A Review of Reliability in New York City Subways

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Motivation

A reliable public transportation system is key to a city's economic vitality and social equity since it enables people to access other parts of the city for a fraction of the price of owning a car. However, in New York City (NYC), the Metropolitan Transportation Authority (MTA) subway system, a network of 472 stations servicing millions of people daily, faces a major reliability crisis (Jia, 1970). The NYC subway system faces chronic service delays driven by a combination of rising demand and aging infrastructure. Over the past decade, ridership has grown far faster than the system’s capacity to accommodate straining stations and signaling equipment. Meanwhile, much of the subway network still operates using old components that were not designed to handle higher passenger volumes. Together, these factors create a system that is frequently strained, more vulnerable to breakdowns, and less capable of maintaining reliable service.

Evidence demonstrates the scale of this problem as recent performance data shows that 17.8% of all subway trains experience delays of five minutes or more, with system-wide on-time performance (OTP) reaching only 82.2% in 2024 (DiNapoli, 2025). This challenge is not only operational but disadvantages commuters, who often face societal consequences. Data shows that the human impact of subway delays is equally as alarming as the delays themselves, with 13% of riders reporting lost wages due to the chronic lateness between the years of 2017 through 2025 (DiNapoli, 2017; DiNapoli, 2025). It is crucial to understand that the inefficiencies do not impact all New Yorkers equally: the subway system disproportionately impacts vulnerable populations. Certain lines have more delays, and the impact of the delays are felt more by people living in lower income areas. While there are legislative efforts underway to mitigate subway delays, including the implementation of Communication Based Train Control (CBTC) and the development of improved methods for measuring service reliability, real change hinges the availability of funds. Only with political advocacy and coalition building can civilians persuade legislators to make meaningful changes to the subway system through allocating more money to renovations. By comparing the systemic causes and patterns of MTA delays against the Tokyo Metro, this report will identify the institutional reforms needed for the creation of a reliable train system in NYC. The urgency of addressing this challenge cannot be overstated, as resilient transit infrastructure directly affects New York’s economic competitiveness, environmental sustainability, and overall quality of life for residents.

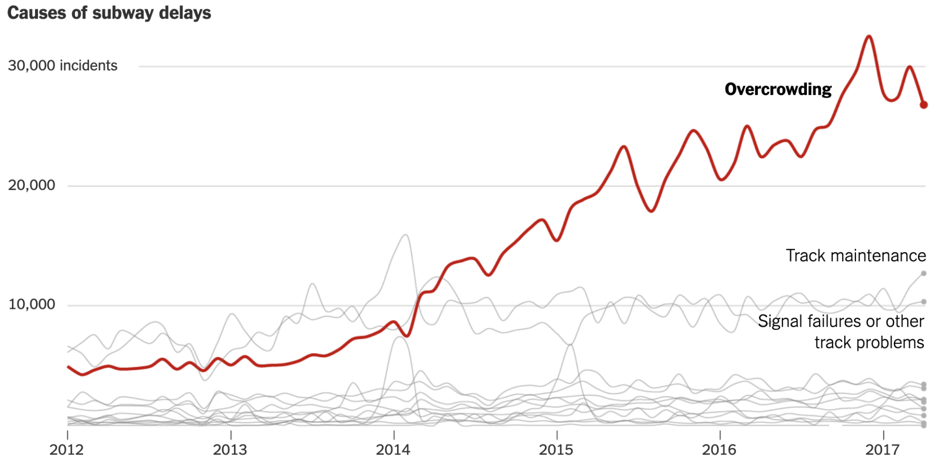
Background Research

Section 1: Infrastructure Constraints

Operating one of the world's largest transit networks, the MTA has a system of 472 stations whose size and complexity make it particularly vulnerable to delays arising from operational, infrastructural, and demand pressures (Jia, 1970). The reason for the continued degradation of service reliability in the NYC subway system as a whole is due to two primary, intertwined factors: exponential growth in the passenger volume and constraints imposed by the system's aging physical and signal infrastructure. According to an analysis of MTA data, crowding has emerged as the leading cause of delay. Overcrowding-related incidents skyrocketed exponentially from 2014 onward, surpassing other incident types to nearly 30,000 annual occurrences by 2017 (Fitzsimmons et al., 2017). Ridership has grown from about four million daily riders in the 1990s to nearly six million which is a level not seen since the 1940s (Fitzsimmons et al., 2017). Notably, ridership increased even though the physical system remained largely unchanged. Between 1990 and 2015, annual ridership rose from 1 billion to 1.8 billion, while the number of subway cars (5,255 to 5,282) and miles of track (493 to 488) remained essentially the same(Fitzsimmons et al., 2017).

The direct connection between heavy ridership and delays is lengthening of dwell time which is the time a train is stationary at a station (Kuipers, 2021). As more people board and disembark than can be accommodated by the scheduled stop, a train's stay on the platform is extended. The result of this effect is measurable, with research confirming that a 10% increase in crowding can add approximately one second of delay to the dwell time (Luan & Corman, 2022). Since these small, localized increases accumulate over numerous stops, the cumulative delay degrades the overall robustness of the train run, leading to congestion and unequal progress throughout the line. In fact, the MTA classifies delays under "extended dwell time," "holding for crowding," and "train congestion", which corroborates that crowding-driven mechanism as the primary contributor to operational setbacks (Luan & Corman, 2022).

Beyond overcrowding, delays stem from persistent issues related to the system's physical infrastructure, often compounded by systemic underfunding (Tankus, 2019). While Figure 1 shown below indicates that incidents related to “Track maintenance” and “Signal failures” did not rise exponentially like crowding incidents, they represent persistent points of failure (Fitzsimmons et al., 2017). The necessity of installing modern safety signals has forced conductors to travel at slower speeds, suggesting that the existing infrastructure is causing the slowdown. Although CBTC was designed to address these constraints by allowing trains to run closer together, operate at higher speeds, and offer more reliable service, it has had limited impact because it exists on only four lines. Installing CBTC on the subway system involves years-long work, such as surveying entire lines; determining the location of equipment on each line; retrofitting the existing trains; installing wayside components; developing customized operating software; planning transitions from traditional signaling; and testing for safety under multiple scenarios. These implementation timelines, combined with the scale of the system as a whole, have hastened expansion while preventing CBTC from functioning as a systemwide solution (MTA, n.d.). The need for a massive, currently unfunded overhaul to implement automatically controlled speed systems, common in other global cities, highlights this fundamental funding deficiency (Tankus, 2019) .



Source: Metropolitan Transportation Authority

*Figure 1 - Causes of Subway Delays (*Fitzsimmons et al., 2017*)*

A combination of rising ridership, longer dwell times, and ongoing problems with signals, tracks, and older trains all contribute to delays. They demonstrate that delays are a consequence of a system stretched far beyond what it was designed for. With few lines having CBTC and major upgrades taking years to complete, the subway just doesn't have the infrastructure to keep up with demand. Improvements will require a significant investment to update the system so it matches conditions riders face today.

Section 2: Delay Patterns

Certain train cars are more likely to fail, making the choice of train car model crucial. For example, while new car models, such as the R188 and R211A, are the most reliable, being able to travel over 250,000 miles, older car models such as the R46, R68, and R62 are significantly more likely to fail, with an Mean Distance Between Failures (MDBF) of under 100,000 miles (MTA, 2025).

A note of interest is that the R211T has a very low MDBF despite being the newest train model class, though this may be due to that there are few trains available at this time, with only 20 trains in operation, in compared to over 200 trains for the model class with the second fewest trains, the R143 (MTA, 2025).

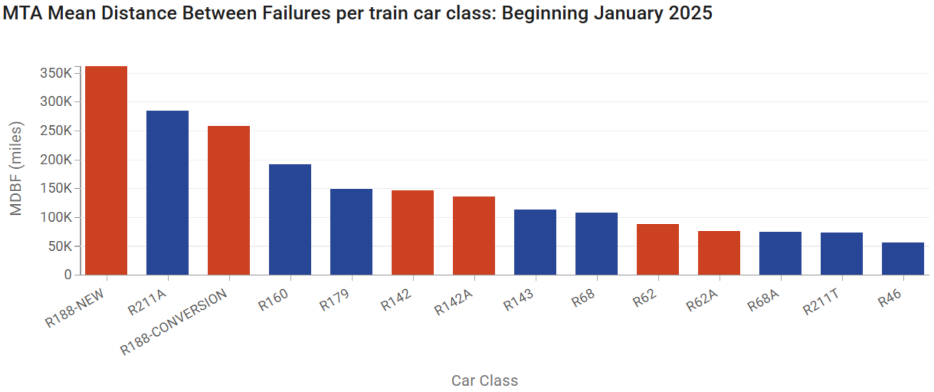


Figure 2 - Newer train models are able to travel significantly longer before breaking down. (MTA 2025)

Oftentimes multiple lines operate on the same track for certain sections of the line called interlining. For example, the E, F, M, and R trains operate on Queens Boulevard in Queens but on 3 different trunks in Manhattan. This has the advantage of allowing people to be able to travel to more destinations without the need to transfer to another train. However, interlining has major issues as stated by Connor Harris, a policy analyst from the Manhattan Institute in his research paper “Five Ways to Improve NYC Subway Operations”, who explains that if a disruption occurs on one line, the disruption will propagate to other lines as well, since they share the same track (Harris, 2023). Additionally, interlining often requires complex junctions, which requires trains to slow down due to traffic and ability to turn within the junction. For example, Harris mentioned a choke point at DeKalb Avenue Junction, a junction connecting the 4 tracks from the Manhattan Bridge into the 6 tracks at DeKalb Avenue Station, through which the B, D, N, and Q trains operate. Because each train needs to go to a different line, a train may need to cross through several tracks, often causing traffic and delays (Harris, 2023).

Some lines are more reliable than others, because they have different fleets as well as different routes. With some having more junctions than others, as well as some lines or sections of the line having CBTC. For example, the L and 7 trains are the most reliable as of 2025, since both run on their own separate tracks, use more modern train cars (R188 on the 7, R143 and R160 on the L), and utilize CBTC throughout the entire line. On the other hand, the B, F, and 2 trains are consistently ranked the worst lines in the entire system. Although it is not clear the reason behind this, patterns indicate that lines using older train models and facing interlining issues, may play a large factor in the delays.

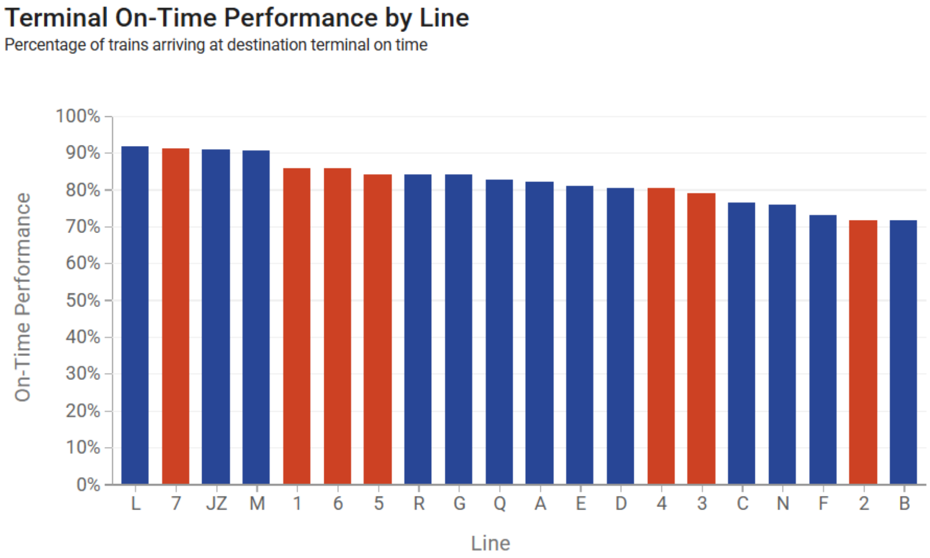


Figure 3 - The L and 7 trains are the 2 most reliable services, excluding the shuttle trains. On the other hand, the F, 2, and B trains have the greatest proportion of delays in the MTA system. (MTA 2025)

The most common cause of delays in 2025 is infrastructure failures, including signal and train failures, making up 36% of the cause of major delays in the subway system. This is followed by planned work, making up 24% of delays, and then police and medical emergencies, making up 23%, leaving the final 17% for operating conditions such as weather, crew availability, and other external factors.

In lower income neighborhoods, people were more likely to be affected by subway delays. There is a reported 4% increase in the loss of wages, 14% increase in being reprimanded at work, 7% increase for being late for a job interview, and a 8% increase for being late to a medical appointment for lower income communities than higher income due to subway delays. Furthermore, according to Stringer, lower income neighborhoods were more likely to grade the subway worse in a survey (Stringer, 2017).

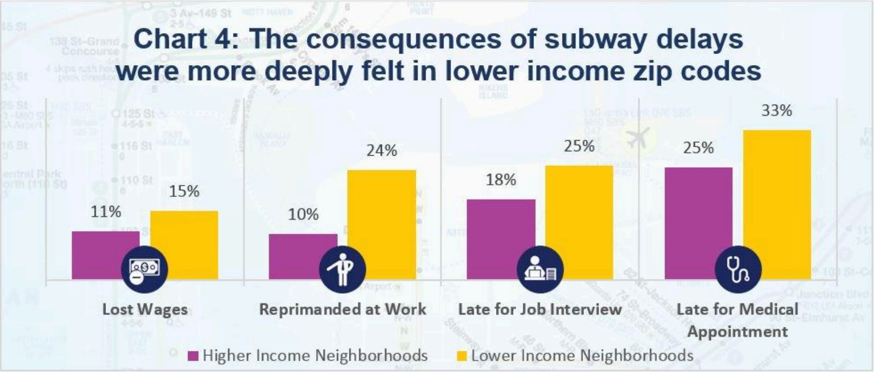


Figure 4 - People from lower income neighborhoods are more likely to suffer from delays by the subway system than from higher income neighborhoods. (Harris 2023)

Section 3: Human Effects of Subway Delays On Ridership and Economics

NYC subway delays are not only operational; they reduce ridership, economic outcomes, and cause consumer stress. This section analyzes these three major effect subcategories.

In transit systems, service reliability is a key predictor of consumer count. Bus transit service reliability, measured through the variance from scheduled times, positively correlates with ridership: less variation from schedules causes greater ridership (Pulugurtha et al., 2022). This correlation is especially strong during peak hours, when the most passengers are affected (Jayanthi, 2021).

Although these studies focus on bus service, the same logic applies to subways. Reliability is a key factor of service quality in transportation systems - long-recognized to affect public transit ridership (Mallett, 2022). All of this evidence suggests greater delays reduce ridership in the NYC subway.

Delays in subway operations also cause both direct and indirect economic costs. Lower ridership directly causes reduced profit from fares, which causes economic strain on the MTA. Delays and disruptions also lower efficiency and productivity, thus directly causing economic loss (American Public Transportation Association (APTA), 2019). A survey of 1,227 subway riders found that 13% of people had lost wages and 2% had lost their jobs as a direct result of late arrivals caused by subway delays, and these disruptions directly cost New Yorkers hundreds of millions of dollars annually in reduced productivity (DiNapoli, 2017). The APTA also estimates that failure to modernize US transit systems leads to $340 billion in lost business sales nationwide (APTA, 2019).

Indirectly, delays reduce labor productivity. Workers arriving late or stressed from transit disruptions cost employers in lost time and worse products. Bad transportation system performance, including delays, reduce business productivity and thus worsen economic output (Weisbrod et al, 2009). While these sources do not isolate subway-specific delay in NYC, it can be reasonably inferred that persistent delays in the subway system are most likely a determinable factor causing measurable economic loss.

Delayed riders also experience negative psychological and social effects, reducing commuter satisfaction and well-being. A study of 208 NYC subway commuters found that longer commutes, associated with delays, were correlated with a higher salivary cortisol level and increased self-reported stress (Evans et al, 2006). Delayed commuters also showed higher stress at work, showing a measurable connection between difficult commutes and cognitive difficulty (Evans et al, 2006).

Perceived safety and environmental comfort also affect consumer well-being. Anxiety related to safety incidents on the subway increased after the COVID-19 pandemic, correlating with declining ridership and higher reported fear amongst passengers (Columbia University Mailman School of Public Health, 2024). Delays worsen these effects: greater crowding and longer commutes increase the time people spend around others, thus increasing discomfort and reducing perceived control, which are predictors of stress.

Delays also cause worse quality of life. A survey found 65% of parents were late to pick up or drop off children from subway delays, while 29% missed medical appointments (Stringer, 2017).

Overall, delays carry significant non-operational costs on society. Delays reduce subway ridership, MTA profit, business productivity, and commuter quality of life while increasing stress and fear.

Section 4: Legislative Approaches to Mitigating Delays

To effectively address delays, the NYC legislature must understand how delays impact different locations, neighborhoods and demographics (Levine et al., 2013). The New York City Transit (NYCT) developed the Wait Assessment (WA) framework to promote data-driven operational decisions. (NYCT, 2016) WA calculates the percent difference between the actual and scheduled headway between successive trains of the same line. WA results are publicly available and are used in the State of the Subways Report Card, a project of the New York Public Interest Research Group. The WA report is used by transit operators to improve scheduling and reduce operational delays by measuring service reliability. However, other statistical methods would be better at indicating service performance, like root-mean-squared subway station wait time (Cramer, 2009). Despite their advantages, the NYCT declared those methods too complex and instead relies primarily on WA. A 2019 audit of NYCT by the Office of the New York State Comptroller (OSC) criticized the WA metric, emphasizing that it measures only a few “snapshot” stations and therefore fails to capture inconsistencies along entire train routes (OSC, 2020). They argue that the WA underrepresents the true extent of delays, misleading legislators about service failures.

Although the implementation of WA has improved legislators’ knowledge of the reliability of various subway lines in NYC, a key limitation remains: NYCT’s inability to predict delays before they occur (Tiong et al., 2022). While expansive predictive models exist for other travel modes, no predictive model has been successfully implemented for subway delays. The most commonly used model is the subway station dwell time (SDT) model (Volovski et al., 2020). However, the SDT model has many significant limitations, most notably its failure to account for multiple factors simultaneously. SDT considers only boarding time, door closing time, and conductor directed delays. Furthermore, most travel agencies only used a single subway SDT value per station, which does not account for variable changes such as weather, demand, and passenger behavior. Quantitative research by Volovski et al. found user induced delays to be steeply correlated with dwell time, suggesting SDT is not sufficient. Instead, Volovki et al. proposes updating the SDT model to include the use of a statistical regression model that accounts for user induced delays. Implementing a better model would provide passengers and legislators more accurate performance data.

Further legislative efforts to help with the subway delay problem in NYC include the advent of the Communication Based Train Control (CBTC) system in 2010 (Sabatier, 2014). CBTC is a signaling system that communicates with trackside monitoring equipment and trains to directly control train operation. CBTC differs from traditional signaling systems since it uses real time data to control the train in real time. The implementation of CBTC in NYC subways has improved service frequency by reducing the necessary safety gaps between trains on the same track and lowering headway. Furthermore, CBTC reduces the fear and number of train collisions (MTA, 2025). CBTC also provides the unique benefit of improving options for train rerouting in the event of a track obstruction. The L and 7 lines have been fully converted to CBTC, resulting in over 90% on time performance. Portions of the E, F, M, and R lines have been completed and work to implement CBTC on other lines is currently underway.

Unfortunately, the implementation of new technological methods of reducing subway delays like CBTC is costly and directly depends on funds provided by the government (Mallett, 2025). State and federal legislatures periodically pass laws dictating the funding limits for surface transportation programs, called surface transportation reauthorization, which directly affects whether transit agencies can implement delay-reducing improvements. While advocates have proposed the widespread use of SDT models (Volovsi, 2020), the capacity of transit agencies to implement these tools is directly limited by the funding they receive. Political advocacy and coalition building are crucial in securing funding from the government for transit infrastructure (Summers et al., 2021).

Section 5: Comparative Analysis of Transit Systems

The performance disparity between NYC and Tokyo's transit systems reveals fundamental differences in maintenance and efficiency in governance. Tokyo Metro, consistently ranked top-tier for achieving average delays under one minute (Oliver Wyman Forum, 2024) while New York's MTA experiences average delays over 5 minutes (DiNapoli, 2025).

The MTA's 24/7 operation's model requires there to be repairs conducted alongside active service, which both slows down maintenance by 50-70% and also slows down train service itself, accounting for 25% of all subway delays, scheduled maintenance (DiNapoli 2025). Currently, the MTA does not have the technological tools that allow for live algorithms to predict delays, providing dispatchers with optimized recovery plans. Without such a system, dispatchers must rely on manual experience, which could lead to multitude of suboptimal decisions which further creates this reactive approach (Wood et al., 2018). In contrast, Tokyo schedules overnight closures, a strategic choice that enables dedicated, efficient, and preventive maintenance (Japan International Cooperation Agency, 2025). The fundamental difference in strategy is how Tokyo performs proactively, nightly uninterrupted maintenance, while the MTA inefficiently tries to maintain its service in off peak hours. While the MTA avoids full shutdowns due to its "the City that Never Sleeps" campaign, it instead suspends or reduces service on entire lines during nights and weekends, creating an efficiency paradox. The MTA fails to deliver reliable access for late-night workers and transit dependent populations (MTA, 2025c). As preventive work is nearly impossible to perform efficiently while other trains are running, the system is forced to rely on temporary fixes, therefore the problem spills back into peak service. This is the primary reason why infrastructure and equipment failures remain the leading cause of delays at 36%, as temporary measures frequently fail under stress of continuous operation (DiNapoli, 2025). These rush hour delays place a burden on its commuters, as 13% of New York workers reported lost wages due to delays (DiNapoli, 2017).

The MTA's governance is fragmented across multiple competing agencies, creating a lack of accountability and sluggish approach to side-wide improvements (Baily, Bosworth, & Doshi, 2020). These agencies include the NYC Transit, Capital Construction, regional railroads like Long Island Rail Road, and Metro-North and with their disorganized structure and "lack of unified management structure", agencies are competing with their respective departmental priorities, delaying critical system-wide projects while also obscuring accountability (DiNapoli, 2019, p. 5). The delayed CBTC signal upgrades are a key example of this failure, as the project required coordination between multiple agencies but suffered from competing priorities in departments (DiNapoli, 2019), demonstrative of how effective communication dictates technological progress which will directly impact commuters. Similarly, also found that since there is no single entity ultimately responsible for the systems performance, accountability was obscured for delays and cost overruns on capital projects (DiNapoli, 2019). Therefore it can be stated that, lack of communication and accountability ensures that even well-funded initiatives will fail to deliver timely benefits to riders. Contrastingly, Tokyo has an integrated management model that establishes a clear chain of command with centralized accountability. This unified structure allows the consistent implementation of standardized maintenance protocols with rapid system-wide technological rollouts (Asian Development Bank, 2023). The Tokyo system's operational culture itself is well-documented in many efficiency studies as it ties management incentives directly to performance metrics. The outcome of this system is more operational success with more rewards such as bonuses which creates a cycle that incentivizes better efficiency in train service (Le et al., 2022). Though not fully transparent, it is known that a considerable portion of managerial compensation is contingent on punctuality, measured in mere seconds, and passenger capacity measured in efficient crowd management and minimal dwell times (JICA, 2025). This creates a financial and professional backing that boosts preventative maintenance and rapid incident response in the Tokyo Metro. The consequence of differences is clear, Tokyo climbs the ladder of train service performance, while New York trails behind because of the gaps in leadership, (Oliver Wyman Forum, 2024).

Conclusion

Reliable subways are critical to a city's economic and social well-being. This report analyzes NYC's subway delays. Growing demand, aging infrastructure, inconsistent maintenance, and poor governance cause delays, creating operational challenges and harming citizens who depend on subways. These problems undermine the accessibility that public transit intends to provide, especially for lower-income riders who experience the worst consequences.

Although NYC has implemented improvements to systems and more accurate performance data, the impact has been limited as modernization is slow and uncoordinated. Comparing NYC to Tokyo shows what is possible with a unified and proactive system.

Subway delays can only be addressed with sustained investment, stronger coordination and planning, and better long-term, preventive maintenance rather than temporary fixes. Reducing subway delays would help connect people to opportunity, support NYC's economic strength, and ensure that all New Yorkers can rely on fast, safe, and consistent service. With clearer governance, modern technology, and committed leadership, the MTA could begin to transform its system into one that serves the needs and expectations of NYC.

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