



Smart Shopping Cart Systems for Automated Retail Checkout: A Comprehensive Review of RFID, IOT, Barcode, and Intelligent Billing Technologies

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Abstract - Long waiting lines at billing counters are a common challenge in supermarkets, particularly during peak shopping hours. This review paper explores self-billing and smart checkout systems that enable customers to scan product barcodes or QR codes using a mobile application, view current product prices, add items to a digital cart, and generate a bill without depending entirely on traditional checkout counters. The review examines existing approaches based on barcode scanning, QR codes, RFID, smart shopping carts, self-checkout systems, digital receipts, and automated verification mechanisms. It also analyses how product information and store-specific selling prices can be retrieved from a retailer's authorized database or API to maintain accurate and dynamic billing information. Particular attention is given to verification methods that can reduce billing fraud and product mismatches without requiring every customer to undergo lengthy manual checking. Based on the reviewed literature, the paper identifies research gaps related to integration of mobile self-scanning, dynamic store pricing, efficient transaction verification, and reduction of checkout waiting time. The findings provide a foundation for designing a smart self-billing application aimed at improving checkout efficiency while maintaining billing accuracy and customer convenience.

Key Words: Automated Billing, Barcode Scanning, IoT, RFID, Mobile Self-Billing, Self-Checkout Systems.

1. INTRODUCTION

The rapid growth of supermarkets and retail stores has increased the need for faster and more efficient billing systems. During peak hours, customers often spend considerable time waiting in long queues at traditional billing counters. The conventional checkout process requires customers to wait for a cashier to scan each product, calculate the total amount, process payment, and generate a receipt. This can increase waiting time and may reduce the overall shopping experience.

Self-checkout technology provides an alternative approach in which customers participate directly in the billing process. With technologies such as barcode scanning, QR codes, RFID, mobile applications, and smart shopping carts, customers can identify products and prepare their bills while shopping. Existing studies have explored smart shopping carts, RFID-based checkout, automated billing, and self-service technologies to improve checkout efficiency and customer convenience.

A mobile-based self-billing system can extend this concept by allowing customers to use their smartphones to scan product barcodes or QR codes, retrieve product information and the current store selling price, and add products to a digital cart. After completing shopping, the application can calculate the total amount, validate the latest prices, process payment, and generate a digital receipt with a QR code. At the store exit, staff can physically compare the customer's products with the digital receipt rather than requiring every product to be scanned again.

However, implementing such a system involves challenges related to dynamic product pricing, product-data access, transaction accuracy, fraud prevention, and efficient verification. Therefore, this review paper examines existing research on self-checkout, smart shopping systems, barcode/QR-based billing, RFID, automated verification, and related retail technologies. It further identifies research gaps and discusses how these technologies can be combined to develop a self-billing system that aims to reduce checkout waiting time while maintaining billing accuracy and transaction security.

2. OVERVIEW AND BACKGROUND

The growth of supermarkets and retail stores has increased the need for faster and more convenient checkout processes. Traditional Point-of-Sale (POS) systems require customers to wait while cashiers scan products, calculate bills, process payments, and generate receipts. Self-checkout systems



address this issue by allowing customers to participate directly in the billing process, potentially reducing waiting time and improving convenience.

Researchers have explored technologies such as barcode scanning, RFID, IoT, smart shopping carts, sensors, microcontrollers, and mobile applications for automated product identification and billing. RFID-based carts can identify products automatically, while mobile and IoT-based systems support customer-driven scanning and digital billing.

However, challenges remain in billing accuracy, product identification, transaction verification, payment security, and customer acceptance. The reviewed technologies demonstrate the potential of integrated self-billing systems that combine product scanning, digital cart management, automated billing, payment, and transaction verification to improve supermarket checkout efficiency.

3. TECHNOLOGY KEY TERMS

Self-Checkout: Enables customers to scan products, generate bills, and make payments with limited cashier assistance.

Barcode/QR Scanning: Identifies products and retrieves their details and prices using a scanner or smartphone camera.

RFID: Uses radio-frequency signals to identify tagged products and can support automatic multi-item detection.

IoT and Sensors: Enable communication between devices and support real-time product and transaction information.

Smart Shopping Cart: Integrates technologies such as RFID, sensors, displays, or controllers to assist shopping and billing.

Mobile Self-Billing: Allows customers to scan products, manage their cart, calculate bills, and make digital payments through a mobile application.

Automated Billing: Calculates the total amount of scanned products and generates the transaction digitally.

Transaction Verification: Checks the purchased products against the generated bill to improve billing accuracy and reduce mismatches.

Payment Gateway: Enables secure electronic payment processing through supported digital payment methods.

Data Security: Protects customer, payment, and transaction information using authentication and other security mechanisms.

Digital Receipt: Provides an electronic record of the completed transaction containing product, payment, and billing details.

Cloud Database: Stores and synchronizes product, pricing, inventory, and transaction information for real-time access.

4. TECHNOLOGY COMPARISON

Technology	Core Function	Key Strength	Main Limitation
Barcode/QR Scanning	Product identification	Low cost and easy deployment	Requires individual scanning
RFID Smart Cart	Automatic product detection	Multiple-item identification	Tag and reader cost
IoT/Sensors	Data communication and automation	Real-time information	Network dependency
Mobile Self-Billing	Scan, cart and payment	Convenient and flexible	Depends on customer participation

Automated
Verification

Bill-product cross-
checking

Improves
transaction
accuracy

Additional
system
complexity

5. TECHNOLOGY INTERVENTION

Technology-based checkout systems shift several billing activities from cashiers to customers. Barcode scanning, RFID, IoT, smart carts, mobile applications, and digital payments support product identification, automated billing, and payment. These technologies enable a mobile self-billing approach that combines product scanning, digital cart management, payment, digital receipts, and transaction verification to improve checkout efficiency and billing accuracy.

6. APPLICATION AREA

These technologies are applicable in supermarkets, retail stores, shopping malls, and self-service shopping environments. They support product identification, automated billing, digital payments, and checkout management, helping to reduce waiting time and improve customer convenience.

7. ADVANTAGES

- Reduces checkout waiting time.
- Enables faster and efficient billing.
- Reduces cashier workload.
- Improves customer convenience.
- Provides real-time billing information.
- Supports digital payments and receipts.
- Reduces paper-based billing.
- Enhances the overall shopping experience.

8. DISADVANTAGES

- High initial implementation cost.
- Dependence on internet and network connectivity.
- Technical and barcode scanning errors may occur.
- RFID requires tagged products and readers.
- Customers may face difficulty using self-checkout systems.
- Risk of missed scans or incorrect product selection.
- Security and transaction verification challenges.

9. CONCLUSION

The study shows that self-checkout and smart retail technologies such as barcode scanning, RFID, IoT, smart shopping carts, and mobile applications can improve supermarket checkout efficiency. These technologies can reduce waiting time, automate billing activities, and provide greater convenience to customers. However, challenges such as technical failures, scanning errors, security, verification, implementation cost, and customer acceptance need to be considered. The reviewed studies indicate that self-billing technologies have the potential to improve checkout processes while maintaining billing accuracy, security, and customer satisfaction. Further research can focus on evaluating their effectiveness in real-world retail environments.



10. FUTURE SCOPE

Future self-billing systems can integrate AI, computer vision, and advanced RFID for automatic product recognition and transaction verification. Real-time synchronization with product and inventory databases can improve pricing accuracy and availability. Further developments may include secure digital payments, personalized offers, loyalty programs, paperless receipts, and enhanced data-security mechanisms. These advancements can improve the efficiency, reliability, security, and scalability of self-billing systems in supermarkets and retail environments.

REFERENCES

1. J. D. Abad, D. R. C. Sayo, J. R. P. Jandayan, C. J. D. De Villa, H. P. Villaflores, and M. M. Navarro, "The Self-Checkout System: Enhancement of Customer Satisfaction by Reducing Long Queuing Lines in Checkout Lanes of Convenience Stores in the Philippines," in Asia Pacific Industrial Engineering and Management Systems Conference, 2016.
2. Martinus, M. S. Wahab, Yudi, and H. Ham, "Data Transmission Using RFID System on Smart Shopping Carts for Checkout Process Efficiency in Supermarket at Indonesia," *Procedia Computer Science*, vol. 179, pp. 902–912, 2021, doi: 10.1016/j.procs.2021.01.080.
3. M. Chauhan, "The Clever Spending Trolley," *International Journal of Research and Analytical Reviews (IJRAR)*, vol. 6, no. 1, 2019. PDF: <https://www.ijrar.org/papers/IJAR19J5889.pdf>.
4. K. Latha, S. U. Sandhya, G. L. Gayathri, and V. Vijayarani, "Smart Shopping Cart Using RFID Technology," *International Journal of Research and Analytical Reviews (IJRAR)*, vol. 6, no. 2, 2019. PDF: <https://www.ijrar.org/papers/IJAR1APP025.pdf>.
5. H. Darisi and S. Nagireddi, "Smart Basket Algorithmic Approach for Shopping in Super Markets Using Rechargeable Smart Card," *International Journal of Research and Analytical Reviews (IJRAR)*, vol. 6, no. 2, 2019. PDF: <https://www.ijrar.org/papers/IJAR2001199.pdf>.
6. S. Chakraborty, P. Majumder, R. Saha, M. Kundu, and S. Chatterjee, "Smart Trolley for Smart Shopping with Automatic Billing System: A Distributed Framework," *International Journal of Research and Analytical Reviews (IJRAR)*, vol. 9, no. 2, 2022. PDF: <https://www.ijrar.org/papers/IJAR22B2600.pdf>.
7. P. B. L. Premsagar, K. Samarth, S. Shreyas, T. Thejas, and S. V., "IoT Based Smart Shopping Trolley," *International Journal of Research and Analytical Reviews (IJRAR)*, vol. 9, no. 2, 2022. PDF: <https://www.ijrar.org/papers/IJAR22B3339.pdf>.
8. K. Ingale, M. Paliwal, S. Jha, G. Masarrat, S. Kodlekere, and S. Shedge, "Delighting Customers: Evaluating Service Quality and Customer Satisfaction of Self-Checkout Users in Sports Retail," *Innovative Marketing*, vol. 20, no. 3, pp. 97–109, 2024, doi: 10.21511/im.20(3).2024.08.