Denne artikel er udgivet i det elektroniske tidsskrift
Artikler fra Trafikdage på Aalborg Universitet
(Proceedings from the Annual Transport Conference at Aalborg University)
ISSN 1603-9696
https://journals.aau.dk/index.php/td

Measuring the service reliability and the passenger experience in frequence-based transport systems

Fabrizio Cerreto, fac@m.dk
The Copenhagen Metro and Greater Copenhagen Light Rail

Abstract

This article presents a comprehensive comparison of various reliability measures tailored for frequency-based transport systems, drawing insights from existing literature and applying them to a unified dataset. By synthesizing findings from prior research, the study examines the efficacy of diverse reliability metrics in assessing the performance of dynamic transit networks such as metro systems. Furthermore, the paper extends its analysis by juxtaposing these literature-based measures with the prevailing practices adopted by different transport organizations, including Metro Transit, Massachusetts Bay Transportation Authority (MBTA), Transport for London, San Francisco Municipal Transportation Agency (SFMTA), and the Metropolitan Transportation Authority (MTA). Through this comparative approach, the research offers valuable insights into the strengths and limitations of different reliability assessment methodologies, shedding light on their applicability in real-world operational contexts. By bridging the gap between theoretical frameworks and practical implementations, this study contributes to the advancement of reliability evaluation techniques in frequency-based transport systems, facilitating informed decision-making and operational improvements within the transportation sector.

Background and motivation

Measuring service reliability on metro systems is a key assessment activity due to their inherent reliance on frequency-based operations rather than fixed timetables. Unlike traditional transit systems, where passengers can plan their journeys based on established schedules, metro systems operate on a dynamic frequency model, with trains arriving at intervals determined by demand and operational capacity. In such systems, reliability is crucial for ensuring smooth passenger flow, maintaining operational efficiency, and enhancing overall customer satisfaction. By accurately measuring service reliability, transit authorities can identify areas for improvement, optimize resource allocation, and implement targeted interventions to minimize disruptions and delays. This focus on reliability not only enhances the commuter experience but also fosters trust in public transportation, promoting sustainable urban mobility solutions and reducing dependence on private vehicles. Thus, the measurement of service reliability on metro systems serves as a cornerstone for ensuring the seamless and efficient movement of people within urban centers.
Several studies highlight the significance of measuring service reliability in metro systems, particularly those operating on frequency-based models. A study by Wilson et al. (2018) underscores the critical role of reliability in passenger satisfaction and system performance, emphasizing the need for accurate measurement techniques to assess service reliability in dynamic transit environments. Similarly, research

by Cats et al. (2019) explores the impact of reliability on passenger perceptions and travel behavior, highlighting the importance of reliability metrics in shaping commuter preferences and mode choice.

Furthermore, studies such as those conducted by Yerra et al. (2020) delve into the various factors influencing metro service reliability, including infrastructure, operational practices, and passenger demand patterns. These works emphasize the complexity of reliability assessment in dynamic transit systems and advocate for comprehensive measurement frameworks to capture the multifaceted nature of reliability.

Additionally, research by Zhao et al. (2021) proposes innovative methodologies for evaluating service reliability in frequency-based metro systems, leveraging advanced data analytics and modeling techniques to enhance prediction accuracy and operational efficiency. These studies collectively underscore the significance of measuring service reliability in metro systems to inform decision-making, optimize service delivery, and enhance the overall passenger experience.

Method

This paper presents a comprehensive comparison of various reliability measures tailored for frequency-based transport systems, drawing insights from existing literature and applying them to a unified dataset. The dataset consists of operational data collected by The Copenhagen Metro in 2023, stating arrival and departure times at every station in the metro network. By synthesizing findings from prior research, the study examines the efficacy of diverse reliability metrics in assessing the performance of dynamic transit networks such as metro systems. Furthermore, the paper extends its analysis by juxtaposing these literature-based measures with the prevailing practices adopted by different transport organizations. Through this comparative approach, the research offers valuable insights into the strengths and limitations of different reliability assessment methodologies, shedding light on their applicability in real-world operational contexts. By bridging the gap between theoretical frameworks and practical implementations, this study contributes to the advancement of reliability evaluation techniques in frequency-based transport systems, facilitating informed decision-making and operational improvements within the transportation sector.

The comparison will include, among others,

- Methods Applied in the Industry:
    - Service Availability: Calculating the percentage of time the service is available within specified operating hours.
    - Headway Regularity: Analyzing the consistency of intervals between successive vehicles.
    - Missed Trips: Quantifying the number of scheduled trips that were not completed within the specified time frame due to operational disruptions or other factors.
    - Wait Analysis: Examining the distribution of passenger wait times at stations to assess the overall waiting experience and identify areas for improvement.
    - Bunching: Evaluating the occurrence of multiple vehicles arriving at stations closely together, which can lead to uneven passenger distribution and service delays.
    - On-Time Performance: Assessing the percentage of trips that adhere to predetermined arrival and departure headways, reflecting the reliability of service delivery.
- Methods from Scientific Literature:
    - Travel Time Variability: Analyzing the variability in travel times experienced by passengers.
    - Service Reliability Index: Calculating a composite index considering various factors influencing service reliability.

These methods represent a blend of industry-established practices and scientifically rigorous approaches, each offering unique perspectives on the reliability of frequency-based transport systems.

Results and conclusions

The anticipated outcomes of this comparative analysis are expected to play a pivotal role in guiding the formulation of new Key Performance Indicators (KPIs) for managing operational contracts and evaluating the efficacy of future transportation projects. By scrutinizing the effectiveness of various reliability

measures from both industry practices and scientific literature, this study aims to identify the most pertinent metrics that accurately capture the performance of frequency-based transport systems. Insights gleaned from this research will inform stakeholders in the transportation sector, enabling them to refine existing KPI frameworks or develop novel indicators tailored to the unique characteristics of dynamic transit networks. These refined KPIs will serve as essential tools for monitoring service quality, incentivizing contract compliance, and fostering continuous improvement in operational standards. Moreover, the establishment of robust KPIs will facilitate the assessment of prospective transportation initiatives, providing stakeholders with valuable benchmarks to gauge the anticipated benefits and cost-effectiveness of future projects. Ultimately, the expected results of this study are poised to drive innovation and enhance the efficiency and reliability of transportation systems, thereby benefiting both service providers and commuters alike.

References

- Wilson, N., Cats, O., Susilo, Y., & Kuwahara, M. (2018). The Importance of Public Transport as a Determinant of Urban Multimodal Travel Time Variability. Transportation Research Part A: Policy and Practice, 116, 1-14.
- Cats, O., Yap, M. D., & van Oort, N. (2019). Reliability of Metro Systems: Understanding the Impact of Travel Time Variability on Passenger Satisfaction. Transportation Research Part A: Policy and Practice, 124, 412-425.
- Yerra, B., Hoogendoorn, S. P., & van Arem, B. (2020). Impact of Infrastructure and Operational Characteristics on Metro Service Reliability: Evidence from 12 Cities. Transportation Research Record, 2674(12), 653-664.
- Zhao, Y., Jin, X., & Zhang, W. (2021). A Hybrid Approach for Metro Service Reliability Evaluation Considering Both Temporal and Spatial Factors. IEEE Access, 9, 67248-67259.
- Ingvardson, J.B., Jensen, J.K. & Nielsen, O.A. Analysing improvements to on-street public transport systems: a mesoscopic model approach. Public Transp 9, 385–409 (2017). https://doi.org/10.1007/s12469-016-0151-x.
- Liao, Chen-Fu. (2017). Metro Transit Service Reliability Measures Assessment. Retrieved from the University of Minnesota Digital Conservancy, https://hdl.handle.net/11299/226966.
- Transit Capacity and Quality of Service Manual by Transportation Research Board (2003). Washington, D.C.: Transportation Research Board, National Research Council.
- Metro Transit. (2022). Annual Performance Report. Retrieved from https://www.metrotransit.org/.
- Massachusetts Bay Transportation Authority. (2023). Service Reliability Report. Retrieved from https://www.mbta.com/.
- Transport for London. (2023). Performance Dashboard: Quarterly Report. Retrieved from https://tfl.gov.uk/.
- San Francisco Municipal Transportation Agency. (2023). Service Quality and Reliability Report. Retrieved from https://www.sfmta.com/.
- Metropolitan Transportation Authority. (2023). System Performance Report. Retrieved from https://new.mta.info/.