E-Mart: Product Placement and Promotion System to Enhance Sales Promotion Effectiveness

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***Abstract*—** Retailers in supermarkets lacks sufficient information at their fingertips when they are in need of determining the placement of products, designing promotion strategies and hence improving the profit of the supermarket and customer satisfaction. This study presents a web based system and an android application required by retailers to make their decision making process more feasible. A set of data items were obtained from a local supermarket and are mined from association rule mining method using Apriori algorithm in order to generate association rules. The system will predict the optimal price of a product using linear regression algorithm, when to host the next product promotion and which product should be promoted. The goal of this research was to design and implement a web based application to view required information on sales predictions and promotion dates in order to make the decision making process effortless for the retailers in supermarkets. A prototype application is designed and implemented using open source tools and technologies.

***Keywords*—** *Data mining, Association Rule Mining, Apriori, Linear Regression Algorithm, Web Application, Android Application, Profit optimization*

INTRODUCTION

One of the main challenges for supermarkets is how to obtain important information from the product transaction databases and product feature databases, in order to increase their sales and profits. Using the association rule mining technique, informed decision can be made easily about product placement, pricing, promotion, profitability and also it can be used to find out whether there are any successful products that have no significant related elements. Complementary products can be placed in close proximity or it can be cross-sold. It is very important for retailers in supermarkets to be aware of customer needs and adapt to them. Association rule mining technique is one of the data mining methods focusing on discovering purchasing patterns by extracting associations from product transaction databases of supermarkets. This helps to determine the products which are bought together and to reorganize the supermarket layout, and also to design promotional campaigns such that the purchase of products can be improved [1].

This study is aimed at providing an integrated solution to assist retailers in supermarkets to;

(1) Identify the products that are sold along with another product.

(2) Figure out the least price a product can be sold and still gain a profit.

(3) Predict the date to host the next promotion in the supermarket.

(4) Predict the product to be promoted in the next promotion.

The implemented system, "E-mart" is a web based and an android application that assists product promotion in Supermarkets based on user buying patterns, profit margins, previous promotion experiences and how the goods must be arranged in a Supermarket. This system is mainly developed for supermarkets with a wide range of products and can be used specifically by retailers in supermarkets to promote supermarket products. This system helps the retailers to make decisions on how to arrange the shelves or floors in the supermarket, by generating association rules which predicts the occurrence of a certain item based on product combinations that occurs frequently in product transactions. Identifying such purchasing patterns and showcasing relevant products in shelves will persuade the customers to buy products which were not intended to buy before entering the supermarket premises. This facility will be beneficial for the retailers as well as for the supermarket in order to enhance their profits and customer satisfaction. The remainder of this research paper will be focusing on the past literature and inventions, system design and implementation, results and conclusion followed by future work of the implemented system.

II. BACKGROUND AND RELATED WORK

Numerous algorithms have been developed over the past several years to mine association rules in large databases. AIS algorithm [2], SETM algorithm [3] and FP-Growth [4] algorithm are few such algorithms which were used before the development of Apriori algorithm which was an influential algorithm for association rule mining. In 1994, R. Agrawal and R. Srikant proposed the Apriori algorithm [5]. The name "Apriori" was given to this algorithm due to the fact that it uses prior knowledge of frequent itemset properties. Apriori algorithm uses a bottom up approach which is known as candidate generation and the breadth first technique. This algorithm was developed in order to operate on an operational database of customer transactions. When compared to other algorithms, Apriori algorithm is easy to implement and its memory consumption is less. Linear regression is a statistical procedure for predicting the value of a dependent variable from an independent variable when the relationship between the variables can be described with a linear model [6].

Over the past few years, several researches and inventions were done based on product promotion systems. Android applications and web applications are client-server software applications where a user interface runs in a web browser. Use of these in product promotion has several advantages such as cost effective development, easy customizable, easier installation and maintenance, increased security, flexible core technologies, accessibility for a range of devices, and are accessible anytime, anywhere. Retailers in supermarkets can analyze the data with the help of these web and mobile applications to make predictions and decisions related to product promotions.

Chou and his colleagues in their article published in 2000, have proposed a computer implemented process to select prospective customers in relation to a particular product and to promote products without any need of marketing campaigns. This system was developed using data mining techniques [7]. In 2001, a wireless shopping device was invented by Hudda, Barghouthi and Aref which can be used to carry out customer transactions. Here, the retailers will have to store relevant information about their products, shopping lists, payment details and delivery addresses on the server. Then the server will trace the location of the device using GPS or RF triangulation which will then direct the customers to merchant locations to view the items to be purchased and also to notify the customers about promotional offers of desired products. This system allows customers to make use of several delivery options based on their preferences and will have access to various price-negotiation methods as well. This system is mainly developed for the customers to make their shopping experience more feasible [8]. Another invention has focused on providing automated speech driven query and response with business or event self-promotion features which are relative to businesses and events over ordinary wired or wireless telephone systems, PC systems, Personal Data Assistants (PDAs) and other communication and information appliances and devices [9]. In 2003, Victor Treyz and Susan Treyz designed a handheld computing device in order to provide customers with shopping assistance services. This device can be used to hold shopping lists, to display promotional offers related to the products in the shopping list, to obtain information about the products being sold in stores and also to receive transaction reminders and other messages. By monitoring the location of the handheld computing device, the relevant services will be provided to users. Also the device can communicate with the retail establishments with the aid of local wireless links [10]. Another article written by Weng and Liu, was based on several aspects of market basket analysis that have been studied in academic literature, such as using customer interest profile and interests on particular products for one to-one marketing in order to improve sales [11]. Chen et al in 2004 researched on purchasing patterns in a multi-store environment to improve the sales. In this article, a new approach was proposed to performing market basket analysis in a multiple-store and multiple-period environment. An efficient algorithm was developed for extracting the association rules. With the help of this approach, a decision can be made by analyzing the purchasing patterns [12]. Boyd and his colleagues focused on product promotions in a business/ an organization. They developed a system to evaluate, analyze, develop and design promotions which will then provide recommendations for each promotion of a target product. And also it analyzes other competing products of the same seller as well as with other competing sellers [13]. Several other studies have been carried out based on the market basket analysis in order to find solutions for certain issues such as determining the placement of goods, designing sales promotions for different segments of customers to improve customer satisfaction and hence the profit of the supermarket are addressed here using frequent itemset mining [14]. Furthermore, Hui et al in 2013 has suggested mobile promotions to increase unplanned spending rather than using physical products in the store as external memory cues, encouraging shoppers to travel more of the store may increase unplanned spending. According to the findings of this research, targeted mobile promotions that are aimed at increasing in-store path length can result in an increased unplanned spending [15].

III. RESEARCH METHODOLOGY

In order to identify the required features for the E-Mart system, the authors conducted a survey where data was obtained through a questionnaire. This questionnaire was given to a sample of 30 individuals who are involved in the supermarket industry and the sampling technique used here was simple random sampling. These information obtained was then analyzed statistically and it was found that the respondents prefer a system which is accessible at anytime and anywhere. With the aid of

these information gathered, the authors decided to implement a product placement and promotion system.

Product transaction data required for the development of the E-Mart system was obtained from a local supermarket which was held in excel spreadsheets. The collected data was then preprocessed in order to make it feasible for the data mining tool to fetch the data. Since transactions with more number of products purchased will provide efficient information, transactions with one or two products are discarded. All the frequent itemsets are generated using Apriori algorithm and based on the confidence level of the frequent itemsets, association rules are derived. Highly informative frequent itemsets are effectively generated in the Apriori algorithm. The Apriori algorithm is given below.

Apriori Pseudocode [edit]

Apriori (T, ε)
$L_1 \leftarrow \{$ large 1-itemsets that appear in more than ε transactions $\}$
$k \leftarrow 2$
while $L_{k-1} \neq \varnothing$
$C_k \leftarrow$ Generate(L_{k-1})
for transactions $t \in T$
$C_t \leftarrow$ Subset(C_k,t)
for candidates $c \in C_t$
$\text{count}[c] \leftarrow \text{count}[c] + 1$
$L_k \leftarrow \{c \in C_k | \text{ count}[c] \geq \varepsilon\}$
$k \leftarrow k + 1$
return $\bigcup L_k$

Figure 2: Apriori Pseudo code

The E-Mart system consist of a web application as well as a mobile application that are user friendly and easy to handle. From the frequent itemsets generated using Apriori algorithm, strong association rules which have higher support and confidence values are stored in a database. The database is designed and is stored in an online server. This contains all the product information including unit price, the sales quantity, invoice number, etc. Then the programmers will produce pieces of codes and fit together to form a program. A good design will be produced with the high cohesion and low coupling. Fig. 1. Illustrates the functionality of the system and Fig. 2. Illustrates the main components of the E-Mart system

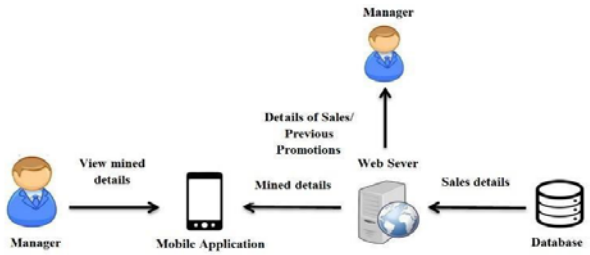

Figure 1: Overview of the functionality of the system

E-Mart System is implemented with the aid of free and open source software tools. The system implementation process composed of data mining, web interface and android application. Therefore, different platforms are needed to implement the system. The database is implemented using MySQL Wamp Server database technologies. R studio is used for data mining related coding. Web interface is developed using Adobe Dreamweaver and bootstrap, HTML and

JavaScript are used to enhance the user interfaces of the web based system. Mobile application is implemented using Android 6.0 with the aid of Android studio tool. XML, JAVA and other android related languages and equipment are used to implement the mobile application.

IV. RESEARCH FINDINGS AND EVIDENCE

Frequent itemsets are generated from the Apriori algorithm for support = 30% and the association rules generated for various confidence values are illustrated in table 1. Fig. 3 shows the graph of Apriori result analysis for various confidence values.

Table 1: Apriori algorithm variation on the Association Rules generated for various confidence levels with support = 30%

Confidence (%)	Total Number of Association Rules
20	161
30	128
40	109
60	53
80	31

The implemented system shows the Association rules that were obtained by the Apriori algorithm in the web dashboard and the Android algorithm in a table format in order for the manager to get a clear idea about the products that are sold along with another product. This will help them in the process of product placement.

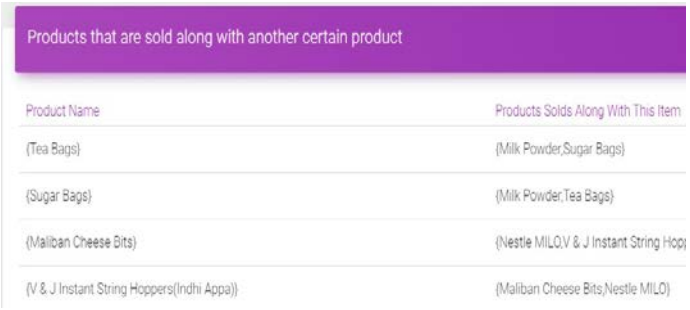

Figure 3: Association Rules Table

Products that has only a month left before the expiration is sorted out and stored in the *Profit Optimization Table*. This table shows the least price a product can be sold and still gain a profit, Profit that can be obtained and how many units the user has to sell in order to gain the profit. These results were taken using the *Linear Regression Algorithm.*

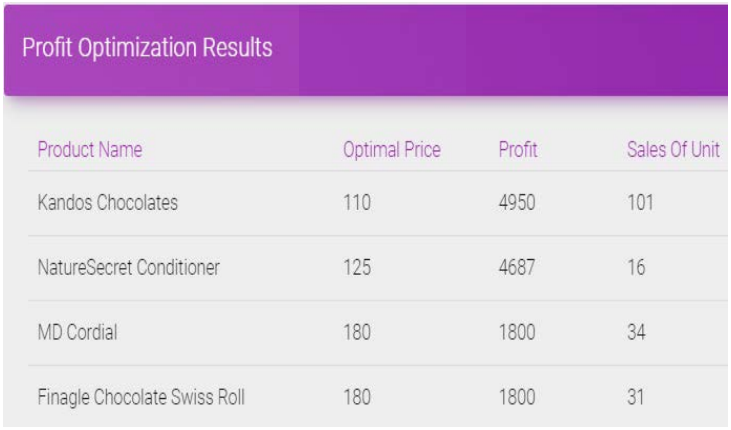

Figure 4: Profit Optimization Table

Maximum and minimum sold product in a week is sorted out and shown in a graphical bar chart manner for the manager to easily understand and take decisions accordingly.

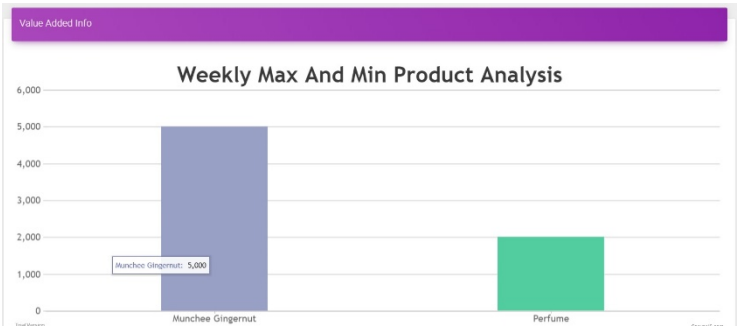

Figure 5: Weekly Max and Min Product Analysis

Products that are in the Profit Optimization Table is added to the *Discount Percentage Calculation* section. User is able click on each product and see the details of the product and also observe the profit a single product can obtain when given a discount.

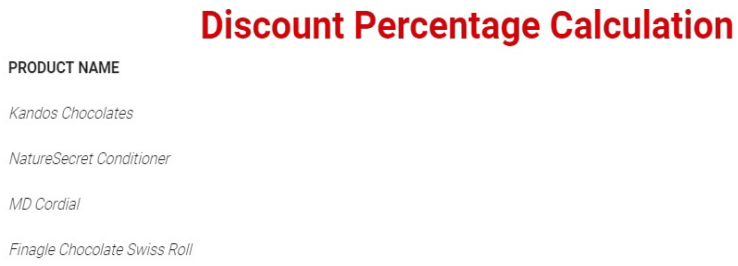

Figure 6: Discount Percentage Calculator Product List

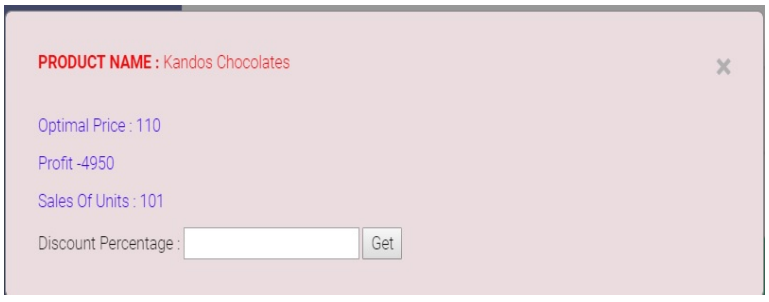

Figure 7: Discount Percentage Calculator

The date to host the next promotion and the product to be promoted and the End Date of the promotion is shown in the website as *Notifications.* The promotion dates are sorted out using past year performances.

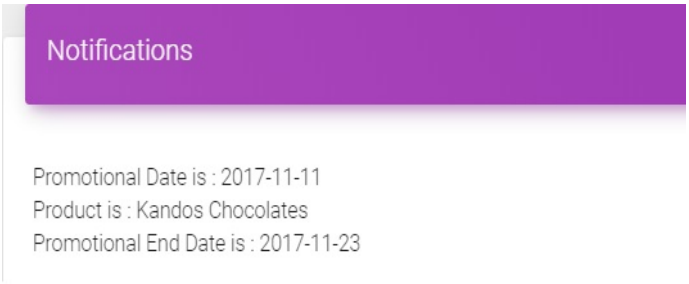

Figure 8: Promotion Date and Product

V. CONCLUSION AND FUTURE WORK

It is proved that the implemented E-Mart system is an efficient and an affordable method for predicting detailed information regarding product promotion, pricing and placement. It is found to be an effective method for real time problem solving. It is evident that the sales promotion effectiveness can be enhanced by using open source tools and technologies in the supermarket context. A limitation of this study is that the implemented system being an online application, requires a stable internet connection. Another limitation in the mobile application is needing a device with Android version 6.0 or above for the application to work. Both mobile and desktop versions must have a proper internet connection for the system to work in its best condition. The client desktop must contain R environment in order for the scripts to run in that particular computer.

The implemented system can be improved by adding features such as business performance measurement and adding Time series analysis to predict the number of stocks that will be required in the future. Furthermore the system can be extended to use in different industries such as clothing and other business related fields rather than using only for the supermarkets.

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