JOBURG TRANSIT DOCUMENTATION

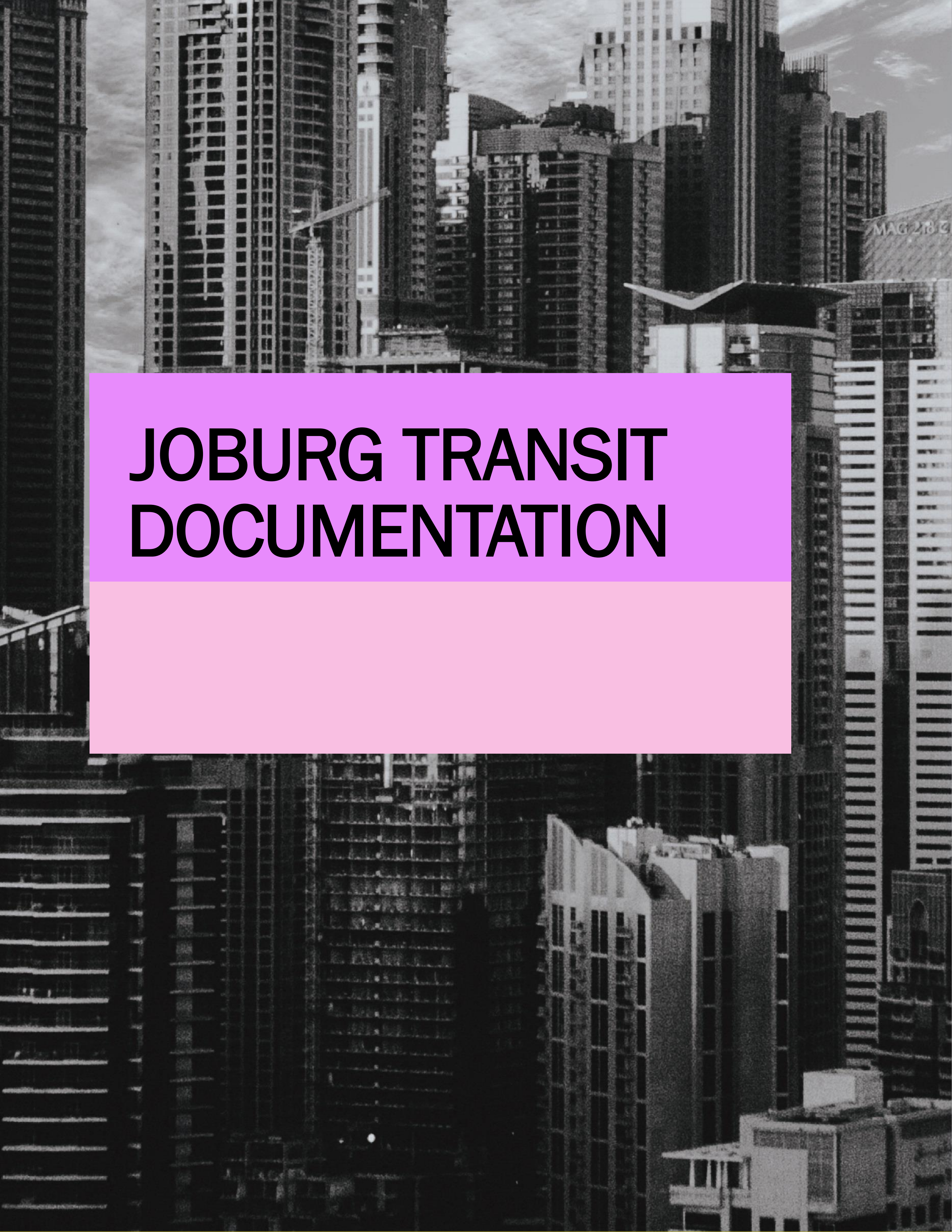


TABLE OF CONTENTS

PROJECT OVERVIEW & TEAM INTRODUCTION

Project Title:

Joburg Transit Predict: Real-Time Bus Prediction and Trip Planning for Johannesburg

Executive Summary:

"Joburg Transit Predict "is an AI-powered platform designed to provide highly accurate, real-time bus arrival predictions and comprehensive trip planning information for Johannesburg's public bus network. It aims to enhance the rider experience by offering transparency and reliability, thereby encouraging greater public transport adoption, addressing the challenge of unpredictable bus arrival times due to various factors like traffic congestion, road incidents, vehicle breakdowns, and driver availability.

Team Members:

1) Motlatsi Moropa
2) Lesego Selebogo
3) Edward Hlapane
4) Katlego Makete
5) Banele Nkambule

Chosen Sector: (Transportation)

We have chosen the transportation sector, and below is the justification for why we chose this sector.

Justification: Public bus transportation in Johannesburg often suffers from unpredictable arrival times due to various factors like traffic congestion, road incidents, vehicle breakdowns, and driver availability. This lack of real-time information makes it difficult for commuters to plan their journeys, leading to long wait times, missed connections, and overall frustration, ultimately discouraging the use of public transport. This presents a significant opportunity for AI to improve urban mobility and public service.

SECTOR RESEARCH & PROBLEM DEFINITION

Existing AI Applications in the Sector:

1. **Google Maps & Waze – AI-Powered Navigation:**

- **Function:** Uses real-time traffic data, GPS signals, and historical driving trends to predict congestion and suggest optimal routes.
- **AI Capabilities:** Detects road incidents, construction zones, and traffic jams; dynamically reroutes users.
- **Benefits:** Reduces travel time, minimizes congestion, and enhances overall commuting experience.
- **Reference:** Google (2020).

2. **Moovit's Transit AI Platform:**

- **Function:** Integrates crowdsourced data, official transit schedules, and AI algorithms to offer real-time public transport updates.
- **AI Capabilities:** Predicts accurate bus/train arrival times, provides service disruption alerts and trip suggestions, and learns usage patterns to improve routing and timing.
- **Benefits:** Supports over 3,000 cities, improves trip reliability and accessibility, and increases commuter trust in public transport.
- **Reference:** Moovit (2025).

3. **Optibus—AI for Public Transport Scheduling:**

  - **Function:** Optimizes bus routes, driver shifts, and vehicle assignments using AI-powered planning tools.
  - **AI Capabilities:** Analyzes ridership trends and historical data, balances fleet efficiency with commuter demand, and adapts to traffic patterns and service constraints.
  - **Benefits:** Reduces operational costs, improves service frequency and reliability, and enables smarter citywide transit planning.
  - **Reference:** Optibus (2024).

Problem Identification & Definition:

Problem:

Public bus transportation in Johannesburg suffers from unpredictable arrival times. This is due to factors such as traffic congestion, road incidents, vehicle breakdowns, and driver availability.

Current State:

This lack of real-time information makes it difficult for commuters to plan their journeys, leading to long wait times, missed connections, and overall frustration, ultimately discouraging the use of public transport.

Pain Points:

The unpredictability leads to decreased public transport usage and contributes to urban traffic congestion as more people choose private cars, worsening urban traffic congestion and increasing carbon emissions in the city.

Quantifiable Impact Metrics:

- **Private Vehicle Usage:** Current estimate of +5–8% increase per year, leading to increased road congestion and carbon emissions.
- **Average Bus Wait Time:** Current estimate of 15–20 minutes, resulting in wasted time, stress, and missed appointments/work.
- **CO_2 Emissions (Transport Sector):** Currently increasing, contributing to health issues (pollution) and environmental concerns.
- **Why AI is the Solution:** AI can process vast amounts of dynamic (GPS, real-time traffic, weather) and static (schedules, topography) data to learn complex patterns and provide highly accurate real-time predictions, which is beyond the scope of traditional static schedules. AI can also analyze unstructured data like social media for disruption detection, providing a comprehensive view for dynamic adjustments that human-managed systems struggle with.
- **Reference:** Lukhele, S. & Sinclair, M. (2020).

AI PROTOTYPE DESIGN & TECHNICAL SPECIFICATIONS

Proposed AI Solution Description:

"Joburg Transit Predict" is an AI-powered platform designed to provide highly accurate, real-time bus arrival predictions and comprehensive trip planning information for Johannesburg's public bus network. It aims to enhance the rider's experience by offering transparency and reliability, thereby encouraging greater public transport adoption. The solution will primarily interact with users through a dedicated mobile application and potentially through digital displays at major bus stops.

Technical Specifications:

AI Technology Utilized:

- Predictive Analytics: "Joburg Transit Predict" is an AI-powered platform designed to provide highly accurate, real-time bus arrival predictions and comprehensive trip planning information for Johannesburg's public bus network. It aims to enhance the rider's experience by offering transparency and reliability, thereby encouraging greater public transport adoption. The solution will primarily interact with users through a dedicated mobile application and potentially through digital displays at major bus stops.
- Text generation/analysis (Disruption Detection & Management): Natural Language Processing (NLP) will analyze social media feeds, news alerts, and official updates for keywords indicating accidents, protests, road closures, or bus breakdowns.
- Classification/Anomaly Detection (Disruption Detection & Management): Monitoring real-time bus speeds and stop durations against learned patterns to detect unexpected delays or prolonged stops that may indicate an issue.
- No-code Tool: We had decided to use Canva AI.

Data Ingestion & Pre-processing:

- Sources: GPS data from all active buses, historical bus schedule data, historical traffic data (from city traffic sensors, Google Maps API, etc.), real-time traffic incidents (from JMPD, Waze API, social media monitoring), weather data (API), public holidays/events calendar data.
- AL/ML for preprocessing: data cleaning and normalization to handle missing values, outliers, and inconsistent formats.

Prototype Components:

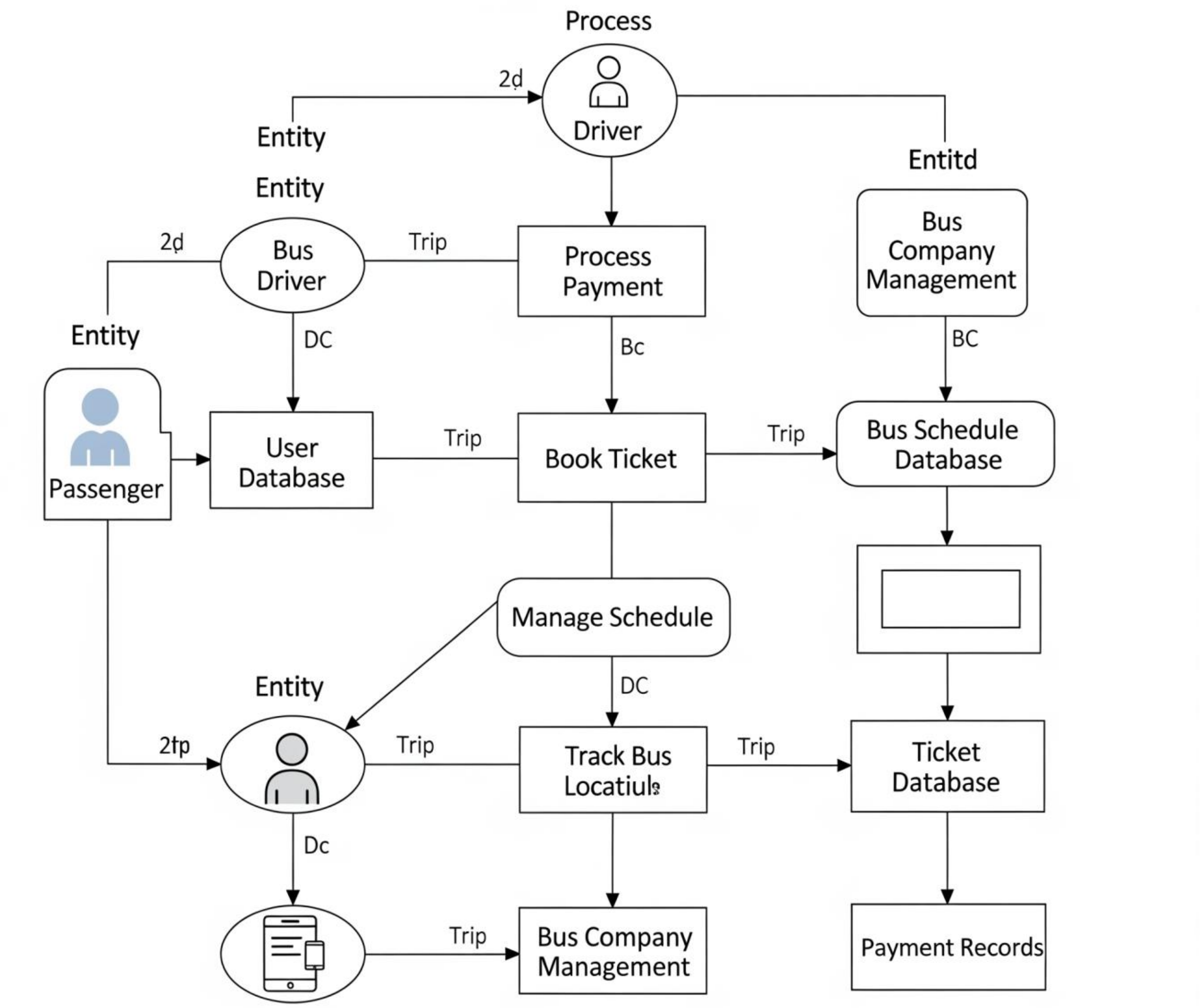
- Data Input Mechanism:
  - User location for "Nearby Stops" and "From" field in Trip Planner.
  - Users search queries for routes or stop.
  - User selection of routes/stops.
  - User input for "To" field and "Depart Now"/"Arrive By" in Trip Planner.
  - User preferences for notifications.
- **AL Processing Component:**

The Real-time Prediction Engine uses LSTMs and GBMs to process dynamic and static data. Disruption Detection uses NLP and anomaly detection.

- **User-friendly Output Presentation:**

- Predicted arrival time for each bus at upcoming stops, with a confidence score.
- Current bus location, speed, number of stops completed, distance to next stops.
- Interactive Map displaying route, bus locations, and stops.
- List of stops with predicted arrival times and delay indicators.
- Disruption alerts.
- Journey options with total travel time, transfers, predicted times, cost, and walk time.
- Push notifications for bus approaching, delays, disruptions, and "Leave Now" prompts.

- **Data Flow Diagram:**



- <u>**User Integration Touchpoints:**</u>
  - **Mobile Application "Joburg Transit Predict":** This is the primary interaction point.
    - **Touchpoint 1: Tapping on a route or stop on the Landing Screen/Home.** This displays detailed information.
    - **Touchpoint 2: Using the "From" and "To" fields in the Trip Planner.** Users input locations for journey planning.
    - **(Additional example): Toggling "AI Mode" button to see system switch between automated and manual control (if applicable to the final prototype).**

- **(Additional example): Selecting a specific direction (e.g., Northbound/Southbound) on the Route Detail Screen.**
- **(Additional example): Customizing notification preferences.**

- <u>API Connections and Dependencies:</u>
  - **Core Operational APIs:**

- **GPS Tracking APIs:** For real-time location tracking, vehicle performance monitoring (speed, fuel consumption, engine diagnostics), and driver behavior analysis. Depends on GPS hardware in buses and data processing/storage systems. Buses transmit data to a central platform which exposes APIs for other systems (e.g., passenger apps) to retrieve vehicle data.
- **Scheduling and Rostering APIs:** For creating and managing bus timetables, driver shifts, and duty rosters. Depends on HR systems for driver information, labour agreement databases, and route planning software. Ingests route data and operational constraints, exposes schedules to passenger information systems, and integrates with driver apps for real-time shift updates and duty assignments.
- **Ticketing and Payment System APIs:** For processing fares, validating tickets (physical or digital), and managing payment transactions. Depends on payment gateways, mobile payment platforms, on-board validators, and fare collection hardware. Mobile ticketing apps use APIs to purchase and display tickets; on-board validators use APIs to check ticket validity; integrates with financial systems for revenue reporting and reconciliation.
- **Incident Management and Dispatch APIs:** For real-time handling of operational issues (delays, breakdowns, accidents), dispatching assistance, and rerouting buses. Depends on GPS tracking, communication systems (radio, mobile), and mapping services. Receives alerts from driver apps, updates real-time passenger information systems with service changes, and integrates with incident reporting tools.

  - **Customer-Facing APIs:**

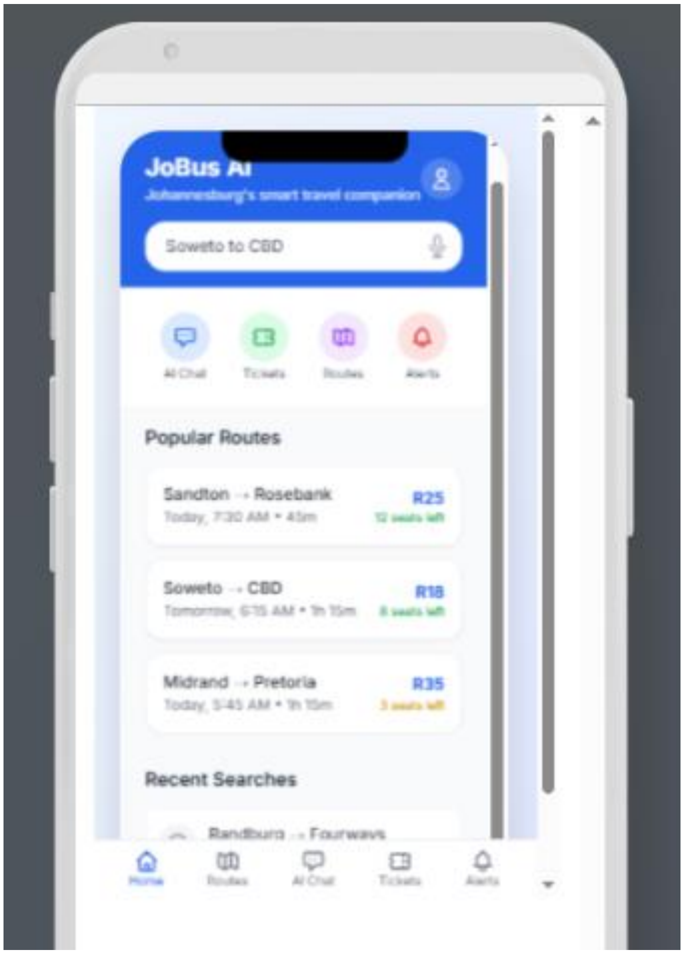
- **Public Transit Routing and Navigation APIs:** For providing passengers with route options, estimated travel times, and turn-by-turn directions for bus journeys. Depends on GIS, real-time traffic data, bus schedules, and stop location data. Consumer-facing apps (e.g., Google Maps) query these APIs for journey planning and receive real-time bus location data for accurate arrival predictions.

- **Real-Time Passenger Information (RTPI) APIs:** For displaying real-time bus arrival predictions at stops and updating passengers on delays or service changes. Depends on GPS tracking data, scheduling data, and predictive algorithms. Feeds data to mobile apps and websites, often using standards like GTFS-Realtime for data exchange.
- **Customer Service and Feedback APIs:** For allowing passengers to submit feedback, report issues, and access customer support. Depends on CRM systems and ticketing systems. Integrates with customer resolution centers and feedback platforms and connects to social media monitoring tools.
  - **Supporting APIs:**
- **Weather Data APIs:** For incorporating weather conditions into route planning, predicting delays, and informing passengers. Depends on weather service providers; used by RTPI systems and scheduling to adjust predictions.
- **Analytics and Reporting APIs:** For extracting and aggregating operational data for performance analysis and business intelligence. Depends on data warehousing and business intelligence tools. Allows for custom report generation and integration with executive dashboards.
- **Security and Authentication APIs:** For securing data access, user authentication, and authorization for various systems. Depends on identity management systems and single sign-on (SSO) providers. Ensures secure communication between all integrated systems and user access control.

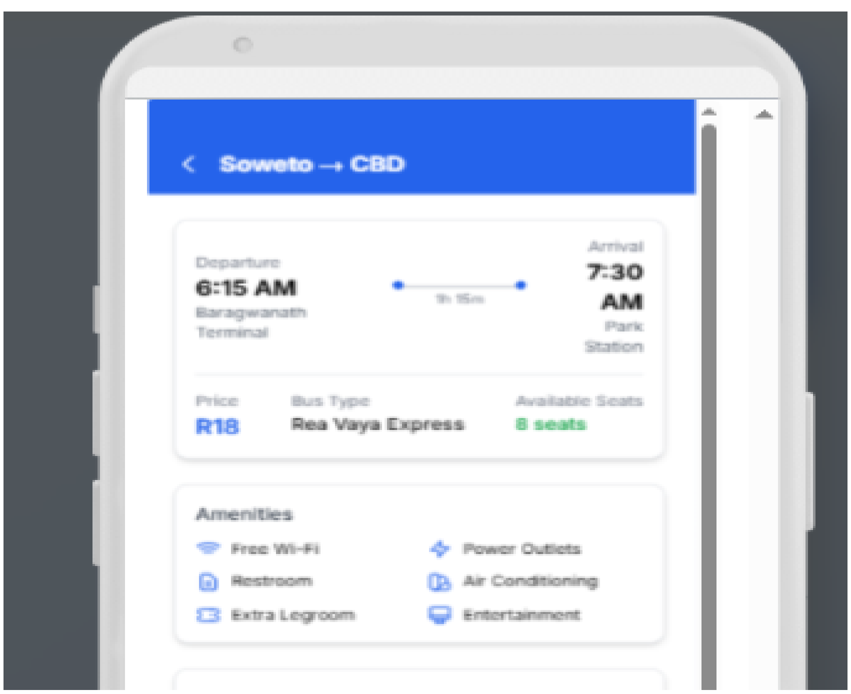
DELIVERABLES PLAN

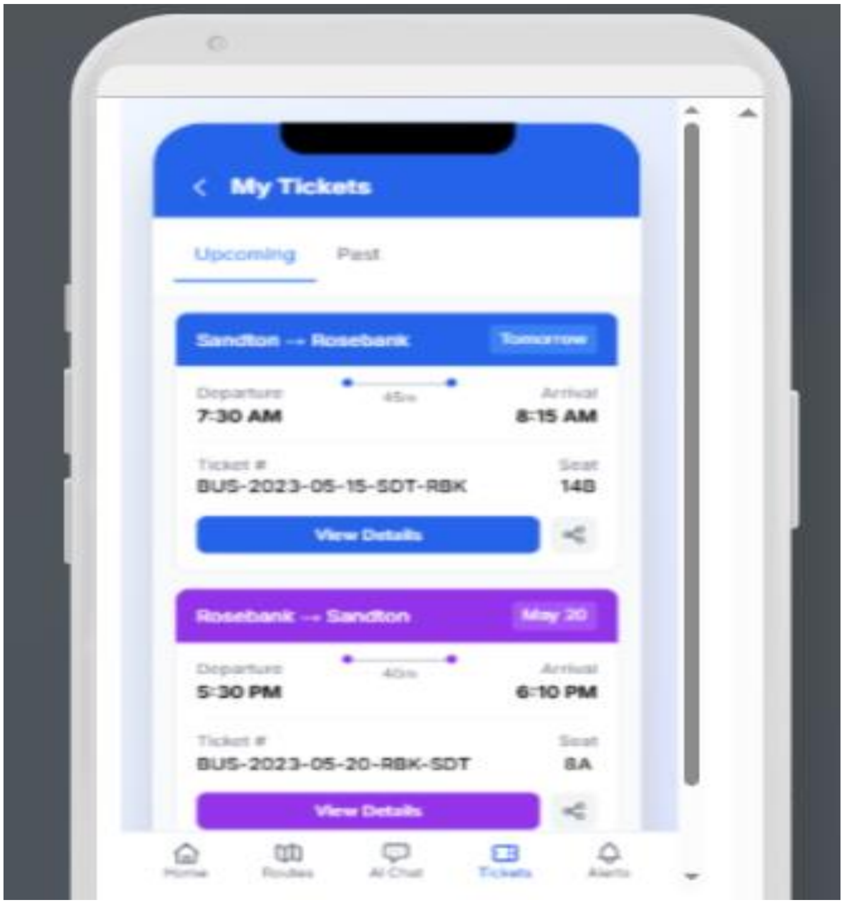
Interactive Figma Prototype:

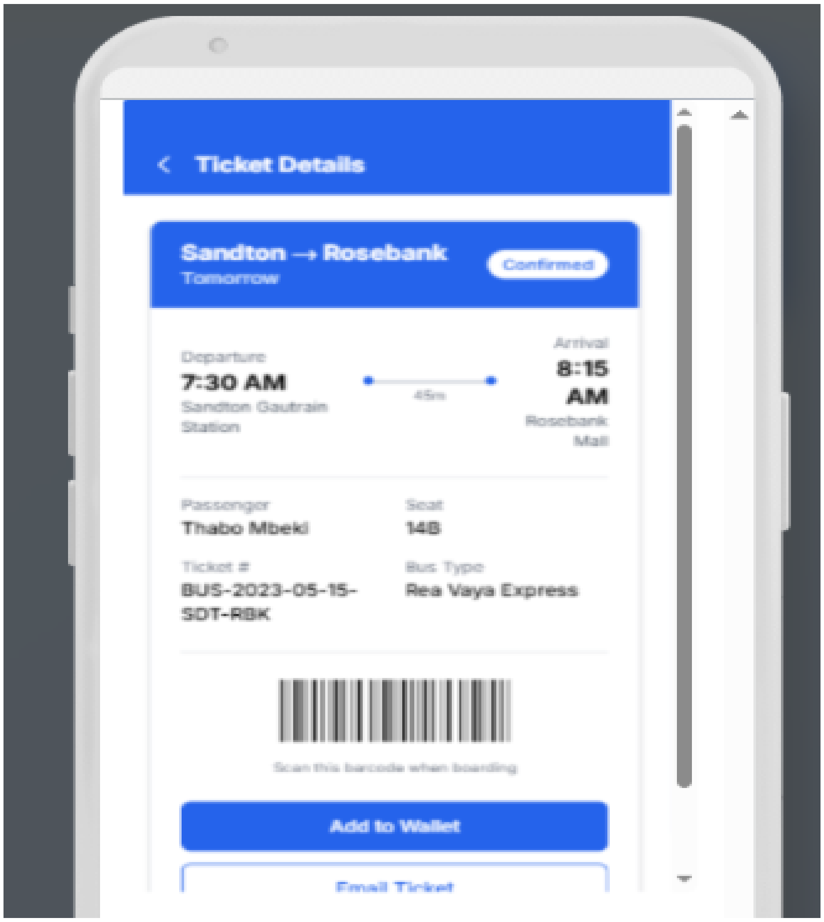
Application Home Page:

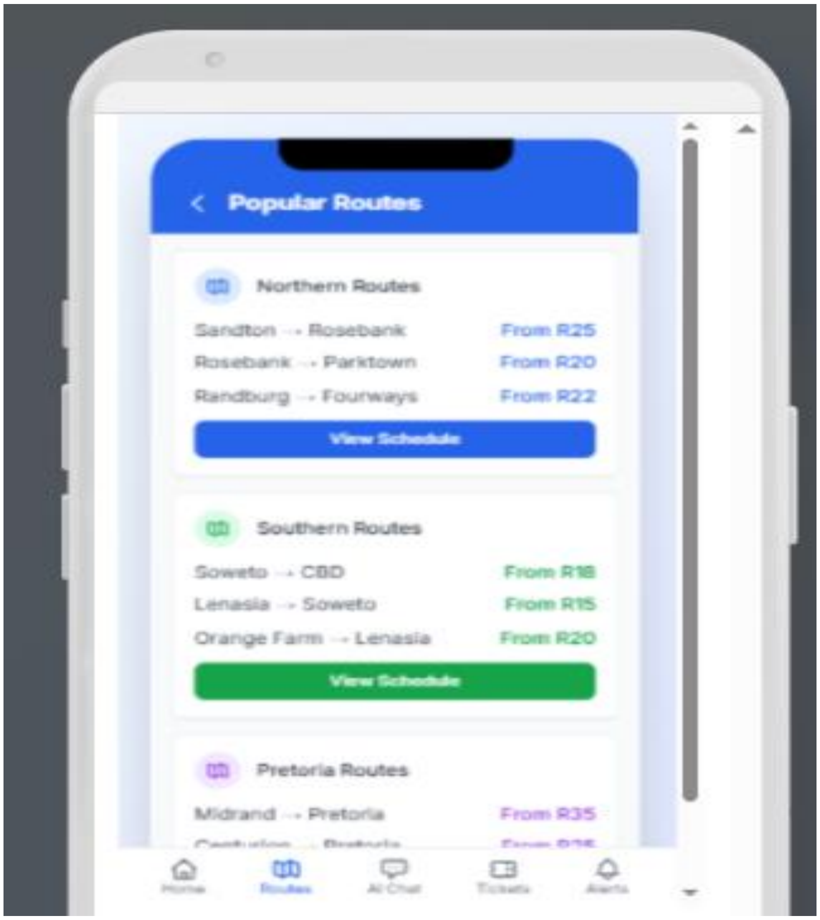


<u>Bus Schedule:</u>




My Tickets
Upcoming
Past
Sandton → Rosebank
Tomorrow
Departure
7:30 AM
Arrival
8:15 AM
Ticket #
BUS-2023-05-15-SDT-RBK
Seat
14B
View Details
Rosebank → Sandton
May 20
Departure
5:30 PM
Arrival
6:10 PM
Ticket #
BUS-2023-05-20-RBK-SDT
Seat
8A
View Details


Ticket Details
Sandton → Rosebank
Tomorrow
Confirmed
Departure
7:30 AM
Sandton Gautrain Station
45m
Arrival
8:15 AM
Rosebank Mall
Passenger
Thabo Mbeki
Seat
14B
Ticket #
BUS-2023-05-15-SDT-RBK
Bus Type
Rea Vaya Express
Scan this barcode when boarding
Add to Wallet
Email Ticket


Popular Routes
Northern Routes
Sandton → Rosebank
From R25
Rosebank → Parktown
From R20
Randburg → Fourways
From R22
View Schedule
Southern Routes
Soweto → CBD
From R18
Lenasia → Soweto
From R15
Orange Farm → Lenasia
From R20
View Schedule
Pretoria Routes
Midrand → Pretoria
From R35


Travel Alerts
Service Disruption
Sandton to Rosebank route experiencing delays due to road construction on Oxford Road. Expect 15-20 minute delays.
Updated 25 minutes ago
Weather Advisory
Heavy rain expected in Johannesburg tomorrow. Possible minor delays on all routes, especially during morning peak hours.
Updated 2 hours ago
Schedule Change
Midrand to Pretoria route has added an additional departure at 6:30 AM daily starting May 20 to accommodate commuter demand.
Updated 1 day ago
Promotion
Home
Routes
AI Chat
Tickets
Alerts

EVALUATION CRITERIA ALIGNMENT

Problem Definition Clarity and Significance:

We have clearly defined the problem: "Public bus transportation in Johannesburg frequently suffers from unpredictable arrival times, caused by factors such as traffic congestion, road incidents, vehicle breakdowns, and driver shortages." We went on to further highlight the significant impact including "decreased public transport usage and contributes to urban traffic congestion as more people choose private cars, worsening urban traffic congestion and increasing carbon emissions in the city." The quantifiable metrics like "+5–8% private vehicle usage per year" and "15–20 minutes average bus wait time" further underscore the problem's significance.

Technical Implementation Feasibility:

Our project utilized established AI techniques: "Recurrent Neural Networks (RNNs), specifically Long Short-Term Memory (LSTM) networks, and Gradient Boosting Machines (GBMs)" for prediction, and "Natural Language Processing (NLP)" and "Anomaly Detection" for disruption management. We have identified comprehensive data sources such as "GPS data from all active buses, historical bus schedule data, historical traffic data (from city traffic sensors, Google Maps API, etc.), real-time traffic incidents (from JMPD, Waze API, social media monitoring), weather data (API), public holidays/events calendar data." The use of "Canva AI" and "Figma" as no-code tools also indicates a feasible development approach.

User Experience Design Quality:

Our "Joburg Transit Predict" mobile application design focuses heavily on user experience. Key features include a "Landing Screen / Home" for quick access, a "Route Detail Screen" with an interactive map and real-time bus information, and a comprehensive "Trip Planner / Journey Planner" with multiple options. The inclusion of "Push Notifications" like "Bus Approaching," "Delay Alert," and "Leave Now" further enhances the proactive user experience.

Ethical Considerations Depth:

This will be demonstrated by the comprehensive 2-page ethical analysis that we had documented in a different document. It will cover potential biases in training data, privacy implications and mitigations (especially concerning GPS data and optional computer vision for passenger flow analysis), accessibility considerations for diverse users, the environmental impact of the solution, and potential unintended consequences.

Presentation Clarity:

This will be demonstrated through the quality of our deliverables: the "Interactive Figma/Miro Prototype," the "2-minute Demo Video", and the "Project Presentation Slides (10-12 slides)". The detailed and structured nature of this project document itself contributes to fulfilling this criterion.

References

- Google (2020) 'Google Maps 101: How AI helps predict traffic and determine routes', Google Blog, 3 September. Available at: https://blog.google/products/maps/google-maps-101-how-ai-helps-predict-traffic-and-determine-routes/ (Accessed: 31 July 2025).
- Moovit (2025) 'Growth Strategy and Future Prospects of Moovit'. Canvas Business Model. Available at: https://canvasbusinessmodel.com/blogs/growth-strategy/moovit-growth-strategy (Accessed: 31 July 2025).

- Optibus (2024) ‘Using AI to create better bus driver schedules, faster’. Optibus. Available at: https://optibus.com/case/using-ai-to-create-better-bus-driver-schedules-faster/ (Accessed: 31 July 2025).
- Lukhele, S. & Sinclair, M. (2020) ‘An analysis of the quality of public transport in Johannesburg, South Africa’, Research in Transportation Economics, 82, 100872. Available at: https://www.sciencedirect.com/science/article/pii/S2352146520305111 (Accessed: 31 July 2025).