

# Design and Implementation of Smart Shopping Trolley

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**Abstract**— The development of a smart shopping trolley using Arduino presents a practical and educational pathway towards enhancing the retail experience in Bengaluru. By harnessing the Arduino's accessible platform and its ability to interface with various sensors and display technologies key aspects of shopping, such as item identification and real-time billing in Indian Rupees, can be realized. This foundational automation directly addresses common pain points encountered by shoppers in Bengaluru's bustling supermarkets, offering a glimpse into a more streamlined and transparent purchasing process.

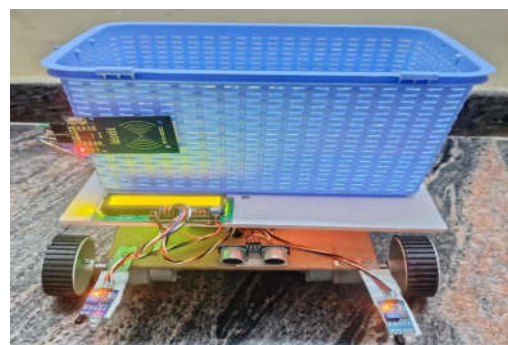
The inherent flexibility of the Arduino ecosystem allows for iterative development and the integration of additional features tailored to the specific needs of the Bengaluru market. The incorporation of sensors for basic navigation could aid shoppers in locating items within the often-crowded aisles, while the addition of wireless connectivity via modules like the ESP32 opens avenues for cloud-based inventory management, personalized offers relevant to Bengaluru consumers, and seamless interaction with user-friendly mobile applications, aligning with the increasing digital penetration in the city. While a fully realized, enterprise-grade smart shopping solution for Bengaluru's diverse retail landscape might necessitate more robust processing power and sophisticated integration, the Arduino-based approach serves as an invaluable tool for prototyping and demonstrating the core principles of smart retail automation.

**Keywords** — *Arduino, RFID Reader, LCD, Ultrasonic Sensor, Gear Motor*

## I. INTRODUCTION

In today's fast-paced world, convenience and efficiency have become critical components of a positive shopping experience. One of the common frustrations for customers in supermarkets and large retail stores is the long wait at billing counters, especially during peak hours. Traditional billing systems are manual and time-consuming, often leading to queues, delayed checkout, and dissatisfaction among customers. As a result, there is an increasing need for smart technologies that can streamline the shopping and checkout process. The concept of a Smart Shopping Trolley addresses this need by integrating automation and embedded systems into the retail shopping environment. It is designed to help customers shop more efficiently by automatically identifying items placed in the trolley, calculating the total bill in real-time, and reducing or eliminating the need to stand in line for checkout. This technology is a step toward modernizing the conventional shopping experience and is in line with the ongoing transformation of retail environments through smart technologies.

At the core of this system is the Arduino microcontroller, a popular open-source electronics platform known for its simplicity, flexibility, and low cost. Arduino is ideal for prototyping and educational purposes, making it a suitable choice for developing a smart trolley system. With its capability to connect various sensors and modules, Arduino acts as the brain of the trolley, processing data from inputs such as barcode scanners, RFID readers, weight sensors, and more. A key feature of the smart trolley is the use of RFID (Radio-Frequency Identification) or barcode scanning technology to identify products. Each product is tagged with an RFID tag or barcode, and when the customer places the item in the trolley, the corresponding reader detects and logs the item. This information is then processed by the Arduino, which updates the list of items and the running total. This eliminates the need for manual scanning by a cashier at the end of the shopping trip. To display the item list and total cost to the customer, an LCD or OLED screen is attached to the trolley. This real-time feedback helps the shopper keep track of their spending, which is especially useful for budget-conscious customers. Additionally, a load cell (weight sensor) can be added to cross-verify the weight of the items in the cart, adding a layer of security and preventing fraud or item misplacement. For communication by integrating automation and embedded systems into the retail shopping environment. It is designed to help customers shop more efficiently by automatically identifying items placed in the trolley, purposes, modules like Wi-Fi (ESP8266/ESP32) or Bluetooth (HC-05) can be integrated into the system even mobile-based payment processing.



**Fig 1:** Smart Shopping Trolley

The Smart Shopping Trolley as shown in Fig 1 is beneficial for customers but also for store owners and managers. It provides real-time inventory tracking and helps reduce labour costs by minimizing the number of employees

needed at checkout counters. The data collected from smart trolleys can be used for business analytics, demand forecasting, and improving the overall efficiency of store operations. This project also reflects the broader trend of IoT (Internet of Things) in retail. By embedding intelligence into shopping carts and connecting them to the internet, stores can create a more interactive, responsive, and personalized shopping experience. As consumers become more tech-savvy, integrating smart solutions into everyday tasks like shopping becomes not just an innovation, but a necessity for competitiveness. From a student and developer perspective, building a Smart Shopping Trolley using Arduino is an excellent learning opportunity. It involves the integration of hardware components, embedded programming, sensor interfacing, user interface design, and wireless communication—all of which are valuable skills in the field of electronics and IoT. The project is also scalable and can be extended with advanced features like voice assistance, GPS tracking, or facial recognition. In conclusion, the Smart Shopping Trolley is a practical, innovative solution aimed at improving the in-store shopping experience. It leverages embedded systems and IoT technologies to solve real-world problems in the retail sector. Using Arduino as the foundation ensures cost-effectiveness and accessibility for educational and experimental purposes, making this project both impactful and achievable.

## PROBLEM STATEMENT

In traditional retail environments, the shopping experience is often time-consuming, inefficient, and lacks personalization. Customers entering large supermarkets or department stores frequently encounter challenges such as difficulty locating specific items, unclear product information, and long queues at checkout. These seemingly small issues accumulate to create a frustrating experience for customers and can result in reduced store loyalty, cart abandonment, or even a shift toward online alternatives. In today's fast-paced world, customers often experience long queues at supermarket billing counters, especially during peak hours. This not only causes inconvenience and delays but also leads to dissatisfaction among shoppers. Manual billing is time-consuming and prone to human error, contributing to inefficiency in traditional retail systems. There is a growing need for an automated solution that can streamline the shopping and checkout process.

The Smart Shopping Trolley aims to address this issue by integrating embedded technology to automate item detection and billing. Using an Arduino microcontroller along with components like RFID or barcode scanners, each item added to the trolley can be identified and its price displayed in real-time on an LCD screen. The total bill gets updated dynamically as products are added or removed, giving customers clear visibility into their expenses while shopping. This system can also include wireless modules like Wi-Fi or Bluetooth to send the final bill to a centralized billing system or mobile device, enabling quicker checkouts and reducing the need for manual processing. By implementing a Smart Shopping Trolley, retail stores can improve operational efficiency, reduce manpower requirements, and offer a faster and more convenient

shopping experience to their customers. Although digital technologies such as smartphones and store-specific mobile apps are available, they are often underutilized or require manual input from the shopper, which disrupts the shopping flow. Checkout counters remain a major bottleneck. During peak hours, customers can spend more time waiting in line than actually shopping. Even with the addition of self-checkout kiosks, issues such as technical glitches, user errors, and staff assistance requests reduce efficiency.

For customers purchasing only a few items, this waiting time can be a deterrent to returning for future purchases. From the retailer's perspective, there is little visibility into in-store consumer behaviour. Unlike online platforms that collect rich data on user interactions, brick-and-mortar stores struggle to track which aisles receive more foot traffic, which products are often picked up but not purchased, or which shoppers are loyal repeat customers. This lack of data reduces the effectiveness of inventory planning, product placement, and targeted promotions. Security and loss prevention are also concerns. Traditional trolleys provide no or security staff to prevent loss, which can be intrusive and time-consuming for both customers and staff. In this context, a Smart Shopping Trolley presents a much-needed, technology-driven innovation. By incorporating RFID or barcode scanners, weight sensors, touchscreen interfaces, and wireless connectivity, smart trolleys can enable automated item detection, real-time price display, budget monitoring, product suggestions, and even mobile checkout without queuing. With built-in GPS or indoor positioning systems, these trolleys can guide users to the exact location of products in the store, saving time and enhancing convenience. Ultimately, a Smart Shopping Trolley transforms passive checkout without queuing. With built-in GPS or indoor positioning carts into intelligent shopping assistants. It bridges the gap between e-commerce convenience and in-store engagement. For customers, it means faster, more personalized, and more enjoyable shopping experiences. For retailers, it opens the door to better analytics, improved inventory control, reduced manpower costs, and stronger customer loyalty.

## OBJECTIVES

- To automate the billing process during shopping: Design a system that allows customers to scan items and generate bills in real-time, thereby reducing or eliminating the need to stand in queues at checkout counters.
- To implement item identification using RFID or barcode technology: Integrate RFID readers or barcode scanners with the Arduino microcontroller to detect and identify items placed in the trolley automatically.
- To provide real-time display of product details and total cost: Use an LCD or OLED display to show the name, price, and total bill dynamically as the customer adds or removes products from the trolley.
- To enable efficient budget tracking for customers: Help customers monitor their expenditure in real-

time during shopping, allowing better control over their budget and reducing impulse purchases.

- To integrate load sensing for item verification and security: Implement a load cell to measure the weight of items and ensure they match the scanned data, preventing billing errors and potential theft.
- To support wireless communication for data synchronization: Incorporate Wi-Fi or Bluetooth modules to allow the trolley to communicate with store servers or customer mobile apps for data logging, billing, or payments.
- To reduce human errors and increase billing accuracy: Minimize manual data entry and cashier-related mistakes by automating the item recognition and billing process.
- Cost-Effective Solution: Using Arduino and affordable electronic components makes this system economical, especially for small or medium-sized stores looking to modernize their operations.
- Scalable and Customizable: The system is easily scalable. Features such as digital payment, mobile app integration, and voice assistance can be added in future versions to meet different store requirements.
- Educational and Technological Value: For developers and students, the project provides hands-on experience with embedded systems, sensor integration, IoT, and microcontroller programming, making it a valuable learning tool.

## II. PROPOSED METHODOLOGY

The block diagram illustrates the architecture of an automated system, likely a smart device or robot, centered around the Arduino Uno microcontroller.

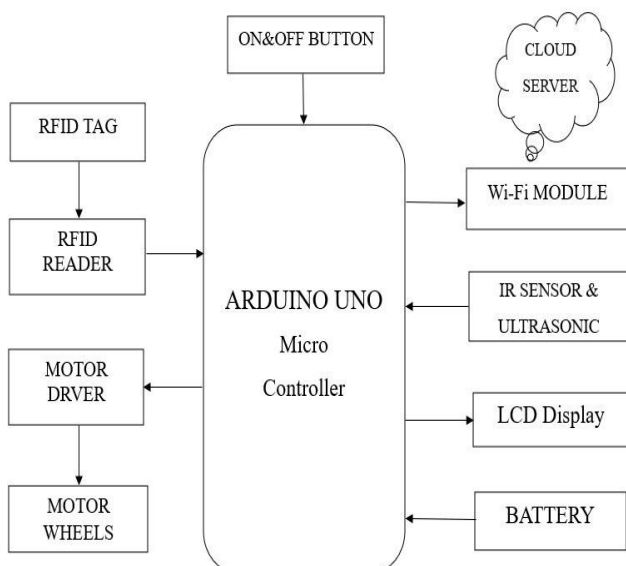


Fig. 2: Proposed Block Diagram

The Arduino Uno serves as the central processing unit, receiving inputs from various sensors and control mechanisms, processing this information based on its

programmed logic, and then generating outputs to control other components within the system. This setup highlights the Arduino Uno's role as the intelligent core, orchestrating the interactions between different hardware modules to achieve the system's intended functionality, potentially within a smart environment in Bengaluru. One key input to the Arduino Uno in this diagram originates from an RFID (Radio-Frequency Identification) system. An RFID tag, attached to an object or person, is read by an RFID reader. This reader then transmits the unique identification data from the tag to the Arduino Uno. This suggests a system that can identify and track items or individuals, a functionality that could be used for various applications in Bengaluru, such as inventory management in a warehouse, access control in a building, or even item identification in a smart shopping trolley.

The diagram also shows an "ON&OFF BUTTON" connected directly to the Arduino Uno. This fundamental control allows a user to manually power the system on or off, providing a basic level of interaction and control over the device's operation. This simple yet crucial component ensures that the system can be easily activated and deactivated as needed, a standard requirement for most electronic devices used in Bengaluru and elsewhere. For environmental awareness and potentially autonomous navigation, the Arduino Uno receives input from "IR SENSOR & ULTRASONIC" sensors. Infrared (IR) sensors can detect the presence of objects by sensing emitted or reflected infrared radiation, while ultrasonic sensors use sound waves to measure distances

The Arduino Uno in this system also interacts with a "Wi-Fi MODULE," which enables wireless communication with a "CLOUD SERVER." This connectivity suggests that the system can transmit data to the cloud for storage, processing, or remote monitoring, and potentially receive commands or updates from the cloud. This IoT (Internet of Things) capability opens up possibilities for remote control, data analytics, and integration with other cloud-based services, aligning with the growing trend of connected devices in Bengaluru.

Finally, the Arduino Uno controls "MOTOR DRIVER," which in turn powers "MOTOR WHEELS." This indicates the presence of a mobile platform or robotic component within the system. The motor driver acts as an intermediary, providing the necessary current and voltage to drive the motors based on control signals from the Arduino Uno. The "BATTERY" provides the power source for the entire system, enabling it to operate independently without a direct wired connection. The "LCD Display" likely serves as an output interface, allowing the system to display information, status updates, or user prompts, providing a visual means of interaction for users in Bengaluru.

## III. FLOWCHART AND IMPLEMENTATION

The flowchart outlines the steps involved in a smart shopping experience using an automated trolley. Initially, the trolley system is powered on, activating its array of sensors (ultrasonic, RFID, IR) and other necessary modules. A crucial first step is the detection of a human user, which triggers the trolley to enter a "follow" mode, suggesting an autonomous or semi-autonomous navigation capability. As

the user adds items to the trolley, the system scans these products, likely using RFID tags or barcodes, to identify them and retrieve their prices. Once items are scanned, the trolley's internal system calculates a running total of the bill. This total is then presented to the user through an integrated LCD display on the trolley and potentially also sent to a

sensors, which prepare the trolley to detect and interact with its environment. This step ensures the trolley is ready for real operation, tracking, and billing. Once the sensors are activated, the trolley enters the human detection phase. Using a combination of ultrasonic, RFID, or IR sensing, the trolley identifies the presence of a human (typically the shopper) and begins to follow them autonomously. This human-following capability helps maintain a seamless and hands-free shopping experience, as the trolley automatically moves along with the customer through the supermarket aisles. As the customer shops and places items into the trolley, the products are scanned using RFID tags or barcodes. Each scanned item is recognized by the system, and its price is added to the total bill in real time. This information is immediately displayed on an LCD screen attached to the trolley or can be sent to a mobile application. The live billing feature allows customers to monitor their expenses while shopping, improving budgeting and transparency.

After all products have been scanned, the customer proceeds to checkout. The system displays the final bill and provides an option for payment, typically through a QR code for online transactions. Once the payment is successfully processed, the system checks if the trolley is ready for the next use. If yes, it resets and returns to the initial detection mode. If not, the trolley powers off and ends the session. This intelligent automation improves efficiency, reduces human effort, and provides a modern solution to supermarket billing challenges.

After a transaction (or if the user is done shopping), the system enters a decision point: "Ready for Next Use". If the trolley is available for another shopper, the process loops back to the human detection stage, preparing for a new shopping session. If the trolley is not ready for reuse (perhaps the user has indicated they are finished and the trolley needs to be reset or returned), the system proceeds to power off, and the operation ends. This cycle illustrates a self-contained and automated shopping workflow, from initial user engagement to final power down, designed to enhance efficiency and convenience in a supermarket setting in Bengaluru.

IV. RESULTS

The movement of a sensor-equipped smart shopping trolley ideally result in intelligent and user-centric navigation within the supermarket. Here's a breakdown of expected outcomes:

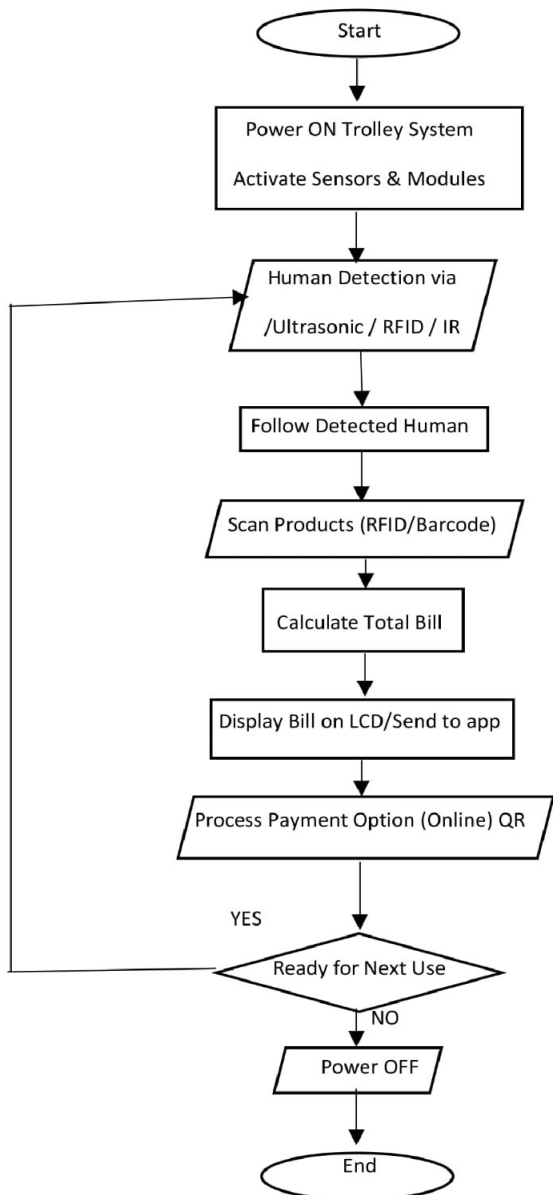
**Autonomous Following:** Using sensors like ultrasonic, infrared, or even computer vision, the trolley should accurately follow the identified shopper as they move through the aisles of a Bengaluru store, maintaining a comfortable and safe distance.

**Obstacle Avoidance:** Sensors would detect obstacles such as other shoppers, displays, and stationary objects, enabling the trolley to autonomously navigate around them without collision, crucial in potentially crowded Bengaluru supermarkets. **Smooth and Adaptive Motion:** The trolley's movement should be smooth, adjusting its speed and

dedicated mobile application on the user's smartphone, providing convenient access to the shopping summary.

Fig 3: Flowchart

The flowchart further indicates an option for processing payment directly through the trolley, specifically mentioning online payment methods, possibly including QR code scanning for transactions, aligning with popular digital payment trends in Bengaluru. The flowchart illustrates the working process of an Automated Smart Shopping Trolley designed for supermarket billing using embedded systems and smart sensors. The process begins when the system is powered on, activating all necessary sensors and modules. These include ultrasonic sensors, RFID readers, and IR



direction in real-time to match the shopper's pace and trajectory, ensuring a seamless and intuitive experience.

**Responsiveness to Stops and Starts:** When the shopper stops, the trolley should also come to a gentle halt and resume following when the shopper moves again, providing a natural and synchronized movement pattern. **Potential for Manual Override:** While autonomous movement is key, the system might also allow for manual control or adjustments by the shopper if needed, offering flexibility in navigating specific situations.



Fig 4: Movement of shopping trolley

❖ PRODUCTS LISTING

Smart Trolley Cart		
Product	Price (₹)	Action
Mango	30.00	Remove
Shampoo	5.00	Remove
Parle-G	10.00	Remove
chips	25.00	Remove
Chocolate	15.00	Remove

Total: Rs.85.00

Clear Cart    Proceed to Checkout

Fig 5: Product Listing

When a smart shopping trolley utilizes a cloud server for billing, the process involves real-time data synchronization and centralized management. As items are added to the physical trolley and identified (via RFID or barcode), this information, along with a unique trolley identifier, is immediately transmitted wirelessly (likely via Wi-Fi, given the context of a shopping environment in Bengaluru) to the cloud server. The cloud server, acting as the central hub, hosts the comprehensive product database containing names, prices in Indian Rupees (₹), and potentially inventory levels for the entire supermarket.

Upon receiving the item identification from the trolley, the cloud server looks up the corresponding product details and price. This information is then relayed back to the smart trolley's display interface (or the user's linked mobile app), updating the virtual shopping cart and the running total in real-time. This two-way communication ensures that the billing information displayed to the shopper in Bengaluru is always accurate and up-to-date, reflecting any changes in price or availability managed centrally on the cloud server.

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❖ DISPLAY ITEMS



Fig 6: Display Product and Price

**Confirmation of Action:** The message "milk added" provides direct confirmation to the shopper that their action of placing the milk (or having it automatically scanned) has been successfully registered by the system. This immediate feedback builds trust and ensures the shopper is aware of what's being added to their virtual cart in the Bengaluru supermarket.

**Individual Item Pricing:** Displaying the cost of each item as it's added ("COST: 45") allows the shopper in Bengaluru to track the price of individual products. This is particularly useful for budget-conscious shoppers or those comparing prices of different items. It provides a granular view of their spending before the total bill is displayed. Upon receiving the item identification from the trolley, the cloud server looks up the corresponding product details and price. This information is then relayed back to the smart trolley's display interface (or the user's linked mobile app), updating the virtual shopping cart and the running total in real-time. This two-way communication ensures that the billing information displayed to the shopper in Bengaluru is always accurate and up-to-date, reflecting any changes in price or availability managed centrally on the cloud server.

**Integration with Scanning Mechanism:** This display is a direct result of the smart trolley's item identification system, which could be RFID or barcode-based, as we discussed

earlier. When the milk (with its corresponding tag or barcode) is detected, the system retrieves its name and price from the store's database (potentially residing on a local server or a cloud server, considering the Bengaluru context) and presents it on the LCD.

**User Interface Simplicity:** The display uses clear and concise language, making it easy for shoppers of all technological proficiencies in Bengaluru to understand the information. The use of abbreviations is minimal, and the key details (product name and cost) are prominently shown. The display uses clear and concise language, making it easy for shoppers of all technological proficiencies in Bengaluru to understand the information. The use of abbreviations is minimal, and the key details (product name and cost) are prominently shown

**Potential for Total Bill Display:** While this specific image only shows the information for the "milk" being added, the LCD would likely have the capability to display the running total of all items in the cart as well. This could be shown on a separate line or updated dynamically after each item is added, allowing the shopper in Bengaluru to constantly monitor their overall spending.

❖ PAYMENT METHOD

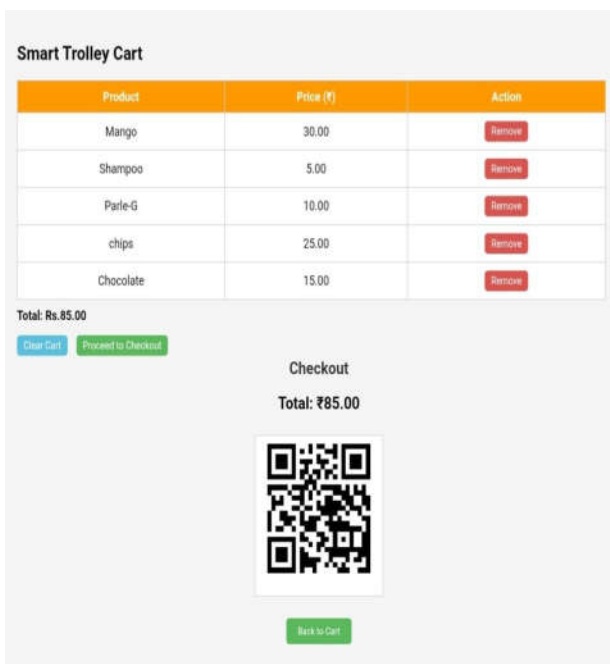


Fig 7: Payment Method

The image shown in fig 7 "Checkout" section below the "Smart Trolley Cart" summary, indicating that the user has likely pressed the "Proceed to Checkout" button. Here's the payment information presented. The image displays the checkout interface of a Smart Trolley Cart system used in automated shopping. At the top, the cart lists five items added by the user—Mango, Shampoo, Parle-G, Chips, and Chocolate—along with their respective prices. Each item has a "Remove" button, allowing the user to delete unwanted products from the list. The total cost of the cart is calculated in real-time and displayed at the bottom of the product table, which in this case amounts to ₹85.00. Below the cart table,

users are provided with two buttons: "Clear Cart" to reset the cart and "Proceed to Checkout" to continue with the billing process. In the checkout section, the total amount of ₹85.00 is displayed again for confirmation. A QR code is generated to facilitate online payment, streamlining the checkout process by allowing users to scan and pay directly using their smartphones. This eliminates the need for physical cash handling or standing in long queues at traditional billing counters. After completing the payment, users can return to the cart interface using the "Back to Cart" button, suggesting a seamless loop for repeat transactions or corrections.

This digital interface demonstrates a key functionality of smart shopping systems, where automation, RFID/barcode-based billing, and online payments merge to create a user-friendly and time-saving shopping experience. Such systems enhance the efficiency of retail operations while offering a modernized shopping method for consumers.

- Checkout: This is the heading for the payment section.
  - Total: ₹85.00: This reiterates the final amount to be paid in Indian Rupees, consistent with the total calculated in the shopping cart summary above.
  - QR Code: A prominent QR code is displayed. This strongly suggests that one of the primary payment methods supported by this smart trolley system in Bengaluru is QR code-based payment, which is highly popular in India, especially through UPI (Unified Payments Interface) apps like Ponape, Google Pay, Paytm, and others widely used in Bengaluru. To make the payment, the shopper would likely need to scan this QR code using their preferred UPI-enabled mobile payment application.
  - Back to Cart: A button at the bottom allows the user to return to the shopping cart to make further modifications before finalizing the payment.

This setup provides a clear and straightforward path for completing the transaction using a widely accepted digital payment method in Bengaluru. The QR code simplifies the payment process, eliminating the need for cash or card swiping directly at the trolley. The "Back to Cart" option offers flexibility to the shopper before they commit to the payment.

This Smart Trolley Cart checkout interface is part of an intelligent billing system designed to simplify and speed up the shopping process in supermarkets. As shown in the image, the cart automatically updates and displays a detailed itemized list of products scanned during shopping, each accompanied by its price and a "Remove" option for real-time editing. This not only helps users maintain control over their purchases but also aids in budget management by showing a live update of the total bill. The items listed—Mango, Shampoo, Parle-G, Chips, and Chocolate—together add up to ₹85.00, calculated automatically by the system.

The next step in the interface is the automated checkout process, which provides a convenient QR code for payment. This QR code links directly to a digital payment gateway, enabling customers to pay instantly through UPI-based apps like Google Pay, Ponape, or Paytm. The use of digital payments eliminates manual errors and delays, supporting a cashless and contactless billing experience, which is especially valuable in today's fast-paced, hygiene-conscious environments. By integrating payment into the trolley system

itself, this design also minimizes the need for traditional billing counters and staff.

Additionally, this system can be expanded to sync billing data with a mobile app, where users can track purchase history, receive digital receipts, and get loyalty rewards. The cart could also be linked to a store's inventory system, updating stock levels in real-time as items are added or removed from the cart. This reduces instances of overstocking or understocking. Overall, the Smart Trolley Cart acts as a self-service, intelligent shopping assistant—streamlining operations for retailers and enhancing convenience and satisfaction for shoppers.

## CONCLUSION AND FUTUREWORK

The development of a smart shopping trolley using Arduino presents a practical and educational pathway towards enhancing the retail experience in Bengaluru. By harnessing the Arduino's accessible platform and its ability to interface with various sensors and display technologies key aspects of shopping, such as item identification and real-time billing in Indian Rupees, can be realized. This foundational automation directly addresses common pain points encountered by shoppers in Bengaluru's bustling supermarkets, offering a glimpse into a more streamlined and transparent purchasing process.

The inherent flexibility of the Arduino ecosystem allows for iterative development and the integration of additional features tailored to the specific needs of the Bengaluru market. The incorporation of sensors for basic navigation could aid shoppers in locating items within the often-crowded aisles, while the addition of wireless connectivity via modules like the ESP32 opens avenues for cloud-based inventory management, personalized offers relevant to Bengaluru consumers, and seamless interaction with user-friendly mobile applications, aligning with the increasing digital penetration in the city. While a fully realized, enterprise-grade smart shopping solution for Bengaluru's diverse retail landscape might necessitate more robust processing power and sophisticated integration, the Arduino-based approach serves as an invaluable tool for prototyping and demonstrating the core principles of smart retail automation.

It provides a tangible platform for learning, experimentation, and the development of customized solutions that cater to the unique characteristics and preferences of shoppers and retailers within Bengaluru. The open-source nature of Arduino further fosters a spirit of innovation and collaboration within Bengaluru's vibrant tech community. Students, hobbyists, and developers can leverage the extensive online resources and community support to explore, adapt, and enhance smart trolley designs, contributing to the growth of local expertise in this emerging field. This collaborative environment can drive the creation of contextually relevant retail challenges. Ultimately, the Arduino-based smart shopping trolley represents a significant step towards a more intelligent and

user-centric shopping experience in Bengaluru. By empowering individuals and businesses to experiment with automation and digital integration at a manageable scale, it lays the groundwork for the future adoption of more advanced smart retail technologies that can enhance efficiency, convenience, and customer satisfaction within. While a fully realized, enterprise-grade smart shopping solution for Bengaluru's diverse retail landscape might necessitate more robust processing power and sophisticated integration, the Arduino-based approach serves as an invaluable tool for prototyping and demonstrating the core principles of smart retail automation.

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