



UK Train Performance Analysis

January 2024 to April 2024

BY

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Objectives



The goal of this project is to perform an in-depth analysis of the UK railway services dataset using Power BI, with the following key objectives:

- ▶ Present a comprehensive overview of railway performance through key KPIs (Key Performance Indicators) such as ridership volume, revenue trends, and service reliability.
- ▶ Conduct a full ridership analysis, identifying:
 - Peak times of the day and week,
 - Seasonal variations,
 - The total number of riders versus the number of cancelled journeys across the dataset's timeframe.
- ▶ Perform detailed station -level analysis, evaluating:
 - Traffic to and from each station,
 - Route popularity,
 - Performance variations across different station pairs.
- ▶ Analyse revenue patterns alongside related KPIs, highlighting factors that influence financial performance.
- ▶ Examine ridership behavior based on ticket class categories (e.g., First Class, Standard Class, Discounted Tickets), assessing demand patterns and revenue contributions.
- ▶ Develop forecasts and strategic recommendations based on historical trends to support operational planning and revenue optimization .

Achieving Comprehensive Railway Analysis





Analysis Dictionary

Tables

Calendar: A table that contains all dates starting from the actual start date till the actual end date and this table also includes the holidays the table includes the following date breakdown that will ease the analysis (Year, Month Number and month Name, Day of week number and day of week name, day of year, week of year, and finally is a weekend or is holiday) that b breakdown will support the analysis and show how exactly a certain period in each station behaves from the ridership and revenue point of view. In my opinion , it is the grid of the tableau we are drawing.

Holidays: a table that contains the official occasions that are considered a vacation to exclude them from the analysis to get more accurate insights , and also we are dealing with 4 different areas around the UK that have different official vacations.

Railway: it is the Main table and considered the core of our data and contains all data related to the purchasing time, date, price, payment method, class, from, to and type)

Stations: it is a table that includes the location for the station with the region, latitude and longitude to accurately calculate the distance between the station .

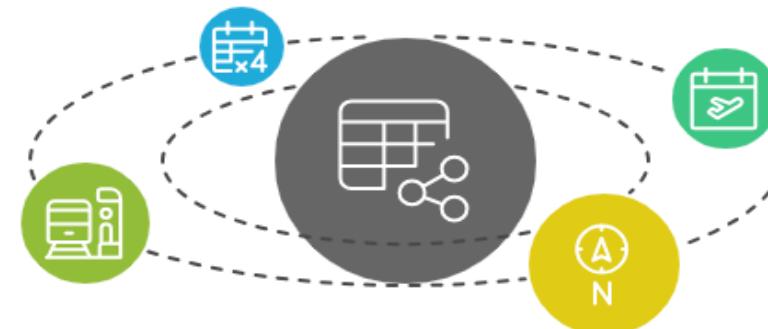
Data Analysis Framework Overview

Calendar

Provides a structured view of dates and holidays

Holidays

Lists official vacation days for accurate analysis



Railway

Contains core data on purchases and travel details

Stations

Includes location data for distance and cost analysis



1- Overall performance dashboard

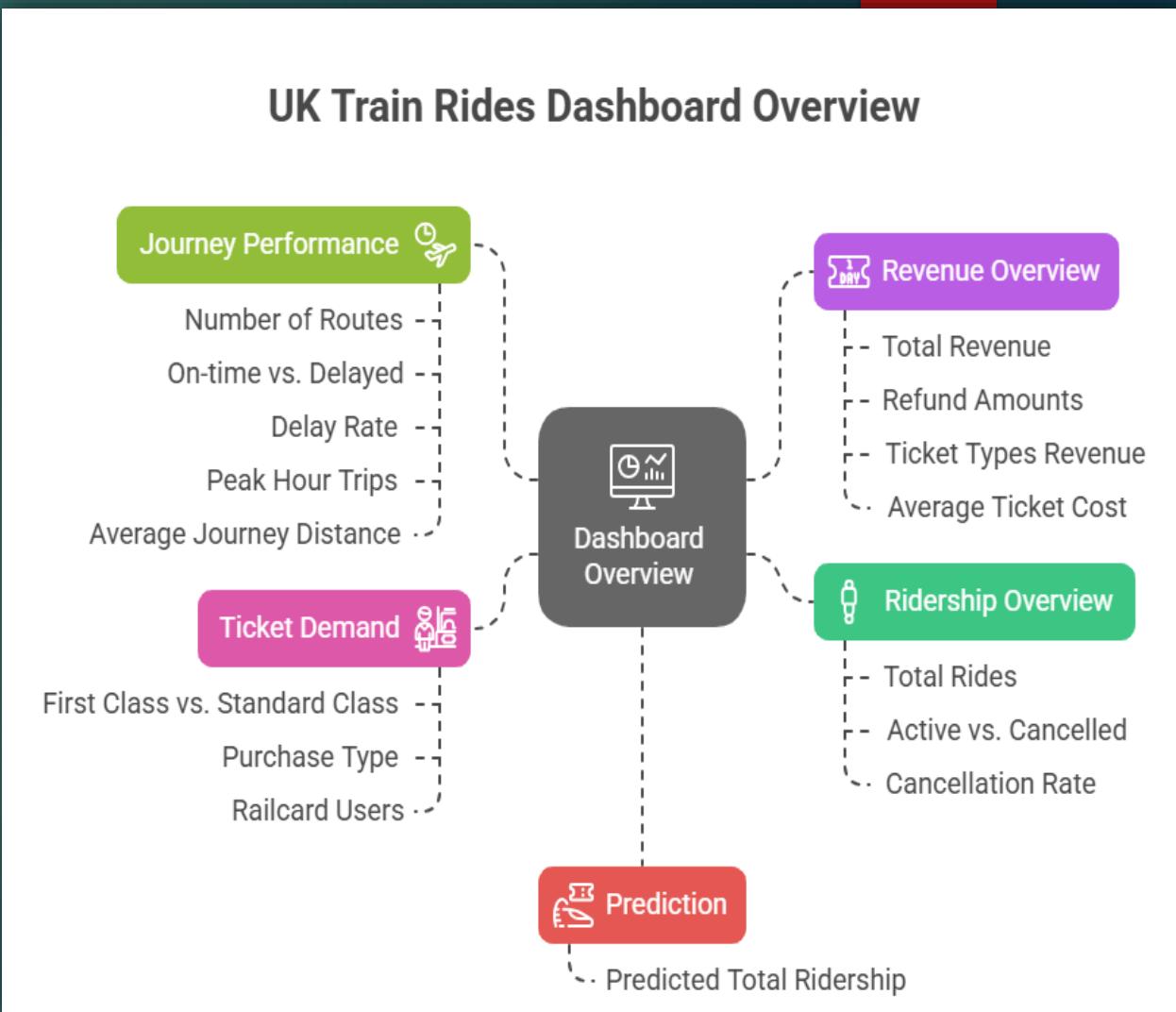
This dashboard provides a high-level summary of the key metrics analyzed in the UK Train Rides dataset between January 2024 and April 2024.

It serves as a quick introduction to the main performance indicators before deeper analysis.

The dashboard summarizes:

- **Ridership Overview**
 - Total number of rides
 - Active vs. Cancelled rides
 - Cancellation rate percentage
- **Revenue Overview**
 - Total revenue generated
 - Refund amounts
 - Ticket types revenue breakdown (Advance Tickets)
 - Average ticket cost
- **Journey Performance:**
 - Number of routes
 - On-time vs. delayed journeys
 - Delay rate
 - Peak Hour trips
 - Average journey distance
- **Ticket Demand:**
 - Demand distribution between First Class and Standard Class tickets
 - Purchase type (Advance, Anytime, Off-peak)
 - Railcard user numbers
- **Prediction:**
 - Predicted total ridership (based on historical trends)

UK Train Rides Dashboard Overview

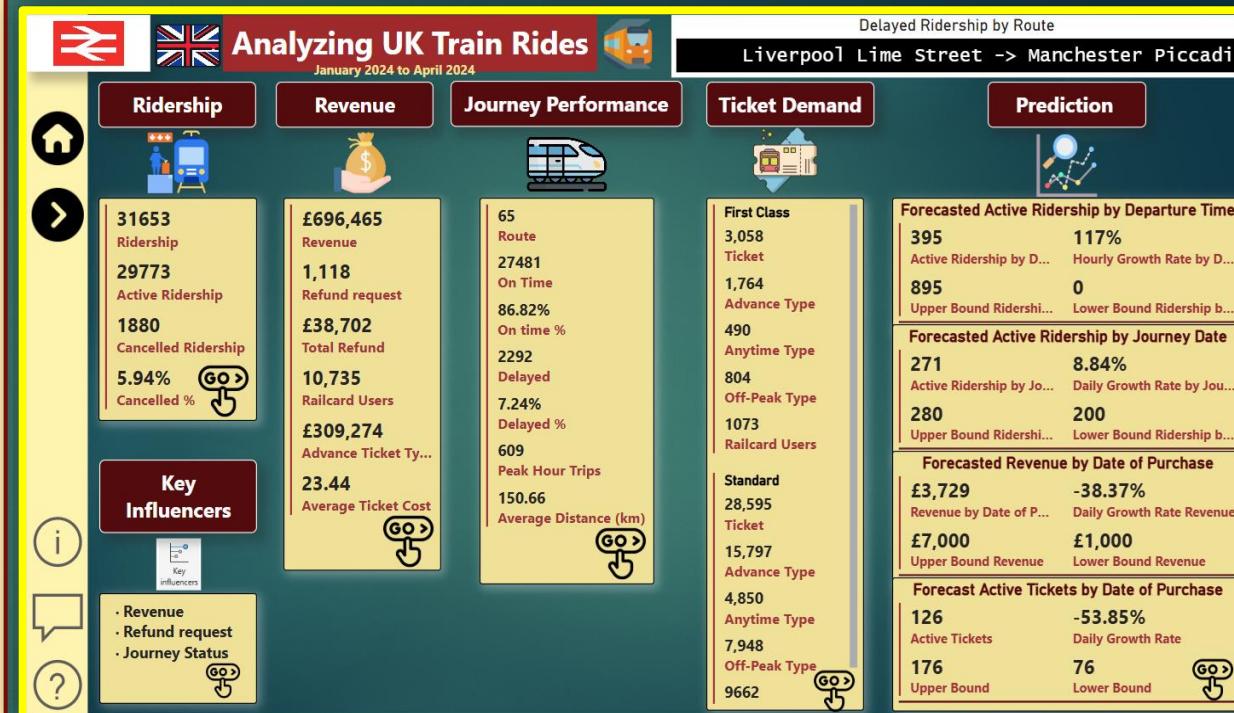




1- Overall performance dashboard

This dashboard provides a comprehensive analysis of UK train rides, focusing on key metrics across ridership, revenue, journey performance, ticket demand, and predictive trends.

- Ridership Card → Total of 31,653 with 5.94% cancellations - Displays total ridership, active ridership, cancelled trips, and the percentage of cancellations.
- Revenue Card → £696,465 generated, with £38,702 refunded from 1,118 refund requests - Shows total revenue, refund volumes, advance ticket sales, Railcard users, and average ticket cost.
- Journey Performance Card → 86.82% of 65 routes arrived on time, while 7.24% experienced delays - Summarizes total routes, on-time performance, delayed trips percentage, peak hour trips, and average distance traveled.
- Ticket Demand Card → Ticket Demand: Standard class dominates with 28,595 tickets, while advance purchases are significantly higher than anytime or off-peak types - Breaks down ticket sales by class (First Class vs Standard) and types (Advance, Anytime, Off-Peak, Railcard users).
- Key Influencers → Analyzes main drivers affecting revenue, refund requests, and journey status.
- Prediction Section → Forecasting Section: Predictive insights show peak active ridership at 395 by departure time, but forecasted revenue and ticket purchases are projected to decline (-38.37% and -53.85% respectively) - Forecasts active ridership by time and journey date, revenue by purchase date, and advance ticket sales trends.

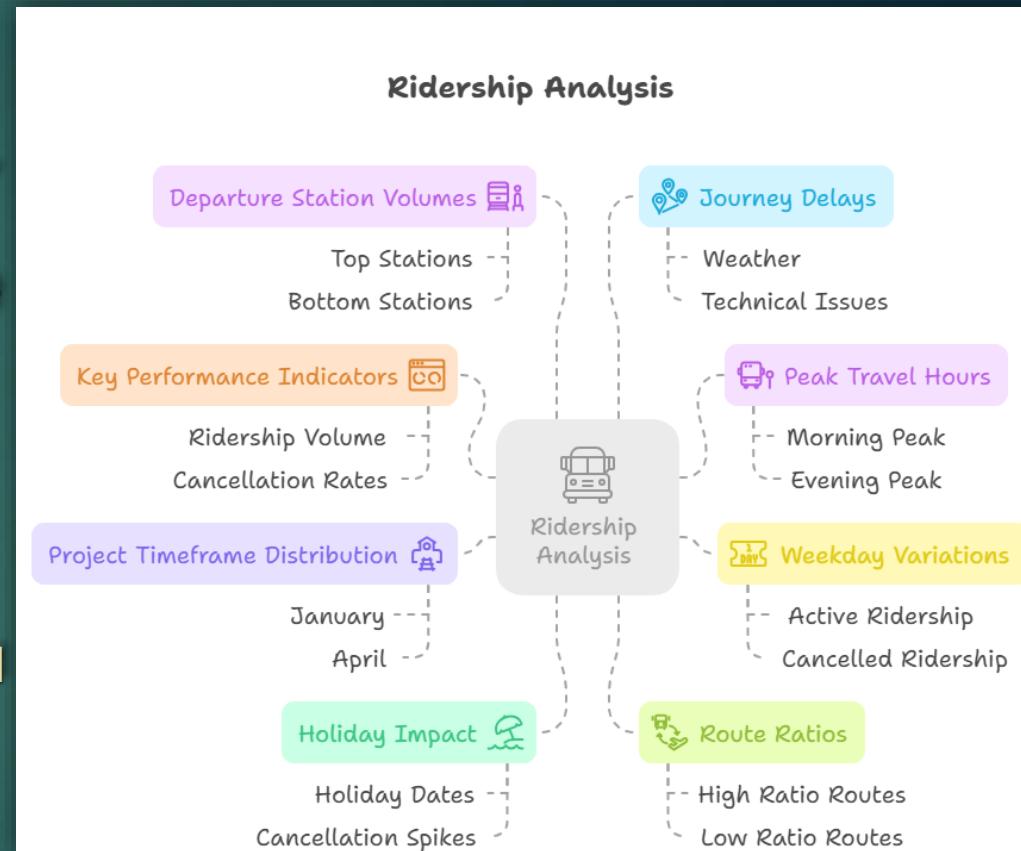


2-Ridership Analysis



Questions

- ▶ What are the major KPIs for the analysis?
- ▶ What are the peak travel hours during the day at each station, and what is the corresponding ridership volume?
- ▶ How does active and cancelled ridership vary across different weekdays?
- ▶ How is the ridership distributed over the project timeframe (January–April 2024)?
- ▶ To what extent do holidays impact ridership cancellations?
- ▶ Which routes show the highest and lowest active-to-cancelled ridership ratios?
- ▶ Which departure stations have the highest ridership volumes?
- ▶ What are the major causes of journey delays, and how frequently does each cause occur?





2- Ridership Analysis

Active Ridership by Departure Time

Summary: Shows the number of active riders over different times of the day.

Insight: Peaks around 8 AM, 12 PM, and 6 PM suggest rush-hour travel periods. Early mornings and late evenings have lower ridership.

Ridership and Cancelled Ridership by Holiday (Top Right - Bar Chart)

Summary: Compares normal ridership against cancellations during major holidays.

Insight: Minor cancellations occurred during holidays like St. Patrick's Day, Good Friday, and New Year's. Ridership was steady with a small percentage of cancellations.

Total and Cancelled Ridership by Day of Week (Middle Left - Horizontal Bar Chart)

Summary: Highlights how many trips were active or canceled across different days.

Insight: Sunday, Friday, and Wednesday show almost equal ridership (around 4.3K each). Cancellations are consistent but relatively low.

Route by Journey Count (Middle Right - Horizontal Bar Chart)

Summary: Displays active versus canceled ridership by specific stations.

Insight:

- Manchester Piccadilly, London Euston, and London Kings Cross have the highest journey counts
- Cancellations are present but smaller compared to active rides.

Ridership by Time (Bottom Left - Line Chart)

Summary: Trends in daily ridership over time (January to April 2024).

Insight:

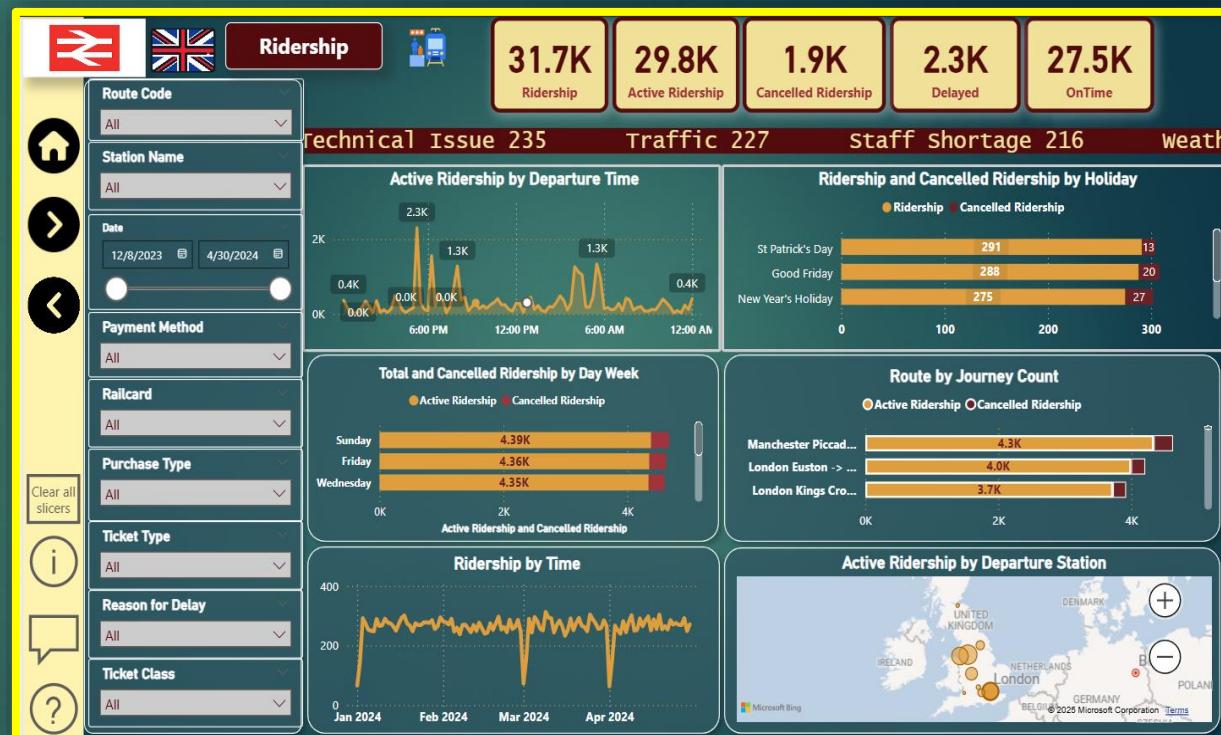
- Consistent ridership with visible periodic dips (likely weekends or specific disruptions).
- Drops might correspond with maintenance, holidays, or failures (like the mentioned signal failure).

Active Ridership by Departure Station (Bottom Right - Map Visualization)

Summary: Geographic representation of ridership volume from various departure stations.

Insight:

- Major activity centers around London and the surrounding cities.
- Larger circles indicate more significant ridership counts.

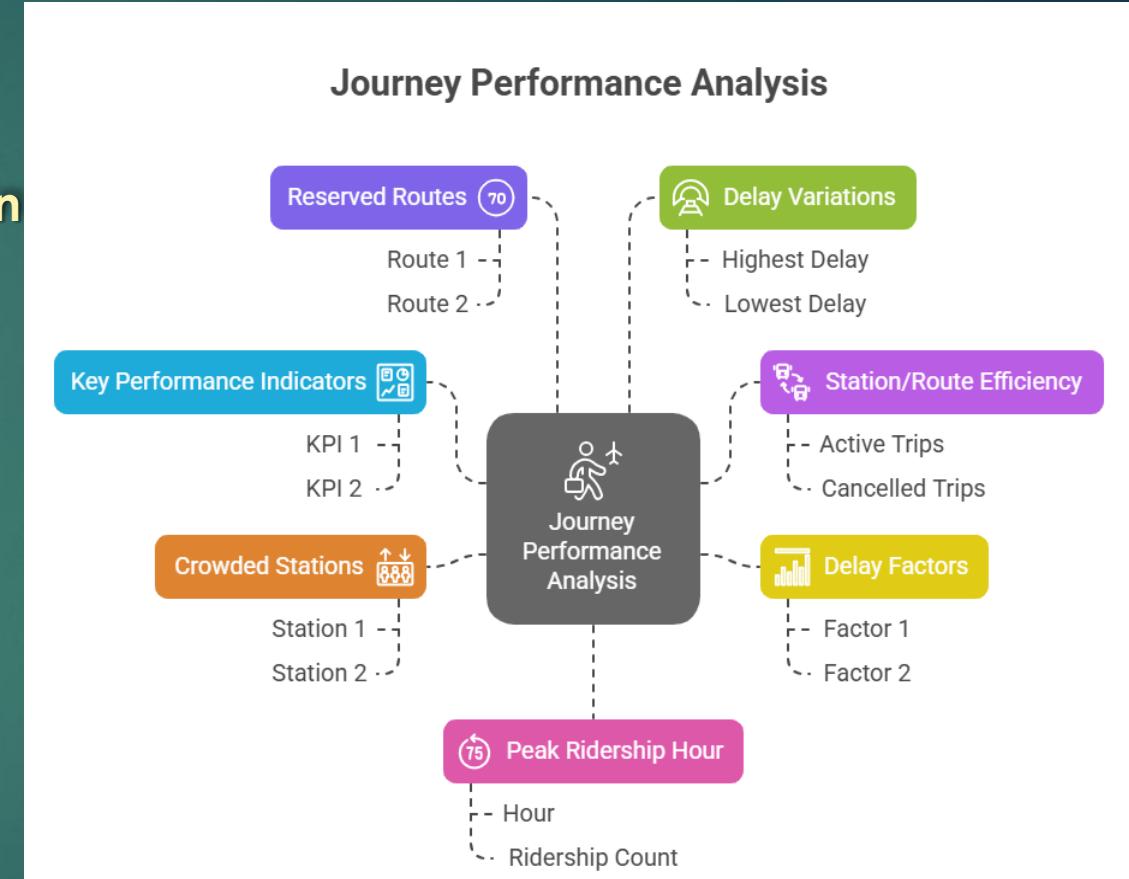


3- Journey Performance Analysis



Questions

- ▶ 1 -What are the main KPIs affecting the performance?
- ▶ 2 -What is the efficiency of the station/route expressed in how many active/cancelled trips occurred?
- ▶ 3 -What is the major factors of delaying and how often?
- ▶ 4 -What is the most crowded station ?
- ▶ 5 -What is the highest reserved route ?
- ▶ 6 -Which is lowest station having delays and which one is the highest ?
- ▶ 7 -The peak hour at which the highest number of ridership when? And how many ridership?





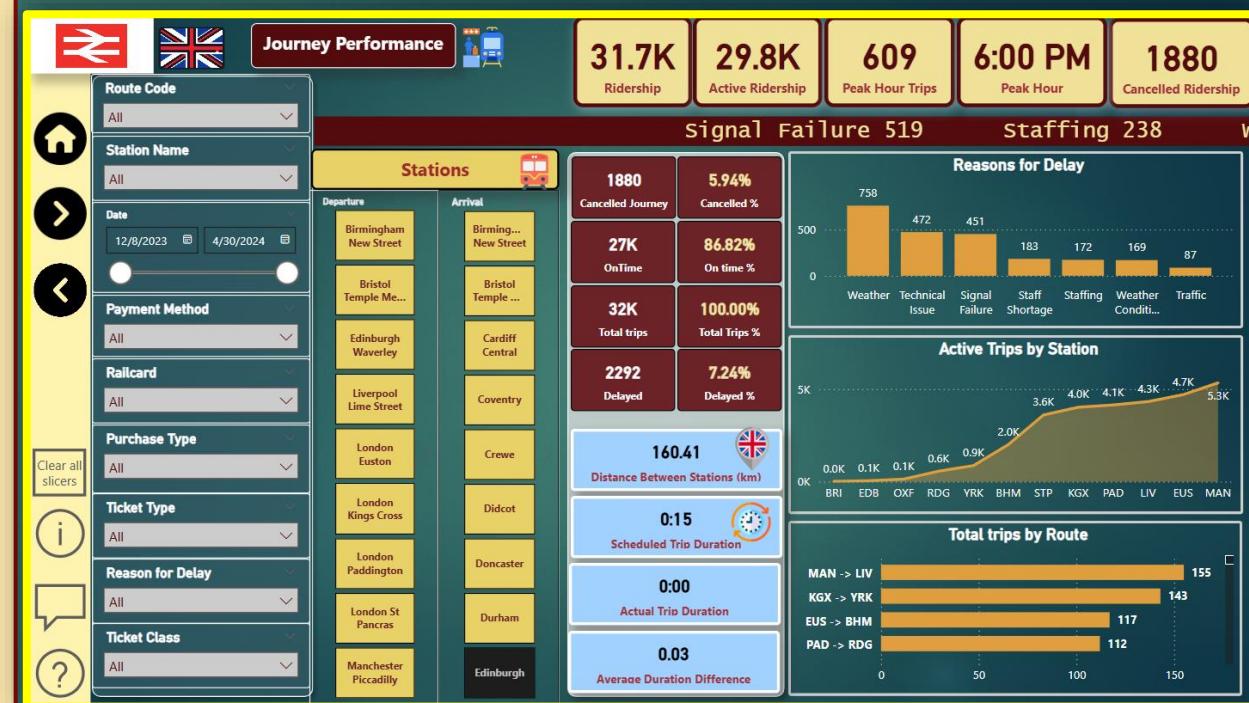
3- Journey Performance Analysis

KPIs:

- ▶ **Ridership:** Total passengers recorded during the period.
- ▶ **Active Ridership:** Passengers who completed their trips successfully.
- ▶ **Peak Hour Trips:** Number of trips during peak traffic hours.
- ▶ **Peak Hour:** The highest ridership time of day.
- ▶ **Cancelled Ridership:** Total passengers affected by journey cancellations.

Visuals and Metrics

- ▶ **Cancelled Journey:** Outlines the percentage and total number of cancelled journeys.
- ▶ **On-Time:** Displays percentage of trips completed without delay.
- ▶ **Total Trips:** Indicates the complete number of trips included in the analysis.
- ▶ **Delayed:** Shows the percentage of journeys that experienced delays.
- ▶ **Distance Between Stations:** Average distance covered between stations.
- ▶ **Scheduled Trip Duration:** Average planned travel time between stations.
- ▶ **Actual Trip Duration:** Shows there's no major deviation from the schedule (potential placeholder or data issue).
- ▶ **Average Duration Difference:** Minimal time difference between scheduled and actual trips.
- ▶ **Reasons for Delay:** Weather, technical issues, and signal failures are the top causes of delays.
- ▶ **Active Trips by Station:** Manchester Piccadilly (MAN) and Liverpool Lime Street (LIV) stations have the highest active trips.
- ▶ **Total Trips by Route (Bottom Right - Horizontal Bar Chart):** The Manchester to Liverpool route has the most trips among the top four listed routes.



4-Revenue Analysis



Questions

- ▶ 1 -What are the main KPIs affecting the revenue?
 - ▶ 2 -How much each payment method share at the revenue?
 - ▶ 3 -Which purchase type gives higher revenue
 - ▶ 4 -What is the size of refund against the revenue at each station?
 - ▶ 5 -What is the effect of the holidays on the revenue?
 - ▶ 6 -What is the month-to-month revenue?
 - ▶ 7 -What is the revenue of each station and which is the best?





4-Revenue Analysis

KPIs:

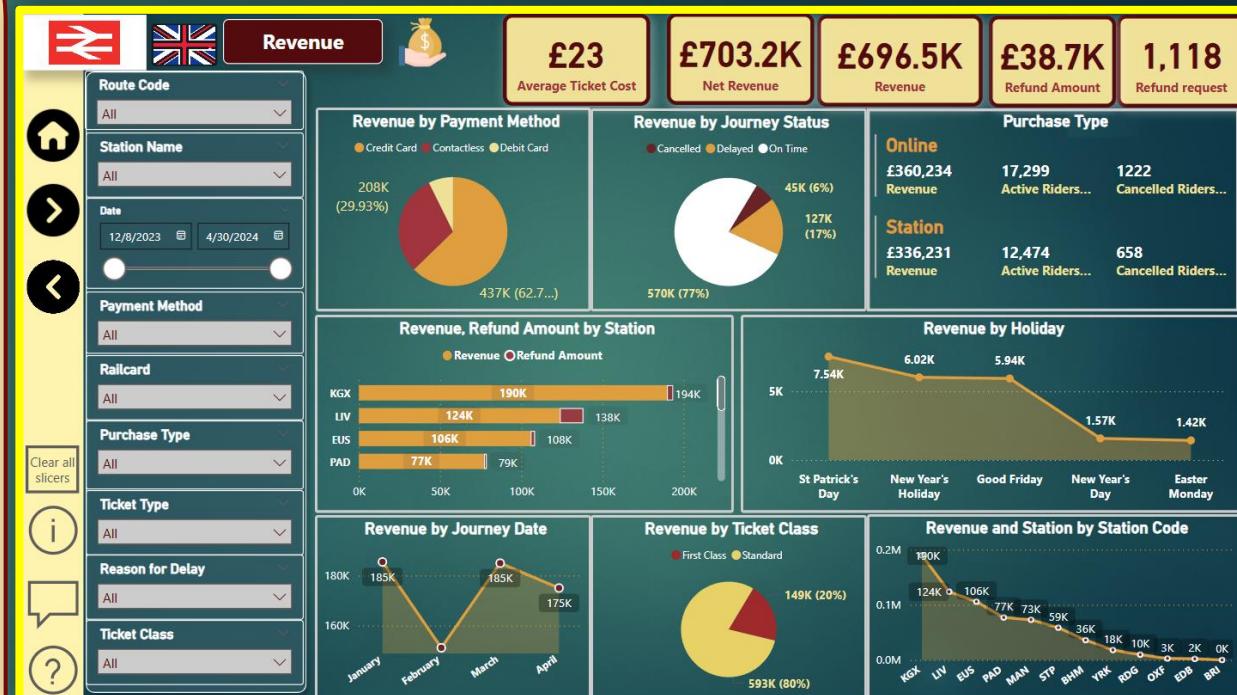
- Average Ticket Cost (£23): The mean price per ticket sold.
- Net Revenue (£703.2K): Total revenue after deducting refunds.
- Revenue (£741.9K): Gross revenue collected.
- Refund Amount (£38.7K): Total money refunded to passengers.
- Refund Requests (1,118): Total number of refund requests made.

Visuals and Metrics

- Revenue by Payment Method: Most revenue comes from debit card payments
- Revenue by Journey Status: Most revenue is generated from on-time journeys (570K), with smaller portions from delayed and cancelled rides.
- Purchase Type: Revenue split shows slightly more online purchases (£360,234) compared to station purchases (£336,231).
- Revenue, Refund Amount by Station: King's Cross (KGX) generates the highest revenue and refund amounts compared to other stations.
- Revenue by Holiday: Highest revenue spikes around St. Patrick's Day (£7.54K) and gradually drops towards Easter Holiday.
- Revenue by Journey Date: Revenue fluctuates monthly, peaking in February and falling sharply in April.
- Revenue by Ticket Class: Standard class tickets dominate the revenue (80%), while first-class tickets account for 20%.
- Revenue and Station by Station Code: KGX leads in station revenue, followed by LIV and PAD with steadily lower earnings across others.

Filters Panel

- Route Code, Station Name, Date Range, Payment Method, Railcard, Purchase Type, Ticket Type, Reason for Delay, and Ticket Class: Dynamic filters allow users to focus the revenue analysis across various factors and travel conditions.

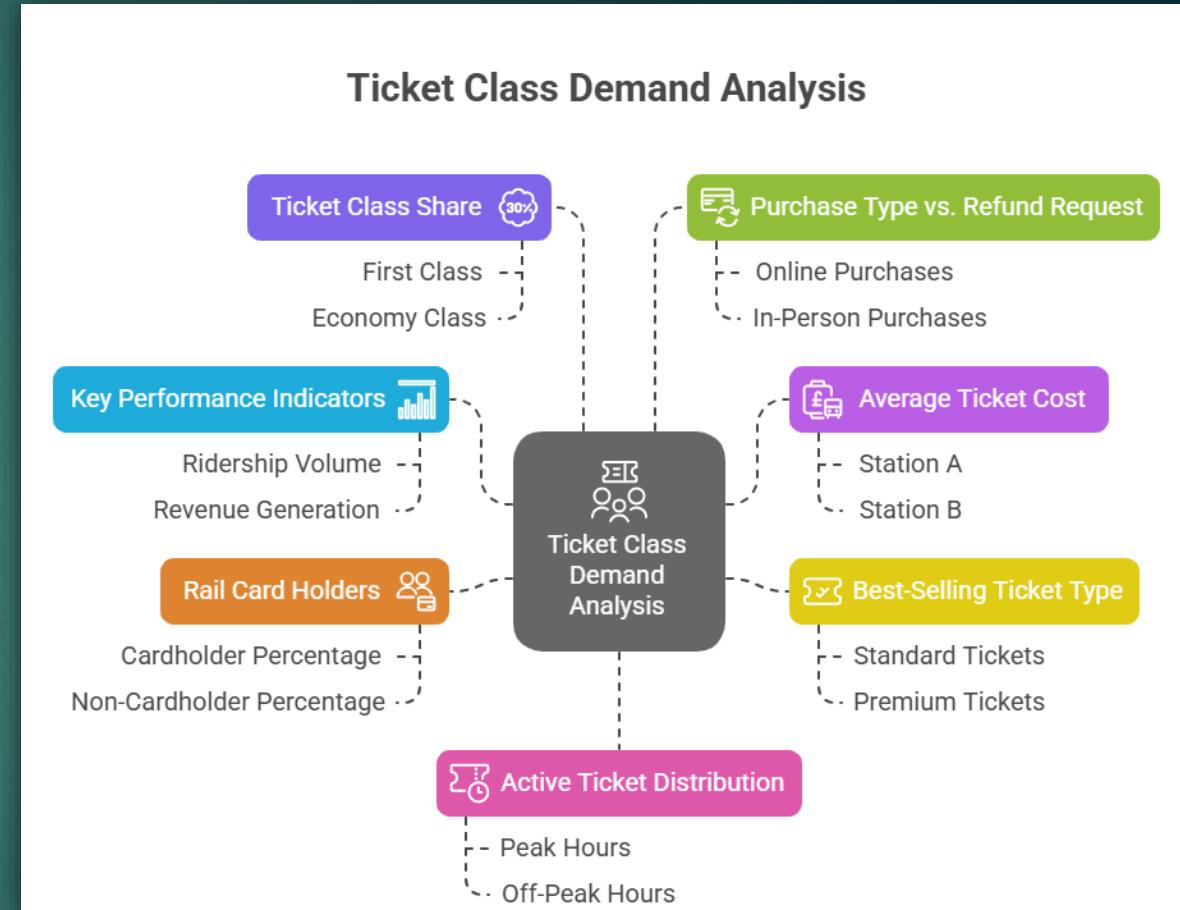


5- Ticket Class Demand Analysis



Questions

- ▶ 1 -What are the KPIs that support the ticket class analysis?
- ▶ 2 -What is the Average ticket cost by station?
- ▶ 3 -What is the best -selling ticket type?
- ▶ 4 -What is the distribution of the rail card holders between the ridership?
- ▶ 5 -What is the percentage share of the ticket class?
- ▶ 6 -Is there a relation between the ticket purchase type and refund request? And which is higher?
- ▶ 7 -What is the distribution of the active tickets along the time frame of the analysis?





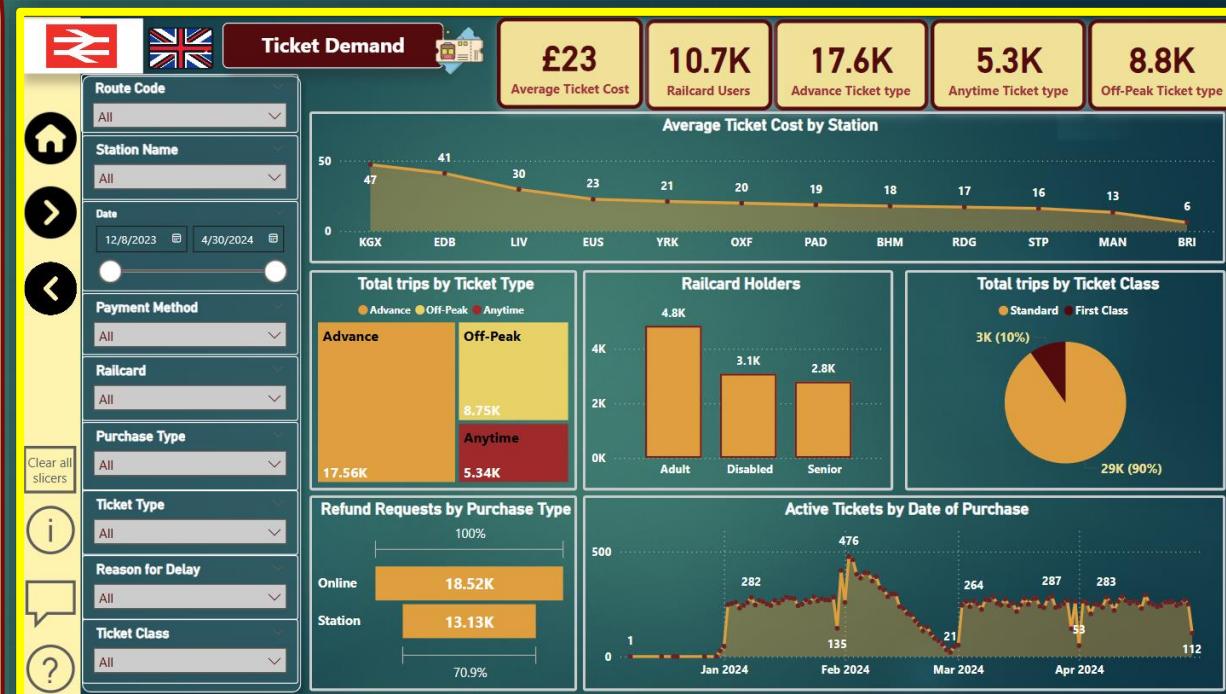
5- Ticket Class Demand Analysis

KPIs:

- Average Ticket Cost (£23): The mean price paid per ticket across all sales.
- Railcard Users (10.7K): Total number of travelers who used a railcard.
- Advance Ticket Type (17.6K): Number of advance tickets purchased.
- Anytime Ticket Type (5.3K): Number of anytime tickets sold.
- Off-Peak Ticket Type (8.8K): Number of off-peak tickets purchased.

Visuals and Metrics

- Average Ticket Cost by Station: King's Cross (KGX) shows the highest average ticket cost, with a general decline across other stations.
- Total Trips by Ticket Type: Advance tickets dominate sales (17.56K), followed by off-peak and anytime tickets.
- Railcard Holders: Adults represent the largest group of railcard users, followed by disabled and senior travellers .
- Total Trips by Ticket Class: Standard class accounts for the vast majority of trips (90%), with only 10% in first class.
- Refund Requests by Purchase Type: Most refund requests came from station purchases (70.9%) compared to online purchases.
- Active Tickets by Date of Purchase: Peak ticket purchase activity occurred in early February, followed by smaller peaks in March and April.



6-Prediction (Forecasting Analysis)



Introduction

The forecasts shown are generated based on historical ridership, revenue, and ticket sales data between December 2023 and April 2024 .

The models use time -series forecasting techniques likely based on approaches such mathematical models embedded within Power BI's forecasting engine.

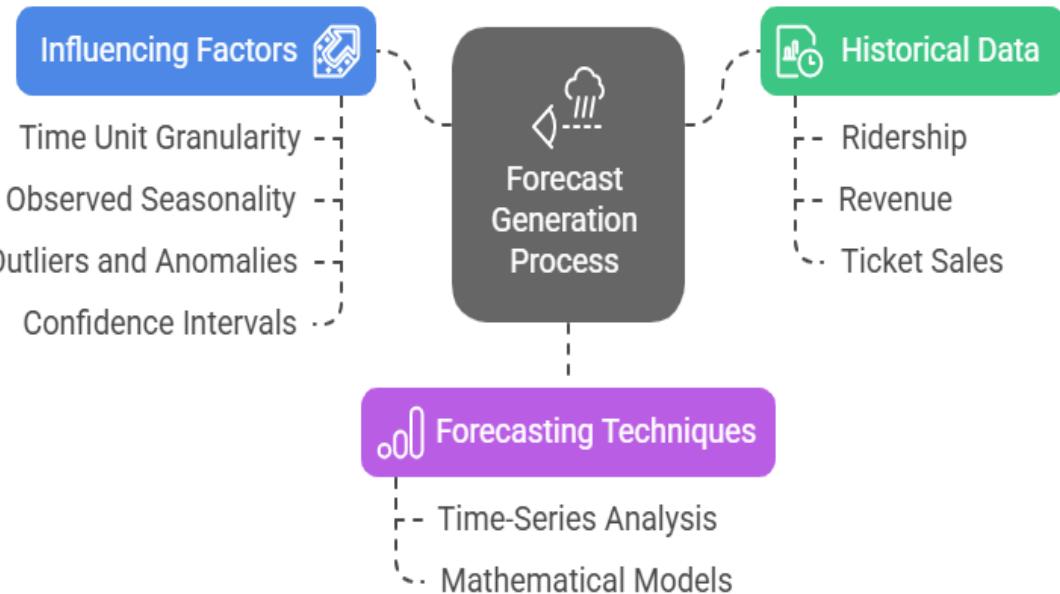
The forecast calculation considers:

- ▶ Historical trends (repeating patterns in past data)
- ▶ Seasonality (daily, weekly, and monthly cyclical effects)
- ▶ Growth rates (positive or negative)
- ▶ Variance and noise (to compute prediction intervals with upper and lower bounds)

Key parameters influencing the forecast:

- ▶ Time unit granularity (hourly, daily, or transaction-based aggregation)
- ▶ Observed seasonality (e.g., weekday vs weekend travel, holiday impacts)
- ▶ Outliers and anomalies (signal failures, unusual surges)
- ▶ Confidence intervals (a range showing uncertainty in predictions)

Forecast Generation Process and Influencing Factors





6-Prediction (Forecasting Analysis)

Forecasted Active Ridership by Departure Time:

The model predicts that 395 passengers will depart per hour on average in future periods, with a strong hourly growth rate of 117.7%.

The forecast exhibits a wide prediction interval (ranging from 0 to 895), indicating high uncertainty, likely due to the high fluctuation in hourly data.

Active Ridership by Departure Time

Historical hourly ridership shows distinct, sharp peaks around typical commuting hours (6 AM–9 AM and 4 PM – 7 PM), with the forecast projecting a flattening of peaks, implying more consistent but slightly reduced ridership across hours in upcoming periods.

Forecasted Revenue by Date of Purchase

Historical revenue highlights clear revenue spikes around key travel seasons (February and April), and the forecast shows a flattening trend, implying that unless special events reoccur, revenue may fall back to baseline levels.

Future revenue is forecasted at £3,729 per day, but with a negative growth rate of -38.37%, suggesting declining revenue potential if current patterns persist.

The forecast range between £1,000 and £7,000 reflects significant uncertainty, possibly linked to variable purchasing behaviors around holidays or promotions.

Forecasted Active Tickets by Date of Purchase

The historical ticketing data shows major purchasing peaks tied to seasonality, particularly early in February and around Easter.

The forecast trend is downward -sloping, reinforcing the need for demand stimulation strategies if business objectives are to be met.

Ticket purchases are forecasted to average 126 per day, with a strong decline rate of -53.85%.

This substantial drop suggests reduced demand or ticketing activity, potentially due to seasonal factors, lower marketing efforts, or passenger behavior changes post-peak seasons.

The forecast band (76 to 176) indicates moderate uncertainty.





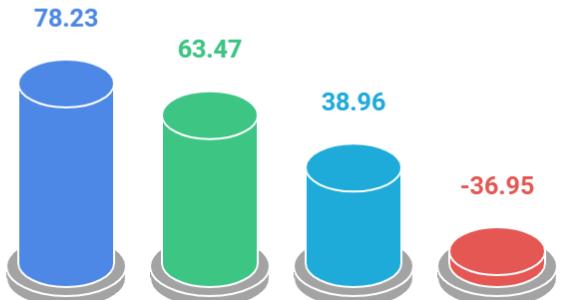
7- Key Influencer

Questions

► 1. What Influences Revenue to Increase ?

Factors Influencing Revenue Increase

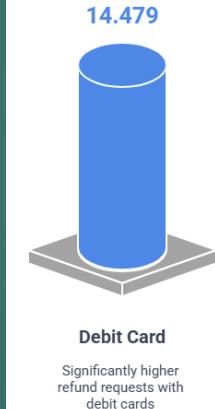
London Euston
High revenue from key London station
7:45 AM - 8:00 AM
Peak commuting hours drive revenue
London Paddington
Significant revenue from major London station
On Time
Revenue decrease due to competitive fares



► 2.What Influences Refund Requests ?

Factors Influencing Refund Request Likelihood

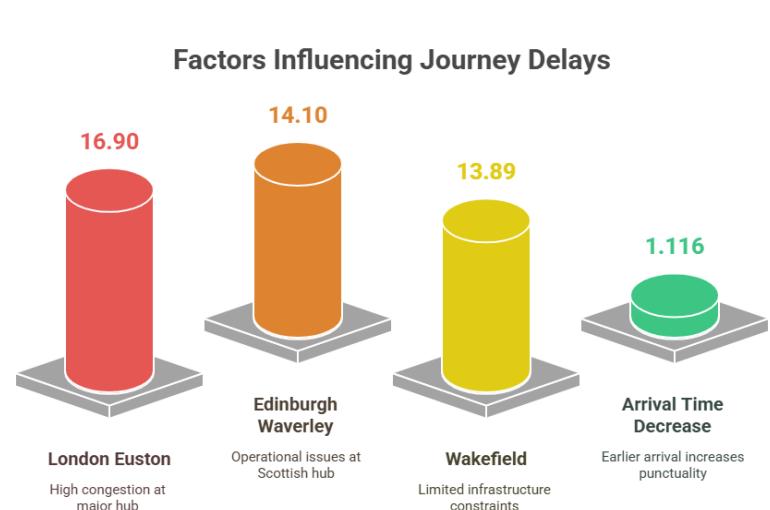
Debit Card
14.479
Significantly higher refund requests with debit cards
Adult Railcard
3.31
Adults more likely to seek refunds
Off-peak Ticket
1.30
Slight increase in refunds for off-peak tickets
Credit Card
0.96
Slightly lower refund requests with credit cards



► 3. What Influences Journey Status to Be Delayed ?

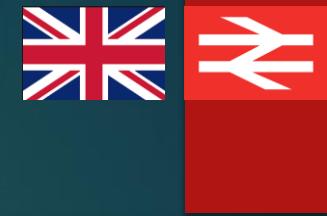
Factors Influencing Journey Delays

London Euston
16.90
High congestion at major hub
Edinburgh Waverley
14.10
Operational issues at Scottish hub
Wakefield
13.89
Limited infrastructure constraints
Arrival Time Decrease
1.116
Earlier arrival increases punctuality



Recommendations

To Increase Revenue



1. Increase Journeys to High-Revenue Destinations :

- ▶ Prioritize scheduling more journeys to London Euston and London Paddington, as these destinations generate the highest revenue (78.23 and 38.96 units, respectively).
- ▶ Ensure these journeys are reliable by addressing operational challenges (e.g., congestion at London Euston) to maintain passenger trust and demand.
- ▶ Example Action: Add more direct trains to London Euston during high-demand periods and improve platform availability to reduce bottlenecks.

2. Capitalize on Peak Times :

- ▶ Schedule additional trains between 7:45 AM and 8:00 AM, as this peak period increases revenue by 63.47 units due to higher fares and passenger volume .
- ▶ Optimize pricing strategies during peak hours to maximize revenue without deterring passengers .
- ▶ Example Action: Introduce dynamic pricing for peak-hour tickets to balance demand and revenue, ensuring sufficient train capacity during these times .

3. Investigate On-Time Journey Revenue Drop :

- ▶ Conduct a deeper analysis into why on-time journeys reduce revenue by 36.95 units. This could involve reviewing pricing strategies (e.g., are on-time journeys priced too low to compete?) or assessing if delayed journeys generate additional revenue (e.g., through fees or alternative bookings) .
- ▶ Adjust pricing or service offerings for on-time journeys to make them more profitable without compromising reliability .
- ▶ Example Action: Test a slight fare increase for on-time journeys to offset the revenue drop, while offering incentives (e.g., loyalty points) to maintain passenger satisfaction .

4. Address Seasonal Revenue Volatility :

- ▶ Analyze the reasons behind revenue drops in March (1K) and May (4K) compared to February (11K). This may involve reviewing journey schedules, marketing efforts, or external factors (e.g., weather, holidays) .
- ▶ Implement targeted promotions during low-revenue months to boost ridership to high revenue destinations like London Euston and Paddington .
- ▶ Example Action: Launch a spring travel campaign offering discounted fares for early bookings to London Euston, encouraging travel during typically low-revenue periods .

Revenue Optimization Strategies

Investigate On-Time Journey Revenue Drop

Understanding revenue drops involves intricate pricing and service analysis.



Increase Journeys to London Euston

Maximizing revenue requires addressing complex operational challenges.



Address Seasonal Revenue Volatility

Simple promotions can mitigate seasonal revenue fluctuations.



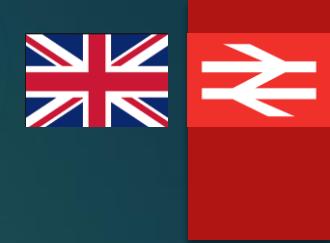
Capitalize on Peak Times

Strategic pricing during peak hours boosts revenue effectively.



Recommendations

To Reduce Refund Requests



1. Minimize Delays and Cancellations :

-Focus on reducing delays and cancellations, especially for journeys paid with debit cards, as debit card users are 14.479 times more likely to request refunds .

-Address operational issues at high-delay stations like London Euston and Edinburgh Waverley (see delay recommendations below) to improve reliability .

-Example Action: Introduce a real-time monitoring system to identify and resolve potential delays before they impact passengers, reducing the need for refunds .

2. Target Adult Railcard Holders :

-Offer incentives for adult Railcard holders (3.31 times more likely to request refunds) to reduce refund requests. This could include faster compensation processes, discounts on future journeys, or priority rebooking for delayed/canceled journeys .

-Example Action: Create an "Adult Railcard Loyalty Program" offering a 10% discount on the next journey if a refund is requested due to delays, encouraging retention over refunds .

3. Improve Off-f-Peak Journey Reliability :

-Enhance the reliability of Off-f-Peak journeys, as their ticket type increases refund likelihood by 1.30 times. This may involve better scheduling to avoid delays or ensuring sufficient train capacity during non-peak hours .

-Example Action: Allocate additional trains for Off-f-Peak routes to Wakefield (a high-delay destination) to reduce delays and improve passenger satisfaction, thereby lowering refund requests .

4. Encourage Credit Card Usage :

-Promote credit card payments, as they reduce refund likelihood by 1.04 times. Offer small incentives (e.g., a 2% discount) for credit card payments to shift passenger behavior .

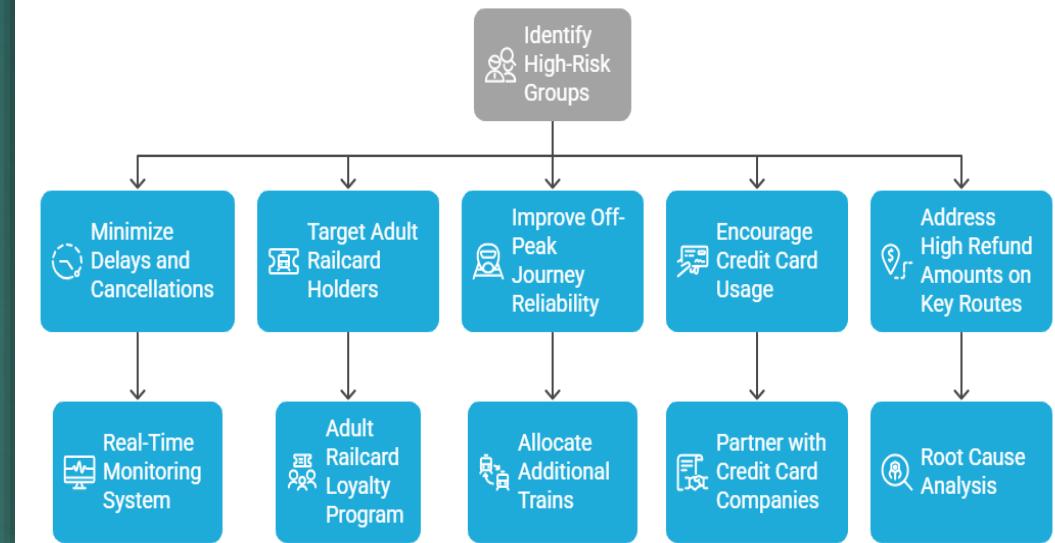
-Example Action: Partner with credit card companies to offer cashback rewards for train ticket purchases, making credit card payments more attractive and reducing refund requests .

5. Address High Refund Amounts on Key Routes :

-The £17 refund amount for the London Kings Cross to York route indicates a need to address underlying issues like delays and cancellations. Focus on improving service reliability on this route to reduce refund requests .

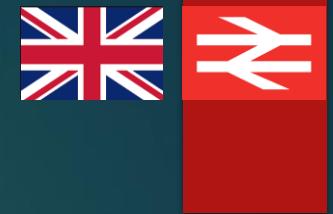
-Example Action: Conduct a root cause analysis of refunds on this route and implement targeted improvements (e.g., better scheduling, more staff support) to enhance passenger experience .

Strategies to Reduce Refund Requests



Recommendations

To Reduce Journey Delays



1. Optimize Operations at London Euston :

- Journeys to London Euston are 16.90 times more likely to be delayed. Address congestion and operational challenges at this busy station by improving scheduling, increasing platform availability, and enhancing coordination with other train services .
- Example Action: Invest in infrastructure upgrades at London Euston (e.g., additional platforms, better signaling systems) to reduce delays and improve journey reliability .

2. Improve Departure Operations at Edinburgh Waverley :

- Journeys departing from Edinburgh Waverley are 14.10 times more likely to be delayed. Tackle operational issues at this station, such as congestion, maintenance schedules, or staffing shortages, to ensure timely departures .
- Example Action: Implement a dedicated departure management team at Edinburgh Waverley to streamline operations and reduce delays, especially for long-distance journeys to London Euston .

3. Enhance Service to Wakefield :

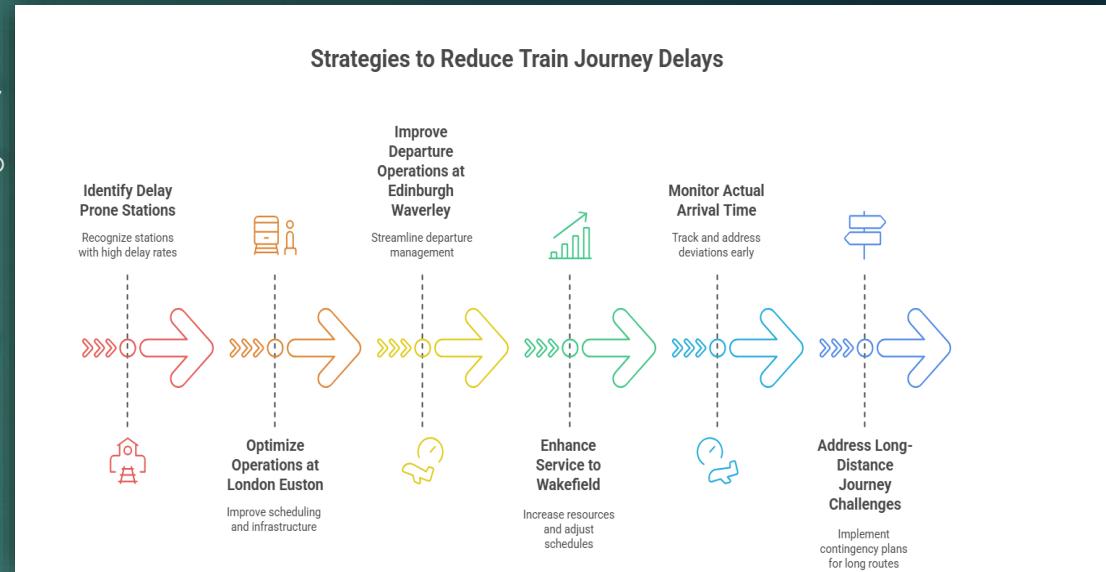
- Journeys to Wakefield are 13.89 times more likely to be delayed. Improve resources at this secondary station (e.g., more platforms, better scheduling) to reduce delays and ensure smoother operations .
- Example Action: Review and adjust the scheduling of trains stopping at Wakefield to minimize conflicts with other routes, ensuring more reliable service .

4. Monitor and Improve Actual Arrival Time:

- A decrease in Actual Arrival Time by 0.24 increases the likelihood of a journey being on time by 1.116 times. Set up daily monitoring of Actual Arrival Time to identify and address deviations early, ensuring journeys stay on schedule .
- Example Action: Use predictive analytics to forecast potential delays based on historical data and adjust schedules proactively to maintain on-time performance .

5. Address Long-Distance Journey Challenges :

- Long-distance journeys (e.g., from Edinburgh Waverley to London Euston) are prone to delays due to distance and external factors (e.g., weather). Implement contingency plans, such as backup trains or alternative routes, to mitigate delays on these routes .
- Example Action: Develop a weather contingency plan for long-distance routes, including prescheduled backup trains to minimize disruptions during adverse conditions .



Final Opinion



Revenue

Revenue is heavily influenced by journeys to London Euston (78.23 units) and London Paddington (38.96 units), as well as peak departure times (7:45-8:00 AM, 63.47 units). However, on-time journeys reduce revenue by 36.95 units, which warrants further investigation into pricing and operational strategies. Seasonal volatility (e.g., 1K in March vs. 11K in February) suggests a need for targeted interventions during low-revenue periods.

Refund Requests

Refund requests are significantly driven by debit card payments (14.479x likelihood), adult railcards (3.31x), and Off-peak tickets (1.30x), while credit card payments slightly reduce requests (1.04x decrease). The £17 refund amount on the London Kings Cross to York route highlights the impact of delays and cancellations on passenger satisfaction.

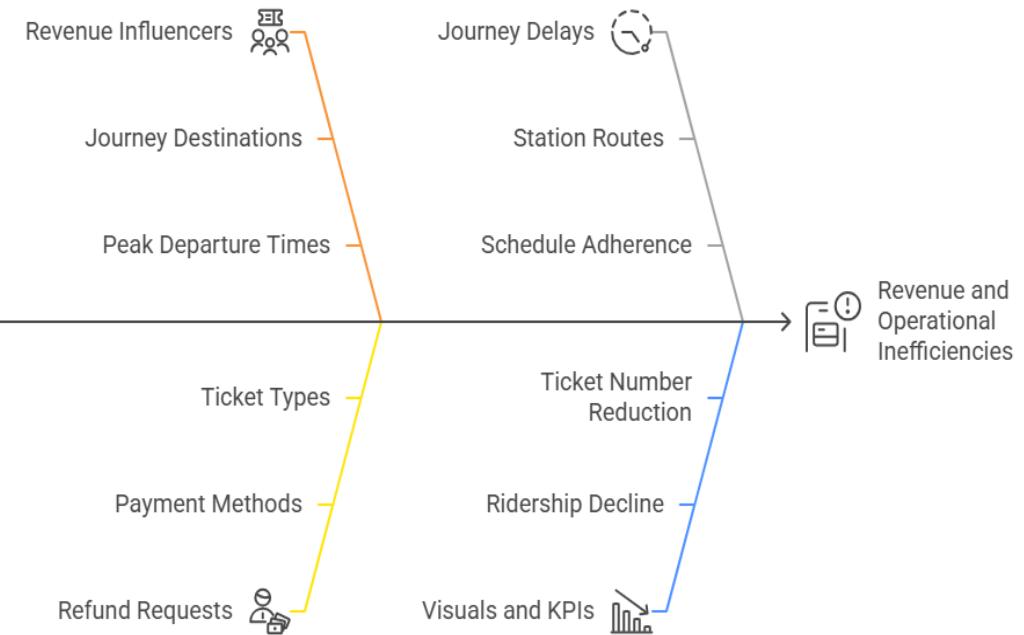
Journey Delays

Delays are most likely for journeys to London Euston (16.90x), from Edinburgh Waverley (14.10x), and to Wakefield (13.89x). Improving Actual Arrival Time (e.g., reducing it by 0.24) increases on-time likelihood by 1.116x, emphasizing the importance of schedule adherence.

Relation to Visuals and KPIs

The drop in ridership (63 passengers in April), ticket numbers (112 in April), and revenue (1K in March) is directly tied to delays and cancellations, particularly involving London Euston and Edinburgh Waverley. These issues also contribute to higher refund requests, as seen in the £17 refund amount for the route.

Analyzing Revenue and Operational Challenges



Strategic Roadmap for Implementation



**operationalize the recommendations,
here's a prioritized roadmap :**

1. Short -Term (0-3 Months) :

- Schedule additional peak-time trains (7:45-8:00 AM) to boost revenue .
- Implement real-time monitoring of Actual Arrival Time to reduce delays .
- Offer incentives for adult railcard holders to reduce refund requests .

2. Medium -Term (3-6 Months) :

- Address operational issues at London Euston and Edinburgh Waverley through better scheduling and resource allocation .
- Launch a spring travel campaign to boost revenue during low-revenue months (e.g., March, May) .
- Promote credit card payments with small incentives to reduce refund requests .

3. Long-Term (6-12 Months) :

- Invest in infrastructure upgrades at London Euston and Wakefield to reduce delays .
- Develop a weather contingency plan for long-distance routes to minimize disruptions
- Conduct a detailed pricing analysis for on-time journeys to address the revenue drop

Strategic Roadmap for Rail Improvement





Thank You