

# **Exploring How WMATA's Metrorail System Can Be Improved**

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On my honor as a University Student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments

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## **Introduction**

The Washington Metropolitan Area Transit Authority (WMATA) Metrorail system, a vital component of the nation's capital's transportation infrastructure, has been serving the Washington D.C. metropolitan area since 1976. As one of the busiest rapid transit systems in the United States, Metrorail plays a crucial role in connecting millions of residents, commuters, and visitors across the District of Columbia, Maryland, and Virginia (WMATA, 2025). With so many commuters in train cars instead of personal vehicles, the region experiences many advantages that are often taken for granted such as reduced traffic congestion, minimized land use for parking, and reduced emissions (Fehr & Peers & EBP, 2024). There are also many economic benefits like increased property tax revenues and making the region more competitive for hosting businesses (Fehr & Peers & EBP, 2024). However, like many urban transit systems, Metrorail faces numerous challenges in maintaining and improving its service quality and ridership levels.

In recent years, the Metrorail system has experienced a decline in ridership due to various factors, including service disruptions, safety concerns, and most notably, the COVID-19 pandemic. During the height of the pandemic, Metrorail ridership dropped by 90% compared to pre-pandemic levels (Qi et al., 2023). However, recent data shows that ridership has been steadily recovering from the effects of the pandemic (WMATA, 2025). This recovery, while promising, also highlights the need for strategic improvements to further boost ridership and enhance the system's efficiency. As the region continues to grow and evolve, it is essential to identify and address key areas that require improvement to enhance the overall efficiency and attractiveness of the Metrorail system.

In any mass transit system, one of the most important metrics is ridership. Understanding and addressing the factors that influence ridership is crucial not only for the financial sustainability of the Metrorail system but also for its role in supporting the region's economic growth. This research will analyze many different aspects of the Metrorail system under the lens of Susan Star's infrastructure framework. The analysis will include interviewing current and past WMATA employees as well as analyzing studies that have been published by WMATA. These sources will provide insights into current shortcomings of the Metrorail system and key areas for improvement. This thesis explores how WMATA can bring ridership back to and even surpass pre-pandemic levels.

### **Metrorail as a Piece of Infrastructure**

Given that the Metrorail system is a premiere piece of infrastructure, Susan Star's (1999) properties of infrastructure can provide an important lens for understanding the connections between the technical, human, and social dimensions of the system. Star breaks down the definition of infrastructure into 9 different properties. For example, in the embeddedness property, Star discusses how infrastructure is sunk into and inside of other structures, social arrangements, and technologies. It is a complex system that both shapes and is shaped by the practices and conventions of the communities it serves. In the context of the Metrorail system, this definition highlights how the transit network is deeply embedded in the social, economic, and physical fabric of the Washington D.C. metropolitan area. Some of the other properties of infrastructure are particularly relevant to this analysis of the Metrorail system: reach and scope, visibility upon breakdown, and embodiment of standards.

Star describes the reach and scope of infrastructure as extending beyond a single event or one-site practice, both spatially and temporally. The Metrorail system exemplifies this through its expansive network spanning the District of Columbia, Maryland, and Virginia. With six lines and 98 stations covering approximately 128 miles, the Metro connects far more than just physical locations (WMATA, 2022). The system also operates for most of the day, opening early enough to serve most early-morning commuters and closing late enough to meet nearly all late-night transit demands (WMATA, 2025).

The system's scope profoundly influences urban development patterns, property values, and daily commuting habits. For instance, the presence of a Metro station often leads to transit-oriented development, with higher-density housing and commercial spaces clustered around stations. This not only makes the stations more accessible but also increases ridership, as more people live within walking distance of these key transit points (moveDC, 2021). Additionally, the Metro's scope includes its integration with many other transit options, including 2 major airports, 2 regional commuter rail lines, Amtrak passenger rail lines, and many local bus systems (CommuterPage, 2025). In doing so, the system creates a comprehensive multi-modal transportation network that extends its influence far beyond the immediate vicinity of its tracks.

Another property of infrastructure is that it becomes visible upon breakdown. For regular riders, the Metro typically functions as a background utility, taken for granted as a reliable form of transportation. However, when technical issues arise — be it delays, breakdowns, or track maintenance — the system's presence suddenly becomes very visible. Breakdowns often lead to frustration and a reevaluation of its reliability, underscoring how the invisibility of well-functioning infrastructure is a mark of its success (Mo et al., 2022). When public transit systems break down or undergo maintenance, they not only become more visible but also more

vulnerable to public scrutiny and criticism. Such incidents can lead to a decrease in ridership, as frustrated passengers may seek alternative transportation methods. The challenge for transit agencies lies in balancing necessary maintenance and upgrades with minimizing service disruptions. Effective communication, providing reliable alternative transportation options during disruptions, and investing in long-term infrastructure improvements are crucial strategies for maintaining public trust and ensuring the continued viability of public transit systems.

Lastly, Star argues that infrastructure takes on an embodiment of standards and takes on transparency by plugging into other infrastructures and tools in a standardized fashion. The Metrorail system incorporates numerous standards, from track gauge and power supply specifications (Keffler, 1985) to ticketing systems and safety protocols (WMATA, 2025). These standards ensure interoperability within the system and with other transportation modes. A good example is the SmarTrip card system. Introduced in 1999, SmarTrip cards use standardized contactless technology that allows seamless integration not only within Metrorail but also with parking facilities and regional bus services offered by other agencies (WMATA, 2025). Safety standards are another crucial aspect of the Metro's infrastructure. Following incidents like the 2009 Fort Totten collision, WMATA has implemented enhanced safety standards and protocols (Pascale, 2019). These standards, while often invisible to the average rider, are fundamental to the system's operation and public trust. The standardization extends to the physical infrastructure as well. The consistent design of Metrorail stations, with their iconic vaulted ceilings and uniform signage, embodies a standard that makes the system recognizable and navigable for users. This standardization contributes to the system's legibility and usability, key aspects of effective infrastructure.

## Case Context

The WMATA Metrorail system has been serving the nation's capital and surrounding areas since its inception in 1976. Through decades of expansion and development, Metrorail has grown to become the third-busiest rapid transit system in the United States. However, the system faces numerous challenges that impact its efficiency and more importantly, overall ridership.

One of the biggest challenges the system faces is securing funding. The Metrorail system is unique in that it was structured without any dedicated funding and is also legally required to pass a balanced budget every year (WMATA, 2023). Without a proper funding mechanism like a regional sales tax, WMATA is left scrambling every year to put together a balanced budget that can meet the fiscal demands of the Metro (Gordon, 2024). This problem also has no easy solution. Cutting service might seem like an obvious solution, but cutting service can lead to a death spiral, as fewer people will ride the Metro, leading to a reduction in fare revenue. For example, in fiscal year 2025, Metro faced a deficit of \$650 million even after cost-saving measures were evaluated. If WMATA were to cut enough service to cover this deficit, it would have to cut \$947 million worth of service to compensate for an estimated \$197 million lost in fare revenues (Gordon, 2024).

Safety and reliability concerns have also cast a shadow over the Metrorail system. One of the most significant examples is the 2021 derailment of a 7000-series train, caused by defects in the wheel assembly (National Transportation Safety Board, 2023). This led to the temporary removal of the entire 7000-series fleet—the newest and most advanced trains in WMATA's system. At the time, the 7000-series made up 60% of WMATA's 1200-car fleet, having replaced much of the aging stock (Repetski, 2021). With more than half of its fleet sidelined, service suffered severely, leaving riders with wait times of up to an hour (Seabrooks, 2021). Another

incident that has damaged public trust was the 2009 Fort Totten crash which resulted in 9 deaths and approximately 80 injuries. This event was due to a faulty track circuit, where a stationary train was essentially invisible to the Automatic Train Operation (ATO) system that was responsible for piloting the trains at the time. This caused the ATO system to drive a train full speed into the stationary train, thinking that there was nothing on the tracks (Pascale, 2019). This event led to major distrust in the system as it had just suffered its deadliest accident in history. The incident also resulted in WMATA removing ATO and going back to operators manually controlling the trains, even though ATO was not found to be at fault (Stevens, 2024). These events highlight systemic challenges and underscore the critical need for safety improvements. While WMATA has taken steps to address these issues, rebuilding public trust remains an uphill battle. Years of excellent service can attract and retain riders, but a single high-profile failure can quickly erase that goodwill.

An additional challenge lies in first-mile and last-mile connectivity. Despite WMATA's extensive network, many riders struggle to efficiently reach their final destinations from Metro stations or even get to the Metro stations themselves. This issue is particularly pronounced in areas with limited bus service or inadequate pedestrian and cycling infrastructure. To address this, WMATA has been exploring various solutions, including partnerships with ride-sharing services and enhanced bus connections (WMATA, 2023). However, implementing these solutions across the diverse urban and suburban landscape of the D.C. area remains complex and resource intensive. Improving first-mile and last-mile connectivity is crucial for increasing ridership and enhancing the overall utility of the Metro.

Despite these challenges, the Metro remains an essential part of the region's transportation ecosystem, reducing traffic congestion, promoting sustainable commuting, and

connecting diverse communities across the D.C. area (see Figure 1). Moving forward, WMATA will need to strategically focus on key areas that will benefit riders the most. In doing so, WMATA will be able to secure higher amounts of ridership and create a bigger positive impact on the region it serves.



**Figure 1.** Metrorail system map (WMATA, 2025).



## Research Question and Methods

The question that I seek to answer with this research is: What are the most important areas that WMATA needs to prioritize going forward to maximize ridership growth? To answer this, I will interview WMATA employees (see Table 1). These interviews will provide valuable insider perspectives on operational challenges, resource allocation strategies, and areas where improvements are most needed. By engaging directly with individuals who have firsthand experience with the system, I aim to uncover insights not readily apparent in publicly available data. I will use Star's properties of infrastructure to guide the interview questions, ensuring that different dimensions of the system are covered. To supplement this, I will be analyzing publicly available agency reports such as the FY2026 Proposed Budget and Capital Improvement Program progress reports. Combining qualitative data from interviews with more quantitative data from published reports will provide a holistic perspective on WMATA's operational strategies and help formulate actionable recommendations to maximize ridership growth.

**Table 2.** Background information for each WMATA employee that was interviewed (James, 2025).

Name	Job Title	Experience at WMATA
Joe Inacio	Metro College Intern	6 Months
Glenn Boyce	Senior Financial Officer	15 Years
Leen'da Chambliss	Manager Board Coordination & Executive Office	23 Years
Mike Vitale	Senior Director, Communications and Signaling Maintenance	3 Years

## Results

WMATA must address three key areas to increase ridership. First, securing a more robust and reliable funding structure with dedicated annual funding is crucial for long-term financial stability and capital improvements. Second, enhancing connectivity by expanding and improving access to the Metro will encourage riders to utilize the system. Finally, improving service frequency and reliability by running more consistent and frequent trains will reduce wait times, making Metro a more competitive and convenient transportation option.

A consistent theme across interviews was the critical need for a dedicated, stable funding source for WMATA. As Glenn Boyce, a Senior Financial Officer with 15 years of experience at WMATA, explained: “The biggest problem for us [...] is the fact that we don't have a dedicated operating fund. We have a dedicated capital infrastructure fund, but we don't have a dedicated operating fund” (Boyce, 2025). This lack of dedicated operational funding creates significant challenges for WMATA in maintaining consistent service levels and planning for long-term improvements. Leen'da Chambliss, who has been with WMATA for 23 years, emphasized this point: “Metro is not structured to be a for-profit organization. So, I think that is the most difficult thing is always having that uncertainty as to what we're able to do now, because ridership itself does not pay for the system” (Chambliss, 2025). The financial instability caused by this funding structure has far-reaching implications. It affects WMATA's ability to maintain existing infrastructure, invest in new technologies, and provide consistent service, all factors that directly impact ridership. Mike Vitale, Senior Director of Communications and Signaling Maintenance, highlighted how funding constraints affect long-term planning and expansion: “New service, new stations, everything like that is sexy, and everyone loves it. It's just the upkeep of it afterwards, and the increased cost... those sorts of things are the things that I think people kind of

forget about” (Vitale, 2025). Beyond this, there are some other vulnerabilities in the current funding structure. One vulnerability, as pointed out by Mike Vitale, a senior director of communications and signaling maintenance, is that WMATA is only allowed to increase its funding from jurisdictional partners by 3% every year, which might not even cover inflation between years (Vitale, 2025). This means that some years, when adjusted for inflation, WMATA might receive less money than the year before, even if they are able to secure a 3% increase in funding. Furthermore, WMATA's capital funding is also at risk. The dedicated capital funding borrowing capacity is projected to be exhausted by FY2029, necessitating new capital funding sources to address ongoing system safety, renewal, and modernization needs (WMATA, 2023). This looming capital funding deficit adds another layer of financial vulnerability to WMATA's already precarious fiscal situation. By securing dedicated funding, WMATA can enhance system reliability, reducing service disruptions and thereby limiting *visibility upon breakdown*.

Improving access to the Metro system emerged as another crucial factor for increasing ridership. This includes both physical access to stations and integration with other transportation modes. Joe Inacio, a Metro College Intern, observed: “I think if just for example, Alexandria, parts of Arlington and Montgomery and Prince George’s County had, you know, bike grids around their metro stations. I mean, I think that that would generate thousands of new riders every day across the entire system” (Inacio, 2025). This observation aligns with the concept of first/last-mile connectivity, which is crucial for making public transit more accessible and attractive to potential riders. On the topic of connecting to other transit options, Inacio added that “A lot of the municipalities within the region the city of Alexandria, Arlington County, Montgomery County, Prince George County, et cetera, have their own transit agencies in their own bus routes. and none of those smaller agencies make it clear, or at least not clear enough, the

levels of connectivity that exist” (Inacio, 2025). Inacio then added on that “The best way Metro can increase ridership is in the last mile and having actual places to go to the at stations, not just parking lots”. By integrating more into other transit options as well connecting more with higher density communities, the Metro will be able to further extend its *reach and scope*, enabling more riders to utilize the system.

The third key area identified for improving ridership is enhancing service frequency and reliability. One thing that many interviewees spoke about when talking about service frequency was the use of ATO throughout the system. Vitale highlighted the potential impact of ATO on service efficiency: “The trains in automatic basically take the human factor out of go, stop, all that other stuff, so the trains run a lot smoother, and they can accelerate faster. So basically, everything is more efficient” (Vitale, 2025). This notion is supported in WMATA’s FY25 Q2 service excellence report, stating that ATO will save up to 6-12 seconds per station and can reduce run times by up to 2.2 minutes (WMATA, 2025). Chambliss also mentioned that ATO provides a more pleasant riding experience: “Some of the things that contribute to a lack of customer satisfaction is what we call the herky jerky ride and so, [ATO] should smooth some of that out” (Chambliss, 2025). Regarding service reliability, WMATA observed that red line on-time performance improved by 3% in December 2024 with the experimental introduction of ATO to the red line. Another aspect of maintaining service reliability is proper maintenance, as Chambliss mentioned: “The only way to [maintain reliability] is to maintain the system properly. And so, you know, if you don't maintain the system, then you get more failures” (Chambliss, 2025). By focusing on the *embodiment of standards* of the system by making ATO a system-wide standard as well as maintaining and even improving their maintenance standards, WMATA can make the Metro a much more competitive mode of transportation.

## **Discussion**

The application of Susan Star's properties of infrastructure to WMATA's Metrorail system was effective for analyzing the more technical aspects of the system. By focusing on certain properties of infrastructure such as reach and scope, visibility upon breakdown, and the embodiment of standards, this framework illuminated key areas where the Metro can improve its service. However, the analysis revealed some limitations, particularly in addressing the political aspects of the system that impact WMATA's funding and decision-making processes.

The findings from this research align with broader theories on urban transportation and transit infrastructure. The challenges WMATA faces are not unique to just its own Metro system but are common in many transit systems worldwide. Public transportation systems across the country demonstrate that a strong funding source is necessary for sustainability, as stable financial support helps ensure proper maintenance, frequent service, and infrastructure improvements that keep these systems reliable and attractive to riders (ITF, 2024). Additionally, the importance of integrating Metro with other modes of transit aligns with research on multimodal transportation networks, which suggests that improving first- and last-mile connectivity is key to increasing ridership. This aligns with the concept that a network of frequent lines significantly expands the usefulness of each individual line, thus increasing ridership potential (Salter, 2019). Furthermore, the notion of strong service heavily contributing to strong ridership numbers can be seen in many transit studies. A study on the sustainable development of urban metro systems emphasized that service efficiency and quality are crucial for maintaining and even increasing ridership (Zhu et al., 2021).

One limitation of this research is its reliance on a small sample of WMATA employees for qualitative insights. While their perspectives provide valuable insider knowledge, a broader set of interviews with policymakers, frequent riders, and independent transit experts could offer a more comprehensive view of WMATA's challenges and potential solutions. Additionally, this study primarily focuses on operational and financial issues rather than deeper behavioral and socioeconomic factors that influence ridership trends. Future research could incorporate survey data from riders to better understand their transit preferences and pain points.

If I were to conduct this research again, I would seek to gather perspectives from a more diverse set of stakeholders, mainly policymakers who make funding decisions that affect WMATA. This would give me better insight into the financial issues that affect WMATA. Additionally, incorporating a comparative analysis with other metropolitan transit systems could highlight best practices and potential solutions that WMATA might adopt.

This research will inform my engineering practice by reinforcing the importance of designing systems with scalability, reliability, and user accessibility in mind. While my career will be in software engineering rather than transportation, the principles of resource allocation and system dependability are universally applicable. Gaining a deeper understanding of how this piece of infrastructure operates behind the scenes has deepened my appreciation for the intersection of technology and public policy.

## **Conclusion**

The broader significance of this research lies in its contribution to ongoing discussions about the future of public transit in the United States. WMATA's challenges underscore the critical need for sustained operational funding, strategic connectivity improvements, and

technological advancements in service reliability. These issues are not unique to Washington, D.C. but are emblematic of transit struggles nationwide. There are a couple of next steps that can be taken to further advance this research. Expanding the scope of the interviews to include a wider range of people such as policymakers would provide valuable information regarding other aspects of the Metro that can be improved. Furthermore, exploring alternative revenue sources such as congestion pricing or a regional tax could lead to valuable findings in sustainable funding sources for WMATA. This research shows that a well-functioning transit system requires strategic financial planning, thoughtful integration with the community it serves, and continuous improvements to service. By addressing these core areas, WMATA can strengthen its role as a critical component of the Washington metropolitan region's transportation network, ultimately making public transit a more attractive and viable option for residents and visitors alike.

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