Smart Ticketing and Overcrowding Control System for Public Transportation

Puja Chavan (Cholke)
Vishwakarma Institute of Technology, Pune, 411037, Maharashtra, India
puja.cholke@vit.edu

Abhijeet Padwal
Vishwakarma Institute of Technology, Pune, 411037, Maharashtra, India
abhijeet.padwal21@vit.edu

Yogesh Pande
Vishwakarma Institute of Technology, Pune, 411037, Maharashtra, India
yogesh.pande21@vit.edu

Parth Nevase
Vishwakarma Institute of Technology, Pune, 411037, Maharashtra, India
parth.nevase21@vit.edu

Mayur Gaikwad
Vishwakarma Institute of Technology, Pune, 411037, Maharashtra, India
mayur.gaikwad21@vit.edu

***Abstract*—Conventional ticketing procedures limit the potential revolutionary effects of public transport. In order to overcome these restrictions, the Smart Ticketing and Overcrowding Control System for Public Transportation presented in this study ingeniously combines RFID and GSM technology. Despite their ease, the current ticketing systems struggle with high costs, interoperability problems, and privacy difficulties. In addition to negatively affecting passenger satisfaction and transportation efficiency, overcrowding. The suggested solution makes use of smart cards with RFID tags to enable quick, con-tactless ticket confirmation. Integration with GSM technology enables real-time communication for tariff calculation and fast ticket confirmation. RFID readers, GSM modems, Arduino micro-controllers, LCD displays, and a crowded control system are all included in the architecture. Through testing, the equipment exhibits notable results. Without paper tickets or manual checks, passengers get seamless ticket validation, which improves convenience. Reduced ticket fraud and improved revenue collection are advantageous to the transportation authority. The technology offers transportation authorities useful data insights for streamlining schedules, fares, and routes. Real-time monitoring provided by the technology enables early overcrowding identification and prevention, protecting the security and comfort of passengers.**

Keywords—Arduino, Passenger, Smart Cards, RFID, GSM, Tickets, Transport.

I. INTRODUCTION

India is experiencing a significant increase in its urban population as a result of the country's fast urbanization, especially in mega cities like Delhi, Mumbai, and Kolkata. By 2001, there were over 285 million people living in cities, making effective public transportation services essential for overcoming traffic and dense urban areas' challenges. The biggest cities have grown at an exponential rate; for example, Delhi, Mumbai, and Kolkata now have populations of over 10 million each. Cities with populations of over 5 million, such as Chennai, Hyderabad, Ahmedabad, and Bangalore, have also shown signs of urban expansion.The notable rise in population, particularly in urban areas, highlights the increased dependence on public transportation. Thirty-five Indian metropolitan areas have more than a million people living in them as of 2001—nearly twice as many as in 1991. The swift expansion of urban areas requires the construction and improvement of public transportation infrastructure in order to meet the increasing demand and reduce traffic in these busy metropolises[6][16].

The Smart Ticketing system makes use of RFID technology, which includes RFID tags on tickets [7][8]. The RFID tags offer their users hassle-free services and security. The components of an RFID system are tags, which are essentially microchips with antennas, and an antennaed interrogator or reader [10]. RFID scanners mounted on automobiles or at station entrances and exits may wirelessly read the unique identification information included in these tags. Passengers merely need to tap their smart cards or paper tickets on the RFID reader to rapidly and without contact validate them [9][13]. The capabilities of the system are further improved with the incorporation of GSM technology. Real-time connection between the transportation system and a central server enables instant ticket validation, fare deductible, and transaction processing. According to, the central server organizes ticketing data, handles fare computations, and offers useful insights into managing passenger flow and income [11]. Transport authorities can make educated judgments on route optimization, timetable planning, and fare structures thanks to this data-driven approach. The Smart Ticketing System has many advantages. Because they are no longer need to use paper tickets or stand in queue for manual ticket checks, passengers experience ticketing that is more convenient and hassle-free [12]. In addition, the system increases the accuracy of revenue collection and decreases the risk of ticket fraud, helping to ensure the financial viability of public transport systems. Transport authorities also acquire useful data insights that they can utilize to boost operational effectiveness, optimize resource allocation, and increase the overall quality of services. By utilizing the capabilities of Global System for Mobile Communications (GSM) and Radio Frequency Identification (RFID) technologies, the "Smart Ticketing System for Public Transport" project seeks to revolutionize the current system of purchasing tickets for public transport. This ground-breaking solution gives users a smooth, automated ticketing experience while giving transport authorities effective fare collecting and revenue management tools.

II. LITERATURE REVIEW

The majority of public transportation systems now in use require a lengthy, time consuming, step-by-step process for the manufacture and issuance of tickets. To obtain a ticket, a person must approach a conductor or go to the ticket counter. The conductor will then hand out tickets. There is no alternative option or backup for a lost ticket, and if he is

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detected, he must pay the fine. The following are some of the surveys done on the digital transport ticket systems: -

In 2017, Research [1] suggested a smart transportation system that is based on IOT in Social, Mobile, Analytics, and Cloud. It is portable and user-friendly, but its drawbacks include the inability to retrieve GPS location and the absence of a recharge card. Existing study [2] introduced passenger segmentation using smart cards in the year 2013. This method allows businesses to better segment their clientele and offer them information and services that are more relevant to their needs. One limitation of this system includes the reliance on smart card data for passenger segmentation. While smart card data provides valuable insights into passenger behaviour and travel patterns, it may not capture the complete picture of passenger characteristics. In 2016, Research [3] proposed employing smart cards for public transportation recharge that are hands-free card wallets with high security leveraging communication and control technologies. One of the major drawbacks of this research paper was that the scalability and integration of the recharge system with existing public transport infrastructure and payment systems are important aspects that are not thoroughly covered in the research paper. Considerations such as interoperability, system capacity, and potential challenges during integration with legacy systems need to be evaluated for practical implementation. Using parallel and distribution systems, Research [4] proposed bus bunching identification using smart cards in 2018. This would boost the share rate of public transportation. Its key flaw was that it was unable to control the bus arrival time prediction.The study [14] describes a personal navigation system for public transportation that makes use of RFID ticketing and the real-time location data that these systems automatically provide. While RFID is important for ticketing, there are no solutions in the literature that use this data to help users navigate the transportation network. In order to close this gap, the research suggests a real-time guidance system, improves user experience, and is reasonably priced. The system's design addresses the shortcomings in public transportation navigation services by emphasizing deployability, affordability, and user-friendliness. By using RFID data for practical passenger navigation in public transportation systems, this work fills a gap in the literature. Existing research [15] emphasizes the use of RFID technology in major cities across the world for ticketing public transportation. Nevertheless, Dhaka's paper-based ticketing system causes corruption, mishaps, and gridlock. This study highlights the efficacy of an automated ticketing system based on RFID in other mega cities. Private sector monopolies, chaos, and a lack of notifications are the current problems. The system intends to improve passenger experience, decrease corruption, and streamline operations by integrating RFID for tracking and ticketing. The study fills the knowledge vacuum by offering an affordable, approachable option for effective public transportation in mega cities such as Dhaka.

III. METHODOLOGY

A. *Radio frequency identification(RFID)*

Radio-frequency identification, or RFID, is a technology that tracks and identifies objects by sending data via radio waves between an electronic tag attached to an object and a reader. The RFID tag, the RFID reader, and the host computer or data processing system are the three main parts of an RFID system.

- RFID Tag: RFID tags are compact electronic devices made up of an antenna and a microchip. Data is stored on the microchip, and radio waves are used by the antenna to communicate with the RFID reader.
- RFID Reader :An apparatus that interacts with the RFID tags is the RFID reader. It sends out radio waves, detects the response from the tag, and reads the data stored on it.Depending on the use, readers can be fixed or portable, and their ranges can vary.

An RFID reader emits an interrogation signal when an RFID tag approaches its range.This signal enters the RFID tag through its antenna, causing the tag's antenna to become current-driven.The microchip in the tag is then powered by this induced current, and it transmits the data it has stored back to the reader through a modulated signal.This signal is picked up by the reader, who then decodes the data and forwards it to the host computer for processing.

RFID communication operates on the fundamentals of electromagnetic induction. The electromagnetic induction law of Faraday can be used to explain the voltage that was induced in the tag's antenna:

$$EMF = -N\frac{\Delta\Phi}{\Delta t} \quad (1)$$

Where:

- EMF is the induced electromotive force (voltage).
- N is the number of turns in the antenna.
- $\Delta\Phi$ is the change in magnetic flux.
- Δt is the change in time.

In this system, an RFID tag is attached to each passenger's smart card or mobile device. These tags will contain the passenger's information such as name, age, gender, and travel history. When a passenger enters a bus or train, the RFID reader will scan the tag and record the passenger's information. This information will then be transmitted to a central server, which will analyze the data and provide real-time information on the occupancy of the bus or train

B. *System Architecture*

The Fig. 1 Shows Proposed System Architecture: The proposed system consists of the following components:

- RFID Reader: The RFID reader is installed at the entrance of the bus or train. It will scan the RFID tag attached to each passenger's smart card or mobile device and record their information.
- Arduino Micro-controller: The Arduino board acts as the brain of the system, processing the data, and

displaying output to the LCD display and GSM module. The Arduino board is programmed using the Arduino IDE, a simple programming environment that allows developers to write, compile, and upload code to the Arduino board.

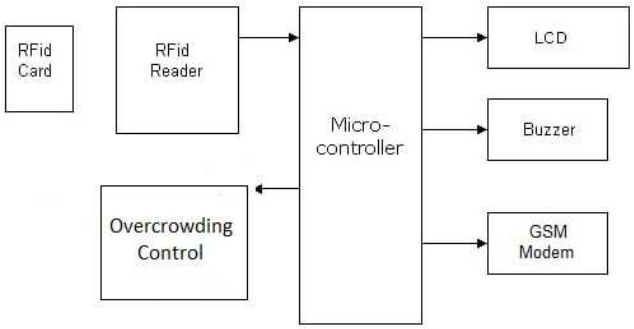

Fig. 1. System Architecture of Smart-ticketing system.

- GSM Modem: The GSM modem will be installed in each bus or train. Upon successful RFID tag scanning and verification, the Arduino micro-controller triggers the GSM modem to send an SMS confirmation to the passenger.The SMS serves as a ticket confirmation and provides relevant details about the journey.
- LCD Display: These displays could be placed at the entrance of each transport vehicle, showing real-time information about the vehicle's occupancy and whether it is safe for passengers to board.
- Overcrowding control system: This component monitors passenger traffic in real-time and provides alerts to transport operators when the passenger count exceeds a predefined limit. The alerts could be displayed on the LCD displays or sent directly to the transport operator's control center.

Overall, this system architecture diagram shows how the integration of RFID and LCD technologies could provide a seamless and efficient transport experience for passengers while also ensuring their safety and comfort

IV. RESULTS AND DISCUSSIONS

Our study aimed to develop and evaluate the effectiveness of a smart ticketing and overcrowding control system for public transportation using RFID and GSM technologies. The proposed system was implemented and tested in a real-world setting, and the following results were obtained:

Fig. 2 shows the circuit diagram of components used in the project such as RFID, GSM, Arduino UNO, LCD display, potentiometer, etc.

The smart ticketing system was found to be highly efficient in terms of ticketing speed and accuracy. The use of RFID technology eliminated the need for physical tickets, reducing the chances of ticket fraud and simplifying the ticketing process for both passengers and transport operators. The overcrowding control system was able to monitor passenger traffic in real-time and provide alerts to transport operators when the passenger count exceeded a predefined limit. This helped to prevent overcrowding and ensure the safety and comfort of passengers.

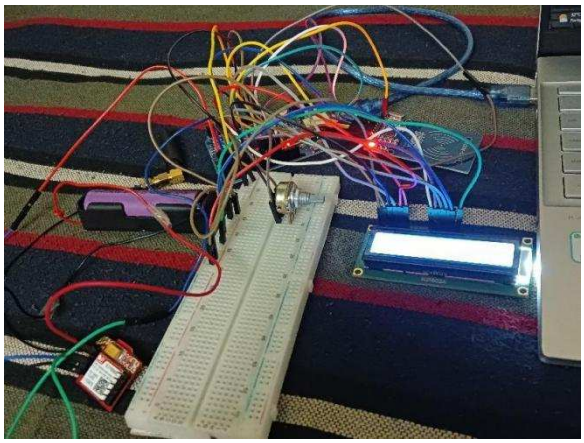

Fig. 2. Model of Smart ticketing system using RFID, GSM & LCD display.

Fig. 3. Output image of Passenger count.

Fig. 3 shows the LCD output image of total passenger count of passengers present in the bus for overcrowding control. The system was found to be reliable and scalable, with the ability to handle a large number of passengers and multiple modes of transportation. The implementation of the system resulted in improved passenger satisfaction, reduced operational costs, and increased revenue for transport operators. The findings of this study highlight the potential of smart ticketing and overcrowding control systems for public transportation using RFID and GSM technologies.

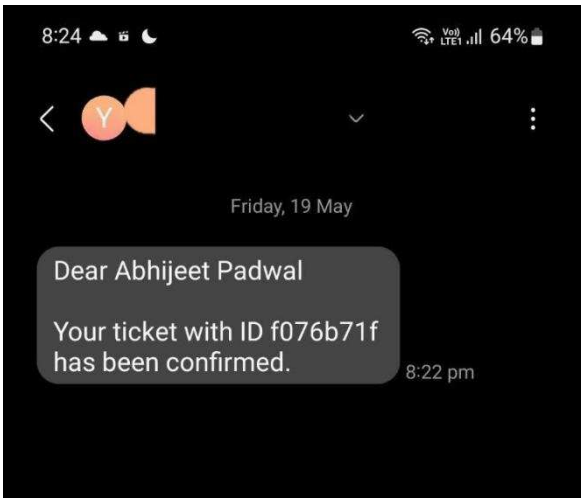

Fig. 4. SMS confirming the passenger's tickets.

Fig. 4 shows the output image of a SMS sent to the passenger's mobile after his ticket has been confirmed and the ticket amount is deducted from his account which is linked to his RFID card. The proposed system offers numerous benefits over traditional ticketing and overcrowding control systems,

including increased efficiency, accuracy, and reliability. The use of RFID technology in ticketing eliminates the need for physical tickets, reducing the chances of ticket fraud and simplifying the ticketing process for both passengers and transport operators. The overcrowding control system helps to prevent overcrowding and ensure the safety and comfort of passengers, while also enabling transport operators to optimize their operations and reduce costs. The scalability of the system is a significant advantage, as it can be easily adapted to handle large numbers of passengers and multiple modes of transportation. The implementation of the system resulted in improved passenger satisfaction, reduced operational costs, and increased revenue for transport operators. However, there are some challenges associated with the implementation of such systems, including the cost of the technology and the need for training and support for transport operators. Additionally, privacy concerns related to the use of RFID technology must be carefully considered and addressed.

In summary, our research shows the potential of smart ticketing and overcrowding control systems for public transportation, but also emphasizes the need for more study to refine and enhance these systems.

V. CONCLUSION

The ground-breaking method offers both passengers and transport authorities a number of advantages. Without the burden of paper tickets or manual checks, passengers may easily utilize public transport, improving their overall travel experience. The accuracy of revenue collection is increased, ticket fraud is decreased, and access to key data insights for better operational planning and service optimization are all advantages for the transportation authority. The adoption of the Smart Ticketing System has the power to drastically improve the sustainability and efficiency of public transport systems. By leveraging advanced technologies, such as RFID, transport systems can enhance their overall performance, improve revenue management, and meet the growing demands of modern travelers. With its ability to streamline ticketing processes, enhance passenger experience, and provide valuable data insights, the Smart Ticketing System sets the stage for a more efficient, convenient, and sustainable future of public transportation. In future, this system can be implemented for various purposes such as Real-time passenger information, Biometric authentication, Voice-based ticketing, Cloud-based architecture, Predictive Analytics, Smart city integration, etc.

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