ISSN 2277-2685
IJESR/April-June. 2026/ Vol-16/Issue-2/122-129
K Srinidhi Reddy *et. al.*, /International Journal of Engineering & Science Research

Full Length Article

Smart Billing Trolley Using IoT With Movement Based Electricity Generation System

K Srinidhi Reddy[1], G Saika Reddy[2], V Sravya Sree[3], B Pavani[4]

[1]Assistant Professor;Department Of Electronics And Communication Engineering Bhoj Reddy Engineering College For Women Hyderabad India
[2,3,4]B.Tech Students; Department Of Electronics And Communication Engineering Bhoj Reddy Engineering College For Women Hyderabad India
saikareddy08@gmail.com, sravyavuligay@gmail.com, pavanidolly1@gmail.com

Accepted 04-04-2026

Abstract
A supermarket or a hypermarket is a form where wide variety of product items is available. These product items can be food, beverages or any household product. The main purpose of supermarkets is to provide availability of all the products and save the time of the customers but sometimes customer gets frustrated while waiting in the queue at billing counter and sometimes they get confused while comparing the total price of all the products with the budget in the pocket before billing.
To overcome these problems, we have designed a smart trolley using Arduino. With this system, there is no need for customer to wait in the queue for the scanning for the product items for billing purpose. Supermarkets or Hypermarkets provide this faculty to only those customers which having membership cards.
When the customer inserts the membership card in the basket or trolley only then it will work as a smart trolley. Otherwise, it will work as a normal trolley. Supermarkets and hypermarkets use this technique as a strategy to increase the number of customers.
In this project we are using NodemcuESP8266 Board, lcd display and rf-id module. When the person want any item must and should show the item to reader. RFID reader will read that number and compares that number in to the internal database and display the amount on to the lcd display. We can continuously add the item in to the trolley. Otherwise if we are not interested any item we can show the same item to the reader. reader will detect particular card and erase the money. lcd display will show the amount and item in trolley.

Introduction

The dynamic growth and the advent of new and exciting development in the field of IoT (Internet of Things) have paved the way for unique ways of using technology in a lot of fields. Wireless communication combined with radio and frequency sensing gives a whole new dimension to the way people interact with devices and use them in their daily routine. Nowadays, supermarkets and shopping complexes have become so commonplace, that they are no longer a luxury afforded only by urban cities. They have expanded beyond the domain of big cities and ventured into rural areas as well. Anybody can go to these stores and buy products that they need, but they are not entirely convenient, especially when a customer has to wait for hours in queues on busy days.

This introduces electronic tags attached to individual objects. When these tags become in the range of reader it reads the stored information of object wirelessly which is known as RFID technology. RFID plays an integral role in the applications of IoT. It consists of three components such as RFID tags attached to the object that contain identity or data about an object, RFID reader that read the data from the tags and central processing system that perform communication in between RFID system to other electronic devices. It emerging a revolutionary effect on a wide range of applications like aircraft maintenance, anticounterfeiting, health care, baggage handling, and supply chain management.

The RFID tags are somewhat similar to the traditional barcodes in their purpose and functionality, as they are used for data processing. However there are a few key differences between the two. Barcode usually requires a barcode reader to visually register the code in order to obtain information, while in the case of RFID, the use of radio waves as a means of recording data means that no line of sight is required. RFID has automatic tracking enabled and allows new information to be updated from time to time while the barcode scanning requires one to manually track the data

and has no provision for updating records. RFID overcomes the drawbacks posed by barcode system which also include durability issues. The system allows a customer to scan the items and the trolley automatically updates the total cost and bills the customer. It also has the provision of setting a budget, which when
exceeded, The system is built such that billing information is sent to a central server in real-time using the ESP8266 wifi module which tracks all the shopping trolleys and allows the client to log into the integrated app to track purchase and make payments digitally on the spot. The ease of functionality, versatility, and adaptability of the RFID enabled shopping cart makes it a state of the art system for shopping. On completion of the customer's shopping, he/she will press the button present on the trolley, which will lock it through the help of a servo motor installed on the trolley to provide security and prevent theft and the final bill will be generated.

Smart Billing Trolley Using IoT With Movement Based Electricity Generation System

In this chapter we will discuss about the existing system, proposed system, block diagram, and methodology of the Smart Billing Trolley Using IoT with Movement- Based Electricity Generation System. This chapter provides an overview of how the system is designed and how it improves upon the limitations of the existing methods.

The existing system focuses on automating the billing process using technologies such as RFID, barcode scanners, and embedded systems. Although these systems reduce manual effort and waiting time, they still face certain limitations such as higher cost, security concerns, and dependency on external power sources.

To overcome these limitations, the proposed system introduces an IoT-based smart billing solution integrated with a movement-based electricity generation mechanism. This system utilizes NodeMCU and ESP8266 for efficient wireless communication and real-time data processing. The addition of electricity generation through trolley movement makes the system more energy-efficient and sustainable. The main objectives of this system are to reduce billing time, eliminate long queues, provide real-time product tracking, enable wireless communication using IoT, and utilize movement-based electricity generation to improve energy efficiency and user convenience.

This chapter also explains the block diagram of the system, illustrating the interaction between different components, and describes the methodology followed for the successful implementation of the project.

Existing System

An existing system of a smart billing trolley is designed to simplify and speed up the shopping and checkout process in retail stores. It typically uses technologies like RFID (Radio Frequency Identification), barcode scanners, and embedded microcontrollers to automatically detect and record items placed in the trolley. Each product is tagged, and when added or removed, the system updates the total bill in real time, which is displayed on an LCD screen attached to the cart. advanced systems are also integrated with mobile apps or wireless communication modules to send billing data directly to the store's server, reducing the need to stand in long checkout queues. This system improves customer convenience, minimizes human error, and enhances overall shopping efficiency.
The existing smart billing trolley system mainly relies on RFID or barcode scanning + embedded systems + wireless communication to automate billing and reduce checkout time, but still faces challenges like cost and security Some

Proposed System

Software and hardware development environment that is built around a very inexpensive System-on-a-Chip (SoC) called the ESP8266. The ESP8266 is designed and manufactured by Express, contains all crucial elements of the modern computer: CPU, RAM, networking (wi-fi), and even a modern operating system and SDK.

That makes it an excellent choice for this system design. The NodeMCU aims to simplify ESP8266 development. It has two key components. (i). An open source ESP8266 firmware that is built on top of the chip manufacturer's proprietary SDK.

The firmware provides a simple programming environment based on eLua (embedded Lua), which is a very simple and fast scripting language wi th an established developer community. For new comers, the Lua scripting language is easy to learn. And to add on NodeMCU can be programmed with the Android IDE too. (ii). A development kit board that incorporates the ESP8266 chip on a standard circuit board. The board has a built-in USB port that is already wired up with the chip, a hardware reset button, Wi- Fi antenna, LED lights, and standard-sized GPIO (General Purpose Input Output) pins that can plug into a bread board. Figure 2 below shows the NodeMCU development board. This proposed system offers several advantages such as reduced dependency on external power sources, improved billing accuracy, faster checkout process, enhanced security using RFID technology, and eco-friendly operation due to electricity generation from trolley movement. Additionally, the system ensures real-time data transmission between the trolley and the central billing unit, improving overall efficiency. It also

minimizes human intervention, thereby reducing errors and operational costs in supermarkets. Furthermore, the user-friendly interface makes it convenient for customers to monitor their purchases and expenses while shopping.

Block Diagram

An RFID tag (of frequency 125khz) is attached to every product in the mall and the reader (EM- 18) is attached to the trolley. At the time of purchase, the tag attached to the product is scanned by the reader. Each tag has a unique EPC. Based on the EPC received by the nodemcu, the information of the product is displayed on the LCD along with the updated cost. This information is also sent to central PC/mobile with the help of wifi transmitter at the trolley and wifi receiver at the PC/mobile. If the customer wants to remove the added product, the product should be scanned again. Then the cost of the corresponding product will be deducted from the bill. The push button is provided at the trolley to indicate the end of the shopping. On pressing of push button, the final bill is displayed on the LCD and the payment through pre charged card can be done. Recharged cards are unique RFID tags provided for each customer.

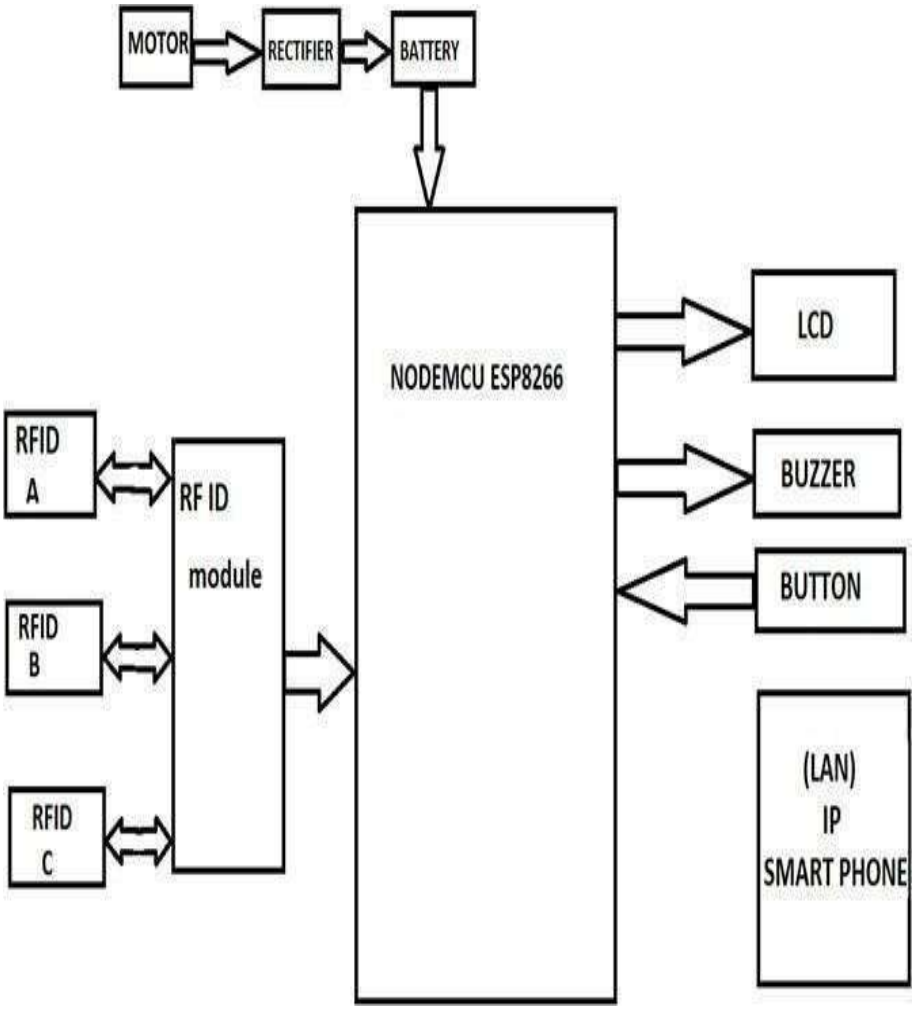


Fig3.1: Block Diagram

RFID Technology

Radio Frequency Identification (RFID) is a wireless communication technology that uses electromagnetic fields to automatically identify and track tags attached to objects. An RFID system mainly consists of three components: a tag (transponder), a reader (interrogator), and a backend database. The RFID tag contains a microchip and an antenna that stores and transmits data, while the reader sends radio signals to detect

and retrieve information from the tag without requiring direct contact or line-of-sight. This makes RFID more efficient and flexible Radio compared to traditional identification methods like barcodes.

RFID technology is widely used in various applications such as inventory management, supply chain tracking, access control systems, and contactless payments. It improves operational efficiency by enabling fast data collection, real-time tracking, and reduced human intervention. With advancements in Internet of Things (IoT) and automation, RFID has become an essential technology in modern industries, offering enhanced accuracy, security, and convenience in data handling and object identification.

Identification processes that rely on AIDC technologies are significantly more reliable and less expensive than that are not automated.

RFID represents a technological advancement in AIDC because it offers advantages that are not available in other AIDC systems such as bar codes. RFID offers these advantages because it relies on radio frequencies to transmit information rather than light, which is required for optical AIDC technologies. RFID technology offers several advantages over traditional barcode

RFID products often support other features that bar codes and other AIDC technologies do not have, Without optical line of sight, because radio waves can penetrate many materials, At greater speeds, because many tags can be read quickly, whereas optical technology often requires time to manually reposition objects to make their bar codes visible, and Over greater distances, because many radio technologies can transmit and receive signals more effectively. than optical technology under most operating conditions. such as rewritable memory, security features, and environmental sensors that enable the RFID technology to record a history of events. RFID tags are mainly classified into three types based on their power source: These tags have a battery but rely on the reader for communication. They offer better performance than passive tags and consume less power than active tags.

RFID is short for Radio Frequency Identification. Generally a RFID system consists of parts. A Reader, and one or more Transponders, also known as Tags. RFID systems evolved from barcode labels as a means to automatically identify and track products and people.

Results & Discussion

In this chapter we will discuss about the results and discussions of the Smart Billing Trolley Using IoT with Movement-Based Electricity Generation System. This chapter presents the outcomes obtained from the implementation of the proposed system and evaluates its performance.

The results include the successful operation of various modules such as RFID-based product identification, real-time data processing using NodeMCU, and display of information on the LCD. The integration of IoT technology enables efficient communication and monitoring of the system. The discussion section analyzes the system performance, accuracy of billing, response time, and reliability under different conditions. It also highlights the advantages, limitations, and possible improvements of the system.

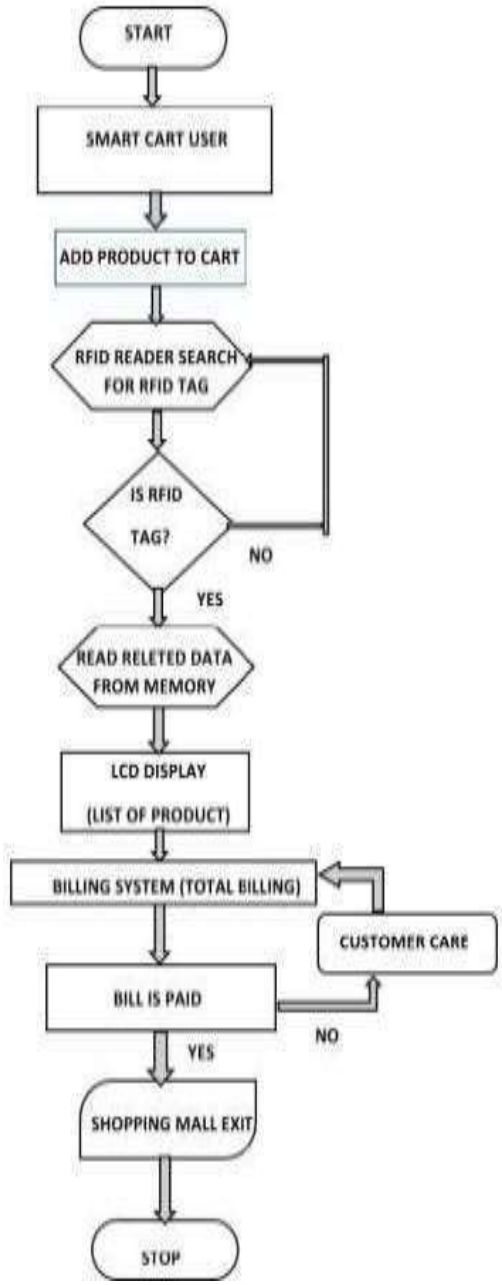
Overall, this chapter provides a clear understanding of how effectively the proposed system meets the project objectives.

In addition, the system is tested under different scenarios to ensure its consistency and stability during operation. The response of the RFID module in detecting multiple products and updating the billing information is carefully observed. The performance of the NodeMCU in handling data transmission and communication with the network is also evaluated.

The efficiency of the movement-based electricity generation system is analyzed to determine its contribution towards powering the components. Any delays, errors, or mismatches in data processing are identified and discussed in detail. Furthermore, the user interface through the LCD display is examined for clarity and ease of use. The overall system integration is verified to ensure that all components work together seamlessly. The findings of this chapter help in understanding the practical applicability of the system and provide insights for future enhancements and improvements. The response of the RFID module in detecting multiple products and updating the billing information is carefully observed. The performance of the NodeMCU in handling data transmission and communication with the network is also evaluated.

Our proposed method of billing is simple, stable as well as reliable. Customers don't have to wait in queues for getting billed. They can easily pay online through our app, thus saving them time. Also, we provide our trolley with security by locking it with the help of servo motor once the shopping is completed. The system is connected to a mobile application that allows users to complete payments online securely, making the entire process faster and more convenient. Additionally, once the shopping and payment are completed, the trolley is automatically ocked using a servo motor mechanism, ensuring security and preventing unauthorized use.

Fig 6.1 : Flowchart



As RFID tags don't work on the line of sight technology, no product can be put inside the trolley without being scanned. Also, as a backup, a security check is done at the door. Another advantage of our project is that we have used ionic framework to develop our app, which enabled

us to provide users with app compatibility with all three formats i.e, Android, Ios and Windows. They can easily pay online through our app, thus saving them time. Also, we provide our trolley with security by locking it with the help of servo motor once the shopping is completed.

Working

A person adds an item to the trolley, the card will be scanned by the RFID reader. Reader sends this code to Node MCU which further reads the product's code and sends it to the cloud, where the product database is available. Then a smart shopping cart application fetches the data and displays it on Lcd. The item details like name, price & total bill of things inserted in the cart are displayed on the Web page. As we add the items, the costs will get added to the total. Thus, the billing is done. Simultaneously all details are displayed on the Webpage. And additionally if we would like to get rid of some inserted item, then that product can be removed by pressing the push button and scanning it again from the trolley. The cost of the removed product will be deducted from the total amount which will be displayed on the mobile app. Every trolley will have a separate Identification number. The smart shopping cart would be able to automatically read the products that have been put into the cart by scanning RFID. A Led is used for giving an intimation when a product is added or removed.

Results

The result was positive and the system responded well. The diagram below shows the complete prototype implementation of the proposed system

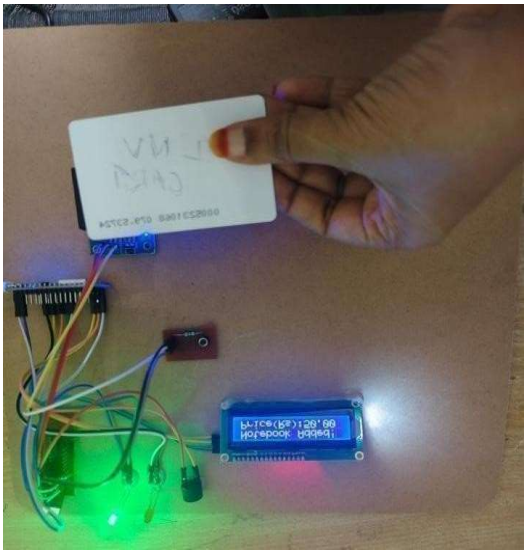


Fig 4 : RFID card scanning

The above figure shows the result of the system which is used to generate the total bill. The EM-18 module scans the RFID tags. Display the bill on LCD

If we want add or delete the items/products, we can do that by using switches. After purchasing all the products we can click on the final payment button.

Then total output will be displayed on LCD.

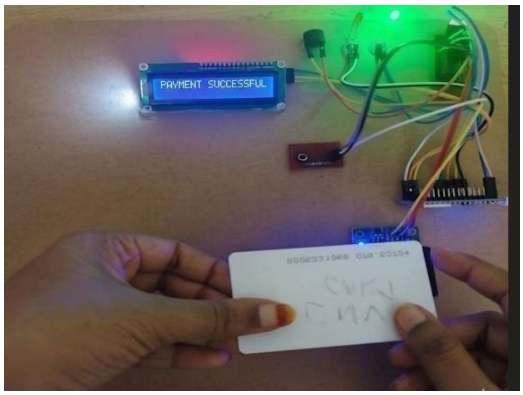


Fig 5 : Results

The interface presents a table with columns for items, quantity, and cost, allowing users to view the products added to the cart. Items such as biscuits, chocolate, and tea are listed along with their respective quantities and prices. At the bottom, a grand total is calculated automatically, indicating the overall cost of the selected items. This system demonstrates real-time billing, helping to reduce manual calculation and improve the shopping experience.

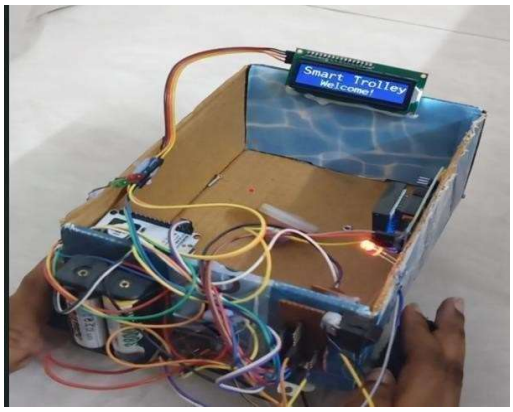


Fig 6 Generation of electricity by movement

The figure illustrates the process of converting alternating current (AC) into direct current (DC), known as Rectification. In this process, diodes are used to allow current to flow only in one direction and block the reverse flow.

During the positive half cycle of AC, the diode conducts and current flows, while during the negative half cycle, the diode blocks the current. Thus, the output becomes a pulsating DC signal. A capacitor filter is used to smooth this output and obtain a steady DC voltage. This DC supply is essential for operating electronic devices and circuits.

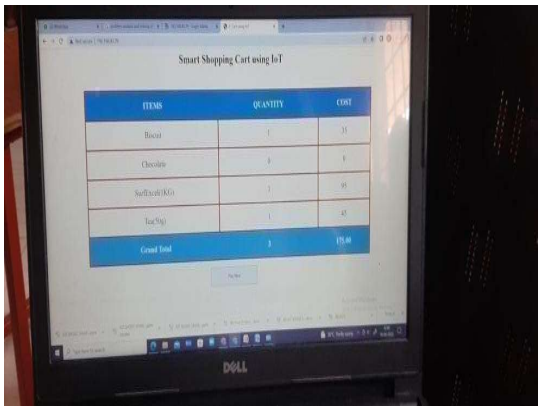


Fig 7 : RFID Smart Payment Prototype

In this specific application, the system recognizes the unique ID (UID) of the card and associates it with a specific account or balance in the code. When you tap the card, the system executes a "transaction" by deducting a value and triggering the success message you see on the LCD.

Conclusion

Thus, with the help of the conclusion, we can say that automatic billing of products using RFID technology will be a more viable option in the future. The system based on RFID technique is efficient, compact, and shows promising performance in real-time applications. RFID is faster and more reliable than barcode systems, as it does not require line-of-sight for scanning, thereby reducing time and effort during shopping. This innovation enhances the overall shopping experience by making it smoother and more convenient. Various system parameters of the smart trolley, such as product name, product cost, and product weight, are clearly displayed for user convenience. Additionally, the system helps in reducing long queues at billing counters and minimizes human errors in billing. It also ensures better inventory management and improves store efficiency. Furthermore, the integration of IoT enables real- time data monitoring and communication, making the system more advanced and user-friendly.

Conclusion and FutureScope

Conclusion

In this project RFID used as security access for the object which there by increases the observation performance. this implementation begins with an automated central billing system in shopping malls and supermarkets. With this, customer no longer have to wait near counter for payment of bills

because of their purchased product information getting transferred to central billing unit. This speed up the billing process and makes it much easier. In addition to this ability, the mechanism also assures identification of cases of the inspired by cheater customer which makes the system more reliable and attractive to both shopper as well as seller. This will take the shopping experience toa whole a new level.

Thus with the help of the conclusion we say that, Automatic billing of products by using RFID technique will be a more viable option in the future. The system based on RFID technique is efficient, compact and has promising performance. Also, RFID is better and faster than barcode reading because the later works on line of sight which is not the case for RFID technique. When the customer selected any item and put smart trolley, customer can easily understand. This will take the overall shopping experience to a different level. Different parameters such as the system parameters of smart trolley like product name, product cost, product weight etc. are display.

IoT based smart shopping trolley is implemented using Node MCU. First this prototype model verified Fritzing CAD tool. Once satisfies our requirements then move on hardware prototype model. When the customer selected any item and put smart trolley, customer can easily understand the particulars about the items like cost, weight and any offers. After completion of his/her shopping, the customer knows total bill and it has possible to remove or add another items also possible before pay the bill through any of mode like credit/debate card or any UPI payments. When the customer selected any item and put smart trolley, customer can easily understand. Weight sensors can be placed at the bottom of the cart for more security purpose. When the customer selected any item and put smart trolley, customer can easily understand. Ultrasonic sensors are placed to avoid imposture. Project is used to improve the security performance and also the speed.

FutureScope

The future scope of smart billing trolleys is highly promising as retail stores continue to move toward automation and digital transformation. With advancements in IoT, artificial intelligence, and cashless payment systems, these trolleys can become more intelligent by automatically detecting items using advanced sensors or computer vision, eliminating the need for manual scanning. Integration with mobile apps can allow customers to track their spending in real time, receive personalized offers, and make seamless payments without waiting in queues. In large supermarkets and malls, smart trolleys can significantly enhance customer experience by reducing checkout time and improving shopping convenience.

In the coming years, smart billing trolleys can also play a major role in smart retail ecosystems by connecting with inventory management systems and data analytics platforms. This can help store owners monitor stock levels, analyse customer buying patterns, and optimize product placement. Additionally, features like navigation assistance inside stores, voice support, and multilingual interfaces can make them more user-friendly. As technology becomes more affordable, even small and medium retailers may adopt these systems, making smart billing trolleys a common part of future shopping experiences.

References

[1] H. H. Chiang et al., "Development of smart shopping carts with customer-oriented service", 2016

[2]K. Prasiddhi, Dhanashri H. Gawali, "Innovative shopping cart for smart cities", Recent Trends in Electronics Information & Communication Technology (RTEICT), 2017

[3] Komal Ambekar, Vinayak Dhole, Supriya Sharma, Tushar Wadekar, Smart Shopping Trolley Using RFID, International Journal of Advanced Research in Computer Engineering & Technology (IJARCET), 4 (10), 2015

[4] M. Vanitha Sheba, Brintha Rajakumari, RFID Enabled Smart Billing System, Indian Journal of Science and Technology, Vol 8, 2015

[5] Dhavale Shraddha D, Dhokane Trupti J, Shinde Priyanka S, IOT Based Intelligent Trolley for Shopping Mall, IJEDR, 2016

[6] P. Chandrasekar, T. Sangeetha, Smart shopping cart with automatic billing system through RFID and ZigBee, 2014

[7] J. Suryaprasad, B. O. Praveen Kumar, D. Roopa, A. K. Arjun, A Novel Low-Cost Intelligent Shopping Cart, 2011

[8] Suganya R, Swarnavalli N, Vismitha S, Rajathi G M, Automated Smart Trolley with Smart Billing using Arduino, IJRASET, 2016

[9] Saad S.S and Nakad Z.S, A standalone RFID indoor positioning system using passive tags, IEEE Trans. Ind. Electron., 58 (5), 2011, 1961 - 1970

[10] A. Yewatkar, F. Inamdarb, R. Singhc, Ayushya and A. Bandale, "Smart Cart with Automatic Billing, Product Information, Product Recommendation Using RFID & Zigbee with Anti-Theft", in Elsevier 7th International Conference on Communication, Computing and Virtualization 2016, Lonavala, India, pp. 793-800.