Combining Data Mining and Group Decision Making in Retailer Segmentation Based on LRFMP Variables

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KEYWORDS
Market segmentation; Customer Lifetime Value (CLV); LRFMP model; Analytic Hierarchy Process (AHP); Clustering; Cluster analysis

ABSTRACT
Data mining is a powerful tool for firms to extract knowledge from their customers’ transaction data. One of the useful applications of data mining is segmentation. Segmentation is an effective tool for managers to make right marketing strategies for right customer segments. In this study we have segmented retailers of a hygienic manufacture. Nowadays all manufactures do understand that for staying in the competitive market, they should set up an effective relationship with their retailers. We have proposed a LRFMP (relationship Length, Recency, Frequency, Monetary, and Potential) model for retailer segmentation. Ten retailer clusters have been obtained by applying K-means algorithm with K-optimum according Davies-Bouldin index on LRFMP variables. We have analyzed obtained clusters by weighted sum of LRFMP values, which the weight of each variable calculated by Analytic Hierarchy Process (AHP) technique. In addition we have analyzed each cluster in order to formulate segment-specific marketing actions for retailers. The results of this research can help marketing managers to gain deep insights about retailers.

1. Introduction
Data mining tools are used to extract the valuable information and knowledge embedded in the vast amount of data [1, 2]. Data mining techniques have been used in many different areas such as market basket analysis [3] customer churn prediction [4], and credit scoring [5]. However, in this paper, we focus on applying data mining to clustering retailers. In fact, we have considered retailers as customers. There is product homogeneity in many consumer categories and any product has a lot of substitutable products. In this situation the consumers might be susceptible to change their consuming products by retailer recommendation. This issue becomes more important for an industry that features considerable interaction between retail salesperson and consumers during in the buying process.
The essence of Business-to-Business marketing is building long term relationship with customers [6]. Especially in manufacture-retailer context, a long term relationship requires manufactures to set up a high level of loyalty [6]. B2B loyalty researches are considerably few. Davis-Sramek, et.al. [7] had focused on retailer loyalty in the supply chain for consumer durable products. They investigated factors affecting retailer loyalty that includes: service quality, satisfaction and commitment. They examined technical service quality and relational service quality as service quality aspects for retailer order fulfillment. They also

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divided commitment into two types: (1) affective commitment (2) calculative commitment. They found technical and relational service quality impacted satisfaction and consequently it impacted both affective and calculative commitment. Finally, affective commitment directly influenced retailer loyalty.

Market segmentation efforts to put similar customers into homogeneous groups. Market segmentation enables marketing department to perform segment-specific marketing actions. By performing different marketing actions for each segment, the firm ensures improvement in its marketing strategies. Some researches used the RFM (Recency, Frequency, and Monetary) model (e.g. [8-11]) for market segmentation.

Chang and Tsay [12] proposed LRFM model by incorporating customer relation length to RFM model. In this study, we have proposed LRFMP model by adding P (Potential) to LRFM model. P is the maximum value of retailer purchases over a particular period. We used K-Means algorithm for clustering retailers based on RFMLP variables. After clustering customers, 10 clusters were obtained. Analytic Hierarchy Process (AHP) was used to determine the weight of each LRFMP variable, according to decision-makers opinions. Then the integrated rating of clusters was computed as the weighted sum of LRFMP values. Finally, cluster-specific marketing actions were formulated to improve behavior and loyalty of each cluster to the firm.

The reminder of this paper is organized as follows. First background of the work is presented in section 2. In section 3, research methodology is explained and experimental results are analyzed. In section 4, the marketing actions are analyzed and formulated. Conclusion is considered in section 5.

2. Literature Review

2-1. CRM

Despite of being an important approach to business, there is no general accepted definition of CRM. Some researches use the RFM model to quantify customer lifetime value. The RFM model was proposed by Hughes [18]. RFM model has three dimensions: (1) Recency: is the time interval between the last purchase and a present time reference, the shorter time interval, the bigger R; (2) Frequency: is the number of customer’s purchases in a particular period, the higher frequency, the bigger demand and the higher loyalty; (3) Monetary value: the total amount of money consumed by the customer over a particular period, the higher monetary, the bigger contribution to business. RFM model is a simple and direct metric for measuring customer value. Chang and Tsay [12] proposed the LRFM model, mainly adding the customer relation length to RFM model.

In spite of being effective method for customer segmentation, RFM model brings some challenges for researchers. The problem with RFM model is determining the weights of the three variables. There are two studies that have contrast idea about this issue. Hughes [18] and Stone [19] indicated that the importance of each variable is identical. However, Chang and Tsay [12] proposed the LRFM model, mainly adding the customer relation length to RFM model.

2-2. Customer Value Analysis

Customer Lifetime Value (CLV) is defined as the obtained profit net present value in a customer’s lifetime [17]. RFM is a common used technique that can be used effectively for customer value analysis and market segmentation.

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2-3. Market Segmentation

The aim of market segmentation is putting the right products or services to a targeted customer group and hence improvement of marketing strategies efficiency. One of the important challenging issues for successful market segmentation is choosing the right data mining techniques. There are many clustering techniques that were used in literature. Table 1, summarizes some researches from the market segmentation context. The clustering algorithms used in these researches are identified.

2-3. Clustering

Clustering is the process of grouping a set of objects into classes of similar objects [1]. The goal of clustering is that the objects within a cluster have the most similarity to each other and the objects in
different clusters have the most dissimilarity to each other ([1,2]). Clustering techniques are subsets of unsupervised learning techniques. Han and Kamber [1] organized clustering techniques into the following categories: partitioning methods, hierarchical methods, density-based methods, grid-based methods, model-based methods, methods for high dimensional data, and constraint-based methods. In this study we have used K-means, from partitioning methods, for grouping customers into different segments according to their LRFM values.

K-means algorithm was suggested by MacQueen [26] and has been used widely due to its ability for quick processing of large amount of data. The operation of K-means is illustrated as follows: (1) selecting K initial centroids; (2) assigning each object to its closest centroid; (3) updating the centroid of each cluster to the mean of its constituent instances; and (5) repeating steps 2 and 3 until centroids don’t change.

2-4. AHP

The Analytic Hierarchy Process (AHP) is a multi-criteria decision-making method developed by Thomas L. Saaty [27]. The AHP has been proposed for integrated and fuzzy problems based on human brain assessment.

The AHP uses paired comparison judgments from a fundamental scale of absolute numbers, approached from decision-makers, for prioritize alternatives to a problem in an architectural structure [28, 29]. Decision-makers must assign a number from 1 to 9 to any comparison (Table 2). This method also measures the degree of inconsistency of judgments. If the inconsistency degree exceeds from 0.1, judgments must be revised.

3. Research Methodology

CLV is a common metric used for planning marketing strategies by managers. Recently, LRFM model is used for quantifying CLV [20, 24]. But this model is not effective for developing some marketing strategies such as cross-selling. In this research we have added customer potential value (P) to LRFM model. By doing so we have derived LRFMP model (Length, Recency, Frequency, Monetary, and Potential value). Potential value is the maximum value of the all purchases of a customer in a particular period. It can represent a measure of additional sales opportunity. Furthermore, it can be used to recommend additional products to a retailer. In other words, it is a measure of conducting cross-selling effort. In this paper we define the potential value of customers as expected purchases that can be obtained from a certain customer. Our argument is that the firm may not be able to formulate differentiated cross-selling action for each retailer if the potential of each customer is not recognized. In addition, using LRFMP values for clustering resulted in better separation of retailers from the perspective of managers.

<table>
<thead>
<tr>
<th>Tab. 1. Market segmentation research review</th>
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<tbody>
<tr>
<td>Author</td>
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<tr>
<td>Shin and Sohn [21]</td>
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<td>Liu &amp; Shih [8]</td>
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<td>Lee and Park [22]</td>
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<tr>
<td>Ho Ha [9]</td>
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<td>Hung and Tsai [23]</td>
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<td>Chan [10]</td>
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<td>Seyed Hosseini, et al. [20]</td>
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<table>
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<tr>
<th>Tab. 2. Numbers for representing paired comparison judgments</th>
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<td>Comparison importance</td>
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<td>2</td>
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3-1. Customer Data
A case study used for evaluating the proposed model was a hygienic manufacture. This manufacture is one of the biggest and oldest producers of hygienic and cosmetic products in Iran. This corporation distributes its products to its customers that range from small retailers to chain and big retailers in any place of Iran. Customers' data was obtained from two datasets; an 18-months customers' transactions dataset with about 1000000 records, and a customers' profiles dataset with about 72000 records. R, F, M and P values for any customer were extracted from customers' transactions dataset and L value was received from customers' profiles dataset.
According to experts' discretion, the P values were set to 1 to 6. In this research L values was computed 6 monthly, because of short period of customers' submission in firm's MIS system.

3-2. Data Preprocessing
Data preprocessing is an important step in data mining process because it improves the accuracy and efficiency of the subsequent modeling [1]. In this research data preprocessing techniques such as data cleaning, data transformation, data integration and data reduction were used to improve the quality of data for clustering. Finally, a dataset with 63599 customers and five dimensions (LRFMP) were achieved that the customers had at least one purchase during one last year.

3-3. Determining LRFMP Weights by AHP
In this paper AHP method utilized for calculating LRFMP weights according to decision-makers opinions. This work was done in 3 steps according to AHP definition. At first step, four decision-makers from three different management layers of sale
department are selected for making paired comparisons. They include: one top level manager, two middle level managers, and one operational manager. At second step, the inconsistency index was computed and checked for each decision-maker judgments. At last, the LRFMP weights were determined by Eigenvalue computations as 0.232, 0.08, 0.297, 0.333, and 0.057 respectively (Fig. 2).

3.4. Finding K-optimum Davies-Bouldin Index
K-means require the user to determine the number of clusters. There are some kinds of useful indexes to determining k as the number of clusters. In this study we have used Davies –Bouldin index to find the optimal number of clusters. The aim of Davies-Bouldin index is identifying sets of clusters that have small intracluster distances and large inter-cluster distances [30].

The Davies –Bouldin index, DB, is defined as:

$$DB = \frac{1}{k} \sum_{i=1}^{k} \max_{j \neq i} \left( \frac{c_i \cdot c_j}{d(c_i, c_j)} \right)$$

(1)

Where k is the number of clusters, c_i is the intracluster distance of cluster i and d(c_i, c_j) represents the intercluster distance between clusters i and j. The number of clusters that minimize DB is taken as the optimal number of clusters. In this study optimal number of clusters, based on Davies-Bouldin index, is 10 clusters (Fig. 3).

3-5. Clustering by K-Means
In this stage customers are segmented into similar clusters according to their LRFMP values. For this purpose values for L, R, F, M, and P were firstly normalized and then clustered into 10 clusters by K-means algorithm. Table3 shows the LRFMP values for each cluster.

3-6. CLV Ranking
The CLV ranking of segments based on LRFMP values and related weights can help managers in knowing more important segments. They can make plans for retaining customers according to this ranking. For determining LRFMP rating for segments, at first, values of L, R, F, M, and P for centroids were normalized. Then LRFMP rating for each segment were computed as follows:

$$C^j = w_L^j C_L^j + w_R^j C_R^j + w_F^j C_F^j + w_M^j C_M^j + w_P^j C_P^j$$

(2)

Where C_j is the LRFMP rating for cluster j, C_L^j, C_R^j, C_F^j, C_M^j, C_P^j are the normalized L, R, F, M, and P for cluster j and w_L, w_R, w_F, w_M, w_P are the related weights for L, R, F, M, and P achieved from AHP.

Tab. 3. Clustering results

<table>
<thead>
<tr>
<th>Cluster</th>
<th>Number of Customers</th>
<th>Length</th>
<th>Recency</th>
<th>Frequency</th>
<th>Monetary</th>
<th>Potential</th>
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<tr>
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<td>5.941</td>
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</table>

Fig. 2. LRFMP weights achieved from AHP

Fig. 3. Cluster validation
After analyzing each segment, in this section we labeled each cluster according to its status (Table 5).

### 4. Marketing Actions

Once a firm performed segmentation on its customers, it should devise differentiated marketing actions for each cluster. In this section we have identified three marketing actions that the firm should perform on clusters.

These actions include: Cross-selling, Strong anti-attrition, and loyalty program. We also found out that for increasing its purchases, the firm should take some procedures to inform consumers about its products. Advertising is an effective strategy for firm to persuade consumers to purchase the firm’s products. The details of work are presented below.

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#### Fig. 4. Cluster CLV segmentation

<table>
<thead>
<tr>
<th>Cluster</th>
<th>Length</th>
<th>Recency</th>
<th>Frequency</th>
<th>Monetary</th>
<th>Potential</th>
<th>LRFMP rating</th>
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<td>0</td>
<td>0</td>
<td>0.018518519</td>
<td>0.007921657</td>
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#### Tab. 4. CLV ranking by weighted sum of normalized LRFMP values

#### 3-7. Analyzing and Labeling Each Cluster

After clustering by K-means algorithm, we achieved 10 clusters. Tables 3,4 summarized clusters information in detail. The examination of results shows that the values of P (potential) are separable in a certain point. This point is the median point of all P values. This median point is equal to 1.7. The p=1.7 point separate the higher half of P values from the lower half. Therefore, some clusters take low potential label while others take high potential label.

According to opinion of firm’s marketing managers, new customers are those who have launched their relationship with firm in the last 1.5 years (three 6-months periods).

On the basis of this assumption, we have took into consider customers with L (length of relationship) lower than 3 as new customer, on the other hand we took into consider customers with L higher than 3 as long life (established) customers. This is shown in Fig. 4.
4-1. Cross Selling
The phenomenon cross-selling by retailers enables consumers to cross-buy their products. By doing so, retailers can increase their revenue contribution from existing customers [31]. One of the key benefits of cross-selling is improving customer retention since Cross-buying by consumers increase their switching costs. The other benefits of cross-selling are increasing profitable lifetime duration of customers [32]. Similar to other marketing initiatives, it is not logical to target all existing customers for cross-selling since marketing resources is limited. The firm should first identify the right customers for cross-selling. In addition, the firm should identify the drivers of cross-buying. Kumar et al. [31] identified some of important drivers of cross-buying, includes: average inters purchase time, ratio of products returns, and focused buying. They also considered trust as an enabler of cross-buying.

When looking to clusters’ information, we notice that some retailer segments have low monetary value. Cross-selling is an effective strategy for manager to increase customers’ life time value along with their lifetime duration and to improve customer retention. This shows that cross-selling program should be applied for all customer segments. However, it is not possible for firm to target all of customer segments for cross-selling due to limited marketing resource of the firm. By considering this issue, the firm must prioritize the customer segments for cross-selling.

We have recognized the priority of each segment for cross-selling as follows: (1) we have constructed two sets, the first set contains the high potential customer segments and the second one includes the low potential customer segments; (2) For both sets, we have computed the value of Cross-selling index (CSI) as follows:

\[
CSI_i = (P_i - M_i/F_i)
\]

Where \(P_i\), \(M_i\) and \(F_i\) are maximum value, monetary value and frequency for segment \(i\) during the time window. As the value of CSI is more, the priority of that segment for cross-selling becomes high.

We have sorted the segments of each set according to their cross-selling index. By doing so, for high potential segments, clusters \(C_2, C_6, C_8, C_9, C_4\) become the most prior to least prior segments respectively for cross-selling actions. Also for low potential retailer segments, clusters \(C_{10}, C_1, C_7, C_4, C_5\) become worth for
cross-selling respectively. The priority of each cluster for cross-selling is shown in Table 6.

4-2. Loyalty Program Investment
Customer loyalty has been generally known as valuable assets in competitive markets for all firms especially for those that active in a non-contractual setting [33]. The business setting for this firm is a non-contractual/continuous according to Fader & Hardi [34], since retailers face low switching cost in this setting; investment in loyalty program is especially important. However, resource investment in building loyalty should be performed according to profitability and value of customers [33]. Kumar & Shah [33] proposed to use CLV as a decision support tool to set maximum dollar value limit for marketing investment on a loyal customer. In this study we have used LRFMP rating as a metric for allocating marketing budget for loyalty program. In this way as the LRFMP rating is high; the level of loyalty program investment becomes high. The levels of investment for each retailer segment are showed in Table 6.

4-3. Strong Anti-Attrition
Customer retention is an important strategy to keep existing customers. Acquisition of new customer costs more than keeping existing customers [4]. It is even suggested that it costs 12 times more to attract a new customer than retaining new one [35]. As can be seen from Table 5, some retailer segments have low recency. This means that the time interval between last purchase and present time reference is high for them. Having low recency, may be sign of retailer defection. There are three segments that have low value of recency; these are including: Cluster 9, Cluster 7, and cluster 3 (Table 5). In order to retain these retailers, the firm should implement strong anti-attrition actions. As fig. 2 shows, the importance of R (recency), from managers’ perspective is low. This means that managers do understand that keeping existing customers is profitable than acquiring new customers; for this reason they assigned low weight for R; this lead to low recency segments still become valuable for firm.

4-4. Advertising
Since retailers are intermediaries between manufacture and consumers, the increase in their buying frequency depends on buying frequency of consumers. In other words, as the buying frequency and volume of the consumers’ purchases increases, consequently the buying frequency of a retailer increases. Therefore, in order to increase the buying frequency of retailers, the firm should execute effective advertising program on consumers. Another way for increasing buying frequency of retailers is improving relationship with them. As the firm improve its relationship with retailers, their loyalty to firm increase. The increase in loyalty cause that retailer place the firm product in the appropriate shelves. Furthermore, since consumers of products still require assistance in selection of products, a loyal retailer may present the firm’s product for them. This issue may lead to consumer purchase of the firm’s products.

5. Conclusion
Today intensive competition and product homogeneity in many consumer categories enables retailers to switch from one manufacture to another for providing their needs. Manufactures do understand that for staying in the competitive market, they should improve their relationships with retailers. Market segmentation is an approach for performing segment-specific marketing actions. Recently, LRFM variables have been used for market segmentation. But this model is not effective for developing some marketing strategies such as cross-selling. For addressing this problem, in this study, we have extended LRFM model by adding an extra parameter P (Potential) to it. After clustering customers by K-Means algorithm, we have obtained ten clusters. After analyzing each segment, we found that there are two segments that are top spenders. In addition, there are five segments that are average value segments. The other three segments have low value. According to segments information, we identified three marketing actions to be implemented on retailers segments these including: cross-selling, strong anti-attrition, and loyalty program. We also recognized that the firm should improve advertising program on consumers. Improved advertising program does inform consumers about the firm’s products and hence increases consumer purchases. The increase in consumers purchases lead to increase in retailers’ purchases, since the retailers are intermediaries between the manufacture and consumers. This research is concerned with one manufacture in hygienic industry. It is worthy future studies applying this model to other cases in different industries.

References


