

Comprehensive Review on Smart Shopping Trolley

T. Sushmitha¹, Sahana N², Sabari Giri O.D³, Tejaswini N⁴

Student, Department of Electronics and Communication Engineering, Atria Institute of Technology,
Bangalore, India^{1,2,3,4}

Abstract: In today's world, people get too busy with their job and find less time for shopping. As we know during weekends shopping malls are much crowded and after shopping it's a tedious process to stand in a long queue and wait for billing to happen. The bar-code-based billing process fails to be on par with the speed of the billing process when it has many products to be scanned. Thus, it is time-consuming and inefficient. So, for this reason, people nowadays undergo online shopping which has got huge drawbacks like quality issues. To overcome this issue, there are many technologies used. RFID technology is one of them. Instead of scanning laser light reflections from printed barcode labels, an RFID scanner recognizes the location and identification of tagged things. It leverages low-power radio frequencies to collect and store data. In this survey, we examine the use of different techniques such as Wireless Sensor Network (WSN), Global System for Mobile communication (GSM), Microcontroller, etc. for the smart trolley. This concept "Smart Trolley" aids us to save time and brings the billing process to be on par with the busy days of the customer. This unique smart trolley system can be easily implemented and tested on a commercial scale and can be made used as a real-time scenario in the future.

Keywords: Microcontroller, RFID, Wireless sensor network, GSM, Smart trolley

I. INTRODUCTION

For the majority of the two millennia, India had the world's largest economy from the first to the nineteenth century. India's economy is described as an emerging market economy with a middle income. It has the world's third-largest purchasing power parity economy and the sixth-largest nominal GDP (PPP). The Indian retail market is projected to be over US\$600 billion, making it one of the world's top five in terms of economic value. India is one of the world's fastest-growing retail markets, with a predicted value of \$1.3 trillion by 2020, In 2018, India's e-commerce retail business was worth \$32.7 billion, and it's predicted to grow to \$71.9 billion by 2022. Developing new products is still a strategic decision for businesses looking to acquire a competitive edge today. Enterprises gradually realize that they may receive information, technology, and labour from outside to jointly develop products in order to succeed from innovation [2][3]. Users, on the other hand, no longer take products offered by the enterprise passively, but actively participate in product development and design, as well as other areas of product creation, in order to co-create value [4]. Customer participation can improve product performance, improve product innovation ability, and perfect products and services, in addition to strengthening the enterprise's competitive advantage and increasing the likelihood of innovation success [5]. The way people shop has changed dramatically. People are shifting away from local marketplaces and toward marts. The explanation is simple: people can acquire everything they need, from vegetables to cosmetics, under one roof.

Nowadays, shopping in a mall for a range of things necessitates the use of a trolley. Many supermarkets nowadays provide shopping conveniences, one of which is a shopping trolley. Customers use it to bring things to the cashier while shopping, and he is not supposed to leave the store. Every time a consumer pulls the trolley from rack to rack to gather products, he or she must also calculate the cost of those items and compare it to the amount of money in his pocket. Even if people now have electronic money, everyone will agree on one issue, standing in long lines for billing. In the end, customers must choose between their valuable time and the number of products they acquire. We can have a very good method of paying our bills in no time because we live in the twenty-first century with great technologies. Consider buying a significant number of products and be ready to pay bills as soon as you're done shopping. It will undoubtedly save us time. Customers, on the other hand, are frequently concerned about a variety of issues when visiting a mall. Most clients, for example, are concerned that the carrying amount will not be sufficient to cover the cost of purchasing things. As a result, clients using RFID smart trolleys will be able to avoid the challenges that customers in hypermarkets face.

II. MOTIVATION

A. DESIGN OF THE SERVICE:

It is critical to note that there is a dearth of understanding on how new services should be developed. As the global economy shifts from manufacturing to services, it's critical to comprehend and understand the new service design process.

In order to please customers, a service concept is a description of client needs and how those needs are met. The goal of development is to provide service perquisites that customers find appealing. Many years ago, most investors concentrated their efforts on industrial research and design. As a result, production methods and processes were essentially optimized; items were created and produced, while service development and design were mostly overlooked. However, the scenario is rapidly changing, and then there's Service Design. Service Interfaces are typically created for intangible items that are helpful, profitable, and attractive to customers while being effective, efficient, and unique to the supplier. The most significant aspect of service design is that it visualizes and formulates solutions that aren't currently available by watching and analyzing client demands and transforming them into possible services or new services.

Sylvan Goldman, the owner of standard food market in Oklahoma, was one of the first to introduce a shopping cart. Customers frequently complain to him about the trouble they have bringing groceries from his store. Goldman attempted to resolve the issue by experimenting with shopping baskets in his store. To make it easier for customers to transport groceries, he mounted the basket on a carriage with little wheels. To help and delight his customers, he commissioned an engineer to create a modern shopping trolley, which he patented 1. Since then, the shopping cart has been mass-produced. Shopping trolleys come in a variety of designs and sizes at today's supermarkets.

Following Goldman, there has been a slew of research and products aimed at improving shopping carts.

B. THE REASON FOR USING A MICROCONTROLLER BASED SYSTEM:

Microcontroller-based systems are less bulky and transferrable. It consumes less energy. As a result, the system becomes affordable. It takes up less room and is simple to install. User-Friendly And Cost-Effective: Because this system relies on a microcontroller, it consumes less energy and occupies less space, making it both user-friendly and cost-effective.

C. GENERIC APPROACHES:

The microcontroller-based design has risen to the top of the electronics trend list. This is a highly specialized field that allows thousands of transistors to be integrated onto a single silicon chip. Nowadays, shopping in a mall for a range of things necessitates the use of a trolley. Every time a consumer pulls the trolley from rack to rack to gather products, he or she must also calculate the cost of those items and compare it to the amount of money in his pocket. Following this approach, the customer must wait in line for billing. So, to avoid headaches such as dragging a trolley, sitting in a billing line, and planning a budget, smart trolley is a new concept that we are introducing. Only the RFID TAG of the product wrapper must be held in front of the RFID scanner by the consumer. Following that, product-related data will be displayed on the display. Customers can purchase a big number of products in a short amount of time and with minimal effort by using this trolley. A computer may be readily interfaced at the billing counter for verification and bill printing.

D. RADIO-FREQUENCY IDENTIFICATION (RFID):

As defined in [1], RFID is a technique that employs radio waves to convey data from an electronic tag, termed an RFID tag or label, attached to an object, through a reader for the purpose of identifying and tracking the object (2015). When RFID technology is used with a trolley, it creates a powerful combination., it may detect the location of items or products, making it easier for customers to find what they're looking for. It can also help the company or the store identify commodities or products that are in short supply. It will be easy for the corporation to order goods or a new product, ensuring that it is always available.

As a result, interactions between the dealer and the supplier will be easier. This trolley is said to assist customers in determining the pricing of things and keeping track of their budget when shopping. Customers who wish to buy something in a mall should select things from the display rack and wait in line for payment. Customers must also wait in line at the cashier for an extended period of time to pay. This will be the hardest hit during the holiday season or if shopping centres continue to use traditional ways of adding the price of each item to the cash register by hand.

III. STATEMENT OF THE PROBLEM

The marketing process, which promotes items to consumers and distributors, is an important aspect of supply chain management. Shopping refers to a gathering of individuals in one location for the purpose of purchasing goods. There are supermarkets or shopping malls that give a venue for people to shop where sellers promote their items to customers and customers buy products based on quality factors such as ingredients, expiration date, brand name, affordable price, and quantity. Traditional retailing is another term for this. Supermarkets are advantageous in terms of retail and urban development.

At the weekend, supermarkets are the most congested places. Making a list, whether on paper or on their phone, is one of the most basic tasks in shopping, as most customers have learned. They must spend a significant amount of time searching for products in the entire supermarket one by one, as well as time waiting in long lines to pay bills. Waiting in lines has a bad impact on people's moods and can lead to misunderstandings or confrontation, such as when someone cuts in line and stands in front of others. Traditional marketing encourages many local jobs, city life, and urban culture, thus this is not an ideal development. The store must also tailor its assortment to the desires of its customers.

As a result, online shopping attracts a big number of customers who purchase goods via the internet and browsers. In the interim, consumers can choose products based on prescribed criteria, ingredients, or instructions and obtain them from defined places. Furthermore, there is a higher risk of fraud, lack of inspection, the item may not work properly or be defective, not be the same product as the item pictured, transaction from stolen credit card, Phishing in which the customer believes they are purchasing a product from a reputable seller, disruption in the retail industry, and failure to provide pricing negotiation. Traditional shopping, rather than internet shopping, makes people feel more valuable, entertains them, allows them to enjoy themselves, and provides them with a high-quality product. Traditional shopping and supermarkets must reinvent themselves in these key scenarios if they are to thrive in the modern-day. Markets, also known as retail hubs or shopping malls, are sites where multiple small businesses come together to form a market. The Smart Trolley proposal stood out among the team's many ideas because of how it might be turned into an exciting technology product that is convenient, easy to use, and efficient, as well as being an add-on service to the existing self-checkout system.

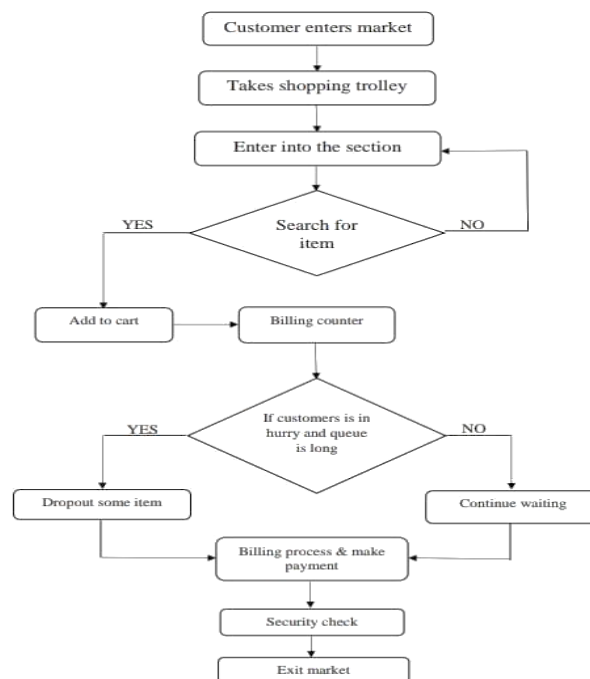


Fig1: Flowchart depicting the present shopping issue

IV. LITERATURE SURVEY

[6] This document contains in-depth information about RFID technology. RFID is a flexible and user-friendly technology that is employed in IoT and embedded devices. To identify products, radiofrequency identification (RFID) tags are routinely employed. Tags and readers are the two components of an RFID system. The reader sends out radio waves and

receives a signal from the RFID tag. This technique was recognized in the 1970s, but it has only recently become increasingly significant. RFID scanning distance can be easily adjusted as per needs. The RFID tags are scanned using a variety of ways. Some use the ATMEGA 32 microcontroller, the Em18 module, and the RC522, which is one of the finest. We can use the Xampp server, ZigBee module, USB wire, Mobile app, or GSM module to generate the bill and transmit it to the cashier, just as we can use the Xampp server, ZigBee module, USB wire, Mobile app, or GSM module to scan.

In [7], is all about combining multiple technologies such as Arduino Uno, RFID, and an Android mobile application, the intended system design for the automation of the purchasing process. Electronic components and software components are the two primary types. In the field of electronic components, the Arduino Uno serves as an intermediate microcontroller that controls RFID technology and facilitates communication between RFID technology and software components such as an Android mobile application through a Wi-Fi module.

In [8], there is a deep study of components used for smart trolleys such as LCD, LCD stands for liquid crystal display, and it is a type of display that looks like a flat panel. An LCD is installed on the cart to display the product information as they are added or deleted, as well as the updated bill details. The commands to the LCD are delivered through the code developed to show the required content. EM18 RFID reader, 125KHz tags are read with an EM-18 RFID reader. It uses a minimal amount of electricity and can read up to 10cm away. It comes in a tiny package and is simple to operate. The communication formats UART and Wiegand26 are available. It can communicate directly with microcontrollers through UART and with a PC via RS232. The HC-12 communication module is utilized to establish wireless connectivity between the trolley and the shopping mall's central PC. This module is commonly used to send and receive digital data. It communicates in half-duplex mode. It has 100 channels with a frequency band of 433.4-473.0MHz. It has a range of up to 1.8 kilometres.

In [9], provides the information is about MIFARE tags, MIFARE, a well-known NXP brand for a wide range of contactless IC components that allow read/write distances of up to 10cm, is more proven and dependable than any other interface technology on the market. The frequency of operation for these tags is 13.56MHz. Backward compatibility within the MIFARE product family provides a seamless transition to higher security and functionality levels. MIFARE Ultralight, MIFARE Classic, MIFARE Plus, MIFARE DESFire, and Smart MX are the most popular products. MIFARE tag's disadvantages are, less supplier experience, backward compatibility issues, less choice of readers, change or migrate all applications, and need to make multiple changes in a short period of time.

In another article, reports that the Smart Trolley will obviously necessitate a very good and adaptable design that will entice the client to utilize the product. Essentially, the trolley is and will continue to be a vital element of the consumers' shopping experience, and companies that utilize them must guarantee that the design meets the needs of the customers [10]. The Smart Trolley should be easy to maneuver; each Smart Trolley should be equipped with a security tracking device to prevent individuals from taking it outside of the retailer's premises, and it should only be used for card payments. It should be equipped with a barcode scanner and a screen device (shopping tablet) to display all scanned products and prices, as well as a help button that may be tapped for any type of assistance. A shopping tablet should be user-friendly, with a touch screen that is simple to operate. The method through which client software communicates with a database server is known as a database connection. The database connection is used by the program to send requests to and receive responses from the database server. The database stores information that the client program may access.

Another method in [11] gives the solution for Why is RFID used? RFID tags are classified into two types, passive and active. Passive tags have no battery life, but Active tags do. RFID deployment of mobile technologies and automated recognition make smart cart technologies more accessible. RFID, in conjunction with wireless networks, makes the traditional retail process faster, more transparent, and efficient. Since the introduction of wireless technology, electronic commerce has evolved to the point where it can give ease, comfort, and efficiency in daily life. The primary goal of this is to create a centralized and automated billing system that makes use of RFID and ZigBee connectivity [11].

The Bayesian Network A Bayesian network, Bayes network, belief network, Bayes (IAN) model, or probabilistic directed acyclic graphical model is a type of Bayesian network. According to this statistical model, a set of random variables and their conditional relationships are represented by a directed acyclic graph (DAG). DAGs are formal Bayesian networks in which the nodes represent random variables in the Bayesian sense. They might be observable quantities, unidentified

factors, or speculations. Edges show conditional dependencies, whereas nodes that are not linked represent variables that are conditionally independent of each other. A probability function associated with each node accepts a specific set of values for the node's parent variables as input and returns the probability distribution of the variable represented by the node. An interesting study gives the feasibility study as the first step that must be taken before starting a business. This research also serves as the foundation for business choices, ensuring that no one party is affected. The feasibility assessment also includes commercial, technological, financial, legal, and risk identification aspects. One of the primary factors for determining feasibility is the marketing component [12].

V. SMART TROLLEY DESIGN ANALYSIS

The components of the Smart Trolley design are as follows. Each component was assigned to a different team member who was responsible for researching and submitting the design requirements.

1. User interface and design of the Smart Trolley
2. Access to the store's database
3. Wireless Internet access
4. Establish a network
5. Scanning product
6. Power
7. Payment mechanisms and receipt creation

A. RESEARCH STUDY

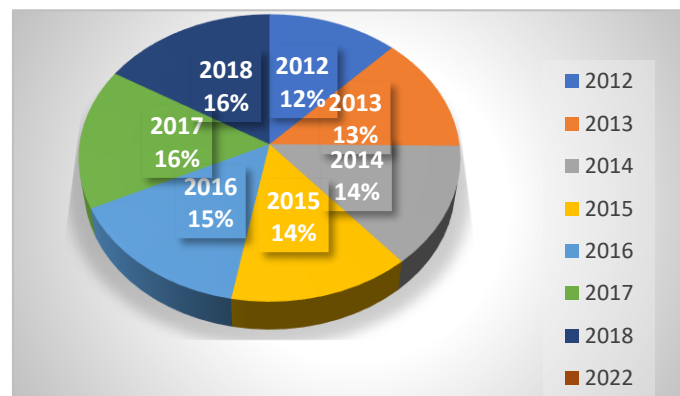


Fig2: From 2012 to 2018, the total number of shopping malls in India increased, with an estimate for 2022.

In 2018, India's eight biggest metropolitan cities had a total of 253 shopping malls. From 188 malls in 2012, this was a steady year-over-year rise. Around a hundred malls are projected to be constructed by 2022. The development of the middle class is reflected in the number of shopping malls.

Sl. no	Functionality	RFID System	Zigbee	Barcode System	Recommendation System
1	Based on Arduino	Yes	Yes	No	Yes
2	RFID Sensors	Yes	Yes	No	Yes
3	Bluetooth	No	No	No	Yes
4	IOT based Wire-less Communication	Yes	Yes	No	Yes
5	Barcode Scanner	No	No	Yes	No
6	Android based Mobile display	Yes	No	No	Yes
7	Location based searching module	No	No	No	Yes
8	Automation of bill generation	No	Yes	No	Yes
9	Shopping list management	No	Yes	No	Yes

Table 1: Comparison of present and recommended system

B. RESULT

The retail component demonstrated by market researchers all indicates that the traditional trolley market is always growing, with total trolley sales increasing by \$250 million in 2013 and \$900 million in 2016. According to another article, several types of creative features found on a trolley to assist its user in shopping can boost trolley sales even more. The trolley has gone through a lot of evolution. Capex Inc, Focal System, Walmart APOLLO, and even Microsoft Corp. are among the companies that have improved its trolley. This means that more trollies have been purchased by an existing mall or a newly opened mall for the convenience of the people, i.e., longer queues. To increase customer convenience and to reduce long and boring queues for the billing process, the concept of a smart trolley will be helpful.

VI. CONCLUSION & FUTURE SCOPE

The Smart Trolley was developed to be a mobile self-service system that will allow users to check out and transact from their local retail store. It is fully synchronized with the store's existing system. With this smart trolley, they will know the exact amount to pay. Each product in the store will have an RFID tag. The customer will be given a special RFID card that will allow them to access the trolley. The security tag is present in almost every item for theft protection. The name of the product, quantity, and price of each product will be displayed. This makes shopping convenient. A database is managed and presented on the cashier side, where the total amount and the number of products is shown for each customer. Obviously, RFID surpasses barcodes in their accuracy, quick response, and durability. This concept eliminates standing in a queue, saves the customer time, and facilitates the shopkeeper's process. This reduces one-third of the overall investment of the shopkeeper for the billing department.

REFERENCES

- [1]. Aboli Hanwate and Poonam Thakare. 2015. Smart Trolley Using RFRID, International Journal of Research in Science & Engineering. Volume: 1, Special Issue: 1.
- [2]. Newey, L., & Verreynne, M. L. (2011). Multilevel absorptive capacity and interorganizational new product development: A process study. *Journal of Management & Organization*, 17(1), 39-55.
- [3]. von der Heide, T., & Scott, D. (2011). More similar than different: A study of cooperative product innovation with multiple external stakeholders. *Journal of Management & Organization*, 17(1), 95-122.
- [4]. H. Ernst, W.D., Hoyer, M. Krafft, S. Jan-Henrik, (2010) User Idea Generation. working paper.

- [5]. Mahr, D., Lievens, A., & Blazevic, V. (2014). The value of customer cocreated knowledge during the innovation process. *Journal of Product Innovation Management*, 31(3), 599-615..
- [6]. Ashutosh Walimbe, Vikrant Pagnis, Akshit Alva, A Sidhesh Balapure, Madhuri Karnik A Survey Paper on Smart Trolley Using RFID Technology Vol. 13, No.2s, (2020), pp. 1597–1602 1597 ISSN: 2233-7857
- [7]. Cart SWETHA K B1 , ABHISHEK G2 , RUTHVIK T3 , MEGHANA B N4 , NARASIMHA REDDY GARI NARESH5 Survey on Smart Shopping 1 Assistant Professor, |Volume 4 Issue 12 | ISSN: 2456-8880.
- [8]. G Manmadha Rao, K Preethi, A Sai Krishna, Afreen Firdaus, Ch Lokesh Rfid Based Smart Trolley for Automatic Billing System (2020) ISSN: 2277-3878, Volume-9 Issue-1.
- [9]. Prajakta Kulkarni1, Prof. Dr. Ashwini Barbadekar MIFARE: A New Technique for Smart Shopping India2 ISSN (Online) 2321 – 2004 ISSN (Print) 2321 – 5526.
- [10]. Ali, S., & Riaz, M. (2015). Smart Trolley. *London South Bank University*.
- [11]. Yewatkar, A., Inamdar, F., Singh, R., & Bandal, A. (2016). Smart cart with automatic billing, product information, product recommendation using rfid & zigbee with anti-theft. *Procedia Computer Science*, 79, 793-800.
- [12]. Purwantono, H. Y., Gunawan, A. A., Tolle, H., Attamimi, M., & Budiharto, W. (2021). A literature review: Feasibility Study of technology to improve shopping experience. *Procedia Computer Science*, 179, 468-479.