# IoT-Based Smart Shopping Trolley with Anti-Theft and Self-Charging Mechanisms

Based on the review of numerous smart retail and IoT-based shopping solutions, a system is designed that automates billing, prevents theft, and ensures energy efficiency, enabling retailers to reduce operational costs, improve customer convenience, and promote sustainable shopping practices.

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ABSTRACT

The Smart Shopping Trolley aims to revolutionize retail shopping by integrating modern IoT technologies into traditional shopping carts. This project introduces a solution that minimizes human intervention, reduces checkout time, and addresses key challenges such as billing inefficiency and product theft. Utilizing components like RFID readers, load sensors, microcontrollers, and digital displays, the trolley enables real-time item detection and billing. Additionally, it incorporates a self-charging mechanism to enhance energy efficiency and sustainability, along with an anti-theft mechanism currently under development. This paper presents the system's architecture, design methodology, implementation progress, and its expected contribution to smart retail environments.

## 1. Introduction

In modern supermarkets, long billing queues and inaccurate manual billing processes lead to poor customer experiences and operational inefficiencies. Smart shopping systems are being developed to streamline these issues. A Smart Shopping Trolley automates the billing process, displays real-time product prices, updates the total bill, and ultimately allows for a contactless checkout experience.

The proposed system is a microcontroller-based embedded solution that interacts with RFID/barcode tags on products, stores data locally, and optionally syncs with cloud or POS systems. Beyond automation, the trolley integrates anti-theft mechanisms (e.g., weight verification and alert systems) and an innovative self-charging feature using solar power or kinetic energy.

This solution supports inclusive shopping, especially for elderly or differently-abled individuals.

## 2. Summary of some research papers

[1] L.S.Y. Dehigaspege et al: Follow Me Multifunctional Automated Trolley with IR tracking and Android-based billing: Developed a multifunctional automated trolley with IR sensors for customer tracking and Android-powered billing, including features like automatic parking and charging.

[2] Suraj S et al: RFID-based wireless intelligent cart with ARM7 integration: Implemented an RFID-based wireless intelligent cart using ARM7 technology for automated item detection and billing.

[3] S. Sainath et al: Raspberry Pi and barcode scanner integration for GUI-based self-checkout: Designed an automated shopping trolley using Raspberry Pi, embedded chips, and barcode scanners, integrated with an Android app for self-checkout.

[4] S.M. Kalyani Dawkhar et al: RFID shopping cart with LCD display showing item name, expiry, and price: Created an RFID-enabled shopping cart displaying product name, expiry date, and price on an LCD screen, though limited to basic functions.

[5] Zubin Thomas et al: Li-Fi-based automatic billing method: Proposed a Li-Fi-based automatic billing system to reduce human intervention during checkout.

[6] Galande Jayshree et al: RFID reader and RF modules for billing and communication to POS: Used RFID readers and RF modules to communicate scanned item details to a billing computer wirelessly.

[7] Parameswaran Ramesh, P.T.V. Bhuvaneswari: RFID-enabled shopping cart with child safety unit: Developed an RFID-based trolley integrated with a child care unit for enhanced safety.

[8] R. Badi, B. Momin: Zigbee + RFID for efficient communication in smart cart: Focused on Zigbee and RFID protocols for efficient wireless communication between the trolley and store systems.

[9] J. Suryaprasad et al: Affordable, functional smart trolley for retail billing: Built a low-cost intelligent shopping cart prototype balancing affordability with functionality.

[10] Thangakumar et al: Entry and exit barcode scanning for theft detection and billing: Designed a shopping cart with entry and exit barcode scanners to verify purchased items and prevent theft.

[11] Anonymous: IoT + reinforcement learning-based navigation in smart carts: Introduced IoT-driven smart carts using reinforcement learning to optimize in-store navigation.

[12] Mobeen Shahroz et al: IoT-based RFID billing cart: Implemented an IoT-based shopping cart utilizing RFID for accurate billing and inventory tracking.

[13] Anonymous: Smart trolley with machine learning, navigation, and weighing: Presented a smart trolley integrating machine learning, navigation assistance, and weighing mechanisms.

[14] [14] Peeyush Garg et al: Arduino-based RFID trolley: Designed an Arduino-based RFID smart cart emphasizing accessibility and ease of implementation.

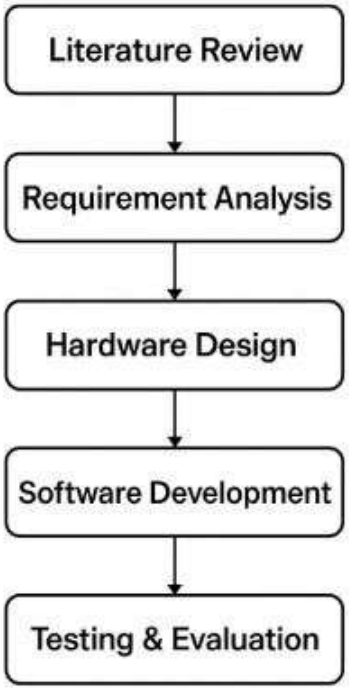
[15] [15] Rajeswararao Kvs et al: IoT-based prototype for retail efficiency: Proposed an IoT-based trolley prototype aimed at increasing retail efficiency.

[16] [16] Manchukonda Gautham et al: RFID streamlining of the shopping process: Used RFID technology to streamline shopping processes and improve billing accuracy.

[17] [17] Anonymous: IoT notification-based cart for enhanced store management: Developed an IoT-enabled smart trolley with a notification system for real-time store management updates.

## 3. Methodology for proposed solution

The IoT-based Smart Shopping Trolley was developed to address checkout delays, theft prevention, and energy efficiency. Requirements were identified through literature review, surveys, and store analysis. The hardware includes RFID readers, load sensors, a touchscreen, Arduino/Raspberry Pi, Wi-Fi/Bluetooth modules, and a solar panel.
Software features embedded firmware for scanning, billing, theft detection, and optional mobile integration.Completed features are RFID scanning, real-time billing, and self-charging. The anti-theft system is in progress, with navigation and mobile payment planned. Development followed Agile sprints, using Tinkercad and Proteus for simulation, and Python and Arduino




## 4. Conclusion

The Smart Shopping Trolley enhances the traditional retail experience by enabling automation, theft prevention, and energy sustainability. The completed modules demonstrate functional reliability and scalability. Future work will focus on integrating navigation, personalized recommendations, and full mobile app integration. This system holds the potential to transform retail environments and contribute to smarter, greener urban infrastructure.

### Credit authorship contribution statement

**.T NAGA JYOTHI:** WRITING – REVIEW & SUPERVISION.

**NITHIYA V:** WRITING-REVIEW & EDITING, WRITING - ORIGINAL DRAFT, CONCEPTUALIZATION.

**PAVAN R:** WRITING - REVIEW & EDITING, WRITING - ORIGINAL DRAFT, CONCEPTUALIZATION.

**SRILAKSHMI P Y:** WRITING-REVIEW, INVESTIGATION, CONCEPTUALIZATION.

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### References

[1] Kumar, A., & Sharma, B. (2018). Smart Shopping Cart Using RFID. IJARCCE, 7(11), 77-80.

[2] Patel, M., & Roy, S. (2019). Smart Shopping Trolley based on IoT with Mobile Application. ICOEI.

[3] Zhang, L., & Singh, T. (2020). The IoT-Based Smart Shopping Trolley System. ICCCI.

[4] Gupta, R., & Fernandes, D. (2021). Smart Shopping Trolley Based on IoT and AI for the Visually Impaired. ICAIS.

[5] Verma, P., & Karthik, N. (2022). Secure and Smart Trolley Shopping System based on IoT Module. ICSTSN.

[6] Thompson, J., & Lewis, S. (2023). Design Framework for Building Smart Shopping Stores Using IoT. Springer.

[7] G. Goran. Module Guide. Technology Evaluation and Commercialisation. London South Bank University.

[8] Scott Fyfe. The Double Diamond Design Process Model.

[9] E. Hong. Upgrading the Shopping Experience with a Smart Trolley. Atelier.net.

[10] J. A. Hoffer et al. Modern Database Management. Pearson Education.

[11] Scientific.Net. Wireless sensors overview.

[12] J.S. Awati et al. Smart Trolley in Mega Mall. IJETAE.

[13] R. O'Neil. Checkout chic: Smart Trolley shops for you. SMH.com.au.

[14] U. Trottmann. NFC - Possibilities and Risks.