

# Using A Combination of RFM Model and Cluster Analysis to Analyze Customers' Values of A Veterinary Hospital

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**Abstract**—The purpose of this study is to identify customers with different behaviors and then develop adequate marketing strategies to maintain good relationships with its existing customers and attract new customers for a veterinary hospital. A two-stage clustering method, the combination of self-organizing maps and K-means method, and RFM model are used to analyze customers' values from the transactions data focusing solely on dogs of a veterinary hospital in Taichung City, Taiwan in 2014. The results show that 4,472 customers are classified into twelve clusters, and seven out of twelve clusters are found to be the best or loyal customers. However, the other five clusters are uncertain customers. Among the five clusters, three clusters are lost customers and two clusters with relatively higher recency values than the average value can be viewed as new customers.

**Index Terms**—customer relationship management, veterinary hospital, data mining, RFM model, cluster analysis, self-organizing maps, K-means method

## I. INTRODUCTION

The pet industry provides multiple pet products and services, such as food, beauty, and medical care. In the past decade, the market for pets grows dramatically. Pet owners are willing to provide special meals, beauty products, and health-related services for their pets to make their pets happy, nice and clean, and healthy. This trend occurs not only in Western countries such as the United States [1] but also in the Asia-Pacific countries such as Japan and Taiwan. The rapid growth of the pet market can be attributed to the following reasons.

First, with the increasing trend of aging baby boomers, singles, empty nesters, and DINKs (dual-income/no kids), keeping pets has become a general trend. Aging people and those who are singles or do not have kids would regard the pets as the substitutes for their kids. Interacting with

companion pets can bring happiness, companionship, and health benefits for them, particularly for the elderly who face serious social isolation [1], [2]. Second, the upcoming generations, Gen X and Millennials, have very different lifestyles and purchasing habits, particularly involving pets. Ridgway et al. [3] pointed out that people who have excessive buying for themselves often spend more on their pets.

In Taiwan, the pet industry has been expanded and becomes very competitive. The important role pets play in people's lives has increased. Many residences in Taiwan own pets and regard them as family members. Therefore, the pet expenditures continue to grow, revealing the increasing involvement of people and their pets [2], [4].

Naturally, pet owners have great demands for veterinary services [5] and would seek for the veterinary hospitals with better service quality. In recent years, the market of veterinary hospitals in Taiwan has been increased rapidly. Because of the fierce competition, veterinary hospitals have to maintain good relationships with their existing customers and acquire new customers for the long-term perspective. Therefore, it is important for veterinary hospitals to make effective marketing strategies to cope with their customers.

Understanding customer behaviors facilitates the pet industry to know customer demands and preferences so as to make particular marketing strategies effectively. However, little is known about the marketing strategies in the pet industry. Data mining techniques are a vital tool that enables the pet industry to achieve customer relationship management (CRM) effectively by identifying valuable customers from the past purchase behaviors. The purpose of this study is to find valuable customers and then develop different marketing strategies to meet the needs from different groups of customers in accordance with their behaviors.

In order to achieve the purpose, this study employs a combination of self-organizing maps (SOM) and K-means method, which is a two-stage step proposed by prior literature [6], [7], together with the adoption of RFM (recency, frequency, and monetary) model. A veterinary hospital located in Taichung City, Taiwan is an example to show how the combination of SOM and K-means method and RFM model work by analyzing its transactions data solely focusing on dogs in 2014 with 4,472 customers. Based on the survey results revealed by Council of Agriculture, Executive Yuan, Taiwan, ROC in 2012, dogs are the most popular pets in the households [8].

When customers are grouped into clusters by the combination of SOM and K-means method, this study initially

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follows the philosophy proposed by Ha and Park [9] to group customers by comparing average RFM values of each cluster to the total average RFM values of all clusters. The importance of customers can be categorized in terms of different RFM values. Later, this study adopts Customer Value Matrix proposed by Marcus [10] to classify customers through different types of behaviors through frequency and monetary. In practice, this veterinary hospital can design different marketing strategies to meet the specific customer needs when different types of customers are identified.

## II. LITERATURE REVIEW

### A. Customer Relationship Management

Customer relationship management has been widely accepted as an important management domain for implementations. In order to compete with others, firms have to pay much attention to CRM relentlessly including technologies and services [11]. Herhausen and Schogel [12] defined CRM as the adoption of information technology to establish, maintain, and enhance good customer relationships and improve customer values. In doing so, firms can do their best to understand and reach customers via complete interactions [13]. In addition, CRM enables firms to strengthen customer loyalty, customer retention, and customer profitability by keeping the existing customers and attracting new customers effectively. To sum up, CRM is particularly important for the firms aiming to enhance their customer service quality [14].

### B. Cluster Analysis

Data mining techniques have been successfully applied in a wide variety of areas, such as marketing, finance, accounting, tourism, and even healthcare industries, which play an important role to achieve CRM [15]-[20]. Cluster analysis, which is one of the data mining techniques, has been widely used in various areas including artificial intelligence, bioinformatics, city planning, image segmentation, information retrieval, machine learning, marketing, and the like [21]-[23]. Specifically, cluster analysis uses partitions to segment a group of data based on the data similarity [21]. That is, the objects within the same cluster have high similarity [16], [23]. Each formed cluster can be viewed as a class of objects from which rules can be derived [24], [25]. Cluster analysis can determine natural subgroups in a data set. Wei et al. [15] stated that SOM and K-means methods are commonly used for cluster analysis.

Self-organizing maps, which is an unsupervised neural networks method, is to organize data in a manner inspired by how the human brain organizes inputs from its environment and is very suitable in marketing screening and problem solving [26], [27]. The feature of SOM is to convert a complex high-dimensional input signal into a simpler two-dimension discrete map, where the underlying hidden patterns are sought. That is, SOM uses a nonlinear generalization of principal components analysis to reduce the complexity of the data [28]. Compared with the traditional cluster analysis approaches, SOM does not provide measures for validation of the cluster analysis results [27].

In contrast to SOM, K-means method, a non-hierarchical

approach, is one of the very popular approaches to perform cluster analysis because of its simplicity of implementation and fast execution [25]. K-means method uses Euclidean distance and has two steps to perform cluster analysis, i.e., assignment and re-estimation steps [25]. However, K-means method is very sensitive to the choice of a starting point to segment the items into  $k$  initial clusters [29], [30].

Both SOM and K-means method have their own strengths in partitioning the data into clusters but each technique still has some disadvantages to proceed cluster analysis. For instance, SOM cannot provide any measures to validate the cluster analysis results, indicating that it is not easy to identify boundaries from the SOM results [27]. K-means method, on the other hand, is very sensitive to the choice of a starting point, and the results generated by K-means method are likely to be affected during the selection of a starting point to partition the data into  $K$  initial clusters [29], [30].

Previous studies proposed a two-stage approach to improve the weaknesses of SOM and K-means method by combining these two methods together. Prior findings showed that the combination of these two methods outperformed either SOM or K-means method [6], [7]. Therefore, this study applies the two-stage approach to perform cluster analysis. That is, SOM is first applied to determine the appropriate number of clusters, and then K-means method is used to partition the data set based on the determined number of the clusters by SOM.

### C. RFM Model

When the marketplace becomes more and more competitive, veterinary hospitals have to do their best to acquire and retain most profitable customers by understanding their customer values. When customer values are found, veterinary hospitals will be able to customize marketing strategies and then fulfill the needs for different types of customers by allocating limited marketing resources. In practice, CRM enables veterinary hospitals to make their marketing strategies effectively and efficiently.

RFM model, a well-known method to analyze customer values, is one of essential tools to achieve CRM through market segmentation. By quantifying customer behaviors, RFM model can analyze and further predict customer behaviors in the database [15], [25], [31]. By definitions, RFM model is composed of three variables (measures) including recency, frequency, and monetary. Specifically, recency is to measure the number of periods since the last purchase, namely days or months. Frequency is to count the number of purchases made in a given time period. Monetary can be defined as either the total amount of the money spent or the average amount of money during a given time period. To sum up, RFM model analyzes customer purchase behaviors through examining when customers purchase, how often they purchase, and how much they purchase in a given time period [32].

The traditional approach to quantify and sort the customer data is to divide the data into five equal segments for each dimension of RFM. That is, the top 20% segment is assigned as a value of 5; the next 20% segment is assigned as a value of 4, and so on. Therefore, each customer can be denoted by a three-digit number out of 125 possible RFM combinations based on RFM model, i.e., 555, 554, 553, ..., 111 [32], [33].

In contrast, Wei et al. [15] used the original data rather than coded number to perform RFM model because RFM model could be more powerful in continuous variables practically. Wei et al. [15] defined RFM model slightly different than the traditional definitions. Their definitions are summarized below. Recency is defined as the time length since the most recent purchase; frequency is the number of purchases during the same period of time; and monetary refers to the total amount of money spent on all purchases given the same period of time. Following Wei et al. [15], this study adopts the original data to perform RFM model.

D. The Classification of Customer Types

Ha and Park [9] used average RFM values of each cluster to compare with the total average RFM values of all clusters in order to classify customers. When the average value of a particular symbol is larger than the total average, an upward arrow ( $\uparrow$ ) is given to that particular symbol, whereas a downward arrow ( $\downarrow$ ) is given when the average value is smaller than the total average. Based on the above philosophy, there would be eight combinations of RFM model. It is worth to note that Wei et al. [15] defined R differently by measuring the number of days since the last visit when the first day of the specified time period is set to one. Therefore, a larger R value indicates the more recent a customer visits.

Though there are eight combinations of RFM model, Ha and Park [9] only identified four major types of customers in terms of the strategic positioning of customer clusters. These four types of customers are composed of lost customers with  $R\downarrow F\downarrow M\downarrow$  and  $R\downarrow F\uparrow M\uparrow$ , new customers with  $R\uparrow F\downarrow M\downarrow$ , loyal customers with  $R\uparrow F\uparrow M\uparrow$ , and promising customers with  $R\uparrow F\downarrow M\uparrow$ . In addition to partition customers into clusters based on the RFM values, the Customer Value Matrix which is very suitable for small retail and service businesses to analyze customer values enables the management to further simplify the RFM analysis to categorize the types of customers [10]. The Customer Value Matrix only adopts F and M variables to partition customers into four different types of scenarios as shown in Figure 1. By using the average F and M values, four scenarios are found including best customers with the symbol of  $F\uparrow M\uparrow$ , spender customers with the symbol of  $F\downarrow M\uparrow$ , uncertain customers with the symbol of  $F\downarrow M\downarrow$ , and frequent customers with the symbol of  $F\uparrow M\downarrow$ .

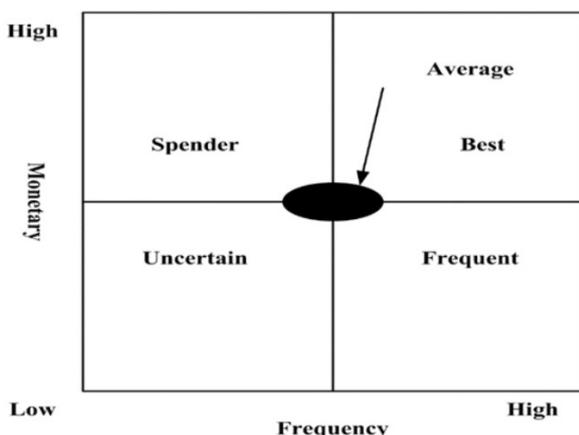


Fig. 1. Customer value matrix

When RFM model is used to analyze customer values, there are eight combinations can be found in terms of R, F, and M variables. In addition, these combinations can be further simplified into lost customers, new customers, loyal customers, and promising customers. Moreover, the Customer Value Matrix enables the management to classify customers into best, spender, uncertain, and frequent customers by F and M variables. In other words, customer values can be evaluated by the Customer Value Matrix and, more importantly, different marketing strategies can be designed to meet different customer needs.

III. A CASE STUDY

The transactions data solely focusing on dogs in 2014 from a veterinary hospital in Taichung City, Taiwan are used in this study. There are 4,472 customers in the data set, and each customer consists of his or her membership number, owner's gender, pet's birthday, visiting dates, monetary spent each time, and examination records. During the data cleaning stage, the following guidelines have been defined and applied in this study. First, the consumptions of zero-dollar records are deleted. Second, if a pet owner visits more than once in a particular day, the pet owner only visits once by the definition. That is, the frequency in that day is one. In addition, the total money spent for that particular pet owner is to aggregate the amounts of the money spent in that particular day. Third, the recency value is defined based on Wei et al. [15]. That is, a value of one is assigned to January 1, 2014, a value of two to January 2, 2014, and a value of 365 to December 31, 2014. In doing so, recency is documented by a numerical value from 1 to 365. Frequency is to count the number of the visits in 2014, while monetary is to sum the total amount spent in 2014. The detailed definitions of RFM model in this study are provided in Table I.

TABLE I  
DEFINITIONS OF RFM MODEL

Variable	Definition
Recency (R)	refers to the number of days since the last visit in 2014
Frequency (F)	refers to the number of visit in 2014
Monetary (M)	refers to the money spent in 2014

In this study, larger R, F, and M values represent more recent, more frequent, and more money spent scenarios, respectively. Specifically, the larger the recency value is, the more recent the customer visits. The maximum, average, and minimum recency values are 365, 207.43, and 1, respectively. Besides, the larger the frequency value is, the more frequent the customer visits. The maximum, average, and minimum frequency values are 125, 3.03, and 1, respectively. Furthermore, the larger the monetary value is, the more money the customer spends. The respective maximum, average, and minimum monetary values are \$99,998, \$3,195.84, and \$50, respectively (calculated in New Taiwan dollars). Table II summarized the detailed descriptive statistics of R, F, and M values.

TABLE II  
DESCRIPTIONS OF RECENCY, FREQUENCY, AND MONETARY

	Maximum	Minimum	Average	Standard deviation
Recency	365	1	207.43	107.37
Frequency	125	1	3.03	5.38
Monetary	99,998	50	3,195.84	5,167.26

A two-stage approach is employed for cluster analysis. In the first stage, SOM is used to determine the appropriate number of clusters. IBM SPSS Modeler 14.1 is the software to perform cluster analysis, and the “Kohonen node” (i.e., SOM) with default values along with the Kohonen mode set to “simple” for cluster analysis are used. The input variables are recency, frequency, and monetary. Figure 2 shows that the best number of clusters among 4,472 customers is twelve. In the second stage, the number of twelve is set up when K-means method is used for cluster analysis. Table III depicts the descriptive statistics of twelve clusters in terms of sample size, average numbers of R, F, and M of the customers, and the symbol(s) of R, F, and M greater than the averages of R, F, and M. Most of the customers are in Clusters 2, 4, 6, 9, and 11, whereas each cluster in Clusters 1, 3, 10, and 12 has the number of the customers less than 10.

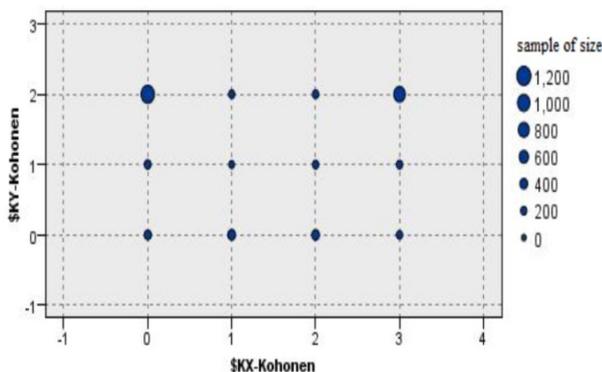


Fig. 2. Twelve clusters generated by SOM

TABLE III  
DESCRIPTIVE STATISTICS OF TWELVE CLUSTERS

Cluster	Sample Size	Average R	Average F	Average M	Item(s) above Average
1	1	358.00	15.00	99,998.00	RFM
2	721	41.80	1.33	1,747.83	
3	1	309.00	125.00	30,504.00	RFM
4	812	330.06	2.25	2,240.76	R
5	31	360.23	40.06	25,491.19	RFM
6	820	189.50	1.96	2,516.07	
7	63	343.05	17.48	24,585.32	RFM
8	318	349.89	9.19	7,349.94	RFM
9	816	118.48	1.66	1,924.33	
10	1	363.00	99.00	14,121.00	RFM
11	883	261.10	2.41	2,751.14	R
12	5	357.60	30.20	65,687.40	RFM
Average		207.43	3.03	3,195.84	

Twelve clusters in Table III can be further partitioned into three different types of combinations based on R, F, and M variables, namely RFM, R, and none. Specifically, Clusters 1, 3, 5, 7, 8, 10, and 12 have all of R, F, and M values larger than the average values of R, F, and M. These seven clusters having the symbol of  $R\uparrow F\uparrow M\uparrow$  are defined as loyal customers with high contributions to this veterinary hospital because they visit more recent and more frequent and spend much more money in 2014. In contrast to loyal customers, both Clusters 4 and 11 having the symbol of  $R\uparrow F\downarrow M\downarrow$  are viewed as new customers because they visit more recent but less frequent and spend less. Finally, Clusters 2, 6, and 9 are the third type of combinations with the symbol of  $R\downarrow F\downarrow M\downarrow$ . Because these customers visit less recent and less frequent and spend much less money, they can be defined as lost customers for this veterinary hospital.

In addition to analyzing the customer value through the combinations of R, F, and M variables, the Customer Value Matrix provides an option to evaluate customer values in terms of F and M variables. Two types of customers are found in Figure 3, i.e., best customers with the symbol of  $F\uparrow M\uparrow$  and uncertain customers with the symbol of  $F\downarrow M\downarrow$ . No customers are found to be either spender or frequent customers in this study. Specifically, Clusters 1, 3, 5, 7, 8, 10, and 12 are best customers, while Clusters 2, 4, 6, 9, and 11 are uncertain customers.

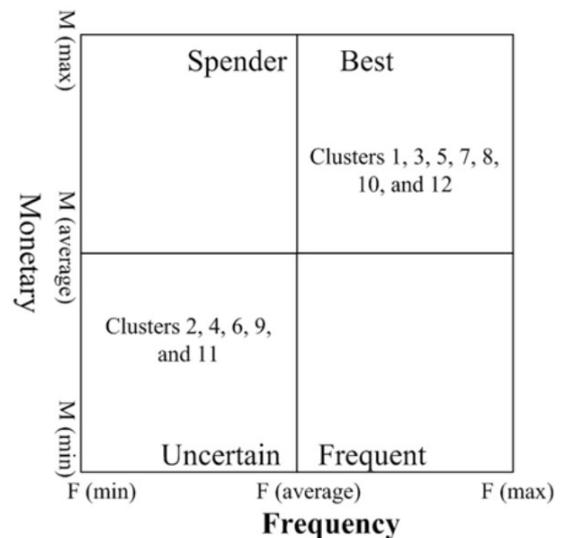


Fig. 3. Twelve clusters in customer value matrix

In practice, using different approaches to analyze customer values would result in somewhat different results in order to categorize the pet owners. Thus, it would be of interest to observe the similarities and differences found by different approaches. Based on the combinations of R, F, and M variables and the Customer Value Matrix, both approaches consider Clusters 1, 3, 5, 7, 8, 10, and 12 to be either loyal or best customers, revealing these customers are essentially important for this veterinary hospital. In contrast to similarities, both approaches have different viewpoints in Clusters 2, 4, 6, 9, and 11. Specifically, Clusters 2, 6, and 9 belong to either uncertain or lost customers, while Clusters 4 and 11 belong to either uncertain or new customers. The Customer Value Matrix defines Clusters 2, 6, and 9 as

uncertain customers. However, the RFM model views Clusters 2, 6, and 9 as lost customers due to lower R values. That is, these customers did not come back to this veterinary hospital for quite a long time. Clusters 4 and 11 belong to uncertain customers based on the Customer Value Matrix. However, the RFM model considers these customer as new customers due to larger R values. In practice, these customers (Clusters 4 and 11) have larger R values than the average R value, indicating that they visit this veterinary hospital more recent.

#### IV. MARKETING IMPLICATIONS

Customer behaviors have been analyzed and different markets have been separated in terms of cluster analysis and RFM model. Thus, this veterinary hospital can develop its marketing strategies by considering the four Ps (product, price, promotion, and place).

Loyal or best customers can be the first target market. This veterinary hospital can further examine pet owners' habits via the transactions to understand their needs. For example, the veterinary hospital can provide customized or VIP (very important person) services or products to these customers. In practice, many veterinary hospitals provide not only the medical care services but also other pet-related services and products. Besides, the veterinary hospital can provide the pet owners more comfortable service environment, free parking, and compassionate and personalized care for the dogs such as mobile veterinary care to enhance the customer perceptions of medical service quality. That is, shaping customer perceptions of services or products would be able to strengthen good customer relationships in the management literature [34].

Bundled services with special discounts can also be provided to loyal or best customers in this veterinary hospital. For instance, the provision of the dental service package could include dental radiographs, teeth cleaning, and other medical examinations. Further, this veterinary hospital can enhance promotions via unique approaches such as internet marketing and sending the newest products or services information via owners' mobile phones or applications such as Line, WeChat, WhatsApp, and the like. Moreover, the veterinary hospital can have Sunday appointments or extended weekday hours of operations to loyal or best customers. Obviously, the relationship with loyal or best customers should be diverge rather than converge in the long-term perspective [35].

The second target market is uncertain customers including lost customers and new customers. The majority of the veterinary hospital are lost customers (Clusters 2, 6, and 9) based on the results of RFM model, revealing this veterinary hospital has to do its best to retain those customers. In practice, lost customers are still likely to become the other type of customers in the future once they become interested in the services provided by this veterinary hospital. On the other hand, despite their little visit and consumptions, new customers visit recently and are still likely to become loyal or best customers over a long period of time if frequency and monetary can be increased. Therefore, this veterinary hospital should adopt particular marketing strategies to strengthen

customer relationship with these new customers.

Bundled service packages can be provided for the lost and new pet owners with different price labels in order to motivate those customers to visit often and consume more. That is, using different price labels (discount information) could be a good approach to prevent customer churn [36]. In addition to bundled service packages, the veterinary hospital can actively participate in community events because the enhancement of the corporate image could affect the customers' willingness regarding whether to stay in this veterinary hospital during and after the services. The service providers can significantly influence service quality by creating the corporate image and further influence customers' choices regarding service providers [37]. The image enhancement helps attract new customers and retain lost customers. Further, the veterinary hospital can extend its hospital hours so as to compete with others.

The veterinary hospital should try to increase new customers' willingness to visit and spend. One of the essential approaches is to build good relationships with new customers by providing preferential price discounts and informing preferential activities for bundled service packages such as dental services and geriatric pet care. On the contrary, the veterinary hospital can deploy less marketing resources to lost customers. For instance, the veterinary hospital can adopt convenient and cheap marketing channels such as sending mobile phone text messages or applications regarding the promotional news and providing economy services or products to retain the customers. Moreover, this veterinary hospital must examine the reasons why the customers are lost and uses the feedback information to improve so as to have a higher retention.

#### V. CONCLUSIONS

The pet industry has experienced a rapid growth in the past decades. Pets play an important role in people's lives. Pets, particularly dogs, become friends and even beloved members of the family [2]. Pet owners regard themselves as parents of their pets and are increasingly devoted to their pets. This is a particular trend for the countries with the increasing aging and decreasing birth rate, such as Taiwan [8]. Facing a strong competition and limited marketing resources, veterinary hospitals have to think about how to satisfy the client needs by making particular marketing strategies to particular customers as some are most profitable customers and some are not.

With the dramatic growth of the pet industry, it is essentially important for veterinary hospitals to keep good relationships with their customers. However, little is known about the marketing strategies in the pet industry. This reveals a need for further understanding. This study analyzes the transactions data focusing on dogs in 2014 from a veterinary hospital with 4,472 customers in Taiwan and further develops its marketing strategies based on analysis results. Data mining techniques facilitate to achieve CRM [4], [38]. Recency, frequency, and monetary are the three input variables for cluster analysis to group customers. A two-stage clustering method by combining SOM and K-means method is applied in this study, and the recommended number of clusters based on the customers is twelve.

Marketing strategies for the veterinary hospital are provided based on the results of RFM analysis and the Customer Value Matrix. Therefore, the veterinary hospital can make unique marketing strategies for different types of customers. Based on Ha and Park's [9] suggestions, three different types of customers are identified, including loyal customers, new customers, and lost customers. Another viewpoint is to use the Customer Value Matrix to classify these customers, and two types of customers are found, i.e., best customers and uncertain customers. When customers are classified, this veterinary hospital can provide different marketing strategies to meet different customer needs.

This study develops two types of marketing strategies for the two targeted markets (i.e., loyal customers and uncertain customers) based on the four Ps (i.e., product, price, place and promotion). In doing so, a veterinary hospital can effectively retain valuable or lost customers and attract new customers. It is worth to note that using different variables might result in different viewpoints in evaluating customer values. In this study, Clusters 4 and 11 are viewed as uncertain customers when F and M variables are taken into account, while these two clusters are classified as new customers when Ha and Park's [9] suggestions are taken into consideration. By further examining the characteristics of R, F, and M variables, Clusters 4 and 11 have relatively higher R values, indicating that these customers have visited this veterinary hospital more recent. If more critical input variables are included, more useful information might be generated for this veterinary hospital to understand what its customers are.

More useful and practical marketing strategies can be made for different types of customers. Hence, future research can examine pet owners' demographic characteristics such as education, age, occupation, gender, and/or the real perceptions regarding the veterinary hospital such as the satisfaction for the service so as to provide further different marketing implications. This study only adopts particular customer data and may thus provide a preliminary analysis including marketing implications to this veterinary hospital. In addition, this study may not generalize the results to the Western countries such as the United States of America due to the cultural differences, consuming habits, and the regulations.

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