

Advanced Retail Shopping System

Prof. Trupti Tekale¹, Sonali Jadhav², Srianant Wadekar³ and Shrutika Chavat⁴

¹⁻⁴JSPM Rajarshi Shahu College of Engineering, Pune, India

Email: truptitekale_it@jspmrscoe.edu.in, sriwadekar2588@gmail.com, sonali.jadhav1503@gmail.com, chavatshrutika@gmail.com

Abstract—While shopping in malls, we face a major problem of standing in queues and waiting for a long time for billing. It is a tedious process, especially during rush hour. Manual billing can sometimes be challenging. These systems also have higher shoplifting rates, which cause a significant amount of loss to retail merchants and vendors. In the case of manual billing, staff dependency results in long queues and influence over choice of customers, as many might opt out of the process and not purchase any products. This cycle can also lead to customer churn. To relieve customers of this trouble, we have proposed an automatic checkout system, where billing and payments can be done by the customer themselves. This system works on the concept of RFID tags. The system allows consumers to complete the purchase process without the help of retailer personnel, shortening queue waits. This also helps reduce business costs, since the staff can help take care of other processes, thereby avoiding inconvenience due to inadequate number of workers, eventually reducing labour cost.

The system also provides a Business Analysis Model for merchants to analyse the demand and sale of items to plan production, which can eventually help increase sales accordingly. The objective of the self-service checkout system is to speed up the checkout process for customers, reduce labour costs and perform business analysis for merchants.

*Using RFID tags also support merchants to track the location of inventory and items.

Index Terms—RFID Based Shopping System; RFID Checkout System; Internet of Things; Embedded Systems; Data Analysis; Trend Prediction; Fashion Forecasting; Merchandise Shopping; Market Basket Analysis; Point-of-Sale; Billing Interface; Automatic Billing, etc.

I. INTRODUCTION

In earlier days of banking, in order to withdraw money, people used to stand in withdrawal queues and follow certain protocols. There used to be bank personnel to hand out the required cash amounts to customers. It was a tedious task, especially during rush hour. To overcome this issue, 'ATM Machines' were incorporated. They reduced majority of efforts on both sides (Bankers and Users) hence, significantly cutting costs. As installation of machines was a one-time expense. Similarly, in today's times, Shopping Checkout Process encounters similar problems. In Order to Overcome these Challenges, we have proposed a similar idea; paralleled with the above example - An advanced shopping system which can be applied to retail stores. This is a system wherein any customer can perform the checkout process on their own. A checkout process is one which permits the customer to scan their shortlisted items and pay their respective bill, sans help of any retailer personnel.

The proposed system consists of: RFID tags attached to each item, an RFID scanner and a billing software connected to the entire system. The billing machine is attached with RFID scanners. When an item is put in this machine basket, the scanners around its rim help read the RFID tag on that item. After the item is

scanned through the basket, it automatically gets logged in to the billing software for bill generation and payment. After every successful transaction, the RFID tag on each product is disabled for clearance through security. After a transaction is completed, the bill is stored as an entry in the 'Sold Database' at the backend. The 'Sold Database' for a specific duration is used by the business analysis model to predict the demand of any item and plan the production or importation of that item in accordance to its demand. This proves helpful for supply management to retail stores, as a detailed analysis and review of sale of each item is provided. For example, during winters, there is usually a hike in the sale of jackets or scarves as compared to any other season. With the help of a Business Analysis Model here, merchant companies can analyse their production and compare it with the sales data in different localities and of certain seasons. The sales data collected is then fed to a machine learning model for trend prediction.

The model outcome will be useful for merchant companies in order to plan production for upcoming part of the year.

The predictions may also be used for setting new fashion trends as a future scope.

II. MOTIVATION

Successful application of RFIDs in attendance systems in schools and offices has been observed. Also, we may observe the performance analysis of individuals based on data generated by these attendance systems. Similarly, RFID technology can be implemented for retail merchandise shopping, and the data collected can be processed and analysed for merchants to plan production likewise.

III. PROBLEM DOMAIN

To introduce a self-checkout system in shopping malls and retail stores with the help of RFID technology in order to reduce thefts and ease the process of checkout by reducing waiting time at billing counters. To provide a detailed business analysis model of the data collected from the generated bills, which helps retailers and merchants to perform strategic planning and shipment of goods to boost sales and profit.

IV. REVIEW OF LITERATURE

Comparing our proposed system with the existing system, incorporation of self-billing machines drastically reduces the waiting time in queues at billing counters in current scenario. Also, the dependency on cashiers/billing personnel is negligible, which makes the billing and verifying free of human-error and cheating. Moreover, use of RFID technology eliminates the need for barcodes, which strengthens the 'security' aspect as barcodes can be tampered with. On the other hand, RFID tags can only be disabled once payment for the respective product is done. Interactive billing screen increases transaction transparency for customers. Compilation and processing of Sold Items data for business analysis is automated through a network of cloud instances. Business analysis model provides merchant companies the ability to predict demand, forecast fashion trends and plan strategies for future production based on past sold data.

In the proposed model and for our research work, we used MySQL DB, phpMyAdmin, Python, Apache XAMPP TensorFlow and Microsoft Excel for the development of billing software, creation, and maintenance of Realtime 'Sold' database and building of the business analysis model. We also used Suitable RFID Module with Tags and an Arduino Uno Board for the hardware components of this system. This study comprises of three major modules involving both hardware and software: RFID Scanning, Data Collection and Processing and Business Analysis.

V. SYSTEM MODULES

A. POS (*Point of Sale*) Checkout Machine

The attendance of students is marked when particular tags are detected in the attendance machine which is nothing but an RFID scanner. The attendance listed after the tags are detected are then considered as the attendance data and is used for monitoring. Similar to this idea, RFID technology can be utilized as an enabler in smart checkout in merchandise shopping.

In order to automatically recognize and track tags attached to the items, radio-frequency identification (RFID) helps us in many ways, which uses electromagnetic fields for its working. A tiny radio transponder, a radio receiver, and a radio transmitter constitute an RFID tag. The tag transmits digital data, often an inventory

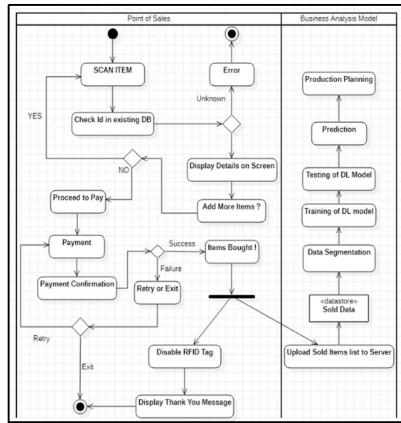


Figure 1: Proposed System Methodology

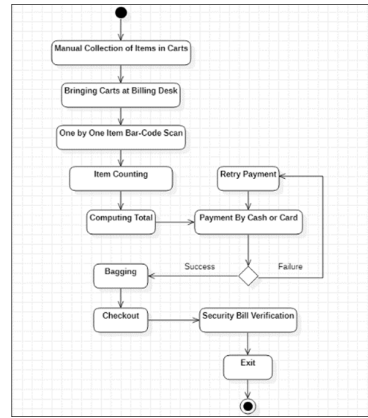


Figure 2: Existing System Activity Diagram

number used to identify the item, back to the reader when it receives an electromagnetic interrogation pulse from an embedded RFID reader device.

It is possible to keep track or log the item using this number. When the tag is scanned at the scanning area, the item is recognized and listed for billing.

The list of items is displayed in the interactive billing screen for customer to preview and proceed. One can pay the bill and proceed to self-checkout.

The POS machine updates the sold data on the live database on connected server for further processing.

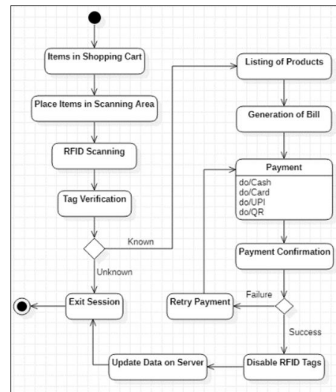


Figure 3: RFID Based Checkout Machine

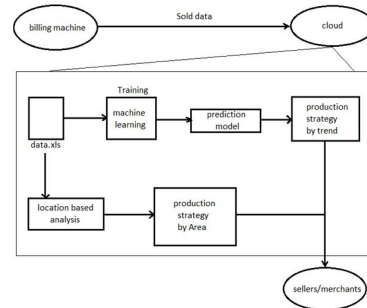


Figure 4: Business Analysis Flowchart

B. Data Collection and Processing

When bills are processed in the Billing Machine, item lists are stored on the server which is then compiled as the data for sold products. The collected data is then to be processed as certain attributes such as offers applied to certain products, time stamps, storage ids, etc. are of no use in post purchase processes. Similar operations are to be performed on data before it is to be forwarded for business analysis.

C. Business Analysis Model

For the business analysis model, we take help of methods such as Market Basket Analysis algorithm. Market basket analysis is a set of statistical affinity calculations that helps better understand and assist their customers through forecasting purchasing habits over time. In the context of our proposed system, this model will help predict the demand of any item and plan the production or importation of that item in accordance to its demand, in that particular retail store. The algorithm involves the use of 'apriori' library in Python, which takes help of the Apriori algorithm used in its analysis. Otherwise, Concepts such as LSTM (Long Short-Term Memory) Neural Network, for sequential data (sold data) analysis, and forecasting fashion trends. LSTM are artificial neural networks which are well-suited for classifying, processing and making predictions on sequential time series data such as the sold data collected from billing machine.

VI. LITERATURE SURVEY

Data Transmission Using RFID System on Smart Shopping Carts for Checkout Process Efficiency in Supermarket at Indonesia, Martinusa, Metta Saridewi Wahaba, Yudia, Hanry Hama [1]

A lengthy queue upon entering the checkout process in supermarkets is an undesired situation for the customers and can possibly cause the number of customers to decrease as well as their loyalties. Therefore, rendering the checkout process efficient is necessary as saving time can help the customers to do other activities in their lives. The purpose of this research is to create a System that consists of Smart Shopping Carts, a smartphone application as an interface, an application for the cashier integrated with the server and database to support data transmission, that enables people to do self-scanning of items and the cashier only must perform payment. This System is developed using the Waterfall methodology and involves tools such as Arduino Uno, RFID, Visual Studio Code, Flutter, PostgreSQL, REST, React dan Node.js. By simulating the process with various variables from observation, the result is efficiency that grows with increasing number of items and customers.

RFID Based Smart Trolley for Automatic Billing System, G Manmadha Rao, K Preethi, A Sai Krishna, Afreen Firdaus, Ch Lokesh [2]

The modern technology has increased the standard of living for the humans and the large crowds are seen at shopping malls. To save time for the customers, it is important to reduce the process of the billing time. This is done using smart shopping system based on RFID. Items that are put in a smart shopping cart are read one by one and the bill is generated and displayed. After the final bill is generated, the customer pays the bill by using their pre-charged cards provided by the shopping mall. The aim is to reduce the time consumption needed for the billing system.

Fashion Trend Forecasting Using Machine Learning Techniques: A Review, Audrey Aurelia Chang, Cynthia, Devita, Jihad Fahri Ramadhan, Zainina Kyla Shafira Adnan, Bayu Kanigoro [4]

Fashion is a fast-paced industry where patterns last up to eight months, being an incredibly competitive industry where trends are constantly evolving. When it comes to companies, forecasting is a significant factor, knowing the trends and making right forecasts in line with the ever-changing trends can make a big difference in the success a company will have. It is important to investigate the various strategies introduced to achieve a more efficient way of predicting demands and consumer needs in order to better understand which techniques are to be used for the best possible outcome. The primary aim of forecasting is to better understand the patterns that impact markets and consumer needs. This paper analyzed the state-of-the-art forecasting methods used to predict market patterns in the fashion industry that could be implemented. The methods implemented to forecast, the models and algorithms used within the methods, the datasets used, and the trade-offs for each system and model used are described in this analysis. In particular, the analysis will further explore Machine Learning models that are widely applied to support the forecasting efforts carried out in the fashion industry.

VII. CONCLUSION

The combination of self-checkout system and RFID technology so that it can be used in shopping malls to solve the problem of standing in lines and waiting for a long time for billing after using the self-checkout system. Through RFID, it can not only scan all items quickly and accurately, once a theft occurs, it is also easy to track the location of the object in inventory. As it takes more time for billing the products because of standing in long queues, so we use the technology of RFID for transmission and photodiode for reception. Moreover, after Process of Product Sale is completed, the sales data then contributes towards prediction of public trends and fashion forecasting. It also helps Merchants in constructing production strategies and planning shipment according to seasons and trends.

FUTURE SCOPE

It can be used in retail of other products such as supermarkets, convenience stores, wellness stores/pharmacies, hardware shops, book stores. Business Analysis Model can be improvised to understand consumer psychology in different localities. Automated retail systems can be combined with e-commerce applications such as merchandise shopping apps. Incorporation of sanitization system for spraying disinfectants on POS machine after every session.

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