Ten Years of TTC Delays an Analysis*

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This study analyzes ten years of delay data from the Toronto Transit Commission (TTC), focusing on subways, streetcars, and buses to assess changes in delay times of these services. The analysis found that buses experience the highest number of delays and the longest total and average delay times, while subway delays are resolved much faster on average. The analysis also delves into the specific challenges each service faces, analyzing which incidents they are most likely to experience and how long those incidents take to resolve. These findings provide data-driven insights for improving TTC operations and uncovering the specific challenges faced by each transportation mode.

*Code and data are available at: https://github.com/Ford-Robert/STA304_City-Of-Toronto-Data.git

1 Introduction

Effective public transportation is vital to any large dense urban area. It has the capacity to significantly reduce traffic congestion (Anderson 2014) and improve transportation times for all residents of a city. Public transportation also provides affordable transportation options allowing for a more equitable society, in which everyone has access to opportunities across a city ("Investing in Public Transit Systems Can Empower Workers and Transform Urban Economies, New Research Shows" 2022). Expanding TTC services, and ensuring reliability, is the best option for taking cars off the road which would directly reduce both emissions (Welle et al. 2023) and car related deaths within the city (Buchanan 2019).

Despite the importance of the TTC, public opinion in Toronto suggests that the TTC is failing to meet the needs of its riders. Complaints about aging infrastructure, frequent delays, and most glaringly safety concerns are widely shared among Torontonians (Mehrabi 2023). Another point of criticism is that the TTC, especially the subway, has failed to expand much in recent years, despite Toronto growing significantly in population.

Considering these concerns this paper analyzes TTC delay data from 2014 to 2024, to assess whether its service have truly deteriorated over the past decade. By examining delays across subways, streetcars, and buses, this study will first compare these services with each other to explore which suffers the most from high delay times and large numbers of incidents. Then this study aims to identify the specific challenges each service faces. Finally, this paper will explore how delay times and incident rates are distributed over days of the week, and how these metrics have trended over the last ten years.

These findings offer insights for policymakers, transit authorities, and the public. By taking a deep dive into the publicly available data, this analysis provides a foundation for understanding TTC delays across buses, streetcars, and subways. The paper includes an exploration of the data by constructing easy-to-read graphs, designed to highlight the areas of greatest concern within the TTC.

2 Data

All data was collected and cleaned using R (R Core Team (2023)), and its tidyverse (Wickham et al. (2019)), lubridate (Grolemund and Wickham (2011)), and readxl (Wickham and Bryan (2023)) packages.

Delay Data detailing the operations of the TTC was collected and cleaned from the Open Data Toronto (Gelfand 2022) website. This data spans about 10 years, from 2014 to 2024. Three separate datasets were used, Delay data related to the Subway (TTC 2024c), Streetcar (TTC 2024b) and Bus(TTC 2024a). The original datasets are separated into a variety of formats depending on which year you are examining. The way in which variable names and the data stored changes over time. To further complicate the collection process, the information found in each dataset was different, though it mostly represented the same concepts. Data that was too difficult to integrate into one combined dataset that incorporated all ten years, and all three modes of transport was excluded. The final dataset contains 1,042,564 observations of 6 variables;

-Date: The Year, Month and Day that a delay occurred

-Day: What day of the week that a delay occurred

-Vehicle: What mode of transport did the delay occur on

-Location: Where did the delay occur. For Subways Location is the nearest station. For buses and streetcars Location is the nearest major intersection or passenger stop.

-Incident: A description of what caused the delay

-Delay: How long in minutes the delay lasted

Table 1: Sample of the Data

Date	Day	vehicle	Location	Incident	Delay
2014-01-01	Wednesday	Bus	York Mills station	Mechanical	10
2014-01-01	Wednesday	Bus	Entire run for route	General Delay	33
2014-01-01	Wednesday	Bus	lawrence and Warden	Mechanical	10
2014-01-01	Wednesday	Bus	Kipling Station	Emergency Services	18
2014-01-01	Wednesday	Bus	VP and Ellesmere	Investigation	10

First five rows of the Final Dataset

In the cleaning phase, all data entries that had an incomplete (NA) value for the Delay variable were removed. Because if a delay occurred but we do not how impactful that delay was, then it does not contribute to the analysis. Data that was clearly erroneous was removed, like negative delay times and extremely high delay times. Furthermore, all observations whose delay time exceeded 998 minutes (999 minutes was the code for a cancellation between 2015 and 2019) were removed.

2.1 Delay of Vehicles

First this paper will assess which Mode of Transport suffers the most from delays. From Figure 1, we observe that buses suffer the highest number of delays and are delayed for the longest period. Interestingly, though the subways suffer from more Incidents than the streetcar, its total time lost to delays is significantly less. This would indicate that individual Subway incidents are resolved faster than Streetcar incidents on average.

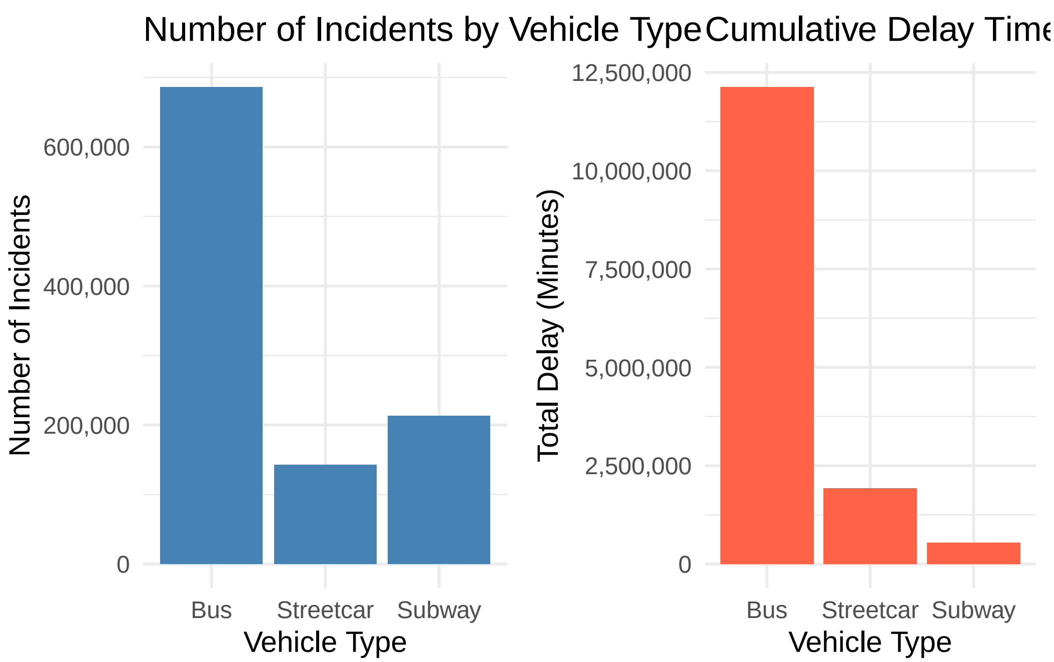

Figure 1: (left) Total Number of Incidents (right) Total Amount of Delay Time

Figure 2 would support this claim, as on average Streetcar delays take 13 minutes to resolve whereas Subway delays only take about 2.30 minutes to resolve. Unfortunately, Buses not only have the most delays, but its delays on average take about 20 minutes to resolve.

2.2 Causes of Delays

To discover why Bus delays are so much worse than Subway and Streetcar delays, we need to observer the differences in how long every type of incident takes to resolve, as well as what type of incident each mode of transport suffers from the most. This will also provide crucial

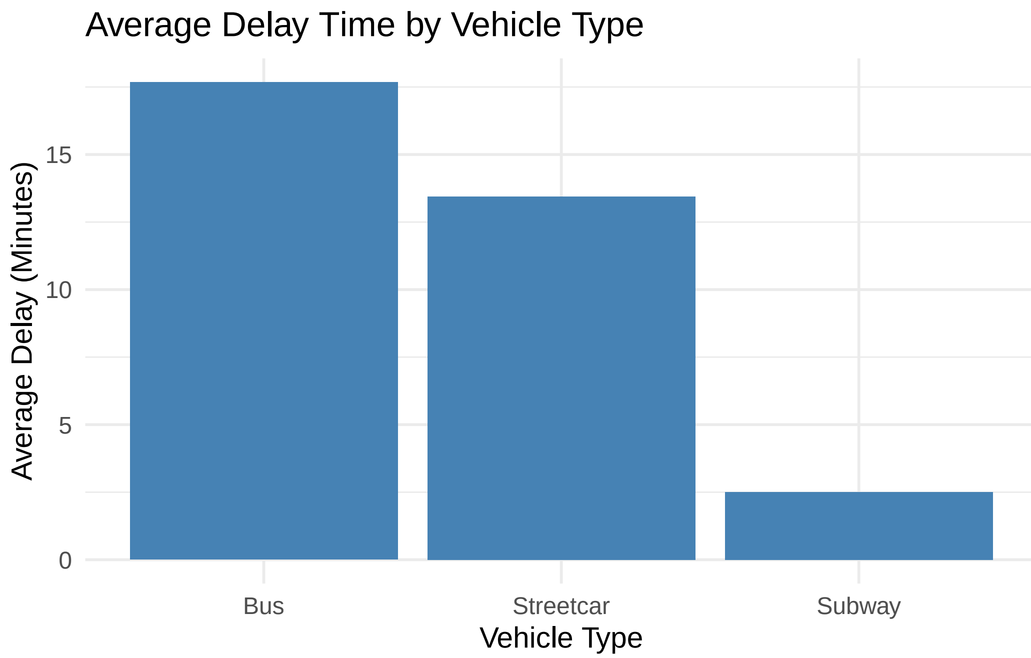

Figure 2: Average Amount of Delay Time by Vehicle Type

insight into which Incidents are the most problematic, then the TTC may focus their efforts on the most disruptive incidents.

From Figure 3 we can see that Diversions make up the bulk of the total time lost to delays over the last 10 years. This could be due to the sheer number of Diversions that happen, or each Diversion causes a large delay. By investigating Figure 4 we observe that Diversions on average take a long time to resolve.

Next, we will break down average delay time by each mode of transport, as this will give us a better understanding of incidents are the most disruptive for each mode of transport. In Figure 5 we observe that buses are most impacted by Held by, Overhead, and Diversions. To most improve Bus services the TTC should focus on reducing the average delay times of these Incidents. Figure 6 displays that the Streetcar is plagued by the same high-cost average delay time incidents. However, the spread for Streetcar is broader so targeting these three incidents would not be as impactful as it is for buses. However, Figure 7 shows part of why the subway suffers so much less from delays. The incidents the subway suffers from take only 4 minutes on average to resolve, in the worst case.

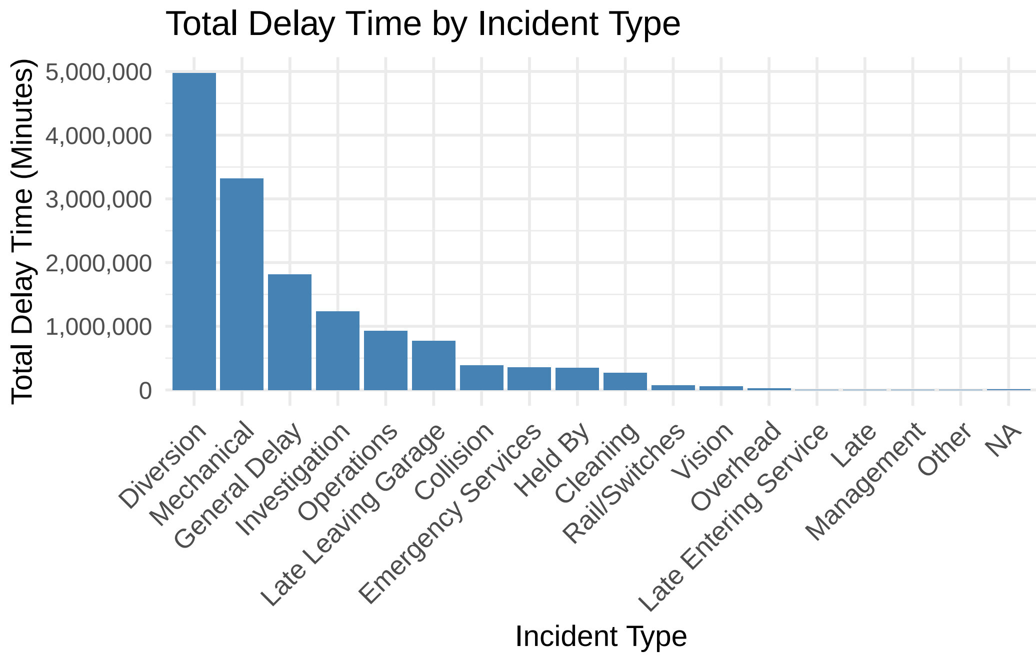

Figure 3: Average Amount of Delay Time for Buses by, Incident Type

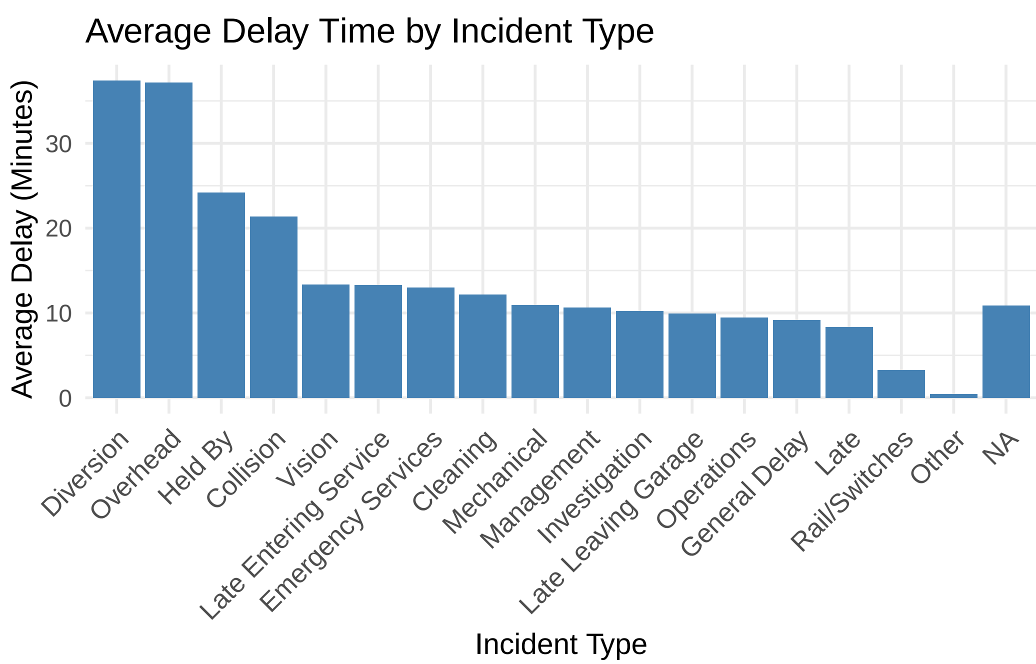

Figure 4: Average Amount of Delay Time by Incident Type

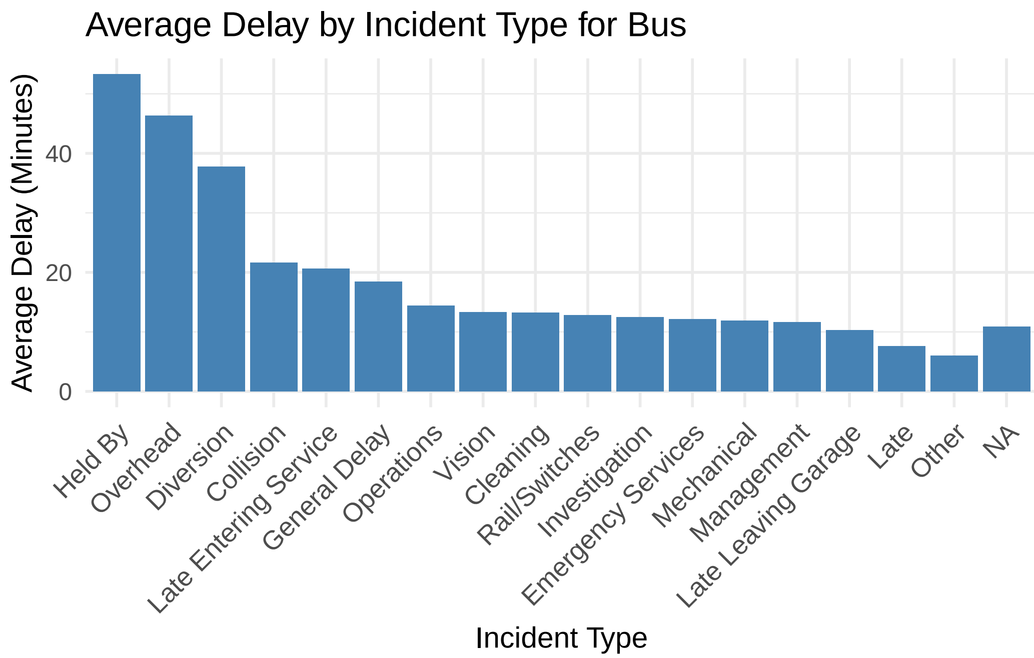

Figure 5: Average Amount of Delay Time for Buses by, Incident Type

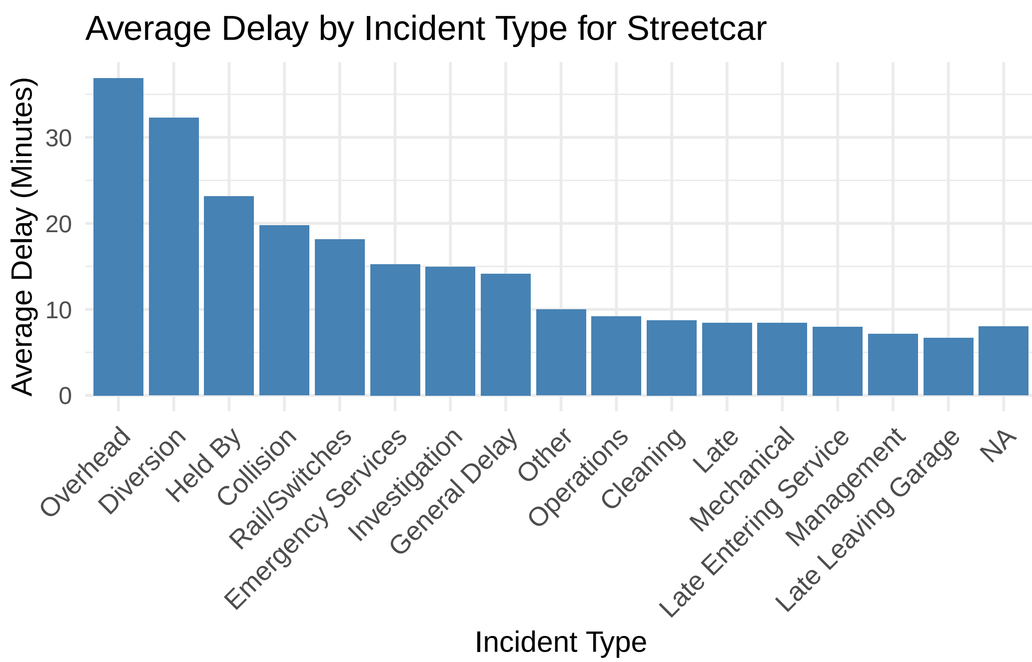

Figure 6: Average Amount of Delay Time for Streetcars, by Incident Type

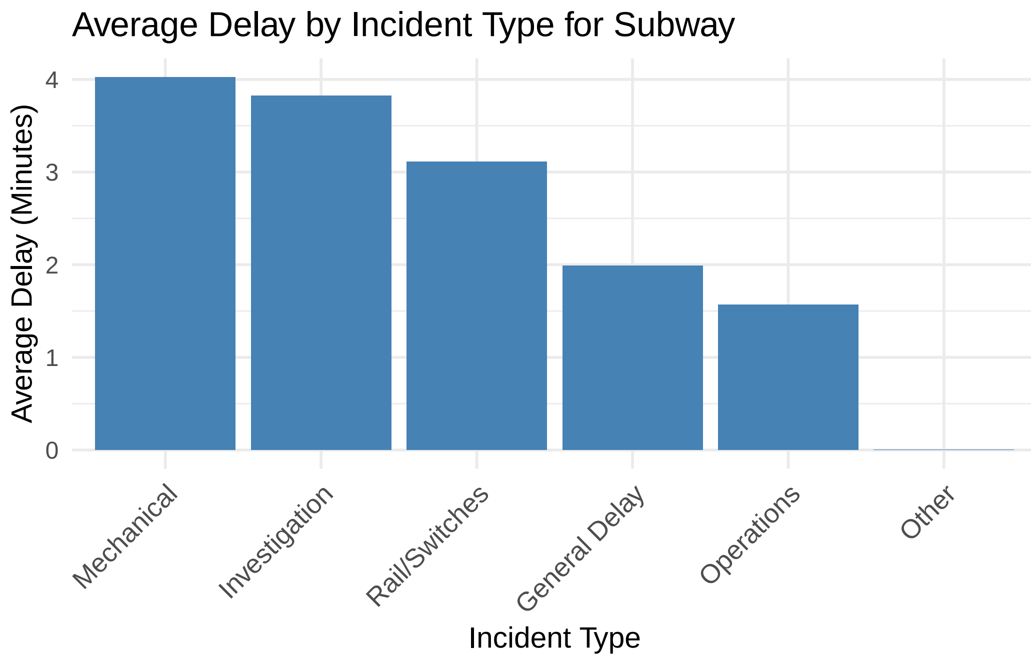

Figure 7: Average Amount of Delay Time for Subways, by Incident Type

2.3 Delays Over Time

To further investigate the data, we will investigate when incidents are likely to occur. From Figure 8 we observe that the average delay time of incidents is about 2 minutes longer on the weekends. This could be because there are less TTC staff on the weekends, so incidents take longer to be delt with. Across months, Figure 9, there is little difference in the average delay time. This is surprising, as in the winter delays could be worse as weather conditions worsen. This may be a testament to the TTC's ability to deal with Toronto's harsh winters.

Finally, to get a wider view of how incidents have changed over the past 10 years we look to Figure 10 and Figure 11 In Figure 10 we see that the number of bus incidents decreased dramatically between 2014 and 2021. Interestingly this trend of lower number of incidents does not correlate with total incident time, as we observe in Figure 11. This may be due to the TTC changing how they classify incidents, so the data is entered differently but the amount of delay time remains stable.

Figure 11 suggests that total incident time remains stable for buses, except in 2020 and 2021 where there is a noticeable drop. This drop could be related to the Covid-19 pandemic for several reasons. Firstly, ridership dropped dramatically during the pandemic therefore fewer buses were scheduled and thus fewer Diversions, Overhead and Collisions. There is a modest drop in Streetcar Delay times as well which would support this narrative. Secondly, the city made public transportation free during the pandemic, so delays due to Investigations would

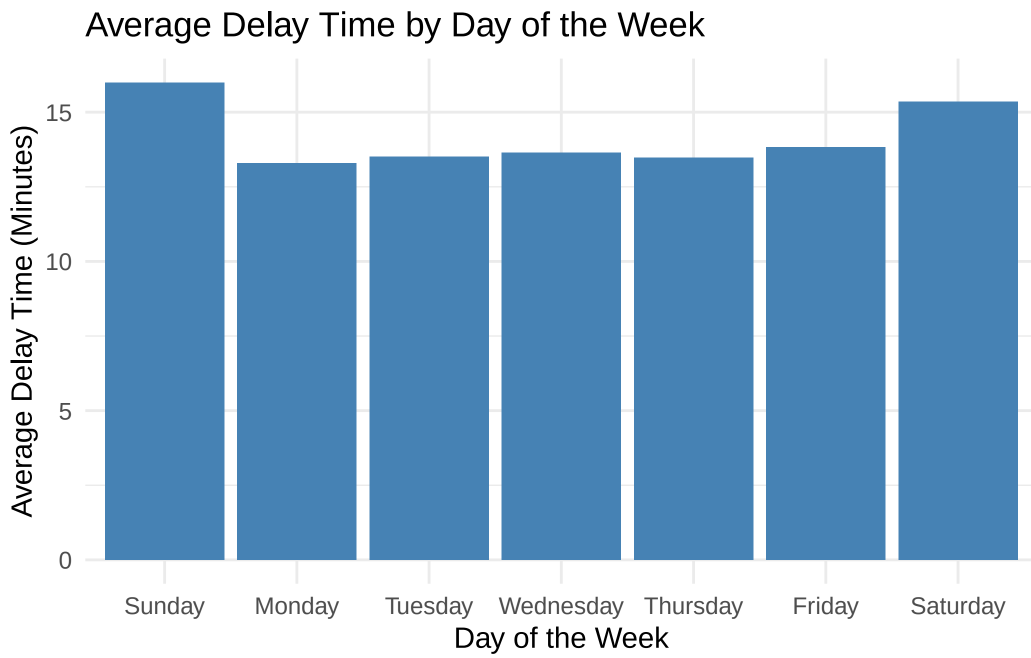

Figure 8: Average Amount of Delay Time by Day

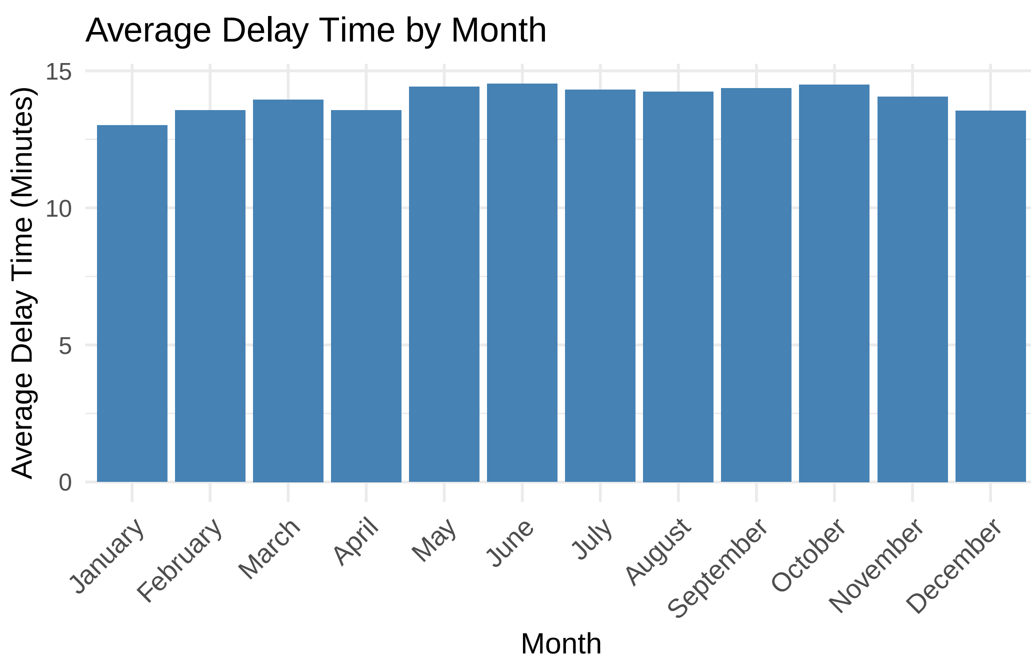

Figure 9: Average Amount of Delay Time by Month

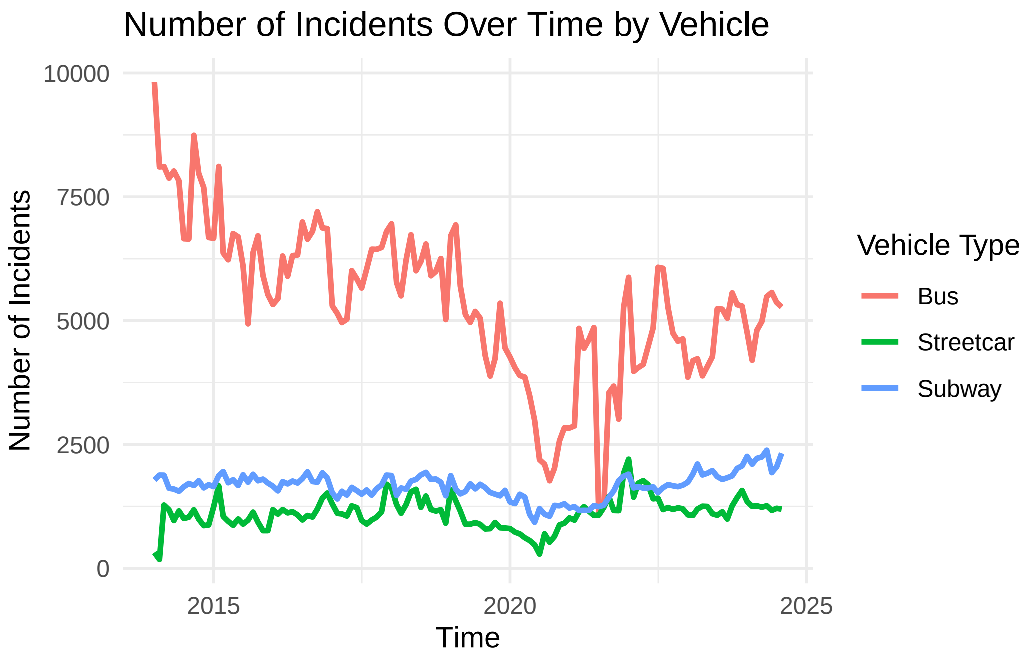

Figure 10: Number of Incidents Over Time

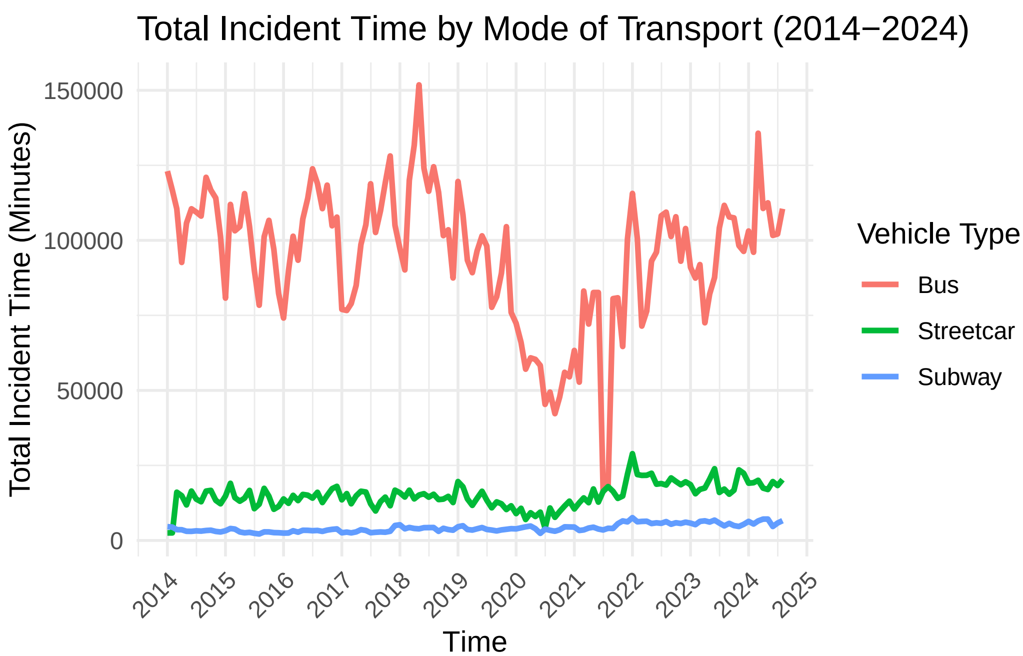

Figure 11: Total Delay Time from 2014 to 2024

fall. In Figure 12 observe that average delay time did not noticeably drop during the pandemic. This lends further support to these claims, as average Incident delay time remained the same, however far fewer incidents were occurring as the system was constricted. Furthermore, Fig10 indicates that over the last 10 years the average delay time per incident has been increasing slightly. This could be an indication that the aging fleet of TTC vehicles requires more time to resolve certain incidents.

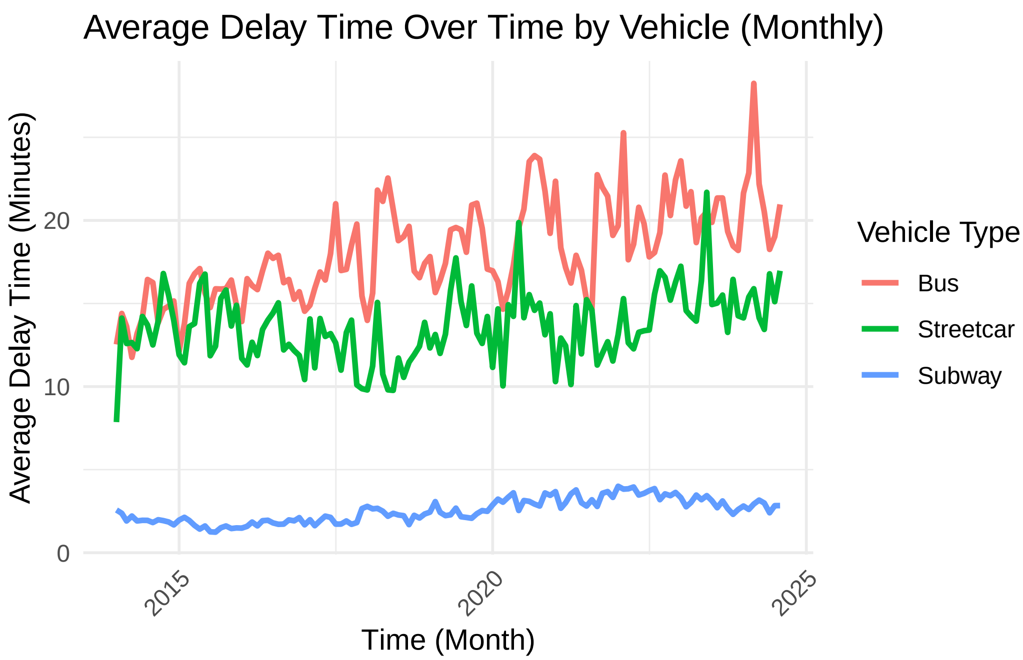

Figure 12: Average Delay Time from 2014 to 2024

3 Discussion

The results show that buses experience the highest number of delays and the longest total and average delay times. Incidents that have long average delay times such as diversions, mechanical issues, and “held by” incidents contribute most to the total delays buses suffer from. In contrast, subway delays are resolved more quickly on average, which may be attributed to less exposure to external factors like traffic, and a more controlled environment allowing for faster repair or replacement.

These findings have important implications for the TTC and its efforts to improve service reliability. For example, reducing the frequency and duration of diversions and mechanical issues could have a disproportionate effect on improving bus services. Expanding the Subway would be a great strategy as subway services are inherently more reliable, so maximizing ridership there would be beneficial.

To build on these findings, further exploration focusing on location data could provide deeper insights into delay patterns across the city. Creating a heat map of Toronto that visualizes delay times would identify geographic hotspots where delays are most frequent or severe. This spatial analysis could help TTC officials focus their efforts on certain neighborhoods, intersections, or corridors that are more prone to delays.

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