AN AI BASED AUTOMATED SUPERMAKET SYSTEM

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Abstract— **In this contemporary society, many sections are being modernized due to a trend towards technology. Nowadays, it is impossible to find a person without a smartphone. People use smartphones to get their day-to-day activities done easily. Automated supermarkets can be pointed out as one such field where smartphone is used for. Instead of traditional outdoor shopping from one place to other, the art of shopping has been developed in various ways using technology. We started to find out a strategy to facilitate the customer to purchase without any rush. The aim of this is to facilitate the customer with best technology from the moment he enters the supermarket and to the end of his transaction without any rush.**

Here we expect to develop an online system focused on AI (Artificial Intelligence). The proposed automated supermarket system performs using an analyzing technique in machine learning algorithms. When a customer enters a supermarket, he/she is identified through this Mobile Application (App), and after supplying him/her a cart he/she goes to the relevant shelf. Using the FP-Growth algorithm which comparison of earlier purchases, new suggestions of commodities are sent to the App. The mobile application analyses the amount of nutrition contained by the previous shopping time and compares it with the amount of nutrition contained by the current shopping time using Singular Value Decomposition (SVD) and Content-Based Filtering with the introduction of a Content Suggesting Algorithm. Then the relevant bill is displayed in the App. The mobile application uses the sorting method, CAS (Compare and swap) algorithm, classification for suggesting the suitable bank promotion to the customers by analyzing products, purchasing behavior, and bank cards. Meanwhile, the staff of the supermarket is informed about the details of commodities purchased by a customer via the Desktop App with the help of Compare and Swap (CAS) algorithm. As a result, by this expected strategy, not only the customer but the employer are also facilitated. Although device-based automated supermarkets are established in various places, they seem to be unsuccessful. The cause for this would be the cost for the devices and maintenance. Therefore with the implementation of our system, customers become convenient for shopping and it assists uplifting the supermarket profits well.

Keywords—Artificial Intelligence, Smart Supermarket, Mobile Application, Automated System, Data Mining

I. INTRODUCTION

This research paper aims increasing client satisfaction with the utilization of Artificial Intelligent technology in the retail stores in Sri Lanka. Nowadays, people move to things which can easily be done. Because of that, they have very little time than the people who lived before. In general supermarkets, the checkout provides the bill to keep the product at the barcode reader one by one. It's a time-consuming approach. This process is done at the counters in long queues. This research paper presents a fast and non-queue supermarket system. By means of supermarket automation solutions of our system, customers are provided with quick and comfortable service in trendy stores. This research worries about prevailing distinctive issues faced by clients once they touch upon grocery trades related to Sri Lankan Supermarkets with a read of exploring. However, grocery dealers will minimize these issues to realize competitive advantage through customer satisfaction. The utilization of AI technologies towards conversion to accelerate client satisfaction, and reciprocally grocery dealers will acquire a competitive advantage. It accepts the grocery dealers' high investment in that-driven services. Supermarkets aim to increase the number of customers by introducing AI-based technologies to the grocery chains of Sri Lanka.

Today most of the systems are connected with mobile phones. Some stores have hard methods to work with the whole system. Have to wait in long queues to purchases at normal supermarkets is another problem. The cashier scans the payment calculations of products one by one in this kind of supermarkets [9]. There is also no enough security system in the shopping cart process, shelf process, and payment process,. Thus, other supermarkets have not the feature of analyzing customer purchasing methods [11]. In this case, the system analyzes the old purchasing details of the relevant customer. Consumers cannot read and understand attentively what contains and they can buy goods via this online supermarket system [12]. We look for the good and bad of the product only after we come home. Sometimes we cannot

exchange those goods. The final result of this research fertilizes the development of a desktop application for staff members and mobile application for customers to solve the above mentioned problems which identified by consumers. This research paper explains how to solve those research problems using the proposed AI based smart supermarket system. So, this research paper explains the customer purchasing behavior through previous purchasing records [11], item self - checkout and removal through the mobile application, check the reorder level of shelf system analyzing through the database [12], check the nutrition level of the products [4], and predict previous purchasing records and offer good bank offers through analyzing old purchases [13].

Fig.1. Overall System Architecture

Advantages of proposed system

- The customers do not have to wait in long queues for purchase.

The existing supermarkets' cashiers scan products one by one to calculate payment. Then customer should wait- in long queues for purchasing goods. In the proposed system, customers can do quick and easy payment methods. [9]

- High-cost devices are not used.

In the existing system, usage of sensors shall check the removed goods, RFID tags are used for a secure and easy purchasing, and finger-print machine is used for a secured payment and many barcode readers are used for scanning the QR code of every product. Those devices are high-cost devices and the maintenance costs are also high. But proposed system only have desktop application, mobile application and database to manage overall system. [9]

- Safety of the device, physical cart, and payment method.

Existing systems use sensors for secure of goods, RFID tags are used for a secured purchasing, Fingerprint machine is used for a secured payment, smart physical carts are used to secure products, and many barcode readers are used to scan every product's QR code. The mobile app payment method, physical cart system and shelf system are the best ways than existing methods. They have more security than other methods. [8]

II. LITERATURE REVIEW

Various proposals have come up to solve the issues faced by the retailers during the retail sales. Today the retail industry is rapidly increasing in Sri Lanka. So retailers need to automate their supermarkets using new technology. Then retailers can increase their profit day by day. In Sri Lankan retailer industry is still developing, but other countries already use modern technology techniques to increase their customer services and other utilities.

This study's [8] aim is to create a rather more comfortable and advanced retail environment where consumers can shop without having to deal with cashiers or queues. This project uses Artificial Intelligence and the Internet of Things to improve the productivity of a supermarket. A person only wants to drive thereafter scanning one's QR code with their unique ID through the app. It will keep track of the customer's visit to the store. Sensors are installed into the shopping trolleys and bins, enabling them to detect when a product is entering or leaving. The items are placed on shelves with compression sensors that detect when they are picked up. All shelves are secured, and only buyers' shopping carts can be unlocked by them. Once the customer arrives at the cashier, all he or she has to do is present his or her card, and money will be subtracted from his or her account in accordance with their purchase, and a receipt will be issued. The authors of this study also mention the limitation of QR Scanning and Face Recognition. For a client, it has become more expensive and frustrating.

Many other existing methods are used RFID tags and Readers to implement the automated supermarket. According to [9] they suggested an electronics hardware system using Radio Frequency Identification Reader, Fixed the shopping cart and Radio Frequency Identification tags are fixed in the product, it helped to avoid the queues. The specifics of the removed product will be shown on the LCD. ESP is used to send data to the main server within range. The user will have access to the data.

Paper [14] author has also used RFID technology as an IOT application, smarter shopping carts are used in this system so that consumers can manage in their question for specific goods. Promotional items are also advertised, and billing information is measured when the consumer purchases a product. The smart shopping cart will be recognized the items in the cart and billed automatically. The sensor on the shopping cart will be updated and sent the number of goods to the main server. Furthermore, inventory control will be much more efficient, as the RFID reader will instantly read all the items instead of being checked physically by a worker.

Paper [10] described, using AR key technologies and Augmented Reality, created a completely operational

Mobile app with an advanced route guidance system for Supermarket. Easy Shopping is a Smartphone, complete app that supports indoor navigation through AR, targeted ads and marketing, context responsive shopping assistance, and remote shopping functionality. It takes the form of augmented imagery using Augmented Reality (AR) technology, and the content of the aid is founded on the principle of dynamic contextualization.

Orel unmanned store [15] is the first shopping experience of Sri Lankan clients. Clients can shop without staff help. They

use a mobile application's QR code to enter the shop. And they also use RFID technology to identify the things from exiting items that haven't been reviewed in the front door. Clients can do payments on their own way. And also the wall has a LED screen and bar code scanner for verifying item's details. Shop shelves are designed in a way that all items are visible to outside clients.

Methods / Features	*Supermarket Automation with Chabot and Face Recognition Using IoT and AI*	*RFID based supermarket shopping system*	*Supermarket Shopping System using RFID as the IoT Application*	*Easy Shopping Android Mobile App*	*Unmanned Store – OREL*	Propose method
Mobile Application	✓	×	×	✓	✓	✓
Desktop Application	×	×	×	×	×	✓
Analyse shopping pattern & Suggest Shopping list	×	×	×	Personalize recommendation	×	✓
Analyse nutritiously & suggest to refill the remain nutritious	×	×	×	×	×	✓
Analyse & suggest to bank promotion	×	×	×	×	×	✓
Analyze & suggest to Product re – order level related brand	×	×	×	×	×	✓
Use high cost devices (RFID tag, scanner, sensors)	✓	✓	✓	AR Technology	✓	×
Security mechanism	×	✓	✓	×	✓	✓
Checkout line less	✓	✓	✓	✓	✓	✓
Self-checkout	✓	✓	✓	✓	✓	✓

Fig.2. Comparisons with existing systems

III. METHODOLOGY

In the Methodology, we did a feasibility study as our first step. We found positive answers based on some questions such as, Is the existing technology possible for the project?, Available In-house technology?, Will it be systematically compatible?, Any schedule restrictions?, Is it possible to meet these restrictions?, Is the project possible considering the limitations of resources?, What are the operations and development costs?, What is the benefit? (Tangible, immaterial), Do the advantages value the costs, Will it be employed when the system is developed, Are there any possible objections? Resistance, Social acceptance? As we got positive results for above feasibility study we started to do our research.

The system describes in this paper uses 'Data Mining' technology with 'Arterial Intelligence.' Mainly, we researched and made our methodology based on FP-Growth algorithm, Market Basket Analysing, Singular Value Decomposition, Content Based Filtering, Sorting Method, CAS algorithm, Naive Bayes Algorithm, Clustering, Classification as follows.

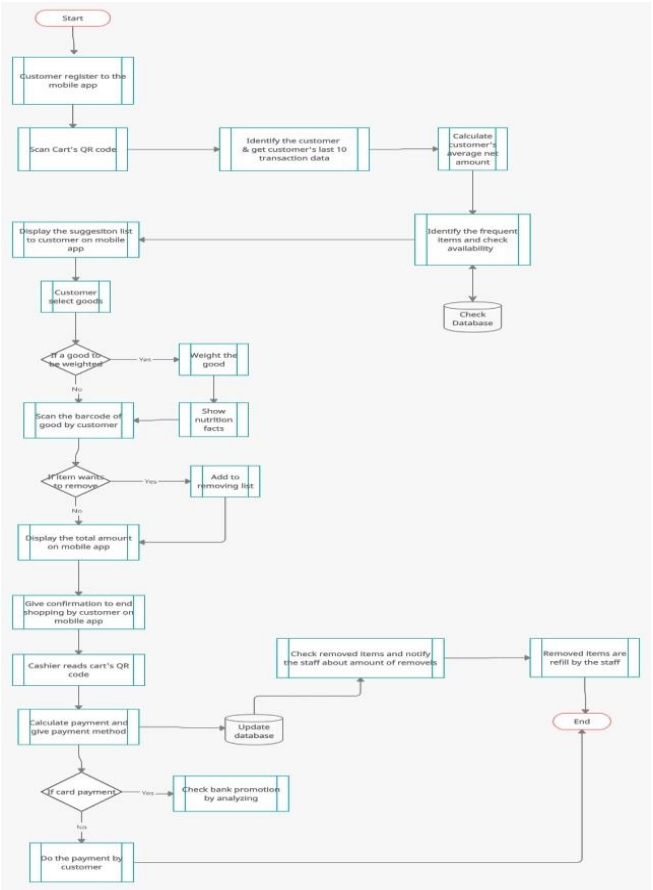

Fig.3. Overall workflow diagram of system

The customer should download our Smart Supermarket Mobile application (SSM), create an account and register before entering to the supermarket. As well as user need to login to the mobile application using valid user name and password before entering the supermarket. This mobile app has a QR code scanner to detect the physical cart. And keep the mobile phone to the cart's QR code to detect what customer takes what physical cart.

For analyzing customer's purchasing behaviors, forecasting demand, analyzing customer purchasing behavior and analyzing market basket, those methods are used for getting ideas of the retail business. The proposed SF solution will present a compact, user-friendly, and low cost with customer purchasing behavior for in-store retail. SF stands for Segments and Frequency. SF analysis is a data mining methodology used to evaluate consumer behavior. This is a helpful way to boost customer segmentation by potential personalized offerings and to classify customer buying activity. After scanning the QR code in the shopping cart, the system will identify the customer's session-id and physical id. Then the system will run the SF methods. After that, the customer received the suggested shopping list. These SF methods have 2 steps.

- The first step is to divide customers as a segment considering their total bill amount. Do the calculation using

previous bill amounts (net value) to find the average total bill value. Use a clustering concept to divide as a segment.

- The second step is getting all transactions under those segments and identifying frequent item sets by using FP-Growth algorithm under association rule.

Then supermarkets can address more effective (low-cost) segments for their marketing process. Because there is a high risk for addressing new customers sometimes than addressing existing customers. After customers are divided into segments, gets all transactions of each customer. Then analyzes market baskets using FP-Growth algorithm and identifies frequent item sets under those segments. Find the frequent item sets, then start making suggestion list according to that. When fulfilling the suggestion list consider the availability in the stock, shelf sequence, most customer essential items, and the average total amount. [11]

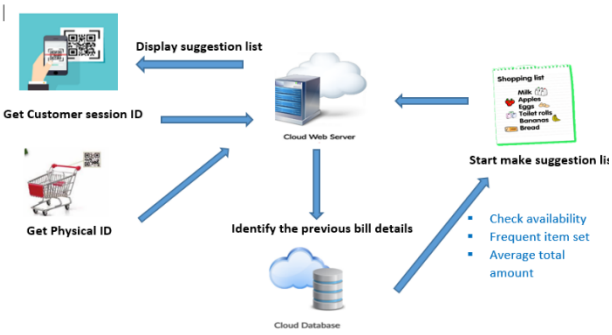

Fig.4. Diagram of purchasing behavior analyzing architecture

This system use mobile application's barcode reader to read products' bar codes and it will show on customer's mobile application's screen. It will show in a user-friendly manner on mobile app to get a clear idea about the product name, quantity and price. For security purpose, each cart uses an automatic opening door to put products to the cart. Once a customer read a barcode of a product by the mobile application's barcode reader then only the automatic opening door will open. As well as, if a customer wants to remove a product inside the cart, customer can easily remove the product from the purchasing list in mobile application's screen. Then it will be added to the removing list on the screen. The data that customer wish to purchase and customer wish to remove from the cart, will store in a temporary database.

There are some other main tasks do in this system. They are,

- Customers can measure foods as they prefer instead of waiting in long ques and find nutrition facts of those foods,
- System will analyze nutrition of natural foods by comparing current shopping items and previous shopping items.

This system uses weight sensors as a scale to measure the weight of natural foods. After measuring the particular foods, customer has to select the food by his mobile application. After detecting food, the screen shows the food name and weight of the food. Then it shows the price related to food and weight. As well as, after identifying the food name and weight, it shows some nutrition facts. After conforming food purchasing by a customer, the barcode sticker printing machine put a barcode sticker as output related to particular food name and weight. The barcode sticker should paste on the food or bag of the food by the customer. As well as, the mobile application analyses the nutrition of food that the specific customer bought at last shopping time and it will compare with the current shopping time using clustering method with Singular Value Decomposition (SVD) and Content Based Filtering by introducing Content Suggesting Algorithm. SVD is a method from linear algebra that has been generally used as a dimensionality reduction technique in Machin Learning. Content based filtering uses item features to recommend other items similar to what the users like based on their previous actions or explicit feedback. These algorithms normally used for recommendation systems. Based on the Content Based Filtering, it predicts the nutrition facts of customer's last shopping time and suggest new foods for customer's current shopping time after comparing the nutrition differences. After purchasing all the products, customer have to confirm his shopping. [3]

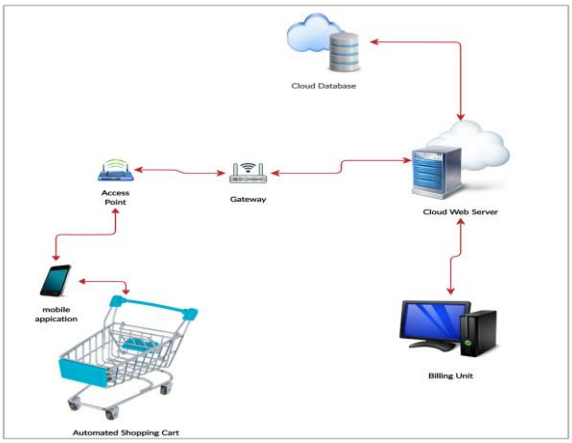

Fig.5. Diagram of automated shopping cart's architecture

After buying products he/she goes to the cashier and type the relevant physical cart id to the cashier's screen invoice interface to detect the relevant details and relevant cart from the system database. Cart table updates purchasing details to the system database. Then the system automatically calculates the finalized payment and shows it in the cashier's screen. After displaying total payment, the system asks the payment method; cash payment, card payment or mobile application payment. If the customer selects cash payment, he can pay by cash, if the customer selects card payment, he can pay by card, and if the customer selects mobile application payment method, read the suggestions of the offers, select the bank which the customer most likes and click that suggestion for payment confirmation.

After confirming the final purchase and selecting payment method, the customer's mobile application displays the bank promotions and the product that has offers today. Therefore every consumer can get good offers by analyzing their old purchases, shells and bank cards using analyzing repeat purchasing for predicting chances of repurchase (Existing customers can get the promotions) and using sorting method and CAS algorithm to give promotions. By analysis those things, system checks each item batch and available

promotions relevant to each item batch. Then calculates the total promotion value relevant to the each bank card. Then the system will check the bank card that will offer more promotions. They suggest the most suitable bank card to the customer. And the stock keeper can create, add, update and delete every field of bank promotions in the desktop application [13].

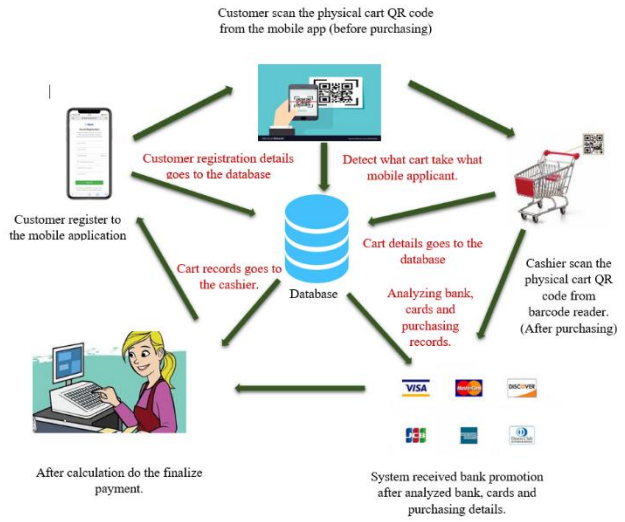

Fig.6. Diagram of Customer registration process architecture

All details of this supermarket are stored in a database. Information of the customer from entering to ending up the transaction at the supermarket conveyed to the database. Only after the transaction is finished, the relevant details are conveyed to the automated shelf system.

The details of the commodities purchased by the customer are conveyed to the database. By that, the details of the removed goods from the shelf can be obtained. And also by comparing the database of the commodities and the shelf, the details can be gained about the shelf which commodities are removed. The details of the removed commodities are informed to the staff by the system via desktop application. The staff is not informed at every removal, but only of the goods which are reaching or surpassing the reorder level. Reorder quantity is used separately in this database. As an example, if 20 packets of Maliban Milk Powder can be packed in the shelf, it mentioned as 15 as the reorder quantity. When a customer purchased an item, the decreased quantity is updated in the current quantity column of the database. When the current quantity is exceeded the reorder quantity, it is displayed as a refill item. Compare and Swap (CAS) algorithm is used for this Automated shelf system. [12]

Another special process is activated here. That is, when an item is exceeded the reorder level, it is checked whether another item of that brand has reached to the reorder level and it is also displayed. For an example, if the Maliban milk powder is exceeded the reorder level, it is checked whether there is another item of that brand has come to the reorder level.

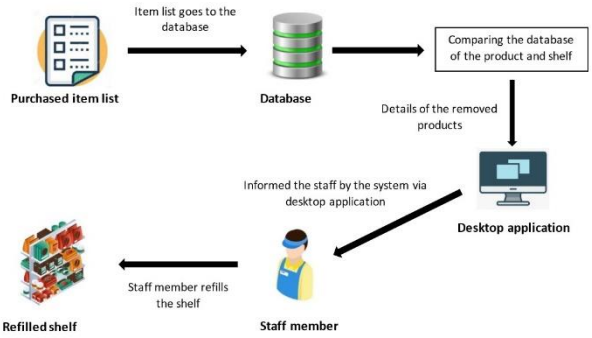

Fig.7. Diagram of automated shelf system architecture

IV. RESULTS AND DISCUSSION

Both the customer and the staff are benefited by the AI based automated supermarket created by us. At common supermarkets, though customers buy their commodities hurriedly, they have to be in the queues for a longtime. The cashier has to read the items, prepare the bill and then to take the payment from customers. But by the system we created, the bill of the commodities that are purchased is automatically displayed on the mobile application of the customer. Then the customer has only to pay his bill at the cashier.

When the customer enters the supermarket his previous bills are checked and new item suggestions are made through the system. As well, according to the payment method, promotions would be checked. Through that the customer feels kind of faith towards the supermarket. When items are removed from the shelf, the shelf is informed by the desktop application and they can refill the shelf easily.

Our proposed system is mainly divided into 4 analytical components. Overall we used 16 test cases to test our supermarket system for all the functions. We mainly gave priority to the analytical component based on artificial intelligent algorithms. The following table shows the accuracy level of each separate component. We obtained 100 transactions based on 20 customers. Tested each component separately because each of these components have different & individual outcomes.

TABLE I: Component accuracy level

Component	Accuracy%
Customer registration & bank promotions	86%
Automated shopping cart	89%
Analysing customer purchasing behaviour	88%
Automated shelf system	87%

V. CONCLUSION AND FUTURE WORK

This research proposed mobile applications and desktop applications for the retail industry. Preliminary results indicate that the system is easy to use and that interesting insight can be obtained when analyzing collected data. The proposed system is based on a cloud service and is therefore scalable to accommodate a large number of users for uploading their transaction data and help businesses in their digital marketing activities.

Clients were given the ability to purchase according to their own will without waiting in long queues for each and every item to be checked at the billing counter. Also, clients get shopping suggestion lists based on their previous transactions. Based on his nutrition behaviors of previous shopping, suggests some foods to full fill the nutrition levels. Supermarket staff do not need to worry about the re-order level under store management, our automated system will identify the re-order level and give notifications. This is a unique feature of the system.

As future work, we expect to test the usability of our proposal with real shoppers.

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