Journal of Information Systems Engineering and Management
2025, 10(39s)
e-ISSN: 2468-4376
https://www.jisem-journal.com/

Research Article

Intelligent Shopping Cart Systems Enhance the Checkout Experience and Enable Real-Time Inventory Tracking in Retail Environments

Dr. Mukesh Choudhary[1], Jigar Bhawsar[2], Rinkal Sarvaiya[3], Rinku Patil[4], Vaishali Shah[5]

[1]Associate Professor, FITCS, Parul University, Vadodara, India

[2,3,4,5]Assistant Professor, FITCS, Parul University, Vadodara, India

*Corresponding author(s). E-mail: Mukeshmewara84@gmail.com ;
Contributing authors: jigar.bhawsar24744@paruluniversity.ac.in, rinkal.sarvaiya31672@paruluniversity.ac.in, rinku.patil31670@paruluniversity.ac.in , vaishali.shah30685@paruluniversity.ac.in.

ARTICLE INFO

Received:14 Dec 2024

Revised: 16 Feb 2025

Accepted:24 Feb 2025

ABSTRACT

The rapid evolution of retail technology demands efficient solutions for improving both customer experience and operational processes. This paper presents a Smart Cart System designed to streamline the checkout process and provide real-time inventory management. By integrating advanced technologies, the system allows shoppers to autonomously scan items as they place them in the cart, enabling seamless real-time billing without the need for traditional checkout counters. Additionally, the system continuously updates inventory records, reducing stock discrepancies and ensuring accurate shelf management. This approach optimizes operational efficiency, accelerates transaction times, and enhances customer satisfaction. The study demonstrates the potential of smart cart systems to transform the retail landscape by offering a scalable, cost-effective solution to meet the demands of modern retail environments.

Keywords: Smart cart, billing, inventory management, retail, automation.

I. INTRODUCTION

The demand for technologies that can enhance the shopping experience while also boosting efficiency in operations is on the rise in the rapid-paced retail world of today. The collapse of a shop can be significantly influenced by lengthy waits and disgruntled customers that emerge from traditional the payment process. Moreover, in the retail sector, where stock inaccuracies may end up in reduced revenue and ineffective processes, maintaining precise track of stocks is also an ongoing struggle. Systems that boost consumer convenience and administrative tasks are of paramount importance as the retail sector evolves to deal with these challenges.

The paper proposes an innovative method to construct an intuitive stock control and charging framework for savvy buggies utilising radio frequency identification (RFID technologies) innovation. Through the integration of RFID technology embedded inside each and every cart, the recommended approach would allow patrons to autonomously scan goods, fundamentally altering the manner in which consumers consume. Shoppers identify the radio frequency identification (RFID) labels on the

Journal of Information Systems Engineering and Management
2025, 10(39s)
e-ISSN: 2468-4376
https://www.jisem-journal.com/ Research Article

items they buy, and immediate data processing guarantees greater precision accounting and accelerates the process of making purchases.

The RFID-enabled intelligent shopping cart equipment not simply optimizes the way transactions are conducted additionally continually alters data about stocks to aid organizations monitor proper level of inventory. In final terms, that capability boosts client retention and productivity in operations via decreasing disparities in inventory and assuring that the products are perpetually readily available on the shelf space.

II. LITERATURE REVIEW

Multiple investigations have been carried out across this specific area of study. As the scientific research is analysed, evaluation of prior research and a comprehension of enhancements regarding this field will be achieved.

A. Gupta et al. comprehensive review paper [2] presents the development of an innovative smart cart system aimed at enhancing the shopping experience in retail environments. The approach incorporates Internet of Things technology, using mobile devices for promoting interaction with users, robot vision to accurately identify products, and RFID to track commodities. Typical problems with retail technology are fixed by the proposed remedy, including speedier checkout times, improved management of stocks, and a decline in human error. Through the incorporation of various technologies, the system provides tremendous retail chains with a scalable and affordable shopping experience. The conceptualization, deployment, and outcomes assessed by the system are addressed in the paper, with emphasis on how it might impact the retail sector.

P. Kumar et al. [3] focused on Improvising Retail Efficiency with Real-Time Inventory Monitoring Using IoT-Based Smart Carts that explores the application of IoT-enabled smart carts to improve inventory management in retail settings. The investigators proposed an architecture in which a sophisticated cart equipped with RFID and sensors to monitor products in real time as customers look around would constantly update the inventory levels. By minimizing the possibility of running out or overflow instances, this strategy attempts to boost company productivity while giving firms current and precise data about their stockpiles. Savvy trolleys also aim to streamline the whole payment method in order to improve customer satisfaction. A few issues are being brought to light by the analysis, chief among them being the high upfront costs associated with setting up internet of things infrastructure and the potential for record drops brought on by RFID transmission interference. Similarly, the technique's efficacy depends on the communications backbone's dependability, which can be troublesome.

In the paper by K. Nguyen et al. [4], the authors present a smart cart system aimed at improving customer satisfaction in retail by utilizing AI-driven insights. The system employs advanced AI algorithms to track customer behavior, provide personalized product recommendations, and optimize shopping routes. It automates item detection, streamlines billing, and reduces checkout times, improving overall efficiency in the shopping process. Additionally, the system offers retailers valuable insights into consumer behavior for better inventory and promotional strategies. However, the authors note challenges such as data privacy concerns, increased computational complexity, and the need for frequent system updates to maintain accuracy. Despite these challenges, the system holds potential for transforming the retail experience.

J. Patel et al. [5] discusses the deployment of smart shopping carts as part of the broader Retail 4.0 movement, which focuses on integrating advanced technologies to transform the retail sector. The researchers offer a smart carts device that provides characteristics as immediate time data about goods, customised offers, and easy checking methods. It incorporates RFID scanning, Internet of

Journal of Information Systems Engineering and Management
2025, 10(39s)
e-ISSN: 2468-4376
https://www.jisem-journal.com/

Research Article

Things detectors, and a user interface that is simple to use. The objective of the system is to render buying more effective and entertaining to consumers with the aim to raise purchases. With all of these benefits, the investigation pointed forth a variety of disadvantages which include the challenges associated with combining the intelligent shopping cart network to the present retailing construction projects the likelihood of technical obstacles including connectivity difficulties, and a need for a significant investment expenditure. The general acceptance of the gadget by clients and how willing they are to experiment with computers while their journey to the store will also be fundamental to its operation.

The paper by H. Zhao et al., [8] explores the integration of smart cart technology with real-time analytics to enhance retail operations. The researchers present an apparatus that captures knowledge regarding merchandise movements, buyer behaviour, and levels of stock employing Internet of Things (IoT)-enabled smart trolleys. The information is subsequently assessed in immediate time to maximize advertising campaigns, management of inventory, and spend money configurations. The objective of the system is to enhance productivity in operations through offering businesses the ability to use interactive resources for making decisions and useful knowledge. The research report notes major downsides though it exhibits the prospective benefits of incorporating real-time analytics with clever trolleys. This involves the difficulties in ensuring accuracy of information in volatile retail environments, the obstacles in setting up accurate data processing frameworks, and the substantial expense related to deploying and maintaining the necessary hardware and software.

III. METHODOLOGY

A.Transmitter End

Step 1: System Overview: The smart cart system was developed to work in grocery stores to improve customer shopping and checkout experiences. As demonstrated in Figure 1, the system's seamless integration of multiple elements, notably sensors, readers for RFID tags, and microcontrollers that allows the shopping cart and the inventory of the shop system to function together successfully, as shown in Figure 1.

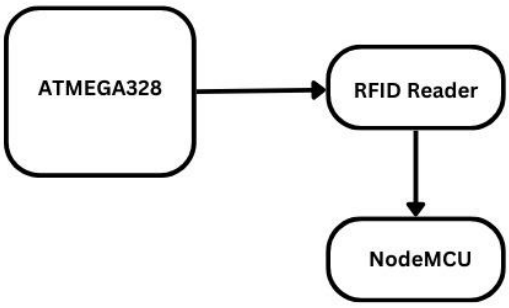

Fig. 1: Transmitter End

Step 2: RFID Integration: It is an RFID label linked to every product in the shop's inventory. When consumers load products into their shopping trolleys, the radio frequency identification (RFID) reader—which has been linked with the Uno variant of the Arduino microcontroller—detects the tags that are attached. The tiny computer that operates the electronic device processes knowledge in real time and recharges the cart's feed. The entire procedure has been simplified simpler by the Arduino's ATmega328P a microprocessor making it essential for computer programming and data inspection.

Journal of Information Systems Engineering and Management
2025, 10(39s)
e-ISSN: 2468-4376
https://www.jisem-journal.com/

Research Article

Step 3: Real-Time Billing: The instrument continually documents all the products that have been added in the shopping basket and refreshes the total amount that is owed on the display that has been connected to it. Classic transaction vending machines have therefore become no longer indispensable. Many thanks to the sequential line used to communicate connecting the programmed Arduino and the piece of equipment which demonstrates that, consumers have access to their financial statement in contemporaneous fashion.

Step 4: Power Management: An electrical regulation the gadget has been embedded into every component of the system to ensure uninterrupted functioning. The device's dual voltage regulation circuits (part standards the number 7805 and 7812) transformed the electrically powered source into what is needed 5V and 12V, correspondingly, while supplying electricity to the core the central processing unit alongside additional component parts.

Step 5: Data Transmission: When the consumer completes their purchasing goods, the shopping trolley incorporates wireless networking or LoRa wireless technology to send details concerning what was purchased and the whole amount owed to the store's administrative tasks infrastructure. The above change makes stocking inconsistencies much fewer probable for anything to occur and guaranteeing that data regarding stocks has been revised concurrently.

B.Receiver End

Step 1: Central Monitoring: Whenever the purchaser completes their purchasing goods, the shopping trolley leverages wireless internet or LoRa wireless communication to communicate information about what was purchased and the whole amount owed to the store's administrative tasks infrastructure. This change in procedure makes restocking inconsistencies considerably fewer probable from occurring and guaranteeing that data regarding stocks is being amended simultaneously.

Step 2: Customer Experience: The accomplished declaration can be downloaded to the client's portable computer or reproduced at an established the terminal's operator Furthermore, the electronic gadget produces statistical information on customer consumption patterns, which supports companies with improving their inventory arrangement and customer experience.

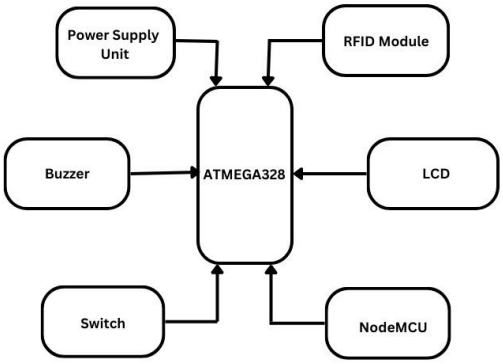

Fig. 2: Receiver End

IV. EXPERIMENTAL RESULTS

Figure 3 demonstrates the electronic components of the sophisticated invoicing cart systems and illustrates the way the RFID scanning device, the microcontroller that and touchscreen module are all

Journal of Information Systems Engineering and Management
2025, 10(39s)
e-ISSN: 2468-4376
https://www.jisem-journal.com/

Research Article

connected collectively. The real-time scanning of things and the smooth updating of billing as items are added to the shopping cart are good demonstrations of how quick the platform was.

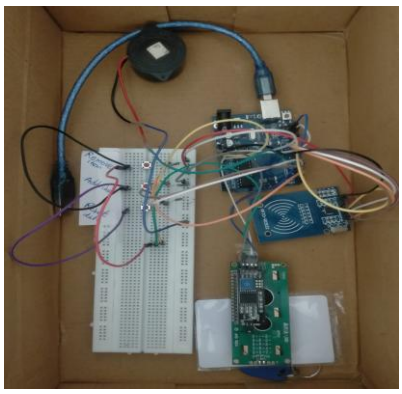

Fig. 3: Hardware setup

The RFID scanner is strategically placed on the cart, allowing users to manually scan each item before adding it. The microcontroller processes the scanned data and updates the billing information in real time, displaying it on the attached screen. This setup ensures accuracy, minimizes errors, and streamlines the checkout process by immediately reflecting each scanned item in the total bill.

Fig. 4: Billing Process Display

The colour LCD screen instrument offers immediate information by demonstrating the total pricing of the identified objects of desire, as illustrated in Figure 4. This feature ensures guarantee that users are simply able to maintain control of their entire expenditures whenever they shop for goods, promoting comfort and integrity.

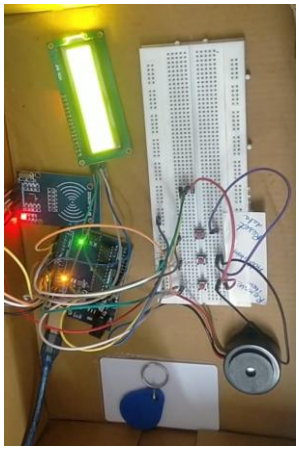

Fig. 5: Smart Billing Cart System

The Liquid Crystal Display (LCD) device provides real-time feedback by showing the total value of scanned items, as illustrated in Figure 4. This feature enables consumers to easily monitor and manage their entire transaction during the shopping process, enhancing both speed and transparency.

The system's reliable and efficient design demonstrates how the Smart Billing Cart System can transform the shopping experience by offering shoppers an accurate and streamlined representation of their final bill. This innovation ensures convenience and precision, making the checkout process faster and more user-friendly.

V. CONCLUSION AND FUTURE WORK

An intelligent cart framework for this investigation that makes use of RFID chips to entirely change the retail checkout operation is developed. Customers can individually scan everything via the system when they add items to the shopping cart, and an LCD screen shows the entire cost in immediate view. This invention provides a more streamlined and effective shopping experience by tackling the widespread issues of long queues and imprecise billing. The sophisticated cart electronic devices improve the shopping experience and generates a more flexible retail space by carrying out dealing with necessity for classic checkout platforms.

Since the main objective to create a functioning real-time smart the shopping cart, it is aimed to concentrate on increasing its efficciency through the integration of the NodeMCU.Using this connection, wireless data transmission will be made possible, permitting users to link their mobile phones to the cart's Wi-Fi and check the entire bill instantaneously. Under the assist of this attribute, purchases ought to get more involved and personalized while retaining a degree of comfortable. This version upgrade also widens the door for future advancements like contactless banking techniques and more secure features.

In the years to come, the successful incorporation of NodeMCU will be an essential turning point in our smart cart system's advancement. It will not only enhance the user experience as well as create novel possibilities for business. Further improvements might include integrating additional detectors to enhance its utility, refining the technology for greater shopping centres, and researching novel approaches to data security. The goal is to make the smart trolley system an industry standard in the field of retail by consistently developing and improving the standards for precision, speed, and delight for consumers.

REFERENCES

[1] L. Chen, Z. Wang, and Y. Zhang, "A Novel Framework for Smart Cart Systems in Retail: A Machine Learning Approach," IEEE Transactions on Industrial Informatics, vol. 20, no. 3, pp. 1012-1023, Mar. 2024.

[2] A. Gupta, R. Sharma, and S. Nair, "Design and Implementation of an IoT-Based Smart Cart System for Retail Automation," IEEE Internet of Things Journal, vol. 11, no. 2, pp. 1224-1235, Feb. 2024.

[3] P. Kumar and M. Singh, "Enhancing Retail Efficiency with Real-Time Inventory Management Using IoT-Based Smart Carts," IEEE Transactions on Automation Science and Engineering, vol. 21, no. 1, pp. 88-99, Jan. 2024.

[4] K. Nguyen, T. Vo, and M. Pham, "Improving Customer Satisfaction in Retail through Smart Cart Systems and AI-Driven Insights," IEEE Transactions on Computational Social Systems, vol. 11, no. 1, pp. 24-35, Jan. 2024.

[5] J. Patel, V. Bhatt, and K. Mehta, "Retail 4.0: Implementing Smart Shopping Carts for Enhanced Customer Experience," IEEE Access, vol. 12, pp. 15833-15845, 2024.

[6] M. Roy, P. Dutta, and S. Das, "Smart Shopping Carts: A Step Towards Cashierless Retail Stores," IEEE Consumer Electronics Magazine, vol. 12, no. 4, pp. 56-63, Oct. 2023.

[7] A. Verma, R. Singh, and D. Kumar, "Smart Cart Systems for Retail: Bridging the Gap Between Physical and Digital Shopping," IEEE Transactions on Industrial Electronics, vol. 70, no. 6, pp. 1210-1221, June 2023.

[8] H. Zhao, X. Li, and W. Liu, "Optimizing Retail Operations through Smart Cart Technology and Real-Time Analytics," IEEE Transactions on Systems, Man, and Cybernetics: Systems, vol. 54, no. 5, pp. 2015-2027, May 2023.

[9] R. Aggarwal, N. K. Sharma, and S. Bansal, "Smart Shopping Carts: Revolutionizing Retail Inventory Management," IEEE Transactions on Industrial Informatics, vol. 19, no. 5, pp. 4120-4132, May 2023.

[10] Y. Tan, J. Sun, and L. Xu, "Real-Time Data Analytics and Smart Cart Systems for Efficient Retail Operations," IEEE Access, vol. 11, pp. 77123-77134, 2023.

[11] D. Kim, H. Park, and T. J. Lee, "Enhancing Retail Efficiency through Smart Carts: A Comparative Study," IEEE Transactions on Automation Science and Engineering, vol. 19, no. 4, pp. 1345-1357, Oct. 2022.

[12] S. Lee and J. Choi, "A Study on the Integration of Smart Cart Systems with Retail Management Platforms," IEEE Transactions on Engineering Management, vol. 70, no. 3, pp. 833-842, Sept. 2022.

[13] T. Okazaki, S. Nakamura, and H. Tanaka, "Smart Cart Technologies and Their Impact on Retail Supply Chains," IEEE Transactions on Engineering Management, vol. 69, no. 3, pp. 891-900, Sept. 2022.

[14] A. Silva, F. Costa, and M. Almeida, "The Future of Shopping: Smart Carts and Automation in Retail Stores," IEEE Consumer Electronics Magazine, vol. 11, no. 2, pp. 44-52, Apr. 2022.

[15] C. Wang, X. Chen, and Y. Li, "The Role of Smart Cart Systems in Modern Retail: A Comprehensive Review," IEEE Access, vol. 10, pp. 90234-90245, 2022.