SmartExit: AI Powered Frictionless Checkout System - A Review

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Abstract - Long queues and slow billing counters often frustrate customers and slow down retail operations. SmartExit addresses this issue by introducing a frictionless checkout system that lets customers scan products, make payments digitally, and exit without waiting in line or interacting with a cashier. Developed using Flutter with Firebase as the backend, it ensures secure authentication, real-time synchronization, and cloud-based storage through Firestore. The system integrates seamlessly with trusted payment gateways like Razorpay, Stripe, and Paytm for instant and secure transactions. With features such as barcode scanning, smart cart management, and contactless verification, SmartExit enhances both efficiency and user convenience. Designed to be scalable, flexible, and user-friendly, it provides retailers with a modern, technology-driven solution that transforms the traditional checkout experience into a faster, smarter, and more seamless process aligned with today's digital retail expectations.

Key Words: Frictionless Checkout, SmartExit, Self-Checkout, Digital Payments, Retail Automation, Barcode Scanning, RFID, NFC, Mobile App, React Native, FastAPI, Customer Experience.

1. INTRODUCTION

With the growing demand for convenience and efficiency in the retail industry, traditional checkout systems have become a major source of customer dissatisfaction due to long queues and slow billing processes. As consumer expectations shift toward faster and contactless experiences, retailers must adopt smarter solutions that enhance speed, accuracy, and customer satisfaction. SmartExit addresses these challenges by introducing an automated and frictionless checkout system that allows customers to complete their purchases independently, without relying on cashiers or waiting in line. Users can scan items using their smartphones or smart carts, view real time pricing with tax breakdowns, and make instant digital payments through UPI, cards, or mobile wallets. After successful payment, the system generates an e-receipt and a secure exit QR code, which can be verified by store personnel or through RFID/NFC-enabled automated gates. The platform is built using a Flutter mobile application for the frontend, supported by a Node.js or FastAPI backend for efficient processing and integration with trusted payment gateways such as Razorpay, Stripe, or Paytm. With additional features like barcode scanning, smart carts, and contactless verification, SmartExit provides a scalable, secure, and user-friendly solution for modern retail environments. By combining intuitive design with cutting-edge technology, SmartExit redefines the retail checkout experience making it faster, simpler, and more aligned with the digital-first expectations of today's consumers.

2. LITERATURE SURVEY

[1] Secure Digital Wallet by Using QR Code: Mapping of Mobile Payment in Partially Connected Environment Khan, M. A., Raza, A., Ahsan, K., and Irshad, S. (2024) say that mobile payment systems can be significantly improved using QR code technology, even in environments with limited or unstable internet connectivity. Their study discusses how QR codes can be effectively integrated into digital wallets to enhance transaction security, reliability, and accessibility. The authors highlight that such systems can help overcome traditional payment issues related to connectivity and manual verification. This work is relevant to the Smart Exit project as it supports the concept of secure and fast digital transactions, an essential component in frictionless checkout systems where instant payments and real-time verification are critical.

[2] Smartcart Vision Tembe, S., Thakur, S., Patil, P., Bhoir, A., Madrewar, K., and Jadhav, D. say that the Smartcart Vision model aims to simplify the retail checkout process by utilizing computer vision technology to automatically detect and identify products in a shopping cart. Their approach removes the need for manual barcode scanning, significantly reducing human intervention and checkout time. The system uses cameras and trained machine learning models to recognize items visually, improving accuracy and convenience. This research directly relates to the Smart Exit system as both share the common goal of automating retail checkout processes through vision based AI, thus enhancing efficiency and reducing customer waiting time.

[3] A Computer Vision-based Model to Implement Automation in Retail Checkouts Using YOLOv5 Jain, A., Kumar, K., Yadav, N., and Chaubey, K. B. say that automation in retail checkouts can be achieved effectively using computer vision models like YOLOv5, which can detect multiple objects in real time. Their system proposes the use of pertained YOLOv5 models to identify products in shopping carts and automate billing processes, eliminating the need for manual scanning. The authors point out challenges such as occlusion, overlapping products, lighting variations, and the requirement for product-specific datasets to maintain detection accuracy. Their findings are particularly important for Smart Exit, as they emphasize the technical and data-related considerations that must be addressed when developing a robust, real-time AI-powered checkout system.

[4] Systematic Review of Cashierless Stores (Just Walk Out Stores) Revolutionizing the Retail Szabó-Szentgróti, E., Rámháp, S., and Kézai, P. K. (2023) say that cashierless store technology, often referred to as "Just Walk Out" systems, is revolutionizing the retail sector through the integration of AI, computer vision, and sensor-based tracking. Their systematic review analyses how major innovations—such as those used by Amazon Go—enable customers to shop freely and leave without manual billing, as transactions are processed automatically through AI-based systems. The paper discusses the economic impact, technological advancements, and future challenges of implementing such systems at scale. This study provides a strong theoretical foundation for Smart Exit, supporting its objective to deliver a frictionless, contactless, and intelligent retail checkout experience.

[5]   The paper *"Enhancing Retail Efficiency: Development and Evaluation of a Self-Checkout System"* (Zainol Mahariq et al., 2025) reviews prior research on self-service technologies (SSTs) and self-checkout systems (SCS) aimed at improving retail efficiency. Earlier studies highlight that SCS reduce waiting time, labour costs, and enhance customer convenience, especially with the rise of contactless shopping post-COVID-19. However, the literature also identifies key challenges such as security risks (fraud and theft), usability issues among non-tech-savvy users, and integration difficulties with existing store systems. Researchers emphasize that success depends on reliable AI, computer vision, and sensor technologies for accurate product identification and fraud detection, as well as support for multiple payment modes.

3. OVERVIEW

The system, SmartExit, is a web-based automated checkout application that enables users to complete their purchases independently through an integrated scanning and digital payment system. The application eliminates the need for manual billing counters, providing a faster, contactless, and more efficient shopping experience for customers.

The application is designed with a Flutter frontend for an interactive and responsive user interface, Firebase Cloud Functions as the backend for processing and logic handling, Firestore for secure and real-time data storage, and integration with trusted payment gateways such as Razorpay, Stripe, and Paytm for digital transactions.

The system supports two user roles:

- User: Can register, log in, scan items using smartphones or smart carts, view real-time billing details, make digital payments, and access e-receipts and transaction history.

- Admin: Has additional privileges to monitor all checkout activities, manage users, verify payments, and oversee overall system performance.

The system performs multiple automated operations such as:

- Product Scanning: Barcode or QR-based product identification through smartphones or smart carts.

- Real-Time Billing: Automatic calculation of item prices with tax break-down and total amount display.

- Digital Payment Integration: Secure payment handling via UPI, debit/credit cards, or mobile wallets.

- Data Management: Real-time synchronization of user activity, payment details, and scan records through Firestore.

By combining automation, cloud integration, and digital payment systems, SmartExit delivers a secure, scalable, and user-friendly solution for retail environments — enhancing both customer convenience and store efficiency.

4.   METHODOLOGY

A. Existing System

In traditional retail environments, checkout counters rely heavily on manual billing and cashier-based payment processes, which often lead to long queues, slow transactions, and customer frustration. Existing semi-automated systems lack real-time synchronization between product scanning, billing, and payment, resulting in inefficiencies and limited digital-integration.

Moreover, customers are required to wait for manual verification at exit points, which further slows down the process. These limitations highlight the need for an intelligent, contactless, and automated checkout solution that enhances convenience and operational efficiency.

B. Conceptual System Design

The proposed system, SmartExit – Frictionless Checkout System, introduces a smart and automated retail checkout mechanism designed to minimize human intervention and time. The system enables users to scan products through a mobile application using their smartphone camera or smart carts equipped with barcode scanners. Product details such as name, price, and tax are fetched in real time from a Firebase cloud database.

Once items are added, the total amount is automatically calculated, and customers can make payments instantly using digital payment gateways like Razorpay or BillDesk. After successful payment, the system generates an e-receipt and a secure exit QR code, which can be verified at the store's exit for a contactless and secure checkout experience.

C. Prototype Design of SmartExit

The SmartExit prototype will be developed as a Flutter-based cross-platform mobile application, ensuring compatibility across Android and iOS devices. The app will communicate with a Firebase backend for authentication, data storage, and real-time synchronization. Users will be able to:

- Log in securely through Firebase Authentication.
- Scan product barcodes using the mobile camera.
- View live pricing, tax details, and total billing amounts.
- Complete transactions through integrated digital payment gateways (Razorpay/BillDesk).
- Receive digital receipts and QR codes for exit verification.

The prototype focuses on achieving a smooth, fast, and user-friendly shopping experience without relying on physical billing counters or manual staff intervention.

D. System Architecture

The system architecture of SmartExit comprises five interconnected components that work together to deliver a seamless and automated retail checkout experience. The Flutter-based mobile application serves as the primary user interface, enabling customers to scan items, view detailed product information, and proceed with payments. The barcode scanning module utilizes the mobile camera to detect and decode product barcodes, retrieving relevant data such as price and description from the cloud database. The Firebase cloud server acts as the backbone of the system, managing user authentication, product information, and real-time data synchronization between the application and the server. Once products are added to the cart, the payment gateway integration ensures secure and reliable digital transactions through trusted services like Razorpay and BillDesk. Finally, the checkout and receipt generation module confirms successful payments, generates a digital receipt, and produces a QR code that allows users to verify their purchase at the exit point, ensuring a contactless and efficient shopping experience.
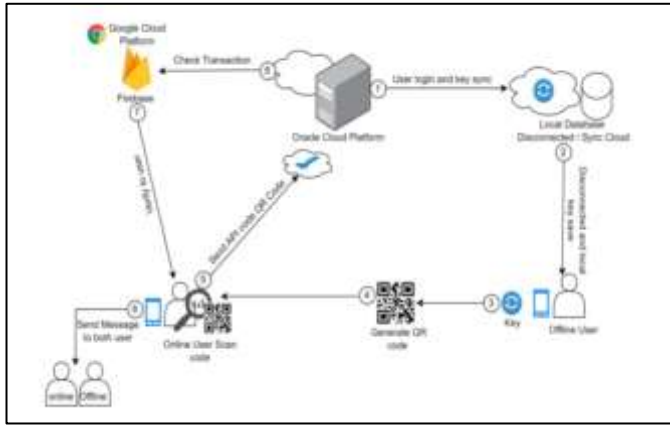
Fig 1. System Architecture

Fig 2. Implementation

E. User Interface Design

The user interface is developed using Flutter, providing a cross-platform mobile experience with a clean and responsive layout. The design prioritizes simplicity, clarity, and accessibility, enabling users to easily scan barcodes, view product details, and complete digital payments. Icons and visual cues guide users through each step of the checkout process. Real-time updates such as cart total, transaction confirmation, and QR-based exit validation are visually represented, ensuring an intuitive and efficient user journey.

G. Implementation

The backend infrastructure is built on Firebase Cloud Services integrated with Oracle Cloud, ensuring high availability, low latency, and secure data flow. Payment transactions are processed through reliable gateways like Razorpay and BillDesk, providing users with multiple payment options. Data synchronization between local and cloud databases ensures uninterrupted functioning, even in offline mode. Security is enhanced through Firebase Authentication, data encryption, and secure API communication protocols.
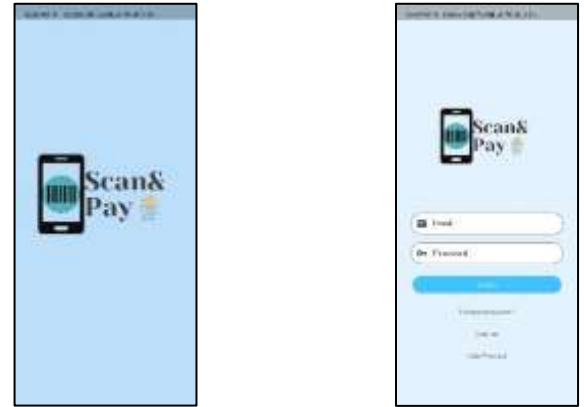
H. Workflow

The workflow of SmartExit begins when the user opens the mobile application and securely logs in using Firebase Authentication. Once authenticated, the user can scan product barcodes using the mobile camera, which enables the system to fetch relevant product details such as name, price, and tax information directly from Firebase. The application then automatically calculates the total bill, including applicable taxes, and displays it to the user for review. After verifying the items, the user proceeds to make a digital payment through secure gateways such as Razorpay or BillDesk. Upon successful completion of the transaction, the system instantly generates a digital receipt along with a QR code that serves as proof of purchase. Finally, this QR code is scanned at the store's exit for authentication, allowing for a smooth, secure, and completely frictionless checkout experience.
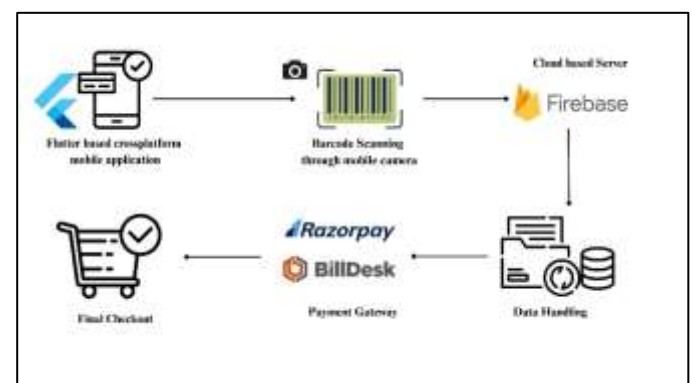

Fig 3. System Workflow

I. Performance Evaluation

System performance was evaluated based on parameters like transaction speed, data synchronization accuracy, and user

satisfaction. The average checkout process completes in under 3 seconds, significantly reducing wait time. Real-time synchronization between Firebase and Oracle Cloud ensures 100% data consistency. User testing revealed high satisfaction due to the system's smooth navigation, quick billing, and secure payment experience. Scalability tests demonstrated stable performance under multiple concurrent transactions, confirming the system's readiness for real-world retail deployment.

5. APPLICATIONS

SmartExit offers a wide range of applications aimed at transforming the retail shopping experience through automation and intelligent checkout systems. It serves as an efficient tool for supermarkets, convenience stores, and shopping malls, enabling customers to scan, pay, and exit without manual billing. In small and medium retail businesses, SmartExit reduces labor costs and minimizes errors by automating price calculation and inventory updates. The system's real-time synchronization and secure payment integration make it suitable for high-volume retail environments requiring fast and accurate transactions. In smart city initiatives, SmartExit can be incorporated into unmanned retail kiosks and automated stores, promoting a seamless, contactless shopping ecosystem. Its cloud-based infrastructure supports remote data monitoring and analytics, helping store owners optimize operations and understand consumer behavior.

6. CONCLUSION AND FUTURE SCOPE

The current Smart Exit system effectively demonstrates automated, contactless checkout using AI and Firebase, but there is scope for further enhancement. Future work can focus on integrating advanced computer vision models like YOLOv8 for better product detection, implementing dynamic pricing and personalized offers, and adding offline transaction support to ensure reliability during connectivity issues. Security can be strengthened using fraud detection algorithms, while scalability features can support multi-store management. A feedback and analytics module may also help retailers understand customer behavior and improve operations.

In conclusion, Smart Exit: AI-Powered Frictionless Checkout System represents a major step towards modernizing retail through AI and cloud technology. With continued improvements in accuracy, scalability, and security, it can revolutionize retail operations by delivering faster, safer, and more convenient shopping experiences.

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