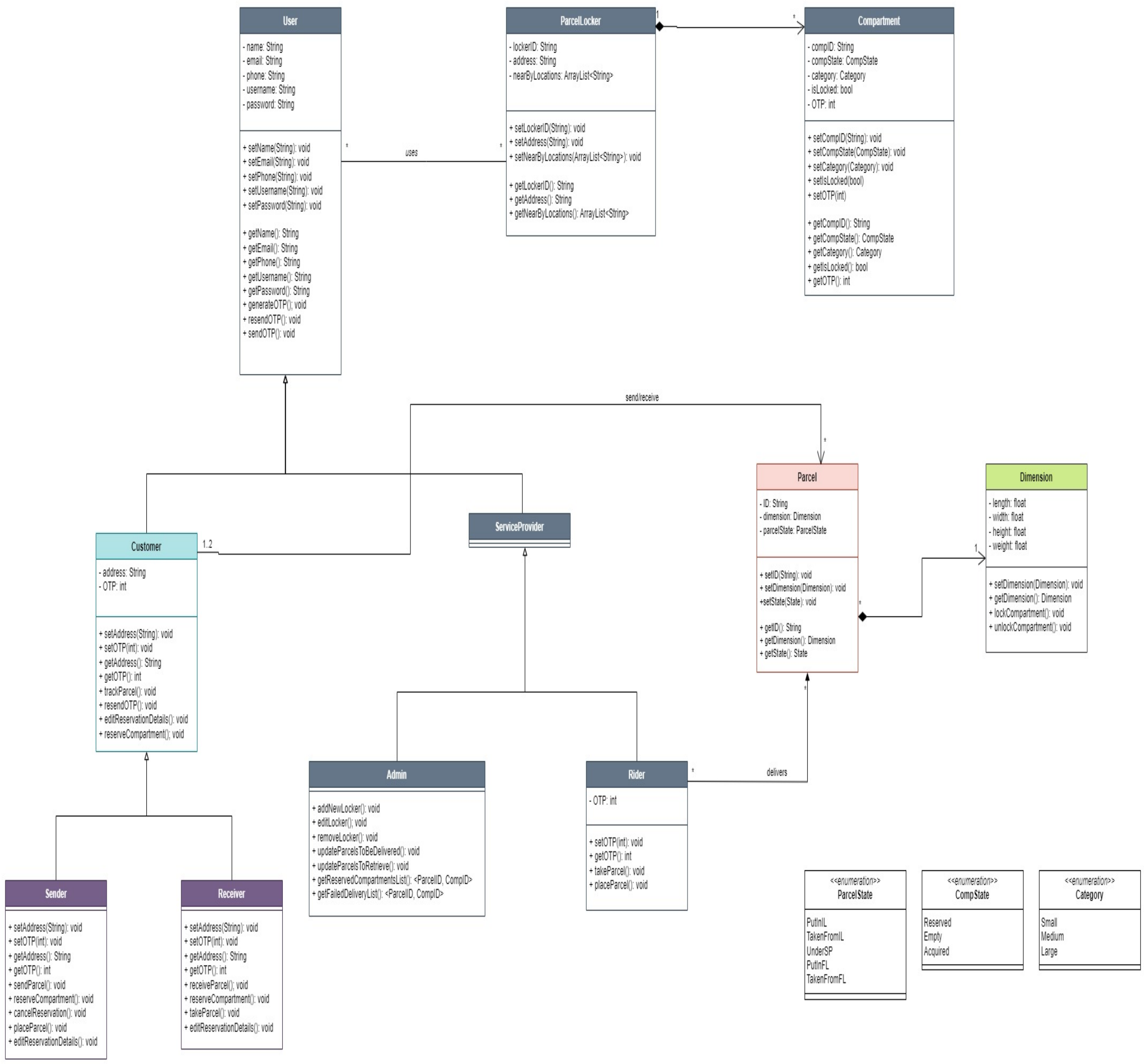

Figure 5.4: Class Diagram

5.6 Policies and Tactics

5.6.1 Conventions and Coding Guidelines

Proper coding guidelines regarding MERN stack will be used so the code is easily understandable. Proper programming conventions will be used. Proper comments in the code will be added for easy understanding and future maintenance. This will give a proper flow for the project.

5.6.2 Coding Environment

The coding environment we will be using for our project is VS code. As it has an editor, compiler, and interpreter all together built into it. It also has huge support, tools, packages, and extensions. It has an auto-indentation feature and also provides suggestions for syntax which makes development easy.

5.6.3 System Testing

We will be using both white and black box techniques for testing different modules of the project. Before deploying, we will thoroughly test every aspect to avoid any errors.

5.6.4 Maintenance of Software

After the completion of the project, this will be easy to maintain.

5.6.5 Extensibility

The system's extensibility will be kept in mind. This will allow to add new features in the future. For this, we will use a modular approach and micro services for every part.

Bibliography

[1] "Postnord - about us." https://www.postnord.se/en/about-us/. Accessed: 2024-10-09 14:00.

[2] "Budbee - about us." https://budbee.com/about-us/. Accessed: 2024-10-09 14:00.

[3] "Posti - about us." https://www.posti.fi/en. Accessed: 2024-10-09 14:00.

[4] "Dhl parcel lockers." https://lot.dhl.com/everything-you-need-to-know-about-parcel-lockers/. Accessed: 2024-10-09 14:00.

[5] "Amazon locker service." https://www.amazon.com/gp/help/customer/display.html?nodeId=GRQMENKQV9RQ6BWF. Accessed: 2024-10-09 14:00.

[6] "Inpost - uk locker service." https://inpost.co.uk/. Accessed: 2024-10-09 14:00.

[7] "Ups locker service." https://locations.theupsstore.com/ny/jericho/471-n-broadway/locker-service. Accessed: 2024-10-09 14:00.