AUTOMATIC FARE COLLECTION IN PUBLIC TRANSPORT

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ABSTRACT

The Automatic Fare Collection (AFC) system in public transport has undergone a transformative enhancement through the integration of QR code technology and a web application. This innovative project aims to streamline the ticketing process, making it more efficient and user-friendly for commuters. Instead of traditional paper tickets or physical cards, passengers can now simply scan a QR code generated by the web application using their smartphones to pay for and collect their tickets. This digital approach not only reduces the environmental impact associated with paper tickets but also enhances the overall speed and convenience of the fare collection process. The web application serves as a centralized platform, allowing users to seamlessly manage their travel transactions, view trip histories, and receive real-time updates. The incorporation of QR codes not only facilitates secure and contactless transactions but also contributes to a more advanced and interconnected public transportation system, ultimately improving the overall travel experience for commuters.

Keywords: *Web application, QR code, Travel, Ticketing process, Public transportation system*.

1. Introduction

In the dynamic landscape of urban mobility, the evolution of public transportation systems has become paramount to meet the growing demands of efficiency, convenience, and technological advancement. The Automatic Fare Collection (AFC) system has emerged as a pivotal element in this transformative journey, aiming to redefine the way commuters engage with fare payment and ticketing processes. This cutting-edge approach to public transportation, leveraging QR code technology and a web application to streamline the fare collection experience. Departing from traditional ticketing methods, the integration of QR code scanning, journey selection, and digital payment options like UPI and PhonePe heralds a new era of contactless and user-friendly transit. This way for a deeper exploration into the advantages and innovations that this Automatic Fare Collection system brings to the forefront of modern urban mobility.

2. Related Works and Literature Survey

The literature surveys propose several technological solutions to modernize and automate fare collection in public transit, aiming to increase efficiency, reduce human contact, minimize paper waste, and improve user convenience. Fingerprint recognition systems allow passenger identification and fare calculation based on route by scanning fingerprints linked to biometric IDs or bank accounts for automatic deductions. RFID tags and smart cards replace paper tickets, enabling tap-and-go entry while deducting fares electronically. GPS integration triggers alerts at destinations and tracks routes for precise fare computation based on distance. Electronic fare collection (EFC) systems analyze longitudinal multi-day payment data to estimate transit demand accurately. Raspberry Pi and EEPROM provide compact computing platforms to authenticate users, manage transactions, and record digital receipts. Keypads allow route input, while SMS confirms payments. These contactless, digital ticketing approaches leverage technologies like fingerprint sensors, RFID, smart cards, GPS, and electronic systems to

create efficient, user-friendly automated fare collection ecosystems for modern public transportation needs, especially crucial during the COVID-19 pandemic's impact on transit sectors worldwide.

3. OBJECTIVES

Integrating QR code and UPI payment technologies for public transportation fare collection can reduce costs for long-distance travelers, eliminate the need for on-board conductors, and ensure automated, real-time transfer of revenues to transportation authorities through a contactless, digital ticketing system.

3.1 KEY COMPONENTS AND TASKS

The proposed automated fare collection (AFC) system is built around leveraging QR code technology and a comprehensive digital ecosystem. A core component is the generation and management of unique personalized QR codes for each registered commuter, seamlessly linked to their user account within the system's user-friendly web application. This web app serves as the central hub, allowing users to create and manage accounts, update personal information, link preferred electronic payment methods (including online transactions, credit/debit cards, mobile wallets), view trip histories, monitor account balances, and receive real-time updates and notifications.

Robust payment integration is a crucial task, enabling the system to process fares through various electronic channels, enhancing accessibility and convenience for commuters. Upon successful QR code scanning and linked payment processing at designated entry points like station gates or vehicle entrances, the digital ticketing component generates virtual tickets within the user's web app, eliminating the need for physical tickets. This contactless approach is fortified by implementing robust security measures such as encryption protocols and secure authentication methods to safeguard user data and transaction integrity.

The system's real-time update and notification capabilities keep commuters informed about account status, fare deductions, service advisories, and relevant announcements, ensuring transparency throughout the journey. Transportation staff can efficiently verify the digital tickets conveniently displayed by commuters. By embracing this paperless, contactless solution, the proposed AFC system actively promotes environmental sustainability by reducing paper usage and waste associated with traditional ticketing methods. Ultimately, these interconnected components and tasks work cohesively to create a seamless, user-friendly, and efficient fare collection process that benefits both commuters and transportation authorities alike.

3.2 METHODOLOGY

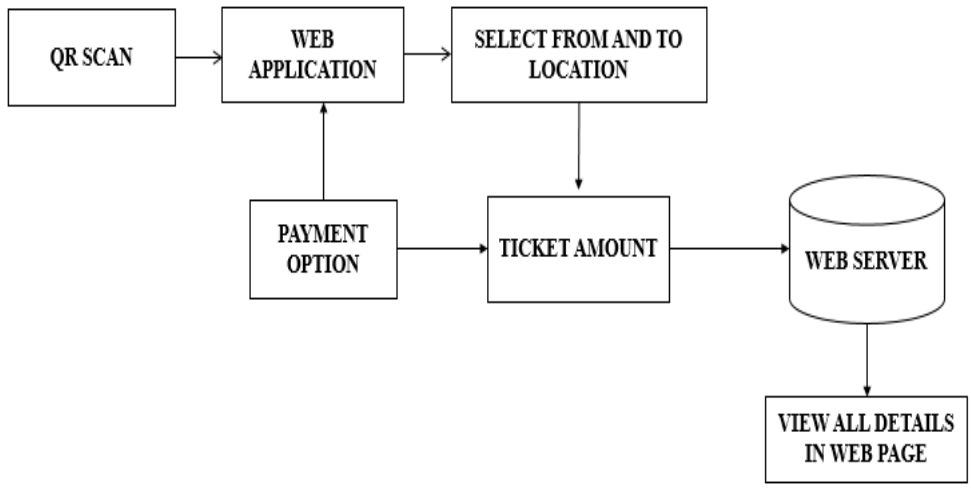

Figure 1. Block Diagram

The core of the proposed automated fare collection (AFC) system lies in leveraging QR code technology for contactless fare transactions. Each commuter is provisioned with a unique personalized QR code associated with

their account, generated through a user-friendly web application. To initiate their journey, passengers simply need to scan their QR codes using their smartphones at designated entry points, such as station gates or vehicle entrances, eliminating the need for physical tickets or cash handling.

The web application serves as the central hub for all interactions within the AFC ecosystem. Commuters can create and manage their accounts, update personal information, and securely link their preferred payment methods, including online transactions, credit/debit cards, mobile wallets, or other electronic payment gateways. This versatility accommodates a broad range of users and enhances the accessibility of the system. The application generates and displays the QR code for each user, facilitating a seamless and contactless payment process during their commute.Upon successful QR code scanning and linked payment method processing, the system generates a digital ticket within the web application, rendering physical tickets obsolete. Commuters can conveniently access and display these digital tickets for verification by transportation staff during their journey. The AFC system incorporates robust security measures, such as encryption protocols and secure authentication methods, to safeguard user information and ensure the integrity of transactions.Furthermore, the web application provides real-time updates on account status, fare deductions, trip histories, and any relevant announcements or service advisories, ensuring transparency and keeping commuters well-informed about their travel activities. By eliminating the need for traditional paper tickets, the proposed AFC system supports environmental sustainability initiatives by reducing paper usage and waste, aligning with broader efforts to minimize the ecological footprint of public transportation systems.

4. PROPOSED WORK MODULES

Figure 2. QR code

The proposed automatic fare collection (AFC) system aims to revolutionize the public transportation experience by seamlessly integrating cutting-edge technologies and user-friendly interfaces across multiple interconnected modules. At the core lies the QR Scan module, empowering commuters to initiate their journey effortlessly by scanning unique QR codes generated by the system using their smartphones. These QR codes serve as digital tickets, eliminating the need for physical counterparts and streamlining the boarding process.

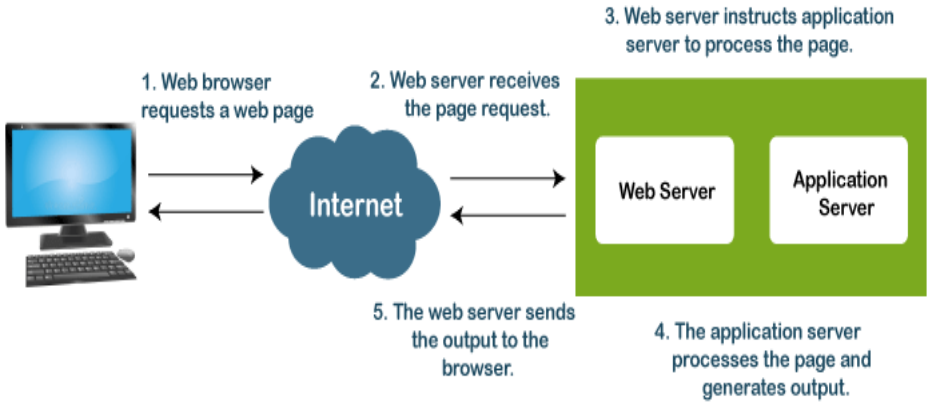

Figure 3. Web Application process

The heart of the system is the intuitive and feature-rich Web Application module, acting as a centralized hub for commuters to interact with various functionalities. Within this module, the Select From and To Location feature allows passengers to input their journey details by specifying the starting and ending locations, such as traveling from Trichy to Madurai. The chosen locations are then seamlessly integrated with the Ticket Amount module,

which accurately calculates the applicable fare based on the selected origin and destination points, ensuring transparent and precise pricing for each passenger's journey. To cater to diverse payment preferences, the Payment Option module offers a versatile and secure transaction experience by integrating popular digital payment platforms like UPI and PhonePe. Commuters can conveniently choose their preferred method, facilitating a smooth and efficient payment process directly through the Web Application. Upon successful payment processing, the Web Application instantly generates comprehensive digital tickets, which include detailed information about the selected journey, such as the origin and destination locations, fare breakdown, and transaction records. This digital ticket serves as a commuter's proof of purchase and can be readily accessed and displayed for verification purposes. Underpinning the entire system is the robust Web Server module, which acts as the backend infrastructure, handling crucial tasks like data processing, communication with payment gateways, and ensuring the seamless functioning of the overall AFC ecosystem. This module plays a critical role in maintaining the system's reliability and efficiency. Furthermore, the View All Details module within the Web Application provides commuters with a personalized dashboard, offering a holistic view of their travel activity. Passengers can conveniently access their journey history, manage transactions, and receive real-time updates on public transportation schedules, fostering transparency and enhancing the overall user experience.

By integrating these modular components, the proposed AFC system not only eliminates the need for physical tickets but also significantly enhances the overall efficiency of fare collection processes. The streamlined experience, facilitated by QR codes and digital transactions, reduces queues and minimizes manual processing, ultimately benefiting both commuters and transportation authorities alike.

5. RESULTS AND DISCUSSION

Fare List Erode to Coimbatore		
Source	Distance (km)	Fare list
Erode	0	0
Thindal	7	15
Perundurai	18	25
Toll gate (Vijaya Mangalam)	28	30
Perumanallur	48	50
Avinashi	59	60
Toll gate (Kaniyur)	90	70
Coimbatore	100	85

Table 1. Fare list from Erode to Coimbatore

The above table (model) is developed for the clarification of fare list. The table 1 is the fare list of public transport for travel between Erode and Coimbatore, two cities in Tamil Nadu, India. The table 1, shows the distance in kilometers from Erode to various milestones along the route, as well as the corresponding fare to travel to that point. For instance, the fare to travel from Erode to Thindal is 15 rupees, and the distance is 7 kilometers. The farthest milestone listed is Coimbatore, which is 100 kilometers from Erode and costs 85 rupees to travel to.

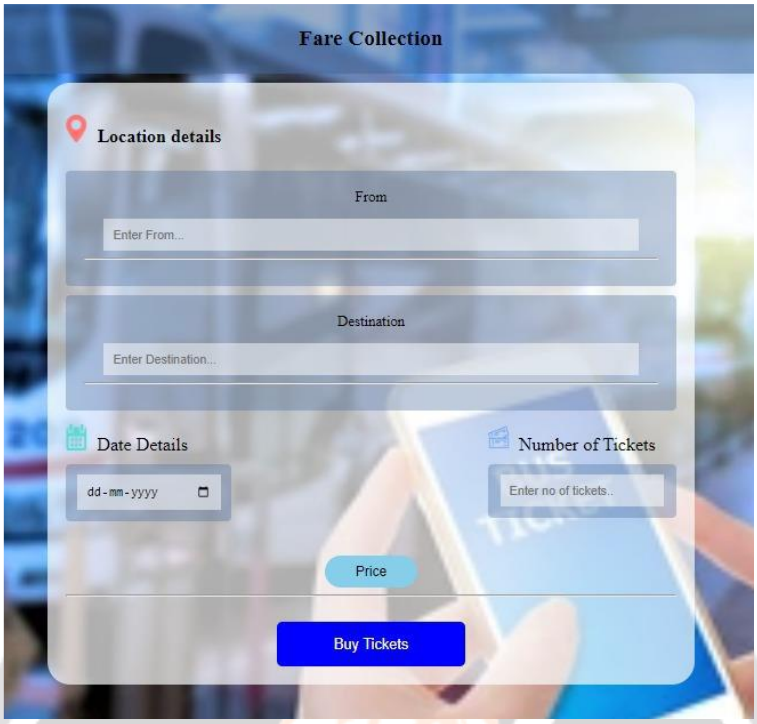

Figure 4. Home page of Web application

The implementation of the innovative QR code and digital payment system has yielded significant results in streamlining fare collection processes and enhancing the overall public transportation experience. Operational efficiency has increased remarkably, with reduced waiting times and minimized manual interventions. Commuters have praised the convenient and hassle-free travel experience provided by the user-friendly web application, which allows seamless QR code scanning, route selection, digital payments, and instant digital ticket generation.

Figure 5. Selection of payments

The integration of the Ticket Amount module has ensured accurate fare calculations based on origin and destination, promoting transparency. The Payment Option module, incorporating popular digital platforms like UPI and PhonePe, has facilitated secure and versatile transactions, accommodating diverse payment preferences. The personalized dashboard within the View All Details module has empowered commuters with access to travel histories, transaction management, and real-time schedule updates, fostering convenience and transparency.

Moreover, the transition to digital ticketing has contributed to environmental sustainability by reducing paper waste and minimizing the ecological footprint of transportation systems. These positive results have been accompanied by ongoing discussions and considerations.Scalability and capacity remain crucial topics as user adoption increases, necessitating assessments of web server and backend infrastructure capabilities. Data security and privacy are paramount, with continuous efforts to address potential vulnerabilities and maintain system integrity. Strategies for user adoption and training could further smooth the transition from traditional ticketing methods.Integration with existing transportation infrastructure, ticketing systems, and databases is being explored to ensure seamless interoperability and data synchronization. Accessibility and inclusivity for users with diverse abilities, technology proficiency, and language preferences are being considered to enhance the system's reach and usability.Continuous improvement remains a priority, with ongoing discussions and feedback loops with

stakeholders driving feature enhancements and ensuring the system's relevance and responsiveness to evolving needs.

Overall, the proposed QR code-based automated fare collection system has demonstrated promising results in terms of efficiency, user experience, and sustainability, while prompting important discussions around scalability, security, integration, accessibility, and continuous improvement to further refine and optimize the system.

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