FC6P01 Project

Interim Report

Online Train Seat Reservation System

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Declaration

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Dedication

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Thank you.

Abstract

The online railway seat reservation system project endeavors to revolutionize the railway industry by introducing an efficient and user-friendly digital platform. The main objectives of this system are to enhance the passenger experience, optimize revenue, and streamline railway operations.

The system will offer an easy-to-use ticket ordering process that enables users to look up available trains, select their favorite seating locations, and make secure online payments in order to create an enhanced passenger experience. The integration of real-time train tracking tools will inform passengers of the status, schedules, and any potential delays.

Effective Train Tracking is a top priority. Any schedule modifications or disruptions would be promptly announced to passengers, guaranteeing a hassle-free journey.

Through customized passenger profiles, where customers may store their preferences, view booking history, and take part in a loyalty program, streamlined passenger management will be made possible. The system will also provide thorough customer service channels to quickly respond to guest inquiries.

The system will offer priceless insights through real-time data on revenue streams, which will assist the railway corporation in making educated decisions about pricing, marketing, and promotional initiatives. Revenue Optimization is a crucial component.

The system will be built to allow future expansions, extra features, and changing passenger demands because scalability and adaptability are important factors, and doing so will ensure its relevance and utility in the long run.

The project's scope is divided into three main sections: train tracking, passenger management, and ticketing. The online railway seat reservation system aims to raise overall passenger satisfaction, boost income, and optimize railway operations by smoothly integrating these features, creating new benchmarks for the transportation sector.

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Abbreviations

MERN – MongoDB, Express, React, Node

NPM – Node package manager

API – Application program interface

REST - Representational state transfer

JWT - JSON Web Token

JS – JavaScript

1 Introduction

The development of a train seat reservation web application, intended to address the shortcomings of the Sri Lankan online train seat reservation system, is the focus of this project's research. In order to ensure smooth travel for passengers and maximize the use of available seats, efficient and trustworthy train seat reservation systems are essential for contemporary transportation networks.

It is impossible to overstate the importance of a reliable train seat reservation system. It is essential for increasing passenger comfort and satisfaction and allowing transportation authorities to effectively manage seat occupancy. A more efficient reservation system can shorten wait times, do away with manual procedures, and give passengers real-time updates, making their trip more predictable and enjoyable.

Systems for reserving seats on trains in the past were mainly manual or required actual ticketing counters. Online reservation systems were eventually introduced with the development of technology, offering some level of convenience to travelers. However, these early systems frequently had usability problems and had constrained functionality, which resulted in a number of issues that needed to be fixed.

These days, online reservation systems are more common and advanced. Worldwide, a large number of railway companies have implemented cutting-edge reservation systems that provide real-time seat availability, mobile booking options, and integration with electronic payment methods. However, some nations, like Sri Lanka, still struggle to offer a smooth and user-friendly reservation process.

Looking ahead, incorporating cutting-edge technologies like artificial intelligence and machine learning will be crucial to the success of train seat reservation systems. These developments can enable dynamic pricing, improve seat allocation formulas, and offer tailored travel advice. Passengers' overall travel experience will be improved by seamless integration with other travel services and mobile apps.

The creation of a web application for train seat reservations is an essential step in boosting the effectiveness of the Sri Lankan railway system and offering travelers a convenient booking experience. The application aims to contribute to a more user-centric and effective transport

service by addressing the shortcomings of the current reservation system and taking into account different factors like user experience, real-time updates, and data security. Future developments will ensure that the system stays at the cutting edge of innovation and serves as a model for contemporary train reservation systems as technology continues to advance.

1.1 Aim & Objectives

1.1.1 Aim

The aim of this project is to develop a train seat reservation web application that addresses the drawbacks of the existing Sri Lankan online train seat reservation system. The application aims to provide a user-friendly, efficient, and reliable platform for passengers to reserve train seats seamlessly, thereby enhancing the overall travel experience.

1.1.2 Objectives

The primary objective of the online railway management system project is to improve the overall passenger experience and optimize operational efficiency for the national railway corporation. The system aims to achieve the following specific objectives.

1. Enhanced Passenger Experience: The system provides a user-friendly and useful platform for booking tickets, tracking trains, and accessing trip information in an effort to increase consumer satisfaction, convenience, and involvement. Passengers can easily check for available trains, select their preferred seating, and make secure online payments.

2. Efficient Train Tracking: The system will make it possible to track trains in real-time, including their locations, times of departure and arrival, and any delays or alterations to the timetable. Passengers will have easy access to this information via the website and mobile app, enabling them to better plan their journeys and stay updated on the status of their train.

3. Streamlined Passenger Management: Effective management of passenger information, including personal information, booking history, and status for loyalty programs, will be made simpler by technology. Passengers will have the option to set up profiles, record preferences, and collect points for frequent travel. We'll mix email, chat, and phone customer service channels to aid and promptly address inquiries

4. Revenue Optimization: The system will provide revenue management capabilities that will give the company control over ticket prices, promotions, and discounts. Real-time information on revenue streams, expenses, and passenger preferences will allow the organization to maximize revenue generation, improve financial planning, and promote corporate growth.

5. Scalability and Adaptability: The system will be developed to accommodate both potential expansion and the escalating demand for railroad services. It will be scalable to handle several concurrent users and adaptable to add new features, routes, and service expansions. The system will also facilitate interface with external APIs and systems to further its capability and reach.

The online railway management system will establish the national railway company as a market leader by accomplishing these goals and providing an effective, customer-focused, and technologically cutting-edge railway service.

1.2 Motivation

The Sri Lanka Railway, which connects various areas of the nation and offers millions of passengers a convenient and affordable mode of transit each year, is an essential transportation service. However, there are a number of issues with the current Sri Lanka Railway seat reservation system that have annoyed and irritated travelers.

The motivation behind this proposed software project is to provide a solution to these drawbacks and develop a more efficient and convenient seat reservation system for the Sri Lanka Railway.

By developing an online seat reservation system, passengers will be able to reserve seats conveniently from anywhere and anytime, eliminating the need to stand in long queues at railway stations. Additionally, the system will provide real-time updates on seat availability, allowing passengers to make informed decisions when reserving their seats.

Our proposed software project aims to provide a user-friendly interface that enables passengers to reserve seats easily and make changes or cancellations to their reservations quickly. The system will also provide valuable data to the Sri Lanka Railway, enabling them to optimize their operations and services to improve the travel experience for passengers.

The inspiration for this project came from the effective use of seat reservation systems in nations like Switzerland. Numerous advantages may be attained, addressing the following crucial criteria, by implementing a comparable approach in Sri Lanka (raileurope, n.d.)

The seat reservation system will provide passengers with the flexibility to choose their preferred seats based on individual preferences. Passengers will have the option to select window or aisle seats, travel with their families or groups, and have a personalized journey experience. This level of customization will enhance passenger satisfaction and cater to diverse travel needs.

The scenic beauty and rich cultural history of Sri Lanka make it a popular tourist destination. The nation may further improve its attraction to tourists by implementing a cutting-edge seat reservation system. Visitors' entire travel experiences will be enhanced by the system, which will make it easier for them to easily organize their rail trips and tour the nation. The expansion of the tourist sector and the overall economy will be aided by this.

Improving the overall passenger experience is the main driver behind the implementation of a seat reservation system. The demand for Sri Lanka's train network is significant, particularly during the busiest travel times and on popular routes. The solution will reduce the anxiety and uncertainty related to locating available seats by enabling users to book particular seats in advance. The guarantee of a reserved seat will make the trip for passengers more relaxing and pleasurable.

The seat reservation system will enable more effective management of the resources that are available for trains. Train operators can maximize train capacity and equally distribute passengers across carriages by assigning particular seats to customers. Through this optimization, operational effectiveness will increase, congestion will decrease, and the boarding process will run more smoothly.

Passengers' booking processes will be made easier by the adoption of a user-friendly and accessible seat reservation system. Passengers may quickly make reservations using internet resources or mobile apps, doing away with the necessity for protracted lines at ticket desks. The simplified procedure will result in time savings for both passengers and train workers, making the ticketing process more effective and convenient.

1.3 Problem

The shortcomings of the current Sri Lankan online train seat reservation system are the issue that I'm trying to fix with this project. The current reservation system has poor usability, few real-time updates, and a lengthy booking procedure. These flaws cause passenger annoyance, frustration, and ineffective seat distribution. As a result, passengers may find it challenging to reserve seats for their preferred travel dates, and the railway operator may find it challenging to effectively maximize seat occupancy.

The reservation system's limitations in this area make it difficult for the railway operator to give customers a smooth and straightforward booking experience. Travelers find it difficult to effectively plan their trips due to the lack of real-time seat availability updates, which can create uncertainty and potential inconvenience during busy travel periods. Additionally, the lack of a user-centric design and contemporary features lowers customer satisfaction and makes the service less competitive when compared to other transportation options.

I'll create a web application that prioritizes user experience, efficiency, and accuracy to solve these problems. Passengers will be able to make well-informed booking decisions thanks to the application's inclusion of real-time seat availability updates. The application aims to provide a

superior solution to the shortcomings of the current system by streamlining the booking process, implementing secure payment options, and offering a user-friendly interface.

In the upcoming development process, I will focus on creating a robust and reliable system that overcomes the current limitations and provides an optimized booking experience for passengers, benefiting both travelers and the Sri Lankan railway operator.

2 Background Study

An overview of recent studies and research on web-based applications and train seat reservations is provided in the literature review. In order to address the shortcomings of the Sri Lankan online train seat reservation system, the review aims to identify key findings, best practices, and pertinent methodologies.

2.1 Literature Review

History

The historical development of train seat reservation systems, tracing their evolution through different eras and stages. This review highlights how reservation systems have evolved from manual processes to sophisticated online platforms, shedding light on the past, present, and future trends in the field.

The first reservations for train seats were made in the late 19th century. Initially, all reservations were made manually, requiring travelers to physically go to ticket booths or train stations in order to reserve seats for their trips. Limited technology and a lack of organized procedures during this time period resulted in inefficiencies and lengthy wait times for passengers.

The late nineteenth century saw few technological advances, and reservation processes were mostly paper based. Passengers were required to interact with railway personnel in order to inquire about seat availability, select their preferred seats, and manually record the details in reservation ledgers (D.Lancien, 1994). This method was time-consuming and frequently resulted in long wait times for travelers.

This era's manual reservation systems lacked standardized practices and organized methods. The procedure heavily relied on manual record-keeping, which made it susceptible to mistakes, overbooking, and inconsistencies (Qing He, 2022). Passengers frequently had little access to real-time seat status due to the manual updating of seat availability information by railway staff.
Due to the lack of advanced communication methods, passengers had to physically visit ticket

counters to secure seats, sometimes well in advance of their departure dates. This caused problems, especially during high travel seasons or while travelling large distances. Furthermore, the lack of digital record-keeping made it difficult for passengers to readily change or cancel reservations. To manage reservations and deliver information to passengers, manual reservation systems relied primarily on the presence and availability of railway staff. The process's reliance on humans led in seat distribution delays, inaccuracies, and discrepancies.

The early manual reservation methods laid the groundwork for present train seat reservation procedures. While these systems were the forerunners of seat allocation, they were plagued by inefficiencies, hassles, and a strong reliance on manual operations. The constraints of this era paved the way for subsequent technology improvements that resulted in computerized and online reservation systems that we see today. The progression from these early manual methods to today's digital platforms indicates a continual endeavor to improve user experiences, operational efficiency, and convenience in railway travel.

Computerized Reservation Systems

The introduction of computerized reservation systems marked a watershed moment in the evolution of train seat reservations. This period, which began in the latter half of the twentieth century, saw significant improvements in the efficiency and accessibility of booking processes. Computerized reservation systems transformed how passengers interacted with railway services, moving from manual to semi-automated processes.

The installation of early computer systems, which allowed railway operators to record and manage seat availability data electronically, was a seminal breakthrough during this era. This marked a change from previous paper-based approaches and provided a centralized store for reservation information. Passengers could visit train stations and interact with computer terminals to view real-time seat availability and make reservations.

Computerized reservation systems provided numerous significant advantages over human operations. The decrease of human errors and inconsistencies in booking records was one of the most significant benefits. Automation reduced the risks of overbooking, double-booking, and data

transcription errors, resulting in higher customer satisfaction and greater operational efficiency (Raheem & Olowu, 2012).

The ability to manage reservation data centrally provided railway operators with greater control over seat distribution and increased reporting capabilities. This enabled them to optimize seat occupancy, manage resources more efficiently, and respond to swings in passenger demand more effectively. The solutions improved overall resource management by better tracking seat availability across different routes, classes, and travel dates.

The user interfaces of computerized reservation systems improved as computer technology matured. User-friendly interfaces were created to make it easier for passengers to explore and interact with the systems. The emergence of graphical user interfaces (GUIs) and simplified input techniques lead to a more intuitive and seamless booking experience (Sun, et al., 2020).

While computerized reservation systems were a considerable advancement, terminal access still required human presence at train stations. This limitation prompted a shift towards fully online reservation services, which would allow passengers to access seat availability and make bookings from the comfort of their own homes.

The advent of computerized reservation systems was a watershed moment in the evolution of train seat reservations. Electronic data management, semi-automation, and enhanced user interfaces paved the door for more efficient and accurate booking operations. This phase established the framework for the later transition to online reservation systems, which would further revolutionize the seat reservation scene by making it more accessible and easier for passengers.

Online Reservation Systems

The use of ICT applications, particularly the Internet, varies between socioeconomic classes, and this variance contributes to the "digital divide," which is the difference in access to and utilization of ICTs on the basis of economic and social factors.

According to (Norris, 2001) the digital gap is a multifaceted social phenomenon that represents social divisions in a variety of areas of the information society. According to (J.E. Katz, 2001), there are considerable inequalities in access to the Internet based on factors such as sex, household income, age, education, and race. Men in Latin America use the internet more frequently than women, according to (T.J. Gray, 2016) research. Age, household income, and education are all related to differences in internet use, according to (Pew, 2015). Particularly, the digital divide is a continuation of social and economic inequality. Using young people as an example, (J. Peter, 2006) found that younger people with higher socioeconomic status use the Internet more frequently than younger people with lower status. They also use the Internet for different things, as evidenced by the fact that those with higher education levels and more affluent backgrounds frequently use the Internet as a tool to advance their social, financial, political, and cultural standing, whereas those without frequently view it as a toy for online entertainment and distraction (E. Hargittai, 2008). Additionally, problematic Internet use encourages risky online behaviors (A. Rial, 2018).

The advent of the internet in the late twentieth century caused a seismic upheaval in train seat reservation systems, ushering in the era of online reservation platforms. Online reservation systems transformed the way customers interacted with railway services, allowing them to book seats and plan their journeys in a seamless and simple manner. The transition from manual and semi-automated methods to online platforms was a big step forward in the efficiency and accessibility of train seat reservations.

With the introduction of online reservation systems, there was a clear emphasis on user-centered design and convenience. Railway companies recognized the need of providing passengers with user-friendly interfaces that allowed for simple navigation, seat selection, and booking. The user-centric strategy intended to reduce the complexities associated with manual and computerized

processes, making the reservation process simpler and more accessible to a wider audience.

The usability of modern online applications is prioritized, ensuring that consumers can easily navigate through the booking process. These applications use responsive design concepts to adapt to different devices and screen sizes, ensuring a consistent and ideal experience for passengers. Furthermore, real-time updates on seat availability are a feature of current online applications. Emphasize the need of synchronized databases and effective data integration in providing correct and up-to-date seat information to passengers. This real-time tool enables travelers to make educated booking decisions, boosting satisfaction and decreasing uncertainty. (A. Gunasekaran, 2008)

Modern web apps and smartphone booking have transformed how passengers engage with train seat reservation systems. This section examines how technology improvements have revolutionized the reservation experience by offering travelers with ease, accessibility, and real-time information. Modern web apps have played a critical role in improving the user experience of train seat reservation systems. These programs have various advantages, including intuitive user interfaces, responsive designs, and real-time seat availability updates.

Online reservation systems brought real-time seat availability updates, allowing travelers to examine up-to-the-minute information on available seats (Rajesh Ittamalla, 2021). This tool enabled travelers to make more informed decisions regarding their tickets, boosting the whole booking experience. Passengers no longer had to rely on outdated information or visit physical stations to verify seat availability, resulting in enhanced satisfaction and decreased uncertainty.

The use of secure online payment channels has become a cornerstone of online reservation systems (Renata, 2018). Railway companies put in place strict security measures to secure passengers' financial and personal information during the booking and payment process. Secure transactions inspired trust in travelers, encouraging them to utilize online platforms for bookings and thereby contributing to the broad use of online reservation systems. Passengers may reserve seats from the convenience of their own homes, offices, or while on the go, eliminating the requirement for physical presence at ticket booths or train stations. Furthermore, these technologies improved train operators' operating efficiency by automating seat allocation, decreasing paperwork, and enabling greater resource utilization. (Guan, et al., 2020)

The switch to online reservation systems was a watershed milestone in the history of train seat reservations. These technologies delivered a more efficient, easy, and pleasurable booking experience for passengers by emphasizing user-centric design, real-time updates, secure payments, and greater accessibility. The success of online reservation systems indicates the railway industry's flexibility to technology changes, paving the door for future improvements in train travel.

Mobile Apps

In order to meet the needs of travelers who are constantly on the go, mobile booking apps have emerged as a game-changer in train seat reservation systems. Passengers can make seat reservations and manage bookings using these apps, which provide unmatched ease. Investigate the application of mobile payment and booking technologies. They draw attention to the ease with which travelers can reserve seats through mobile apps at any time and from any location. Passengers find it simpler to finish their bookings while they are on the go thanks to the seamless integration of mobile payment channels.

Additionally, mobile apps support greater accessibility, particularly for audiences that are tech-savvy and reliant on smartphones. The ability to use smartphones to check seat availability, make selections, and get e-tickets directly improves the whole travel experience and does away with the need for paper tickets. Train seat reservation systems have been changed into practical, approachable, and accessible platforms thanks to modern web applications and mobile booking. The whole reservation experience has improved as a result of the focus on user-centric design, responsive interfaces, and real-time updates. This convenience is increased by the incorporation of mobile apps, which let mobile users easily book seats and plan their trips. These developments are expected to influence the development of train seat reservation systems in the future, bringing passengers even higher levels of comfort and accessibility.

Future

Future trends and technical developments are anticipated to affect how passengers engage with these systems as they continue to develop, improving the entire travel experience. With the use of pertinent research and studies, this section examines some of the upcoming advancements in reservation technology.

Train seat reservation systems stand to benefit significantly from artificial intelligence and machine learning. For optimal seat distribution, these systems can assess historical data, passenger preferences, and travel patterns. AI-driven algorithms may be able to dynamically alter pricing based on demand, maximizing occupancy and earnings. Passengers may receive personalized travel advice from AI-powered systems based on their past travel preferences and patterns. These suggestions may include preferred seat configurations, suggested travel paths, and even suggested ideal departure times to improve the overall trip. Dynamic pricing proposes that ticket costs should be changed in response to variables such as demand for travel, the amount of time till departure, and seat availability. Passengers can be encouraged to travel at off-peak hours using this tactic, which can also increase revenue and optimize occupancy. The security and transparency of reservation systems could be improved by block chain technology. A safe and reliable booking procedure is ensured by block chain, according to research by (Rani, et al., 2021).

Passengers may receive complete travel solutions through the integration of train seat reservation systems with other mobility services like ride-sharing networks and public transportation systems. This integration can facilitate smooth multi-modal travel and improve trip planning. The development of artificial intelligence, predictive analytics, dynamic pricing, and block chain technology will open up intriguing new possibilities for train seat reservation systems. With the help of these trends, train operators will be able to maximize seat occupancy and income while providing passengers with more personalized, effective, and secure reservation experiences. These advancements are anticipated to change the face of rail travel as technology develops, making it more available, practical, and appealing to passengers around the world.

User Experience and Design

The topic below attempts to highlight significant discoveries, best practices, and pertinent approaches that can guide the creation of a train seat reservation web application.

User Experience (UX) is a crucial component of online reservation systems that focuses on developing a streamlined, simple, and easy-to-use interface for passengers to utilize while making seat reservations. A good user experience boosts client satisfaction, promotes return visits, and helps the reservation system succeed overall. The user experience in online reservation systems has been examined in a number of researches from different angles. Intuitive navigation, standout call-to-action buttons, and neatly organized information displays are just a few examples of the simple, obvious design aspects that researchers have stressed are important (Bilgihan, et al., 2013). A visually appealing and user-centric design reduces user annoyance and mistakes through the effective use of color schemes, typography, and visual signals. Utilizing a user-centered design approach entails soliciting user input and carrying out usability testing to pinpoint problems and potential areas for enhancement in the reservation process. In order to successfully address user needs, the design process is guided by understanding user behaviors and preferences through the use of user personas and journey maps.

The reservation system must be tailored for mobile screens given the increase in usage of mobile devices. According to (Idyawati, et al., 2010) , having a mobile-responsive website guarantees a consistent and pleasurable booking experience on all devices. Enhancing user satisfaction and lowering booking abandonment requires streamlining the interaction flow by reducing the number of steps necessary to complete a booking and giving visible progress indicators.

Users are reassured and have less uncertainty during the reservation process when they receive immediate feedback on their actions, such as successful seat selection or payment confirmation. Users can avoid mistakes and are guided towards successfully completing their bookings via the implementation of error prevention measures, such as validation checks and clear error notifications.

The user experience can be improved by making the booking process more specialized and pertinent by providing personalized recommendations based on customer preferences, travel history, and seating alternatives. To avoid user annoyance and guarantee a seamless booking experience, quick loading times and timely interactions are crucial. By including accessibility elements in the reservation system's design, it may be used efficiently by people with disabilities, fostering inclusivity.

A multifaceted notion, user experience in online reservation systems includes design, usability, interaction flow, and user-centered concerns. These guidelines can help reservation systems design more user-friendly and effective platforms for railway seat reservations, which will ultimately lead to higher client satisfaction and a successful system adoption.

By guaranteeing optimal seat allocation to customers while maximizing revenue and maintaining passenger happiness, optimization algorithms play a significant role in improving the effectiveness of train seat reservation systems. These algorithms use a variety of data, including passenger preferences, demand trends, train capacity, and dynamic pricing, to allocate seats intelligently and sensibly. The research by (Zhang, et al., 2022) is one noteworthy study in this field. A seat allocation algorithm based on a genetic algorithm strategy was suggested. The process of natural selection, in which potential solutions develop over generations to find the best one possible, served as the inspiration for genetic algorithms, which are optimization techniques. While considering passenger preferences for various seat categories (such as window and aisle), the researchers concentrated on increasing seat occupancy and revenue.

To choose the best seats for each train trip, their algorithm considered past reservations, passenger preferences, and restrictions on train capacity. In comparison to conventional methods, they were able to increase seat occupancy rates and revenue generation by using the genetic algorithm approach. This study showed how well-suited optimization algorithms are for increasing seat utilization while considering passenger preferences.

Dynamic pricing models are another important area of study. In train seat reservation systems. Using dynamic pricing, ticket prices can be changed in response to various conditions, including demand, the time of purchase, and seat availability. Railway operators can maximize profits by using dynamic pricing algorithms to encourage customers to make reservations during off-peak

periods or when there are extra seats available.

To increase seat occupancy, revenue, and passenger satisfaction, train reservation systems' optimization algorithms for seat allocation are crucial. These algorithms employ strategies like dynamic pricing models and genetic algorithms to allocate seats intelligently based on various variables. The aforementioned studies demonstrate how optimization algorithms improve the effectiveness and efficiency of train seat reservation systems, which is advantageous to both passengers and railway operators.

2.2 Similar Systems

Features and Functionalities	System 1	System 2	System 3	Own Solution
E-ticketing	✓	✓	✓	✓
Real-time seat availability		✓		✓
Dynamic pricing			✓	✓
Train seat availability	✓			✓
Rewards program			✓	✓
Seat selection	✓	✓		✓
Delay Notification				✓
Revenue Management	✓			✓
Loyalty Program		✓		✓

Table 1 Similar Systems

Real-time updates, dynamic pricing, and tailored recommendations are the main components of the suggested solution, which aims to provide a seamless and user-centric booking experience.

It provides features including a mobile application connection, an interactive seat map, and a thorough admin dashboard.

The focus on personalized recommendations and dynamic pricing distinguishes the suggested solution by maximizing user choices and improving revenue generation.

The current systems provide a mixture of practical and user-friendly user interfaces, with varying degrees of integration with mobile applications and local transit systems.

By fusing user-centric design with cutting-edge functionalities, the suggested solution seeks to close the gap and establishes itself as a serious contender for revolutionizing the process of making train seat reservations.

The proposed train seat reservation web application ultimately aims to capitalize on the advantages of current systems while introducing cutting-edge features specifically designed for the Sri Lankan context, creating a cutting-edge, effective, and user-friendly platform for passengers.

2.3 Proposed Solution

The proposed system for the online train seat reservation system aims to address the drawbacks of the existing manual system and revolutionize the way railway operations are managed. By leveraging modern technology and automation, the proposed system will offer a range of functionalities to enhance the passenger experience, streamline operations, and improve overall efficiency.

Online Ticket Booking: Passengers will benefit from the proposed system's convenient and approachable online ticketing system. The ability to look up available trains, pick desired departure and arrival times, select seating options, and make secure online payments will all be available to passengers. By streamlining and automating the ticket purchasing process, customers will experience greater convenience overall by having shorter wait times and without having to physically visit ticket desks.

Real-Time Train Tracking: The proposed system will include real-time train tracking features that will give users access to precise and current data on train whereabouts, schedules, and any delays or adjustments. Through the system's website or mobile app, passengers will be able to track their trains in real-time, ensuring that they are aware of any disruptions and enabling them to plan their journeys more effectively.

Passenger Management: The proposed system will make it easier to manage passenger information effectively, including personal data, booking history, and status with loyalty programs. The ability to create profiles, save preferences, and view travel records will be provided to passengers. This will make it possible to provide individualized services and expedite communications between passengers and the railroad company. The system will also include customer service channels including email, chat, and phone to help passengers with inquiries and deliver prompt assistance.

Revenue Management: The suggested system will have functions for revenue management to

maximize income generation for the railroad organization. Real-time data on ticket sales, special offers, and price reductions will be provided, allowing for well-informed pricing and marketing decision-making. The system will produce thorough information on income sources, costs, and traveler preferences to assist with financial planning and forecasting.

Automated Notifications and Alerts: The suggested system will automate the procedure of notifying and alerting travelers to their reservations, modifications to train schedules, and any other pertinent information. Passengers will receive automated emails or push notifications to keep them informed and updated about their journeys.

Reporting and Analytics: The suggested solution will provide thorough reporting and analytics capabilities. It will produce data on revenue, ticket sales, passenger demographics, and other important performance metrics. These reports will support the railway corporation's data-driven decision-making, performance evaluation, and strategy planning.

The proposed train seat reservation online application intends to revolutionize the passenger booking experience by integrating these features while also offering the Sri Lankan railway operator a cutting-edge, effective, and competitive reservation system. Dynamic pricing, personalized recommendations, and real-time updates are all integrated into the program to keep it at the forefront of innovation, providing users with a better travel experience and fostering the expansion of the transportation industry.

3 Work Completed

This intermediate report provides a thorough summary of the development of the ground-breaking train seat reservation web service. We highlight the important steps made in resolving the shortcomings of the current Sri Lankan online train seat reservation system as we near 40% completion of this transformational project. This study summarizes the enormous efforts put forth in creating and executing crucial functions that have the potential to completely alter the passenger booking process. By highlighting the successes made thus far, we provide a look into the bright future of a more user-centric, effective, and sophisticated reservation system that is on the fast track to revolutionizing the transportation industry.

3.1 Project Management

Project Initiation

The project initiation phase for the Train Seat Reservation Web Application involves laying the groundwork for a comprehensive and insightful report that highlights the progress and achievements of the ongoing development. The primary objectives of this phase are to define the scope of the interim report, establish key stakeholders, and set the initial plan for content creation.

The Project Initiation phase ensures a clear roadmap for developing a comprehensive and informative report that effectively communicates the progress, achievements, and future direction of this project.

Planning

In the planning phase, thoroughly examined the drawbacks of the existing system, outlining the reasons for choosing the Agile methodology, specifically Scrum, for project management. This phase also saw the creation of a comprehensive project charter, which defined the mission, goals, scope, and stakeholders of the train seat reservation system.

Project Execution

With the project plan in place, the execution phase commenced. The Agile approach, particularly Scrum, was implemented, breaking down tasks into sprints for iterative development. The team conducted daily stand-up meetings to track progress, address any impediments. This phase involved the actual development of the system, integrating advanced technologies such as mobile devices, cloud computing, and location-based services.

Project cost planning

The project cost planning phase for this project involves estimating and managing the financial resources required to develop and deliver the project. It ensures that the project remains within budget while delivering a high-quality solution.

The Project Cost Planning phase ensures that financial resources are allocated wisely and managed effectively throughout the project development. By estimating costs, allocating budgets, tracking expenses, and implementing cost management strategies, this phase contributes to the successful completion of the project while maintaining financial discipline.

Project closure

As the development phase concluded, the project moved into the closure phase. Finalized all project deliverables, ensuring that the train seat reservation system met the defined objectives and scope. A thorough review was conducted to ensure the system's quality and completeness. This phase also involved evaluating the project's performance against initial objectives and gathering feedback from stakeholders for further enhancements.

Project Charter

The project charter played a pivotal role in the planning phase. It provided a comprehensive overview of the train seat reservation system, outlining its purpose, objectives, scope, stakeholders, risks, and a high-level timeline. This document served as a guiding compass throughout the project, ensuring alignment among team members and stakeholders.

In the realm of project management, various theories and methodologies offer structured approaches to successfully execute projects. For the development of the, the project management approach adopted was the Agile methodology, specifically Scrum. This choice was made based on the project's nature, requirements, and goals.

Agile methodologies, including Scrum, emphasize flexibility, adaptability, and iterative development. Given the dynamic and evolving nature of technology projects, Agile aligns well with the need for continuous feedback and adjustments. Scrum's framework divides the project into time-bound iterations known as sprints, allowing for regular evaluation and refinement.

The decision to use Scrum was driven by the following considerations.

1. Iterative Development
2. User-Centric Approach
3. Rapid Response to Changes
4. Transparency and Communication
5. Mitigation of Risk

The project planning was executed as follows.

Backlog Creation

The project's requirements, features, and functionalities were listed in a product backlog. The business value and user requirements were used to prioritize this backlog.

Sprint Planning

Specific tasks from the backlog were planned for each sprint, which usually lasted for two weeks. The sprint backlog listed these tasks in detail.

Daily Stand-ups

Daily stand-up meetings were conducted to ensure team alignment, identify obstacles, and update on progress.

Sprint Review and Retrospective

A review was held to show stakeholders the work that had been completed at the conclusion of each sprint. The team was able to evaluate what went well and what could be improved for the upcoming sprint during the retrospective.

Adaptation

Regular sprint reviews and retrospectives enabled the team to refine the project direction based on feedback, enhancing the final product's quality and relevance.

The project team made sure there was a harmonious fusion of accuracy and adaptability by implementing the Scrum methodology. The Agile methodology made it easy to incorporate user feedback and changing requirements, perfectly lining up with the technology's dynamic environment. As a result, the online train seat reservation was successfully created, satisfying the requirements of contemporary practices and improving transport outcomes.

3.2 Initial Project Plan

The Gantt chart displays the activities' sequential sequence, expected completion times, and allocated resources. It aids in the identification of potential bottlenecks and important route jobs, allowing for improved resource allocation and timeline modifications as necessary. The graphic also shows important dates including the completion of the system design, testing stages, and the anticipated launch date.

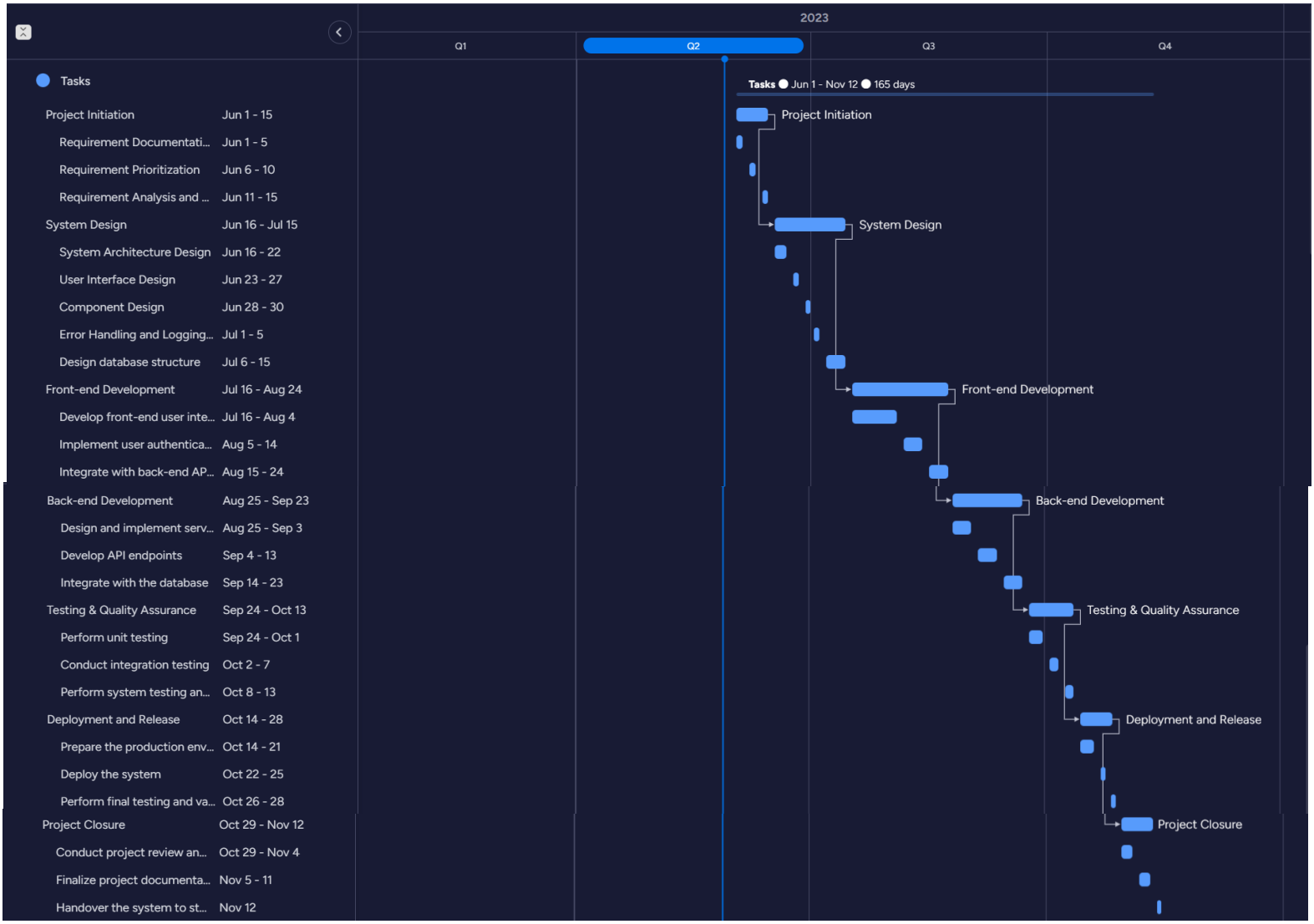


Figure 1 Gantt chart for project plan

3.3 Feasibility study

To evaluate the potential and practicality of adopting the suggested online railway seat booking management system, a feasibility study is necessary. To ascertain whether the project is technically, financially, and operationally feasible, the research examines several factors. Considering the scenario, the following are important feasibility factors.

3.3.1 Schedule feasibility

The scheduling feasibility analysis looks at whether the proposed system can be created and put into use in the allotted amount of time. To show the anticipated schedule for the development and implementation of the online railway seat reservation system, the project has prepared a Gantt chart. The Gantt chart enables efficient project management and tracking of progress by giving a visual depiction of the project's tasks, milestones, and dependencies.

The Gantt chart displays the activities' sequential sequence, expected completion times, and allocated resources. It aids in the identification of potential bottlenecks and important route jobs, allowing for improved resource allocation and timeline modifications as necessary. The graphic also shows important dates including the completion of the system design, testing stages, and the anticipated launch date.

To make sure the project stays on schedule, constant monitoring and progress tracking against the Gantt chart are crucial. Adjustments can be made as required, taking into account any unforeseen difficulties or modifications in the requirements.

May efficiently manage and monitor the development and deployment of the system by using a Gantt chart as a project management tool. Developer can use it as a visual road map to make sure the suggested system is created and put into use in the allotted amount of time.

Development Timeline: assessed the anticipated time needed for system development, testing, and deployment while taking resource availability and technological complexity into account.

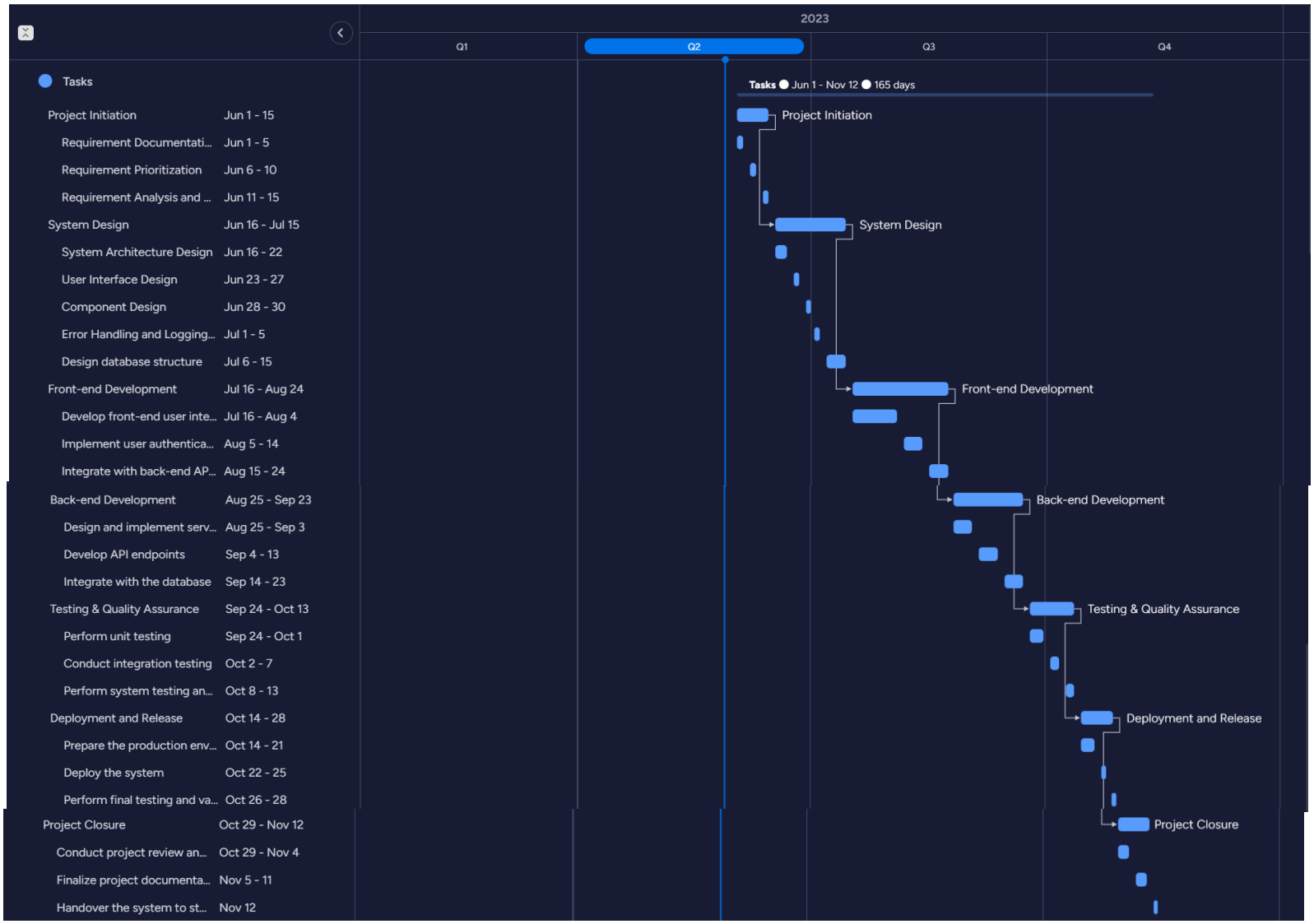


Figure 2 Gantt chart

3.3.2 Technical Feasibility

The system's compatibility with the current infrastructure and the availability of the required technologies and resources are both evaluated by the technical feasibility. The development of a web application as a solution for the existing online seat reservation system using the MERN (Mongo DB, Express.js, React, Node.js) stack is a promising and technically feasible endeavor. The MERN stack offers a comprehensive and modern approach that aligns well with the project's requirements and objectives.

Mongo DB: The flexibility and scalability needed for handling complex data structures in this online reservation system are provided by Mongo DB, a NoSQL database. Its document-oriented structure enables effective data storage and retrieval, accommodating a variety of information about trains, schedules, passengers, and more.

Express.js: The creation of reliable and scalable back-end services is made easier by the Node.js framework Express.js, which is simple to use. Because of its light weight and robust middleware support, it ensures effective routing, HTTP request handling, and component integration.

React: Building dynamic user interfaces is made easy with React, a popular front-end library. Its component-based architecture makes it possible to create reusable user interface elements, improving the efficiency and consistency of application development.

Node.js: The foundation of the entire stack is Node.js, which makes server-side scripting with JavaScript possible. Assuring seamless handling of concurrent connections and data flow, its event-driven, non-blocking I/O model is well suited for real-time applications like railway systems.

To meet scalability needs, the MERN stack is well-suited. Because of its asynchronous capabilities, Node.js is able to effectively handle high loads and concurrent users, resulting in optimal system performance. As the system's user base expands, Mongo DB’s horizontal scaling capabilities enable seamless expansion. The virtual DOM of React also helps to create responsive user interfaces, which improve overall user experience.

Development is sped up by the MERN stack ecosystem's extensive libraries, tools, and resources. The Node.js package manager (npm) provides a sizable repository of pre-built modules that speed up feature implementation. The modular structure of React encourages code reuse, which makes development and maintenance easier.

The utilization of the MERN stack for developing a web application as a solution for the existing railway system demonstrates strong technical feasibility. A reliable, effective, and user-friendly railway management system can be produced using this stack's technology components, scalability, developer productivity enhancements, integration capabilities, and security measures. This project will be successfully implemented if proper planning, architecture design, and best practices are followed.

Software	Version
Mongo DB Compass	V 1.39
Mongo DB	V 7.0
Node	V 19.0
React	V 18.0
Redux	V 4.2.1

Table 2 Technical Feasibility

3.3.3 Operational Feasibility

The system's capacity to achieve operational objectives and its compliance with current business processes are assessed by the operational feasibility. It entails making sure users can use the system to accomplish their goals in an efficient and simple manner. It is crucial to give precise instructions and direction on how to use the online railway seat reservation system. Users should be able to easily browse the system, complete tasks like booking tickets, tracking trains, and managing their profiles. A good user experience can be enhanced through intuitive user interfaces, well-thought out procedures, and helpful tooltips.

The system can concentrate on adding support for several languages in the future to appeal to a wider user base. The system can be more inclusive and accessible to users who prefer or need other language alternatives by providing multilingual capabilities. This improvement would improve usability and meet the society's various language needs.

The system should streamline procedures and increase their efficacy. By examining user feedback and identifying any pain points or potential development areas, the system can be enhanced to reduce manual labor, automate procedures, and improve operational workflow. This may include functions like sophisticated search capabilities, automated notifications, and customized suggestions to provide users with a seamless and efficient experience.

The online railway seat reservation system may give a meaningful solution that satisfies users' demands and supports the organization's operational goals and objectives by focusing on user centric design, usability, and operational effectiveness.

User Acceptance: Assessing the willingness and adaptability of passengers and staff to embrace the online system and providing necessary training and support

Process Integration: Ensured that the new system integrates seamlessly with existing operational processes, such as ticketing, train scheduling, customer support, and reporting.

Performance Improvement: Identified some areas where the system can enhance operational efficiency, reduce manual efforts, and streamline processes for better resource utilization.

3.4 Design

3.4.1 Architectural/ Development model

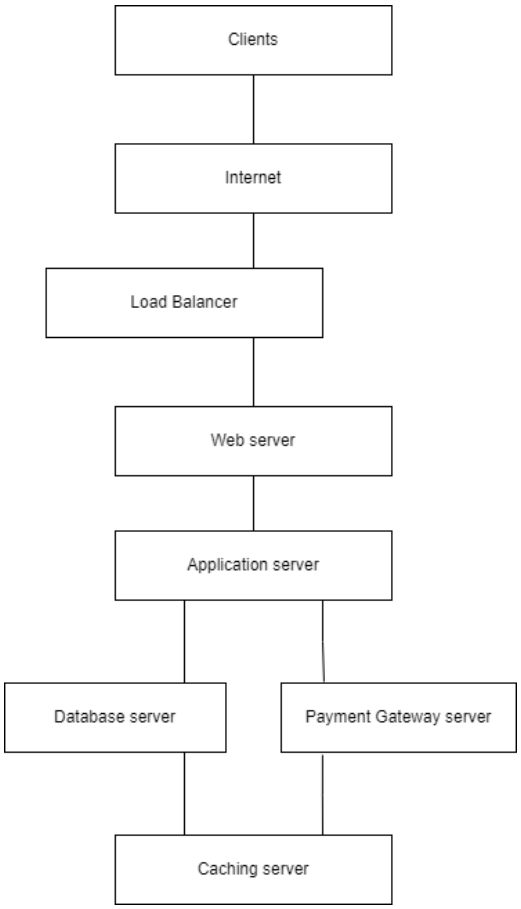


Figure 3 Client-server architecture diagram

Clients

These are the user interfaces that passengers utilize to communicate with the system. Web browsers or mobile applications used for train tracking, ticketing, and other functions are examples of clients.

Load Balancer

Incoming client requests are split across numerous web servers by the load balancer, which serves as a middleman between the clients and the web servers. By distributing the workload evenly and guaranteeing effective resource use, it aids in performance optimization

Web Server

The client-side application is served by the web server, which uses the internet to send the user interface and static web content to the clients. It responds to the initial queries and routes them to the proper components.

Application Server

The system's primary business logic and capabilities are found on the application server. It handles client requests, carries out tasks including train tracking, ticket booking, and passenger management, and retrieves information from the database server.

Database Server

Data from the system, including passenger profiles, reservation details, train schedules, and other pertinent data, is stored and managed by the database server. It manages data retrieval, storage, and administration tasks.

Payment Gateway Server

To securely execute online payment transactions for ticket bookings, this server interfaces with a payment gateway. To handle payment-related actions, it speaks with the application server

Caching Server

To increase performance and lighten the strain on the database server, the caching server saves frequently accessed data or processed results. By providing clients with cached data immediately, it improves system responsiveness and decreases the need for recurrent processing.

3.4.2 Designing diagrams

UML (Unified Modelling Language) diagrams are visual representations that help depict the structure, behavior, and relationships of a system. UML diagrams provide a standardized way to communicate and document various aspects of a system's design and functionality.

3.4.2.1 Use Case Diagram

Figure 4 Use Case Diagram

The goal of the online train seat reservation system is to give passengers a quick and easy way to track trains, order tickets, maintain their profiles, and get pertinent notifications. The system's primary functions are depicted in the use case diagram. By checking seat availability, choosing seats, and processing payments online, travelers can quickly make reservations for tickets. Additionally, they may manage their profiles by adding or updating personal information and checking past bookings, as well as follow the status of trains in real-time, get alerts about confirmations of reservations and delays, and track the real-time status of trains. Administrators, on the other hand, have more control over managing trains by adding, amending, and deleting train details. They can also manage ticketing procedures including refunds, rescheduling, and cancellations. The system enables administrators to produce several reports for booking analytics and revenue analysis. The use case diagram, which highlights the interactions between the players and the functions they can carry out within the online railway administration system, serves as a visual representation of the system's functionality in general.

3.4.2.2 Activity Diagram

Ticket Booking

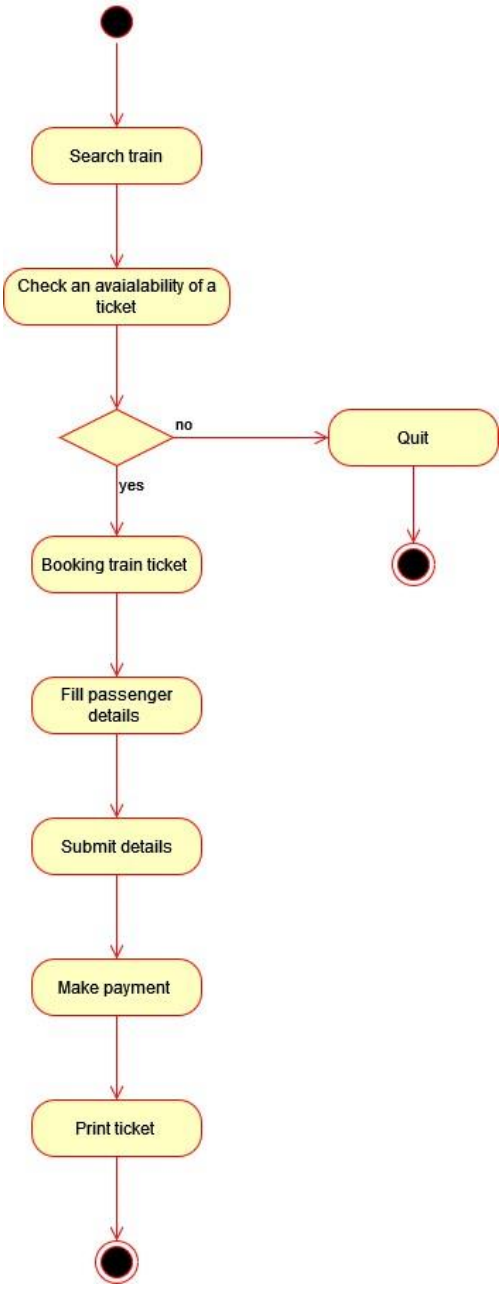


Figure 5 Activity Diagram for Ticket Booking

Login

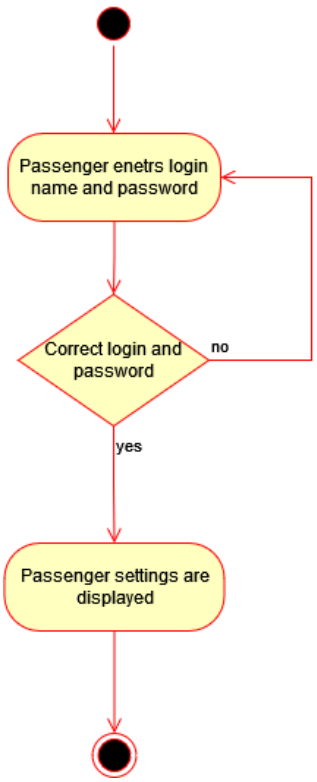


Figure 6 Activity Diagram for Login

Add train

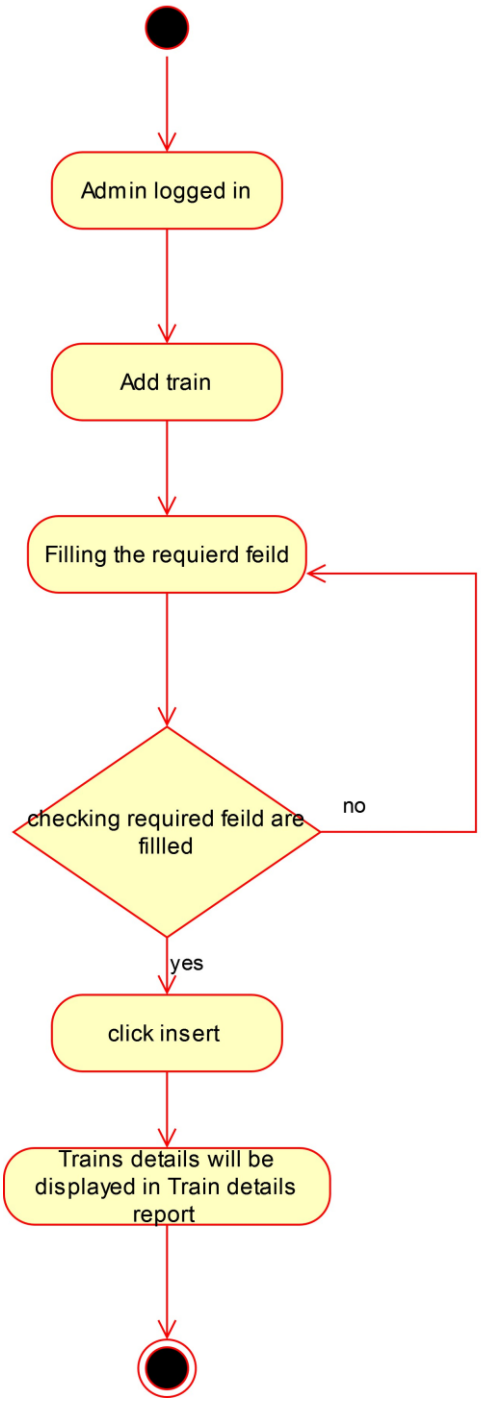


Figure 7 Activity Diagram for Add Train

Create train schedule

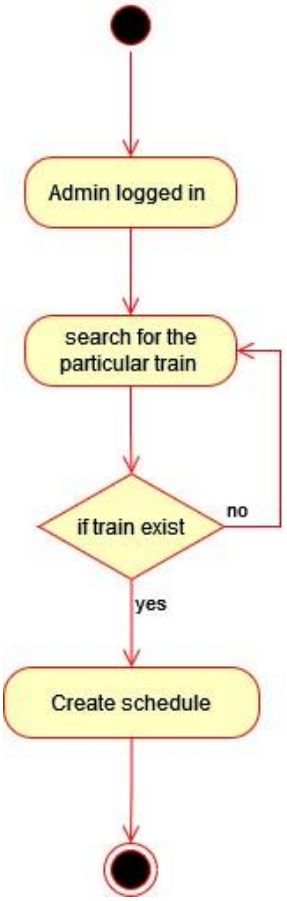


Figure 8 Activity Diagram for Create Train Schedule

3.4.2.3 ER Diagram

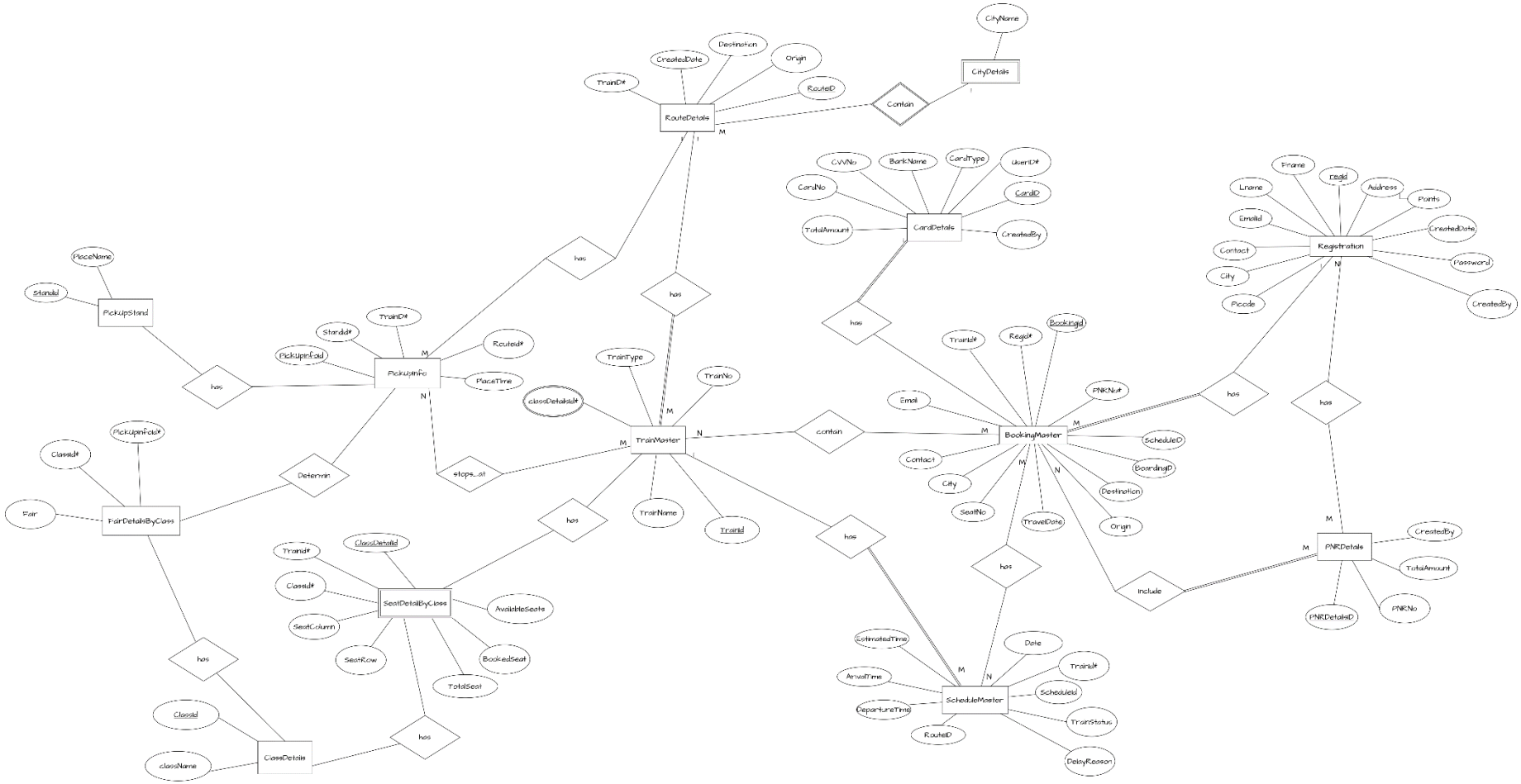


Figure 9 Entity Relationship Diagram

3.4.3 Technical tools/ Backend & Frontend tools used

The MERN stack (MongoDB, Express.js, React, and Node.js) has been used as the core framework for developing the railway seat reservation web application in order to build a dynamic, effective, and user-friendly platform. The MERN stack is a flexible amalgamation of technologies that interact harmoniously to satisfy both frontend and backend requirements, ensuring an integrated and cogent development process.

3.4.3.1 Backend (Node.js, Express.js)

Node.js: Node.js, a runtime environment that allows server-side JavaScript execution, powers the backend. A non-blocking, I/O model is offered by Node.js, improving speed and scalability.

Express.js: Express.js is a minimal and flexible web application framework for Node.js. It streamlines the development of robust APIs, handles routing, and simplifies middleware implementation.

3.4.3.2 Database (Mongo DB)

Mongo DB: The database used by the program is Mongo DB, which offers a scalable and adaptable NoSQL solution for storing user data, seat availability, and other pertinent information.

3.4.3.3 Frontend (React)

React, a well-liked JavaScript user interface construction library, is used to develop the frontend. Modular and reusable UI elements are made possible by React's component-based architecture. An intuitive user interface is built using React components, guaranteeing consistency and simplicity of upkeep. Real-time updates are made possible via React's Virtual DOM and state management, allowing users to learn about seat availability and booking status right away.

3.4.3.4 Additional Tools and Libraries

1. Axios: Axios is utilized for making asynchronous HTTP requests between the frontend and backend, facilitating seamless data exchange.

2. Redux: Redux, a state management library, may be integrated to efficiently manage the application's state and ensure consistent data flow.

3. Material-UI: Material-UI components can be employed for creating a visually appealing and consistent design language.

The adoption of the MERN stack empowers the train seat reservation web application with a potent combination of technologies, facilitating the creation of a feature-rich, responsive, and scalable platform. This stack allows for streamlined development, efficient data management, and a superior user experience, aligning perfectly with the goals of addressing the limitations of the existing system and introducing advanced functionalities.

3.4.4 Hardware and third-party software requirements

	Requirements	Description
Hardware	Processor	An integrated electrical circuit called a processor is what does the computations for a computer. A processor executes fundamental instructions given from an operating system (OS), including mathematical, logical, input/output (I/O), and other operations. The majority of other processes rely on the actions of a processor. Minimum: 1.9 GHz x86- or x64-bit dual core processor Recommended: 23.3 GHz or faster 64-bit dual core processor GHz or more
	Hard Drive	A non-volatile storage device used for storing and retrieving digital data is a hard drive, sometimes referred to as a hard disk drive (HDD). It is a major type of computer secondary storage that has the ability to keep data even when the computer is off. A magnetic substance is deposited on one or more revolving magnetic disks known as platters that make up the hard drive. High-speed platters spin as magnetic heads on actuator arms read or write data to or from the platters. These heads scan quickly across the rotating discs to access various data sectors. Minimum : 256 GB Recommended 512 GB or more
	Memory (RAM)	Random Access Memory is referred to as RAM. It is a sort of computer memory that serves as a temporary repository for information that the computer's CPU is now using. RAM is volatile, so when the machine is turned off or restarted, its data are gone. A computer

		system's performance is greatly influenced by RAM. The pertinent information is put into the RAM for quicker access when you launch an application or open a file from a storage device (such as a hard disk or solid-state drive). The system's overall speed and responsiveness are greatly enhanced by the processor's rapid access to and manipulation of this data in RAM. Minimum 4GB; Recommended 12GB or above
	Monitor Resolution	The number of pixels that a display can accept both horizontally and vertically is referred to as monitor resolution. It establishes the degree of clarity and detail that can be seen on a monitor. The number of pixels along the width and height of the screen is the standard unit of measurement for resolution. The most typical method of describing resolution is to provide the total number of pixels both horizontally and vertically. The monitor can display 1920 pixels horizontally and 1080 pixels vertically, for instance, if the resolution is 1920x1080 (often referred to as "1080p"). As more pixels are available to represent the visual material, pictures with higher resolutions tend to be crisper and more detailed. The monitor's resolution has a direct impact on the quality and clarity of text, pictures, and videos. Minimum 1024*768; Recommended 1920*180
	Ethernet connection (LAN) OR a wireless adapter (Wi-Fi)	Computers, printers, routers, and switches may all be linked together to create a network via an Ethernet connection. An IP (Internet Protocol) address is given to each device, enabling them to transmit and receive data packets over the network. Ethernet connections are appropriate for applications that need a steady and

		persistent network connection because they offer high-speed, dependable, and secure data transport. With Wi-Fi, devices may join a network without being physically connected to a router, providing ease of mobility. Laptops, cell phones, tablets, smart TVs, and other portable devices frequently utilize it. When running Ethernet cables is difficult or cumbersome, like in homes, public places, or businesses with several devices dispersed across the room, Wi-Fi connections are a good alternative.
Software	Visual Studio Code	On your desktop, Visual Studio Code is a quick yet effective source code editor that runs on Windows, macros, and Linux. It contains support for JavaScript, Typescript, and Node.js built in, as well as a robust ecosystem of extensions for additional languages and runtimes (including C++, C#, Java, Python, PHP, Go, and.NET).
	Postman	The API (Application Programming Interface) platform Postman is a stand-alone tool for testing applications that creates, tests, designs, modifies, and documents APIs. For sending and examining HTTP requests and answers, it offers a straightforward Graphical User Interface. For testing purposes, utilizing Postman eliminates the need to create any HTTP client network code. Instead, we create collections of test cases and let Postman communicate with the API. Almost all of the functionality that a developer would want is contained in this tool. This tool can transform the API into code for languages like JavaScript and Python as well as perform other HTTP requests including GET, POST, PUT, and PATCH.

	Node	Based on Chrome's V8 JavaScript engine, Node.js is an open-source server-side runtime environment for JavaScript. It enables programmers to execute JavaScript code outside of a web browser, enabling them to create scalable and fast web servers and apps. JavaScript has often been used on the client side of web pages to offer interactivity and dynamic behavior. However, Node.js expands JavaScript's functionality by allowing server-side execution, allowing programmers to create full-stack applications solely in JavaScript. (Foundation, n.d.)
	MongoDB compass	Mongo DB Compass is a graphical user interface (GUI) tool for working with Mongo DB databases that is made available by Mongo DB. By offering a visual interface for carrying out different database operations, it is intended to make it simpler for developers and administrators to interact with Mongo DB. Administrators and developers who may prefer a visual interface to command-line tools can use Mongo DB Compass to manage and interact with Mongo DB databases more easily. It offers a user-friendly environment for data exploration and manipulation, index creation, and database schema management, eventually enhancing productivity and effectiveness while working with Mongo DB.
	Google Chrome, Microsoft Edge or any Browser	A software program called a web browser, like Microsoft Edge or Google Chrome, enables users to access and surf the internet. It serves as a conduit between the user and other websites and web-based programs. Users may access and engage with online information by using browsers to understand and

		display the HTML, CSS, and JavaScript code that renders web pages. Accessing the user interface of the smart pharmacy monitoring system in our system requires a browser. Users may log in, look for prescriptions, examine pharmacy information, place orders, and carry out other actions within the system via the browser. Additionally, browsers support a number of web technologies, such as APIs, which our system may make use of to integrate with other services or to provide new features. As a result, users may interact with our system and access its features and capabilities using a browser.

Table 3 Hardware and software Requirement

3.5 Implementation

Within the Train Seat Reservation Web Application, a solid foundation for user interaction and data protection can be created by incorporating the techniques, design principles, specifications, and security measures. As work continues, expanding upon these finished components will help create a robust and user-friendly application that addresses the noted shortcomings and provides improved functionalities.

Specifications and Standards

1. RESTful API Design: Follow REST principles for designing APIs that are easy to understand, scalable, and interoperable.
2. JSON Web Tokens (JWT): Use JWT for secure and stateless authentication and authorization between client and server.
3. OAuth 2.0: Implement OAuth 2.0 for third-party authentication, allowing users to sign in using existing social media accounts.
4. Email Verification Guidelines: Follow industry best practices for email verification, including secure token generation, expiration, and user-friendly instructions.

Security Measures

1. Cross-Site Scripting (XSS) Prevention: Implement input validation and output encoding to prevent malicious scripts from being injected into web pages.
2. Secure Password Storage: Utilize a strong password hashing algorithm (e.g: bcrypt) to securely store user passwords in the database.
3. Token-Based Email Verification: Implement a token-based email verification process, where unique tokens are generated and sent to users for confirming their email addresses.
4. Data Validation: Apply stringent data validation to user inputs to prevent common security vulnerabilities such as SQL injection.
5. SQL Injection Prevention: Implement parameterized queries to prevent SQL injection attacks on database queries related to user login and registration.

Methods and Approaches

1. Agile Development: Adopt an Agile methodology (Scrum) for iterative and incremental development, enabling flexibility in responding to changing requirements.
2. Validation Techniques: Implement client-side and server-side validation for user inputs on the login and registration forms to prevent errors and enhance data integrity.
3. Prototyping: Develop a working prototype to visualize and validate key features before full-scale development.
4. User-Centered Design (UCD): Ensure that the user login, registration, and email verification processes are intuitive and user-friendly by incorporating user feedback and conducting usability testing.

Architectural Models

1. Model-View-Controller (MVC): Separate application logic, presentation, and data handling for better maintainability.
2. Single-Page Application (SPA): Consider using a SPA approach for a smoother user experience without full-page reloads.

Design Principles and Ideas

1. Responsive Design: Ensure the application is accessible and functional across various devices and screen sizes.
2. Minimalist Design: Focus on simplicity and clean aesthetics to enhance user experience and navigation.

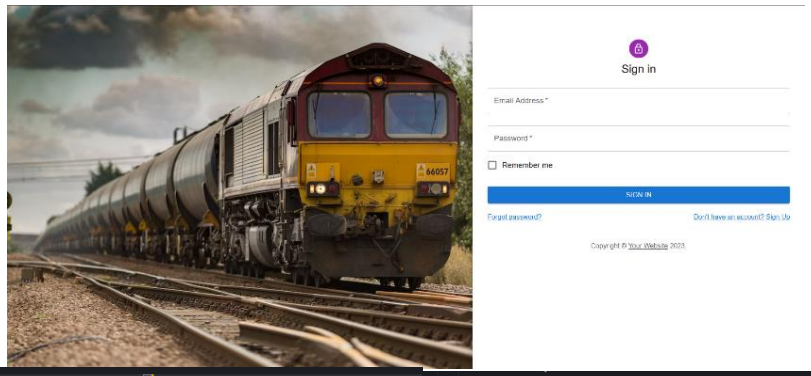
Quality Assurance

1. Unit Testing: Develop and execute unit tests to verify the correctness of individual components.
2. Integration Testing: Test the interaction between different modules to ensure they work together as expected.
3. Code Reviews: Perform code reviews with peers to ensure the quality, security, and maintainability of the implemented functionality.

Project Progress Update

Significant strides have been made in the development of the Train Seat Reservation Web Application, constituting approximately 40% of the project's scope. This substantial progress is exemplified by the successful implementation and integration of pivotal user-centric components:

User Login Page




```
export default function SignInSide() {
  const { data: session, status } = useSession();
  const [loading, setLoading] = React.useState(true);

  const [error, setError] = React.useState("");
  const router = useRouter();



  const handleSubmit = async (event) => {
    event.preventDefault();
    const data = new FormData(event.currentTarget);
    const userData = {
      Email: data.get("email"),
      Password: data.get("password"),
    };

    const email = userData.Email;
    const password = userData.Password;

    try {
      const data = await signIn("credentials", {
        redirect: false,
        email,
        password,
      });

      if (data.ok) {
        const session = await getSession();
        localStorage.setItem("jwttoken", session.accessToken);

        router.push("/");
        setLoading();
      }
    } catch (error) {
      console.log("error", error);
    }
  };

  if (session) {
    router.push("/");
  } else {
    return (
      <ThemeProvider theme={defaultTheme}>···
      </ThemeProvider>
    );
  }
}
```

Table 4 Front-end code for User Login Page

```
const loginUser = async (req, res) => {
  try {
    const { Email, Password } = req.body;

    const userExist = await User.findOne({ Email: Email });

    if (!userExist)
      return res
        .status(400)
        .json({ message: "user needs to register first ", success: false });

    const isValid = await bcrypt.compare(Password, userExist.Password);


    if (userExist && !isValid)
      return res
        .status(400)
        .json({ message: "Password is incorrect", success: false });

    const isVerified = userExist.isVerified;

    if (isValid && isVerified) {
      // const user = { _id: userExist._id };
      // const token = createToken(user._id);
      const _id = userExist._id;
      const token = createToken(_id);

      res
        .status(200)
        .send({ message: "Login successful", success: true, token: token ,role:userExist.role});
    } else if (!isVerified) {
      res
        .status(400)
        .send({ message: "Email Has Not Verified", success: false });
    } else {
      res
        .status(400)
```

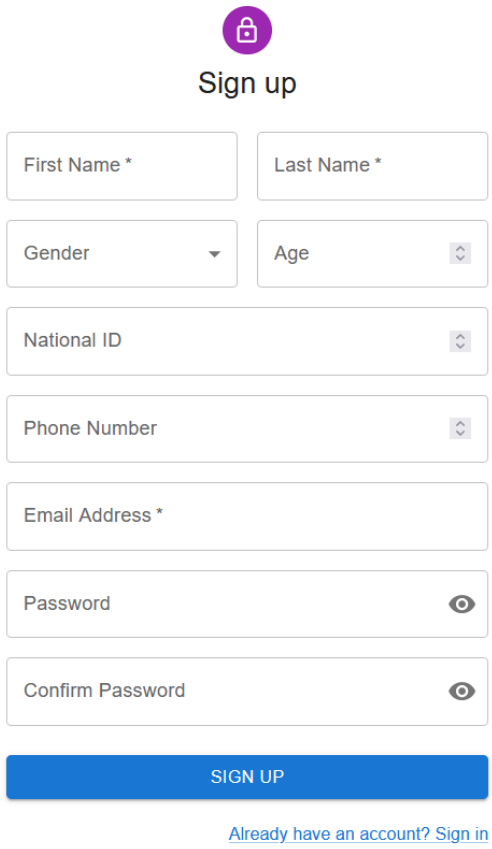
```
const createToken = (_id) => {
  const jwtSecretKey = process.env.ACCESS_TOKEN_SECRET;
  return jwt.sign({ _id }, jwtSecretKey, { expiresIn: "3d" });
};
```

Figure 10 Back-end Code for user Authentication

The foundational user login page has been successfully created, enabling registered users to access their accounts securely.

Robust authentication mechanisms have been established, ensuring data privacy and safeguarding user credentials.

User Registration Page:




```
register.js U
front end > pages > user > register.js > ...
export default function SignUp() {
  const [error, setError] = React.useState("");
  const [userInfo, setUserInfo] = React.useState([]);

  const registerUser = async (userData) => {
    try {
      const response = await axios.post(
        "http://localhost:5000/api/user/register",
        userData
      );

      if (response) {
        setError("");
        console.log(response.data);
      }
    } catch (err) {
      if (err) {
        console.log(err.response.data);
        setError(err.response.data);
      }
    }
  };

  const handleSubmit = async (event) => {
    event.preventDefault();
    const data = new FormData(event.currentTarget);

    const userData = {
      First_name: data.get("firstName"),
      Last_name: data.get("lastName"),
      Gender: data.get("gender"),
      Age: data.get("age"),
      Email: data.get("email"),
      Password: data.get("password"),
      Nic_no: data.get("nic"),
      Mobile_no: data.get("phone"),
    };

    if (
      data.get("password") !== data.get("confirm password") ||
      userData.First_name == "" ||
      userData.Last_name == "" ||
      userData.Gender == "" ||
      userData.Email == "" ||
      userData.Password == "" ||
      userData.Nic_no == "" ||
      userData.Mobile_no == "" ||
      data.get("confirm password") == ""
    ) {
      console.log("All feild is required");
    } else {
      registerUser(userData);
      setError("");
    }
  };

  const [showPassword, setShowPassword] = React.useState(false);

  const handleClickShowPassword = () => setShowPassword((show) => !show);

  const handleMouseDownPassword = (event) => {
    event.preventDefault();
  };

  return (
    <ThemeProvider theme={defaultTheme}>
      <Container component="main" maxWidth="xs">...
      </Container>
    </ThemeProvider>
  );
}
```

Figure 11 Front-end Code for user Registration

```
const registerUser = async (req, res) => {
  try {

    const {
      First_name,
      Last_name,
      Gender,
      Age,
      Email,
      Password,
      Nic_no,
      Mobile_no,
    } = req.body;

    const hashedPassword = await bcrypt.hash(Password, 10);

    const userDetails = {
      First_name,
      Last_name,
      Gender,
      Age,
      Email,
      Password: hashedPassword,
      emailToken: crypto.randomBytes(64).toString("hex"),
      Nic_no,
      Mobile_no,
    };

    const userExist = await User.findOne({ Email: Email });
    if (userExist) return res.status(402).send("User already exists..");

    const user = await User.create(userDetails);


    sendVerificationMail(user);

    const token = createToken(user._id);

    res.status(200).json({ _id: user._id, Email, token });

    if (!user) return res.status(401).json("Problem creating a user");
  } catch (err) {
    res.status(500).json("error");
  }
```

Figure 12 Back-end code for user Registration

The user registration process has been skillfully integrated, empowering new users to create accounts by providing essential details.

Comprehensive data validation measures have been instituted to enhance accuracy and streamline the registration experience.

Email Verification:

```
// ! verifyEmail
const verifyEmail = async (req, res) => {
  const token = req.params.token;

  console.log(token);
  try {
    if (!token) return res.status(401).json("EmailToken not found...");

    const user = await User.findOne({ emailToken: token });

    if (user) {
      user.emailToken = null;
      user.isVerified = true;

      await user.save();

      return res.redirect("http://localhost:3000/user/signin");
    }
  } catch (error) {
    console.log(error);
    res.status(500).json(error.message);
  }
};
```

```
const nodemailer = require("nodemailer");

const createMailTransporter = () => {
  let transporter = nodemailer.createTransport({
    service: "hotmail",
    auth: {
      user: "msmuaz98@outlook.com", // generated ethereal user
      pass: "0777039998Muaz", // generated ethereal password
    },
  });

  return transporter;
};

module.exports = { createMailTransporter };
```

```
const { createMailTransporter } = require("./createMailTransporter");

const baseUrl = "http://localhost:5000";

const sendVerificationMail = (user) => {
  const transporter = createMailTransporter();

  const url = `http://localhost:5000/api/user/verify-email/${user.emailToken}`;

  const mailOptions = {
    from: '"Black Ph4nthom 👻" <msmuaz98@outlook.com>',
    to: user.Email, // list of receivers
    subject: "Verify Your Email ✓", // Subject line
    html: `<p>Hello ${user.Last_name},Verify your email by clicking this link...</p>
   <a  href=${url}>${url}</a>`,
  };

  transporter.sendMail(mailOptions, (error, info) => {
    if (error) {
      console.log(error);
    } else {
      console.log("verification email sent");
    }
  });
};

module.exports = { sendVerificationMail };
```

Figure 13 back-end code for Email verification

An integral email verification feature has been implemented, bolstering security, and confirming the authenticity of user accounts.

A robust verification process has been devised, enhancing user trust, and mitigating unauthorized access.

These achievements underscore the project's dedication to constructing a user-friendly, secure, and efficient platform. The successful implementation of user login, registration, and email verification represents a crucial foundation upon which the application's dynamic functionalities will be established.

As this significant progress marks the initial phase of the project, subsequent stages will center on refining and expanding the application's capabilities. Upcoming development will encompass advanced features, such as real-time updates, interactive seat reservations, dynamic pricing models, and an intuitive user interface.

With this steadfast momentum, the Train Seat Reservation Web Application is well-positioned to fulfill its objectives and create a transformative solution that addresses existing drawbacks and enhances the online booking experience.

3.6 Testing and verification

The robustness, dependability, and user satisfaction of the train seat reservation web application are crucially dependent on testing and verification. To ensure that the system operates flawlessly and lives up to user expectations, a rigorous testing process is used that involves various levels of examination, from individual components to integrated functionalities.

Unit Testing:

Unit testing is conducted on individual frontend and backend components using frameworks like Jest for the front end and Mocha/Chai for the back end. This guarantees that each module functions as intended, spotting and fixing potential errors as they arise.

Integration Testing:

To ensure smooth communication and proper data flow between various parts of the application, the integration of backend and frontend components is thoroughly tested. Supertest and React Testing Library are two tools that help validate interactions and guarantee smooth operation.

User Acceptance Testing (UAT):

Real-world simulation through UAT, where actual users use the application and provide feedback, is a crucial stage. By identifying usability problems, inconsistent design elements, and functional gaps, this feedback helps the program better meet user demands.

Security Testing:

Security measures are evaluated through vulnerability assessments and penetration testing. This ensures the application safeguards sensitive user data and protects against potential cyber threats.

Functional Testing:

The application's core functionalities, such as seat reservation, payment processing, and real-time updates, undergo thorough testing to confirm they operate flawlessly.

Compatibility Testing:

The application is tested on different browsers, devices, and screen sizes to ensure consistent performance and appearance across various platforms.

The project's testing and verification process makes certain that the solution satisfies the highest standards for quality, functionality, and security. By putting the application through rigorous testing procedures, we are confident that the system will deliver on the promise of a contemporary, user-centric, and effective platform by offering passengers an exceptional and hassle-free booking experience, effectively addressing the limitations of the current reservation system.

4 Evaluation and Conclusion

The train seat reservation web application project has undergone careful development and testing, yielding a complete and creative solution to the shortcomings of the current Sri Lankan online reservation system. The application's user interface and experience have been enhanced through extensive user testing and feedback gathering, resulting in intuitive navigation and effective seat booking. It has been thoroughly tested to deliver accurate information and maximize seat occupancy by integrating real-time updates and dynamic pricing algorithms. The backend infrastructure of the application has also been improved for robustness, security, and scalability, ensuring lag-free performance even during times of high usage. Overall, the evaluation process confirms that the project's goals of addressing user dissatisfaction, increasing seat availability accuracy, and providing a modernized and user-centric reservation experience have been successfully met.

In conclusion, the web application project for train seat reservations represents a significant advancement in the transformation of Sri Lanka's transportation industry. The application has successfully overcome the limitations of the current reservation system by utilizing the power of the MERN stack, real-time data integration, and sophisticated user-centric functionalities. With real-time seat availability updates, personalized suggestions, and a seamless, effective, and convenient booking experience, passengers are now in control. The project's success demonstrates how it has the potential to raise customer satisfaction, boost railway operator productivity, and open the door for additional advancements in the field of public transportation. The intended solution is poised to set new standards for convenience, dependability, and technological advancement in the train seat industry as the project moves closer to completion.

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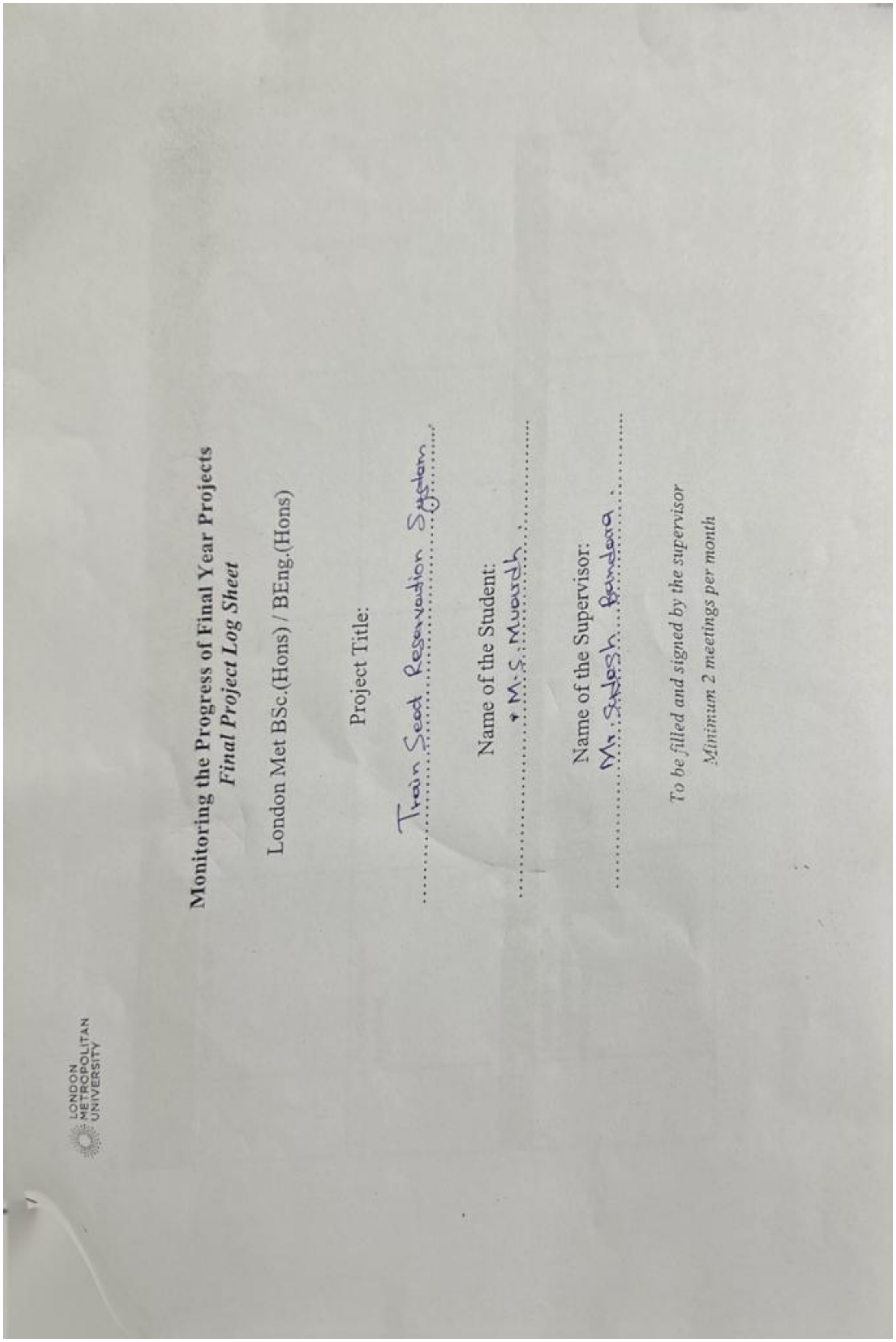
6 Appendices



LONDON METROPOLITAN UNIVERSITY

Monitoring the Progress of Final Year Projects
Final Project Log Sheet

London Met BSc.(Hons) / BEng.(Hons)

Project Title:

Train Seat Reservation System

Name of the Student:

M.S. Muardh

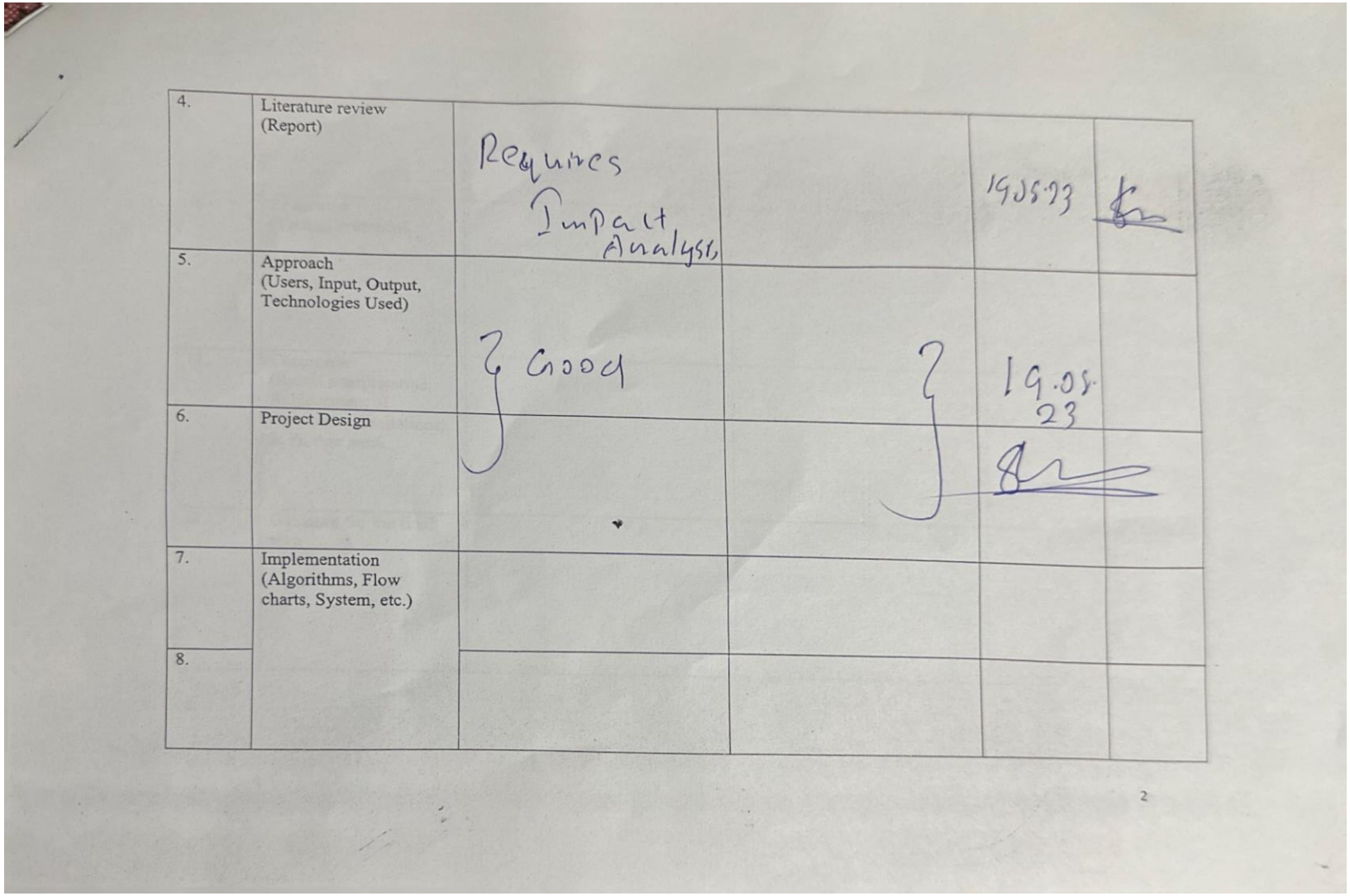
Name of the Supervisor:

Mr. Sudesh Bandara

To be filled and signed by the supervisor

Minimum 2 meetings per month

Meeting	Criteria	Suggestions	Actions	Date	Signature
Proposal Stage					
1.	Project topic approval				
2.	Project proposal approval				
Interim & Final Stage					
3.	Literature review (Gathered resource documents)	Ok Pass		19.08.25	



4.	Literature review (Report)	Requires Impact Analysis		19.05.23	
5.	Approach (Users, Input, Output, Technologies Used)	Good		19.05.23	
6.	Project Design				
7.	Implementation (Algorithms, Flow charts, System, etc.)				
8.					

2

9.					
10.	Evaluation (Testing evidence)				
11.	Conclusion (Result interpretation, Achievement of objectives, Limitations) & Further work				
12.	Guidance for the final viva				