International Journal for Multidisciplinary Research (IJFMR)
E-ISSN: 2582-2160 ● Website: www.ijfmr.com ● Email: editor@ijfmr.com

The Smart Shopping Trolley

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Abstract

The Smart Shopping Trolley is an IoT-enabled solution designed to enhance the shopping experience by automating checkout and reducing inefficiencies. It features a barcode scanner, LCD display, buzzer, push button, and all controlled by an Arduino microcontroller. Products are registered via barcode scanning, with real-time updates displayed on the LCD. A buzzer confirms successful scans, while the system generates a QR code for mobile payment and prints a receipt. This innovation streamlines shopping, reduces billing errors, and minimizes human staff dependency. Designed for supermarkets and retail stores, it optimizes efficiency and enhances customer satisfaction.

Keywords: Smart Shopping Trolley, IoT-enabled, Automated Checkout, Barcode Scanner, Arduino Microcontroller, LCD Display, QR Code Payment, Billing Automation, Retail Efficiency, Customer Satisfaction

1. Introduction

The rise of smart technologies and IoT (Internet of Things) has paved the way for groundbreaking innovations in the retail sector. Traditional shopping in supermarkets and retail stores often faces challenges such as long queues, manual billing errors, and inefficiencies in customer service, highlighting the need for a smarter, automated solution. The Smart Shopping Trolley addresses these issues by integrating advanced IoT components into a conventional shopping cart. It provides a seamless shopping experience through an RFID scanner, allowing customers to add items by scanning their RFID tags before placing them in the cart. An Arduino microcontroller ensures real-time registration, displaying item details, price, and the total bill on an LCD screen. A buzzer confirms successful scans and alerts users to duplicate or unregistered items. The checkout process is quick and intuitive, initiated by pressing a push button that generates a QR code for mobile payment. Once the payment is completed, a thermal printer issues a receipt for verification at the store exit. This automated system eliminates long queues and manual billing, making shopping faster and more convenient. Retailers benefit from reduced manpower requirements, minimized billing errors, and optimized operational efficiency. The trolley's modular and scalable design makes it suitable for various retail environments, ensuring user comfort while housing all essential IoT components. By combining IoT and embedded systems, the Smart Shopping Trolley represents a significant advancement in retail automation, redefining how customers interact with retail spaces and paving the way for the future of smart shopping solutions.

2. Literature Survey

Tapan Kumar Das et al., [1] explains about book tracing and theft detection using RFID technology. This system mainly helps to automate the process without the intervention of human and to overcome the disadvantage of bar code technology.

Rahul R et al., [2] proposed a study on implementation of smart library system using IOT. The main aim is to solve the difficulty in tracking down the details of library transactions due to slow system, loss of data about the books and difficulty in updating the information on regular basis by using RFID and IOT technologies. This system will manage and control all the information of the library and provides benefits for staffs and students. This system is more efficient and utilizes less time.

Sakshi Maurya et al., [3] focused to reduce manual work and to track the position of the book using IR sensor installed in each rack. IR sensor continuously senses the availability of the book in the rack and stores the information in the cloud. It helps the user for easy access of book.

Bipin Kumar Yadav et al., [4] introduced a library access system smartphone application using android. The main aim is to provide easy option for accessing their library account through the android device. It provides the option for the user to check the availability of books in the library and saves the time. Database is created to store the information.

M. Kabil Dev et al.,[5] explains the role of QR code in reaching mobile users of academic libraries for the effectiveness and potential to deliver library services to a new generation of students. It can hold more information than bar coding. If there is any damage to the code, it is likely to render it unreadable.

Sasrika Reddy Garlapati et al.,[6] emphasized on various bar code techniques and checks whether the large data encoding into same dimension is possible or not. It allows secure data transmission by encoding data into bar codes. Paper makes a study about the existing bar- coding technique.

J.N.V.R. Swarup Kumar et al.,[7] explains an overview of the current states and trends in RFID technology. It focuses on the challenges that the face

3. Methodologies

The objectives of the proposed system are as follows:

1. Barcode Scanning and Item Display Interface
2. Button-Triggered Code Generation
3. QR Code for Payment Gateway
4. Payment Confirmation and Bill Generation Methodology for objective 1:

- Barcode Scanning – Use a barcode scanner (e.g., Zebra or QR module) connected to ESP32 via UART or I2C.
- Database Integration – Store product details locally (SD card/EEPROM) or in a cloud database (Firebase) for real-time lookup.
- LCD Display – Show item details (name, price, quantity) and update the total price dynamically.
- Hardware Components – ESP32, barcode scanner, LCD display (16x2 or TFT), and Wi-Fi for cloud access.
- Software Tools – Arduino IDE with barcode scanning, LCD control, and database libraries as shown in figure 1

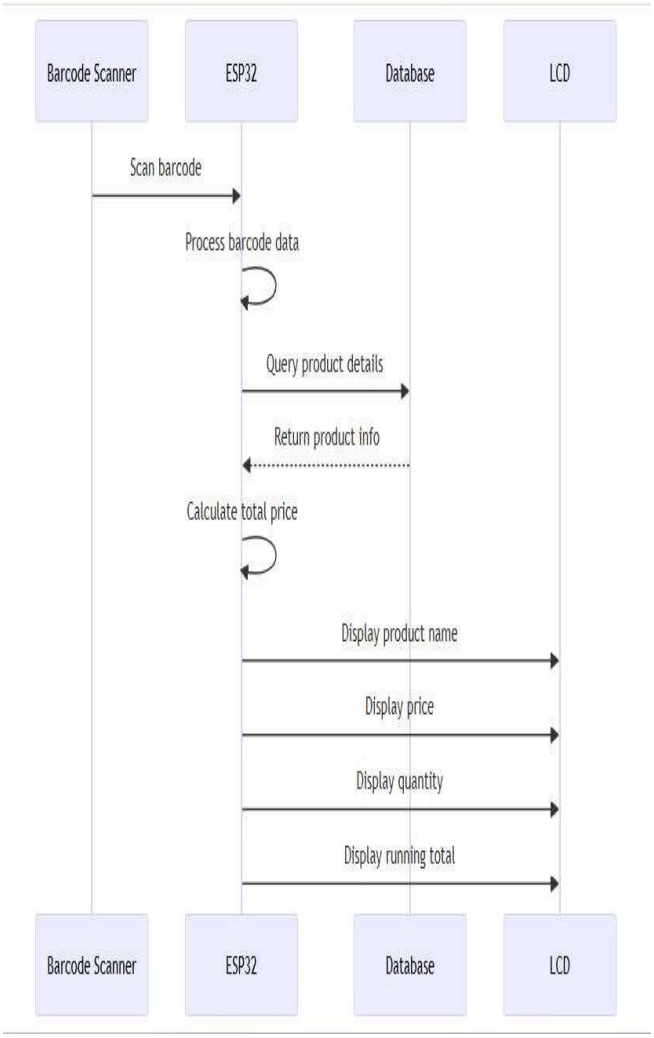

Fig. 1. Flow Chart for payment process

Methodology for objective 2:

- Objective: Generate and display a unique 6-digit code after the user presses a button to indicate that the shopping session is complete.

Implementation: The above Figure 2 represents the button triggered code generation which helps to know the implementation process of code generation.

a. Button Setup: Connect a physical button to the ESP32. When the button is pressed, the system triggers a function to generate a random 6-digit code.

b. Random Code Generation: Use a random number generator to generate the 6-digit code. You can use random Seed () and random () functions in Arduino to create this number.

c. Display the Code: Display the generated code on the LCD, ensuring that it is easily readable and clear for the customer to note down.

Implementation Tools:

a Hardware: ESP32, Push Button, LCD.

b Software: Arduino code to handle button press detection, random number generation, and LCD output.

- All the books present in a library is embedded with RFID tags.
- The user cards and RFID readers are used to read these tags.
- Once the user borrows the book then the book is scanned and that scanned information is uploaded to the database.
- After that the issue/push button is pressed.

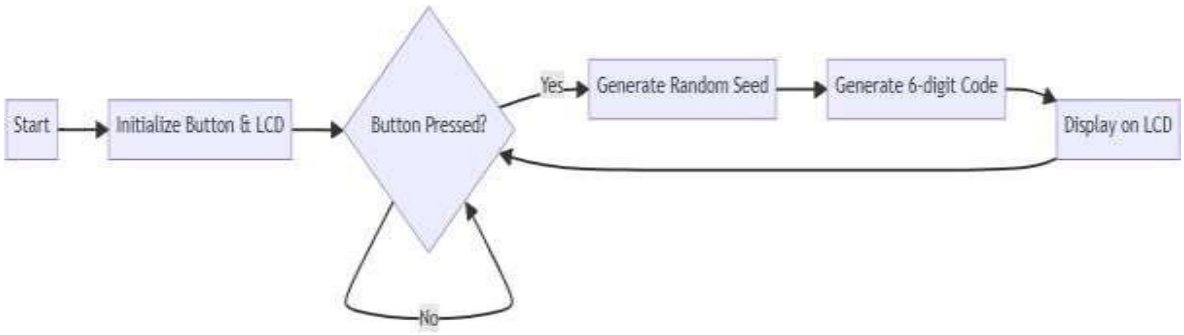

Fig. 2. Flow Chart for book issue process

Methodology for objective 3:

- Generate Payment URL When the user completes shopping, a unique 6-digit transaction code is created. A payment URL is then generated using this code for reference.
- QR Code Generation the ESP32 uses a QR code generation library (e.g., `qrcode`) to convert the payment URL into a scannable QR code. This QR code is displayed on an LCD screen.
- Payment Gateway Integration the QR code links to a third-party payment gateway like Razor pay or Stripe, allowing customers to pay via UPI, credit/debit cards, or net banking.
- Payment Confirmation Once the transaction is completed, the user is redirected to a confirmation page, verifying the payment was successful.
- implementation Tools The system requires ESP32 and an LCD for hardware, along with QR code generation libraries and a payment gateway API for software integration. As shown in figure 3

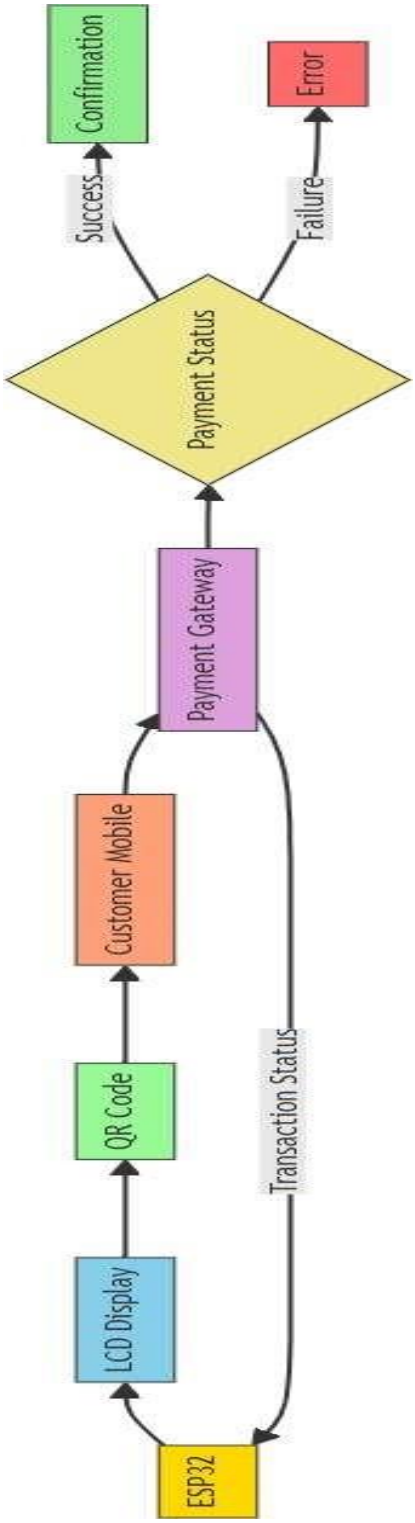

Fig. 3. Flow chart for objective 3

Methodology for objective 4:

- In Display Confirmation Message: After payment, ESP32 shows a confirmation message on the LCD with the total amount paid and the 6-digit reference code.
- Generate Bill: The system creates a bill (PDF or text file) with item details, quantities, prices, taxes, and total amount as shown in figure 4
- Provide Download Link: The bill download link is available on the payment gateway confirmation page or via a QR code.
- Enable Download: The user can download the bill using their phone via Wi-Fi.

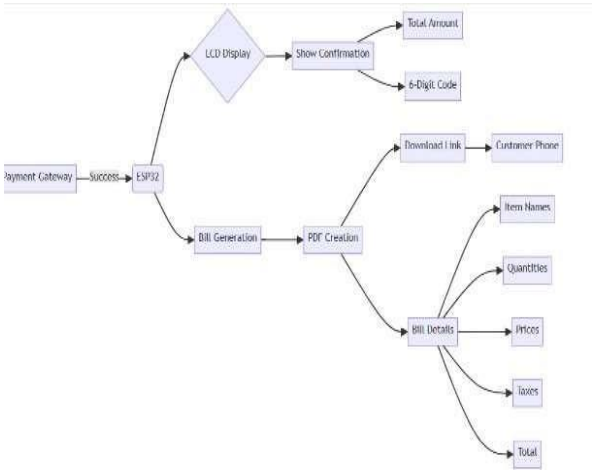

Fig. 4. Flow chart for objective 4

4. System Design

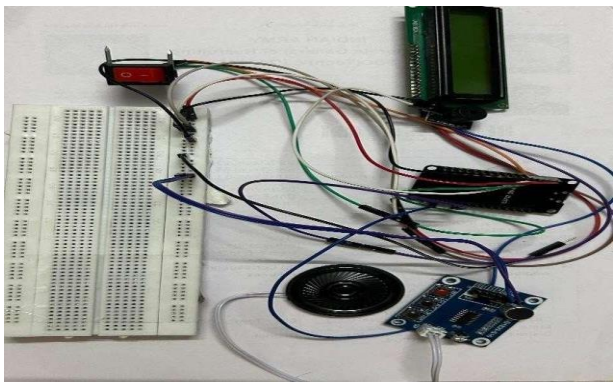

Fig. 5. Block diagram of the system design

As shown in the figure5, it consists of.

The working principle of this system mainly includes There it consists of breadboard LCD voice module, ESP32 cam, ESP32 Wi-Fi model and a switch which are interconnected to each other

1) Item Scanning & Display:

To scan the items and the display it names quantity and rate

2) Generating Payment Code

Once shopping is done, the customer presses a button on the trolley. A unique 6-digit code is generated and displayed on the LCD.

3) Payment via QR Code:

The user scans a QR code near the trolley. A website opens, allowing payment via UPI, Card, Net Banking, or Pay Later.

4) Confirmation & Bill Download

After successful payment, a confirmation message is displayed. The user has the option to download the bill for reference.

5. Block Diagram

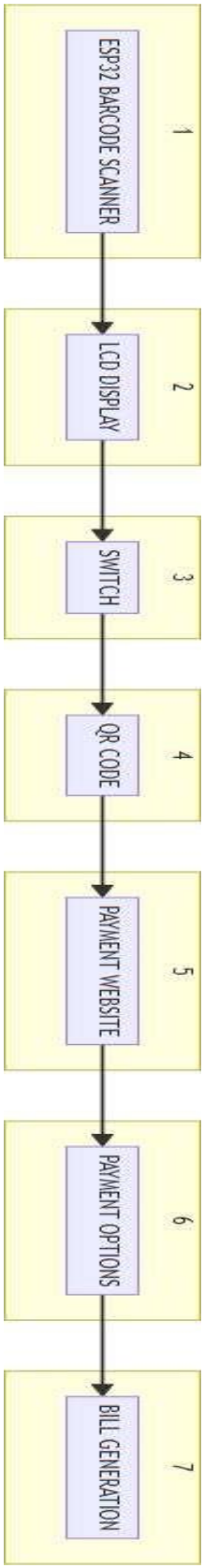

Figure 6: Block diagram

6. Performance Analysis

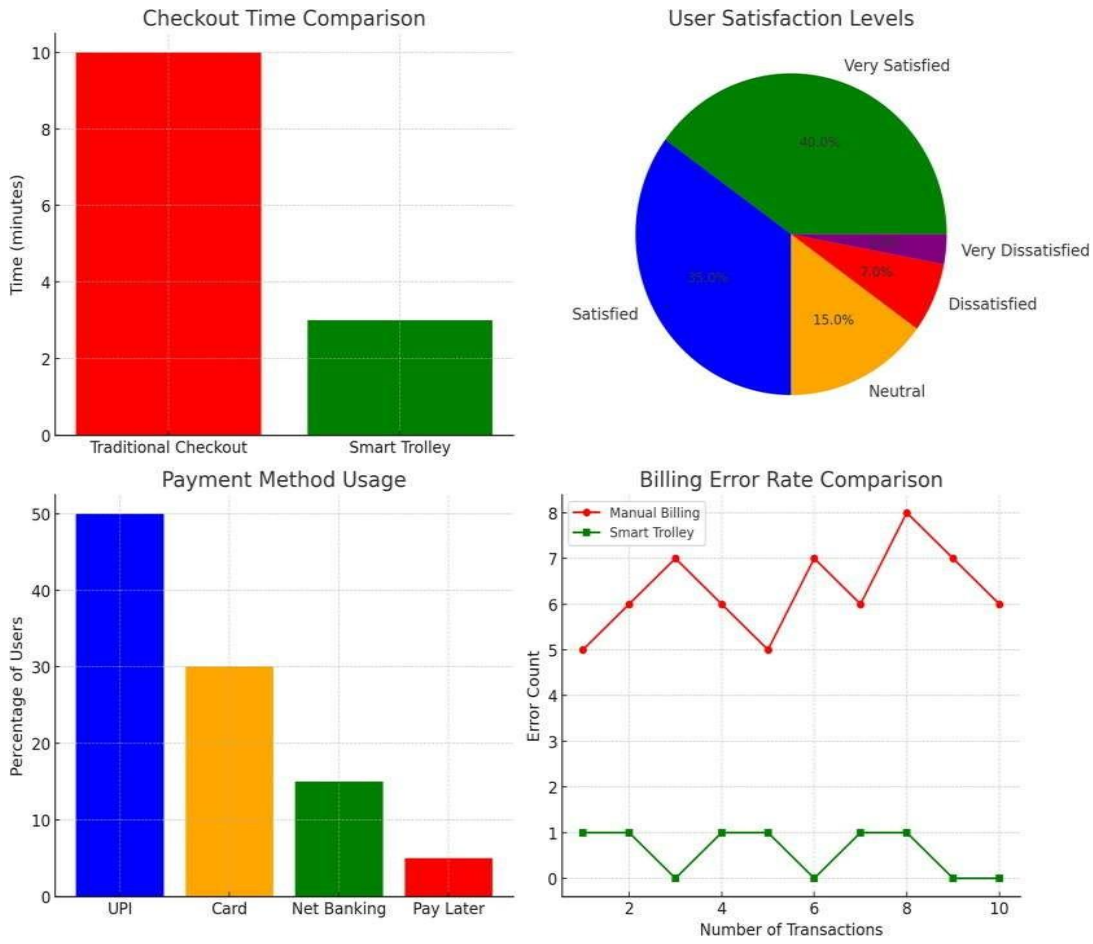

Figure 7: Performance Analysis graphs

7. Advantages and Disadvantages Advantages

- Efficiency: Automates product scanning and billing, reducing checkout times and eliminating long queues.
- Transparency: Real-time updates on the LCD ensure that customers are fully informed about their purchases and expenses.
- Ease of Use: The system is intuitive and user-friendly, requiring minimal effort to operate.
- Security: QR code-based payments provide a secure and reliable transaction process.
- Cost-Effectiveness: Affordable components ensure that the system is economically feasible for implementation in retail environments.

Disadvantages

- Scalability Issues: Deploying the system in large stores may require enhanced networking capabilities to handle multiple trolleys simultaneously.
- Integration with Inventory Systems: Future iterations could include real-time inventory tracking and automatic stock updates.
- Enhanced User Interface: Improvements to the LCD interface, including multilingual support and promotional offers.
- Energy Optimization: Enhancing battery efficiency to increase operational hours.
- Data Privacy: Implementing encryption to protect customer data and payment information.

8. Comparison Table

Author	Description	Improvement in proposed project
Tapan Kumar Das et al., [1]	A smart shopping trolley automates shopping and billing using RFID, Arduino, and Wi-Fi, sending e-bills to customers.	The smart trolley uses RFID and Wi-Fi, while the Smart Shopping Trolley uses barcode scanning and IoT components.
Rahul R et al., [2]	An automatic smart trolley uses Node MCU and RFID tags to reduce billing time, displaying scanned products on an OLED screen.	The Smart Shopping Trolley uses barcode scanning and IoT components, while the automatic smart trolley uses RFID tags and Node MCU microcontroller.
Sakshi Maurya et al., [3]	A smart trolley system detects items and displays costs on an LCD screen, with a mobile app for customers to view and manage their purchases.	Here we uses barcode scanning and IoT components, whereas the smart trolley system uses a mobile app and LCD display.
Bipin Kumar Yadav et al., [4]	A proposed cart system uses RFID technology to scan products, reducing billing queue wait times. Each product has a passive RFID sticker with name and price information.	The proposed cart system uses RFID technology to scan products, while the Smart Shopping Trolley uses barcode scanning and offers additional features like QR code payment, receipt printing, and real time updates.
M.Kabil Dev et al.,[5]	A Smart Trolley enables customers to shop and pay bills, without waiting in line, using Arduino, RFID, and Wi-Fi technology.	They uses Arduino UNO, RFID reader and tag, and Wi-Fi module, we barcode scanning and IoT components.
Sasrika Reddy Garlapati et al.,[6]	IoT-based smart cart integrates RFID, image processing, and weight sensors for efficient shopping and checkout.	The Smart Shopping Trolley uses barcode scanning, while the IoT-based system uses RFID, image processing, and weight sensors for enhanced accuracy.

9. Conclusion

Smart Shopping Trolleys an innovative and efficient solution designed to enhance the retail shopping experience by automating the billing process. By integrating an ESP32 microcontroller, barcode scanner, LCD display, and payment gateway, the system minimizes checkout time and eliminates the need the speeds for manual billing. The real-time display of item details and total price on the LCD ensures transparency, making the shopping process more convenient for customers.

The implementation of a QR code-based payment system allows for a cashless transaction experience, reducing the need for long queues at the billing counter. Multiple payment options such as UPI, Card, Net Banking, and Pay Later provide flexibility and accessibility to all users. The unique 6-digit code generation further enhances the security and accuracy of transactions, ensuring that each trolley is linked to its respective payment.

With this automated system, both customers and retailers benefit significantly. Customers experience a faster and hassle-free shopping journey, while retailers can improve efficiency by reducing manpower costs and optimizing billing processes. The integration of IoT technology in the shopping trolley opens doors for further enhancements, such as real-time inventory tracking and AI-based product recommendations.

Overall, the Smart Shopping Trolley represents a step towards smart retail automation, aligning with modern technological advancements in the retail sector. By reducing manual intervention and improving efficiency, this project has the potential to revolutionize shopping experiences, making them more seamless, interactive, and user-friendly.

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