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IntelliScan is a Mobile AI-Based Tool that Tracks Product Expiry, Stock, and Profitability for Smarter Retail Analytics

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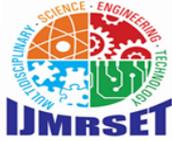
ABSTRACT: This paper presents a software-based Smart Digital Trolley System that simplifies the shopping and billing process in supermarkets. The system eliminates manual checkout delays through a QR-based billing module and enables users to search and add products digitally without IoT sensors or physical hardware. It provides an interactive interface where customers can log in, view items, add them to their cart, and generate a QR code for instant payment. The system is built using the MERN stack (MongoDB, Express.js, React.js, Node.js) to ensure seamless integration, data management, and a real-time shopping experience. This project offers an efficient, scalable, and cost-effective solution for modern retail environments.

I. INTRODUCTION

In traditional retail stores, customers often face long queues at billing counters, which leads to frustration and wasted time [1]. Additionally, the lack of digital convenience makes the shopping process less efficient and less engaging for users. As technology continues to evolve, there is a growing need for smart and user-friendly solutions that simplify the overall shopping experience [2].

To address these challenges, the proposed Smart Digital Trolley System introduces a modern, software-driven approach to shopping. Unlike traditional smart trolleys that depend on hardware sensors or IoT devices, [6] this system focuses entirely on a digital platform [8]. It eliminates the need for costly hardware components while still providing all the essential features for a smooth shopping experience.

Through this system, customers can conveniently view and select products online from a digital catalog. They can manage their virtual cart, update quantities, or remove items as needed. Once their selection is complete, the system generates an instant QR code for secure and quick payment, ensuring a hassle-free checkout process [9]. Moreover, the Smart Digital Trolley System allows users to access their order history and digital bills anytime [3]. This feature enhances transparency and helps customers keep track of their expenses. Overall, the system ensures accurate billing, time-saving checkout, and easy usability — making it an ideal solution for both small and medium-scale retail stores [4].



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II. RELATED WORK

In recent years, several researchers and developers have proposed hardware-based smart trolley systems that rely on technologies such as RFID tags, barcode scanners, and various sensors [10]. These systems aim to automate the billing process and reduce waiting time at checkout counters. While these approaches are functional and effective, they come with significant limitations, including high implementation costs, complex hardware integration, and maintenance challenges.

Many of these hardware-oriented systems require specialized equipment like RFID readers, microcontrollers, and sensors for product detection and billing [8]. Such dependencies not only increase the overall cost of installation but also make the system less scalable for small and medium-sized retailers. Additionally, maintaining these systems demands technical expertise and regular updates, which may not be feasible for every store.

In contrast, our proposed solution focuses entirely on delivering a web-based digital experience without the need for any physical hardware or IoT devices. All the smart trolley functionalities — such as product selection, billing, and payment — are implemented using APIs and frontend logic, making the system lightweight and easy to deploy [5].

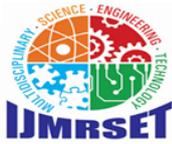
Furthermore, by integrating cloud-based data management, the system achieves the same level of efficiency as hardware-driven solutions while maintaining a lower cost and simpler setup. This approach ensures better accessibility, easier maintenance, and higher adaptability for different types of stores, making it a more practical alternative to traditional hardware-based models [11].

III. METHODOLOGY

The methodology of the Smart Digital Trolley System focuses on delivering an efficient and secure digital shopping experience through a fully software-based setup. The frontend (React.js) provides a responsive interface for browsing, cart management, and checkout, while the backend (Node.js and Express.js) handles authentication, billing, and QR payment via REST APIs [5]. MongoDB stores user, product, and transaction data for fast and scalable access, and JWT authentication ensures secure, role-based access control. Overall, this architecture enables smooth operation, strong security, and high system performance.

A. Software Setup: The software setup of the Smart Digital Trolley System is entirely based on the MERN stack, ensuring a robust, scalable, and efficient architecture. The frontend, developed using React.js, provides a dynamic, responsive, and user-friendly interface that enables customers and staff to perform essential operations such as login, product browsing, cart management, and checkout with ease. The backend, built using Node.js and Express.js, manages all core functionalities through RESTful APIs, including user authentication, product and cart operations, billing, and instant QR code generation for secure payments. The database, powered by MongoDB, efficiently stores and retrieves user information, product data, shopping cart details, and transaction records, ensuring quick access and scalability for large datasets. For security, JWT (JSON Web Tokens) is implemented to enable secure login and role-based access control for different user types—Customer, Staff, and Admin [11].

The software architecture follows the MERN Stack structure, which is divided into three key layers. The Frontend (Client Layer), powered by React.js, serves as the user interaction platform. The Backend (Application Layer), implemented using Node.js and Express.js, handles all application logic and communication between the client and database. The Database (Data Layer), managed by MongoDB, is responsible for data storage and retrieval. Each module within the system communicates through secure HTTP requests via REST APIs, ensuring smooth data flow, reliability, and efficient integration across all layers of the system.



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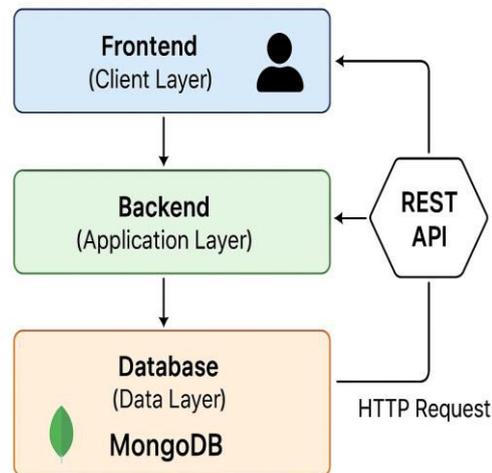


Figure 3.1 Software Setup

B. Workflow: The Digital Trolley System ensures a smooth and secure shopping experience through its well-structured functional modules. In the User Authentication module, customers can register or log in securely, while staff and administrators have separate login access for managing inventory tasks such as adding or updating items. The Item Management module enables authorized staff or admins to add products to the database, each defined by attributes such as name, price, and stock quantity.

The Cart Operations module allows customers to view all available products, add selected items to their virtual cart, update quantities, remove items if needed, and view their total bill dynamically as they shop. Once shopping is complete, the Checkout & QR Billing process begins — the system generates a unique QR code containing the customer’s order details and total payment amount. The customer can then scan this QR code using popular payment applications like UPI, Paytm, or Google Pay to instantly complete the transaction[6].

After successful payment, the Order Management module converts the customer’s cart into a finalized order, which is stored in the database. Customers can later review all their previous purchases through the Order History section for easy reference and expense tracking. Additionally, the Product Search feature enhances user convenience by allowing customers to search for products by name or product ID. The system quickly retrieves and displays matching items from the database, helping users find their desired products efficiently and improving the overall digital shopping experience [9].

C. Digital Trolley: In this software-only system, the digital trolley is implemented as a virtual cart that operates through APIs, allowing seamless communication between the user interface and the backend. It provides real-time cart updates, instant bill calculations, and automatic QR code generation for fast and secure payments. The user interface is designed to be clean, intuitive, and responsive, ensuring that customers can easily manage their shopping experience without any technical complexity [12].

This software-driven approach removes the dependency on physical sensors, hardware components, or microcontrollers while retaining the core concept of a “smart trolley.” By focusing on digital integration and automation, the system offers the same level of convenience and intelligence as a hardware-based model, but with greater scalability, reduced cost, and easier maintenance.

D. Alert System : The alert system in this software is managed through the frontend using React.js, providing users with real-time feedback during their shopping experience. Success alerts are displayed when items are added or removed from the cart, ensuring users are immediately informed of their actions. Warning alerts appear when invalid item IDs are entered or when products are out of stock, helping users make quick corrections without confusion [6].



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Error alerts are triggered in situations such as failed payments or API communication issues, allowing users to take appropriate action promptly. By incorporating these alert types, the system ensures smooth operation, enhances reliability, and improves the overall user experience through clear, responsive, and informative notifications [9].

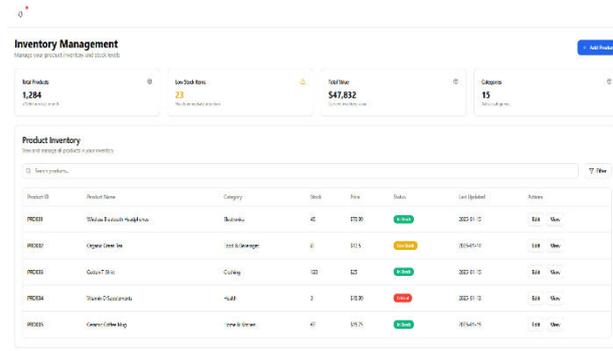


Figure 3.3 Alert System

E. Digital Map : The Digital Map feature serves as a modern alternative to traditional in-store navigation systems by integrating smart technology for efficient product search and display. Instead of manually searching through aisles, customers can use this software to instantly locate products by entering the product name or ID. Once entered, the system retrieves essential details such as price, stock status, and product images, ensuring that customers receive accurate and real-time information about the items they are looking for [3].

All retrieved product data is presented in a clean and structured digital interface, displayed in either grid or list format for easy comparison and browsing. This organized layout enhances the shopping experience by allowing customers to view multiple products simultaneously, evaluate their features, and make quick, informed decisions. The simplicity of the design ensures that even first-time users can navigate and interact with the system effortlessly [2].

By offering a software-based digital mapping system, the need for physical store navigation is completely eliminated. Customers gain immediate and convenient access to the store’s full product catalog, significantly improving shopping efficiency and satisfaction. This digital transformation not only streamlines the shopping process but also promotes a user-friendly and tech-driven retail experience that aligns with modern consumer expectations.

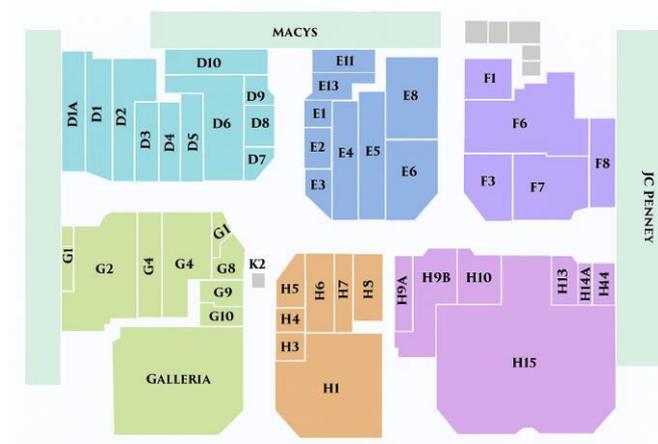


Figure 3.4 Digital Map



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IV. IMPLEMENTATION & RESULTS

The proposed Smart Digital Trolley System was developed using the MERN Stack (MongoDB, Express.js, React.js, Node.js) to create a responsive, interactive, and fully digital shopping platform. The frontend, designed with React.js, provides modules for user login and registration, product browsing, cart management, and QR-based checkout. It includes an alert system that displays success, warning, and error messages to improve user experience during various actions such as adding or removing products or completing payments. Additionally, the system replaces traditional in-store navigation with a digital product map feature, allowing users to search for items by name or ID and instantly view product details like price, stock, and image in a structured grid layout. The backend, built using Node.js and Express.js, manages RESTful APIs that handle user authentication, role-based access, product and cart operations, and billing logic. The MongoDB database efficiently stores user details, product data, and transaction records, with indexing applied for faster product searches and data retrieval. All APIs were tested using Postman to ensure smooth communication and quick response times across different modules [1].

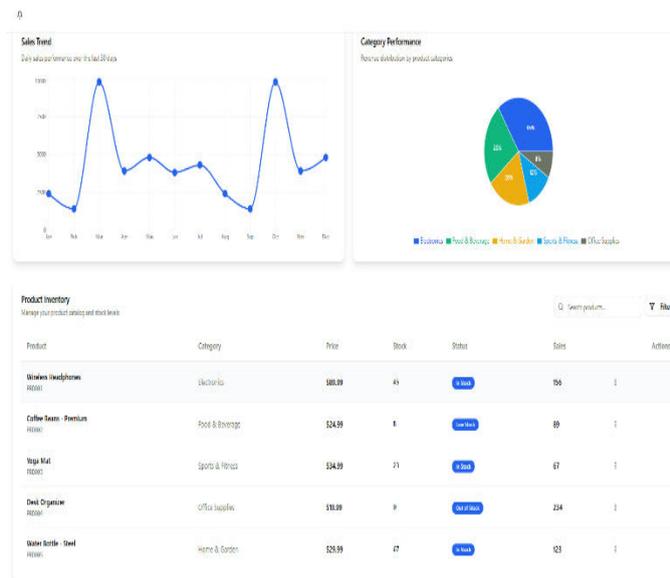


Figure 4 Product DashBord

The system was tested with multiple users under customer, staff, and admin roles to evaluate its performance and accuracy. The results showed that the system handled login, product addition, cart updates, and QR-based billing effectively with an average response time of less than one second. Users were able to generate accurate bills, complete digital payments, and view past orders without manual intervention. The alert and notification system provided real-time feedback during operations, enhancing usability and reliability. Overall, the Digital Trolley System successfully demonstrated how a fully software-based approach can replace traditional hardware-driven smart trolleys [7]. It offers a cost-effective, scalable, and efficient solution for modern retail environments by digitizing the entire shopping and billing experience while maintaining accuracy, speed, and ease of use.

V. DISCUSSIONS

The implemented Smart Digital Trolley System was tested with multiple users across different roles, including customers, staff, and administrators [10]. The system performed efficiently, allowing users to log in securely, browse and add items to their cart, generate accurate bills through QR codes, and view previous orders—all without manual checkout. During testing, all API operations responded quickly and executed without errors, demonstrating the system's efficiency, reliability, and real-world usability [4]. The average response time remained minimal, confirming that the system can handle typical store operations smoothly in a real-time environment.



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Test Parameter	Expected Output	Observed Result	Status
User Login & Registration	Secure authentication	Worked correctly with JWT	Yes
Add to Cart & Update	Items added/removed dynamically	Updated instantly	Yes
QR Code Billing	Generate and scan successfully	Payment simulated successfully	Yes
Order History	Display past transactions	Data retrieved accurately	Yes
API Response Time	Below 1 second	Achieved consistently	Yes

Figure 5 System Testing Results

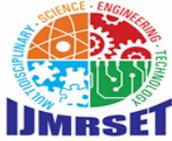
VI. CONCLUSION

The Smart Digital Trolley with QR Billing and Product Search offers a modern, software-driven shopping experience that eliminates the need for physical sensors or complex hardware. Designed using the MERN Stack (MongoDB, Express.js, React.js, Node.js), the system provides a seamless, fully digital solution for managing shopping and billing activities [6]. It enables customers to browse products, manage their virtual carts, and complete transactions through quick QR-based payments, all within an interactive web interface [9]. The integration of React.js ensures a smooth and responsive user experience, while Node.js and Express.js handle backend logic efficiently through secure APIs. MongoDB supports the system with fast and scalable data management for users, products, and order records.

This system enhances convenience and reduces the time spent at billing counters by automating cart operations and payment processing. Its clean and user-friendly interface allows easy navigation, product search, and instant billing, making it accessible even for non-technical users. Since it operates entirely on software, it is cost-effective, easy to maintain, and highly scalable for small to medium-sized retail environments. Overall, the Smart Digital Trolley provides a reliable, efficient, and affordable approach to digitizing shopping and billing processes, helping traditional stores transition into modern, technology-driven retail systems [12].

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