School of Information and Communication Technology

Griffith University

7821ICT

Green City Situation Awareness

Final Report

Proof of Concept Demonstrator for Sustainable Transport

22/10/2024 T2 2024

Industry Partner: City of Gold Coast

Client Project Mentor and Advisor: Phillip Karfs

Initial Support: Vanessa A Fernandes

Team members:

Omkar Dhananjay Kulkarni (s5325810)

Vlessety Vishal Kumar (s5314434)

Viet An Nguyen (s5321461)

Zhanrui Liao (s5290972)

Table of Contents

Table of Contents

1. INTRODUCTION

This report presents the findings and outcomes of the Green City Situation Awareness project, conducted for the City of Gold Coast. The project aims to analyse the impact of the Queensland Government's 50c public transport fare initiative and assess changes in road traffic patterns and public transport usage. We provide insights into how public transport usage and traffic flow have evolved over the study period.

The report is divided into three main sections, each addressing a critical aspect of the project:

1. Public Transport Analysis

This section examines the impact of the 50c fare initiative on public transport usage, assessing changes in customer behaviour, the percentage change in ridership compared to previous months and the same month last year, and any emerging trends.

2. Delay Hours Analysis

Here, we analyse road traffic data to measure the reduction or increase in delay hours. The analysis highlights the effectiveness of the fare initiative in reducing congestion and improving traffic flow.

3. Traffic Volume Analysis

The final section focuses on traffic volume, analysing the changes in the number of vehicles on the road and comparing trends before and after the implementation of the 50c fare trial. This helps assess overall traffic density and movement patterns.

Each part of the report explains the methodology, presents the output of the analysis, and offers conclusions based on the findings. Finally, after these three parts, the report concludes by summarising the overall insights derived from the project, offering a comprehensive view of the impact of the 50c fare initiative and the observed changes in traffic patterns.

2. PUBLIC TRANSPORT ANALYSIS

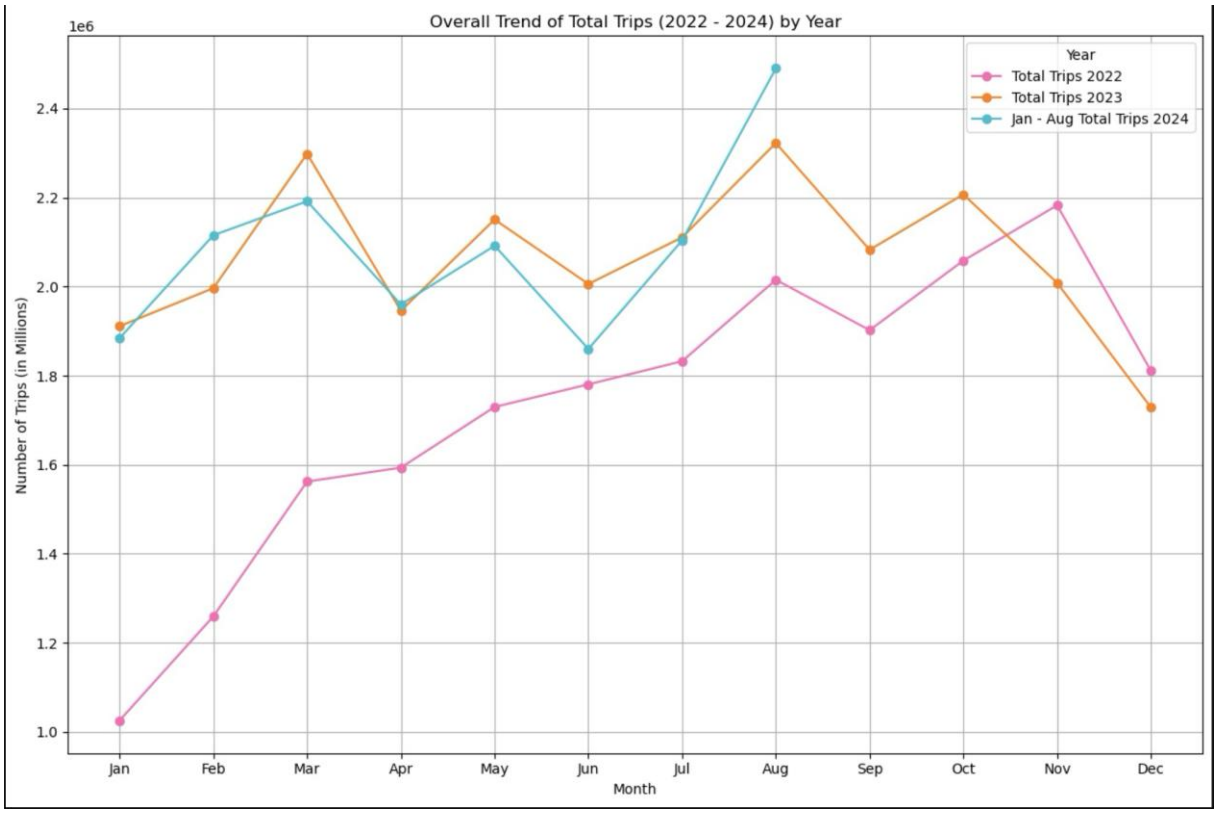
2.1 Introduction

In this section, we analyse the impact of the Queensland Government's 50c fare initiative on public transport usage. The goal is to identify changes in customer behaviour, examining how the reduced fare influenced ridership patterns. We compare public transport usage before and after the initiative, analysing percentage changes in ridership month-over-month and against the same months in the previous year to uncover significant trends. Additionally, we include a prediction analysis to forecast the number of trips from September to December and a comparison of weekend vs. weekday usage to explore different travel behaviours during the week.

2.2 Overall Trends (Jan 2022 - Aug 2024)

To provide a comprehensive view of public transport usage, we first analysed data spanning from January 2022 to August 2024. This allowed us to identify underlying trends and fluctuations over time, both before and after the implementation of the 50c fare initiative.

Below is a graph that visually represents these trends:



Key Findings:

A. 2022 had a steady rise in trips across the months, with no sharp fluctuations.

B. 2023 had a relatively high start, peaked in June, and then had a notable decline by December.

C. 2024 was following a similar pattern to 2023 but with more variability, especially in the latter part of the year, where August saw noticeable peaks.

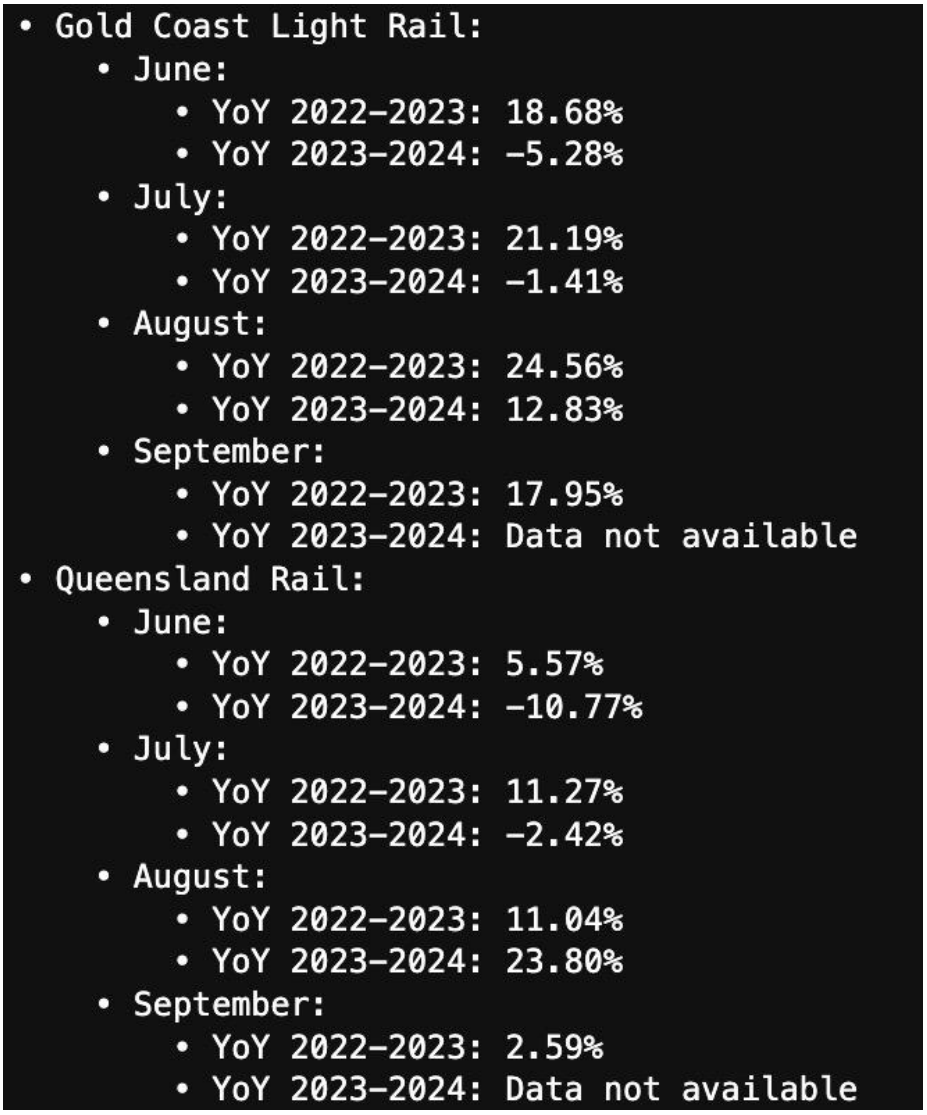
Conclusion: The rise in August 2024 may correspond with the 50c trial, causing increased public transport usage during these months.

2.3 YoY % Change

After obtaining the overall trends from January 2022 to August 2024, we conducted a year-over-year (YoY) percentage change analysis to compare public transport usage across different modes—Gold Coast Light Rail, Queensland Rail, and Surfside Buslines. The analysis was performed for each month from June to September, comparing the usage in 2022–2023 and 2023–2024.

Standard formula to calculate % change i.e. [(New value) - (Old Value)] / (Old Value) * 100

YoY % changes are as follows:



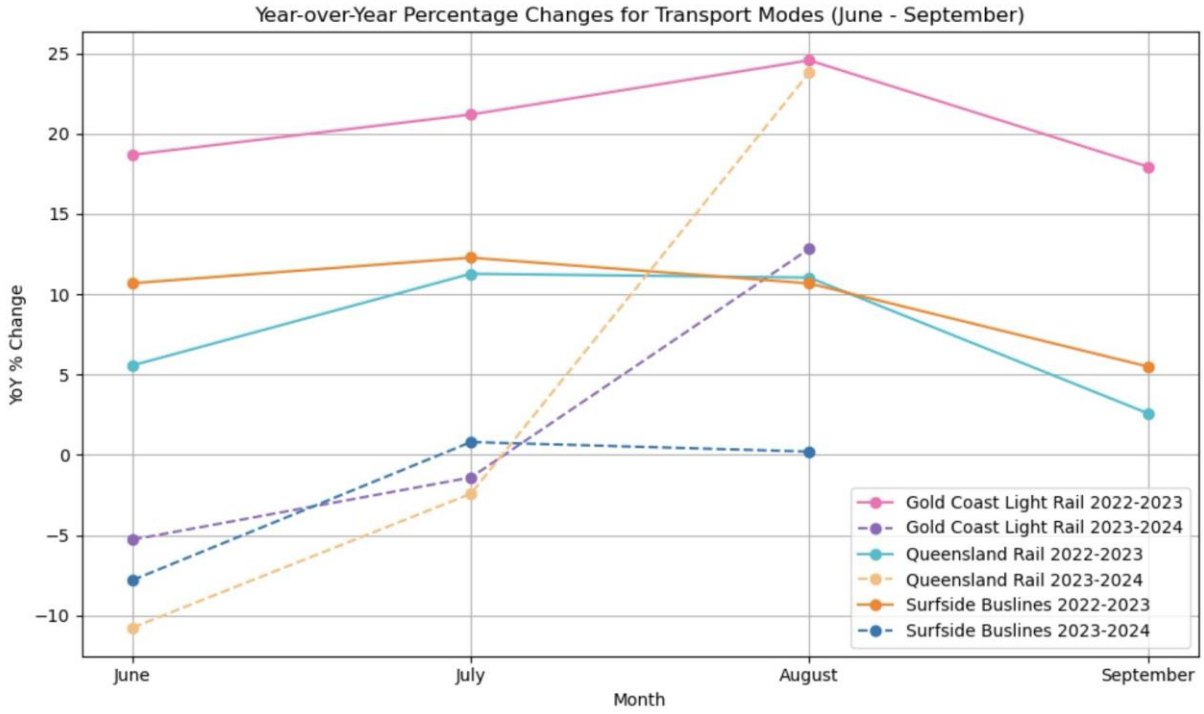
2.4 Interpreting the numbers:

A. Positive O/P when New Value is greater than previous value e.g. August 2024 v/s August 2023.

B. Negative O/P when New Value is lower than previous value e.g. June 2024 v/s June 2023.

C. It would have been 0 if values were same. Not applicable for our case.

After calculating these percentage changes, we plotted the data to visually assess the trends and better understand the shifts in ridership behavior.



2.5 Key Findings

A. The Gold Coast Light Rail saw the most significant increase from 2022 to 2023, and despite starting at a negative percentage in 2023-2024, it showed strong recovery by August.

B. Queensland Rail showed modest year-over-year changes, with a slight improvement in both periods, peaking in August 2024.

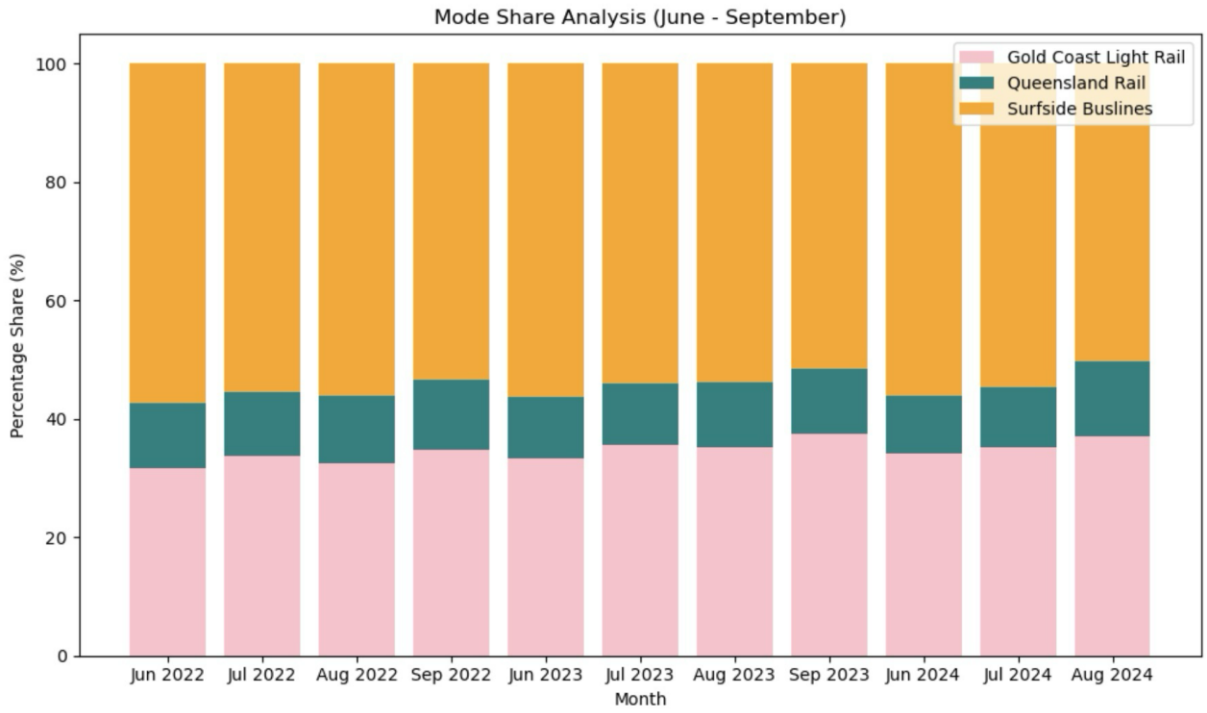
C. Surfside Buslines experienced a recovery from negative values in both periods, but the 2023-2024 increase in August was much more drastic.

Conclusion: The 50c fare trial in August 2024 significantly boosted public transport usage, particularly for the Gold Coast Light Rail and Surfside Buslines, both of which saw marked increases compared to previous months and years. While Queensland Rail also showed a modest rise, its growth was less pronounced. The sharp spike in August, followed by slight declines in September, indicates the trial had a substantial but possibly temporary impact on travel behaviour.

2.6 Mode Share Analysis and Finding

Following the year-over-year percentage change analysis, we conducted a Mode Share Analysis to determine the contribution of each transport mode—Gold Coast Light Rail, Queensland Rail, and Surfside Buslines—to the total public transport trips. This analysis helps in identifying which modes dominate the total trips and how their contributions have shifted over time.

The following graph illustrates the mode share breakdown for each mode of transport.



Key Findings:

A. The Gold Coast Light Rail consistently holds around 30% of the mode share.

B. Queensland Rail has a steady share, making up around 10-15% of the total mode. Its contribution remains stable, similar to the light rail.

C. Surfside Buslines consistently dominates the mode share, accounting for around 60% or more. This indicates that bus usage is the most prevalent mode of transport compared to the other two.

Conclusion: The graph highlights the stable distribution of public transport mode share in the Gold Coast region, with Surfside Buslines consistently holding the largest share, followed by Gold Coast Light Rail and Queensland Rail. Despite policy changes like the 50c fare trial in August 2024, the relative distribution of these modes remains largely unchanged, indicating strong preferences for bus transport.

2.7 Peak vs Off Peak Month Analysis and Findings

After the mode share analysis, we conducted a Peak vs. Off-Peak Month Analysis to understand how public transport usage fluctuates during peak and off-peak times across different months. This analysis helps identify when the highest ridership occurs and whether the 50c fare initiative had a distinct impact on peak or off-peak periods.

The results of this analysis showed significant differences in ridership patterns:

	Peak Month	Off-Peak Month	Peak Trips	Off-Peak Trips
Gold Coast Light Rail	Aug 2024	Jun 2022	922271	563579
Queensland Rail	Aug 2024	Jun 2024	312974	183718
Surfside Buslines	Aug 2024	Jul 2022	1254522	1016811
Total	Aug 2024	Jun 2022	2489767	1780385

Key Findings:

A. All transport modes reached their peak usage in August 2024, which aligns with the 50c fare trial, suggesting that the trial significantly boosted ridership.

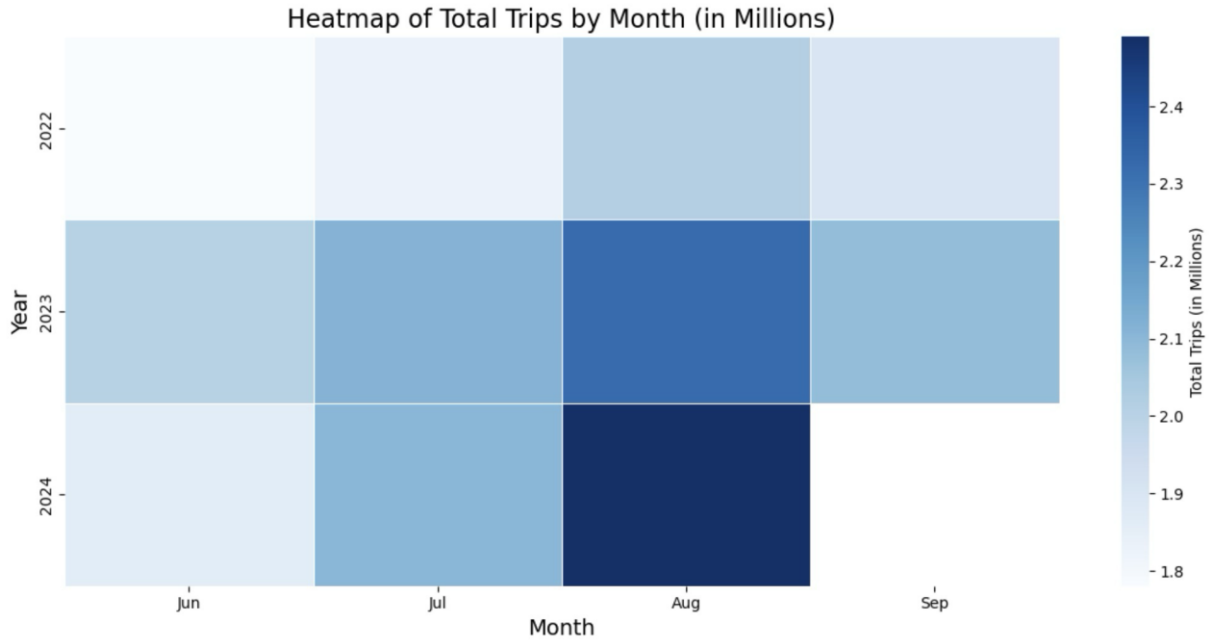
B. The off-peak months vary, with Gold Coast Light Rail experiencing its lowest ridership in June 2022, while Queensland Rail's off-peak was in June 2024 and Surfside Buslines in July 2022.

C. The difference between peak and off-peak trips is most notable for Surfside Buslines, which consistently maintains higher ridership even during off-peak months.

D. The data strongly suggests that the 50c fare trial in August 2024 drove substantial increases in public transport usage across all modes, with the highest trip counts recorded during that month. However, trip numbers during off-peak months were relatively lower.

2.8 Heatmap Peak vs Off Peak Month Analysis and Conclusion

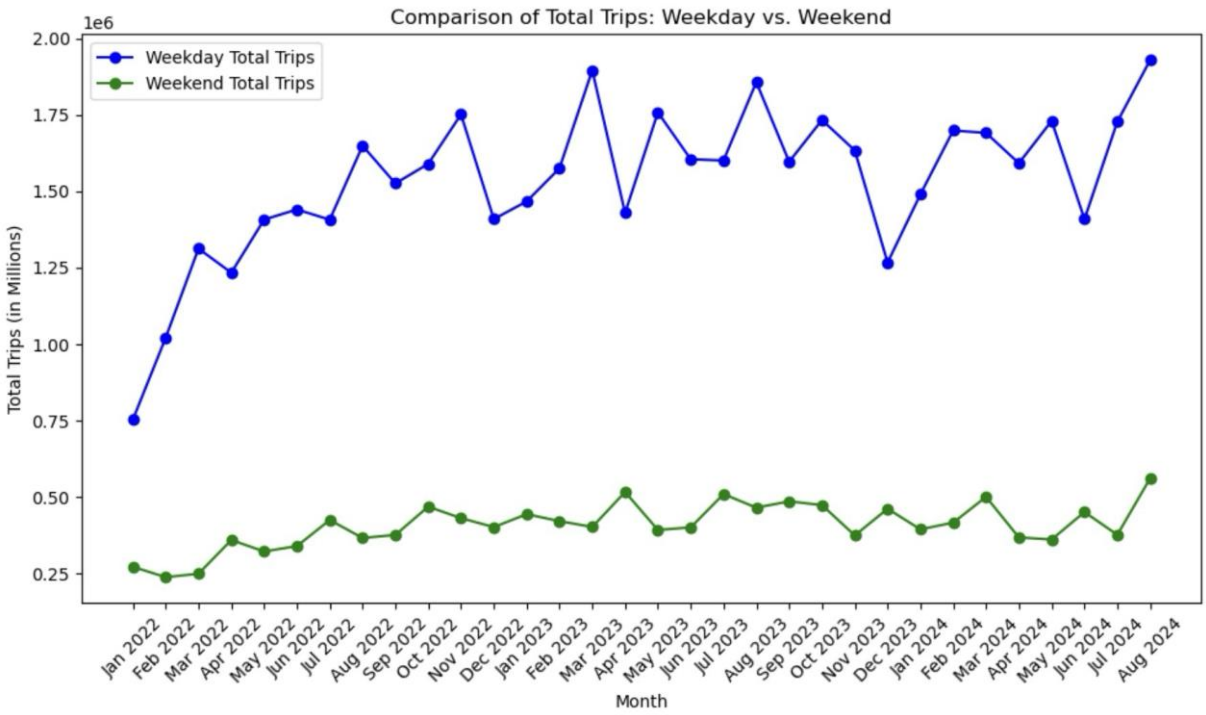
To better visualize these ridership patterns, we plotted a heatmap showing the distribution of trips across peak and off-peak months.



Conclusion: The heatmap clearly highlights that August 2024 saw a significant spike in public transport usage, with over 2.4 million trips, which coincides with the 50c fare trial. Other months, particularly in 2022 and early 2024, show fewer total trips, reinforcing the impact of fare changes and other factors on ridership behaviour.

2.9 Weekday vs Weekend Overall Trends (Jan 2022 to Aug 2024) and findings

After analyzing peak vs. off-peak trends, we plotted the overall Weekend vs. Weekday Analysis from January 2022 to August 2024. This analysis helped us observe how ridership behavior varied between weekends and weekdays over time, providing insights into the general patterns of public transport usage before and after the 50c fare initiative.



Key Findings:

A. The number of weekday total trips (represented by the blue line) is consistently higher than the number of weekend total trips (represented by the green line) over the observed period.

B. There is a noticeable upward trend in weekday trips starting from January 2022, reaching a peak around June 2023, with fluctuations afterward. The graph shows a slight increase again in mid-2024.

C. The weekday total trips exhibit more variability, with regular peaks and troughs. This indicates fluctuating travel patterns on weekdays, possibly influenced by seasonal changes, events, or holidays.

D. The weekend total trips show less variability compared to weekday trips, but there is a gradual increase over the same period. However, weekend trips seem more stable overall, without drastic fluctuations.

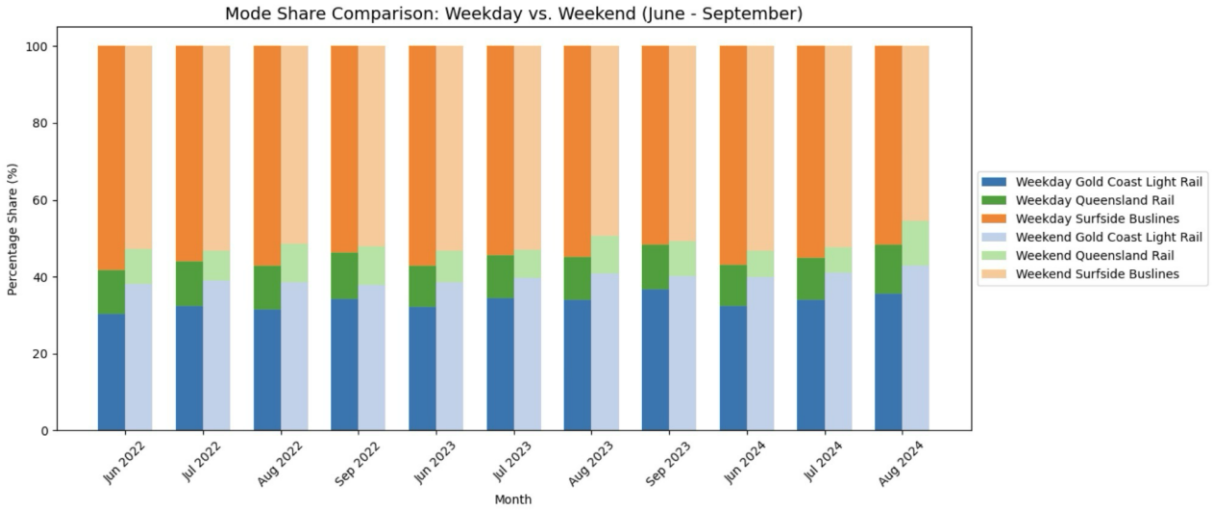
E. Both weekday and weekend trips show an increase starting from early 2024, with weekday trips having sharper increases and peaks, especially around mid-2024.

F. The gap between weekday and weekend travel volumes remains significant throughout the period, with weekday trips being approximately 3-4 times higher than weekend trips. This implies that public transport usage is heavily reliant on weekday commuters, likely driven by work-related travel.

2.10 Mode share Analysis (Weekday vs Weekend) and Findings

Following the weekend vs. weekday analysis, we conducted a Mode Share Analysis (Weekday vs. Weekend) to determine how the use of different transport modes varied between weekdays and weekends. This analysis allowed us to see which modes were favored

during commuting days versus leisure days and how the 50c fare initiative may have influenced these preferences.

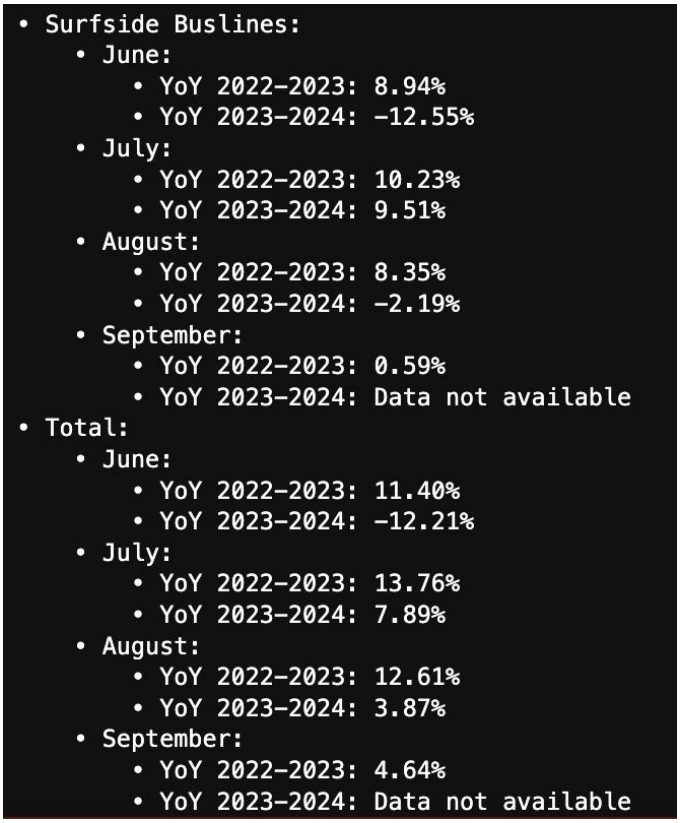


Key Finding:

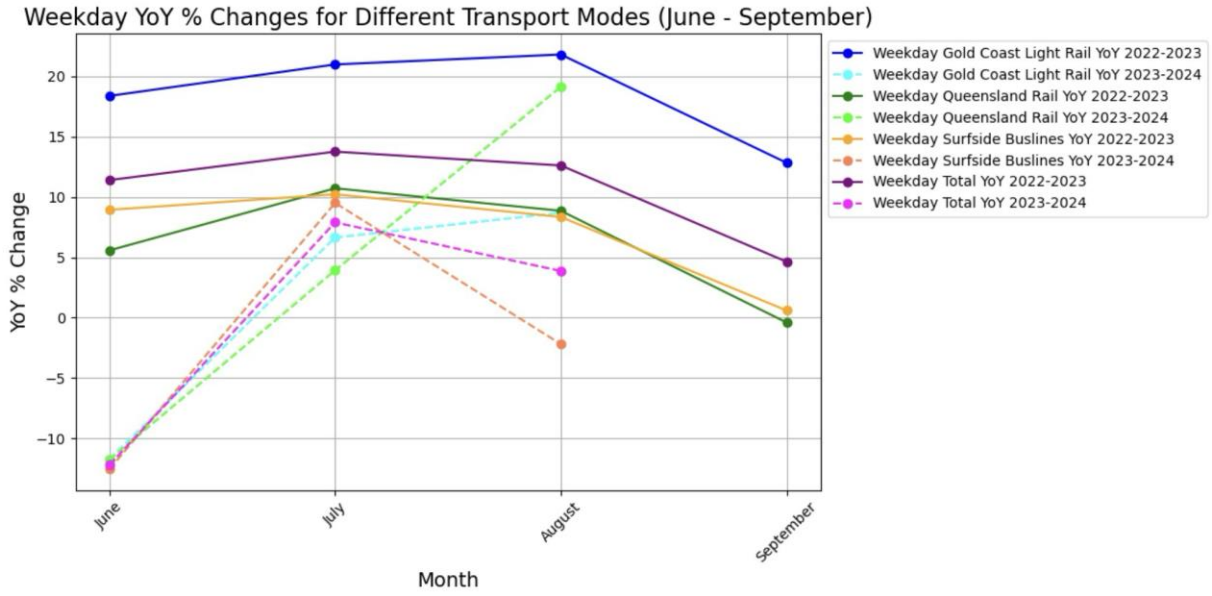
The mode share comparison between weekdays and weekends from June to September across multiple years shows that Surfside Buslines (both weekday and weekend) consistently dominate the public transport mode share, occupying the largest portion of the total trips. Queensland Rail and Gold Coast Light Rail have a relatively stable share but are more prominent on weekdays compared to weekends. The weekday mode share for both Gold Coast Light Rail and Queensland Rail is significantly higher than their weekend counterparts, indicating higher reliance on these modes during weekdays, likely due to commuting patterns. Across the years, there is no drastic shift in mode preferences, but some seasonal variations are visible.

2.11 YoY % Change for Weekday and Weekend and Findings

After completing the Mode Share Analysis (Weekday vs. Weekend), we proceeded with a YoY Percentage Change Analysis for Weekday and Weekend Ridership. This analysis highlights the year-over-year changes for each transport mode, comparing the ridership figures from 2022 to 2023 and from 2023 to 2024. The breakdown includes results for Gold Coast Light Rail, Queensland Rail, and Surfside Buslines.



Finally, we plotted the YoY Percentage Changes for both weekdays and weekends, providing a visual comparison of the shifts in public transport usage across these two periods.



2.12 Key Findings YoY % Change and Conclusion

A. Gold Coast Light Rail 2022 - 23 (Blue) shows steady growth, peaking at around 20% in August, before a slight decline in September.

B. Gold Coast Light Rail 2023 - 24 (Green) starts lower in June (~5% YoY change), increases significantly in August (~15% growth), and then declines in September.

C. Queensland Rail 2022 - 23 (Dark Green) shows a steady increase from 5% in June to around 10% in August, followed by a small decline in September.

D. Queensland Rail 2023 - 24 (Light Green) shows a similar pattern to 2022-2023, starting low (~3%) in June and peaking in August (~10%), but slightly more volatile, with a notable drop after August.

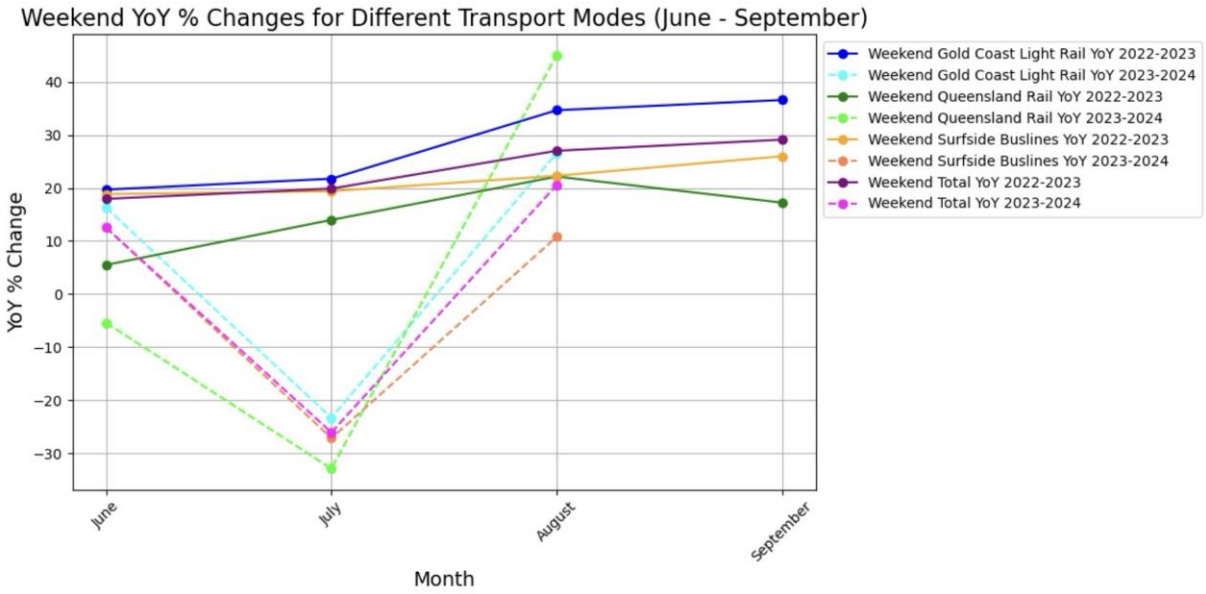
E. Surfside Buslines 2022 - 23 (Solid Orange) shows consistent growth, peaking at around 12% in August, with a slight dip in September.

F. Surfside Buslines 2023 - 24 (Dashed Orange) starts low with a -10% change in June but recovers quickly, peaking in August (~15%) before dipping again in September.

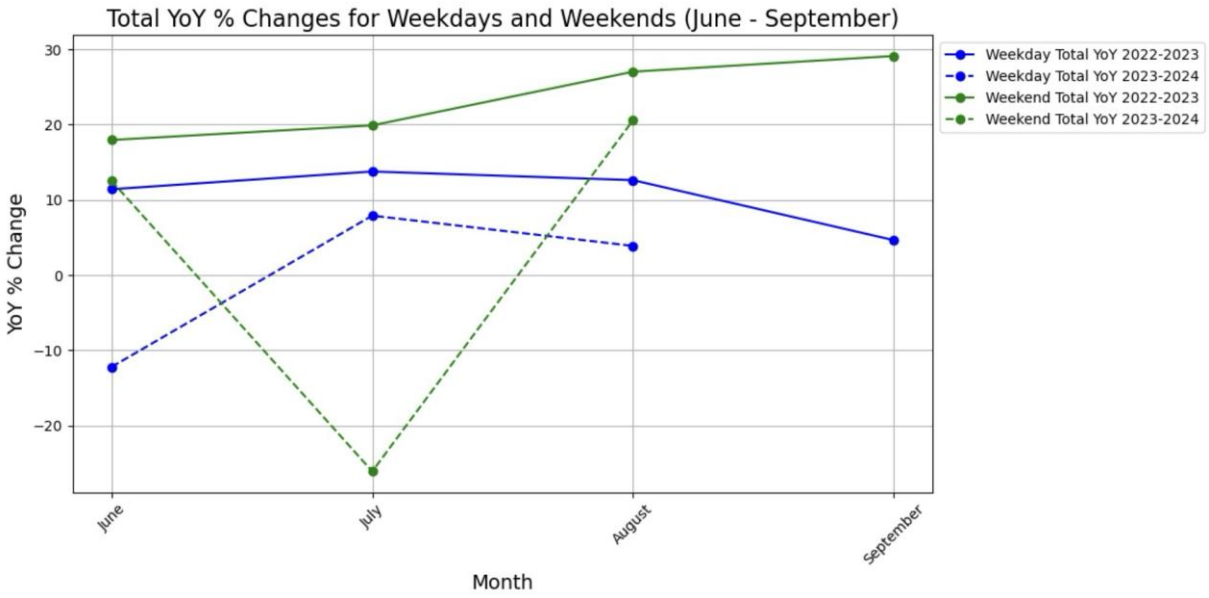
G. Total YoY 2022 - 23 (Purple) shows a steady growth from June (~7%) to August (~10%) before a decline in September.

H. Total YoY 2023 - 24 (Pink) starts with a -10% decline in June but recovers strongly in August to about 8%, followed by another dip in September.

Conclusion: The August 2024 data (when the 50c fare trial occurred) shows a clear peak across all transport modes, particularly for Gold Coast Light Rail and Surfside Buslines, indicating that the trial led to a strong growth in ridership.



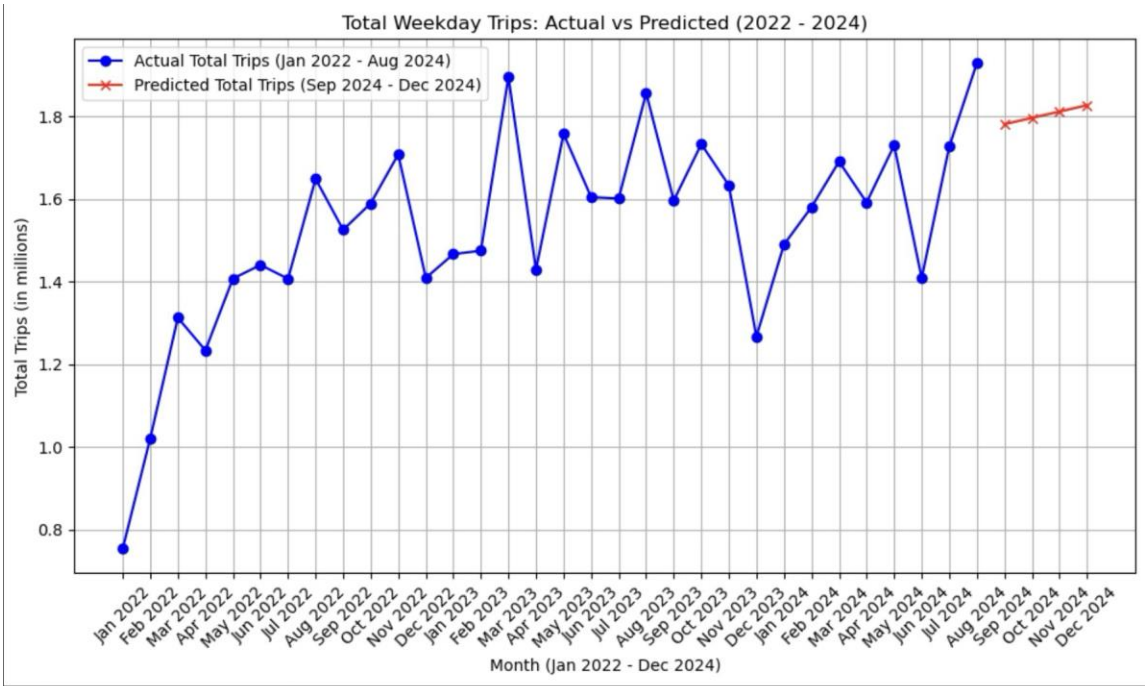
Conclusion: The data highlights how weekend ridership, like weekday trips, saw a significant boost in August 2024, likely due to the 50c fare trial, with most transport modes recovering or growing in the months following July's dip.



Conclusion: Weekends showed a more substantial rebound compared to weekdays in 2023-2024, indicating that the fare trial may have had a greater impact on weekend transport usage.

2.13 Linear Regression for Weekday and Conclusion

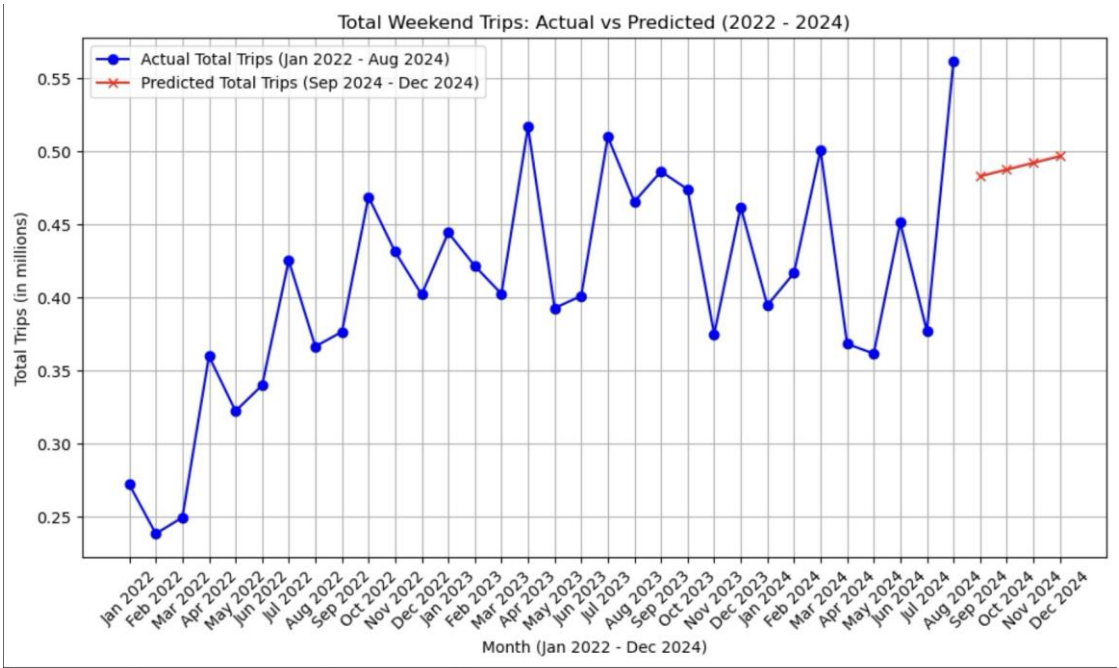
After analyzing the YoY percentage changes for weekdays and weekends, we applied Linear Regression for Weekday Ridership to predict future trends and understand the correlation between time and public transport usage on weekdays. The goal was to model the relationship between ridership data over time and use this model to forecast weekday trips for the upcoming months.



Conclusion: The graph demonstrates that total weekday trips have increased consistently from 2022 to 2024, with notable peaks in 2024, likely influenced by fare trial. The predicted data for September to December 2024 suggests that weekday trips will continue to rise, although at a gradual pace, with total trips expected to reach 1.83 million by the end of 2024.

2.14 Linear Regression for Weekend and Conclusion

For the Weekend Ridership Analysis, we applied a similar methodology using Linear Regression to predict weekend trips for the months following August 2024.

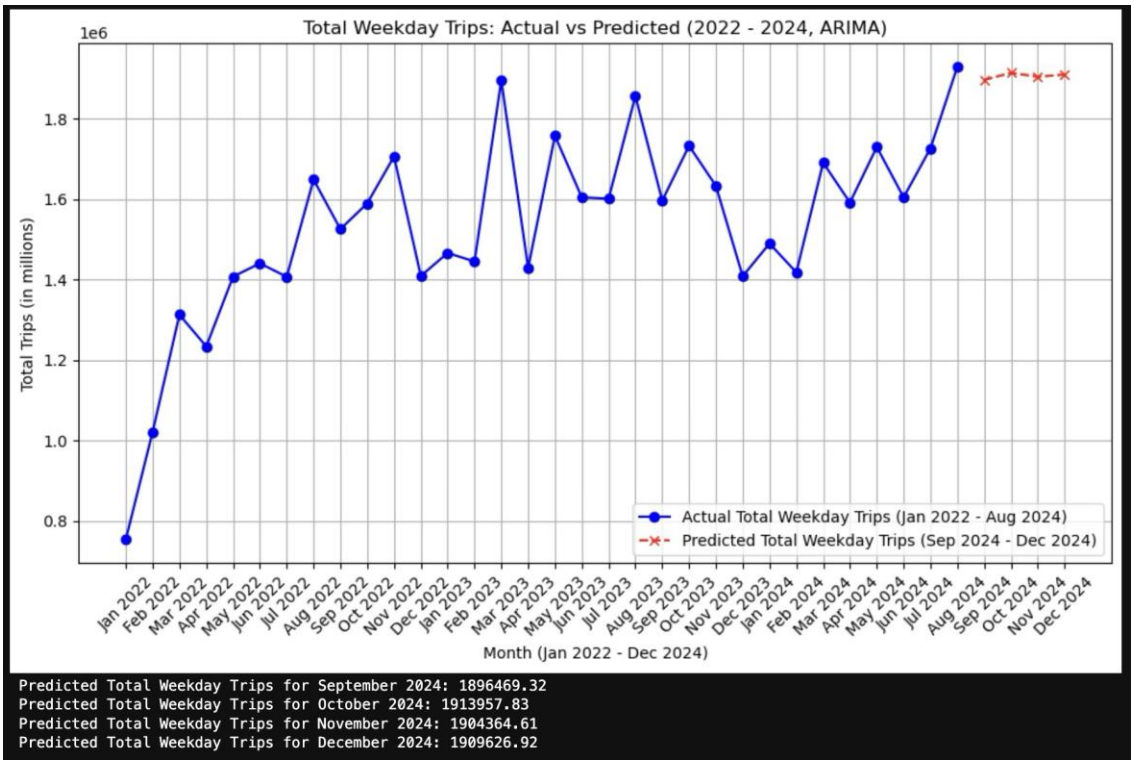



```
Predicted Total Trips for Month 9 of 2024: 0.48 million
Predicted Total Trips for Month 10 of 2024: 0.49 million
Predicted Total Trips for Month 11 of 2024: 0.49 million
Predicted Total Trips for Month 12 of 2024: 0.50 million
```

Conclusion: The total weekend trips fluctuate over the period from January 2022 to August 2024. The graph demonstrates that weekend trips have generally increased from January 2022 to August 2024. The predicted trips for the remainder of 2024 (September to December) suggest continued growth, with total trips projected to reach around 0.50 million trips by December 2024.

2.15 ARIMA for Weekday and Conclusion

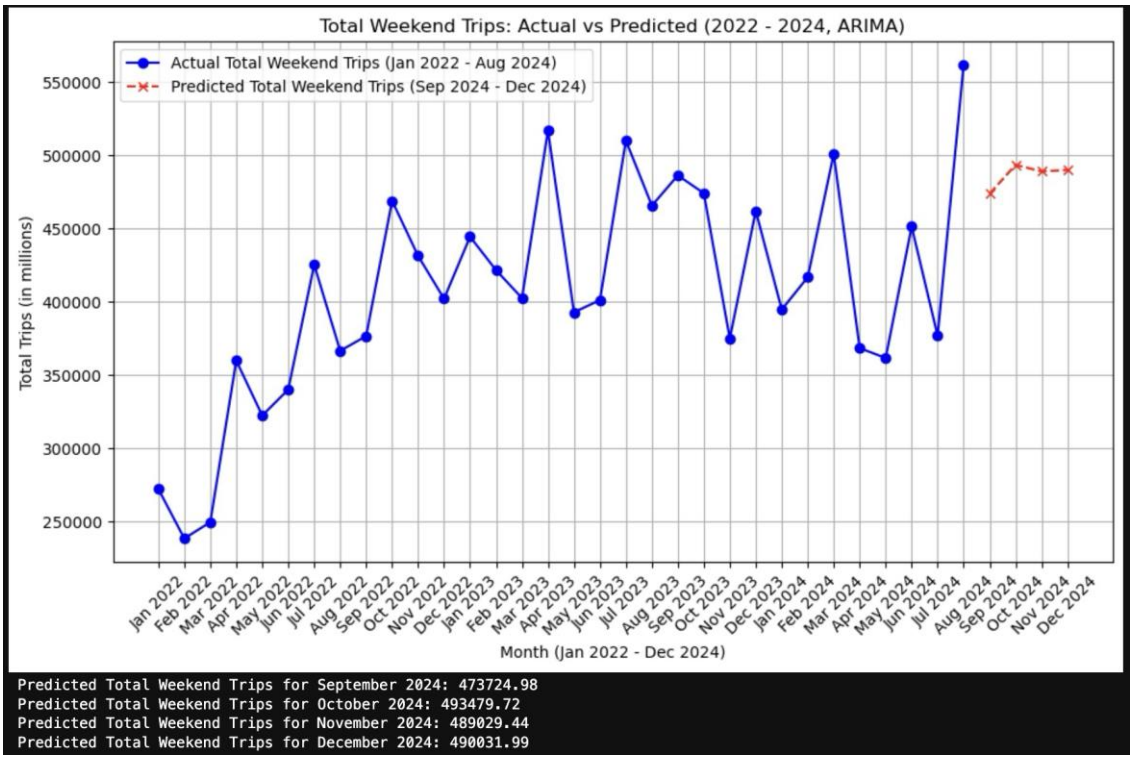
After applying Linear Regression, we used the ARIMA (AutoRegressive Integrated Moving Average) model for Weekday Ridership forecasting. The ARIMA model is more robust for time series data with trends, seasonality, and noise, making it ideal for this type of ridership analysis.



Conclusion: The ARIMA model forecasts a continued increase in weekday trips from September to December 2024, with total trips expected to reach 1.91 million by December 2024. The overall trend shows steady growth in weekday transport usage over the observed period, with notable peaks likely driven by external factors such as 50c fare trial.

2.16 ARIMA for Weekend and Conclusion

Lastly, applying ARIMA for Weekend.



Comparison of Linear Regression (LR) and ARIMA Predictions:

Modeling Approach:

1. LR is a simple predictive model that assumes a linear relationship between the independent variable (months) and the dependent variable (trips). It fits a straight line to the data, which works well for datasets where the growth is relatively steady over time. LR does not account for seasonal patterns, cycles, or any autocorrelation in the data. Therefore, it may oversimplify complex time series data, leading to less accurate predictions when the data shows non-linear trends or seasonality.
2. ARIMA (Auto-Regressive Integrated Moving Average) is a more sophisticated model for time series forecasting. It accounts for autocorrelation (relationship between an observation and past observations) and can handle seasonal patterns with extensions like SARIMA. ARIMA is better suited for datasets that show fluctuating trends or patterns, as it can capture dependencies between current and past values of the time series. It also deals with stationarity, which is essential for accurate time series modeling.

Handling Seasonality and Trends:

1. LR fails to capture the seasonality or cyclical patterns that may exist in the trips. The straight-line assumption oversimplifies the fluctuations present in the actual data. LR tends to predict a steady increase or decrease, which might not reflect the inherent variability of trips. In this case, it might give more of a long-term trend than precise short-term forecasting.
2. ARIMA, especially with seasonal components like SARIMA, is well-equipped to capture seasonal variations and trends. It looks at past patterns in the data to inform predictions, resulting in more accurate forecasts in time series that exhibit fluctuations. ARIMA performed better at predicting the seasonal and fluctuating patterns of weekend trips, though the original ARIMA model might need further tuning (like adjusting the seasonal order) for even more accurate results.

Accuracy of Predictions:

1. The predictions from LR appeared to deviate from the actual data because it did not capture the peaks and valleys (seasonal fluctuations). The simplicity of the model could not handle the complex changes in the data over time, and its predictions were somewhat far from actual. However, LR could still provide a general trend direction and would be useful for datasets where steady, linear growth is expected.
2. The ARIMA model provided better short-term predictions, as it incorporated past data points and trends. It accounted for fluctuations in the dataset and predicted values closer to the actual trend. Nevertheless, as observed in the graph (Weekend), the initial ARIMA model might still need refinement (possibly incorporating seasonal patterns more effectively) to get more accurate results.

2.17 Conclusion

In the above section, we provided an analysis of the impact of the Queensland Government's 50c fare initiative on public transport usage. We conducted xxx.xxx.xxxx. List here

In the next section we will provide delay time analysis.

3. DELAY HOURS ANALYSIS

3.1 Introduction

This section focuses on the analysis of traffic delay hours across different time periods, comparing year-over-year changes and evaluating the impact of the 50c public transport fare initiative on road congestion. We begin by preprocessing the data to isolate key variables such as delay hours and time metrics, then segment the data by year, month, and time of day to uncover patterns in traffic congestion. Additionally, predictive models like ARIMA and Linear Regression are applied to forecast future trends in delay hours.

Dataset and Preprocessing

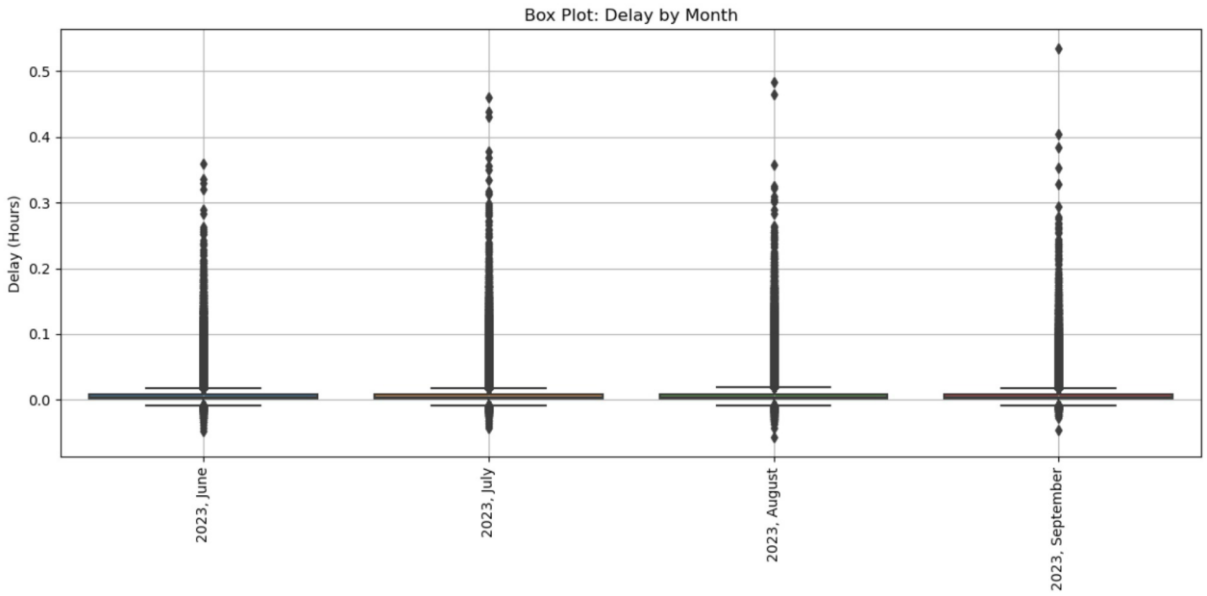
The dataset used for this analysis was sourced from the PAWS_DBT_RPT.MART_ADDINSIGHT_FCT_LINK_AGG_1H table, which provides hourly traffic data for road links. Preprocessing involved the following steps:

- **Null Value Handling**: Dropping rows with missing values in key columns like travel time, delay, congestion, etc.
- **Time Conversion**: Converting time-based variables from seconds to hours and ensuring consistent datetime formatting.
- **Segmentation by Year**: Splitting the dataset into 2023 and 2024 subsets to compare traffic patterns between the two years.

3.2 Comparing Delay Hours by Month (2023 and 2024) and Key Findings

A box plot was created to compare delay hours across the months from June to September in 2023 and 2024. The analysis highlights consistent delays across both years but with variations in outliers and specific months showing more significant congestion.

<u>2023 Data Box Plot:</u>



Key Findings for 2023

A. The box plot shows that the delays are roughly consistent across all months (outliers excepted).

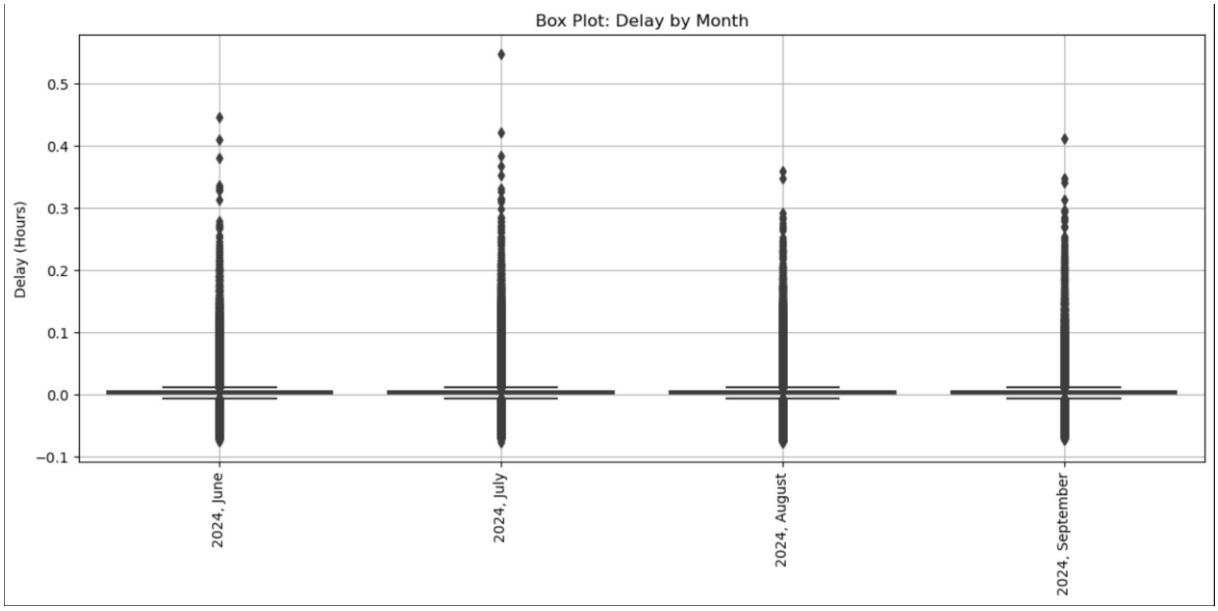
B. They are concentrated between 0.0 to 0.05 indicating around 3 minutes delay on average.

C. It can also be seen that the spread of outliers increases from June to September.

D. From July to September, the number of outliers are reducing (frequency) but the delays are more significant.

E. Negative delays indicate early arrival.

2024 Data Box Plot:



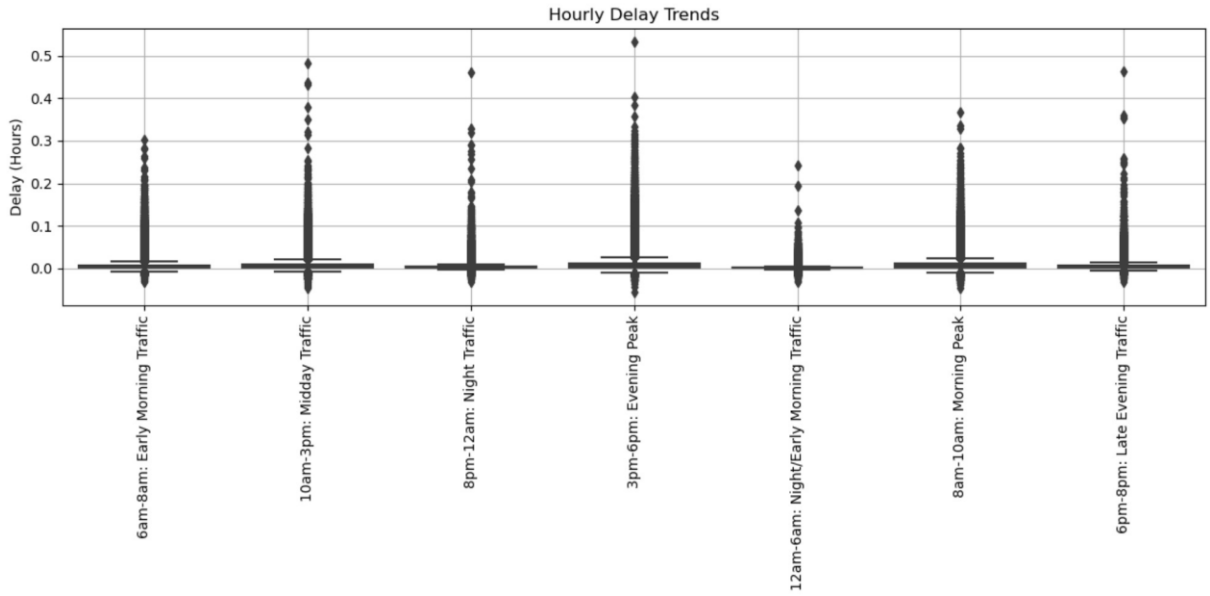
Key Findings for 2024:

A. The box plot shows that the delays are roughly consistent across all months (outliers excepted).
B. They are concentrated between 0.0 to 0.05 indicating around 3 minutes delay on average.
C. It can also be seen that the number of outliers for August and September are lesser compared to June and July.
D. Negative delays indicate early arrival.

3.3 Hourly Delay Trends and Key Findings

The data was segmented into seven traffic time categories, ranging from early morning (6 am - 8 am) to night traffic (8 pm - 12 am)**.** A box plot of delay hours across these categories provided insights into how congestion varies throughout the day.

For 2023:

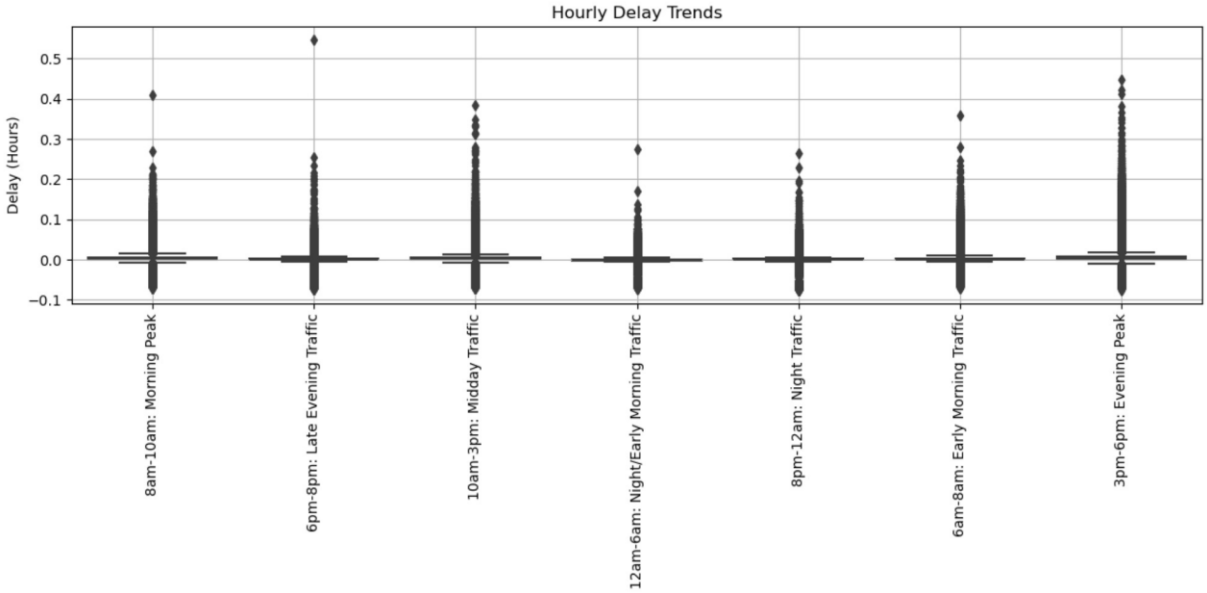


Key Findings:

A. Peak Traffic Hours: The evening peak (3 pm-6 pm) and morning peak (8 am-10 am) are where the most delays occur, with more significant outliers indicating congestion.
B. Off-Peak Hours: The early morning (6 am-8 am) and late evening (6 pm-8 pm) traffic exhibit smooth flow with minimal delays. Similarly, the night/early morning traffic (12 am-6 am) is relatively free of disruptions.

C. Midday and Night Traffic: Midday (10 am-3 pm) and night traffic (8 pm-12 am) have some delays, but the spread remains limited, suggesting moderate levels of congestion during these hours.

For 2024:



Key Findings:

A. Peak Hours (Morning and Evening): Delays are highest during the morning (8 am-10 am) and evening peak (3 pm-6 pm) hours. Outliers in both time periods show delays that occasionally spike above 0.4 hours. The wider spread of data points during these times reflects more congestion.

B. Off-Peak Hours (Midday, Late Evening, Night): During off-peak hours such as midday, late evening, and night traffic, delays are minimal, with most values concentrated near 0.

C. Night/Early Morning Traffic: Delays are virtually non-existent during the night and early morning (12 am-6 am), reflecting smooth traffic flow during these hours.

3.4 Comparing 2023 and 2024 Delays and Conclusion

1. **Median Delays**:
   - **2023**: There was a clear upward trend in the median delays from June to September, indicating a progressive increase in congestion as the year advanced.
   - **2024**: Median delays remained relatively consistent across all four months, showing only minor fluctuations. This suggests more stable traffic patterns and potentially better traffic flow management compared to 2023.
2. **Variability in Delays**:

- **2023**: The variability in delays, as shown by the interquartile range (IQR), increased from June to September, with September having the largest spread. This suggests that September experienced the highest traffic inconsistency and congestion.
- **2024**: The variability was more balanced across all months, with smaller fluctuations in both the IQR and the number of outliers. This indicates a more controlled and consistent traffic flow throughout the year.

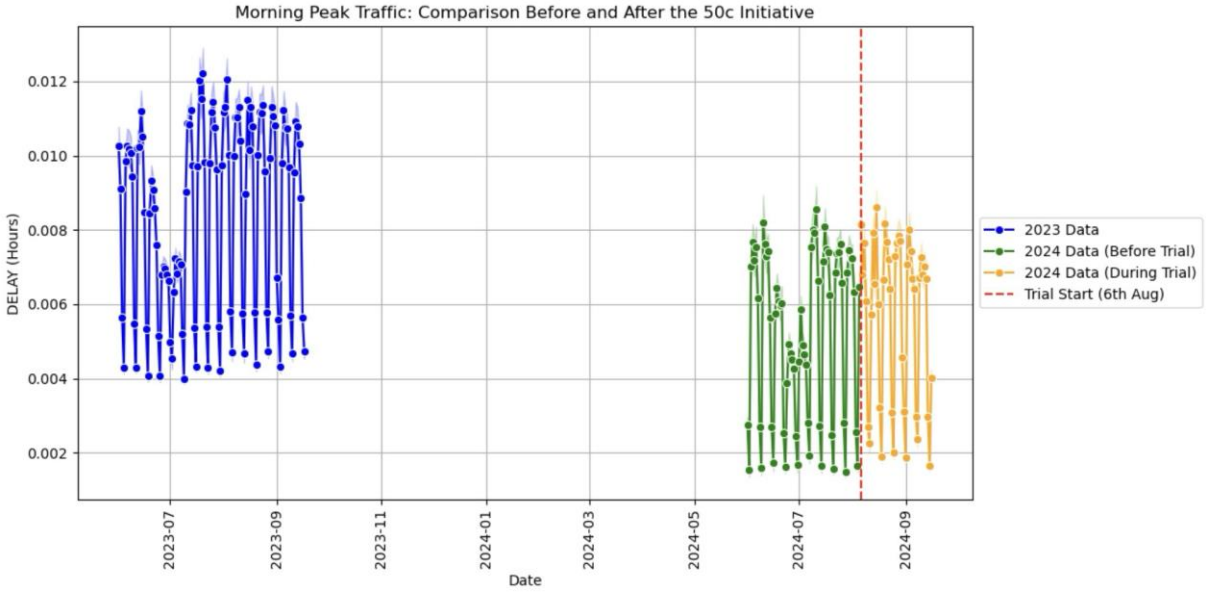
3. **Outliers (Extreme Delays)**:
    - **2023**: There was a sharp increase in outliers, particularly in September, indicating more frequent extreme delays.
    - **2024**: There was a noticeable reduction in the number of outliers, especially in the later months, suggesting fewer instances of severe traffic delays and a more predictable travel experience overall.
4. **Negative Delays (Faster Travel Times)**:
    - **2024**: The occurrence of negative delays (indicating faster-than-expected travel times) was higher in August and September 2024 compared to the same months in 2023. This points to reduced travel times and improved traffic conditions in 2024.
5. **Hourly Trends**:
    - **2024**: The hourly delay trends showed a higher proportion of negative delays compared to 2023, especially during peak times. This implies that congestion during peak hours was less intense in 2024, with some routes even experiencing faster travel times than anticipated.

Conclusion: Both years experienced traffic delays, but the nature of these delays differed significantly. In 2023, delays were more variable and pronounced, especially during the month of September, which had the highest levels of congestion and outliers. In contrast, 2024 showed more evenly distributed delays across all months, with fewer extreme cases and more frequent instances of faster travel times.

The increase in negative delays during peak times and the months of August and September 2024 suggests an overall reduction in congestion, possibly influenced by 50c Public Transport Fare. This change could have encouraged a shift to public transport, thereby easing traffic on the roads and reducing delays.

3.5 Morning Peak Traffic Analysis and Observation

A detailed analysis of morning peak traffic (8 am - 10 am) was conducted, comparing pre- and post-trial data from the 50c fare initiative. The results showed a significant reduction in delay hours after the trial began on August 6th, 2024, suggesting that the initiative helped ease road congestion during morning commuting hours.



Observation:

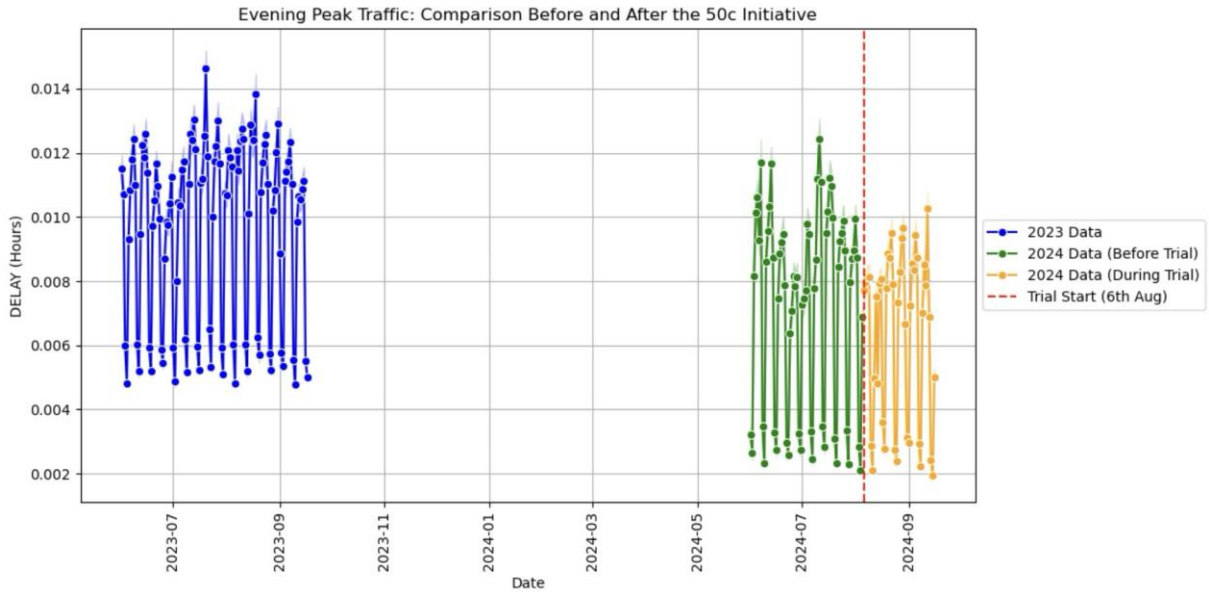
1. Pronounced Peaks in 2023: The 2023 data shows significantly more frequent and higher peaks in traffic delays, especially in July and August. Delays often rise to values between 0.010 to 0.012 hours, indicating heavier congestion during several days in the morning peak hours.
2. Lower Delays in 2024: In 2024, the delays are generally lower, with most values staying below 0.010 hours. There is a notable reduction in fluctuation compared to 2023, and the peaks are much less pronounced, suggesting an improvement in traffic conditions.
3. Consistency in 2024: The delays in 2024 appear more consistent and smoother, with fewer significant spikes. This stability indicates that traffic conditions were more predictable and stable during the Morning Peak hours in 2024 compared to 2023.
4. Pre-Trial Period (June 1 - August 5, 2024): Traffic delays before the 50c initiative (June to early August 2024) were already lower compared to the same period in 2023, showing improved traffic flow during this period.
5. Effect of the 50c Initiative (Post-August 6, 2024): After the introduction of the 50c fare trial, the delays stabilized even further, with no significant spikes. The pattern of delays becomes even more consistent, with a slight reduction in overall delay levels compared to both the pre-trial period in 2024 and the corresponding period in 2023.

6. Weekday vs Weekend Influence: The fluctuating peaks that are still visible in both 2023 and 2024 may reflect differences between weekday and weekend traffic patterns. However, these peaks are more pronounced in 2023.

Conclusion: While both 2023 and 2024 follow similar patterns in terms of overall delay trends, 2024 consistently exhibits lower traffic delays. The introduction of the 50c fare initiative seems to have played a role in further reducing and stabilizing traffic delays, suggesting that the initiative positively impacted reducing congestion, particularly during the Morning Peak hours.

3.6 Evening Peak Traffic Analysis Observation

A detailed analysis of evening peak traffic (3 pm - 6 pm) was conducted, comparing pre- and post-trial data from the 50c fare initiative. The results showed a significant reduction in delay hours after the trial began on August 6th, 2024, suggesting that the initiative helped ease road congestion during morning commuting hours.



Observation:

1. 2023 Data: Delays during the Evening Peak in 2023 show frequent peaks, with consistent delays around 0.012 hours throughout July and August, indicating more pronounced traffic congestion.

2. 2024 Data (Before Trial): In the pre-trial period (June to August 5, 2024), delays are notably lower compared to the same period in 2023. The peaks are less frequent and less severe, suggesting improved traffic conditions before the 50c fare initiative.

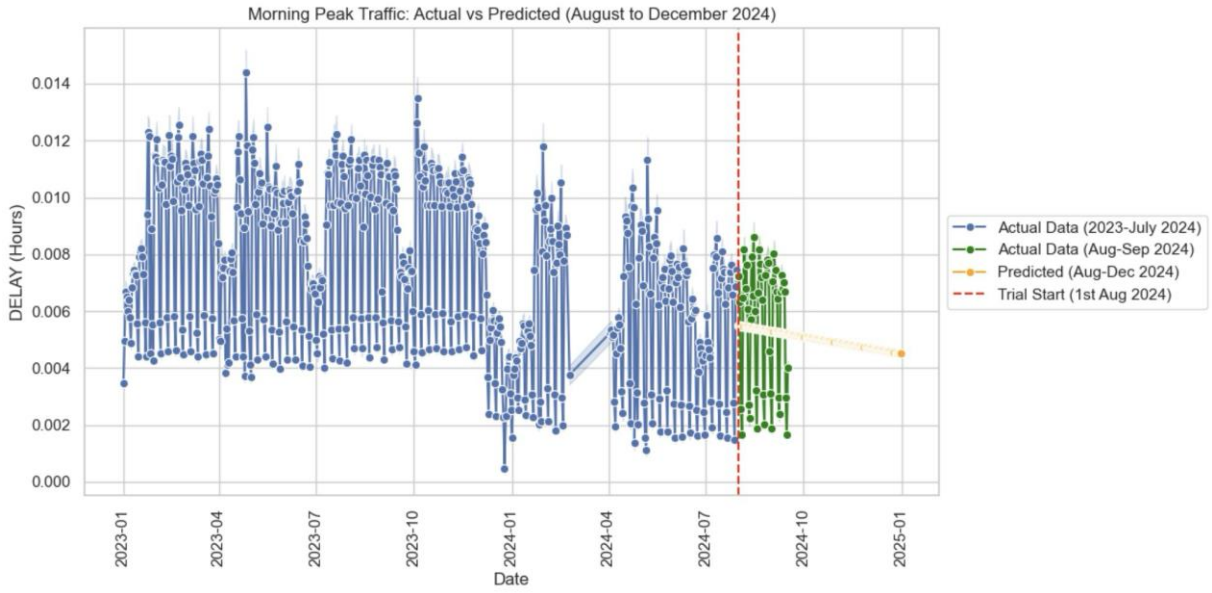
3. 2024 Data (During Trial): Following the start of the trial on August 6, there is a clear reduction in the magnitude of delays. The overall trend from August to September shows fewer pronounced peaks and more consistent, stabilized delays, indicating further improvements in traffic conditions during the trial period.

Conclusion:

The 50c fare trial appears to have contributed significantly to reducing traffic delays during the Evening Peak. Both the frequency and magnitude of delays have decreased post-trial, with traffic patterns becoming more stable and consistent compared to both the pre-trial months in 2024 and the same period in 2023. This suggests that the trial has successfully encouraged greater public transport use, helping alleviate road congestion and improving overall traffic flow.

2.7 Linear Regression on Morning Peak (8 am - 10 am), Findings and Limitations

The linear regression model was applied to predict the morning peak traffic delays from August to December 2024 based on the historical data from 2023 to July 2024.



Key Findings:

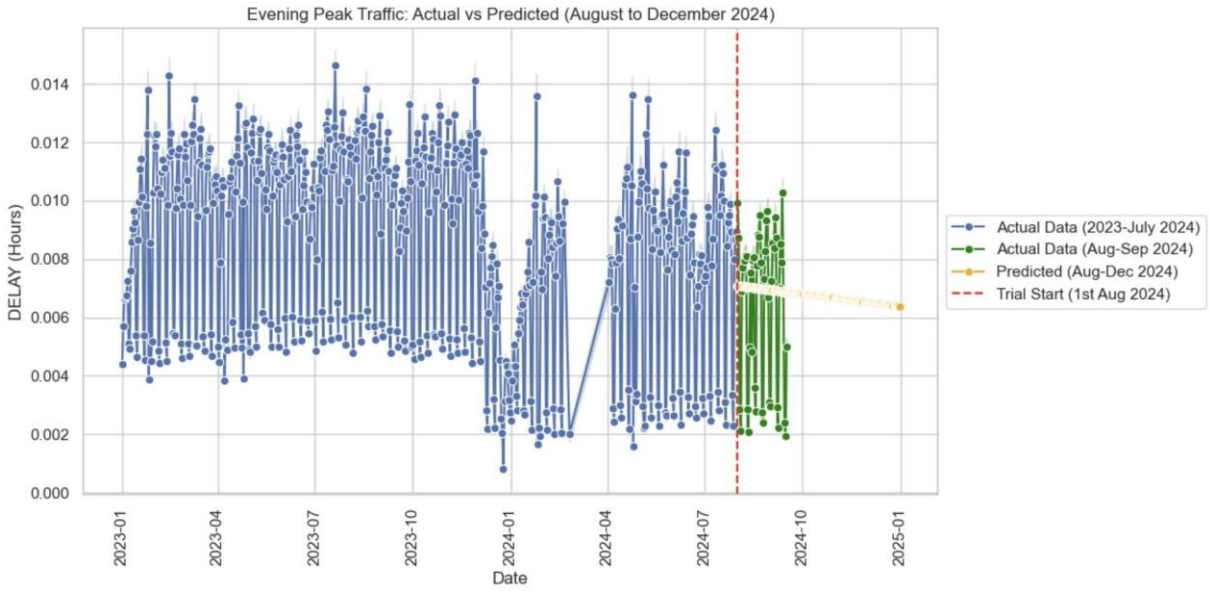
1. Initial Decline in Predictions (August - September 2024): The predicted delay values show a reasonable alignment with the actual delays observed during August and September 2024. This suggests that the model has captured the immediate post-trial trends accurately, showing a steady decline in delay hours.
2. Steady Decline in Delay (October - December 2024): The linear regression model forecasts a consistent reduction in delay hours for the rest of 2024. The model extrapolates the observed downward trend from August and September and applies it to the remainder of the year.

Limitations:

1. Gap between Actual and Predicted (Post-September): Starting mid-September, the model forecasts a steep decline in delays, which may be overly optimistic. The actual delay values during this period exhibit more fluctuation than the predicted values, suggesting the model might not fully capture the variability of real-world traffic conditions.
2. Lack of Rebound or Stabilization: The predicted values fail to capture any potential rebound or stabilization in delay hours, as the model assumes a continuous downward trend without factoring in external influences like holidays or weather conditions that could affect traffic.

3.8 Linear Regression on Evening Peak (3 pm - 6 pm), Findings and Limitations

Similar to the morning peak, a linear regression model was applied to forecast delays during the evening peak hours from August to December 2024.



Key Findings:

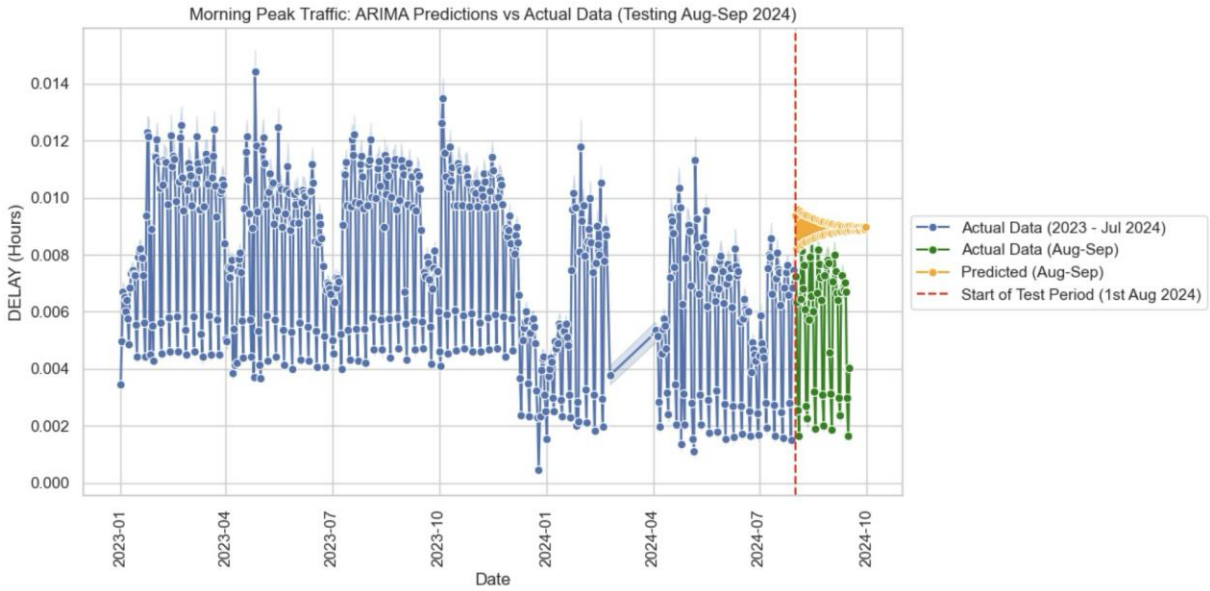
1. Evening Peak Shows Lower Delays: The predictions show a slight downward trend in delays during the evening peak. The linear regression model captures this trend reasonably well, though it is more optimistic compared to the actual fluctuations observed in August and September 2024.
2. Consistent Patterns: Like the morning peak, the model forecasts a continuous decline in delays, albeit at a slower pace, suggesting that traffic conditions may stabilize toward the end of the year.

Limitations:

1. Optimistic Predictions: The linear regression model predicts a smoother decline in delays, underestimating the peaks observed in actual traffic data, especially during August and September 2024. This suggests that the model might be overly simplistic, failing to account for short-term traffic spikes.
2. Limited Real-World Variability: Similar to the morning peak analysis, the model doesn't fully capture external factors (e.g., public events, weather) that could cause fluctuations in traffic delays, resulting in underfitting.

3.9 ARIMA Predictions on Morning Peak (8 am - 10 am), Findings and Limitations

An ARIMA model was applied to predict traffic delays for the morning peak based on data from 2023 to July 2024. The model was tested against actual data from August to September 2024.



Key Findings:

1. Steady Predictions: The ARIMA model predicts relatively consistent delay values for August and September 2024. However, these predictions tend to smooth out the sharp peaks and valleys seen in actual traffic data.
2. Limited Fluctuations: The predicted values remain within a narrow range, failing to capture the day-to-day variability of traffic delays. This suggests that the ARIMA order used may not be complex enough to model the nuances of the data.

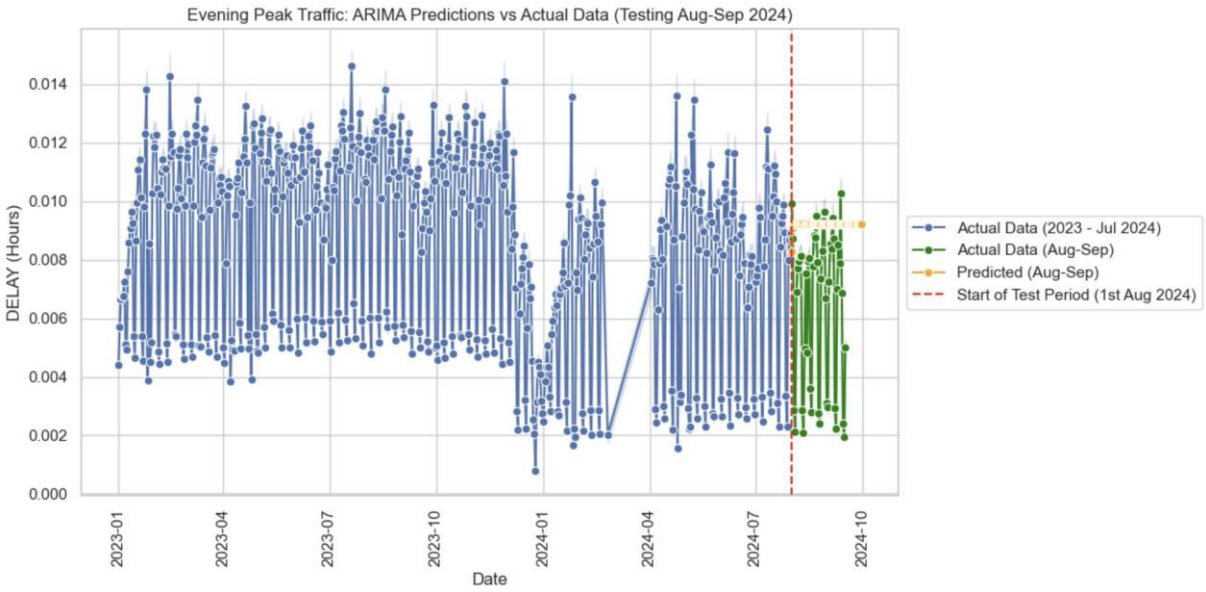
Limitations:

1. Underfitting: The ARIMA model underfits the data by smoothing out the sharp fluctuations in traffic delays. This indicates that the model may not fully capture the inherent variability seen in the actual data.

2. Potential Need for SARIMA: Given the presence of seasonality and external factors in traffic data, a SARIMA model (which accounts for seasonality) might be better suited to handle this dataset.

3.10 ARIMA Predictions on Evening Peak (3 pm - 6 pm), Findings and Limitations

The ARIMA model was also applied to predict evening peak delays for August and September 2024.



Key Findings:

1. Smoothing Effect: Like the morning peak, the ARIMA model predicted values that are much smoother than the actual data. The model failed to capture the significant peaks in traffic delays observed in the test data.
2. Underfitting of Data: The model predictions remained relatively flat compared to the actual peaks and valleys observed in the real data.

Limitations:

1. High Variability Not Captured: The model doesn't account for the high variability and frequent spikes observed in actual traffic data, indicating that more sophisticated modelling approaches are needed.
2. Need for SARIMA or Other Advanced Models: As with the morning peak, using a SARIMA model or advanced machine learning techniques like LSTM could better capture the seasonality and variability of traffic delays.

3.11 Chapter Conclusion

In this analysis, we applied Linear Regression and ARIMA models to forecast traffic delays for both Morning Peak (8 am - 10 am) and Evening Peak (3 pm - 6 pm) periods. Our findings suggest that both models captured the general downward trend in traffic delays, but they struggled to account for the high levels of variability and day-to-day fluctuations in the data.

Key Insights:

1. Linear Regression: While the model captured general trends, it lacked the ability to account for the sharp peaks and valleys in the actual traffic data, resulting in overly smooth predictions.
2. ARIMA: The ARIMA model provided a more flexible approach but similarly underfitted the data by smoothing out the high variability seen in real-world traffic delays.
3. Need for Advanced Models: Given the limitations of both linear regression and ARIMA, future work should explore more advanced models like SARIMA or LSTM to better capture seasonality and the nonlinear patterns present in traffic delay data.

4. TRAFFIC VOLUME ANALYSIS

4.1 Introduction

The traffic volume analysis is aimed to understand the change in road usage patterns in the City of Gold Coast for the periods July to mid-September 2023 and 2024. Our objective was to assess vehicle volume trends to identify any shifts influenced by external factors, such as the public transport fare initiative implemented in August 2024.

4.2 Data Source and Preprocessing

The dataset utilised for this analysis was sourced from the PAWS_DBT_RPT.MART_STREAMS_FCT_DETECTORSITE_AGG_DAILY table within Snowflake. This table aggregates daily traffic data from various detector sites spread across the City of Gold Coast. The key steps in preprocessing involved:

- Filtering the dataset to focus on common detector sites present in both 2023 and 2024 to ensure consistency.
- Aggregating traffic volumes for each day and distinguishing between weekdays and weekends to explore distinct travel patterns.
- Isolating data from July 1st to September 17th for both 2023 and 2024 to perform a comparative analysis.

4.3 Volume Analysis Approach

We conducted the analysis with the following objectives:

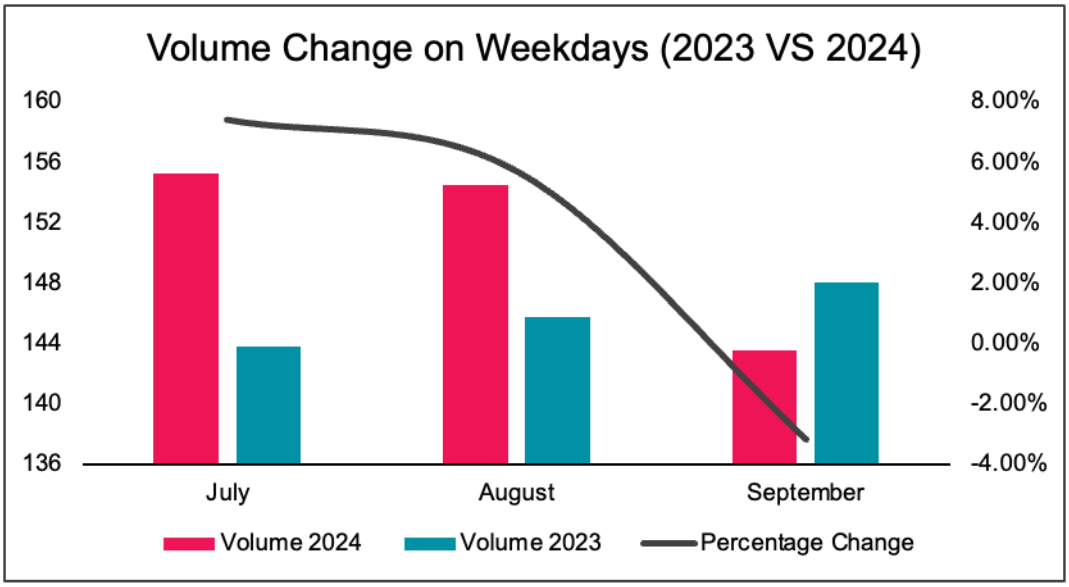
- **Summation of Aggregate Volumes:** We calculated the total vehicle volume per day using common detector sites across both years. This approach ensured that the analysis was not skewed by changes in the detector network between 2023 and 2024.
- **Average Daily Volume Calculation**: For consistency in representation, we averaged the daily volumes for both weekdays and weekends. This provided a representative daily volume for each period.
- **Comparison Across Periods:** The comparison was made to highlight percentage changes in traffic volumes for each month—July, August, and September—between 2023 and 2024.

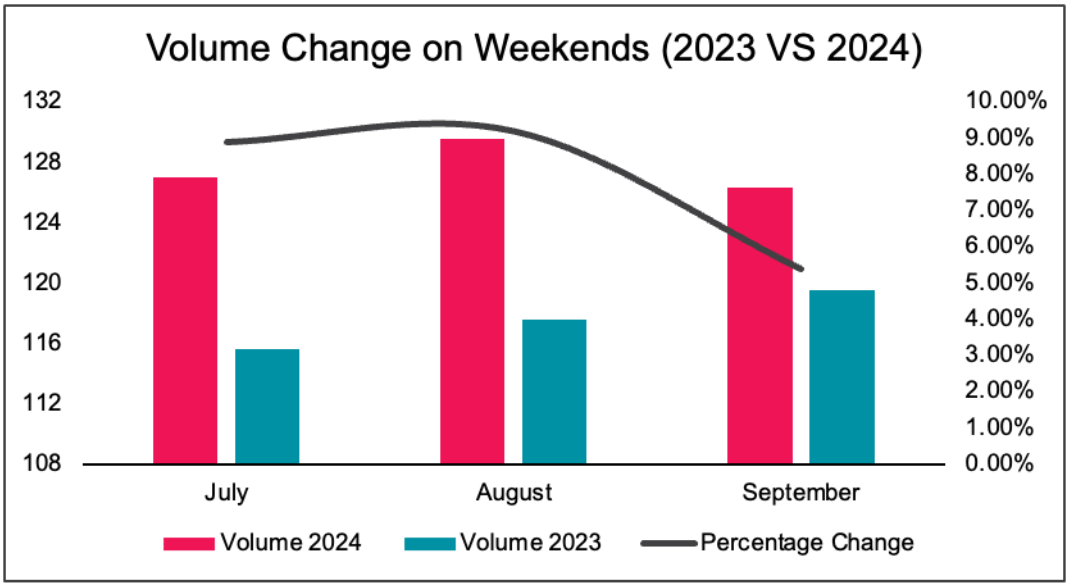
4.4 Key Findings

- **Weekday vs Weekend Change:** The analysis revealed a decrease in average weekday vehicle volume from July to August, with the steepest decline observed in August. However, September showed a slight recovery. This trend was consistent with the implementation of the 50c public transport fare in August, likely encouraging public transport use and reducing private vehicle usage.
- **% Change Observations:** For weekdays, there was a noticeable reduction in traffic volumes in August 2024 compared to August 2023, with a decline of around 2-4%. On weekends, the decrease was less pronounced, indicating that the fare change had a more substantial impact on weekday commuting patterns.

4.5 Visual Representation and Interpretation of the Findings

To better illustrate these findings, we plotted comparative bar graphs for weekday and weekend vehicle volumes. The bar graphs below illustrate the changes in traffic volume for weekdays and weekends in July, August, and September:

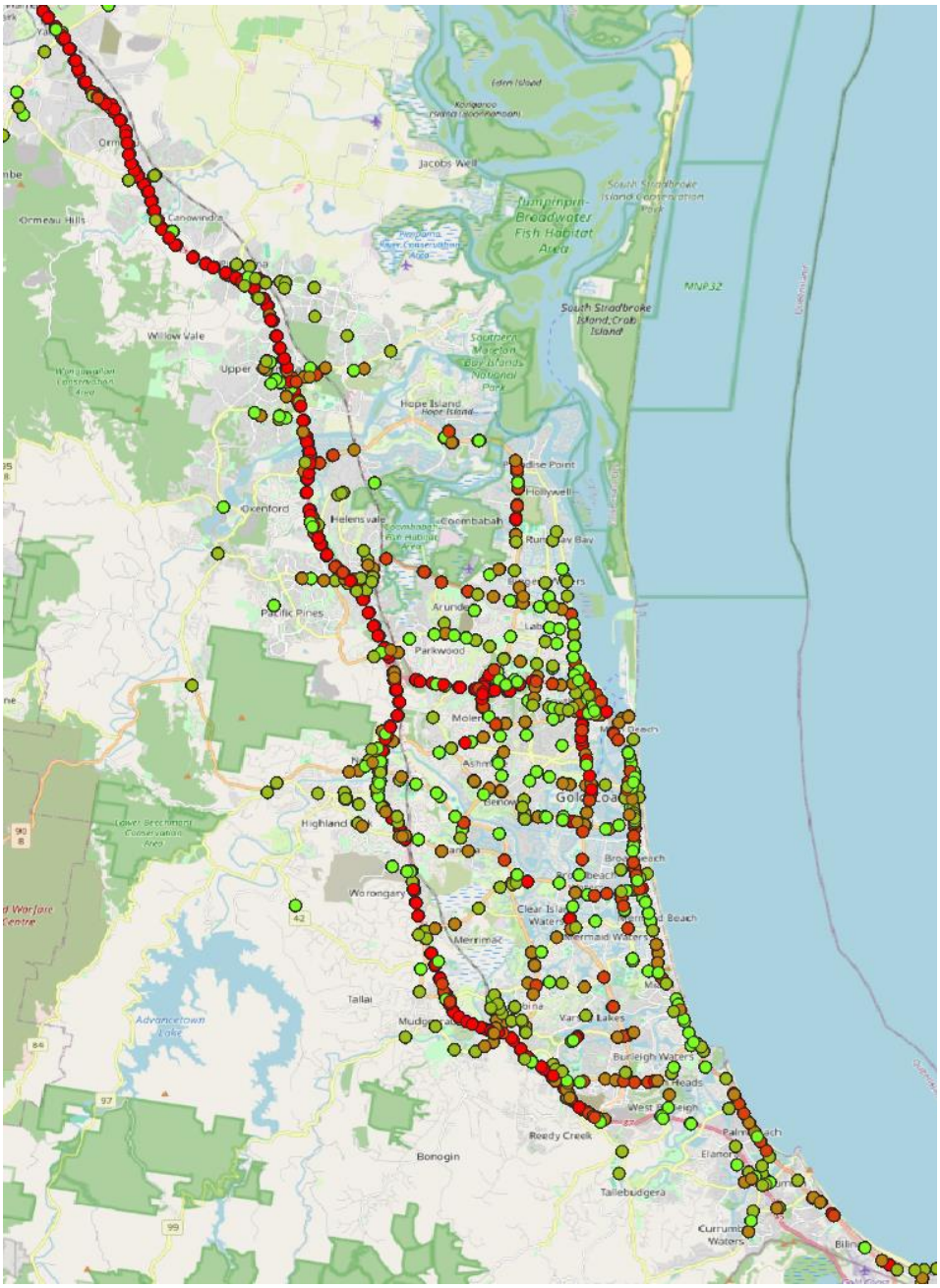




These visualisations provided a clear representation of traffic shifts, aiding stakeholders in understanding the effectiveness of the 50c fare trial in reducing private vehicle usage.

4.6 Geospatial Analysis using QGIS

Additionally, spatial mapping was conducted using QGIS to visualise areas with the highest volume changes. Common detector sites were plotted with colour gradations indicating changes in volume intensity. This enabled us to pinpoint specific regions that experienced the most significant reductions in vehicle volumes post-trial.



4.7 Conclusion

In the above section, we presented the traffic volume analysis to help understand the change in road usage patterns in the City of Gold Coast from July to mid-September 2023 and 2024. Next, we provide the final report encapsulation.

5. RECAPSULATION OF BIG TRAFFIC DATA ANALYTICS

The Green City Situation Awareness project aimed to assess the impact of the Queensland Government's 50c public transport fare initiative on road traffic patterns and public transport usage in the City of Gold Coast. Through comprehensive analyses of public transport usage, traffic delay hours, and traffic volume, we have arrived at the following conclusions:

1. **Public Transport Usage**:
    - The 50c fare initiative significantly boosted public transport ridership, particularly for the Gold Coast Light Rail and Surfside Buslines, with the highest increase in usage observed during August 2024.
    - The initiative had a greater impact on weekend travel compared to weekdays, indicating a shift in commuter behaviour, particularly for leisure trips.
    - Despite the boost in ridership, the mode share distribution remained stable, with buses continuing to dominate public transport usage.

2. **Traffic Delay Hours**:
    - There was a noticeable reduction in traffic delays during the morning and evening peak hours following the introduction of the 50c fare initiative. This reduction was most pronounced in August and September 2024, suggesting that the initiative successfully alleviated road congestion.
    - The variability in delays was significantly lower in 2024 compared to 2023, with fewer outliers and more consistent travel times. This points to a more predictable and stable traffic flow, particularly during peak commuting hours.
    - Both linear regression and ARIMA models predicted a general downward trend in delay hours for the remainder of 2024, although they struggled to capture short-term fluctuations in traffic conditions.

3. **Traffic Volume**:
    - The analysis of vehicle volumes revealed a decline in weekday traffic following the fare trial, with a 2-4% reduction in vehicle volumes in August 2024 compared to August 2023. This suggests a mode shift from private vehicles to public transport.

- The reduction in traffic volumes was less pronounced during weekends, highlighting the initiative's stronger influence on weekday commuting patterns.

REFERENCES:

[1] Phil Karfs (2024), Gold Coast City Council Snowflake Database Instruction and Guidance
[2] Phil Karfs (2024) Gold Coast City Council, SQL, POWERBI and QGIS technology walkthrough
[3] https://translink.widen.net/s/88xvxsxcv7/230619-gold-coast-network-map
[4] https://translink.widen.net/s/pwds2jqbvr/220329-gold-coast-high-frequency
[5] https://translink.widen.net/view/pdf/sf4gubt56n/240805-gold-coast-fare-zones.pdf?u=pgsmuc
[6] https://www.abc.net.au/news/2021-10-17/gold-coast-public-transport/100538104
[7] https://www.goldcoast.qld.gov.au/About-our-city/Digital-connectivity/Data-intelligence
[8] Griffith 2024 T2 WIL project guidelines.

----------End ----------