An Intelligent Cloud-based Mobile CRM Framework for Stock Replenishment in the Retail Industry

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Abstract

Recently, mobile application has been emerged in the retail industry for managing customer relationship because of its convenience and fast information sharing. In general practice, customers can only obtain sales and promotion information by visiting the physical stores or websites. They have to spend lots of time on searching the products they are interested in. On the other hand, without prompt communication with customers, it is challenging for retailers to attract customers effectively. Due to the lack of effective analysis and real time promotion channel, retailers could hardly predict the customer demand resulting in poor stock replenishment and loss of sales. In order to let retailers analyze customer purchase behaviour and promote their products actively, an intelligent cloud-based mobile CRM framework (ICMF) is proposed in this paper for enhancing effective communication between customers, staff and retailers. By integrating RFM analysis and k-means clustering in a cloud-based mobile application, appropriate marketing strategies can be formulated for sales promotion so as to maintain long term relationship with customers. In addition, fuzzy logic approach is proposed to determine the stock replenishment strategy for preventing out-of-stock. By conducting a case study in a retail-clothing company, the result reveals that the ICMF can analyze customer behavior effectively while the number of times in out-of-stock is reduced significantly.

1. Introduction

Retail trade is one of the important sectors in Hong Kong. According to the Hong Kong Census and Statistics Department, nearly 50,000 retailers are operated in Hong Kong, contributing to 57.7 millions in sales income in 2013. With an increasing number of retailer shops, the competition becomes fierce which also increases the pressure faced by the retail industry. In order to increase the retail sales and fulfill customer demand, retailers tend to focus on customer relationship management (CRM) for building good and long term relationship with customers. However, the traditional CRM approach mainly focuses to formulate the marketing strategy based on historial sales record. Then, retailers can only promote their products in retail shops or online, and wait for customers to visit their shops. If the target customers do not aware of the sales promotion, the profit of the retailer may reduce.

On the other hand, due to the lack of customer behavior analysis, the sales trend and customer demand are difficult to predict. Hence, retailers are unable to understand the purchase pattern of customers for determining the stock replenishment plan so as to prevent stock-out and overstocking. This may lead to high warehousing and stock out costs. Without an effective analysis on customer behavior and real time promotion channel, reduction in market share, loss of reputation and profit may result for the retailers.

To be proactive in customer attraction and enhancing operation effectiveness, mobile application has been emerged for facilitating sales promotion and formulating stock replenishment plan. With the use of mobile application, retailers can analyze customer purchase behavior, formulate marketing strategies and promote their products actively. After that, retailers can arrange stock replenishment for preventing stock-out or overstocking so as to reduce the holding and ordering costs. Therefore, in this paper, an intelligent cloud-based mobile CRM framework (ICMF), integrating RFM analysis, k-means clustering and fuzzy logic, is proposed for formulating marketing strategies and stock replenishment strategy so as to attract customers and increase sales.

2. Literature Review

In this section, the review of CRM in the retail industry is given to highlight the existing problems. After that, mobile application for CRM and AI techniques are studied to provide the basic information for developing the framework of ICMF.

2.1 CRM in the retail industry

Retailing is the set of business activities that adds value during selling services and products to customers for their personal or family use; moreover, in the distribution channel, retailer is the final business that links up the manufacturers and customers (Cox and Brittain, 2004). Recently, researchers focus on CRM to enhance the retail performance (Anderson et al., 2007). According to Hosseini et al. (2010), CRM is a comprehensive business and marketing strategy for customer retention and customer loyalty formation by integrating technology, information, and all business activities. Gustafsson et al. (2005) reviewed the consumer satisfaction and consumer retention behavior by studying the telecommunication services. On the other hand, the replenishment of stock has to be sensitively responded for guaranteeing the right amount of goods to shops in a well-timed manner (Leung et al., 2003). However, the unpredictable customer demands in dynamic business environments causes the high operation cost in the retail industry (Hugos & Hulitzky, 2011). Therefore, in order to maintain the good customer relationship, mobile applications can be adopted in the retail industry.

2.2 Mobile applications in retail industry

Mobile computing has influenced the commercial industry and caught the research community's attention and become the new trend in between the consumers via smartphones (Forman and Zahorjan, 1994). There are several continuous improvements in mobile computing hardware thoughout these years, including better processing power, broader wireless network bandwidth, and improved mobile devices capabilities (Holzer & Ondrus, 2011). In the mobile application industry, there are numerous sectors interposing along the value chain customarily (Tsalgatidou et al., 2001; Adrian, 2002; Barnes, 2002; Maitland et al., 2002; Buellingen et al., 2004; Ballon et al., 2008; and Funk, 2009). Also, each sector has its own unique functions. Cloud computing can reduce the operational and capital costs as the cloud computing cost is calculated by the usage amount (Grossman, 2009). Lee (2014) interprets that cloud computing is an Internet-based computing platform which provides services and computing resources to corporations. Therefore, the small and medium enterprises are not required to build their own IT infrastructure to support their e-commerce activities. On the other hand, there are many uncertainties existing in a customer and product analysis process, such as the customer type and the procurement lead time of product arrival, having solely a cloud-based platform is not enough for solving with all uncertainties. Therefore, artificial intelligence (AI) techniques are then suggested for making the decision support.

2.3 AI techniques

AI techniques including RFM analysis, K-means clustering and fuzzy logic are widely adopted for CRM and stock replenishment in the retail industry. The RFM model is commonly used for selection and segmentation in direct marketing and database marketing in the retail industry (Fader et al., 2005) Moreover, Wu and Lin (2005) has proven very effective when applied to marketing databases. According to Lumsden et al. (2008), consumers can be segmented based on three attributes of buying behavior, including recency, frequency, and monetary value. Clustering is one of the most commonly used data mining techniques to group objects into different families of similar objects. Chang et al., (2007) stated the objects could be anything like customers, web users or even documents. For instance, k-means clustering can help the firm to group their data into different clusters without providing the types of relation they are (Wu and Kumar, 2008). It tries to find out K partitions based on different requirements and then has classification to fulfill different criteria. (Verma, et al., 2012; Seong, Misra & Yao, 2013). Fuzzy logic is one of AI techniques for inventory management. Zadeh (1965) proposed fuzzy logic which is a class of objects with a range of rankings of membership and categorized by a membership (characteristic) function which

allocates to each object a ranking of membership grading between zero and one. According to Pham & Chen (2002) and Hung & Chung (2006), fuzzy logic is an effective approach for managing and dealing with uncertainties. It is found that fuzzy logic is a promising tool to deal with inventory control (Syed & Aziz, 2007; Dutta & Kumar, 2012).

In summary, effective CRM and inventory control strategies are important for the retailers. In order to maintain a good CRM and inventory control, an intelligent cloud-based mobile CRM framework, integrating RFM analysis, k-means clustering and fuzzy logic, is proposed in this paper for the retailer to manage the customers relationship and inventory level.

3. Design of Intelligent Cloud-based Mobile CRM Framework (ICMF)

In order to keep a close customer relationship and provide effective stock replenishment, this paper proposes an intelligent cloud-based mobile CRM framework (ICMF) for delivering the most appropriate marketing strategies and decision support for stock replenishment. Figure 1 shows the ICMF which consists of 5 tiers: (i) Data acquisition, (ii) Customer data analysis, (iii) Product data analysis, (iv) Content management system, and (v) Mobile CRM implementation.

3.1 Tier 1: Data acquisition

The data of customers and the products are retrieved from the POS database of the numerous stores. Customer data includes: customer ID, customer name, transaction records, point balance, and membership status; whereas, product data includes: product ID, product name, price quantity. Through the process of extraction, transformation and loading (ETL), the incomplete and incorrect data is sorted out and the data with inappropriate format is reformatted as well. Thus, the extracted data will be loaded to the centralized data warehouse for further processing.

3.2 Tier 2: Customer data analysis

In this tier, the RFM model is employed for finding out the customer loyalty to the brand by analyzing the customer data. Table 1 shows the detailed definitions of RFM attributes. The customer data from the centralized data warehouse will be quantified into the numerical recency, frequency and monetary values for the RFM analysis. For the recency values, the customers are divided into five equal groups, i.e. score 5 for top 20% recency values, score 4 for the next 20% recency values, and so on. This process is also undertaken for frequency and monetary values. Therefore, customers will be assigned the corresponding ranks in the RFM analysis.

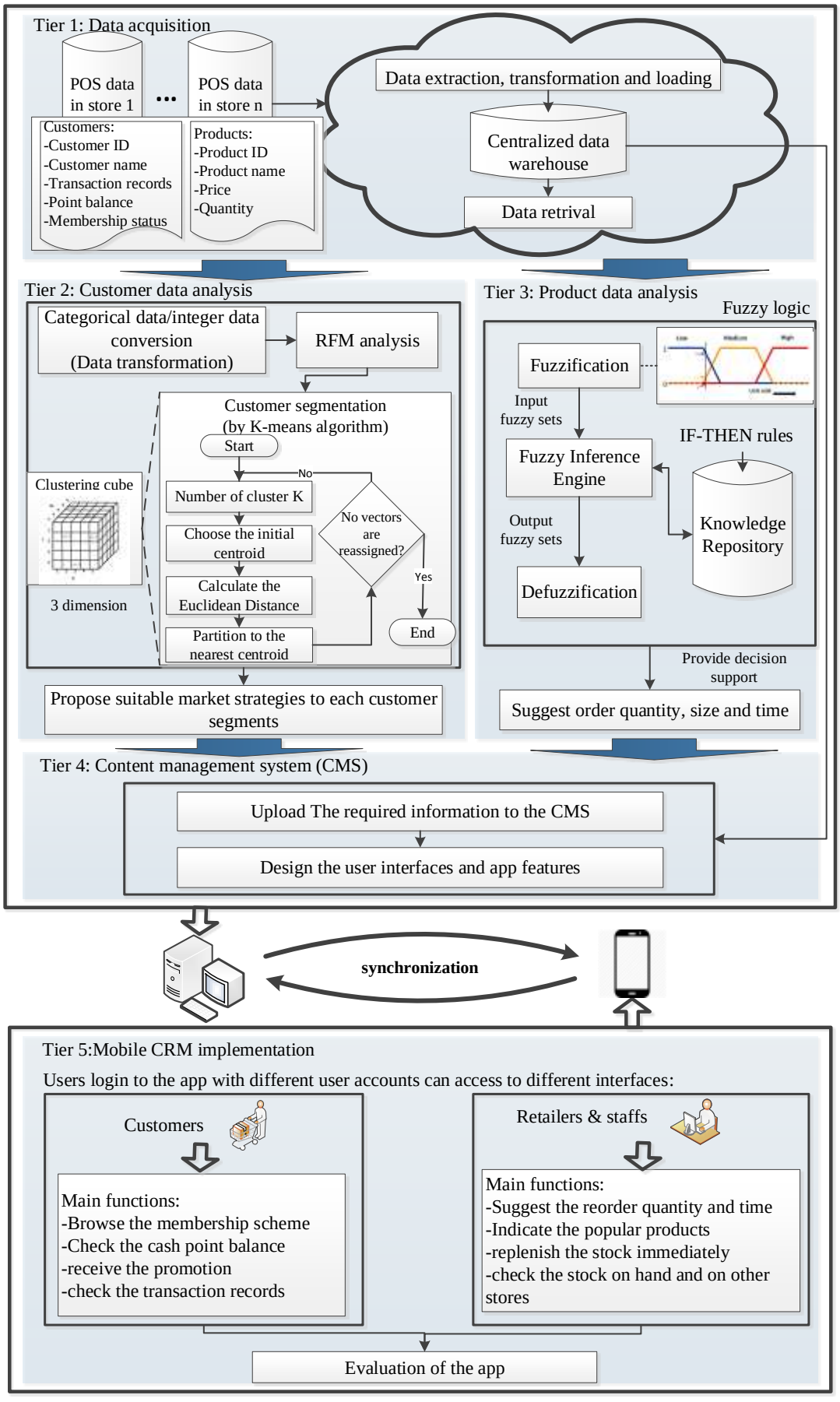

Figure 1 The intelligent cloud-based mobile framework (ICMF)

Table 1 The definitions of RFM attributes

Attributes	Definitions
Recency (R)	The time interval between the latest purchasing behaviour of the customer and present;
Frequency (F)	The number of transactions of the customer in the specific period of time;
Monetary (M)	The amount of the money spends by the customer in the particular time period.

In order to classify the customers, k-means clustering algorithm is used to partitioning the customers into eight segments by the input of RFM results. K-means clustering algorithm starts with determine the appropriate *k* clusters, then the initial centers $p_v, v = 1,2 \dots k$ of the clusters arbitrarily is chosen. After then, the *n* vectors will be partitioned to the nearest centers by using Euclidean Distance (ED), which is $d(p,q_i)=\|p-q_i\|_2$. The new center by calculating the means of the assigned vectors within that cluster will be computed. The above processes will repeat until all vectors are no longer reassigned. Eight clusters will be arranged based on the values of the centroid centers as shown in Table 2.

Table 2 Eight clusters by k-means clustering algorithm

Type	RFM Arrangement	Customer Type
1	$R_hF_hM_h$	Loyalty
2	$R_hF_hM_l$	Shopper
3	$R_hF_lM_h$	Valuable
4	$R_hF_lM_l$	New
5	$R_lF_hM_h$	Old
6	$R_lF_hM_l$	Frequent
7	$R_lF_lM_h$	Spender
8	$R_lF_lM_l$	Reminder

3.3 Tier 3: Product data analysis

The product data is extracted and processed to fuzzy logic for providing decision support of stock replenishment strategies. The fuzzy logic involves three main components: (i) fuzzification, (ii) fuzzy inference engine and (iii) defuzzification. The input data is converted into fuzzy sets by fuzzification as shown in Figure 2. The fuzzification is created by the predetermined classification of fuzzy regions based on the inputs and memberships functions. The obtained input fuzzy sets are then transmitted to fuzzy inference engine which is linked to a knowledge repository with the IF-THEN rules. The IF-THEN rules are a set of fuzzy rules which representing the relationship between input and output parameters. The rules should be pre-defined by the retailer based the business natures. Thus, the output fuzzy sets from the fuzzy inference engine are defuzzified for the transformation from fuzzy sets to crisp values. Based on the output crisp values, the retailers are able to decide the order quantity and frequency for stock replenishment.

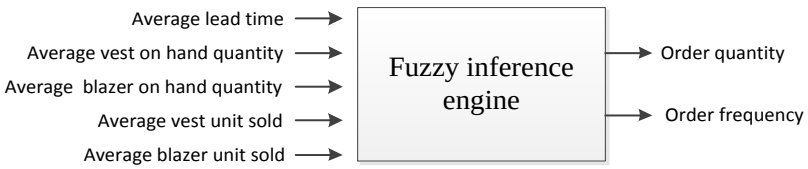

Figure 2 The inputs and outputs of fuzzy logic

3.4 Tier 4: Content management system (CMS)

After the customer data and product data analysis, the appropriate marketing strategies and the stock replenishment decision support can be proposed. The customer data, product data, and output results will be visualized by using the CMS, which allows the users to publish, edit, modify, organize, delete, and maintain in a mobile app format.

3.5 Tier 5: Mobile CRM implementation

The information in the app format is synchronized with the ICMF. There are two types of user accounts with different interfaces, i.e. customer and staff accounts. Apart from the general customer/inventory information, promotions and discounts will be allocated based on the results of customer data analysis in the customer account, and suggested order quantity and frequency will be provided in the staff account.

4. Case Study

Flora Collections is a Danish multinational retail-clothing company, established in 2005. It is well-known for its fast-fashion clothing for men, women, teenagers and children. It has 280 stores in 10 countries and as of 2016 employed around 6000 people. The business goal of the company is offering trendy clothing at attractive prices.

4.1 Existing problems in Flora Collections

In order to maximize the company profit and maintain a closer customer relationship, Flora Collections seek to have an efficient stock replenishment strategy and provide a favourable membership programme for its customers. However, the following problems have been discovered in its stock replenishment operation and feedbacks that restrain it from fully accomplishing its goals: (i) low visibility of information between the stores and back offices, (ii) over reliance on human experience for making stock replenishment decisions, (iii) make the stock replenishment decision not only inside the office, (iv) high operation cost in supply chain, (v) unitary promotions to all customers, (vi) inefficient membership and company information extraction. The ICMF is thus proposed for Flora to provide an efficient stock replenishment strategy and foster customer loyalty, which in turn will maximize the company profit and maintain a better customer relationship.

4.2 Implementation of ICMF in Flora Collections

In the pilot study, 100 sample of customers' information and two products information (vest and blazer) were included. The RFM values was calculated from the time interval between the latest purchase and present, the number of transactions in the particular period and the total money spent within the particular period. The RFM scores is further processed by the k-means clustering algorithm demonstrated in the software, Weka, as shown in Figure 3. Customers were classified into at most eight clusters according to the RFM arrangement. The number of clusters was set at 8 (k=8). After analyzed the eight clusters, there are seven type of customers are found because two of eight original clusters have the same $R_hF_lM_l$ pattern to classify to the same type of customers. Table 3 shows the result of RFM analysis and k-means clustering respectively.

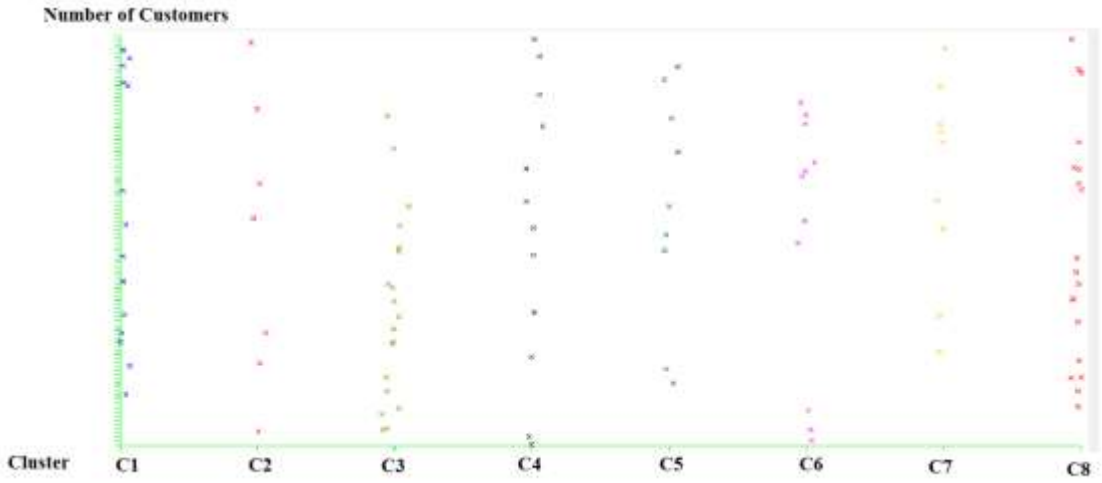

Figure 3 Clustering results by using Weka

Table 3 Results obtained by RFM analysis and k-means clustering

Cluster	Size	Recency value	Frequency value	Monetary value	RFM arrangement	Customer Type
C1	14	1.4286	4.7857	2.7857	$R_lF_hM_h$	Old
C2	7	1.5714	3	2.3968	$R_lF_hM_l$	Frequent
C3	19	4.4737	4.1579	1.8421	$R_hF_hM_l$	Shopper
C4	12	3.0833	4	4.8333	$R_hF_hM_h$	Loyalty
C5	9	5	1.3333	2.3333	$R_hF_lM_l$	New
C6	11	2.0909	1.7273	1.3636	$R_lF_lM_l$	Reminder
C7	9	3.7778	1.3333	2.5556	$R_hF_lM_l$	New
C8	19	1.2632	2.2632	3.6842	$R_lF_lM_h$	Spender
Overall	100	2.8361125	2.8250875	2.724325		

Relevant data was transferred for product data analysis using FL technique. A Matlab fuzzy logic toolbox software was employed for facilitating the data analysis. The membership functions of input and output and the predefined rules are input and stored in the software.

Table 4 shows the example of predefined rules stored in FL repository. Figure 4 and 5 show the fuzzy set of input valuables and output valuables, respectively. By entering the quantitative value of input valuables to fuzzy logic toolbox software, the value of output valuables can be determined. Figure 6 shows the results of product data analysis tier.

Table 4 The example of predefined rules stored in FL repository

IF	**Then**
Lead time is relatively long AND Vest on hand quantity is r small AND Blazer on hand quantity is small AND Vest unit sold is large AND Blazer unit sold is large	Order quantity is significantly increased AND Order frequency is slightly increased

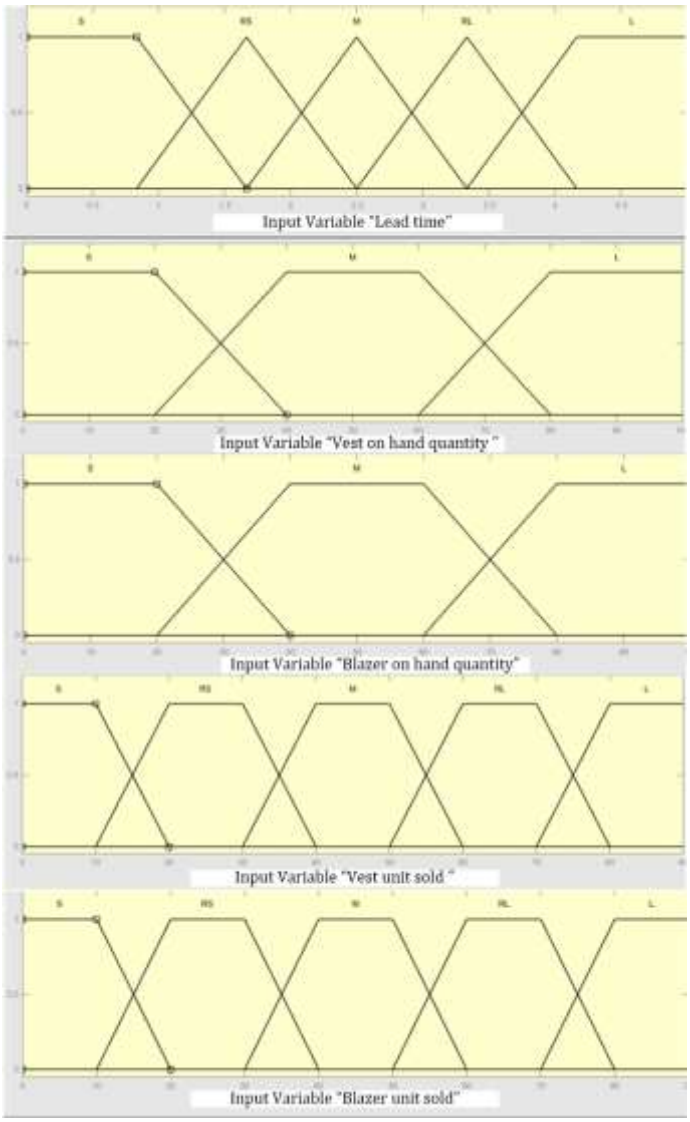

Figure 4 The fuzzy set of input variables

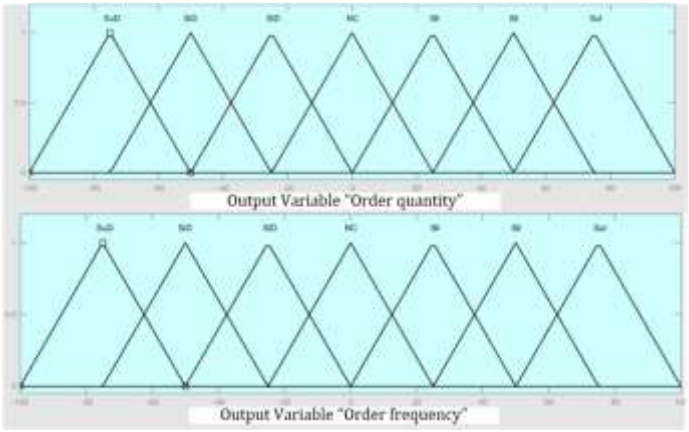

Figure 5. The fuzzy set of output variables

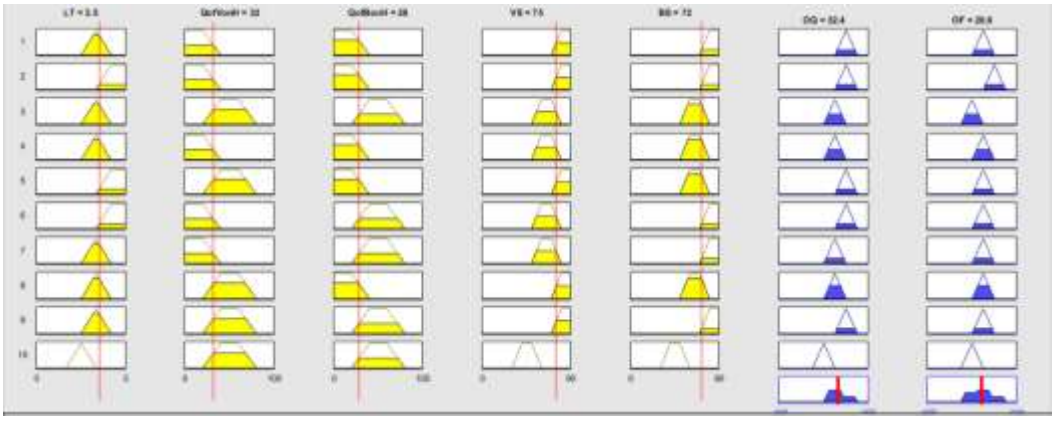

Figure 6. The results of product data analysis tier

From the above results, customer and product information are integrated into the mobile app platform by using CMS. The prototype app interfaces are designed for demonstrating the ICMF. Figure 7 – 9 show the log-in interface for customer and staff, the interface of stock replenishment, and the interface of CRM, respectively.

Figure 7 The Log-in interface

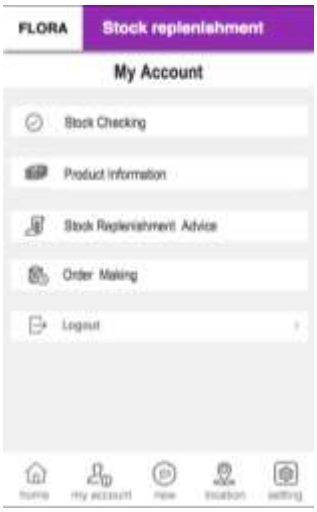

Figure 8 The interface of stock replenishment

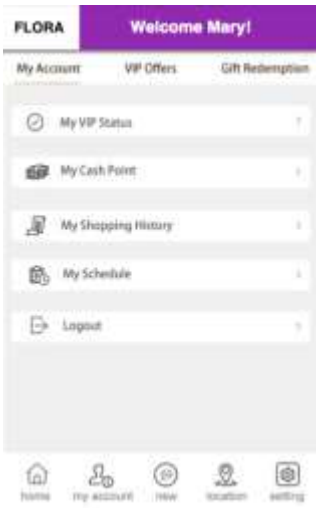

Figure 9 The interface of CRM

5. Results and Discussion

By conducting a case study in a boutique, the result shows that the ICMF can analyze customer behavior effectively while the number of times in out-of-stock and over-stock is reduced significantly.

5.1 Enhancement in customer relationship

The ICMF allows the the retailers to formulate the most appropriate marketing strategies according to the customer segments. The customer segments are partitioned by the RFM scores with k-means clustering algorithm. Hence, the formulated marketing strategies can focus on the needs and behavior of the customers. Customers can receive the appropriate promotions and information which can enhance the customer loyalty and proximity. Moreover, this can be the comparative edge among the competitors and increase the customer satisfaction about the company. Therefore, the company can differentiate their services provided from other competitors by providing ad hoc marketing strategies. As a result, a close and profitable customer relationship can be obtained.

5.2 Reduction in number of times in out-of-stock and over-stock

After adopting the ICMF, the company can have better inventory control by eliminating the problems of the excess stocks and the insufficient inventories. Fuzzy logic approach is applied to provide accurate decision support for the stock replenishment. Since the inventory information is processed and analysed in the cloud platform, this can avoid human errors and eliminate the bias compared with making stock replenishment decision manually. Consequently, the quality of the stock replenishment decision can be improved, and the inventory cost can be cut down.

6. Conclusion

Nowadays, customers have higher requirements to the services provided by the company, and the customer demand in current fashion market is dynamic. There are two contributions in this paper: (i) enhancing the customer relationship and (ii) improving the inventory control. The incorporation of RFM analysis, k-means clustering and fuzzy logic in this paper is novel technique for providing the marketing strategies and stock replenishment decisions. The marketing strategies can be designed according to specifc customer behaviours for improving their satisfaction. On the other hand, the accurate stock replenishment decision can be given to the retailers to reduce the costs of stock-out and over-stock. With this innovative and smart design of ICMF, retailers can real time monitor and replenish the stock anytime while customer can receive the updated tailor made promotion. Therefore, the proposed ICMF can enhance the mobile application in retail industry effectively.

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