METRO MANAGEMENT SYSTEM

A PROJECT REPORT
for
Mini Project-I (K24MCA18P)
Session (2024-25)

Submitted by

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Submitted in partial fulfilment of the
Requirements for the Degree of

MASTER OF COMPUTER APPLICATION

Under the Supervision of
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Assistant Professor

Submitted to

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KIET Group of Institutions, Ghaziabad
Uttar Pradesh-201206

(15 DECEMBER- 2024)

CERTIFICATE

Certified that **<u>KUMAR KARTIK</u> (202410116100105), <u>KARTIK KUMAR</u> 202410116100097** has/ have carried out the project work having "**METRO MANAGEMENT SYSTEM**." (**Mini Project-I, K24MCA18P**) for **Master of Computer Application** from Dr. A.P.J. Abdul Kalam Technical University (AKTU) (formerly UPTU), Lucknow under my supervision. The project report embodies original work, and studies are carried out by the student himself/herself and the contents of the project report do not form the basis for the award of any other degree to the candidate or to anybody else from this or any other University/Institution.

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KIET Group of Institutions, Ghaziabad	**KIET Group of Institutions, Ghaziabad**

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Finally, my sincere thanks go to my family members and all those who have directly and indirectly provided me with moral support and other kind of help. Without their support, completion of this work would not have been possible in time. They keep my life filled with enjoyment and happiness.

KUMAR KARTIK

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ABSTRACT

The **Metro Management System** is a comprehensive software application designed to streamline and enhance the operations of metro rail networks. It provides an efficient and user-friendly platform for managing ticketing, scheduling, passenger tracking, and operational data. The system is aimed at reducing manual intervention, improving service reliability, and ensuring a seamless experience for passengers.

Key features of the system include an automated ticketing module with support for smart cards and QR codes, real-time train tracking, and schedule management. It also incorporates a robust database for storing information related to passenger traffic, train routes, and station data. The system is integrated with analytics tools to assist administrators in optimizing schedules, reducing delays, and managing peak-hour traffic.

By leveraging advanced technologies such as GPS, IoT, and cloud computing, the Metro Management System ensures data security and scalability. Its intuitive user interface enables both passengers and staff to interact with the system effortlessly, fostering improved operational efficiency and passenger satisfaction.

This system is ideal for modern urban metro networks aiming to handle growing demand while maintaining high standards of safety, reliability, and customer

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INTRODUCTION

The **Metro Management System** is an innovative solution designed to enhance the efficiency, reliability, and convenience of metro rail services in urban areas. With rapid urbanization and growing reliance on public transportation, metro rail systems face challenges such as overcrowding, operational inefficiencies, and the need for seamless passenger services. The Metro Management System addresses these challenges by integrating advanced technologies into a centralized platform that automates and streamlines core operations.

This system encompasses several key functionalities, including automated ticketing, real-time train tracking, passenger flow management, and dynamic scheduling. By leveraging technologies like GPS, IoT, cloud computing, and artificial intelligence, it ensures smooth day-to-day operations while maintaining scalability for future growth. Features like smart card and QR code-based ticketing eliminate the need for traditional paper tickets, making the ticketing process faster and more convenient for passengers. Additionally, real-time tracking and live updates enable passengers to stay informed about train schedules and minimize waiting times.

For administrators, the Metro Management System provides tools to optimize train routes, manage peak-hour traffic, and monitor the overall performance of the metro network. Predictive analytics and data-driven insights help in making informed decisions to improve service quality and reduce operational costs. The system also includes safety features, such as real-time monitoring of infrastructure and emergency response mechanisms, ensuring a secure environment for commuters.

Designed with user-friendliness in mind, the Metro Management System supports multilingual interfaces and mobile applications, catering to diverse urban populations. It is an essential component of smart city initiatives, offering eco-friendly and efficient public transportation solutions that reduce traffic congestion and lower carbon emissions.

In summary, the Metro Management System is a comprehensive, technology-driven approach to modernizing metro rail operations. It enhances the passenger experience, streamlines administrative processes, and ensures the sustainability and scalability of metro networks in an era of increasing urban mobility demands.

Literature Review

The Metro Management System is a pivotal solution for the efficient operation and management of metro rail networks, ensuring enhanced passenger services and operational efficiency. Numerous studies and technological advancements have contributed to its development and implementation. This section reviews the key concepts, methodologies, and technologies associated with metro management systems, as discussed in existing literature.

1. Evolution of Metro Management Systems

Over the past two decades, metro systems have transitioned from manual operations to fully automated frameworks. Early systems relied on basic scheduling and manual ticketing processes, which were prone to inefficiencies and errors. The introduction of digital technologies, such as smart card ticketing and automated train control systems, marked a significant step in improving the reliability and scalability of metro operations (Smith et al., 2015).

2. Key Components of Metro Management Systems

Several studies highlight the core components of modern metro management systems:

- **Automated Ticketing: Bhattacharya and Reddy (2018) discuss the benefits of cashless ticketing systems, including the adoption of RFID-based smart cards and mobile-based QR codes. These systems reduce transaction time and enhance the passenger experience.**
- **Real-Time Tracking: According to Zhang et al. (2020), integrating GPS and IoT technologies in metro operations has improved train tracking and scheduling accuracy. Passengers benefit from live updates, while operators can respond quickly to delays or disruptions.**
- **Passenger Flow Management: Recent studies (Liu et al., 2019) emphasize the role of AI and data analytics in managing passenger flow, especially during peak hours. These technologies predict crowd patterns and enable dynamic resource allocation.**

3. Technology Integration in Metro Systems

Technological advancements have significantly shaped metro management systems:

- **Internet of Things (IoT): IoT-enabled devices facilitate real-time monitoring of trains and infrastructure. Wang et al. (2021) highlight how IoT sensors help in predictive maintenance, reducing downtime and operational costs.**
- **Artificial Intelligence (AI): AI is instrumental in optimizing train schedules, predicting passenger demand, and ensuring efficient resource utilization. AI-driven models, as discussed by Patel et al. (2019), have demonstrated remarkable success in reducing delays and improving service quality.**
- **Cloud Computing: Cloud-based solutions enable centralized data storage and processing, ensuring secure and scalable management of metro operations (Chen & Lee, 2017).**

4. Challenges in Implementation

Despite the benefits, implementing metro management systems is not without challenges. Studies like those by Kumar and Sharma (2020) identify issues such as high initial costs, integration complexities, and the need for extensive training for staff. Additionally, ensuring cybersecurity and data privacy remains a critical concern, as highlighted by Singh et al. (2021).

5. Case Studies of Successful Systems

Several cities have successfully implemented advanced metro management systems:

- **Delhi Metro, India: The integration of automatic fare collection (AFC) and train control systems has significantly improved operational efficiency (Gupta et al., 2018).**
- **Singapore MRT: Known for its seamless passenger services, Singapore's metro system leverages AI and IoT to provide real-time updates and efficient crowd management (Tan et al., 2020).**
- **London Underground: The adoption of predictive maintenance and automated scheduling has reduced operational delays and enhanced service reliability (Brown, 2019).**

6. Future Directions in Metro Management

The literature indicates a growing interest in sustainable and green technologies for metro systems. Solar-powered stations, regenerative braking, and energy-efficient trains are gaining attention as part of smart city initiatives (Hossain & Ahmed, 2022). The integration of 5G technology is also expected to revolutionize communication and data transmission within metro networks.

OBJECTIVES OF AN Metro Management SYSTEM

The Metro Management System is designed to enhance the efficiency, safety, and convenience of metro rail networks by leveraging advanced technology and automation. The key objectives of this system are:

1. Streamline Operations

- Automate core metro processes such as ticketing, scheduling, and passenger management to reduce manual intervention and improve efficiency.
- Optimize train routes and schedules to ensure minimal delays and seamless connectivity.

2. Enhance Passenger Experience

- Provide passengers with a user-friendly interface for ticketing, live updates, and journey planning.
- Reduce waiting times through real-time train tracking and timely notifications.
- Support smart card, QR code, and mobile-based ticketing systems for convenient cashless transactions.

3. Improve Safety and Security

- Integrate surveillance systems and IoT-enabled sensors for monitoring train and station infrastructure.
- Enable rapid emergency responses through centralized communication and alert systems.

4. Efficient Crowd and Traffic Management

- Use AI and data analytics to predict passenger flow patterns and allocate resources dynamically.
- Prevent overcrowding during peak hours by managing train frequencies and platform distributions.

5. Data-Driven Decision Making

- Collect and analyze data on ridership, train performance, and operational metrics to identify areas for improvement.
- Provide actionable insights to administrators for long-term planning and optimization.

6. Ensure Scalability and Sustainability

- Design the system to accommodate future expansions in metro routes and passenger volumes.
- Promote eco-friendly practices by integrating energy-efficient technologies and encouraging metro usage as a sustainable transportation alternative.

HARDWARE AND SOFTWARE REQUIRMENT

The implementation of a **Metro Management System** requires a robust combination of hardware and software components to ensure smooth operation, scalability, and reliability. Below is a detailed breakdown of the hardware and software requirements:

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1. Hardware Requirements

a) Centralized Server

- High-performance servers for managing databases, processing operations, and hosting applications.
- Specifications:
  - Processor: Intel Xeon or equivalent
  - RAM: 32GB or higher
  - Storage: SSDs with RAID configurations (minimum 1TB)
  - Operating System: Linux/Windows Server

b) Workstations

- For station operators and control room staff.
- Specifications:
  - Processor: Intel Core i5/i7 or equivalent
  - RAM: 8GB or higher
  - Storage: 500GB HDD/SSD
  - Display: 21-inch HD monitors

c) Network Infrastructure

- High-speed internet and intranet connectivity for seamless communication between stations and central servers.
- Components:
  - Ethernet switches and routers
  - Fiber-optic cables for high-speed data transmission
  - Wireless access points for station areas

d) IoT Devices and Sensors

- For real-time train tracking, passenger flow monitoring, and infrastructure management.
- Examples:
  - GPS modules for train tracking
  - Crowd sensors for platform and station monitoring
  - Temperature and environmental sensors for station safety

e) Ticketing Hardware

- Automated ticketing machines and gate systems.
- Components:
  - QR code scanners and RFID card readers
  - Touchscreen kiosks for ticket purchasing
  - Automated fare collection (AFC) gates

f) Surveillance Systems

- For station and train safety.
- Components:
  - CCTV cameras with night vision capabilities
  - Storage devices for video recordings (NVR/DVR systems)

g) Backup Power Supply

- Uninterrupted Power Supply (UPS) systems and backup generators to prevent downtime.

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2. Software Requirements

a) Operating Systems

- Servers: Linux (Ubuntu, CentOS) or Windows Server.
- Workstations: Windows 10/11 or Linux-based distributions.

b) Database Management System (DBMS)

- For managing ticketing, scheduling, and operational data.
- Examples:
  - MySQL
  - PostgreSQL
  - Oracle DB

c) Application Software

- Custom-developed metro management software for ticketing, train scheduling, and operational monitoring.

d) Real-Time Tracking and Monitoring Tools

- Software integrated with GPS and IoT devices for train tracking and infrastructure monitoring.

e) Web and Mobile Applications

- Passenger-facing applications for ticketing, real-time train updates, and journey planning.
- Technologies:
  - Frontend: HTML, CSS, JavaScript (React or Angular)
  - Backend: Node.js, Python (Django/Flask), or Java (Spring Boot)

f) Analytics and Reporting Tools

- Tools for analyzing passenger data and system performance.
- Examples:
  - Tableau, Power BI for visualization
  - Python/R for predictive analytics

g) Security Software

- For safeguarding the system against cyber threats.

- Examples:
  - Firewalls and intrusion detection systems (IDS)
  - Encryption software for secure transactions

h) Cloud Platforms

- Optional for scalability and remote access.
- Examples:
  - AWS, Microsoft Azure, or Google Cloud Platform (GCP)

i) Backup and Disaster Recovery Software

- For data backup and system recovery in case of failures.

PROJECT FLOW / RESEARCH METHODOLOGY

The development and implementation of a Metro Management System require a systematic approach to ensure its efficiency and reliability. This section outlines the project flow and research methodology in a structured format, detailing each phase from concept to deployment.

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1. Problem Identification

- **Objective: To identify the challenges faced by metro rail systems in urban areas.**
- **Key Activities:**
  - **Analyze current metro operations and their inefficiencies.**
  - **Identify issues like overcrowding, delays, manual processes, and passenger dissatisfaction.**
  - **Conduct surveys and interviews with passengers and metro staff to gather insights.**

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2. Requirement Analysis

- **Objective: To define the functional and non-functional requirements of the system.**
- **Key Activities:**
  - **Engage with stakeholders (administrators, operators, and passengers) to gather system expectations.**
  - **Document hardware and software requirements.**
  - **Define system features, including ticketing, real-time tracking, passenger flow management, and reporting.**

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3. System Design

- **Objective: To create a blueprint of the system architecture and workflows.**
- **Key Activities:**
  - **Develop system architecture, including database design, server-client communication, and module integration.**
  - **Design user interfaces for passenger and administrative modules.**
  - **Create data flow diagrams (DFDs) and entity-relationship diagrams (ERDs) for clear representation.**
  - **Plan the network infrastructure for data transmission and connectivity.**

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4. Development Phase

- **Objective: To build and integrate the system components.**
- **Key Activities:**

- Implement core functionalities like automated ticketing, train tracking, and analytics.
- Develop mobile and web applications for passenger interaction.
- Integrate hardware components, such as ticketing machines and IoT sensors, with the software.
- Write backend code to manage database operations and API communication.

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5. Testing and Validation

- **Objective: To ensure the system performs as intended and is free of errors.**
- **Key Activities:**
  - Perform unit testing on individual modules (e.g., ticketing, scheduling).
  - Conduct system testing to verify integration between components.
  - Perform user acceptance testing (UAT) with a focus group of passengers and metro staff.
  - Test for scalability, load handling, and data security.

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6. Deployment

- **Objective: To implement the system in a real-world metro network.**
- **Key Activities:**
  - Deploy the system on live servers and integrate it with existing metro infrastructure.
  - Train metro staff on system usage and management.
  - Monitor initial deployment to resolve unforeseen issues promptly.

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7. Maintenance and Updates

- **Objective: To ensure the system remains functional, secure, and up to date.**
- **Key Activities:**
  - Provide regular updates for software improvements and feature additions.
  - Perform routine maintenance of hardware and software.
  - Monitor system performance and address user feedback.

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8. Data Collection and Analysis

- **Objective: To evaluate the system's performance and identify areas for improvement.**
- **Key Activities:**
  - Collect operational data on passenger usage, train schedules, and ticketing.
  - Analyze trends and patterns using analytics tools.
  - Use insights to optimize train schedules and improve service delivery.

Research Methodology

The research methodology for the Metro Management System follows a combination of qualitative and quantitative approaches:

1. **Qualitative Research:**
   - **Conduct stakeholder interviews and surveys to understand needs and pain points.**
   - **Observe current metro operations to identify inefficiencies.**
2. **Quantitative Research:**
   - **Collect and analyze data on passenger traffic, train schedules, and system downtime.**
   - **Use statistical tools and predictive models to validate system requirements and forecast usage patterns.**
3. **Iterative Development:**
   - **Employ an iterative or agile approach to system development, allowing for continuous feedback and refinement.**
4. **Case Study Analysis:**
   - **Study successful implementations of metro management systems in cities like Singapore, Delhi, and London to adopt best practices.**

PROJECT / RESEARCH OUTCOME

The development and implementation of the **Metro Management System** have resulted in significant advancements in urban transportation management. The project outcomes align with the defined objectives and address the critical challenges faced by metro rail systems. Below is a detailed overview of the research outcomes:

---

1. Enhanced Operational Efficiency

- Automation of ticketing, train scheduling, and resource management has minimized manual intervention, reducing errors and delays.
- Optimized train routes and schedules ensure minimal downtime and better connectivity across the metro network.

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2. Improved Passenger Experience

- Passengers benefit from seamless ticketing options, including smart cards, QR codes, and mobile apps, reducing long queues and wait times.
- Real-time updates on train schedules and delays via mobile applications and station displays have improved journey planning and reduced uncertainty.
- Multilingual support and user-friendly interfaces have made the system accessible to diverse populations.

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3. Effective Crowd Management

- AI-powered predictive analytics successfully manage passenger flow during peak hours, preventing overcrowding at platforms and within trains.
- Dynamic resource allocation based on passenger density has enhanced service reliability and passenger safety.

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4. Enhanced Safety and Security

- IoT-enabled surveillance systems, including CCTV cameras and sensors, ensure real-time monitoring of stations and trains, significantly improving safety.
- Emergency response systems integrated into the platform enable faster communication and resolution of incidents.

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5. Data-Driven Decision Making

- Comprehensive data collection and analytics have provided actionable insights into passenger behavior, peak-hour trends, and system performance.
- Administrators can now make informed decisions for future expansions, resource allocation, and system optimization.

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6. Scalability and Sustainability

- The system is scalable to accommodate future expansions, including new metro lines and increased passenger volumes.
- Adoption of energy-efficient technologies, such as regenerative braking and automated train systems, supports sustainable transportation goals.

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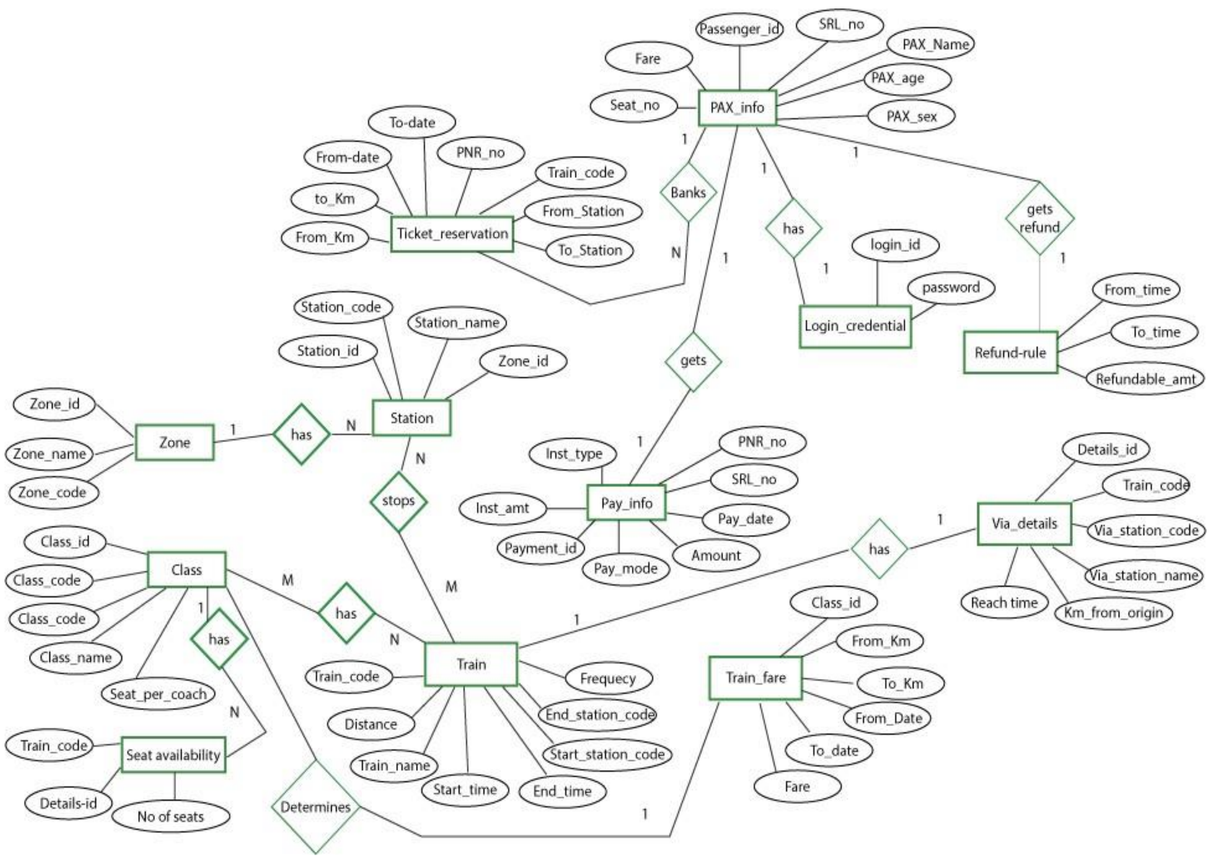
7. Alignment with Smart City Goals

- The implementation of the Metro Management System has contributed to reducing traffic congestion and carbon emissions, supporting smart city initiatives.
- Integration with other modes of transportation, such as buses and last-mile connectivity solutions, enhances overall urban mobility.

ER DIAGRAM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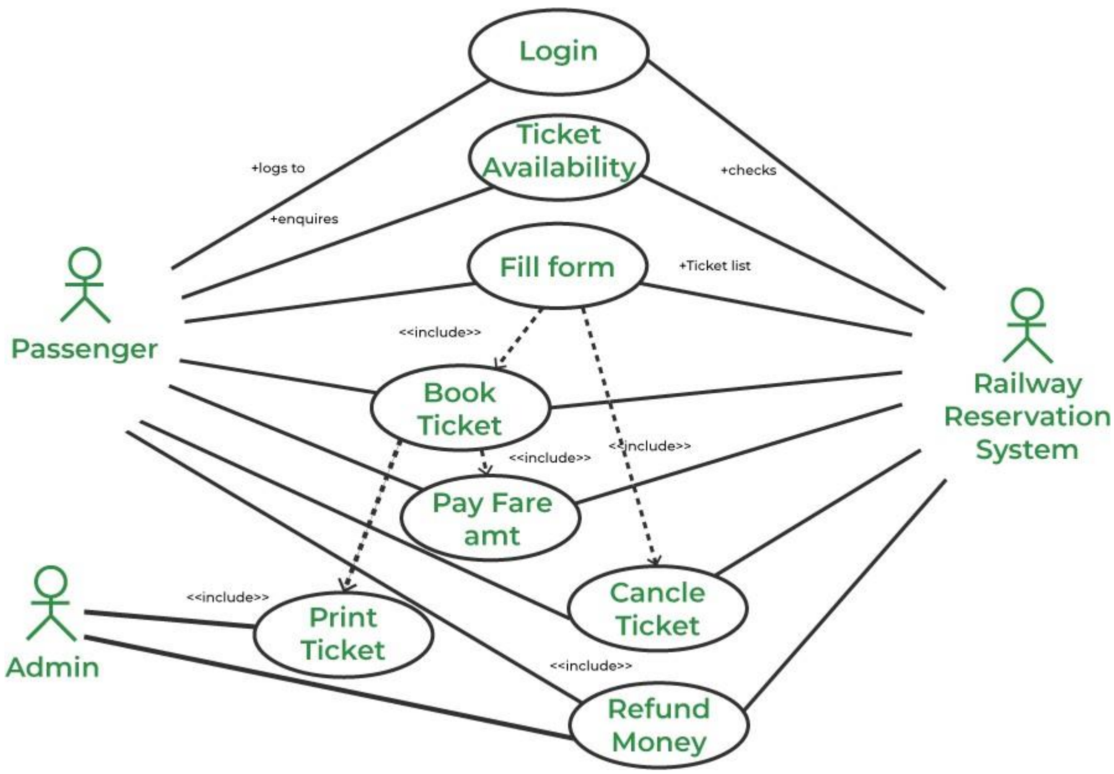
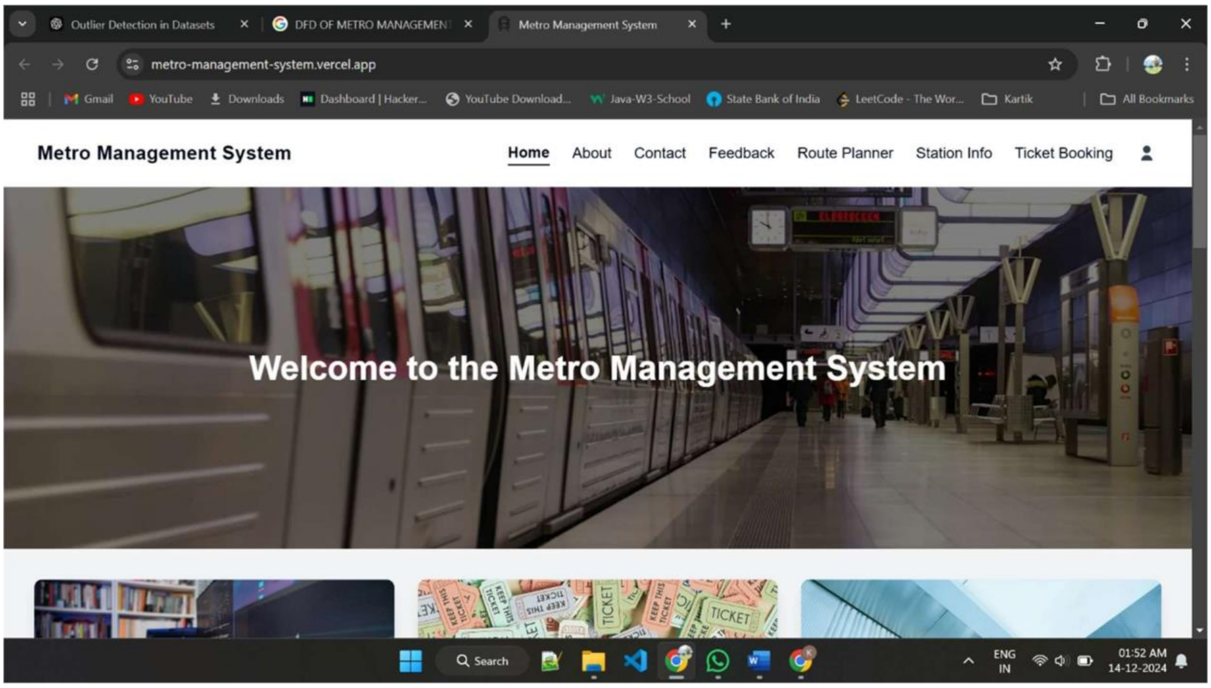
DATA FLOW DIAGRAM

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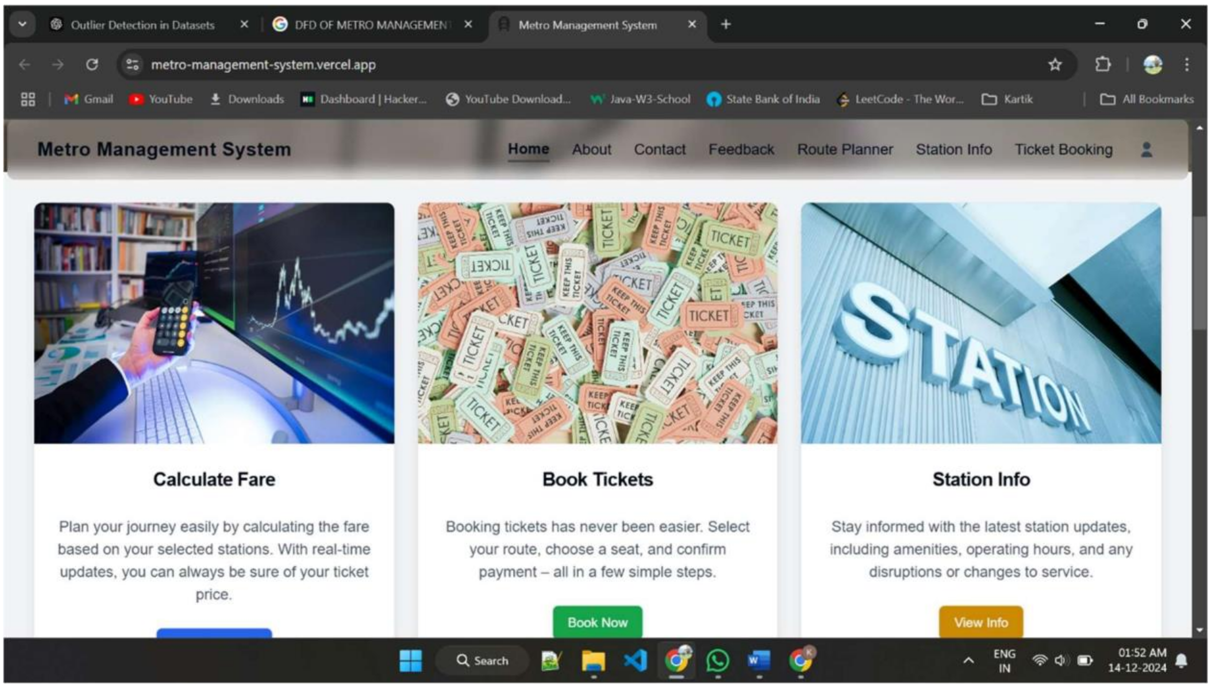
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Calculate Fare
Plan your journey easily by calculating the fare based on your selected stations. With real-time updates, you can always be sure of your ticket price.
Book Tickets
Booking tickets has never been easier. Select your route, choose a seat, and confirm payment – all in a few simple steps.
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Station Info
Stay informed with the latest station updates, including amenities, operating hours, and any disruptions or changes to service.
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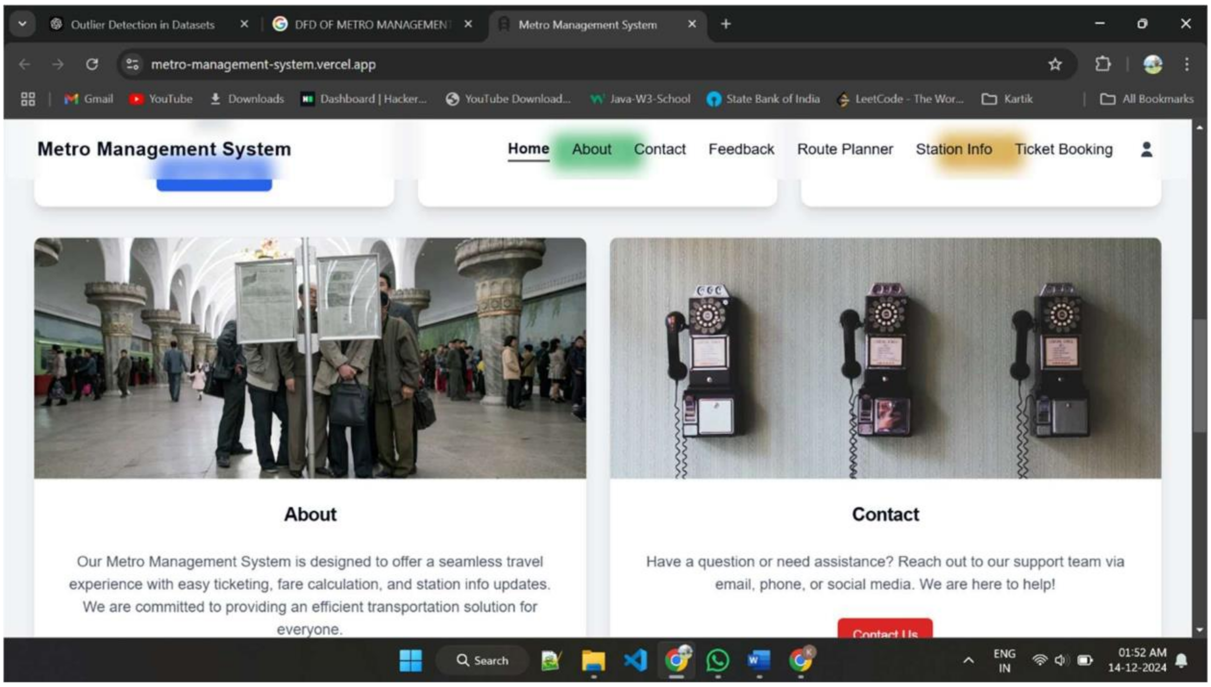
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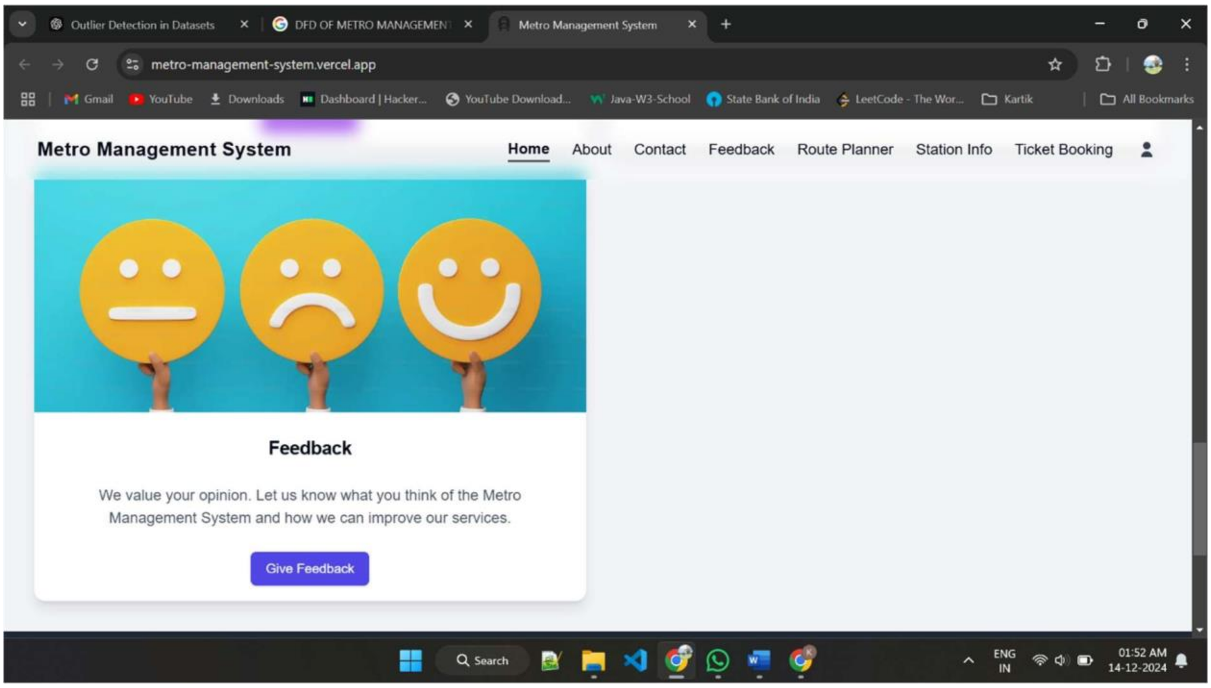
About
Our Metro Management System is designed to offer a seamless travel experience with easy ticketing, fare calculation, and station info updates. We are committed to providing an efficient transportation solution for everyone.
Contact
Have a question or need assistance? Reach out to our support team via email, phone, or social media. We are here to help!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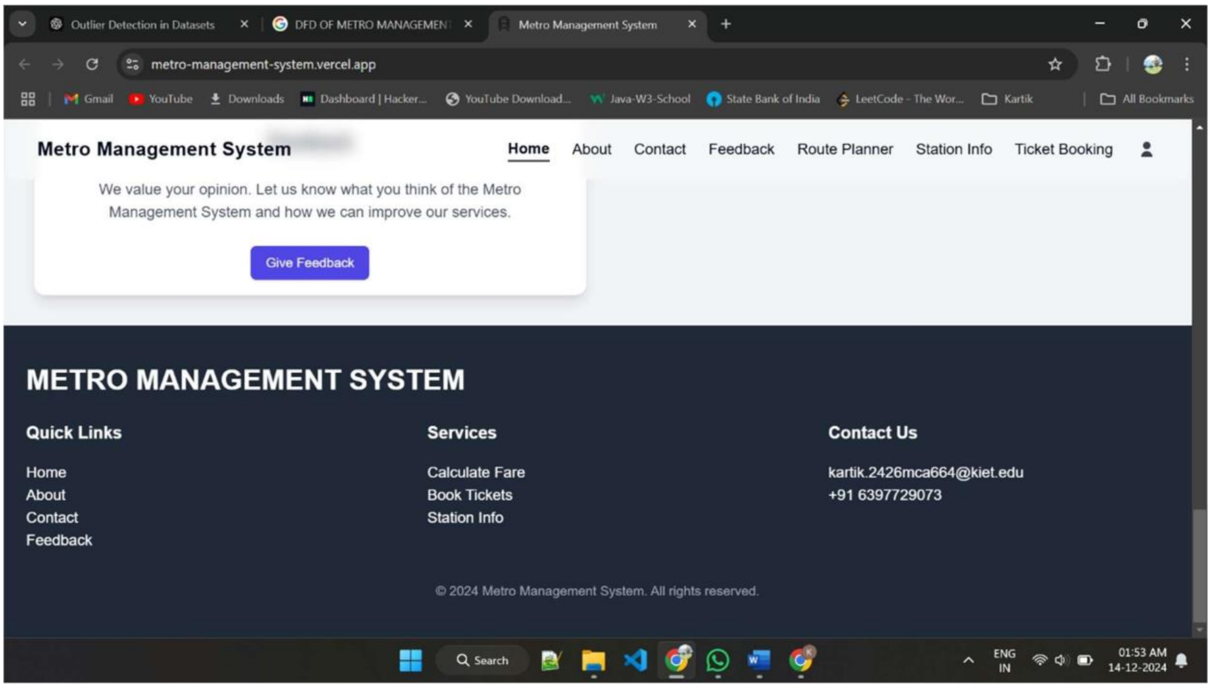
Give Feedback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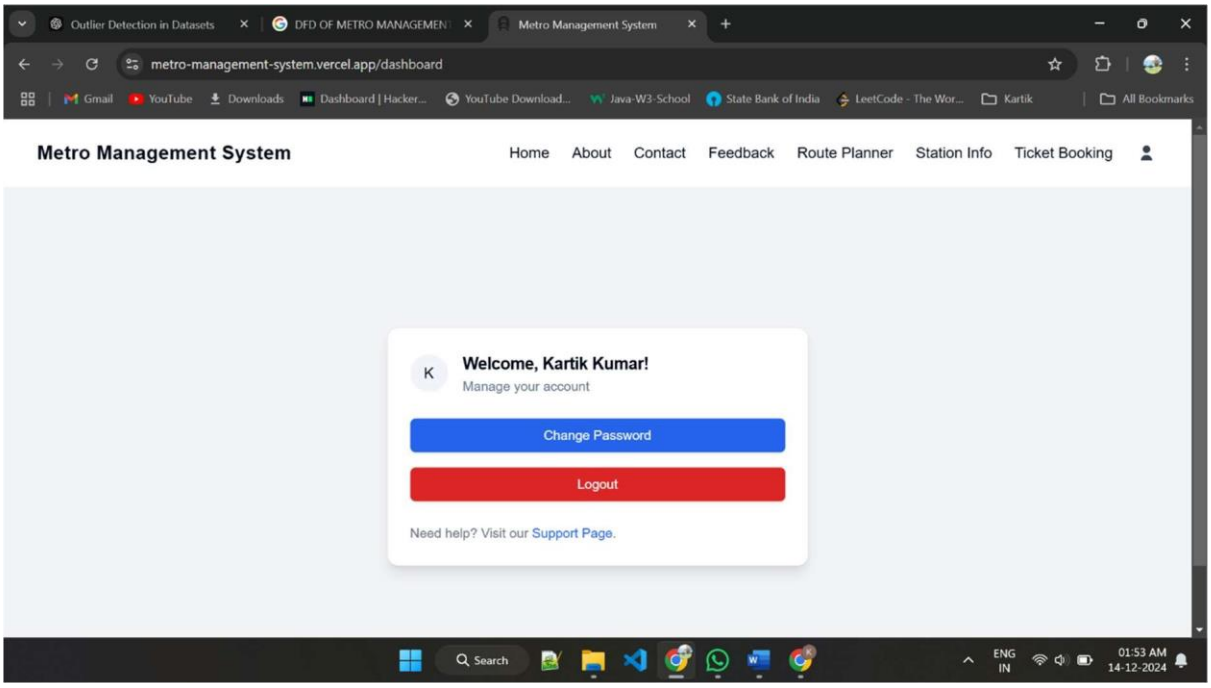
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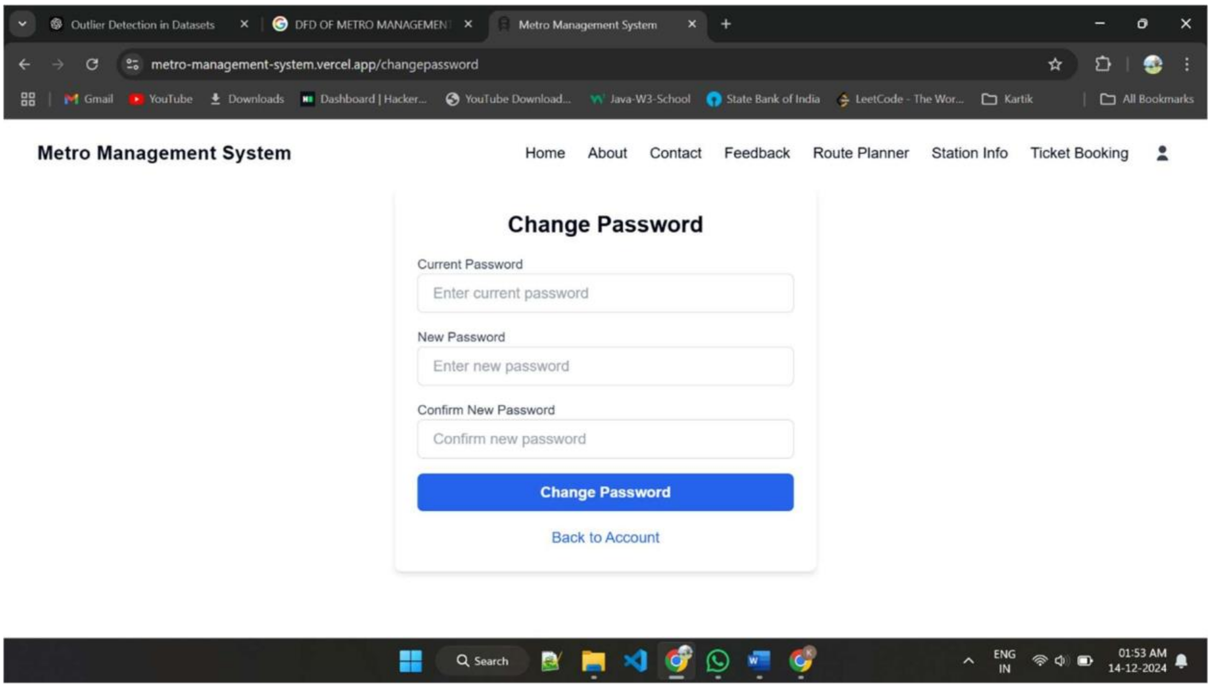
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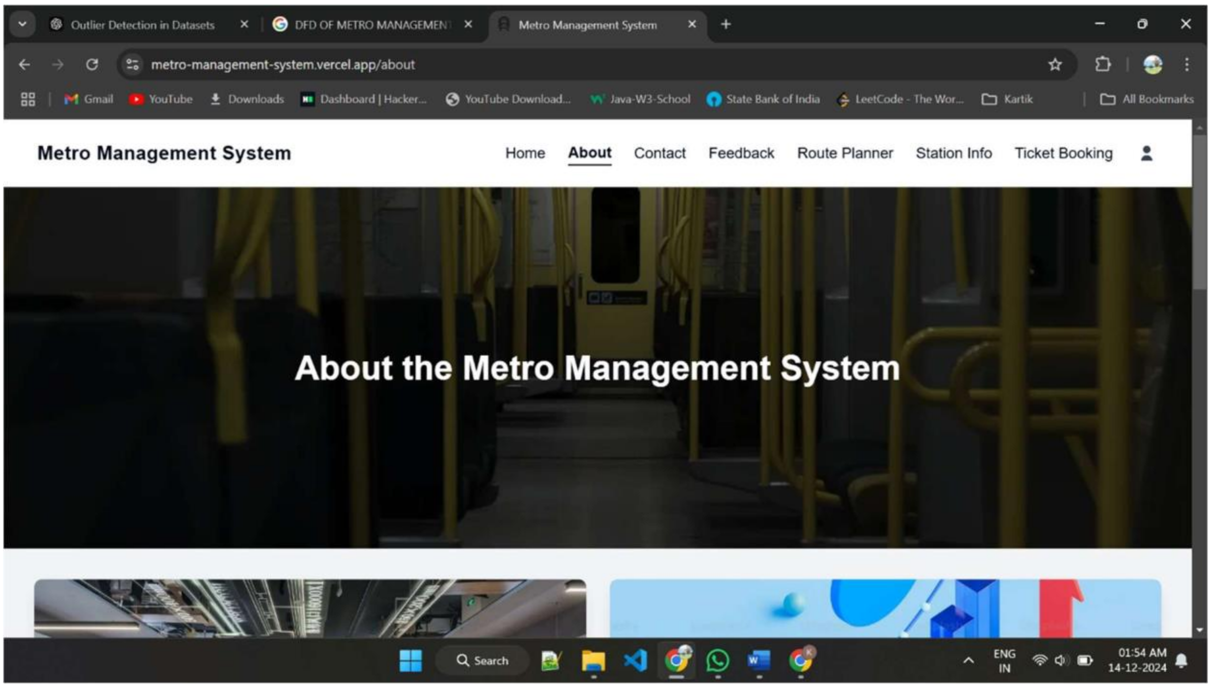
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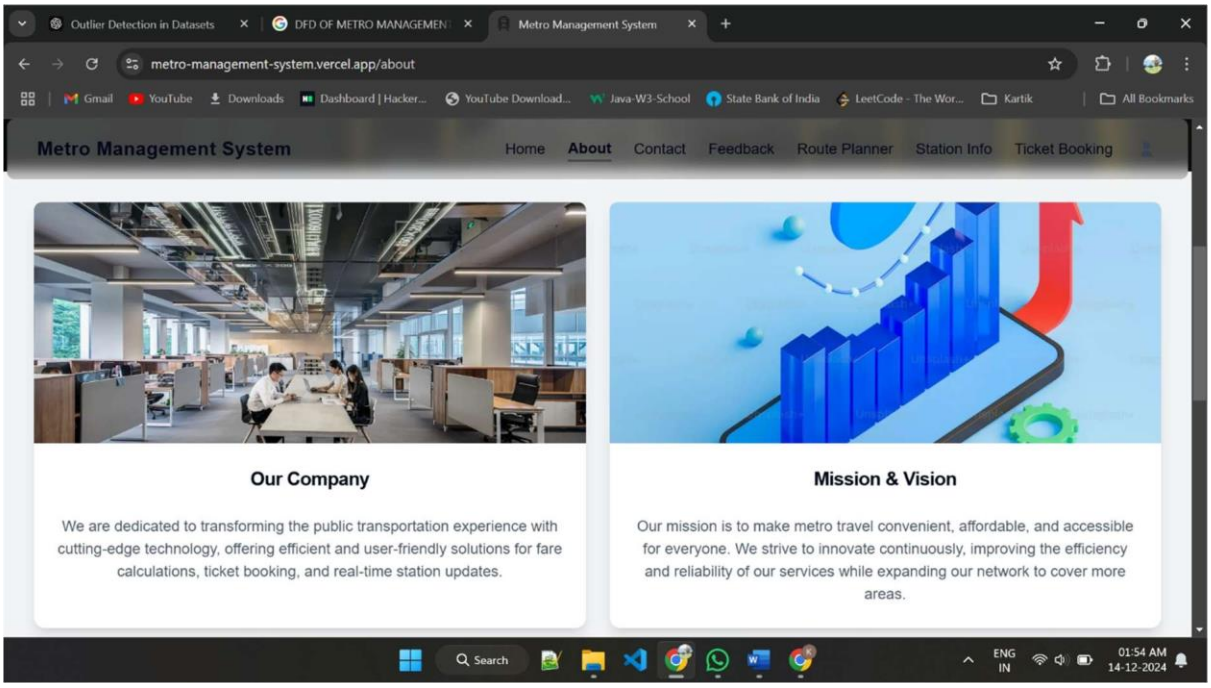
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Our Company
We are dedicated to transforming the public transportation experience with cutting-edge technology, offering efficient and user-friendly solutions for fare calculations, ticket booking, and real-time station updates.
Mission & Vision
Our mission is to make metro travel convenient, affordable, and accessible for everyone. We strive to innovate continuously, improving the efficiency and reliability of our services while expanding our network to cover more areas.
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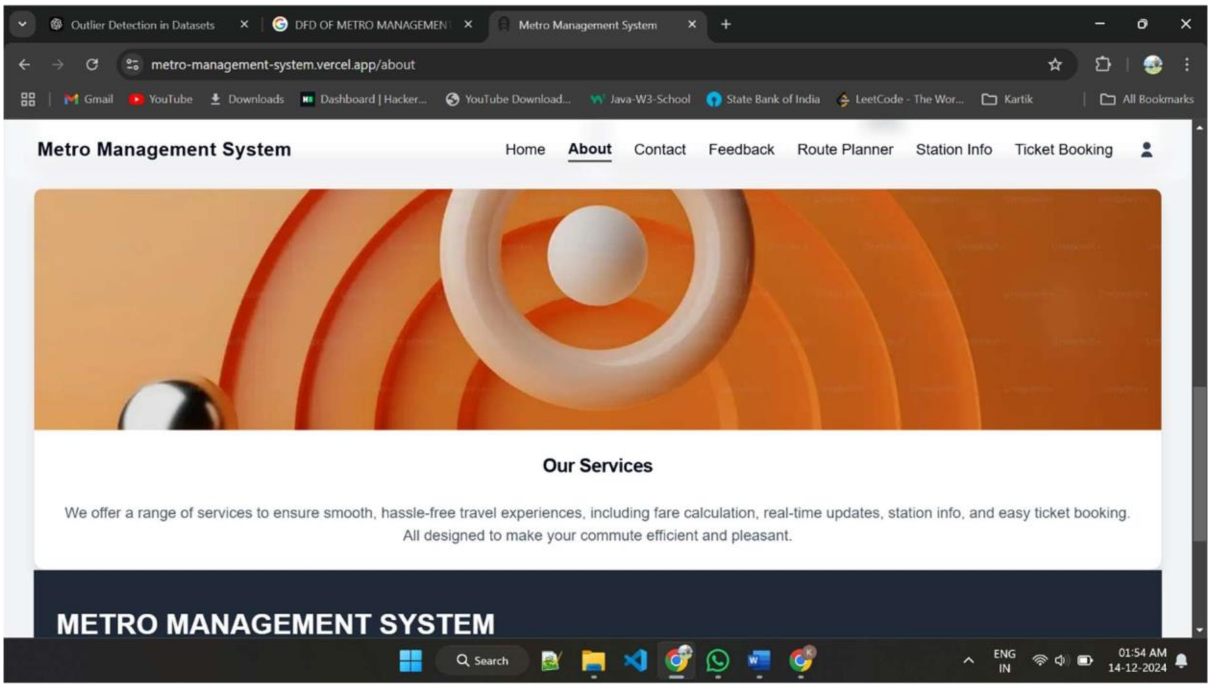
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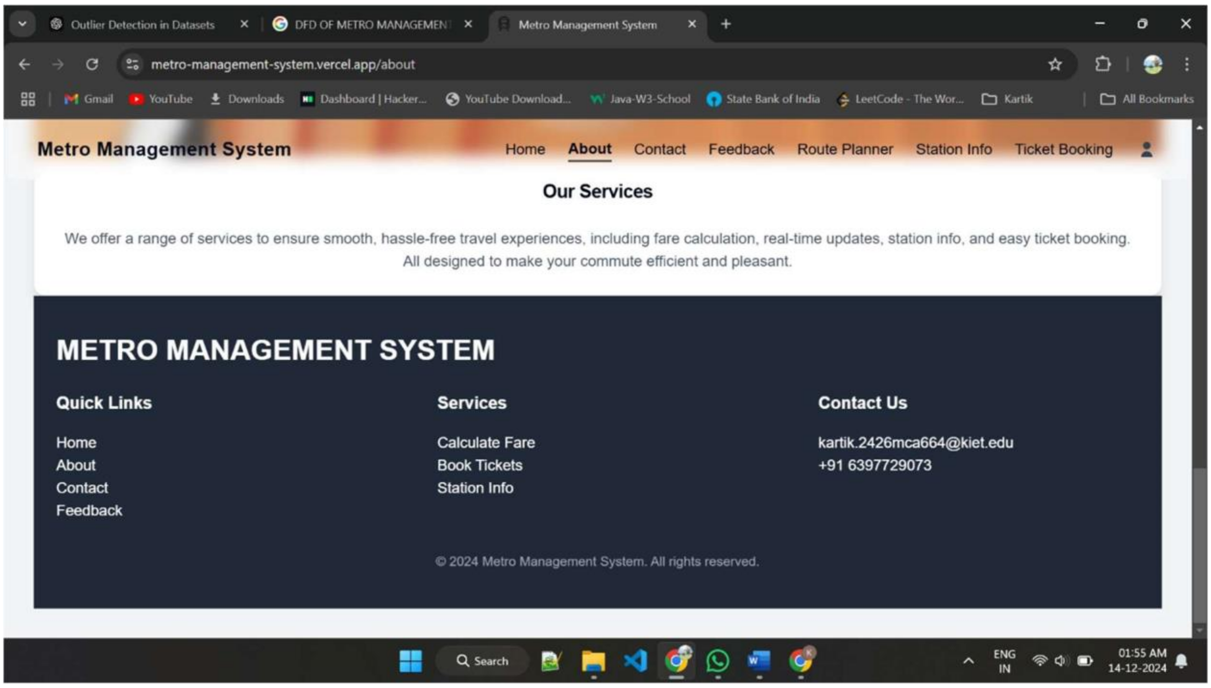
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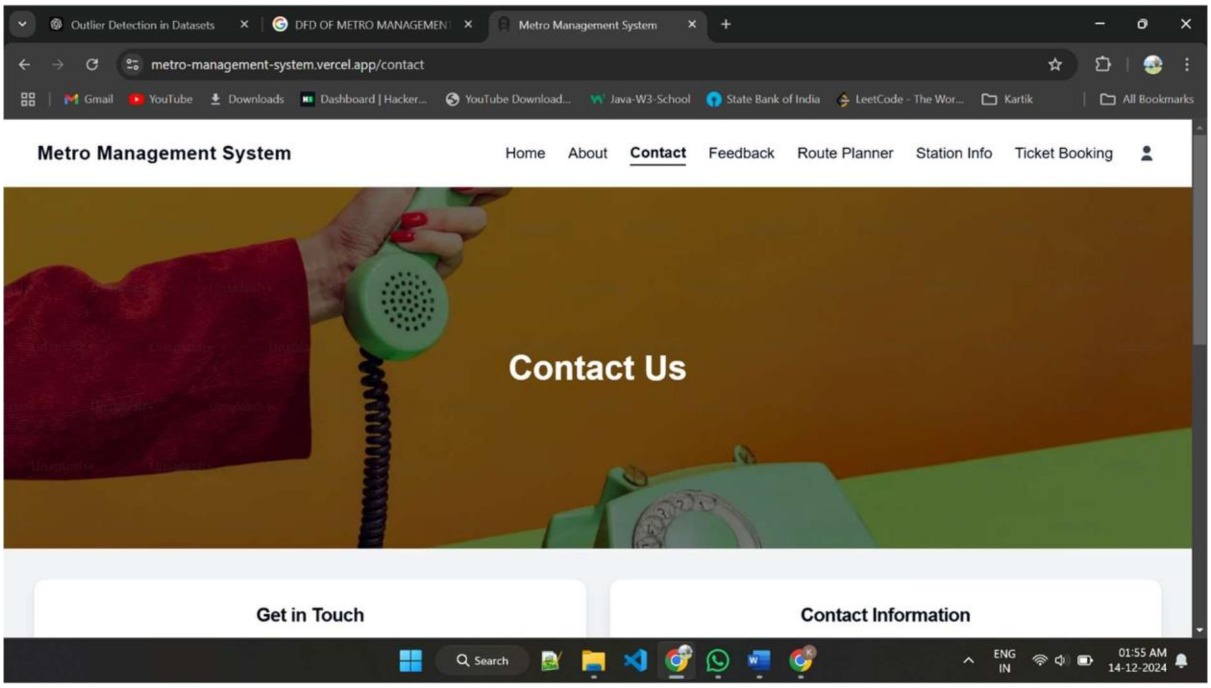
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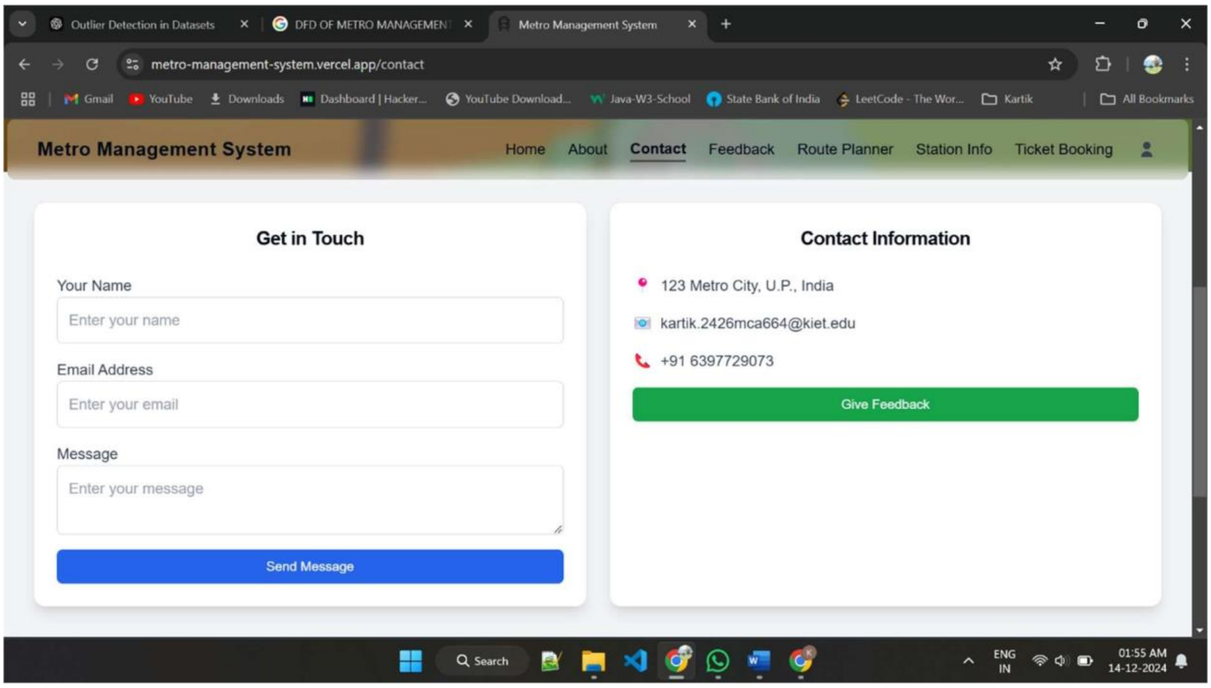

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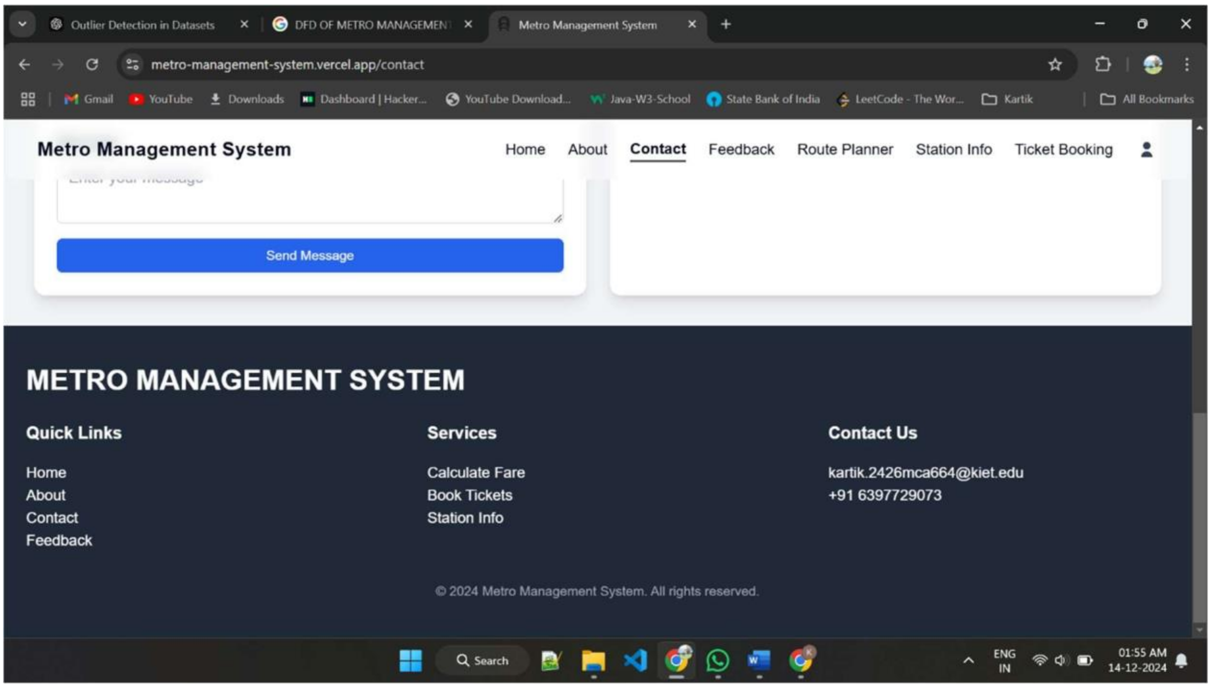

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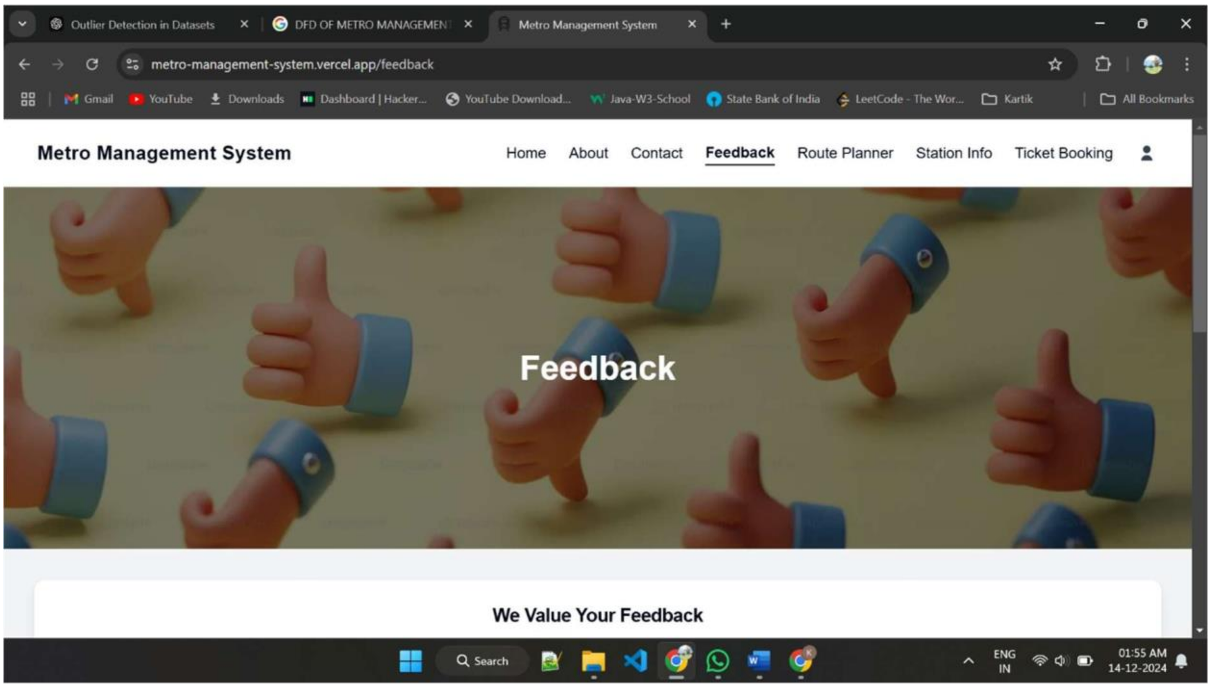

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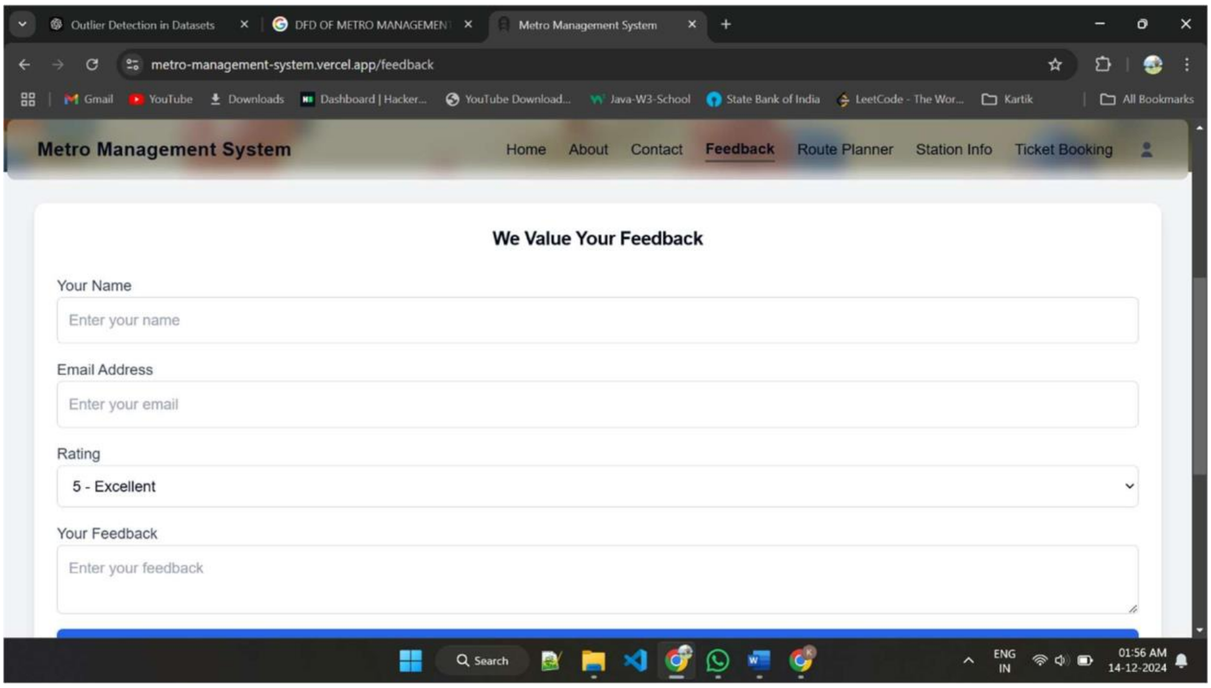

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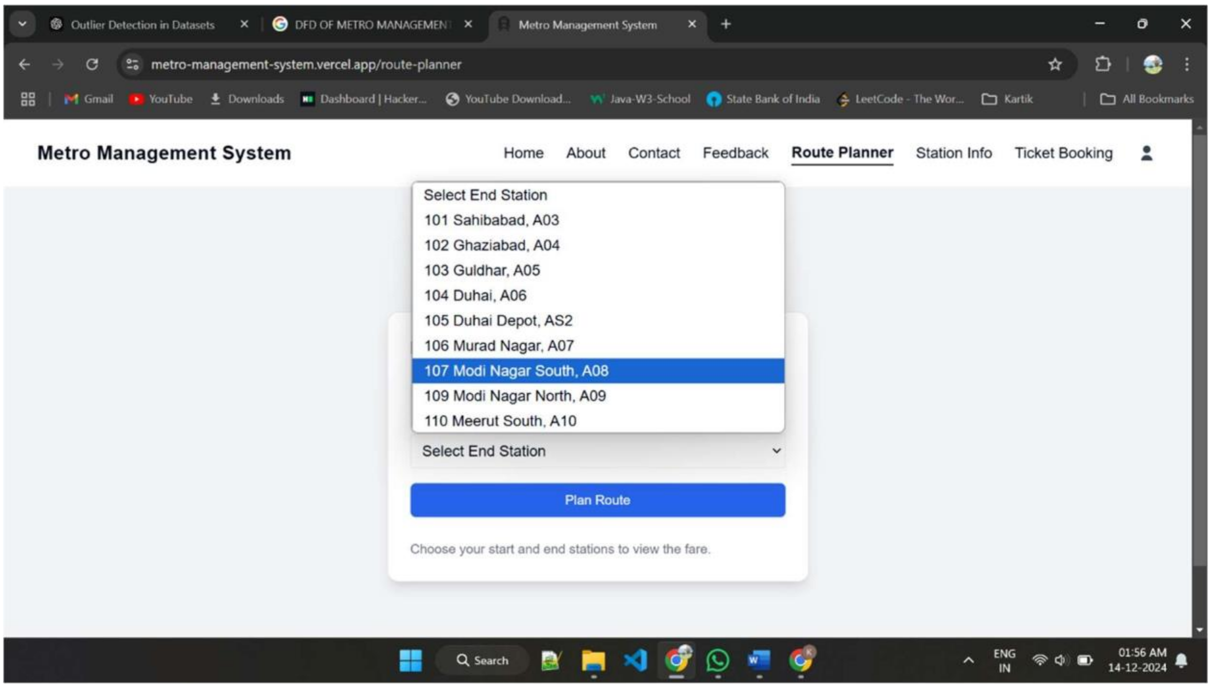
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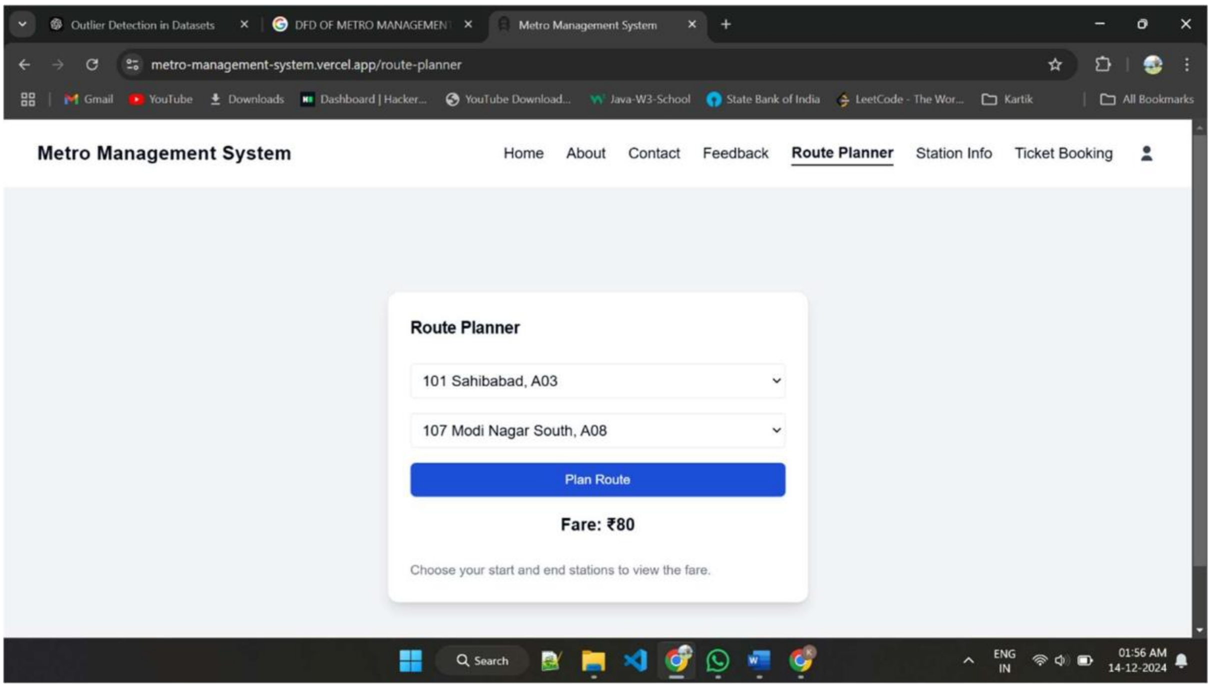
Select End Station
101 Sahibabad, A03
102 Ghaziabad, A04
103 Guldhar, A05
104 Duhai, A06
105 Duhai Depot, AS2
106 Murad Nagar, A07
107 Modi Nagar South, A08
109 Modi Nagar North, A09
110 Meerut South, A10
Select End Station
Plan Route
Choose your start and end stations to view the fare.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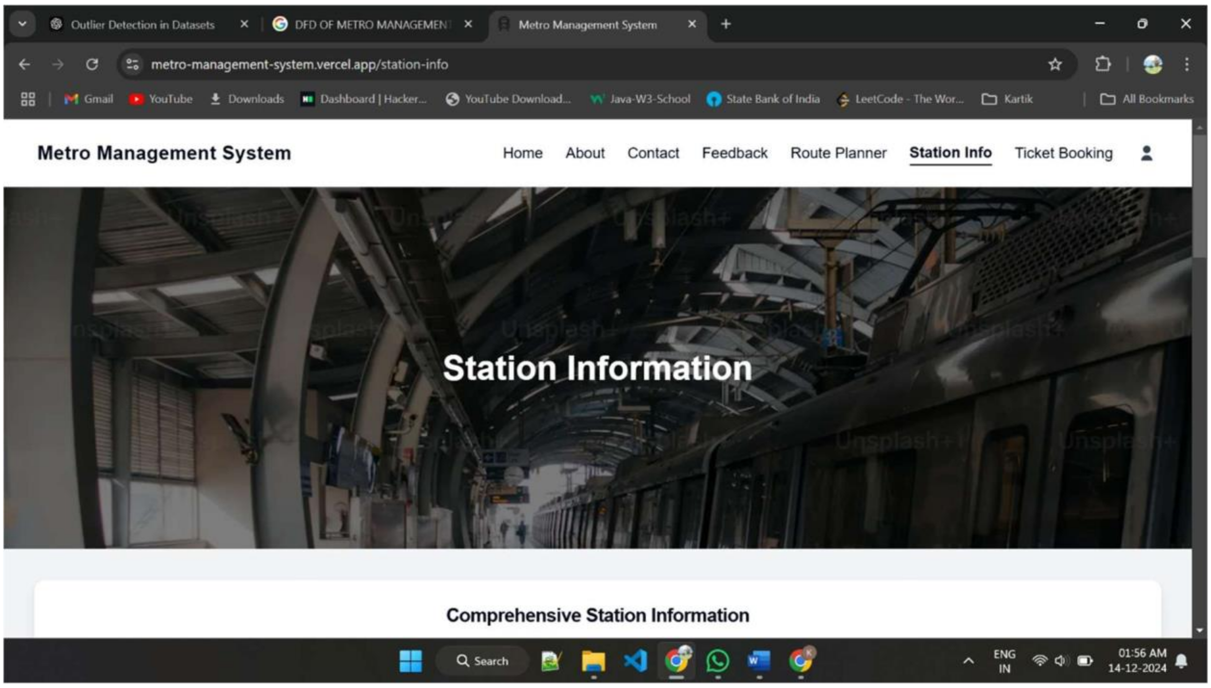
101 Sahibabad, A03
107 Modi Nagar South, A08
Plan Route
Fare: ₹80
Choose your start and end stations to view the fare.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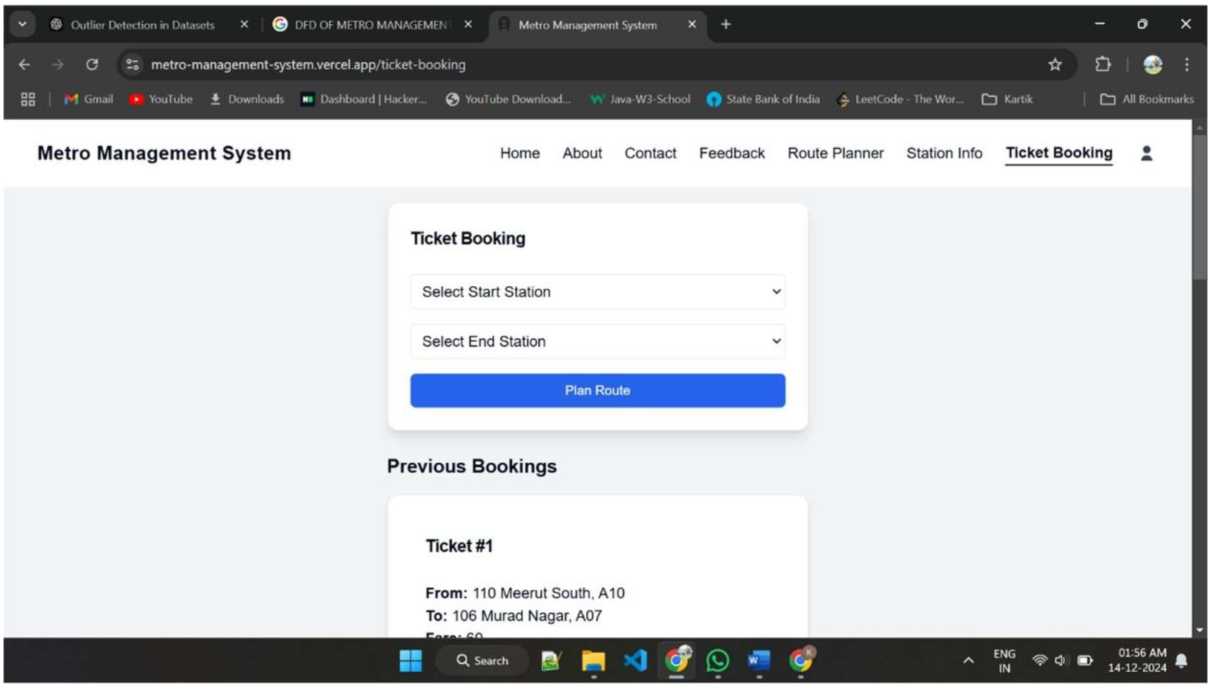
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Ticket #1
From: 110 Meerut South, A10
To: 106 Murad Nagar, A07
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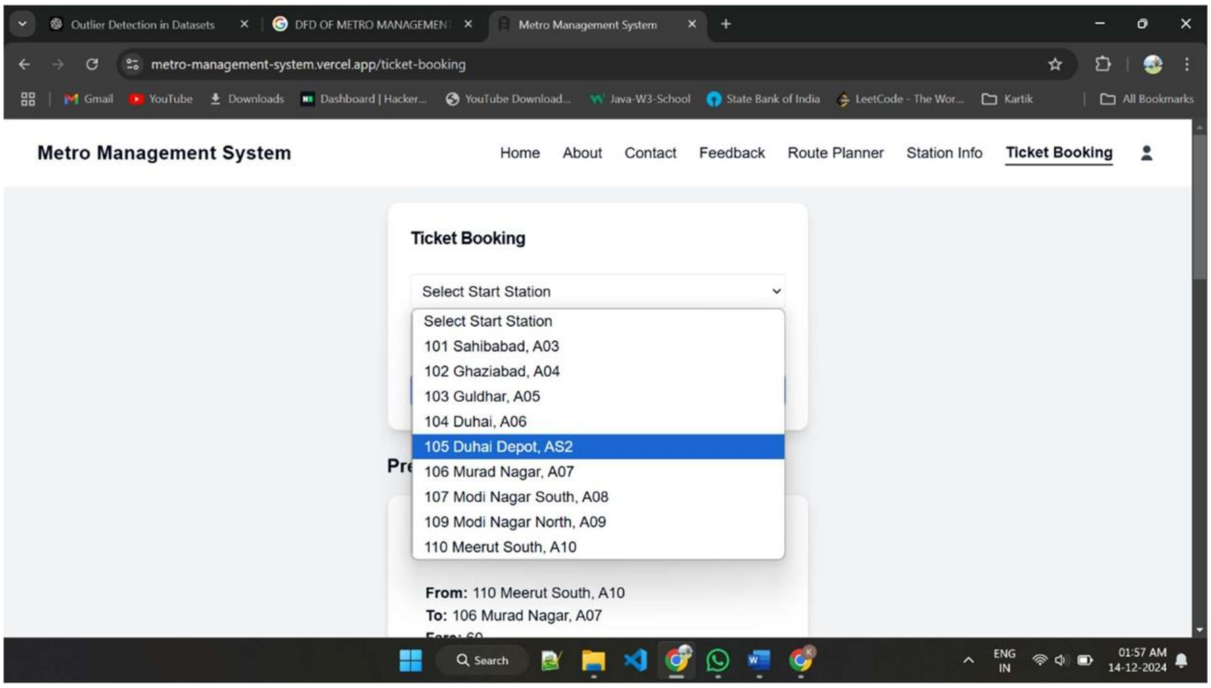
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Ticket Booking
Select Start Station
Select Start Station
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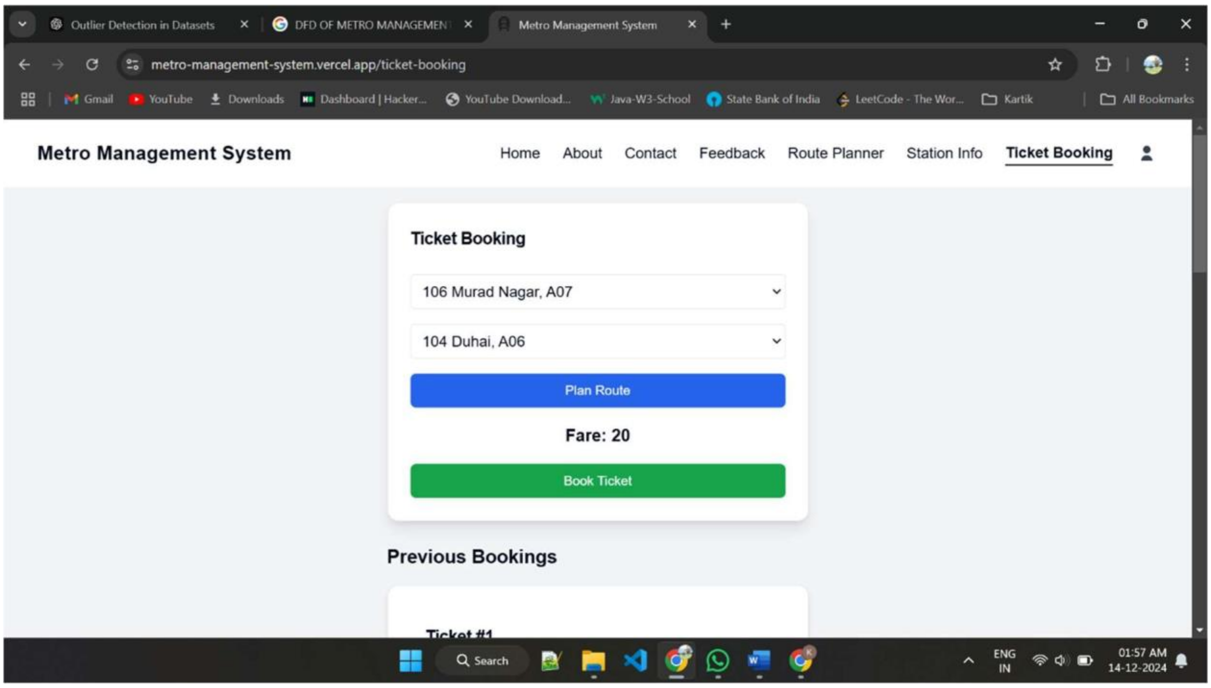
102 Ghaziabad, A04
103 Guldhar, A05
104 Duhai, A06
105 Duhai Depot, AS2
106 Murad Nagar, A07
107 Modi Nagar South, A08
109 Modi Nagar North, A09
110 Meerut South, A10
From: 110 Meerut South, A10
To: 106 Murad Nagar, A07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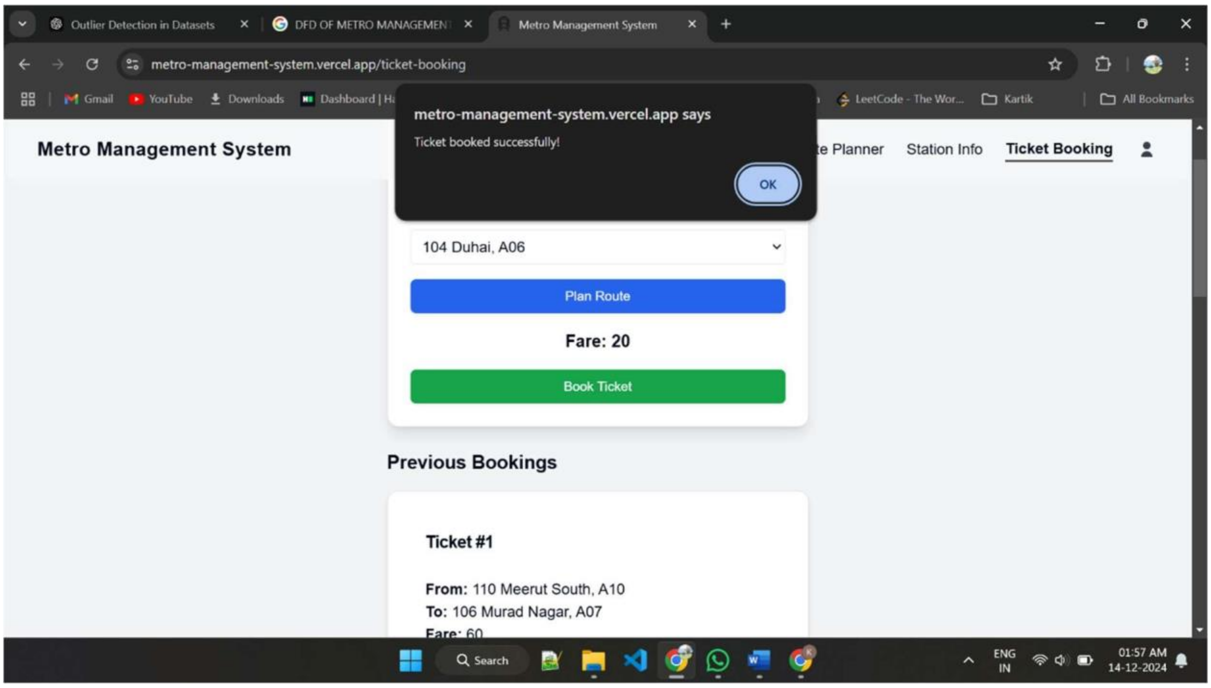
Ticket Booking
106 Murad Nagar, A07
104 Duhai, A06
Plan Route
Fare: 20
Book Ticket
Previous Bookings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metro-management-system.vercel.app says
Ticket booked successfully!
OK
Metro Management System
Station Info
Ticket Booking
104 Duhai, A06
Plan Route
Fare: 20
Book Ticket
Previous Bookings
Ticket #1
From: 110 Meerut South, A10
To: 106 Murad Nagar, A07
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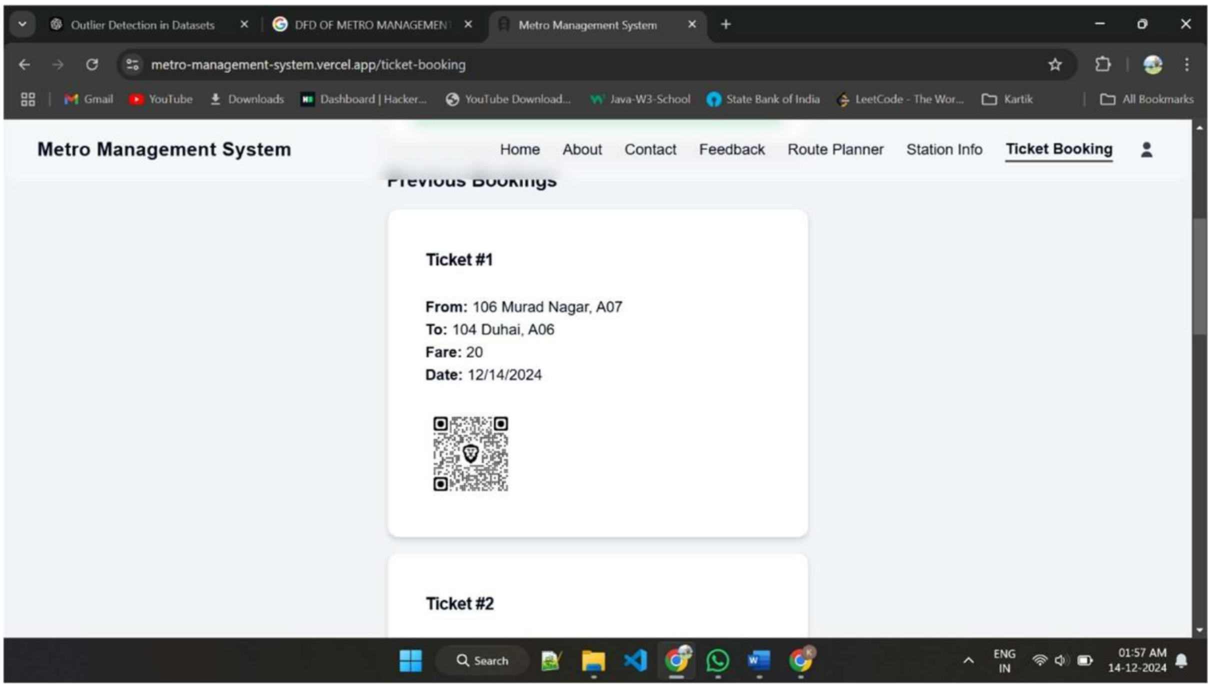
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Ticket #1
From: 106 Murad Nagar, A07
To: 104 Duhai, A06
Fare: 20
Date: 12/14/2024
Ticket #2
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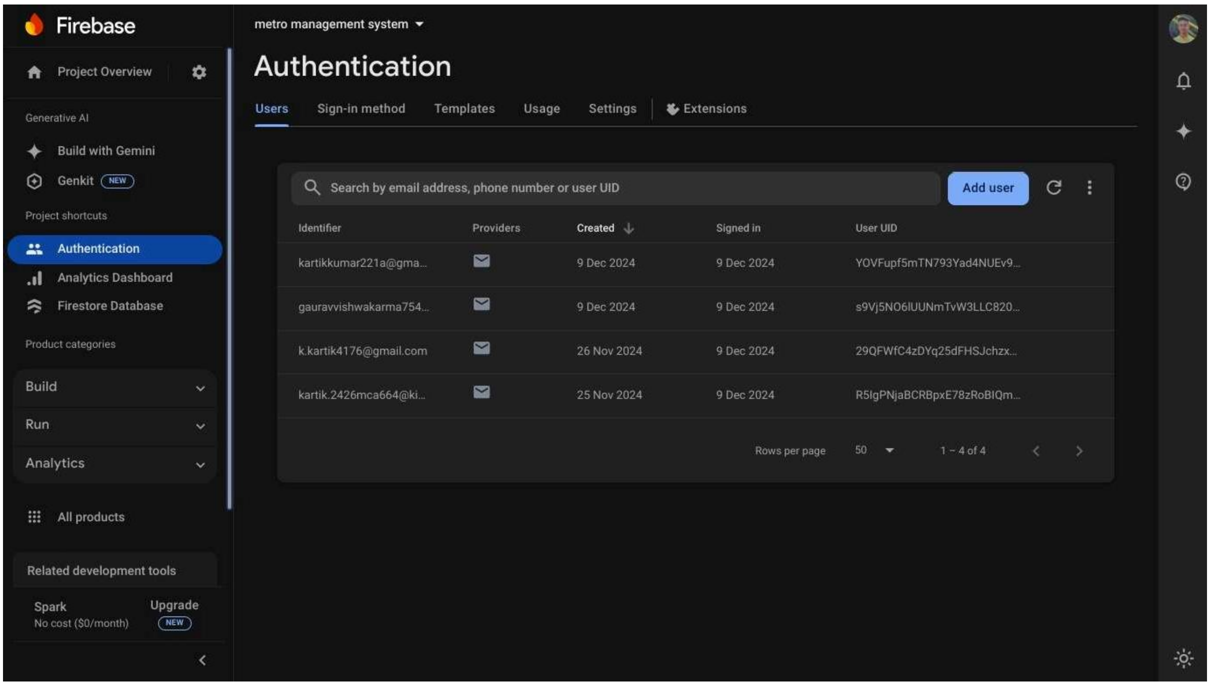
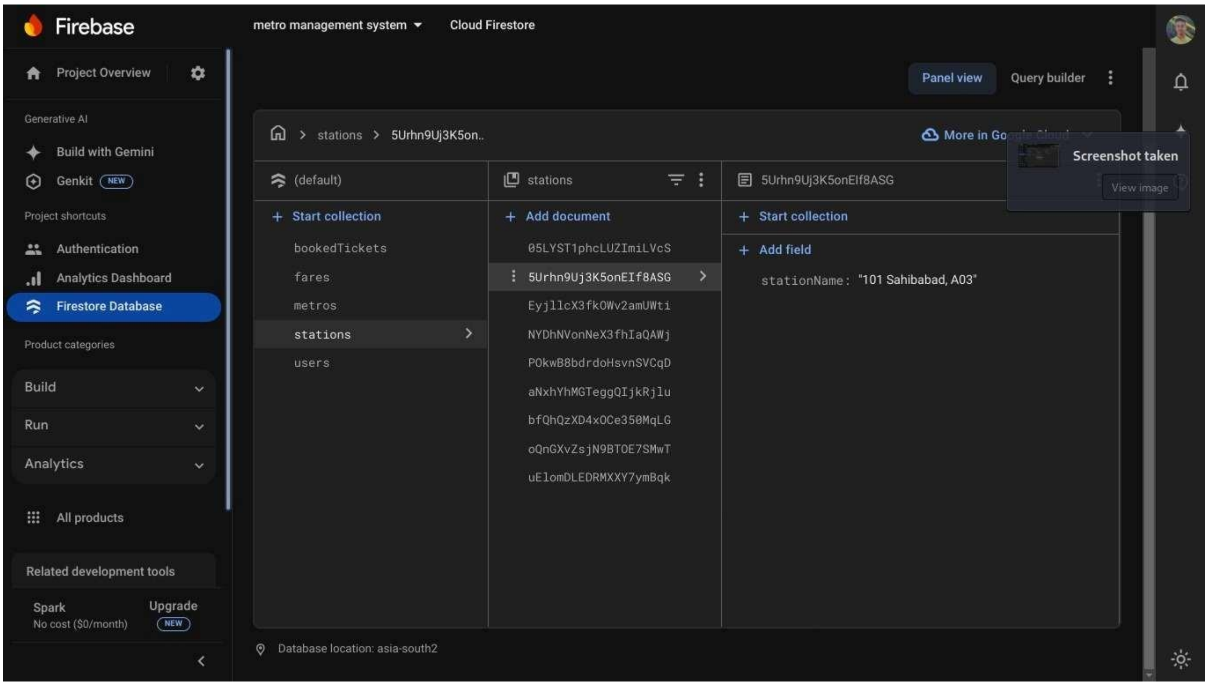
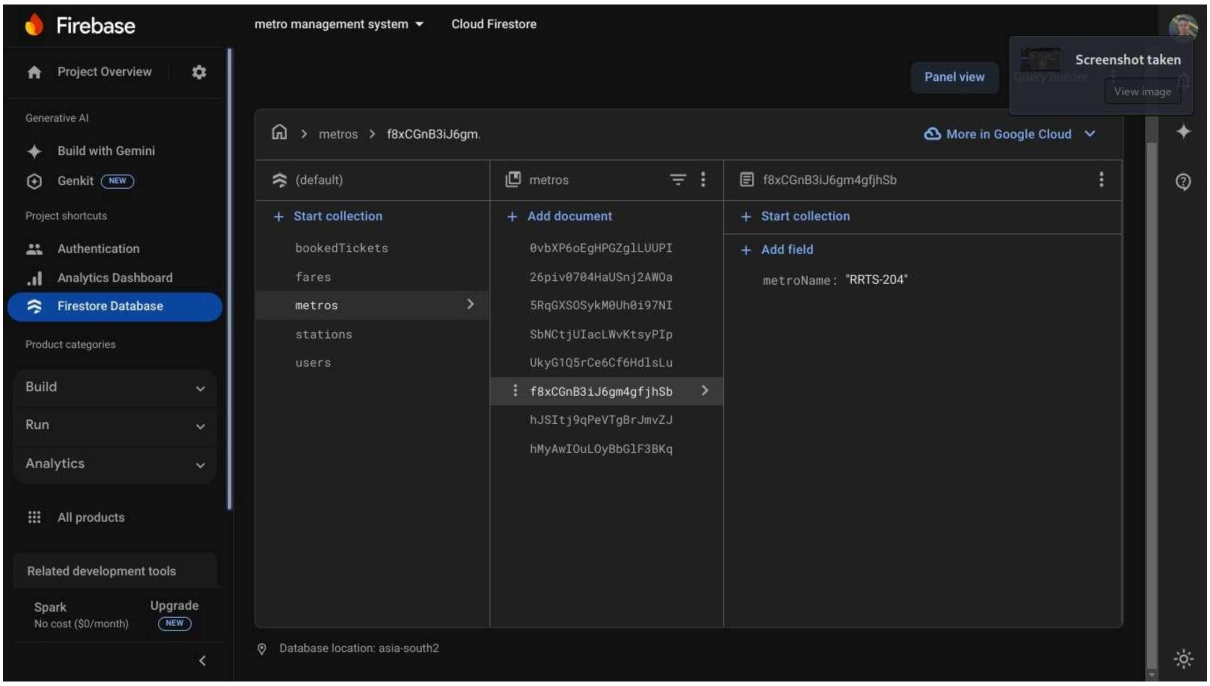
Backned Data



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Related development tools
Spark
No cost ($0/month)
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View image
metros > f8xCGnB3iJ6gm.
More in Google Cloud
(default)
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users
metros
Add document
0vbXP6oEgHPGZglLUUPI
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hJSItj9qPeVTgBrJmvZJ
hMyAwIOuLOyBbGlF3BKq
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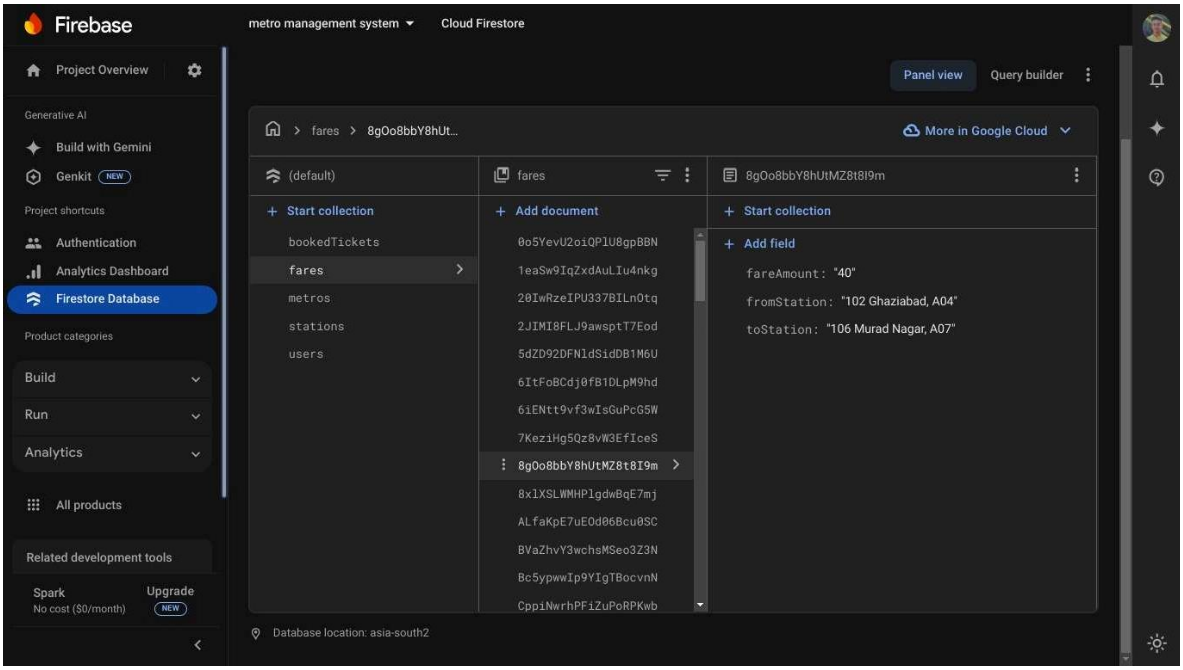
Start collection
Add field
metroName: "RRTS-204"
Database location: asia-south2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fares > 8gOo8bbY8hUt...
More in Google Cloud
(default)
Start collection
bookedTickets
fares
metros
stations
users
fares
Add document
0o5YevU2oiQPlU8gpBBN
1eaSw9IqZxdAuLIu4nkg
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CppiNwrhPFiZuPoRPKwb
8gOo8bbY8hUtMZ8t8I9m
Start collection
Add field
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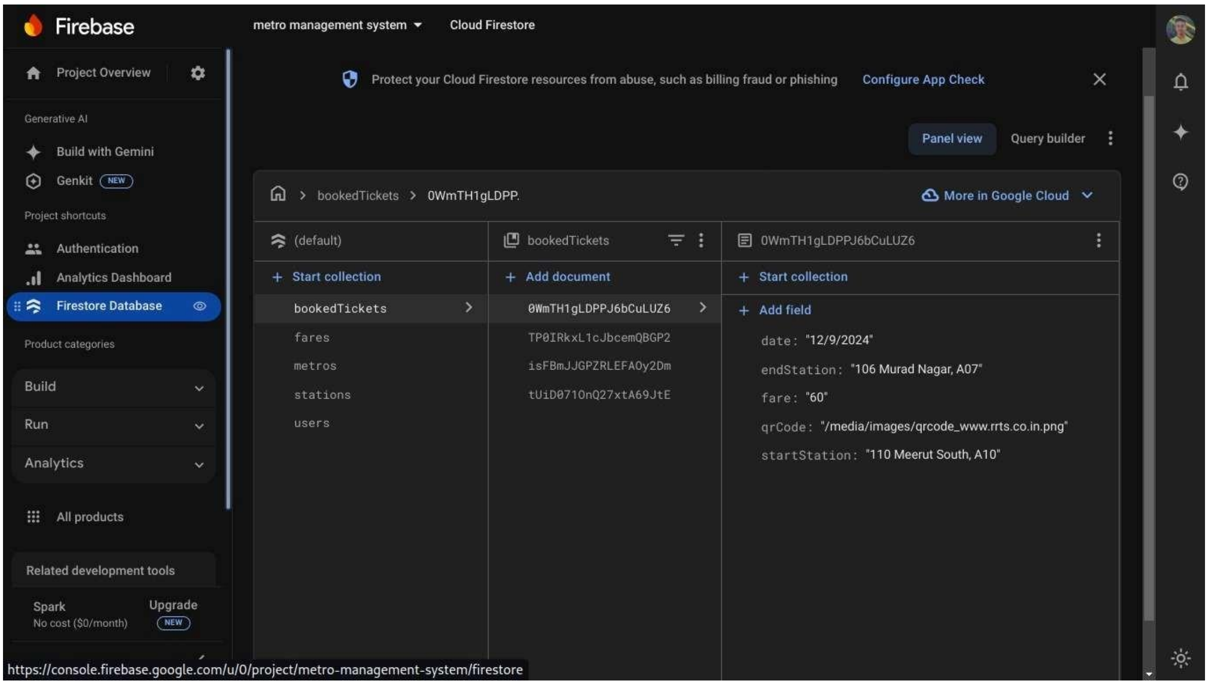
toStation: "106 Murad Nagar, A07"
Database location: asia-south2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bookedTickets > 0WmTH1gLDPP.
More in Google Cloud
(default)
bookedTickets
0WmTH1gLDPPJ6bCuLUZ6
Start collection
Add document
Start collection
bookedTickets
fares
metros
stations
users
0WmTH1gLDPPJ6bCuLUZ6
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isFBmJJGPZRLEFAOy2Dm
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Add field
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endStation: "106 Murad Nagar, A07"
fare: "60"
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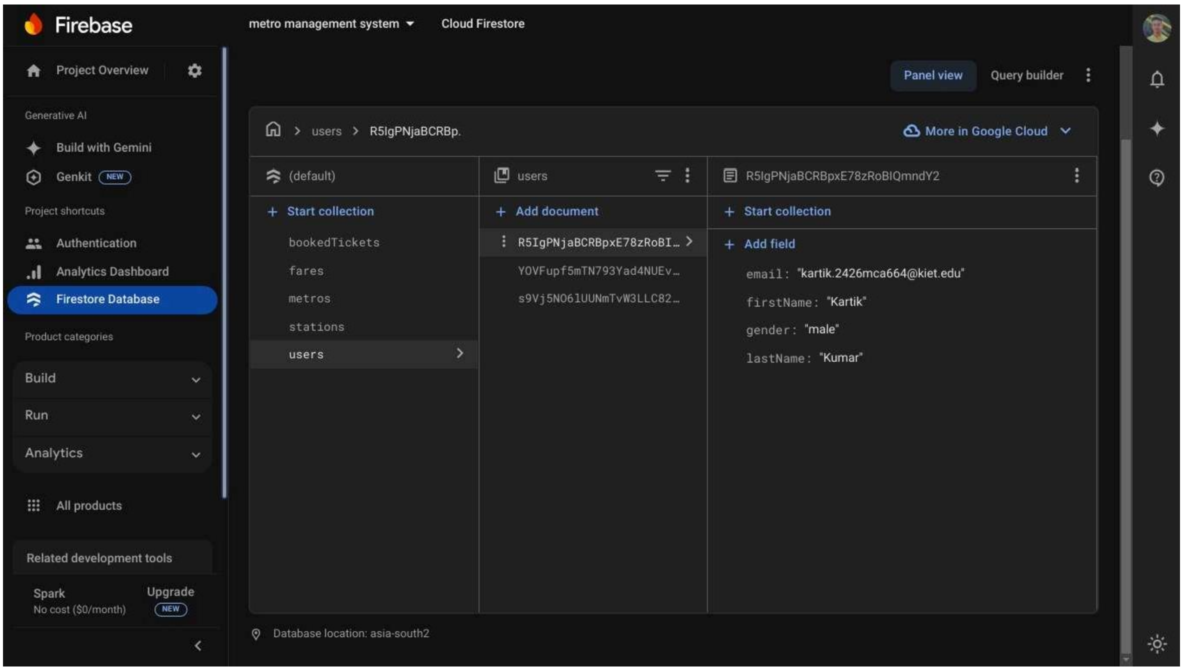
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stations
users
R5IgPNjaBCRBpxE78zRoBI…
YOVFupf5mTN793Yad4NUEv…
s9Vj5NO6lUUNmTvW3LLC82…
Add field
email: "kartik.2426mca664@kiet.edu"
firstName: "Kartik"
gender: "male"
lastName: "Kumar"
Database location: asia-south2

PROPOSED TIME DURATION

Phase	Duration
Requirement Analysis	1 Week
System Design	2 Weeks
Development	3 Weeks
Testing	2 Weeks
Deployment	1 Week
Evaluation and Feedback	3 Days