DEPI Round 3 Graduation Project

UK Train Rides Analysis & Visualization

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Project Proposal

Objective: Analyze UK train operating data to identify performance trends, root causes of delays, and passenger journey impacts using Power BI for data integration, analysis, and visualization.

Business Objectives:

- **Improve Travel Planning: Identify the most reliable train operators, routes, and times for travel.**
- **Understand Delay Causes: Analyze root causes and patterns of delays and cancellations across the network.**
- **Performance Benchmarking: Compare Train Operating Companies (TOCs) against each other and national standards.**
- **Data-Driven Decisions: Provide comprehensive, interactive dashboards for commuters, leisure travelers, and transport analysts.**

Project Plan

Phase	Tasks	Duration	Milestone
1. Data Preparation & Cleaning	Find/download train data files, clean data, fix errors, handle missing values	Week 1-3	Clean, ready-to-use dataset in Power BI
2. Analysis Planning	Define key questions, create initial charts, sketch dashboard mockups	Week 4	Agreed-upon questions and dashboard sketch
3. Dashboard Development	Build charts/graphs, add filters/interactivity, team testing	Week 4-5	Finished, interactive Power BI dashboard
4. Reporting & Presentation	Write summary report, create presentations, practice delivery	Week 6	Project completed with report and presentation

Resources

Power BI, Excel, Data Analysis Tools

Task Assignment & Roles

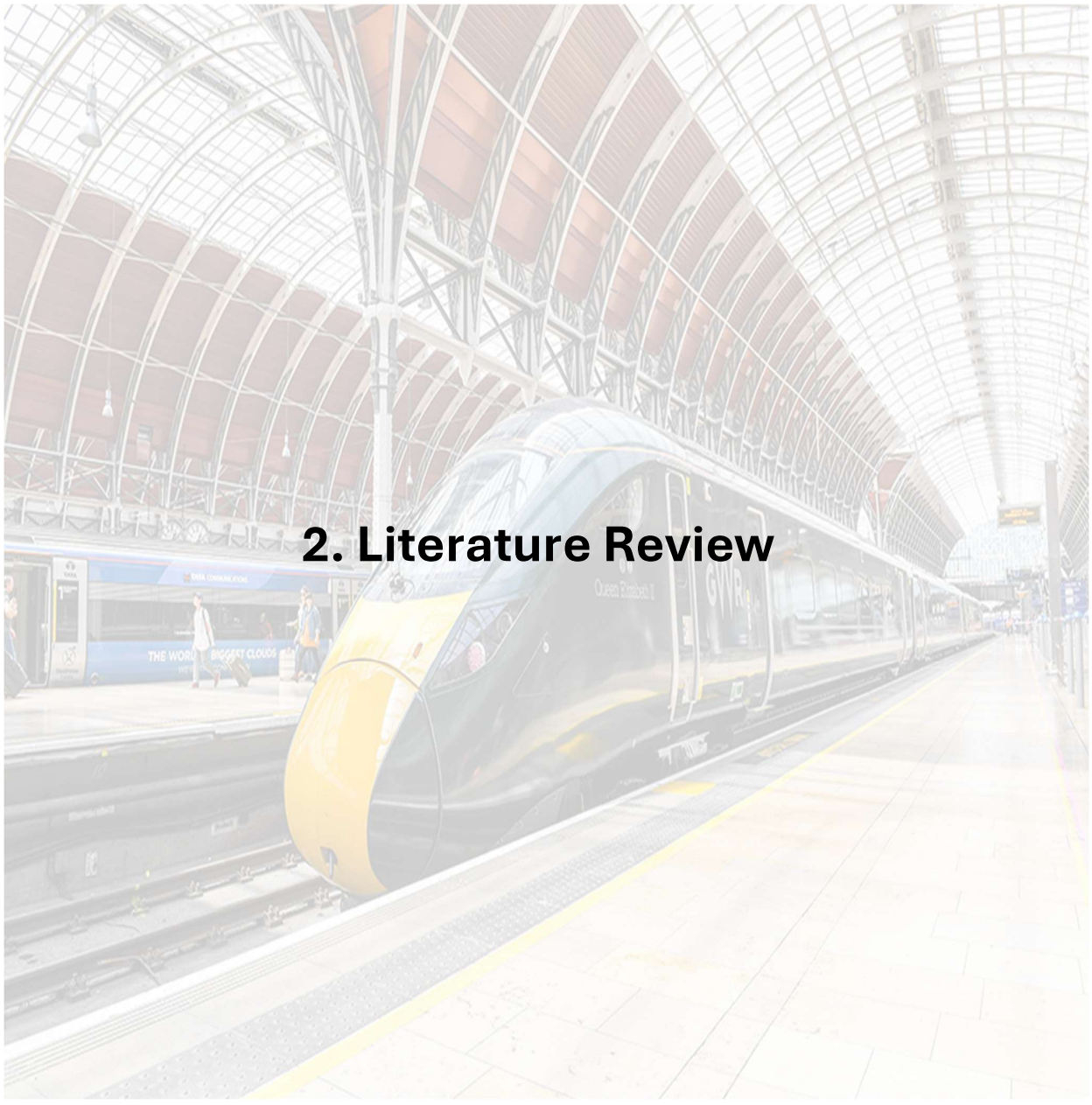
- **Data Understanding & Structure: Tarek**
- **Data Quality Assessment: Mariam**
- **Data Model Design: Mora**
- **Data Cleaning & Transformation: Mohamed**
- **KPI Calculations: Alaa**
- **Dashboard Development: Team collaboration**
- **Reporting & Presentation: All team members**

Risk Assessment & Mitigation Plan

- **Risk: Data inconsistency and missing values → Solution: Data validation techniques and conditional calculations**
- **Risk: Performance issues with large datasets → Solution: Efficient DAX queries and data model optimization**
- **Risk: Inaccurate time calculations → Solution: Adjusted formulas for cross-midnight journeys**

KPIs (Key Performance Indicators)

- **Delay frequency and duration**
- **Cancellation rates**
- **Journey times**
- **Performance by TOC (Train Operating Company)**
- **Route reliability metrics**



2. Literature Review

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Feedback & Evaluation

Project focuses on practical analysis of transportation data with clear business applications. Strong emphasis on data cleaning and visualization.

Suggested Improvements

- **Expand analysis to include seasonal trends**
- **Add predictive analytics for delay forecasting**
- **Incorporate passenger volume data for impact analysis**

Final Grading Criteria

Based on data accuracy, visualization effectiveness, user interaction, analytical insights, and presentation quality.

3. Requirements Gathering

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Stakeholder Analysis

- **Travelers: Commuters and leisure travelers seeking reliable journey planning**
- **Transport Analysts: Professionals needing performance insights**
- **Train Operating Companies: Management requiring operational benchmarking**
- **Government Agencies: Regulatory bodies monitoring network performance**

User Stories

- **"As a daily commuter, I want to see which train operators have the best punctuality records to choose reliable services."**
- **"As a transport analyst, I need to understand root causes of delays to recommend operational improvements."**
- **"As a TOC manager, I want to compare my company's performance against competitors to identify areas for improvement."**

Functional Requirements

- **Performance analysis by operator, route, and time period**
- **Delay cause analysis and trending**
- **Interactive filtering by date, operator, route**
- **Geographical visualization of performance**
- **Drill-down capabilities to detailed journey data**

Non-functional Requirements

- **Dashboard load time under 5 seconds**
- **Clear, intuitive data visualization**
- **Responsive design for different devices**
- **Accurate and up-to-date information**

4. System Analysis & Design

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Problem Statement & Objectives

Manual analysis of UK train performance data is time-consuming and lacks interactivity. This project automates the process through Power BI dashboards to provide immediate, actionable insights for various stakeholders.

Use Case Diagram

- **Travelers: View performance dashboards for journey planning**
- **Analysts: Perform detailed analysis and generate reports**
- **TOC Managers: Monitor company performance metrics**
- **Administrators: Manage data updates and system maintenance**

Software Architecture

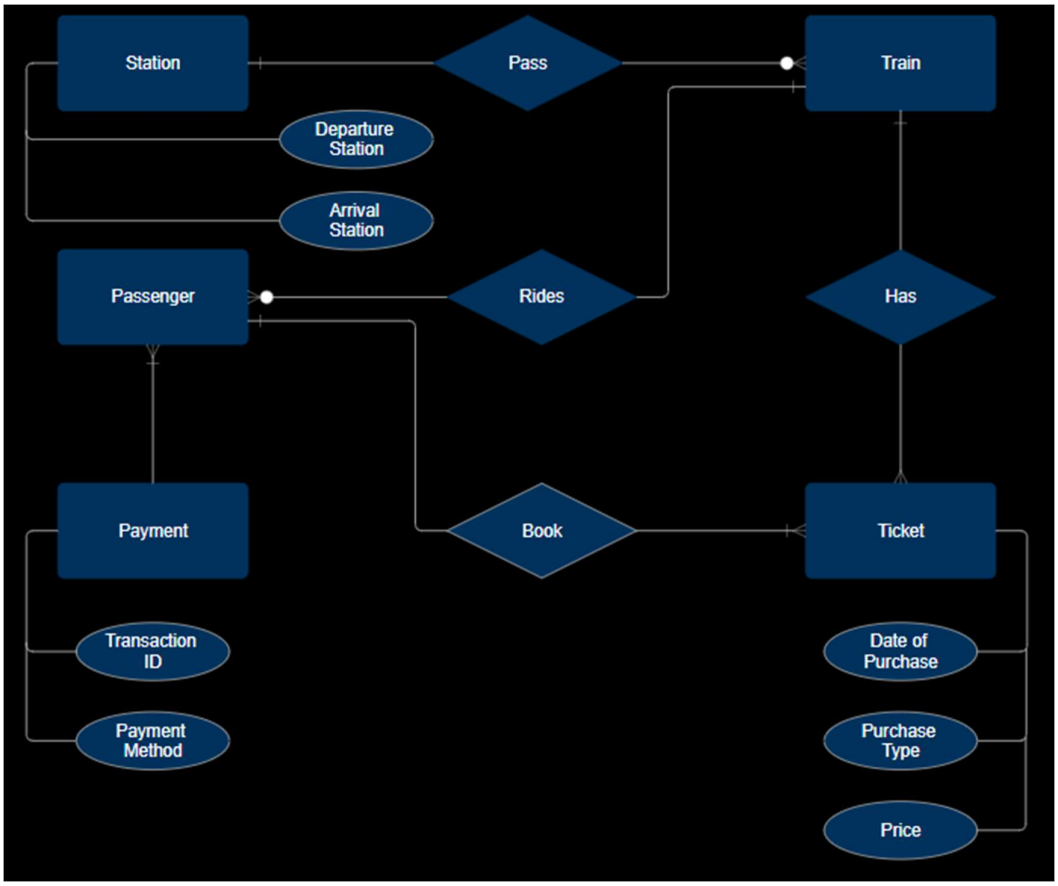
Power BI dashboard for visualization, file-based data storage (CSV/Excel), with data flowing from source files through Power Query transformation into interactive visuals.

Data Flow & System Behavior

- **DFD: Data extraction → Power Query transformation → Power BI visualization**
- **Activity Diagram: Load data → Clean/transform → Calculate metrics → Visualize → Generate insights**

Database Design & Data Modeling

- **Logical Schema: Tables for Journey facts with dimension tables for Time, Operators, Routes**
- **Physical Schema: Optimized for Power BI with proper keys and relationships**
- **ER Diagram: Relationships between Operators, Routes, Journeys, Delays**



UI/UX Design & Prototyping

- **Wireframes: Dashboard layout with performance overview, operator comparison, delay analysis, and geographical views**
- **UI/UX Guidelines: Professional color scheme, intuitive navigation, clear typography, interactive filtering**

5. Implementation & Deployment

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Technology Stack

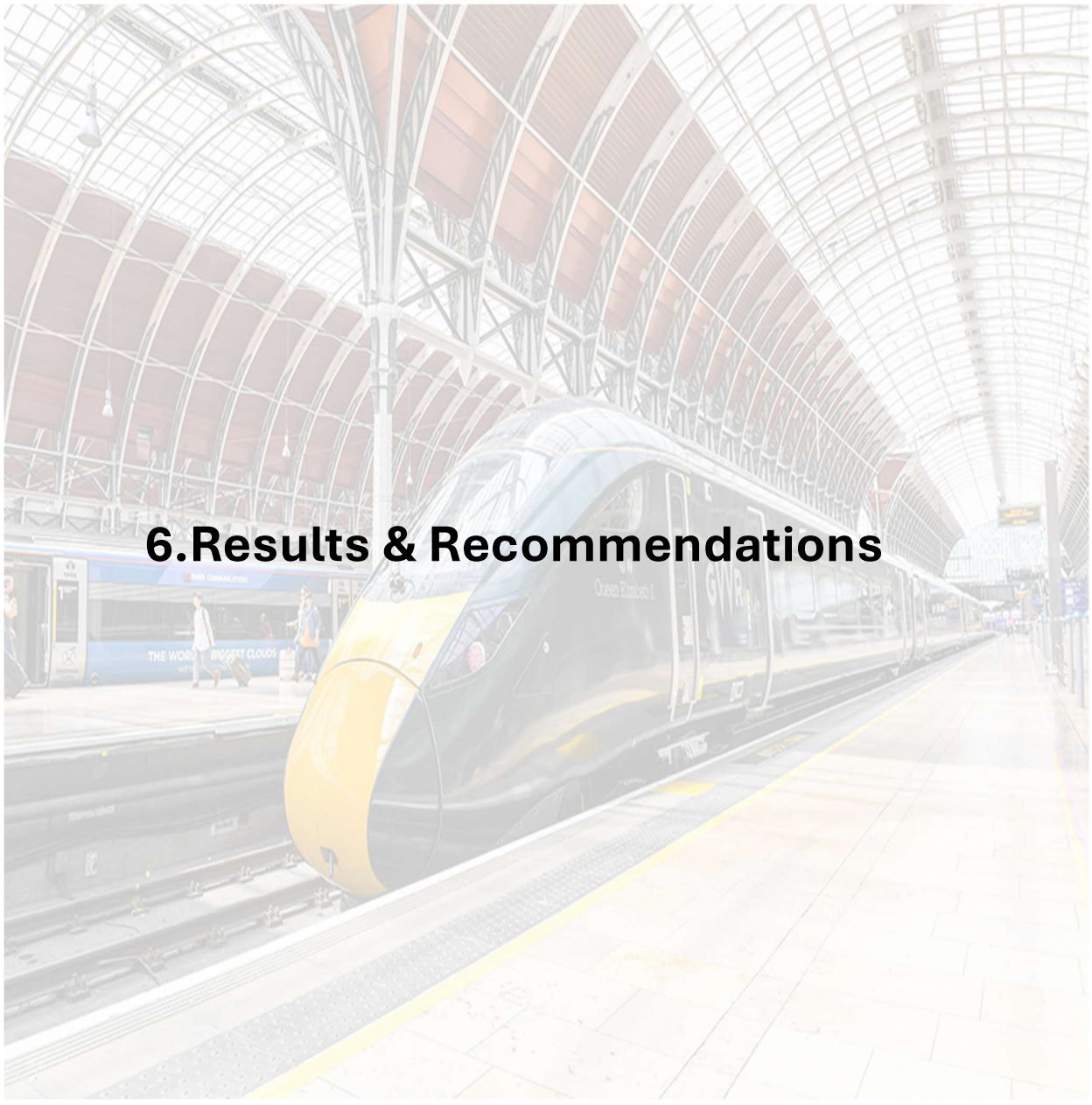
- **Dashboard: Power BI**
- **Data Storage: CSV files**
- **Analysis: Power Query, DAX**
- **Sharing: Power BI Service**

Deployment Strategy

- **Data refresh schedules configured in Power BI Service**
- **Dashboard published to relevant stakeholder groups**
- **Access controls implemented based on user roles**

Key Implementation Challenges & Solutions

1. **Negative Duration Values: Fixed by adjusting time calculation formulas to handle cross-midnight journeys**
2. **Missing Delay Reasons: Addressed by replacing nulls with "No Delay" for on-time journeys**
3. **Inconsistent Data Entries: Standardized delay reason categories (e.g., unified "Signal Failure" variations)**



6.Results & Recommendations

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6.1.Executive Summary of Key Findings

The UK Train Rides dashboard analysis reveals a robust commercial performance with significant operational challenges. While the operating company maintains strong revenue growth (22.4%) and healthy ticket sales, operational reliability issues persist, particularly concerning delays and cancellations that directly impact customer satisfaction and refund rates.

6.2 Detailed Results Analysis

6.2.1 Commercial Performance: Strengths and Opportunities

Positive Indicators:

- **Strong Revenue Growth: Month-over-month revenue growth of 22.4% demonstrates effective commercial strategy and market demand**
- **Balanced Ticket Type Revenue: Revenue distribution across Anytime (36.6%), Off-Peak (34.22%), and Advance (29.18%) tickets indicates diversified pricing strategy success**
- **High Online Adoption: 19,000 online purchasers vs 13,000 station purchasers show successful digital transformation**
- **Premium Class Demand: First-class tickets (800 sold) contribute disproportionately to revenue given higher pricing**

Areas for Improvement:

- **Payment Method Concentration: Over-reliance on credit cards (£4.7M revenue) presents potential risk and limits customer payment flexibility**
- **Rail card Penetration Gap: Only 33.9% of customers use rail cards, suggesting untapped potential in loyalty programs**

6.2.2 Operational Performance: Critical Challenges

Significant Concerns:

- **Poor Punctuality: Only 87.25% of journeys are on time, with 6.89% delayed and 5.86% cancelled**

- **Excessive Delay Times: Average delay of 45 minutes significantly impacts customer experience and operational efficiency**
- **High Refund Rate: 3.6% refund rate (289 requests) indicates substantial customer dissatisfaction**
- **Technical Issues Dominance: Technical problems account for approximately 300 delayed journeys, representing the primary cause of service disruption**

Operational Strengths:

- **Consistent Trip Duration: Average trip duration of 74 minutes shows reliable scheduling when services operate normally**
- **Geographic Coverage: Strong presence across key routes including Birmingham, York, Manchester, and Liverpool.**

6.3 Strategic Recommendations

6.3.1 Immediate Actions

Operational Priority: Technical Reliability

1. **Implement Emergency Maintenance Protocol**
   - **Conduct immediate technical audit of rolling stock and signaling systems**
   - **Establish rapid response teams for technical fault resolution**
2. **Enhance Delay Communication System**
   - **Implement real-time delay notification to passengers via mobile app**
   - **Train staff in proactive customer communication during disruptions**
3. **Promote Railcard Adoption**
   - **Launch "Refer a Friend" campaign with 20% discount for new railcard holders**
   - **Integrate railcard promotion into online booking flow**
   - **Target goal: Increase railcard penetration to 40% within 3 months**

6.3.2 Medium-Term Initiatives

Operational Improvements

4. **Technical Infrastructure Upgrade**
   - **Implement IoT sensors on critical train components**

- **Develop partnership with technical suppliers for improved support**

5. **Staff Training and Development**
   - **Launch specialized technical training program for engineering staff**
   - **Implement cross-training to address staff shortage contingencies**
   - **Develop delay management certification for operational staff**
6. **Payment System Modernization**
   - **Integrate additional payment methods (Apple Pay, Google Pay, PayPal)**
   - **Implement contactless payment expansion across all stations**
7. **Revenue Optimization**
   - **Introduce dynamic pricing for Advance tickets based on demand forecasting**
   - **Develop premium first-class experiences to justify higher pricing**
   - **Create bundled offers for popular routes (e.g., Manchester-London)**

6.3.3 Long-Term Strategic Initiatives

Transformational Projects

8. **Digital Transformation Phase 2**
   - **Develop AI-powered delay prediction and prevention system**
   - **Implement comprehensive customer relationship management platform**
   - **Create personalized travel experience through mobile app enhancements**
   - **Fleet Modernization Program**
   - **Develop 20-year fleet replacement strategy focusing on reliability**
   - **Invest in hybrid/electric trains for key intercity routes**
   - **Partner with manufacturers for custom reliability requirements**

6.4 Key Performance Indicators (KPIs) for Success Measurement

Recommended Operational KPIs

- **Reduce average delay time from 45 to 20 minutes within 12 months**
- **Increase on-time performance from 87.25% to 95% within 18 months**
- **Decrease technical-caused delays by 60% within 12 months**
- **Reduce refund rate from 3.6% to 1.5% within 12 months**

Recommended Commercial KPIs

- **Maintain revenue growth above 15% quarterly**
- **Increase railcard penetration to 45% within 12 months**
- **Reduce credit card revenue dependency to 70% within 6 months**
- **Grow first-class ticket sales by 25% within 12 months**
- **Customer Experience KPIs**
- **Achieve 90% customer satisfaction rate for delay communication**
- **Increase mobile app usage by 40% within 6 months**
- **Reduce customer complaint resolution time to under 24 hours**

6.5 Risk Mitigation and Implementation Framework

Implementation Risks

- **Technical Debt: Legacy systems may impede quick fixes → Phase upgrades starting with most critical components (Signaling system, ...)**
- **Staff Resistance: Operational changes may face pushback → Involve staff in solution design and provide comprehensive training**
- **Budget Constraints: Capital-intensive improvements may face funding challenges → Implement phased funding approach with clear ROI demonstration**
- **Success Metrics Monitoring**
- **Monthly performance reviews against established KPIs**
- **Quarterly business case validation for major investments**
- **Bi-annual customer satisfaction surveys**
- **Real-time dashboard monitoring of critical operational metrics**

6.6 Conclusion

The analysis demonstrates that while commercial performance is strong, operational reliability represents the most significant opportunity for improvement. By implementing the recommended actions systematically, the UK Train Rides service can transform from a commercially successful but operationally challenged service to an industry leader in both revenue generation and customer satisfaction. The prioritized focus on technical reliability, combined with strategic commercial initiatives, provides a clear roadmap for sustainable growth and improved passenger experience.