

DIGITAL TICKETING SYSTEMS IN METRO RAIL SERVICES: A STEP TOWARDS SMART MOBILITY

K. LALITHA¹, Dr. B. VIJAYAKUMAR²

Ph.D. Research Scholar¹

Associate Professor & Research Supervisor²

PG & Research Department of Commerce

Dwaraka Doss Goverdhan Doss Vaishnav College (Autonomous)

Arumbakkam, Chennai – 600 106, India.

lalithaakathirvel@gmail.com¹, vijayakumar_sakthi@yahoo.in²

Abstract:

Urban transport systems have seen tremendous change as a result of digital transformation. The use of digital ticketing methods including contactless payments, smart cards, QR codes and smart phones app is the one of the best advancements in metro rail services. Passenger convenience, transparency and manual intervention are all improved by these methods. The contribution of digital ticketing systems to smart mobility and better governance in metro train services is examined in this conceptual study. The study offers a conceptual framework that connects digital ticketing with effectiveness, transparency, passenger's satisfaction and sustainable urban transportation. It is based on the collection of existing literature and smart mobility theory.

Keywords:

Digital ticketing, Smart mobility, CMRL, Metro rail, urban transport

1. Introduction

In metro politician cities, there are now significant transportation issues due to rapid urbanisation and rising population density. Urban transport systems now frequently face problems with fuel usage, traffic congestion pollution. Cities are changing to intelligent transportation options to solve these issues. Urban mobility is supported by metro rail systems, which have become an effective and eco friendly form of public transportations.

Metro services are progressively implementing digital ticketing systems as a result of the development of digital technology. Long lines, revenue leaks and operational inefficiencies are common problems in traditional cash and paper ticketing systems. Whereas, the commuter's access to quicker safer, more convenient travel options with the help of

digital ticketing systems. Digital Ticketing system including smart cards, QR tickets through mobile apps contactless payments are very comfortable for the commuters.

Digital ticketing is the step forward in smart mobility. The term “smart mobility” explains how digital technology, data management and creative thinking are combined to increase the sustainability, accessibility and efficiency of transportation. It also helps to cut down the long queue and saves time. Minimising in- person interactions, guaranteeing transaction transparency and facilitating real – time data collecting. To improve passenger comfort and operational efficiency, Indian metro train systems in Hyderabad, Bengaluru, Chennai and Delhi have adopted a variety of digital ticketing systems. These devices have speed up transactions, decreased the dangers associated with handling currency and made it possible to better monitor passenger flow patterns. The usage of digital payments supports cashless transactions and financial inclusion, which is line with the government of India’s Digital India policy.

Although digital ticketing systems are increasingly being used in metro rail services, little conceptual research has thoroughly investigated how they may support smart mobility outcomes. The majority of research focuses on passenger satisfaction and service quality, with little attention paid to the wider connection between digital ticketing and the development of smart urban transport.

Thus, the purpose of this conceptual study is to investigate how metro rail’s digital ticketing systems support intelligent mobility. The paper suggests a conceptual framework that connects passenger satisfaction, operational effectiveness, transparency and sustainable urban transaction development with digital ticketing methods.

1.1.Objectives of the study

The objectives of the study are,

- To understand the concept of digital ticketing systems in metro rail services
- To examine the role of digital ticketing in operational efficiency
- To analyse the relationship between digital ticketing and passenger’s satisfaction
- To explore how digital ticketing systems contribute to smart mobility

2. Review of Literature

Almost every service industry, including public transport has been impacted by the digital transformation in recent years. To increase productivity and customer convenience, metro rail

system progressively implementing digital technologies. In many large cities, digital ticketing methods including contactless payments, smart cards, QR codes and mobile ticketing are becoming more widespread.

According to Parasuraman et.al (1998), enhancements to service delivery systems raise customer satisfaction and perceived service quality. Customers are more likely to give a service a positive rating when technology streamlines the process. Digital ticketing streamlines entry and exit processes and cuts down on waiting times for metro rail services.

In the words of Davi's (1989) technology acceptance mode, people are more inclined to embrace new technology if they find it easy to use and beneficial. Because they save time, lessen physical labour and provide conveniences through mobile applications and cashless payments, digital ticketing systems are frequently used.

Based on studies on public transport, passenger's happiness is greatly impacted by operational effectiveness and dependability (Eboli & Mazzulla, 2007). Quicker ticketing procedures ease station traffic and enhance the whole journey. Similarly, Lai and Chen (2011) discovered that passenger's behavioural intentions are positively impacted by perceived value and service quality.

Recent discussions on smart mobility emphasize the integration of digital infrastructural, data analytics and sustainable transport systems. Digital ticketing plays a foundational role in smart mobility because it enables seamless travel, supports data – driven planning and encourages cashless transactions.

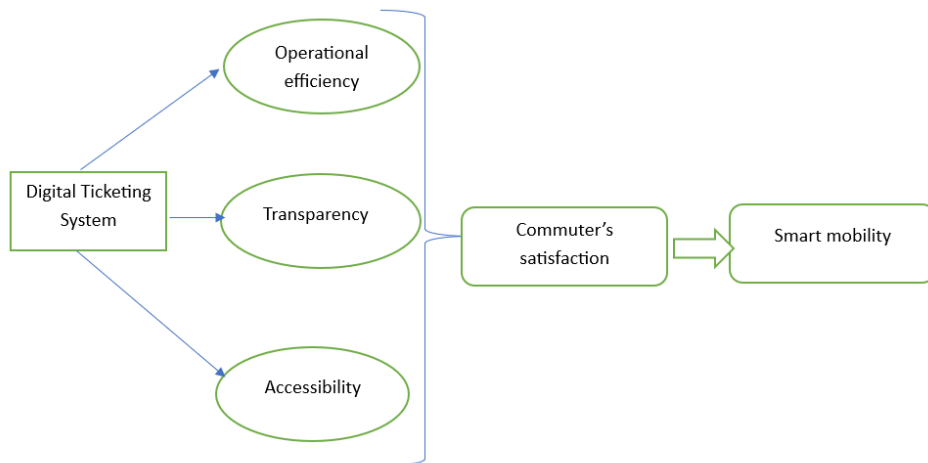
However, while many studies focus on service quality and passenger satisfaction, fewer studies conceptually connect digital ticketing systems with broader smart mobility outcomes. Therefore, there is a need to examine how digital ticketing contributes not only to operational improvements but also to sustainable urban mobility.

3. Research Methodology

This nature of the study is conceptual and based on secondary data. The study used theoretical analysis and review of literature to develop the conceptual framework. No primary data has been collected.

3.1. Conceptual Framework

The conceptual framework showing digital ticketing system in metro rail services.



3.2.Digital Ticketing system

A digital ticketing system is an electronic fare collection system that replaces traditional paper-based techniques for ticket issuance, validation, and management in transportation services, particularly in metro rail systems. Through digital platforms like smartphone apps, smart cards, QR codes, or web portals, commuters can buy, store, and use tickets.

In metro train services, a digital ticketing system is an electronic fare collection system that uses technology to allow passengers to buy, store, and validate tickets digitally rather than on paper. Contactless smart cards, mobile tickets with QR codes, and internet platforms with automated fare collecting gates are how it runs. The system minimises manual errors and waiting times by supporting contactless and cashless transactions. By enabling commuters to order or recharge tickets at any time, it increases accessibility, guarantees transparency through precise fare records, and boosts operational efficiency. All things considered, digital ticketing improves passenger convenience and is a crucial part of intelligent mobility in urban transport networks.

A typical metro digital ticketing system is made up of a number of interconnected parts that cooperate to guarantee efficient passenger flow and seamless fare collection. The Automated Fare Collection (AFC) system, which consists of smart card readers, computerised entry and exit gates, and QR code scanners to verify tickets and facilitate easy platform access, is the initial part. Smart cards, rechargeable contactless cards that work via a tap-in and tap-out system and enable automatic fare deduction based on trip distance, make up the second component. The third element consists of mobile ticketing apps that give

commuters flexibility and convenience by integrating with digital wallets, offering app-based QR tickets, and enabling online recharges. Last but not least, the backend management system ensures correctness, transparency, and efficient operational control by supporting the complete framework with software for fare calculation, passenger data management, and revenue tracking and reporting.

There are several ways to introduce digital ticketing into metro train services that improve efficiency and convenience. One popular kind is QR code ticketing, in which a ticket is created via a mobile app and validated by scanning it at entry and exit gates. Contactless smart cards, which serve as prepaid travel cards and enable quick tap-based validation at automated gates, are another popular technique. Another cutting-edge solution is mobile-based NFC ticketing, which makes use of smartphones with Near Field Communication capabilities to enable easy fare payment without the need for physical cards. Furthermore, online reservation and recharge systems guarantee flexibility and round-the-clock accessibility by allowing travellers to make reservations or reload their travel cards via websites or mobile applications. All of these digital ticketing options work together to make metro travel more efficient and convenient.

3.3.Operational Efficiency

Operational efficiency in metro rail services is the enhanced performance and simplified operation made possible by technologically advanced fare management systems. The use of digital validation tools in conjunction with automatic entrance and exit controls makes passenger flow more efficient and well-organised, especially during rush hour. Quick access to platforms is made possible by contactless payment options, which also improve station throughput capacity and lessen bottlenecks. By ensuring accurate deductions and reducing the likelihood of human error, technology-based fare computation improves financial accuracy and accountability. Better scheduling, crowd control, and resource allocation are also made possible by centralised monitoring systems, which offer real-time information into passenger quantities and transit patterns. All things considered, technology-enabled ticketing systems help metro train networks run more smoothly, be more reliable, and provide better service.

3.4.Transparency

The clarity, openness, and accountability upheld in fare transactions and service operations within metro rail services are referred to as transparency in digital ticketing systems. Commuters can quickly check their transactions with the use of technology-based ticketing

solutions, which offer clear information about fare structures, balance data, journey history, and payment confirmations. By removing hidden fees and reducing pricing ambiguity, digital records help to improve passenger and service provider confidence. By preserving precise and verifiable transaction data, automated systems further reduce the possibility of revenue leakage and illegal activity. Furthermore, real-time notifications and easily accessible digital receipts boost trust in the system's dependability and fairness. Transparency in digital ticketing, thus, fosters financial accountability, institutional credibility, and increased commuter confidence in metro train operations.

3.5. Accessibility

The ease with which commuters can acquire, utilise, and manage transit tickets via inclusive and user-friendly technology platforms is referred to as accessibility in digital ticketing systems. Simple, user-friendly ticket buying, validation, and recharging procedures are guaranteed by a well-designed digital system that is accessible through a variety of channels, including web portals and mobile applications. People with varying degrees of computer literacy can use the system thanks to features like bilingual interfaces, clear instructions, and device compatibility. Additionally, passengers can access services whenever they want without relying on physical counters thanks to round-the-clock availability. Accessible digital ticketing systems encourage inclusivity and improve the entire metro rail service passenger experience by lowering both technological and physical obstacles.

3.6. Commuter's satisfaction

In metro rail services, commuter happiness is greatly influenced by operational effectiveness, transparency, and accessibility taken together. Passengers' perceptions of the overall quality, dependability, and equity of the transportation system are influenced by these three factors. By guaranteeing timely and easy travel, operational efficiency raises commuter happiness. Passengers view a service as dependable and well-run when they can get in and out of stations fast, avoid huge lines, and encounter few delays. Accurate fare deductions and quicker processing times lessen annoyance and boost system trust. Positive travel experiences are directly correlated with a smooth journey, which raises satisfaction levels.

Transparency promotes trust, which increases enjoyment. Commuters are reassured that they are being charged fairly when price calculations are transparent, transaction records are readily available, and pricing structures are publicly published. Credibility is increased and ambiguity is decreased with the provision of digital receipts and real-time notifications.

Passengers' overall assessment of the quality of the services is greatly influenced by their level of trust in the system's fairness.

As accessibility makes the system convenient and inclusive for all users, it increases user happiness. Commuters have more comfort and flexibility when ticketing platforms are simple to use, accessible on many devices, and available at any time. Features like easy-to-use interfaces and compatibility for multiple languages lower barriers for users of various ages and digital literacy levels. Comfort, convenience, and general user pleasure are all improved by a system that can adapt to a variety of user needs.

Transparency fosters confidence, accessibility promotes inclusivity, and operational efficiency ensures performance. When these components work well together, they provide a satisfying commuter experience that boosts satisfaction and promotes continuous usage of metro rail services.

3.7.Smart Mobility

Metro commuter satisfaction and smart mobility are closely related since commuter satisfaction influences and is influenced by smart mobility projects. Technology-enabled services including digital ticketing, real-time train information, automated fare collection, and mobile applications are the first steps toward smart mobility in metro rail networks. When these systems work well, commuter happiness rises because they cut down on waiting times, ease ticketing difficulties, and improve convenience.

Passengers' opinions of the quality of the services are directly impacted by reliable scheduling that is backed by data analytics, which increases timeliness and decreases crowding. Feelings of safety and comfort are important factors that determine happiness, and they are further reinforced by clean stations, safety surveillance systems, intelligent security checks, and well-maintained equipment.

Additionally, multimodal integration enhances the overall travel experience by facilitating seamless and stress-free journeys, such as seamless communication between buses, metro, and last-mile services. Commuters' confidence in the metro system rises when they enjoy convenience, accessibility, transparent fare structures, and prompt grievance redressal procedures.

A key goal of smart mobility is to promote a modal shift from private vehicles to public transport, which is encouraged by high commuter satisfaction ratings. This change

encourages sustainable urban development, lessens traffic congestion, and cuts carbon emissions. Therefore, metro commuter happiness is a strategic performance metric that supports long-term urban transport sustainability and represents the effectiveness of smart mobility projects, rather than just a service outcome.

4. Discussions and Conclusion

As a strategic move toward smart transportation, this conceptual study looked at digital ticketing systems in metro rail services. The examination of current research and theoretical underpinnings demonstrates that digital ticketing is a revolutionary governance tool in urban transport systems rather than just a technical advancement. By cutting down on waiting times, minimising human error, and optimising passenger flow, technologies like smart cards, QR code tickets, mobile applications, NFC-based payments, and Automated Fare Collection (AFC) greatly increase operational efficiency. These enhancements improve resource allocation, crowd control, and station management, especially during peak hours. By eliminating revenue leakage and enhancing financial accountability, digital ticketing also fosters transparency through automated fare calculation, digital receipts, and easily accessible transaction data. In order to ensure inclusive and user-friendly service delivery, accessibility is further improved by bilingual interfaces, digital platforms that are available around-the-clock, and streamlined processes.

The study also emphasises how commuter happiness, which serves as a mediating factor between digital ticketing and smart mobility results, is influenced by operational efficiency, transparency, and accessibility taken together. Passengers' perceptions of the quality of the services they receive such as speedy entry and exit, transparent fare deductions, and easy payment options improve, which increases their trust and encourages them to use the metro services again. Therefore, smart mobility encompasses more than just digital adoption; it also involves data-driven planning, sustainability, and passenger-centric governance. Digital ticketing immediately contributes to less traffic, lower carbon emissions, and sustainable urban development by facilitating a modal shift from private automobiles to public transit, enabling smooth travel, providing real-time analytics, and promoting cashless transactions. Digital ticketing systems are therefore a fundamental component of smart, effective, and sustainable metro rail services.

According to the study's findings, digital ticketing systems are essential to converting metro rail services into intelligent mobility ecosystems. Digital ticketing greatly increases

commuter happiness by increasing accessibility, guaranteeing transparency, and improving operational efficiency. Together, effective fare collection, shorter wait times, precise transaction records, and intuitive digital platforms raise commuter confidence and service quality. Therefore, digital ticketing serves as a strategic governance tool that improves institutional performance and service delivery in metro rail systems, in addition to being a technological innovation. Moreover, greater passenger satisfaction promotes a modal shift toward sustainable public transportation and repeat use of metro services. The conceptual framework created in this study highlights the significance of combining technology, passenger-centric policies, and data-driven management, and it clearly connects digital ticketing systems to more general smart mobility results. Thus, digital ticketing serves as a driving force behind the development of inclusive, transparent, effective, and ecologically friendly urban transportation. To maintain long-term sustainability and improved mobility in metropolitan areas, digital infrastructure must be continuously strengthened and upgraded.

References

- Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly*, 13(3), 319–340. <https://doi.org/10.2307/249008>
- Eboli, L., & Mazzulla, G. (2007). Service quality attributes affecting customer satisfaction for bus transit. *Journal of Public Transportation*, 10(3), 21–34. <https://doi.org/10.5038/2375-0901.10.3.2>
- Lai, W. T., & Chen, C. F. (2011). Behavioral intentions of public transit passengers—The roles of service quality, perceived value, satisfaction and involvement. *Transport Policy*, 18(2), 318–325. <https://doi.org/10.1016/j.tranpol.2010.09.003>
- Parasuraman, A., Zeithaml, V. A., & Berry, L. L. (1988). SERVQUAL: A multiple-item scale for measuring consumer perceptions of service quality. *Journal of Retailing*, 64(1), 12–40.
- United Nations. (2019). *World urbanization prospects 2018: Highlights*. United Nations, Department of Economic and Social Affairs.
- Government of India. (2015). *Digital India programme*. Ministry of Electronics and Information Technology. <https://www.digitalindia.gov.in>
- Banister, D. (2008). The sustainable mobility paradigm. *Transport Policy*, 15(2), 73–80. <https://doi.org/10.1016/j.tranpol.2007.10.005>
- Cohen, B. (2012). *The smart city wheel: Innovations in smart cities*. Climate Institute.