

SMART CARD SYSTEM FOR PUBLIC TRANSPORTATION

Mrs.T.Sashirekha¹, Vadla Deekshitha²

*1 Assistant Professor, Department of CSE, Malla Reddy College of Engineering for Women.,
Maisammaguda., Medchal., TS, India*

2, B.Tech CSE (20RG1A05K2),

Malla Reddy College of Engineering for Women., Maisammaguda., Medchal., TS, India

ABSTRACT

This article analyzes the key benefits and drawbacks of both conventional and intelligent ticketing systems, as well as potential gains from switching to smart cards or e-ticketing from traditional ones (paper tickets and magnetic cards). Examined are two concepts for developing an intelligent ticketing system for urban public transportation. First are electronic tickets and associated equipment; second are electronic tickets and their functional components. An study of the practical effects of the implementation of smart cards and e-ticketing has also been included in the paper. Contactless smart cards have shown to be superior than contact ones in real-world testing and trials, as well as in the following adoption of electronic tickets. However, a new era of cutting-edge technology need even more potent fixes, including virtual ticketing systems, which may be implemented by introducing mobile technologies. Consequently, the analysis of the e-ticket is the primary emphasis of the article. Keywords: Interactive voice response call centers, Bluetooth, SMS, contact, contactless, dual-interface smart cards, card reader, e-ticket.

I. INTRODUCTION

With the launch of the Smart Traveling Card, travel convenience has undergone a paradigm leap. RFID technology, NODEMCU, and an OLED display are all flawlessly integrated to transform the travel experience. This novel card seeks to simplify travelers' payment experiences on buses, trains, and metros, among other forms of public transit. The

ability to charge the linked account in real-time, which offers an unmatched degree of flexibility and control, sets this smart card apart from traditional travel cards.

The integration of RFID technology, an open-source, extensible IoT platform called NODEMCU, and an OLED display results in a travel payment system that is both smart and intuitive for consumers to use. Travelers may easily swipe their card at specified locations on buses, trains, and metro stations thanks to the RFID reader included into the card, which enables quick and contactless transactions. This smooth integration helps to lessen traffic and transit delays in addition to improving the effectiveness of the travel process.



Figure.1: Over view of the Smart Travel Card The NODEMCU, functioning as the brains of the operation, establishes a robust connection between the smart card and the user's account, enabling real-time financial transactions. Users can conveniently manage and monitor their account balance, adding funds as needed through a secure and user-friendly interface. The advanced functionalities of the NODEMCU empower the card with the capability to process transactions rapidly, ensuring a smooth and hassle-free experience for travelers.

The OLED display serves as the interactive interface, providing users with essential information such as account balance, transaction history, and travel details. This visual feedback enhances transparency and user engagement, allowing individuals to stay informed about their travel expenditures in real-time. The display also contributes to a more intuitive and user-centric interaction, fostering a positive user experience.

The Smart Traveling Card not only revolutionizes the way commuters navigate through different modes of transportation but also introduces a novel approach to managing travel expenses. This integration of cutting-edge technologies not only elevates the efficiency of travel transactions but also places the power of financial control directly into the hands of the users. As we delve deeper into the functionalities and design principles of this smart card, it becomes evident that it represents a transformative leap towards a more connected, convenient, and user-centric future of travel.

1.1: Problem Statement:

Within the realm of contemporary urban transportation, commuters grapple with persistent challenges regarding the efficiency and convenience of payment methods across diverse travel modes, including buses, trains, and metros. The existing travel card systems, while functional for fare payment, lack a fundamental feature – real-time fund management. This deficiency becomes particularly notable in dynamic travel scenarios where users require the ability to adjust account balances on-the-go. To address this critical gap, a Smart Traveling Card is envisioned, seeking to redefine the travel experience by providing users with a contactless and dynamically managed payment solution. The objective is to offer a user-friendly, efficient, and flexible payment system that aligns with the dynamic nature of modern urban commuting.

The primary issue at hand lies in the inadequacy of traditional travel cards to furnish users with comprehensive and

instantaneous financial control during their journeys. The envisioned Smart Traveling Card aims to transcend these limitations, offering a solution that not only seamlessly facilitates various transportation modes but also empowers users to dynamically manage and replenish their associated accounts in real time. This innovation responds to the evolving expectations of travelers who seek both convenience and control in their daily commutes.



Figure.2 : Problem faced before Smart Travel Card

As urban centres expand and mobility options diversify, there is a growing demand for a payment solution that aligns with the dynamic nature of modern urban commuting. The solution aims to revolutionize the payment paradigm, not merely as a transactional tool but as a dynamic financial management interface for commuters. By addressing this pivotal challenge in transportation payment systems, the Smart Traveling Card emerges as a transformative solution that not only simplifies transactions but also enhances user engagement and financial transparency throughout the entire travel experience.

1.2: Problem Scope:

The challenges faced by urban commuters in current transportation systems form the core of the problem scope addressed by the Smart Traveling Card initiative. Within the scope of contemporary urban environments, where diverse modes of transportation such as buses, trains, and metros coexist, the existing travel card systems fall short in providing a holistic and dynamically managed payment solution.

The identified problem lies in the absence of real-time fund management capabilities, a crucial aspect for users navigating through dynamic travel scenarios.

The scope extends to the need for a payment system that not only caters to the functional aspects of fare payment but also allows users to make on-the-go adjustments to their account balances. This is particularly relevant as urban commuters increasingly seek seamless, contactless, and flexible payment options that align with the rapid pace and unpredictability of modern commuting.

The envisioned Smart Traveling Card project aims to address this gap by redefining the scope of travel payment solutions. It seeks to provide commuters with a card that not only facilitates smooth transitions across various transportation modes but also empowers them with real-time financial control. The scope encompasses a user-friendly, efficient, and flexible payment system that aligns with the evolving expectations of modern travelers.

As urban centers continue to grow, and mobility options diversify, the problem scope extends to accommodating these changes by offering a solution that transcends the limitations of traditional travel cards. The Smart Traveling Card project aims to introduce a transformative approach, where the scope expands beyond transactional functionality to embrace the card as a dynamic financial management interface for commuters. This scope, therefore, envisions a solution that not only simplifies payment transactions but also enhances user engagement and financial transparency throughout the entire spectrum of the travel experience.

1.3: Advantages of using Smart travel card

The Smart Traveling Card initiative presents a host of advantages poised to transform the urban commuting experience and address existing challenges in payment systems.

Real-time Fund Management: One of the primary advantages of the Smart Traveling Card is its unique capability to enable real-time fund management. Commuters can

dynamically adjust their account balances, offering unprecedented flexibility and control over their travel expenditures.

Contactless and Seamless Transactions: Leveraging RFID technology, the Smart Traveling Card facilitates contactless transactions. This not only enhances the overall efficiency of fare payments but also contributes to reduced congestion and transit delays, particularly in high-traffic areas such as metro stations and buses.

User-friendly Interface with OLED Display: The inclusion of an OLED display provides commuters with a user-friendly interface, offering real-time information on account balances, transaction history, and travel details. This visual feedback enhances transparency and user engagement, contributing to a positive user experience.

Efficient and Swift Transactions: The integration of NODEMCU as the core component ensures efficient and rapid processing of transactions. Commuters can experience swift and seamless interactions, reducing wait times and enhancing the overall efficiency of the payment system.

Enhanced Financial Transparency: The Smart Traveling Card promotes financial transparency by allowing users to monitor their account balances and transaction history in real time. This feature contributes to better financial planning and management for commuters.

Flexibility Across Multiple Transportation Modes: The card's versatility allows it to be used across various transportation modes, including buses, trains, and metros. This versatility simplifies the commuting experience for users who frequently switch between different modes of transport within urban environments.

Empowerment of Commuters: By placing real-time financial control in the hands of commuters, the Smart Traveling Card empowers users to manage their travel expenses dynamically. This empowerment aligns with the evolving expectations of

modern travelers who seek both convenience and control in their daily commutes.

Adaptability to Evolving Urban Dynamics:

As urban centers continue to grow and mobility options diversify, the Smart Traveling Card is designed to adapt to evolving urban dynamics. The card's capabilities anticipate the changing needs of commuters and provide a forward-looking solution for urban transportation challenges.

The Smart Traveling Card offers a range of advantages, from real-time fund management and contactless transactions to user-friendly interfaces and adaptability to diverse transportation modes. These advantages collectively contribute to a transformative and enhanced commuting experience for urban dwellers.

1.4 Proposed Solution:

The proposed solution, the Smart Traveling Card, serves as a comprehensive response to the challenges inherent in current urban transportation payment systems. Leveraging advanced technologies such as RFID, NODEMCU, and an OLED display, this innovative card introduces a groundbreaking approach to fare payments and account management.

At the core of the solution is the real-time fund management feature, allowing commuters to dynamically adjust their account balances on the go. This capability addresses a critical gap in existing travel card systems, providing unparalleled flexibility and control over travel expenditures. The Smart Traveling Card's use of RFID technology ensures contactless and seamless transactions, contributing to enhanced efficiency and reduced congestion in high-traffic transportation hubs.

The user-friendly interface, facilitated by the OLED display, empowers commuters with real-time information on account balances, transaction history, and travel details. This visual feedback enhances transparency, user engagement, and overall satisfaction with the travel payment system. The integration of NODEMCU ensures swift and efficient transaction processing, reducing wait times

and optimizing the overall payment experience for users.

The card's versatility allows it to seamlessly transition across various transportation modes, including buses, trains, and metros, making it an adaptable solution for users navigating diverse urban environments. The proposed solution not only addresses current challenges but also anticipates the evolving dynamics of urban mobility, aligning with the changing needs and expectations of modern travellers.

The Smart Travelling Card serves as a transformative solution that goes beyond traditional transactional functionalities. It redefines the payment paradigm by offering commuters a dynamic financial management interface, enhancing the entire spectrum of the travel experience. With its innovative features and adaptability, this proposed solution is poised to revolutionise urban commuting, providing a seamless, user-centric, and technologically advanced payment system for the modern era.

1.5 Aim and Objectives

Aim:

The primary aim of the Smart Travelling Card initiative is to revolutionise the urban commuting experience by addressing the inherent challenges within current transportation payment systems. The proposed solution is designed to introduce a dynamic and user-centric approach to fare payments, offering a seamless and technologically advanced payment system.

The overarching aim is to empower commuters with real-time fund management capabilities, allowing them to dynamically adjust their account balances during travel. By incorporating RFID technology, the card aims to facilitate contactless and seamless transactions, thereby enhancing the overall efficiency of fare payments and contributing to reduced congestion in transit hubs.

Another key aim is to provide users with a user-friendly interface through the integration of an OLED display. This interface offers real-time information on account balances, transaction history, and travel details, fostering

enhanced transparency and user engagement. The inclusion of NODEMCU in the solution aims to ensure swift and efficient transaction processing, reducing wait times and optimising the overall payment experience for commuters.

The proposed solution further aims to cater to the diverse needs of commuters by offering versatility across multiple transportation modes, including buses, trains, and metros. This adaptability aligns with the evolving dynamics of urban mobility, addressing the changing expectations of modern travellers.

The primary aim of the Smart Travelling Card is to provide commuters with a revolutionary payment system that not only simplifies transactions but also empowers users with real-time financial control, enhances user engagement, and anticipates the evolving needs of urban mobility.

Objectives:

1. Real-Time Fund Management: Enable commuters to dynamically adjust their account balances in real-time during their journeys.

2. Contactless and Seamless Transactions: Implement RFID technology to facilitate contactless transactions, reducing wait times and enhancing overall transaction efficiency.

3. User-Friendly Interface: Integrate an OLED display to provide commuters with a user-friendly interface, offering real-time information on account balances, transaction history, and travel details.

4. Efficient Transaction Processing: Utilise NODEMCU to ensure swift and efficient processing of transactions, contributing to a seamless and optimised payment experience.

5. Versatility Across Transportation Modes: Design the Smart Travelling Card to seamlessly transition across various transportation modes, including buses, trains, and metros, enhancing its adaptability for diverse urban environments.

6. Enhanced Financial Transparency: Provide users with a transparent view of their financial transactions, fostering better financial planning and management.

7. Reduced Congestion in Transit Hubs:

Contribute to reduced congestion in high-traffic transportation hubs by promoting contactless transactions and efficient fare payments.

8. Anticipation of Evolving Urban Mobility:

Anticipate and cater to the changing dynamics of urban mobility by designing a solution that aligns with the evolving expectations and needs of modern commuters.

9. User Empowerment: Empower commuters by placing real-time financial control in their hands, allowing for increased autonomy in managing travel expenses.

10. Positive User Experience: Aim for a positive overall user experience by combining technological advancements with user-centric design principles.

11. Technological Innovation: Showcase technological innovation by leveraging RFID, NODEMCU, and OLED display to create a solution that stands at the forefront of contemporary urban transportation advancements.

12. Adaptability to Urban Growth: Design the Smart Travelling Card as an adaptable solution that can accommodate the growth and changing dynamics of urban centres and their transportation systems.

The objectives of the Smart Travelling Card initiative encompass a holistic approach to enhancing the urban commuting experience, ranging from real-time fund management to technological innovation and adaptability to evolving urban mobility needs.

II. LITERATURE SURVEY

The extensive literature survey undertaken for the Smart Travelling Card initiative is a nuanced exploration across various domains, providing a comprehensive understanding of existing research, technologies, and methodologies. Delving into the intricate landscape of urban mobility and payment systems, the survey uncovers the multifaceted challenges faced by commuters in contemporary transportation networks. Studies on congestion dynamics, user experiences, and financial management in urban transportation

set the stage, offering valuable insights into the complex milieu that the Smart Travelling Card seeks to address.

Moving into the realm of technology, the survey scrutinises the application of RFID technology within transportation systems. The focus is on how RFID facilitates contactless transactions and augments the overall efficiency of fare payment. The examination extends beyond theoretical frameworks to encompass real-world implementations, drawing from success stories and challenges faced in integrating RFID-based payment solutions. Concurrently, the survey probes the capabilities of NODEMCU, an open-source IoT platform, assessing its potential in optimising transaction processing. Insights garnered from this exploration are pivotal in understanding how the integration of such technologies contributes to the efficiency and seamlessness of the proposed Smart Travelling Card.

The integration of OLED displays in user interfaces emerges as a pivotal aspect of the survey, elucidating the impact of visual feedback on user engagement, transparency, and overall user experience. By drawing from relevant studies, the Smart Travelling Card initiative aims to implement a user-centric design that prioritises empowerment and positive interactions. Furthermore, the survey navigates through existing payment solutions adept at transitioning across various transportation modes. This investigation is instrumental in uncovering the key factors that contribute to the versatility and adaptability required for success in the diverse and dynamic landscapes of urban environments.

The literature survey extends its reach to studies focusing on real-time fund management in travel cards. Understanding user experiences, challenges, and the implications of such systems on financial transparency provides crucial insights. Success stories and case studies related to smart card initiatives in urban transportation contribute valuable lessons, offering a practical

understanding of the triumphs and challenges encountered in real-world implementations.

The literature survey for the Smart Travelling Card initiative delves into a multifaceted exploration of existing research, technologies, and methodologies across several key domains. Firstly, an in-depth examination of urban mobility and payment systems provides valuable insights into the challenges inherent in current transportation paradigms. Studies on congestion, user experience, and financial management in urban transportation form the foundation for understanding the contextual background of the Smart Travelling Card initiative.

The survey then scrutinises the application of RFID technology in transportation systems, investigating its role in facilitating contactless transactions and enhancing efficiency in fare payment. Exploration of success stories and challenges in implementing RFID-based payment solutions informs the potential benefits and pitfalls of incorporating this technology. Additionally, the survey delves into the use of NODEMCU, an open-source IoT platform, assessing its capabilities in optimising transaction processing and overall efficiency in IoT-based solutions.

The integration of OLED displays in user interfaces takes centre stage in the literature survey, where studies on visual feedback contribute to user engagement, transparency, and a positive overall experience. Insights from these studies inform the user-centric design principles for the Smart Travelling Card, emphasising empowerment and positive interactions. Furthermore, an exploration of existing payment solutions that transition seamlessly across various transportation modes, including buses, trains, and metros, sheds light on the versatility and adaptability required for success in diverse urban environments.

The survey extends to literature on real-time fund management in travel cards, aiming to understand user experiences, challenges, and the impact of such systems on financial transparency. Additionally, it explores success

stories and case studies related to the implementation of smart card initiatives in urban transportation, offering valuable lessons from both triumphs and challenges.

In a broader context, the literature survey encompasses technological innovations in urban mobility, focusing on advancements in payment systems, smart cards, and IoT applications. This exploration is crucial for aligning the Smart Travelling Card initiative with the evolving landscape of transportation technology. Lastly, insights from smart city initiatives emphasise the importance of adaptability and scalability in transportation solutions, ensuring that technological advancements meet the changing dynamics of urban centres. The comprehensive literature survey aims to equip the Smart Travelling Card initiative with a nuanced understanding of existing knowledge, enabling it to leverage insights, bridge identified gaps, and contribute to the evolution of innovative solutions in urban mobility and payment systems.

Zooming out, the survey widens its lens to capture technological innovations in urban mobility, exploring advancements in payment systems, smart cards, and IoT applications. This exploration is vital for ensuring that the Smart Travelling Card initiative aligns seamlessly with the evolving technological landscape of transportation. The survey culminates by gleanings insights from smart city initiatives, emphasising the paramount importance of adaptability and scalability in transportation solutions. This broader perspective ensures that technological advancements are not only innovative but also capable of meeting the dynamic needs of burgeoning urban centres.

The extensive literature survey is a crucial foundation for the Smart Travelling Card initiative, providing a rich tapestry of insights, best practices, and potential pitfalls. It equips the initiative with the knowledge needed to navigate the complex intersection of technology, user experience, and urban dynamics, ensuring a holistic and informed

approach to the development of this innovative solution.

III. BLOCK DIAGRAM

The methodology for the Smart Travelling Card initiative is intricately structured to translate the wealth of insights derived from the extensive literature survey into a tangible and innovative solution. This multifaceted approach involves a combination of technology integration, user-centric design principles, and a robust testing and implementation strategy.

The first facet of the methodology focuses on the integration of key technologies. The implementation of RFID technology takes centre stage, necessitating the development of both hardware and software components for enabling seamless contactless transactions. Simultaneously, the integration of NODEMCU, an open-source IoT platform, is strategically planned to optimise transaction processing. This involves the development of software functionalities to harness the capabilities of NODEMCU for swift and efficient transaction processing in real-time. Additionally, the inclusion of an OLED display in the card's design is a crucial aspect. The methodology emphasises the development of a user-friendly interface that showcases real-time information on account balances, transaction history, and travel details.

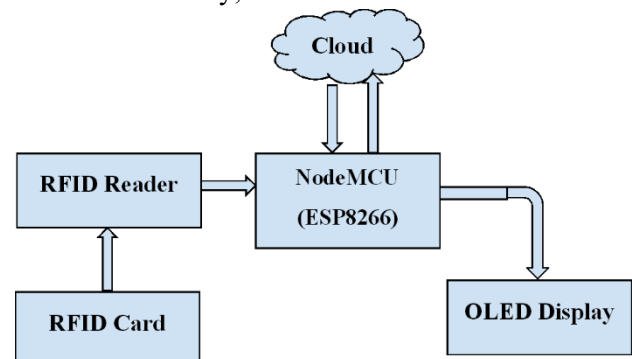


Figure.3: Block Diagram

The second aspect of the methodology revolves around the implementation of user-centric design principles. Prototypes and mockups will be created, incorporating iterative feedback from users to refine the design continually. The real-time fund

management capabilities of the Smart Travelling Card will be a pivotal focus, allowing users to dynamically adjust their account balances during travel. The design will prioritise transparency, ensuring users have a clear understanding of their financial transactions.

Testing forms an integral part of the methodology. The versatility of the Smart Travelling Card across multiple transportation modes will undergo comprehensive testing through simulation scenarios and real-world scenarios. Efficiency and transaction processing will be rigorously tested to assess transaction speed, system responsiveness, and overall reliability. Pilot testing with a select group of users will provide valuable real-world feedback on usability, reliability, and overall satisfaction.

The scalability and adaptability of the technology to different urban environments and varying scales of transportation systems will be assessed as part of the methodology. This involves evaluating how well the Smart Travelling Card aligns with the dynamic needs of urban centres, ensuring its continued effectiveness as cities evolve.

The methodology adopts an iterative development approach, where insights from testing phases and user feedback inform continuous refinement. Optimization processes will be implemented to enhance system efficiency, user interface, and overall performance. Throughout the entire process, comprehensive documentation will be maintained, encompassing design principles, technological integrations, testing methodologies, and user feedback. Knowledge transfer sessions will ensure the seamless dissemination of information for future maintenance and enhancements.

The proposed methodology reflects a systematic and adaptive approach, ensuring the Smart Travelling Card initiative not only meets its outlined objectives but also remains flexible and responsive to the dynamic landscape of urban mobility and technological advancements.

IV. HARDWARE COMPONENTS

4.1 NodeMCU (ESP8266)

The NodeMCU ESP8266 is a powerful and versatile platform designed for Internet of Things (IoT) development. The ESP8266 is a cost-effective Wi-Fi microchip known for its capability to enable wireless communication in IoT applications. NodeMCU, on the other hand, is an open-source firmware and development kit that simplifies the process of prototyping and programming the ESP8266. With built-in Wi-Fi connectivity, the NodeMCU ESP8266 allows devices to connect to the internet wirelessly, making it suitable for a wide range of IoT projects. One notable feature is its support for the Lua scripting language, providing a high-level programming environment for developers. Additionally, it is compatible with the Arduino IDE, allowing those familiar with Arduino to use the NodeMCU platform. Equipped with General Purpose Input/Output (GPIO) pins, the ESP8266 facilitates interfacing with various electronic components, making it ideal for applications such as home automation and sensor networks. The NodeMCU ESP8266 has garnered significant community support, resulting in an extensive collection of libraries and documentation, making it a popular choice for rapid IoT prototyping and development.

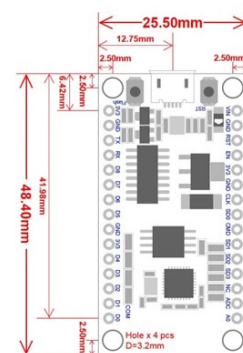


Figure.4: NodeMCU 2D View

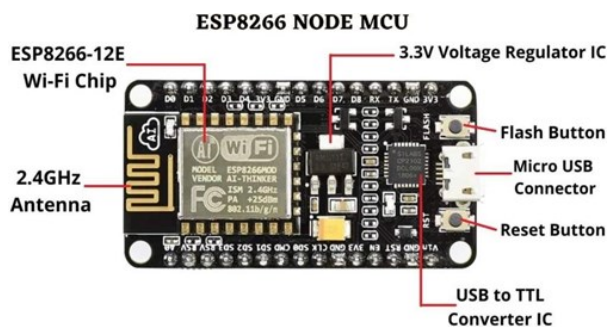


Figure.5 : NodeMCU Parts

The NodeMCU ESP8266 development board typically has GPIO (General Purpose Input/Output) pins that can be used for various purposes, including interfacing with sensors, actuators, and other electronic components. Below is a common pinout configuration for the NodeMCU development board

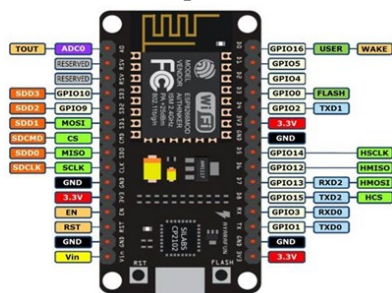


Figure.6 : NodeMCU ESP8266 Pinout

4.2 OLED Display:

OLED displays are available in a range of sizes (such as 128×64, 128×32) and colors (such as white, blue, and dual-colour OLEDs). Some OLED displays have an I2C interface, while others have an SPI interface.

One thing they all have in common, however, is that at their core is a powerful single-chip CMOS OLED driver controller – SSD1306, which handles all RAM buffering, requiring very little work from your Arduino.

In this tutorial, we'll be using both I2C and SPI 0.96-inch 128x64 OLED displays. Don't worry if your module is a different size or color; the information on this page is still useful.

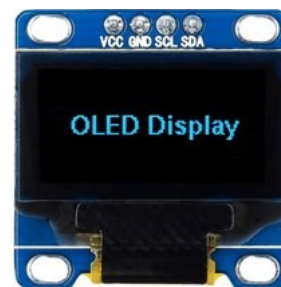


Figure.7: OLED Display

4.3 RFID

Radio Frequency Identification (RFID) is a form of wireless communication that incorporates the use of electromagnetic or electrostatic coupling in the radio frequency portion of the electromagnetic spectrum to uniquely identify an object, animal or person. It uses radio frequency to search, identify, track and communicate with items and people. It is a method that is used to track or identify an object by radio transmission used over the web. Data digitally encoded in an RFID tag which might be read by the reader. This device works as a tag or label during which data is read from tags that are stored in the database through the reader as compared to traditional barcodes and QR codes. It is often read outside the road of sight either passive or active RFID.



Figure.8: RFID

V. CONCLUSION

1. ITS designed to streamline ticketing processes demands significant financial outlays and in-depth research. Some technologies have limited usage because there is a risk that better, more efficient methods may be introduced.

2. Since it is difficult to predict the trends in technological progress, a thorough cost-benefit analysis is essential. ITS have a very high potential to enhance the urban transport ticketing system, notwithstanding issues around the obsolescence of electronic equipment in terms of more effective software and the advent of new alternative solutions.

3. Fast-track methods for enhancing the intelligence of urban public transportation networks include contactless smart cards and e-ticketing.

4. Simple payment methods for urban transportation are essential to the smooth operation of an intermodal urban public transportation system. For this reason, the most reputable public transportation providers often use contactless smart card based ticketing systems. Smart card based ticketing systems can only be economical for multimodal trips due to their high installation costs. Covering as many kinds of transportation as possible, including subterranean and terrestrial transportation, is essential.

5. The paperless or "virtual" ticketing system that underpins e-ticketing makes it very user-friendly and appealing to travelers. This is the most creative approach, and it has already been used with great success in city public transportation systems.

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