

# **Beyond Delays: How Service Alerts Disrupt Lives and Challenge Reliability on the MBTA**

This presentation explores the current state of transit and community resilience in  
Boston

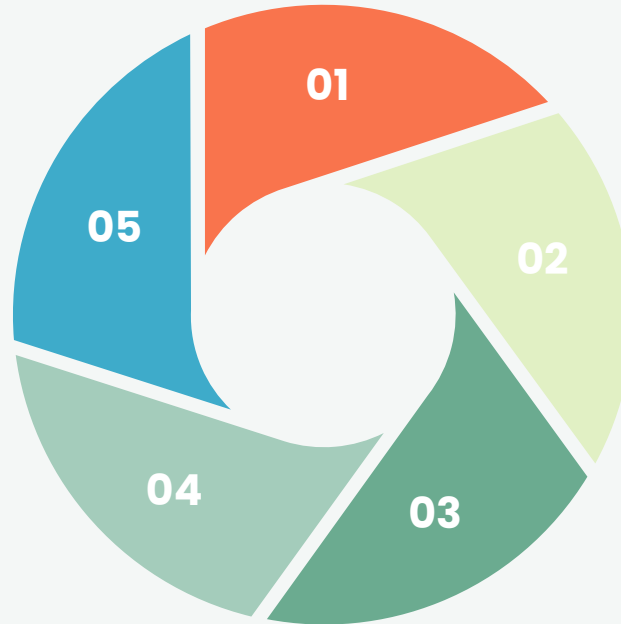
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# Introduction & Thesis

This research seeks to understand if there is a correlation between frequency of service disruptions and different demographics at each subway station. The result will be used to understand if there are any groups of people significantly impacted by service disruptions.

Access to reliable transportation is a chronic issue for vulnerable populations



On February 15, 2024, MBTA experienced a severe power disruption, leaving many commuters stranded

Reliability issues with the subway system have been a growing concern among Bostonians

Personal vehicle ownership is not a viable option for everyone

# Literature Review

- Urban resilience is the ability of a city to withstand, adapt to, and recover from disruptions
- Transportation systems, like the MBTA, are crucial for a city's economic and social wellbeing
- Implementing strategies to enhance transit system resilience can contribute to overall urban resilience



# Applying Resilience Thinking

## 1. Maintaining diversity and redundancy.

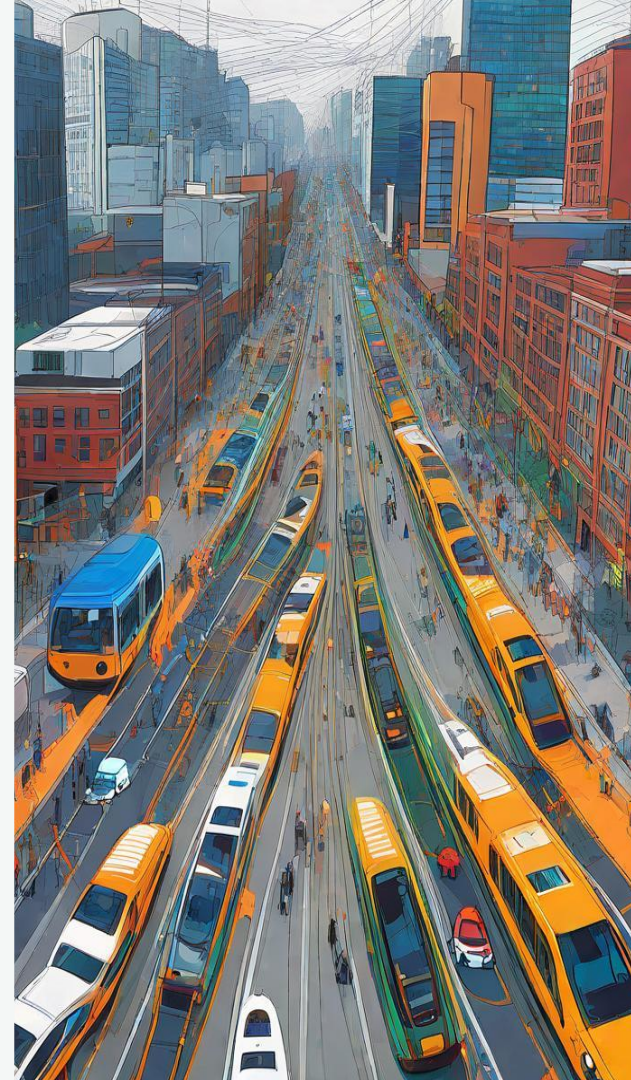
This involves developing a multimodal network offering various transportation options like buses, trains, and cycling infrastructure.

## 2. Managing connectivity.

Designing a well-connected network with bypasses, transfer hubs, and interlinking modes minimizes the impact of localized incidents.

## 3. Managing slow variables and feedbacks.

Identifying emerging problems based on data feedback, and adapting strategies accordingly.





# Applying Resilience Thinking Cont'd...

4. Foster complex adaptive systems thinking.  
Analyzing past disruptions and conducting regular drills help identify weaknesses and improve response strategies.
5. Encouraging learning.  
Learning through data collection and analysis allows for informed decision-making.
6. Broadening participation.  
Through stakeholder engagement with passengers, communities, businesses, and policymakers ensures all voices are considered in planning and decision-making.
7. Promote polycentric governance.  
Fostering collaboration between government agencies, transit operators, and private sector partners.



# Building Urban Resilience

## 1. Location mitigation.

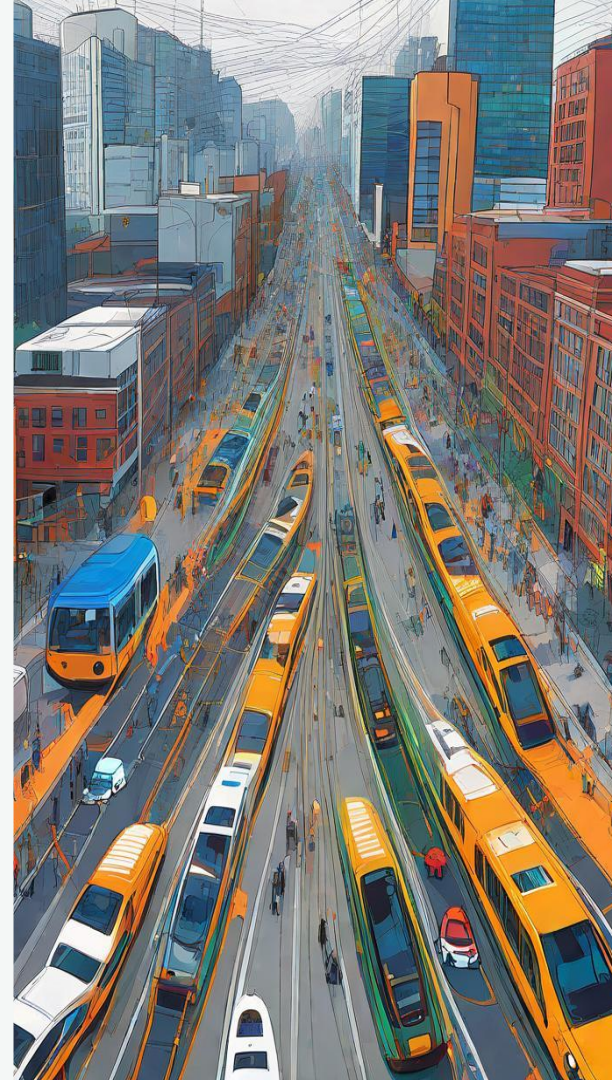
Urban planners should consider resilient locations for any track expansion plans and have redundant stock of equipment for locations at a higher risk of failure.

## 2. Structural mitigation.

Introduce floodwalls and raise or reinforce tracks. Ensure regular assessment of track quality.

## 3. Operational mitigation.

Establish a “Disaster Management Plan” for when floods occur, when trains run off the track, or when trains are down for maintenance.



# Methods & Analysis: Understanding the Impacts of Service Disruptions

## Service Alerts

This dataset provides detailed information about system-wide alerts, including severity, affected stations, and the general cause.

## Passenger Demographic Survey

The MBTA's Rolling Rider Census represents the diversity of people who ride MBTA services. This data includes age, race, income, and vehicle ownership statistics and more.

## Customer Satisfaction Survey

This dataset tracks customer satisfaction with the service, reliability, and communication of the MBTA.

## Station Entry Counts

The count of gated station entries for any station with service by year from 2014 to the present year.

# Methods & Analysis Cont'd...

## Reliability

This data is measured as the percentage of riders who waited less than or equal to the amount of time scheduled between trains.

## Headways

This dataset contains the headways, or time between departure of one train from a stop to the departure of the next train departing from that same stop, for rapid transit vehicles.

## Travel Times

This dataset contains the travel times between origin and destination pairs on a single line.

## Prediction Accuracy

This dataset contains the prediction accuracy for subway and bus. Prediction accuracy is determined by the number of accurate predictions vs the number of total predictions for each "bin" or timeframe.



# Methods & Analysis Cont'd...

DATASET	BY STATION	BY LINE	DATE COVERAGE START	DATE COVERAGE END
<b>SERVICE ALERTS</b>	Yes	Yes	Jan-19	Jul-23
<b>CUSTOMER SATISFACTION SURVEY</b>	No	No	Feb-16	Dec-23
<b>PASSENGER SURVEY</b>	Most Stations	Yes	Jan-22	Dec-22
<b>ENTRIES*</b>	Most Stations	Yes	Jan-14	Jan-24
<b>RELIABILITY</b>	No	Yes	Jan-16	Jan-24
<b>TRAVEL TIMES**</b>	Most Stations	Yes	Jan-16	Dec-23
<b>HEADWAYS**</b>	Most Stations	Yes	Jan-16	Dec-23
<b>PREDICTION ACCURACY</b>	No	Yes	Aug-20	Dec-23

\*The entries dataset did not have enough station level coverage to be used in the quantitative analysis.

\*\*The date range used for these datasets was adjusted to be the same as the date range for service alerts in the quantitative analysis.

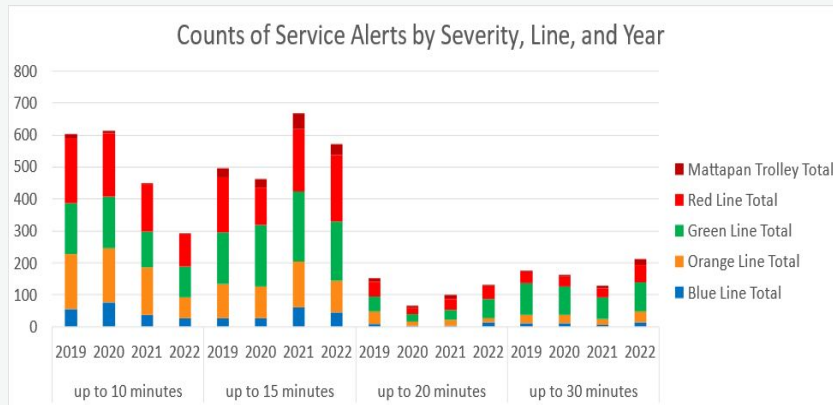
# Qualitative Analysis: MBTA Service Alerts

## Service Alerts

Service alerts on the MBTA are often caused by 'Disabled Train' incidents, primarily due to equipment issues. The age of the system, especially the Green Line, contributes significantly to these alerts. However, there are plans for improvement, including the addition of new trains in the near future.

SERVICE ALERT CAUSE	COUNT OF CAUSE	PERCENT OF TOTAL
NA – NOT AVAILABLE	2164	36%
DISABLED TRAIN	1723	29%
POLICE ACTION	448	7%
SIGNAL PROBLEM	398	7%
MAINTENANCE	345	6%
MEDICAL EMERGENCY	297	5%
POWER PROBLEM	179	3%
CONSTRUCTION	161	3%
ACCIDENT	97	2%
SWITCH PROBLEM	65	1%
FIRE	51	1%
TRACK PROBLEM	47	1%
WEATHER	46	1%
SPECIAL EVENT	13	0%
TRAFFIC	4	0%
HOLIDAY	2	0%

# Qualitative Analysis: MBTA Service Alerts Severity



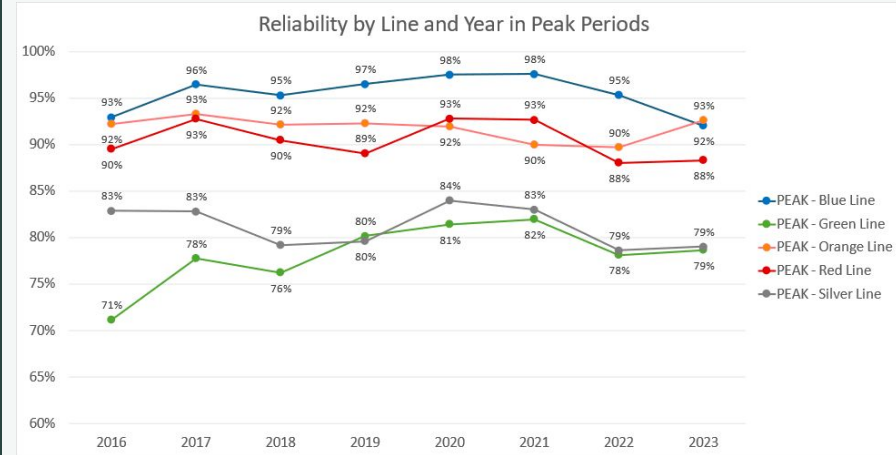
## Trend of Service Alerts and Severity

Analyzing the trend of service alerts by line and year, we observe that in 2022, there were fewer 10-minute delays but a higher number of longer delays compared to the previous three years. It will be interesting to see if there is any improvement in 2023 and 2024. Additionally, reliability data shows that, except for the Blue Line, all other lines have either increased or maintained their reliability in 2023 compared to 2022. While maintaining high reliability can be challenging for light rail, the long-term targets for heavy rail lines and the Green Line are at least 90%, and 80% for the Silver Line buses.

# Qualitative Analysis: MBTA Reliability

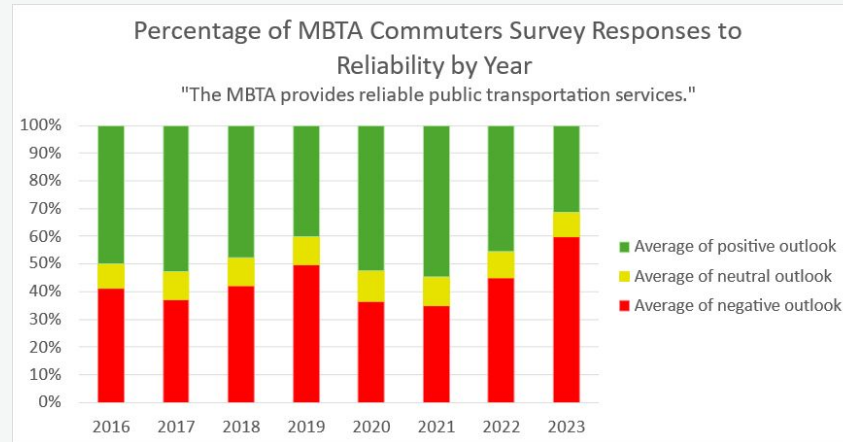
## Reliability

In addition to service alerts, the reliability data can infer to system performance and whether or not riders are waiting longer than expected headway times to board a train during peak periods. Besides the Blue Line, have seen an increase or maintained reliability in 2023 compared to 2022. While light rail can be more difficult to maintain higher reliability, the long-term targets for reliability for all heavy rail lines and the green line is at least 90% and 80% for the silver line busses.





# Qualitative Analysis: MBTA Passenger Survey



## Passenger Survey

Even though reliability does not seem to be declining in 2023, patience of MBTA riders seems to be wearing thin. The following charts shows responses to a customer satisfaction survey and what percentage of riders felt that the MBTA provided reliable public transportation services. In 2022, riders were evenly split between a positive and negative outlook, but in 2023 there was an uptick in negative feedback.

# Quantitative Analysis

## Regression Model

A regression model was created using five variables to achieve a 57.4% R-squared value with over 99% significance. The five variables selected, ranked from most to least significant and all with positive relationships, are as follows:

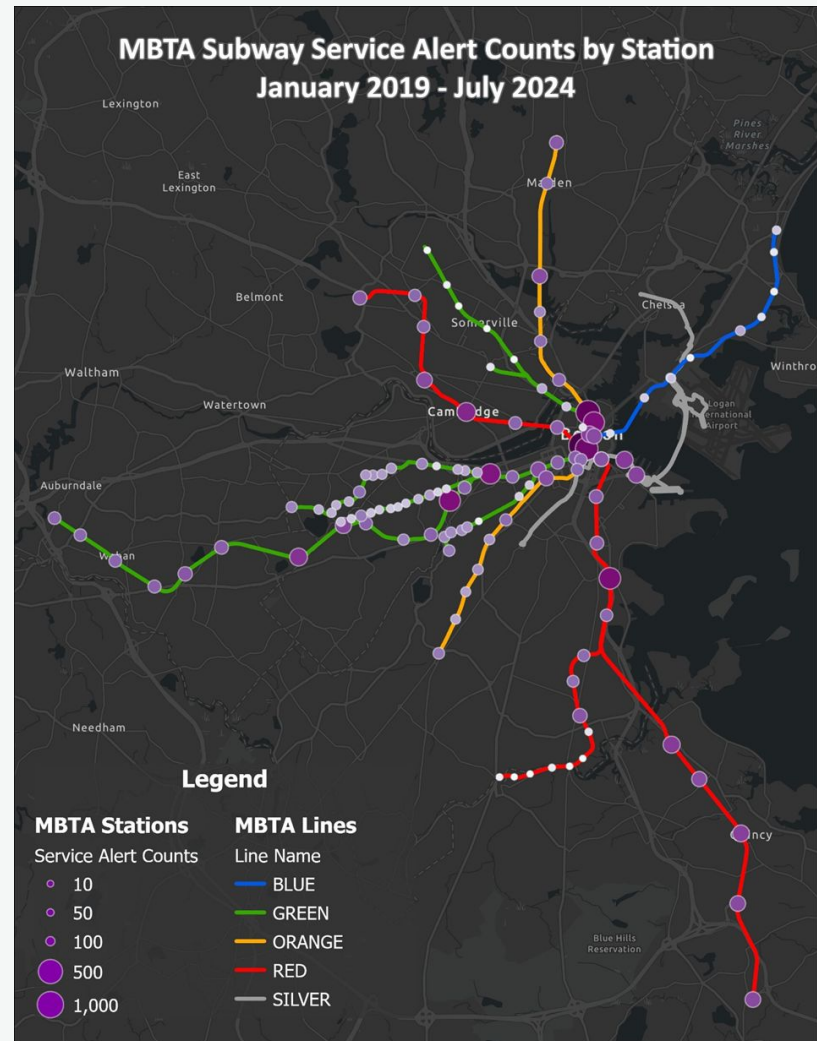
1. Riders age 65+
2. Riders who take the subway 6-7 days per week
3. Households with incomes greater than \$75k
4. Asian ridership
5. Red line stations
6. Reduced or free fare program members

Dependent variable:	
alert_details	
age_65_plus	1,908.424*** p = 0.00001
freq_6_7_dpw	1,069.547*** p = 0.00002
asian	257.084*** p = 0.002
hh_income_gt_75k	214.119*** p = 0.001
Red	71.340*** p = 0.0002
reduced_free_fare	4,518.956* p = 0.056
Constant	-147.541*** p = 0.00001
Observations	127
R2	0.594
Adjusted R2	0.574
Residual Std. Error	68.801 (df = 120)
F Statistic	29.269*** (df = 6; 120)
Note:	*p<0.1; **p<0.05; ***p<0.01

# Service Alert Map

## Residual Effects

It is also worth noting that for those who live further out on a line, especially one that branches, they are affected by service alerts not only at their station, but also at stations downstream on their routes. The following map shows the alert count total at each station used in the analysis. The results of linear regression showed a significance in the amount of service alerts experienced at red line stations, which can also be observed here. The size of the circle correlates to the count of service alerts recorded at each station.



# Conclusion

01

**Problem:**

Service disruptions disproportionately affect vulnerable populations and surprisingly, higher-income earners as well.

Riders further out on branch lines are impacted by alerts beyond their community stations.

02

**Solution:**

New and improved trains, Transparent communication, Enhanced resource allocation, Improved response teams, Track maintenance & speed restriction removal, Digital signage & multi-channel alerts, Station renovations, Increased public engagement

03

**Positive Outlook:**

New leadership at the MBTA, MassDOT, City of Boston, and State level brings promise for a more resilient subway system.

