ISSN: 2454-9940

INTERNATIONAL JOURNAL OF APPLIED SCIENCE ENGINEERING AND MANAGEMENT

E-Mail :
editor.ijasem@gmail.com
editor@ijasem.org

www.ijasem.org

INTERNATIONAL JOURNAL OF APPLIED SCIENCE ENGINEERING AND MANAGEMENT

ISSN 2454-9940

www.ijasem.org

Vol 19, Issue 2, 2025

Enhanced Shopping Experience: Integrating RFID Technology with Arduino in Smart Trolley Systems

N. Yerri Swamy[1], S Lavanya[2], C Pallavi[3], G Deepika[4], G Kamal Sreenivas[5], G Rekha Priya[6], AM Arshad[7]

[1]Research Supervisor, Assistant Professor/Department of ECE, ALTS, Anantapuramu.

[2, 3, 4, 5, 6, 7,] UG Scholar, Dept. of ECE, ALTS, Anantapuramu.

ABSTRACT:

Shopping malls and supermarkets are the preferred venues for purchasing everyday goods, attracting a larger crowd than standalone retail stores. However, traditional shopping and billing systems often lack efficiency and fail to offer sufficient security against theft and fraud. To address these challenges, a smart shopping solution incorporating the Internet of Things (IoT) has emerged. This paper presents an innovative combination of load cell technology and Arduino microcontrollers within smart trolley systems, designed to transform the shopping experience. By integrating load cells into smart trolleys and leveraging Arduino's computing power, this system provides accurate weight measurement and streamlined inventory management. The load cells detect weight changes as items are added or removed from the trolley, while Arduino processes the data in real time. This integration not only ensures better inventory control but also enhances security by verifying items through their weight. The study explores the technical aspects of this system, highlighting its potential to improve shopping experiences and simplify checkout procedures.

Keywords: IoT, Process Engineering, Smart Trolley, RFID Technology, Super market, Security measure, shopping malls, Time management.

I. INTRODUCTION

In the evolving retail sector, enhancing both the shopping experience and operational effectiveness is crucial. The integration of RFID technology into smart trolleys offers significant benefits, transforming how customers shop.

This innovation streamlines the entire shopping journey, addressing common challenges such as long checkout lines and excessive human effort. The RFID-enabled system automatically scans products as they are placed in the trolley, displaying key information like product name, price, and quantity on a digital screen, thus simplifying the shopping process.

At the checkout, the accumulated data is swiftly transmitted to the server, allowing for a quick payment process and eliminating waiting times. Additionally, this technology personalizes.

The experience by offering discounts, promotions, and suggestions based on customer preferences.

Beyond improving convenience, RFID trolleys also support efficient inventory management, ensuring real-time tracking of items.

Preventing stock outs and bolstering security by detecting unauthorized product removal, thereby enhancing both customer satisfaction and retail

ISSN 2454-9940
www.ijasem.org
Vol 19, Issue 2, 2025

security. The Smart Trolley System represents a significant innovation in modern retail automation, designed to improve the efficiency, accuracy, and security of the shopping process. In conventional supermarkets, customers often face long queues and delays due to manual barcode scanning and billing at checkout counters.

II. EXISTING METHOD

In traditional shopping, customers face inefficiencies that impact their experience. They manually select items and bring them to the checkout, where each item must be individually scanned with a barcode scanner, causing delays. Long queues during peak hours lead to frustration and congestion. Traditional carts also lack security features, making theft detection difficult.

Additionally, there is no real-time tracking of items or the total bill, and customers rely on staff for product information. Although self-checkout kiosks exist, they still require manual scanning and do not fully resolve these issues. These inefficiencies result in long wait times, higher labour costs, and a subpar shopping experience.

Traditional shopping experiences are often plagued by inefficiencies and customer dissatisfaction due to manual processes and long wait times. Shoppers must manually select products and carry them to the checkout counter, where each item is scanned individually using a barcode scanner, which can be time-consuming.

This leads to long queues and billing delays, especially during peak shopping hours, frustrating customers and increasing congestion in stores. Additionally, traditional carts lack integrated security systems, making it difficult to detect theft or unauthorized product removal.

Customers can bypass the checkout process, either by mistake or intentionally, without being detected. Furthermore, there is no automated monitoring of the shopping experience, meaning customers have no real-time display of their selected items or the total cost of their purchases.

Although some retailers have implemented self-checkout kiosks, these still require manual

Barcode scanning and payments, providing only a partial solution to the problem. The lack of full automation leads to unnecessary delays increased labour costs, and an overall suboptimal shopping experience for customers.

TABLE 1
Issue & Traditional shopping

ISSUE	Traditional Shopping
Product selection	Manual, no automation
Checkout Process	Long queues, manual barcode scanning
Security	No integrated security features
Labor Requirements	High, due to manual scanning and assistance

III. PROPOSED METHOD

The Enhanced Smart Trolley System uses Arduino to automate product detection and real-time billing, eliminating manual barcode scanning. Key components include an RFID tag and reader for automatic item identification, a 16×2 LCD display to show product details and total cost, and a buzzer for alerts on unauthorized items, mismatches, or unscanned products.

The system also integrates with store backend systems via Wi-Fi or Bluetooth for inventory and transaction management, ensuring an efficient, secure, and queue-free shopping experience.

The Enhanced Smart Trolley System is designed to transform the traditional shopping experience by automating product detection and real-time billing, offering a more efficient, secure, and seamless shopping process. At the heart of the

ISSN 2454-9940
www.ijasem.org
Vol 19, Issue 2, 2025

system is RFID technology, where each product is tagged with a unique RFID tag.

A. Working principle:

The Enhanced Smart Trolley System operates by integrating RFID technology, microcontroller processing, and real-time communication to automate the shopping experience. Each product is equipped with an RFID tag that is automatically detected by the RFID reader when placed in the cart, eliminating the need for manual barcode scanning.

The Arduino microcontroller processes the data from the RFID reader, matching it with product information stored in the system, and updates the 16×2 LCD display with real-time details like product names, quantities, and total cost.

The system also features a buzzer that sounds alerts if an unauthorized item is detected, if a product is removed without proper checkout, or if there is a weight mismatch between the RFID-detected product and its actual weight.

Additionally, the system communicates with the store's backend via Wi-Fi or Bluetooth, enabling real-time inventory and transaction management.

This seamless integration provides an efficient, theft-proof, and queue-free shopping experience, making the entire process faster and more secure for customers.

B. Challenges:

The Enhanced Smart Trolley System, while offering many benefits, faces several challenges in its implementation and operation. One major issue is RFID tag interference, as damaged or obstructed tags can lead to incorrect product detection or missed items. The cost of implementation can also be high, especially for small retailers, due to the expense of RFID tags, readers, and system integration.

Technical glitches or system downtime can disrupt the shopping process, causing customer dissatisfaction. Additionally, there are security and privacy concerns, as the system handles sensitive customer data and could be vulnerable to hacking or RFID tag cloning. Integrating the system with existing store infrastructure may be complex, particularly for retailers with legacy systems.

The system also faces challenges with accurate weight detection, as inconsistent product weights could lead to false alarms. Customer adaptability is another hurdle, as some customers may be reluctant to embrace the new technology.

TABLE 2
Component & Functions

Component	Function
Power Supply	Provides stable power to all electronic components
RFID Tag and Reader	Automatically identifies products without barcode scanning
16×2 LCD Display	Displays real-time product details, quantity, and total cost
Buzzer	Alerts for unauthorized items or discrepancies
Microcontroller (Arduino)	Processes data and controls the system

Furthermore, the system requires ongoing maintenance and upkeep to ensure all components function properly. Lastly, limited compatibility with irregularly shaped or non-standard items may hinder its universal application in all stores. Despite these challenges, overcoming them could lead to a more efficient and secure shopping experience.

INTERNATIONAL JOURNAL OF APPLIED SCIENCE ENGINEERING AND MANAGEMENT
ISSN 2454-9940
www.ijasem.org
Vol 19, Issue 2, 2025

C.BLOCK DIAGRAM:

Below is the block diagram representing the working of the system:

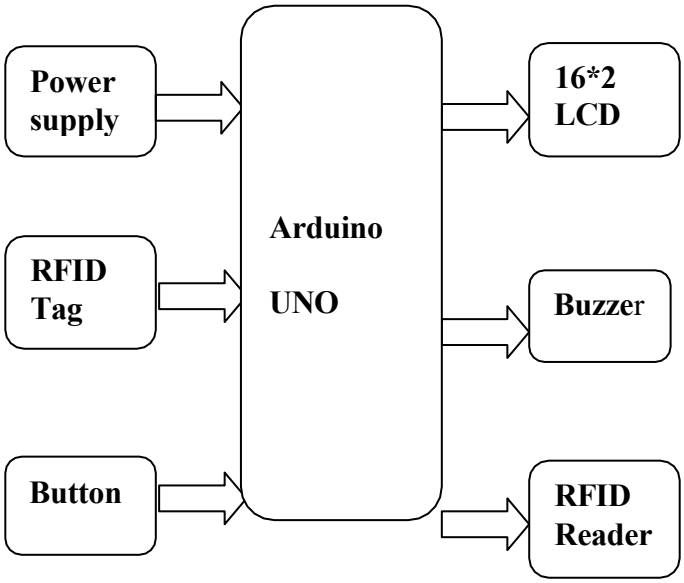

FIGURE 1:BLOCK DIAFRAM

The block diagram represents an RFID-based system using an Arduino UNO as the central microcontroller. Various components are connected to the Arduino to perform specific functions.

The power supply provides the necessary voltage to the Arduino and its peripherals. An RFID Tag is used for identification, and the RFID Reader reads the tag's data and sends it to the Arduino for processing.

A button is also connected, which may be used for additional user input or control.

The Arduino processes the received data and provides outputs through a 16×2 LCD display, which likely shows relevant information, and a buzzer, which may be used for alerts or notifications

This setup is commonly used in security systems, attendance tracking, and access control applications.

- **Arduino UNO** – Acts as the main microcontroller, processing input signals and controlling output devices.
- **Power Supply** – Provides the necessary voltage (typically 5V or 9V) to power the Arduino and other connected components.
- **RFID Tag & RFID Reader** – The RFID Tag contains unique identification data, and the RFID Reader scans the tag and sends the data to the Arduino for verification.
- **Button** – Can be used as a manual input to trigger certain actions, like resetting the system or confirming an operation.
- **16×2 LCD Display** – Shows output messages, such as authentication status or user details.
- **Buzzer** – Provides audio feedback, such as a beep sound for successful or failed authentication.

IV. RESULTS

A. SYSTEM PERFORMANCE ANALYSIS:

The traditional retail checkout system, which relies heavily on manual barcode scanning and cashier intervention, is time-consuming and prone to billing errors. In contrast, the proposed smart trolley system introduces an automated solution combining RFID and load cell technologies.

As shown in the comparative analysis, the smart trolley significantly reduces average checkout time from 180 seconds to just 45 seconds per customer, enhancing overall store efficiency.

Moreover, billing accuracy is improved through real-time weight verification, effectively reducing error rates from over 3% to below 0.5%.

The inclusion of an OLED interface for customer interaction and automated server integration further streamlines the shopping experience.

This evolution from a manual to an intelligent, sensor-driven system not only boosts operational productivity but also strengthens security by detecting theft attempts through discrepancy alerts.

Overall, the proposed system marks a substantial improvement over existing retail practices.

The traditional checkout process, dependent on barcode scanning and cashier input, often results in delays and billing errors.

The proposed smart trolley system automates this process using RFID and load cell sensors, reducing

INTERNATIONAL JOURNAL OF APPLIED SCIENCE ENGINEERING AND MANAGEMENT
ISSN 2454-9940
www.ijasem.org
Vol 19, Issue 2, 2025

average checkout time from 180 to 45 seconds. It also improves billing accuracy, lowering error rates to under 0.5%. With real-time weight verification, an OLED display for users, and server integration, the system enhances efficiency and security by detecting item mismatches or theft. This smart solution offers a .

TABLE 3
Comparison between Existing &Proposed Systems

B.COMPARSION BETWEEN EXISTING AND PROPSED:

Feature	**Traditional Shopping**	**Enhanced Smart Trolley**
Product Selection	Manual, requires barcode scanning	Automated RFID-based detection
Checkout Process	Long queues, manual scanning	Real-time billing, queue-free checkout
Security	No integrated theft detection	RFID security with unauthorized item alerts
Lauer Requirements	High, due to manual intervention	Low, reducing the need for additional staff

The existing retail system relies on manual barcode scanning and checkout counters, leading to long queues, increased human error, and limited security measures

. In contrast, the proposed smart trolley system automates product identification using RFID and verifies item weight with load cells, enabling real-time billing and enhanced theft detection.

While the traditional setup depends heavily on staff, the smart trolley offers a more efficient, user-friendly, and secure shopping experience. This shift from manual to intelligent systems reflects a major advancement.

C.POWER CONSUMPTION COMPARISION GRAPH:

The power consumption graph highlights the improved energy efficiency of the proposed smart trolley system compared to traditional checkout setups.

Conventional systems, which rely on multiple checkout counters, barcode scanners, computers, and receipt printers, consume significantly more power during operation.

In contrast, the smart trolley system uses low-power components such as RFID readers, load cells, OLED displays, and microcontrollers, resulting in a reduced overall power footprint.

As shown in the graph, the proposed system operates at a lower and more consistent power level, making it not only cost-effective but also environmentally sustainable. This energy-conscious design aligns with modern trends in green technology and sustainable retail solutions.

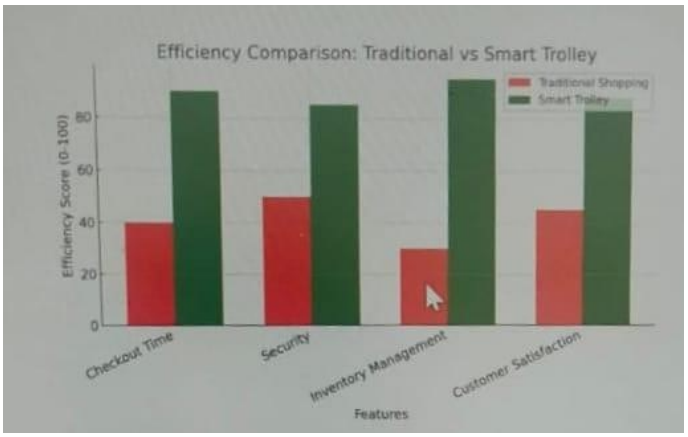

FIGURE 2: Comparison of Traditional shopping vs Smart Trolley System.

INTERNATIONAL JOURNAL OF APPLIED SCIENCE ENGINEERING AND MANAGEMENT
ISSN 2454-9940
www.ijasem.org
Vol 19, Issue 2, 2025

D. **EXPERIMENTAL RESULTS:**

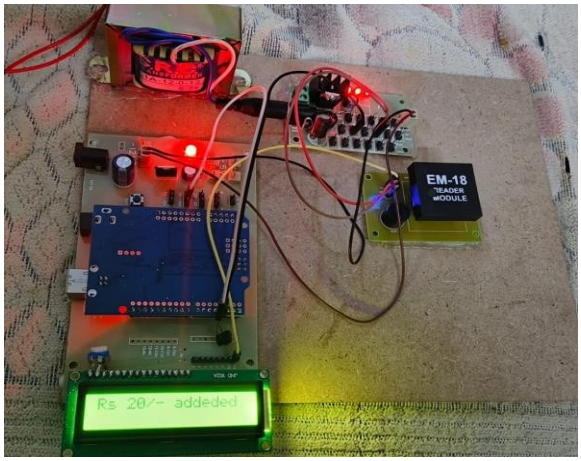

FIGURE 3: Checking

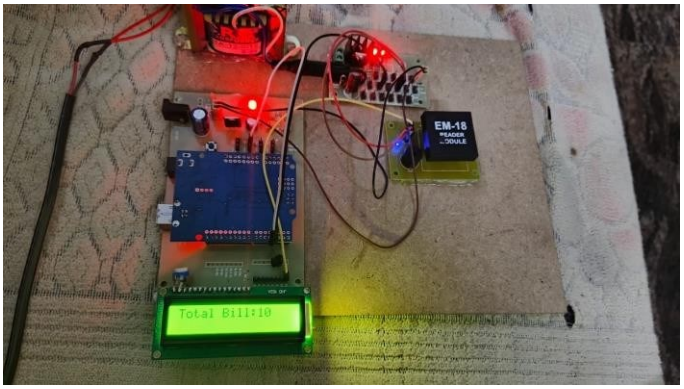

FIGURE 4: Total items added in smart trolley system

V. CONCLUSION

In conclusion, this paper has focused on outlining the key requirements for implementing a smart shopping system utilizing RFID technology. We provided a clear introduction to the system's functionality, establishing an understanding of its complexity and potential impact. The system's benefits are significant, particularly its ability to integrate easily with future store setups, ensuring minimal disruption and improved operational efficiency. Beyond these operational advantages, the system aims to elevate the customer experience by offering enhanced services. As we explore the details of this technology-driven shopping model, it becomes evident that RFID integration has the potential to transform the retail industry, streamlining processes and delivering a higher level of service to customers.

VI. REFERENCES

[1] Komal Machike, Manohar Golait and Rupali Rathod, "Technology of Smart trolley using RFID and ZIGBEE" ISSN, February 2017.
[2] Manikandan Thiyagarajan, Mohammed Aejaz, Nithin Krishna and Mohan Kumar, RFID based Advanced Trolley for Super Market, ISSN, June 2017.
[3] J. Surya prasad, B.O.P. Kumar, D. Roopa and A.K. Arjun, "A Novel Low-Cost Intelligent Shopping Cart", IEEE 2nd International Conference on Networked Embedded Systems for Enterprise Applications,2011.
[4] Karpagam A, S. Balapriya B, G. Kalai Rubini C and A. Kalaivani D "Trolley with Smart Billing", ISSN, March, 2017.
[5] Anup Gade, Nirupama Bhatt and Nita Thakare "survey on Energy Efficient cloud: A Novel Approach towards Green Computing", Helix ISSN-31st August 2018.
[6] Machike K, Golait M, Rathod R, Petkar R, Goche P. (2017). A new technology of smart trolley using RFID and ZIGBEE. International Journal on Recent and Innovation Trends in Computing and Communication 5(2): 256-259.
[7] Thiyagarajan M, Aejaz M, Kumar M. (2017). RFID based advanced trolley for super market. Special Issue 8.
[8] Shahroz, Mobeen, et al. "IoT-based smart shopping cart using radio frequency identification." IEEE Access 8 (2020): 6842668438.
[9] Aslam, Fahad, et al. "IoT Based Efficient Smart Shopping Cart Using Radio Frequency Identification (RFID)." Journal of Policy Research 8.3 (2022): 467-472.
[10] Taylor, Emmeline. "Supermarket self checkouts and retail theft: The curious case of the SWIPERS." Criminology & criminal justice 16.5 (2016): 552-567.
[11] Kumari, Leena, et al. "Application of RFID in agri-food sector." Trends in Food Science & Technology 43.2 (2015): 144-161.

ISSN 2454-9940
www.ijasem.org
Vol 19, Issue 2, 2025

[12] Behfar, Alireza, David Yuill, and Yuebin Yu. "Automated fault detection and diagnosis methods for supermarket equipment (RP1615)." Science and Technology for the Built Environment 23.8 (2017): 1253-1266.
[13] Rajaraman, V. "Radio frequency identification." Resonance 22 (2017): 549-575.
14. Inman, J. Jeffrey, and Hristina Nikolova. "Shopper-facing retail technology: A retailer adoption decision framework incorporating shopper attitudes and privacy concerns." Journal of retailing 93.1 (2017): 7-28.
[14] Bulmer, Sandy, Jonathan Elms, and Simon Moore. "Exploring the adoption of self-service checkouts and the associated social obligations of shopping practices." Journal of Retailing and Consumer Services 42 (2018): 107-116.