



Bus Performance Study

August - September 2023

Prepared by



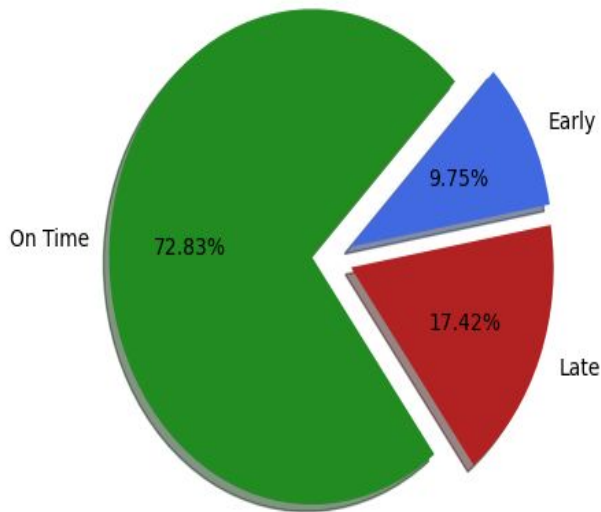
Overview



By analyzing WeGo bus spacing data from August 2023 - September 2023, the Nashville Software School team aimed to identify patterns and correlations to controllable or external factors as they relate to headway, or the amount of time between vehicle arrivals at a stop.

Two main variables were analyzed: headway deviation and adherence.

What is the overall on-time performance by adherence & what does the distribution look like?



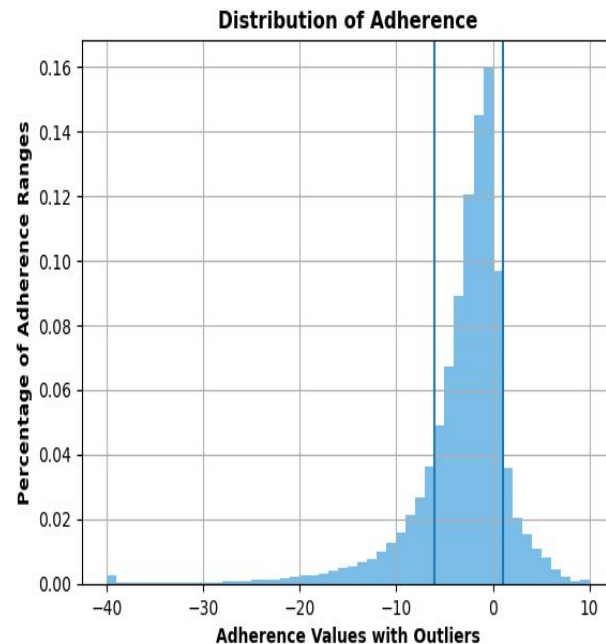
How we define our categories for adherence: We put all instances into 3 categories when they had a recorded adherence value.

On-time: Between -6 and 1

Late: Less than -6.

Early: Greater than 1

Without knowing what the goal metrics are we can not say if this is within company parameters. However the on-time percentage is impressive!



The WeGo Data contained 350,328 rows. There were 11,468 null values for adherence.

Our data without nulls contains 338,860 rows



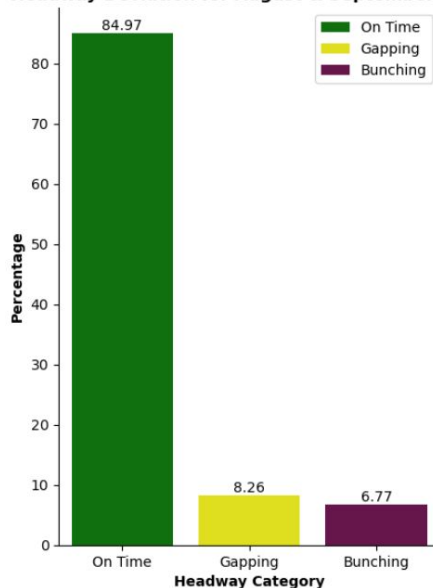
What is the overall on-time performance by headway deviation?

What does the distribution look like?

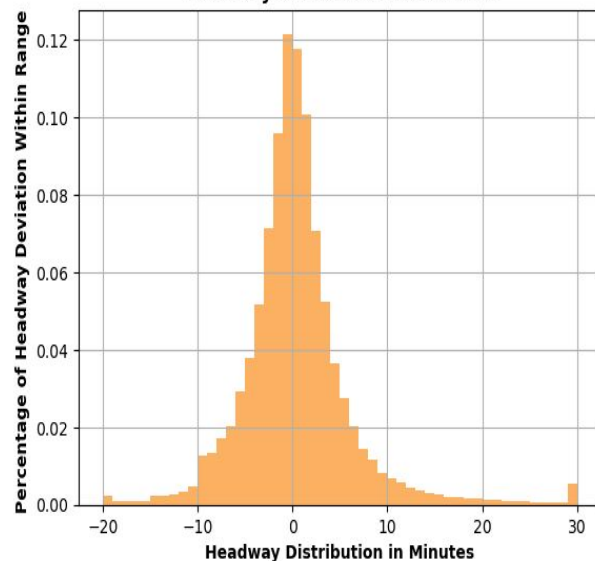
Headway Deviation terms defined:

- Bunching = Less than 50% of scheduled headway.
- Gapping = Greater than 150% of scheduled headway.
- On-time = Between 50% and 150% scheduled headway.

Headway Deviation for August & September 2023

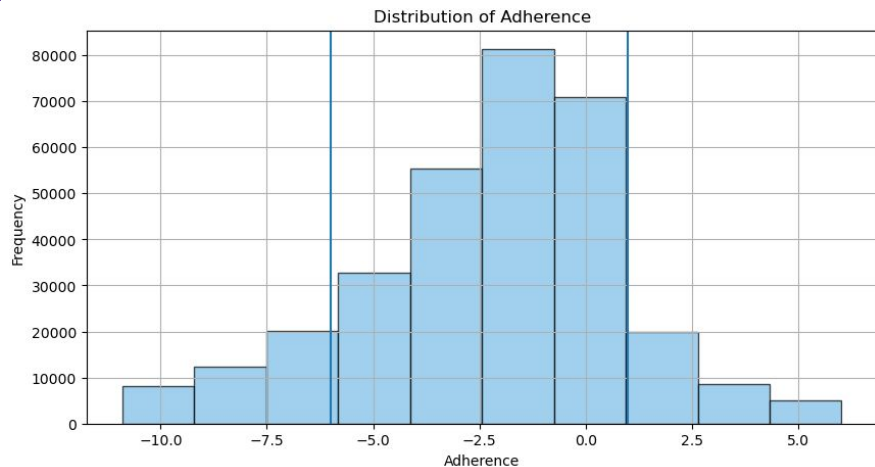


Headway Deviation Distribution

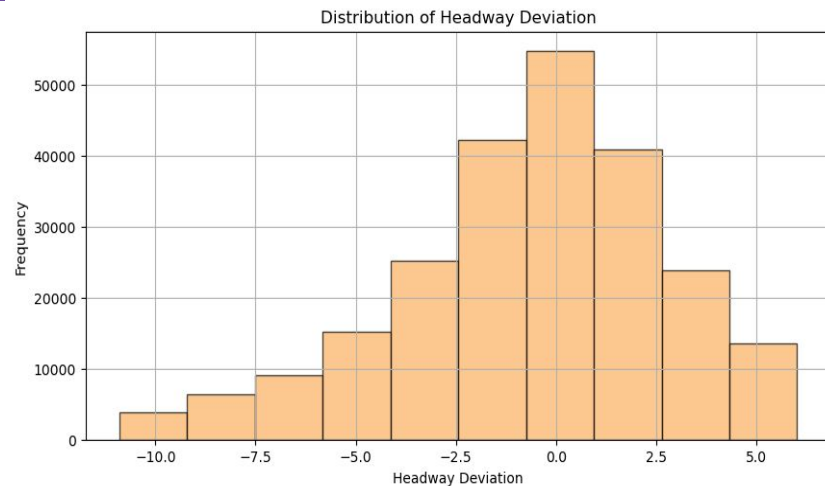


There were 84436 null values for headway deviation. So our new data contains 265892 rows.

What do the overall distributions of adherence and headway deviation look like?



The adherence appears to be stable as the the histogram shows peaks in the acceptable ranges of -6 and 1

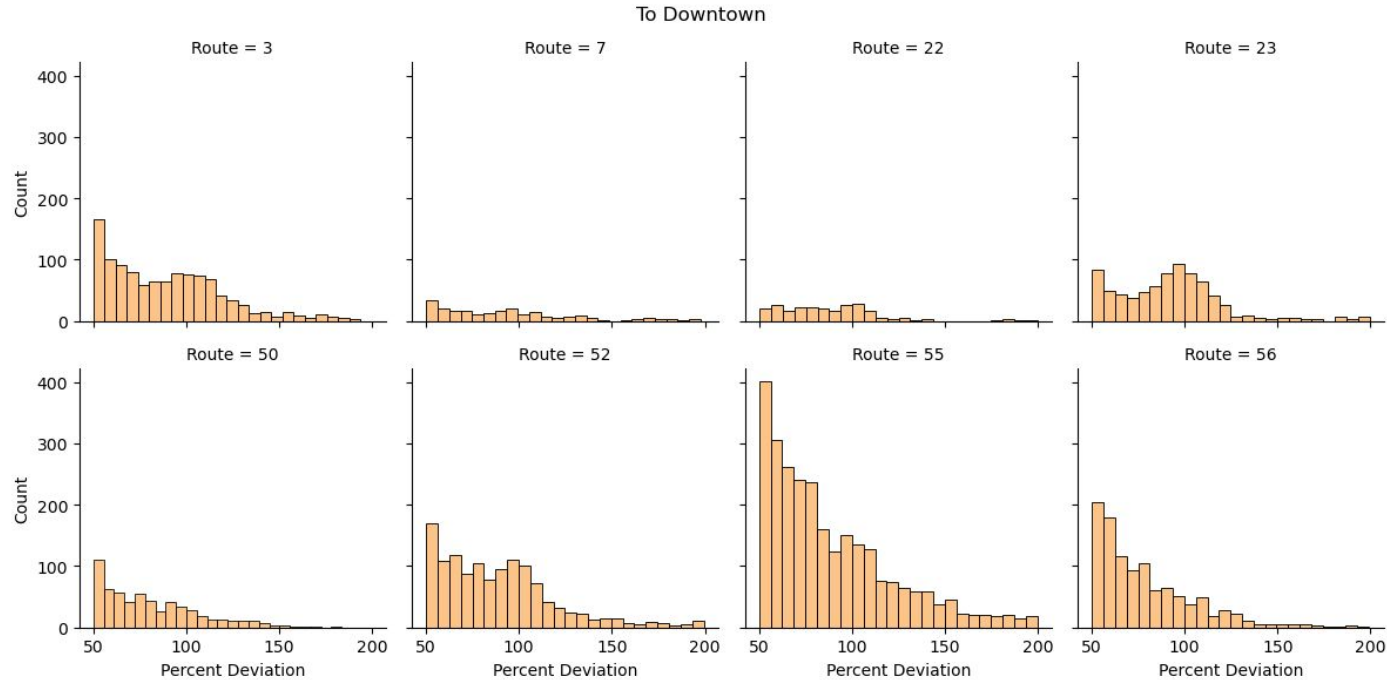


The headway deviation appears to be stable as the histogram shows peaks in the acceptable ranges of -2.5 and 2.5

Visuals are without outliers



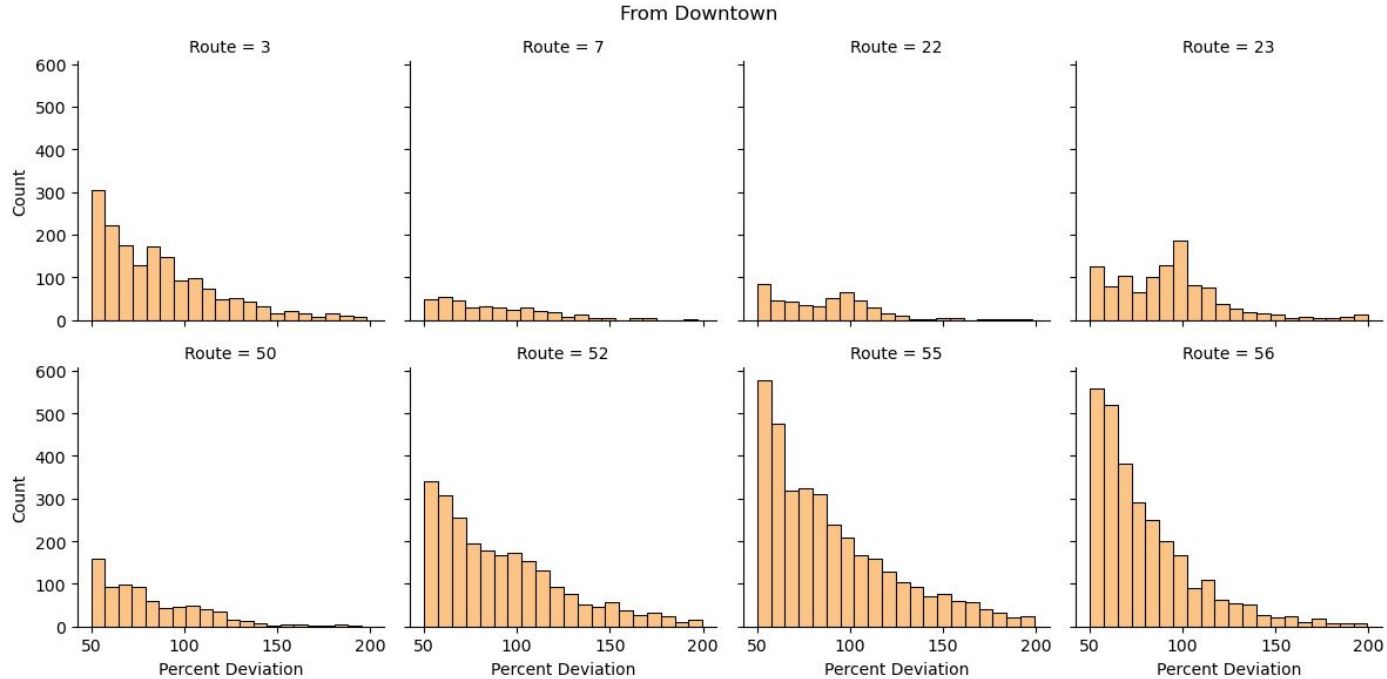
How does direction of travel and route affect the headway?



Percentage of Headway Deviation to Downtown



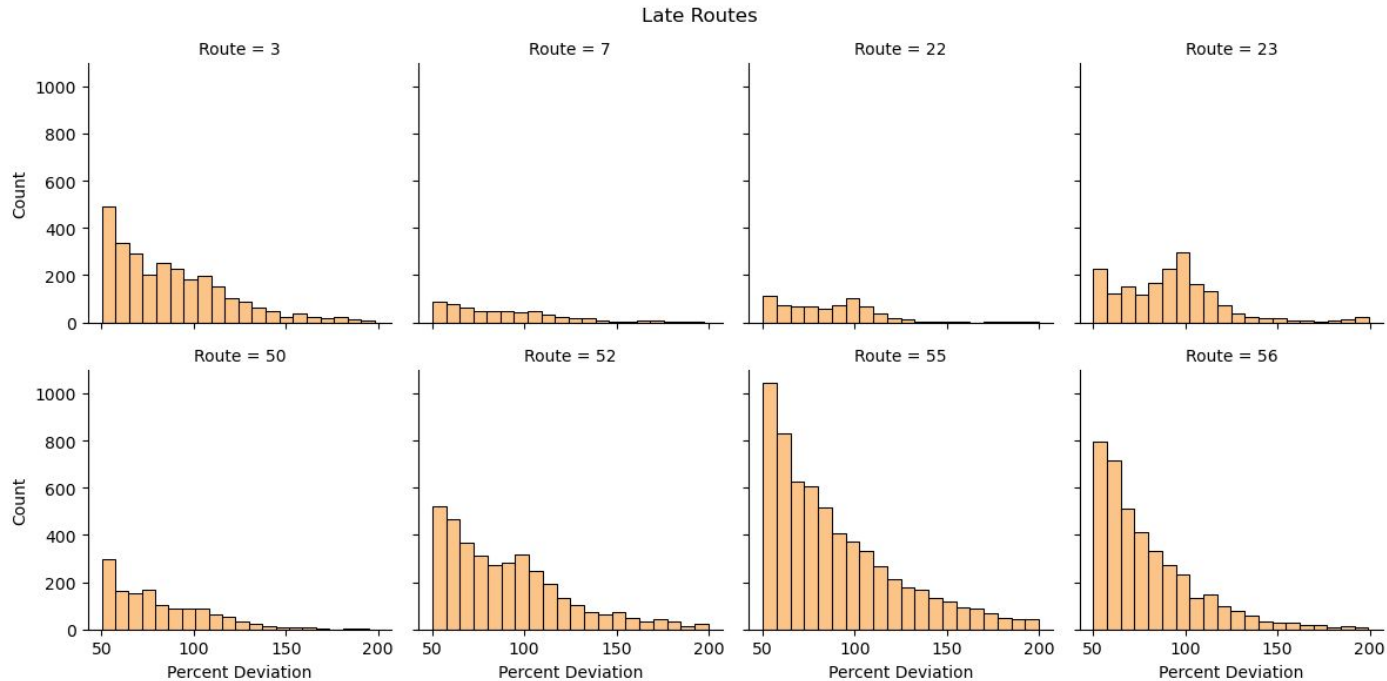
How does direction of travel and route affect the headway?



Percentage of Headway Deviation From Downtown



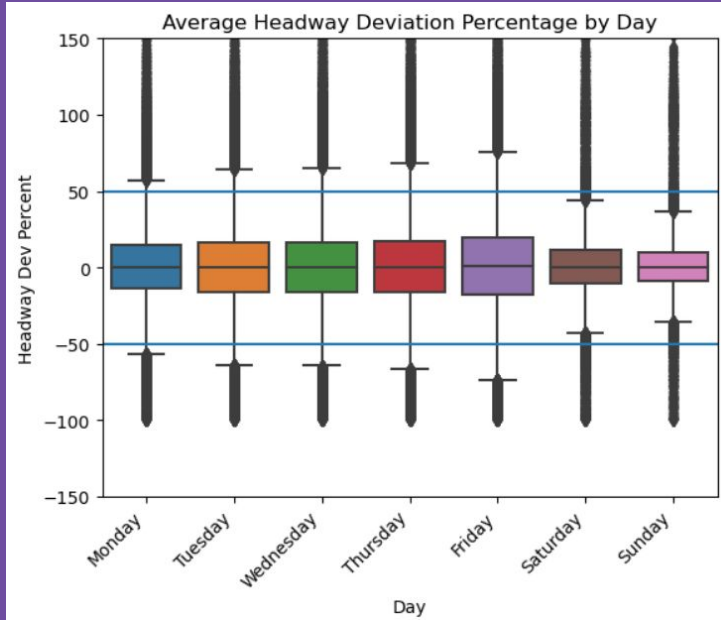
How does lateness and route affect the headway?



Percentage of Headway Deviation of Late Routes



How does day of the week affect headway?

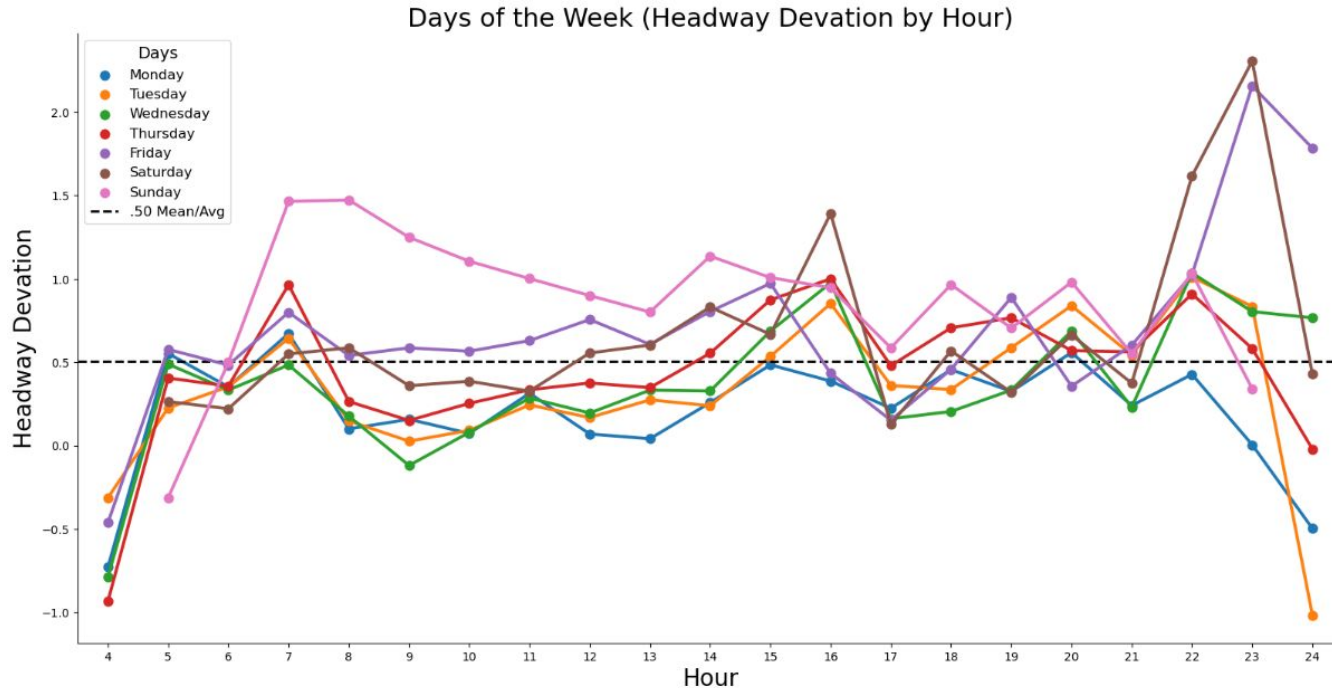


Headway is greatly affected by the day of the week.

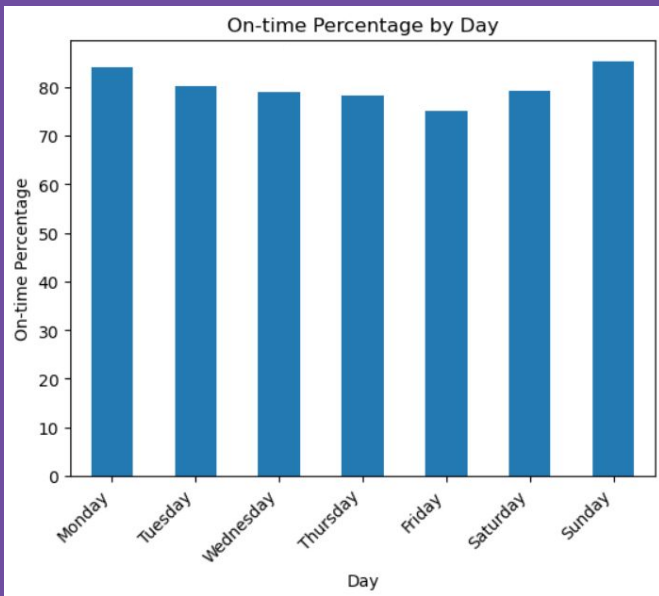
- Starting on Monday **the headway deviation percentage varies more as the week progresses.**
- Saturday and Sunday have less bus routes than during the week, and traffic is lighter, leading to less headway deviation.



How does time of day affect headway?



How does day of the week affect on-time performance?

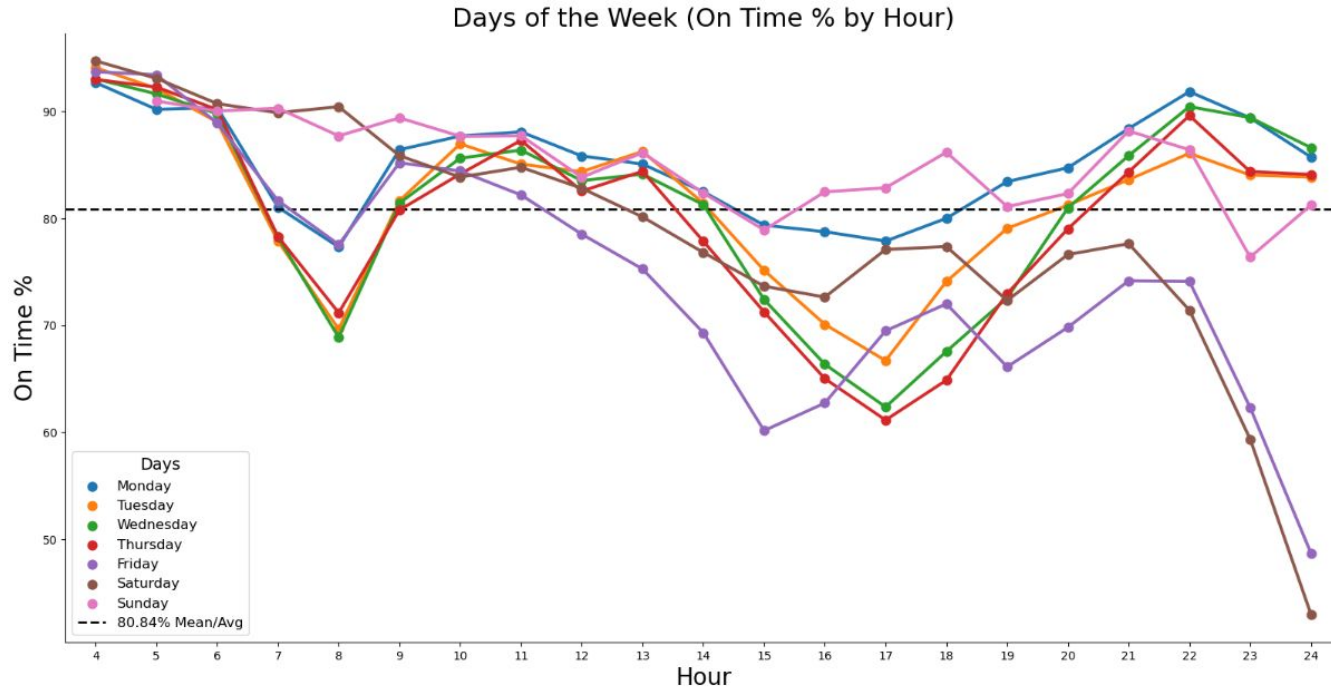


On-time performance is mildly affected by the day of the week.

- Starting on Monday the **on-time percentage steadily decreases as the week progresses.**
- Again, Saturday and Sunday have less bus routes than during the week, and traffic is lighter, leading to higher on-time percentages.



How does time of day affect on-time performance?

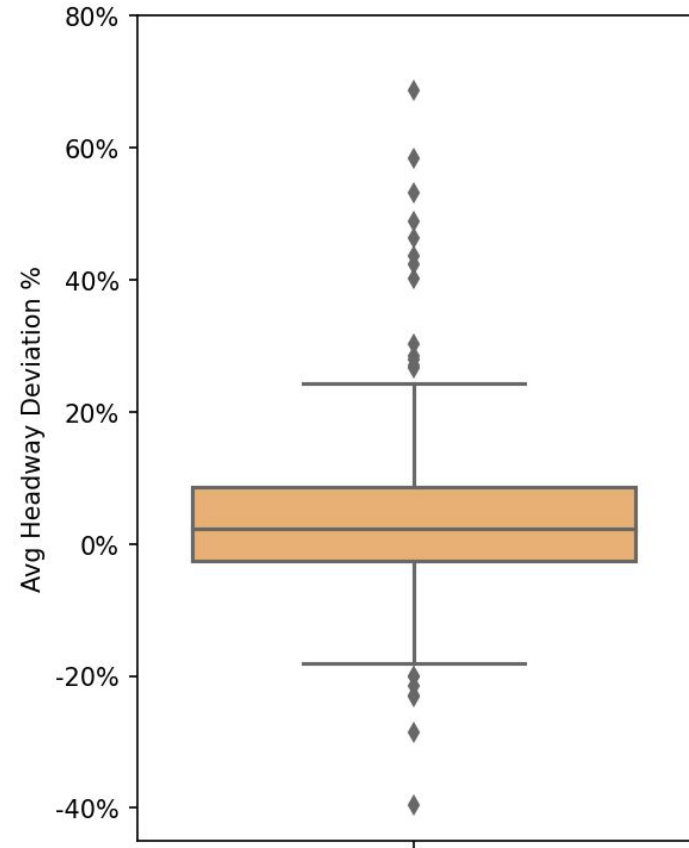


How much of a factor is the driver on:

% Headway Deviation

Mean	+3.4%
Q1	-2.6%
Median	+2.3%
Q3	+8.7%
Std Dev	11.9%

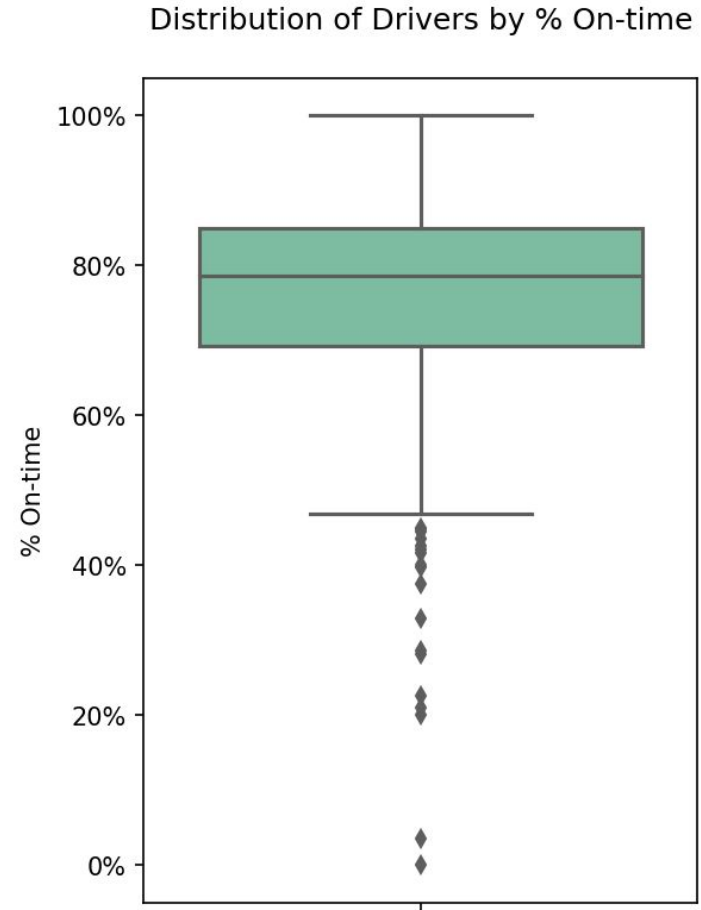
Distribution of Drivers by Avg % Headway Deviation



How much of a factor is the driver on:

On-time Performance

Mean	74.9%
Q1	69.2%
Median	78.6%
Q3	85.0%
Std Dev	15.5%



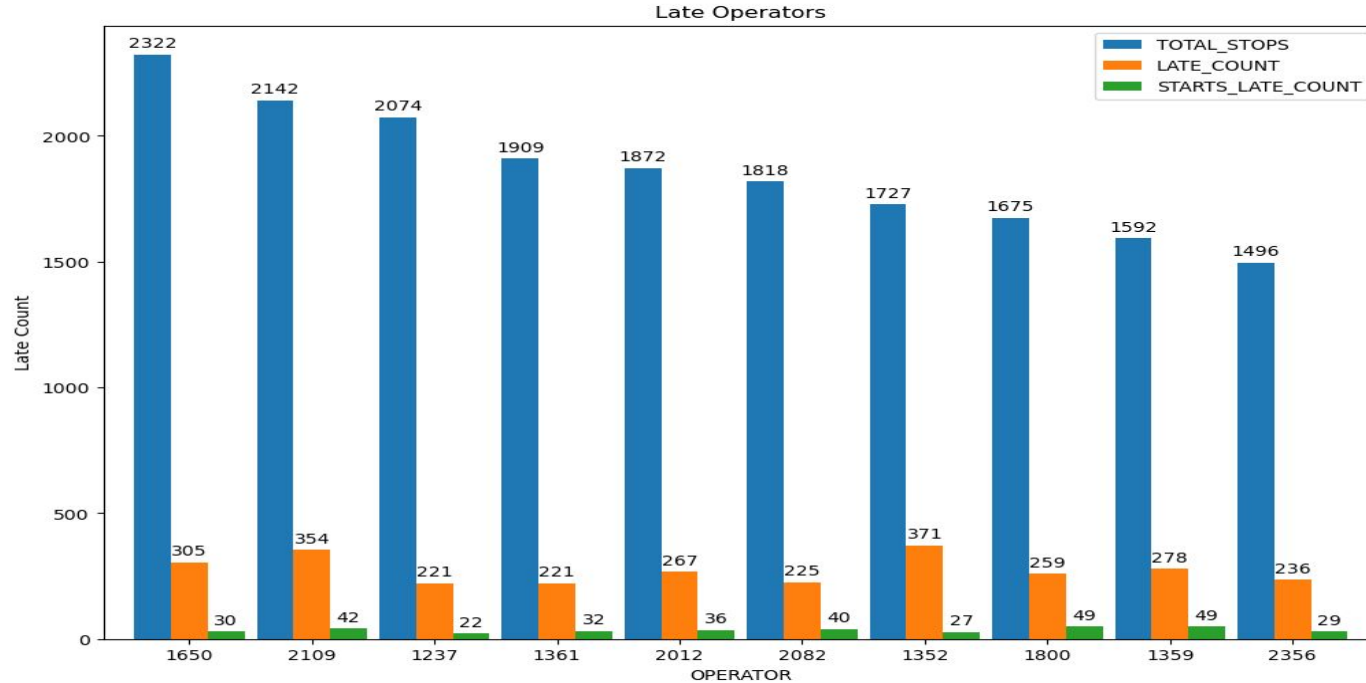
Do more active drivers perform better?

- There are **no strong correlations** between driver statistics and the number of records they have.
- There is a weak positive correlation between a driver's timeliness and their amount of records.
- In general, **more active drivers are on time slightly more often.**

Driver Correlation Matrix	Number of Records
% Headway Deviation	-0.061
Early Departure	-0.129
On Time Departure	+0.255
Late Departure	-0.167



Drivers with the most late stops.



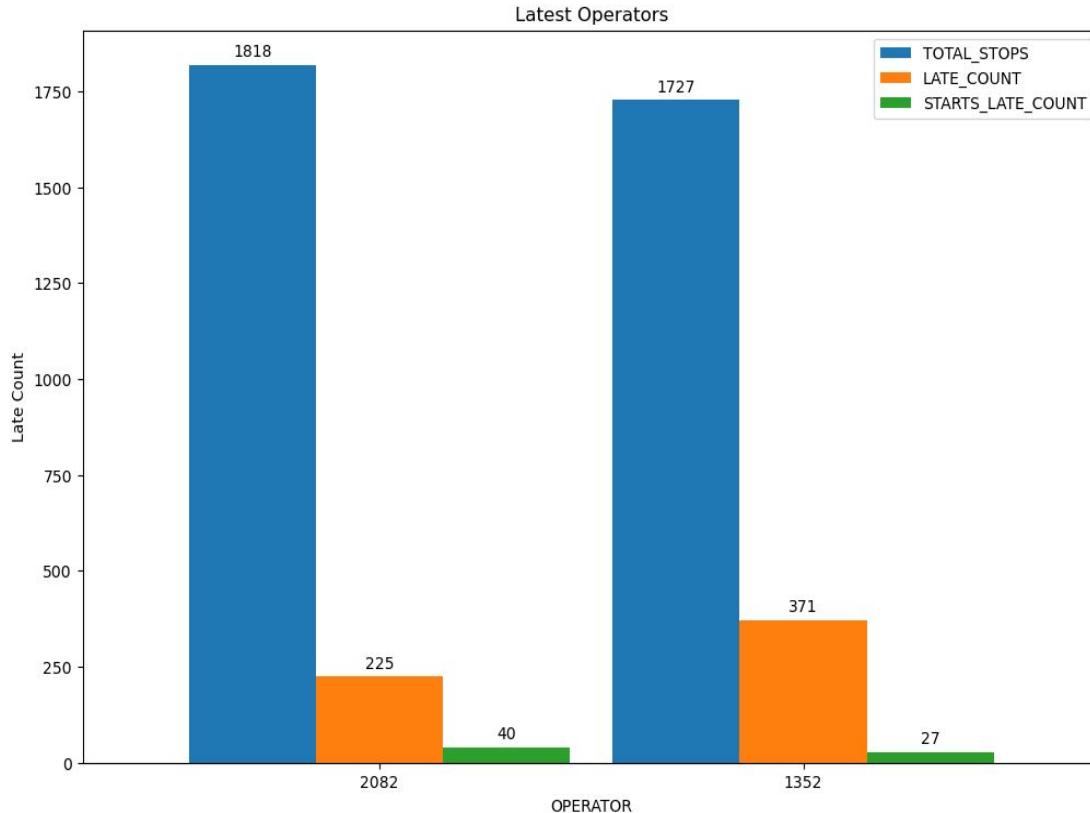
How much of a factor is the driver on headway and on-time performance?

Overall, the driver does play a factor in the count of late stops they have, but a bigger factor is their routes and the time of day that they drive.

- Of the top 10 people with the highest count of late stops, 6 of them were on route 55.
- While some of them had many more late stops than others, they tended to have more overall stops to make (ie, they drove more often).
- It is worth noting also that 2 of the top 10 overall late counts, were also in the top 10 late counts across 2 separate routes.
- Driver 2109 had 197 late stops on Route 55 and 142 late stops on route 50.
- While driver 1237 had 137 late stops on route 56 and 84 on route 3.



Route 55 is the hardest route to drive.



- Route 55 had the largest count of drivers with late stops.
- The greatest of which was 371 and the least of which was 225.
- However, it's also worth noting the time of day difference between the two drivers.
- Driver 1352 spent most of his trips in the earlier hours of the mornings, going towards downtown, this could play a factor in his count of late stops because he would be sitting in traffic.
- Driver 2082 spent most of his route 55 trips in the early afternoon coming from downtown, when traffic is less of a factor.



So do drivers impact their own late counts?

We see various reasons for late stops. While the evidence shows that the driver does have an impact on how many stops they are late to, **lateness is more often an effect of the route and the time of day** they are scheduled to drive their routes.

Getting a better handle on late starts would be a great means of reducing the number of late stops that are directly controllable by driver.



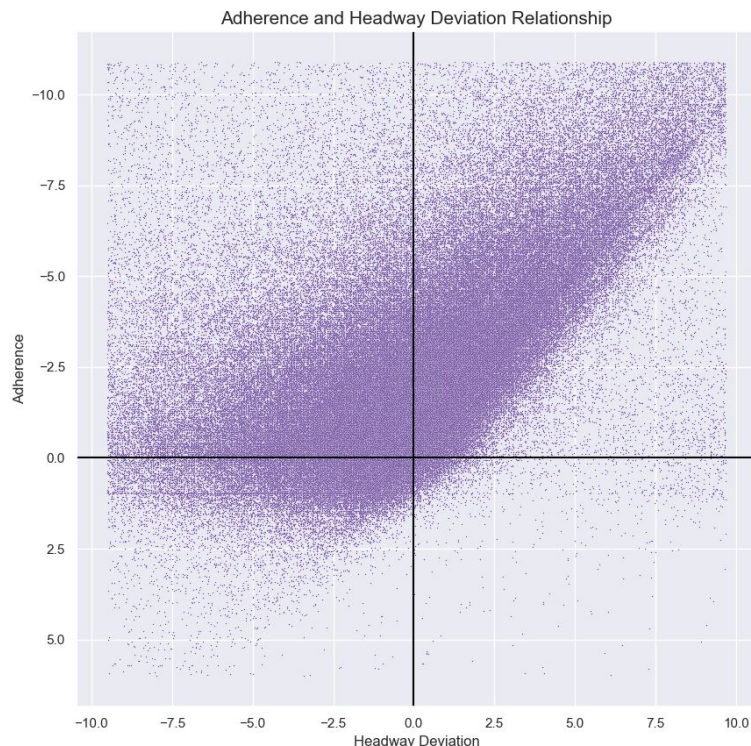
Is there any relationship between adherence and headway deviation?

59,000 Late Departures

- **46%** had an 'acceptable' headway (Deviation < 50%)
- **22%** had no headway data
- **24%** had a 'gap' headway
- **8%** had a 'bunching' headway



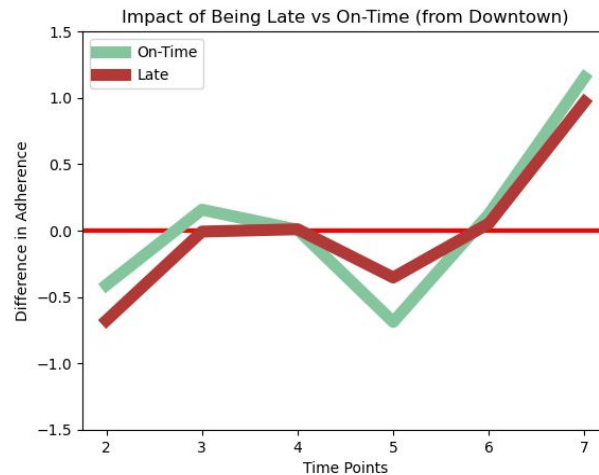
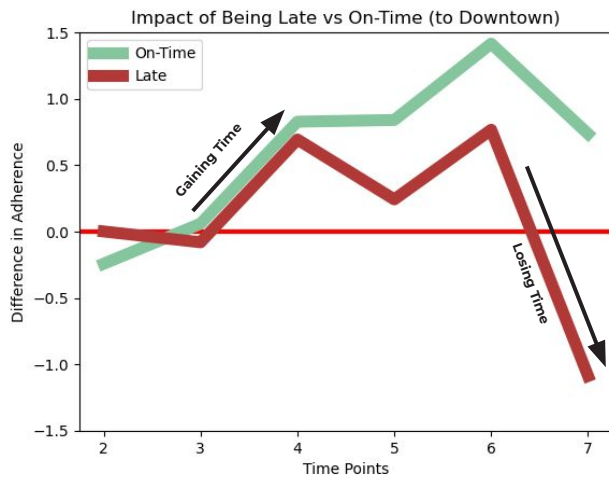
Is there any relationship between adherence and headway deviation?



- The scatter plot represents data between the 25th and 75th percentiles.
- Adherence and headway deviation have a **-0.54 correlation** coefficient.
- The chart shows that as lateness increases, headway gap increases.



Downstream effects of being late to first stop to downtown vs from downtown



- **To Downtown Routes:** Although the pacing for the late bus picked up after the 3rd stop (almost matching the on-time pacing), as the number of stops increases, it seems the gap between on-time and late buses increases.
- **From Downtown Routes:** For the first 4 stops, the pacing of the late bus is actually closing the gap and not only matches the pace of the on-time buses, but the pacing is even higher until stop #6. Stops from routes coming from downtown is less affected by having a late start as it pertains to gaining/losing time.



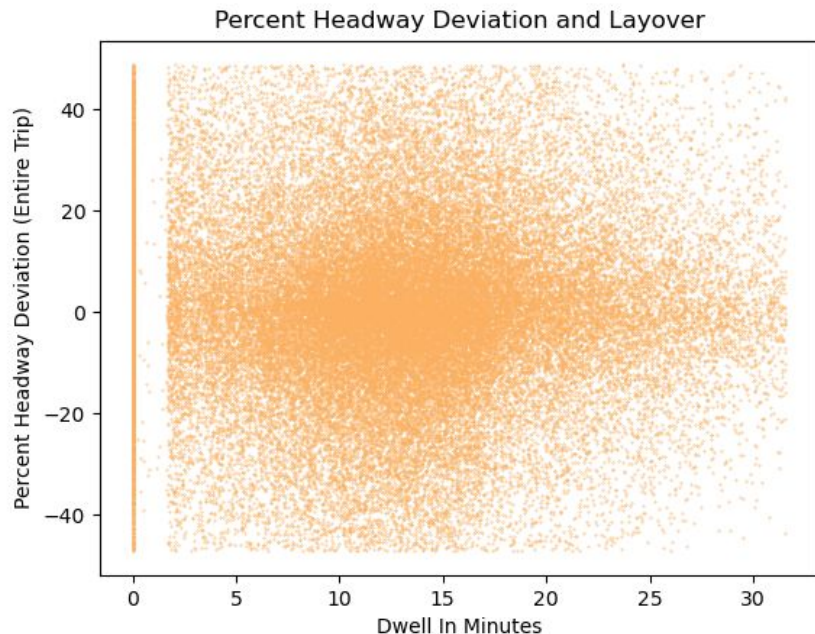
What is the impact of layover at the start of the trip on headway stability?

Layover times at the initial stop do not impact headway stability.

- Headway stability was calculated using a percent change of headway deviation.
- The ideal value for percent change of headway deviation is zero.
- Bunching and gapping can be inferred from the percent change headway deviation.



Layover and Percent Headway Deviation (excluding statistical outliers)



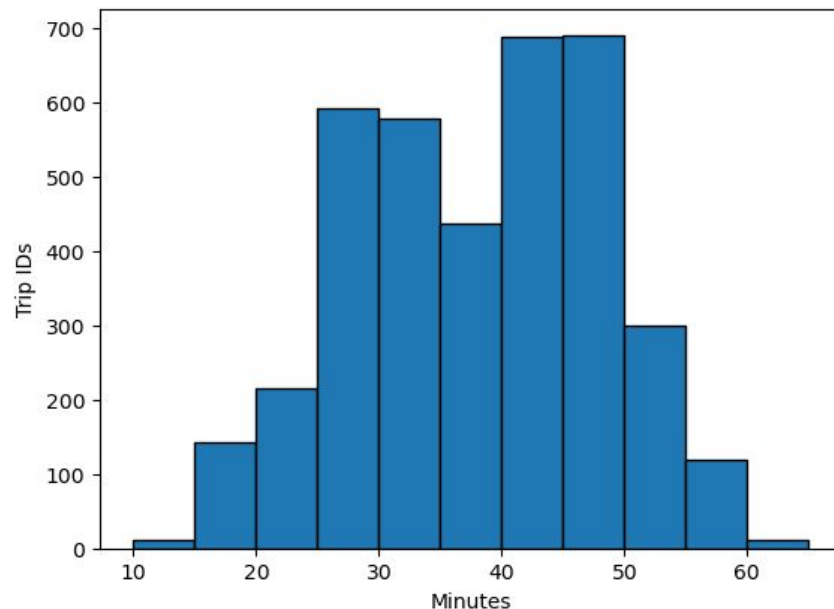
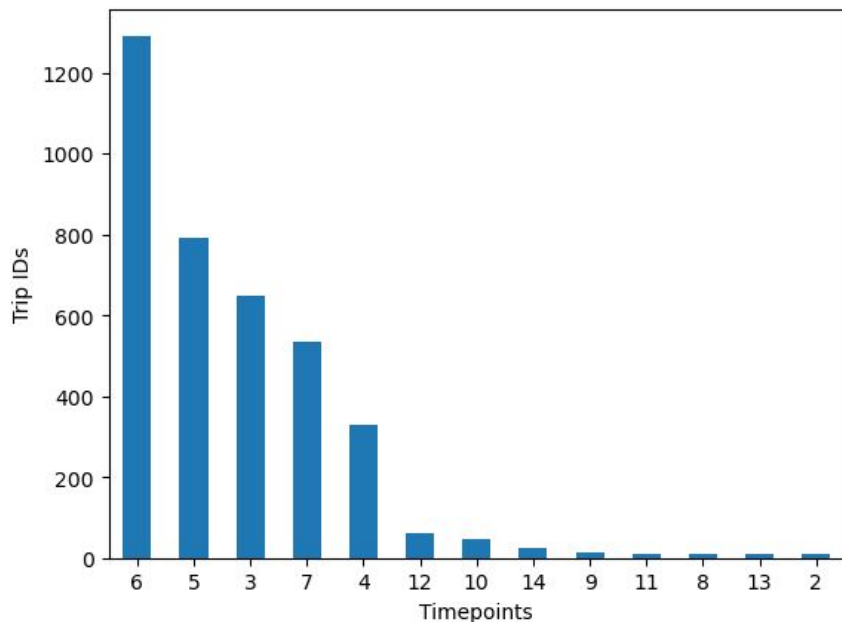
- There does not exist any trend lines as the layover time increases.
- However, it is important to note that the data clusters around zero percent headway deviation.



There is no correlation between layover and headway stability

Does headway become less stable the further the bus has travelled on its trip?

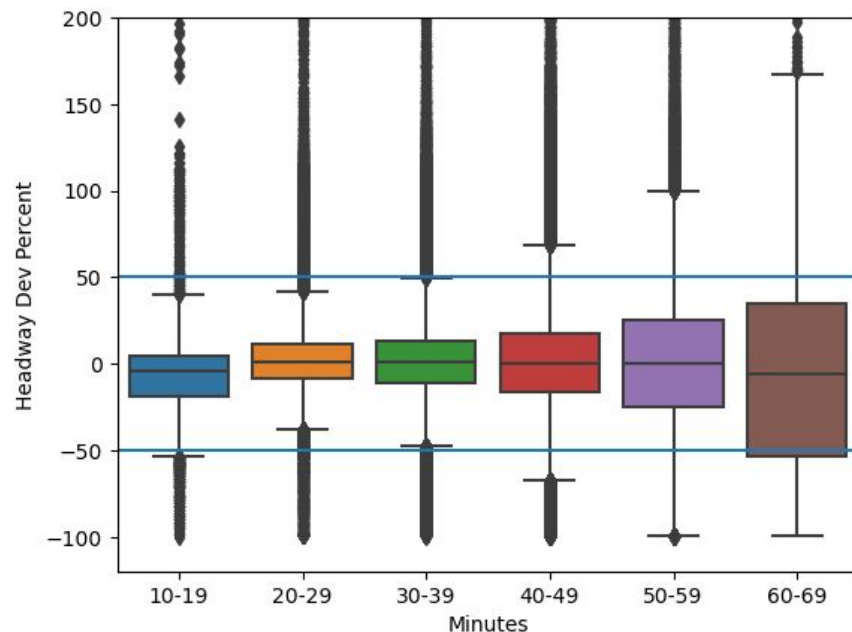
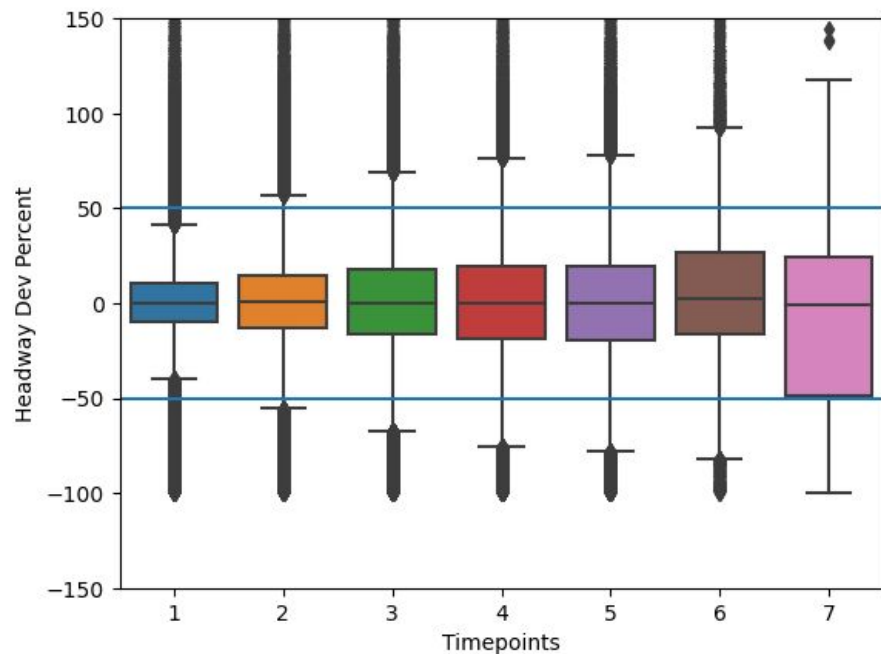
Total **Length** of 3782 Trip IDs



Most trips have a total of 6 timepoints and last 30-50 minutes

Does headway become less stable the further the bus has travelled on its trip?

Length of Trip vs Headway Deviation Stability



Yes



Key Takeaways

- The overall on-time performance is over 70 percent and the adherence and headway deviations are in the defined acceptable ranges.
- Route has more of an impact on bus performance than direction (to downtown or from downtown) overall.
- Day of the week as well as time of day affect both headway and on-time performance.
- Longer trips result in a less stable headway.
- For downstream effects based on lateness at the first stop:
 - **To Downtown Routes:** as the number of stops increases, it seems the gap between on-time and late buses increases.
 - **From Downtown Routes:** Stops are less affected by having a late start as it pertains to gaining/losing time.



Thank you

