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Direct marketing using fuzzy clustering of customers (Case study of a mobile phone company)

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Abstract
This study is done to consider and cluster customers of a mobile phone service provider that randomly selected from the community. The data which is collected from the customer consists of three parts. The first section includes indicators that have been selected to perform clustering analysis. The second part is the amount of customers' consumption from a variety of services and the third part include other mobile services. This research in term of purpose is survey descriptive research. After fuzzy clustering and efficiency indicators considering, the calculations showed that two clusters was appropriate. The first cluster includes the majority of women with lower incomes and less job stability and less loyalty to the company and the second cluster includes the men with higher income and job stability and loyalty.
The results indicate that overall the uses of the long-distance telephone service have most income and the wireless networks have the lowest income. Paging extra services and voice mail have the most demand, call waiting and having some lines in the same time and dialogue divert have the lowest demand among the customers. The results in the mobile market and determine the appropriate strategy for each part to develop direct marketing is very useful.

Keywords: Fuzzy clustering, efficiency indicators, mobile services, market segmentation, direct marketing.

1. Introduction
Nowadays, data analysis techniques are being widely used by different organizations for management purposes. These techniques which are named by various issues such as data mining can be developed in different areas of management. One of these areas is market management. The advantages of data mining and it's applications in industry is increasing, because it helps businesses to find hidden information amongst a mass of data and as a result these industries are able to recognize their customers. In this field, data mining has a variety of tools. Cluster analysis is one of the most important ones (Choporian, *et al*. 2001, Timm *et al*., 2004) [7, 32].

The most popular techniques of data mining in marketing are clustering techniques. These techniques are very useful for market segmentation and to improve marketers' performance in comparison to traditional and intuitive methods of segmenting the market, nowadays companies are paying more attention to direct marketing (Tsekouras & Sarimveis, 2004) [33].

Direct Marketing Association (DMA) has defined direct marketing as follows: any direct contact with a customer or business does to get a response in form of an order (direct order), a request for more information or a visit to the store or other places where a particular product or service. Another definition of this concept is provided by the direct marketing magazine: direct marketing is a measurable marketing system that uses one or several media to produce a measurable response or transaction at any location.
So if instead of establishing advertising and sales strategies for the entire clientele of an organization in a market, at first segmentation of customer using clustering techniques were applied and then strategies for each sector according to the specific characteristics of each part were established. There would be many advantages for the organization including: reduction in the cost of marketing and advertising, higher efficiency of the sales department, closer and faster relationship with various customers departments, etc (Gower, 1971, Halkidi *et al*., 2001, Kaufman, 1990, Pakhira *et al*., 2005, Wang & Zang, 2007, Wu & Yang, 2005) [15, 17, 23, 30, 34, 37].
Clustering techniques are very diverse and include various types such as definite clustering, fuzzy clustering (Bezdek, 1973, J. Yao, 2000, Lucieer, 2009) [2, 21, 28] sectional clustering, hierarchical clustering, etc. Since clustering nature or categorizing the market into different sections, in a way that there is maximum similarity within a section and maximum difference between different sections, it cannot be suited for clustering customers into different categories with clearly defined borders, and it would be desirable that the fuzzy clustering technique be used, so that the boundary between different clusters of the market wouldn't be definitive, for the nature of market segmentation is uncertain. So in this study we try to highlight this concept and apply clustering to market segmentation. The results of this study as pilot could be used as a guide to apply clustering analyses to market segmentation (Döring *et al*., 2006, Dunn, 1973, Fisher & Wood, 1998, Höppner *et al*., 1999) [11-13, 20]. Since clustering patterns use the nature of the data for clustering, it can be one of the best tools for market segmentation.

2. Literature review
In this part of the research we discuss theoretical basis and review the literature on fuzzy clustering and market segmentation.

2.1. Fuzzy clustering
Since the fuzzy theory was presented by the Iranian scientist prof. Lotfali Asgarzadeh, this theory is used in various fields

of science. One field is data mining, after revealing definitive clustering algorithms defects, researchers looked for other methods that don't have definitive methods inefficiencies, following these efforts, fuzzy clustering algorithms were introduced and were classified the data into different clusters based on their membership functions (Newman *et al*., 1998, Bezdek, 1973, Dave, 1996,1997, Gath & Geva, 1989) [2, 3, 9, 14].

2.2. Market segmentation

Market Segmentation is the market division process to specific subsets, in which customer behavior and needs are the same and each of these subsets can be used as a target market with identifies strategies. Also, market segmentation, means the process of evaluating the attractiveness of a section of the market and selecting one or more segments of the market (Kotler & Armstrong, 2005, Hollensen, 2015) [19] with the highest potential revenue, as customers (Keegan and Schlegelmilch, 2005). In 1934, Frederick introduced the concept of division (Böck, 1974, Cross *et al*., 2015) [4, 8]. This concept was attention center of academic meeting and whole industries in the past 73 years because of the importance and benefits of that has become clear in different types of marketing, such as consumer marketing, industrial marketing, service marketing, nonprofit marketing, and social marketing. Some studies were divided academic research in this field into four groups (Kotler & Armstrong, 2005, Krishnapuram & Keller, 1993) [25]:

1. Develop principles and models of clustering
2. Research methods of clustering
3. Development and application of statistical analysis tools in clustering
4. Run clustering

These research areas are separated in a way that makes imperfect understanding of the whole process of segmentation. At first glance, it seems that clustering is a simple process but in reality is a complex. In the early 1930s, Robinson defined theory of imperfect competition (Shaw, 1992). Then classical economic concepts about supply and demand balance were in conflict with the theory of Robinson and lines. It was the beginning of segments in the market. Smith in 1956 in an article titled "product differentiation and market segmentation as a strategy of segmentation successor" said differentiation in supply and procurement of goods is related to production orientation, while market segmentation fundamentally originated from a focus on marketing and customer recognition. Market segmentation from 1960 as a vital process has been mentioned to the success of marketing. Much research has been done on the clustering and despite the many articles that have been written in heterogeneous market segmentation, market segmentation approach and its adoption by organizations and companies, many organizations do clustering not to be successful. Some important articles in this area are shown in table 1.

Table 1: Market segmentation studies

Subject	Author
Product differentiation and market segmentation as alternative marketing strategies	Smith, W. R. (1956)
Benefit segmentation: a decision-oriented research tool	Haley, R. I. (1968)
Industrial market segmentation	Wind, Y., & Cardozo, R. N.
Issues and advances in segmentation research	Wind, Y. (1978)
Strategic segmentation: how to carve niches for growth in industrial markets	Garda, R. A. (1981)
Business segmentation bases: Congruence and perceived effectiveness	Kalafatis, S. P., & Tsogas, M. H. (1998)
A review of industrial market segmentation research and a proposal for an integrated segmentation framework	Cheron, E. J., & Kleinschmidt, E. J. (1985)
Loyalty-based segmentation and the customer development process	Knox, S. (1998)
Market segmentation in the Indonesian banking sector: the relationship between demographics and desired customer benefits	Alfansi, L., & Sargeant, A. (2000)
Balancing theory and practice: A reappraisal of business-to-business segmentation	Mitchell, V. W., & Wilson, D. F. (1998)
Marketing management: A relationship approach	Hollensen (2015)
How marketing managers use market segmentation: an exploratory study	Cross, J. C., Belich, T. J., & Rudelius, W. (2015).

3. Research methodology

This research type is descriptive - survey and also in term of aim is theoretical-practical. The population consisted of 760 mobile clients in a private company. Simple random sampling was used and also software used in this research is S-Plus.

4. Results and discussion

It was mentioned before that data population includes 760 costumers of a private cell phone company. These data includes three sections of information. The first section contains indices which were selected to execute the clustering analysis. The second section includes details about how much the costumers use different services provided by the company. Third section includes data about other services offered by the company to each individual customer. This category consists of binary variables which indicate if these services are provided to each individual costumer. These services include simultaneous use of multiple lines, using voicemail, paging, internet and other services.

4.1. First section: Indices

According to the obtained information, the following indices were used as indices in order to execute fuzzy clustering analysis.

Table 2: Indices in fuzzy cluster analysis

Row	Indices	Scale	Unit of measure	Nature of the measure	Name
1	Time	Scale	Month	Customer loyalty	Tenure
2	Age	Scale	Year	Age	Age
3	Income	Scale	Thousands of dollars	Financial status	Income
4	Service time	Scale	Year	Personality & stability	Employ
5	Gender	Nominal	-	Gender	Gender
6	Relatives	Scale	Number	Number of close persons	Reside

4.2. Second and third section: Customer services information

After customer clustering, to identify information of these sections including customers' information and different types of services in order to establish customer-oriented marketing policies, the information of this part is used. The data analyst tries to establish an appropriate statistical relationship between clusters and customers' information, in order to develop appropriate marketing plans. Indices considered for this section are shown in table2.

Table 3: customers' indices

Row	Title	Name	Indicator	Measurement unit
1	Second section: Consumption amount	Longten	Proportion of long distance calls to period	Unit of currency
2		Tollten	Proportion of free calls to period	Unit of currency
3		Wireten	Proportion of wireless services usage to period	Unit of currency
4		Cardten	Proportion of phone cards usage to period	Unit of currency
5	Third section: extra services	MultiLine	Simultaneous multiple lines service	Yes or no
6		Voicemail	Voicemail service	Yes or no
7		Pagingser	Paging service	Yes or no
8		Internet	Internet service	Yes or no
9		Callid	Caller ID service	Yes or no
10		Callwait	Call waiting service	Yes or no
11		Foreward	Call diversion service	Yes or no
12		Confer	Conference call service	Yes or no
13		Ebill	Online payment service	Yes or no

4.3. Clustering results

After fuzzy clustering using S-Plus software and calculating clusters efficiency indicators, two-cluster segmentation was found to be suitable for the examined data. So in this section, according to two-cluster efficiency, all analyses will be done in two-cluster segmentation. As it can be observed in the following table 4, by calculating two of the efficiency indicators for 2, 3 and 4 clusters, it can be concluded that two-cluster segmentation is suitable based on the nature of data with covering the optimal directions (table 4).

Table 4: Appropriate number of clusters

Number of clusters	PC	PE
Optimal direction	Max	Min
C=2	0.271	-0.16
C=3	0.11	-0.154
C=4	0.067	-0.037

According to Silhouette figure and some indicators those are suitable for distinguish number of cluster in software S-plus, two appropriate clusters are considered. Classification index (PC) is a simple index that shows the maximum number of suitable data. Division entropy index (PE) index is shown in the table shows the minimum number of suitable clusters.

By determining two clusters for the clustering in figure 1 of Silhouette, indicators as described and average value is obtained 0.43. Also two indices of 6 have ability to explain 89% changes.

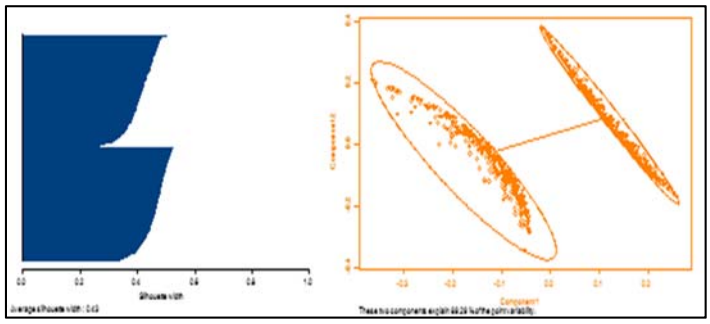

Fig 1: fuzzy clusters and silhouette indicator for two clusters

By determining three clusters for the clustering in figure 2 of Silhouette, indicators as described and average value is obtained 0.33. Also two indices of 6 have ability to explain 89% changes.

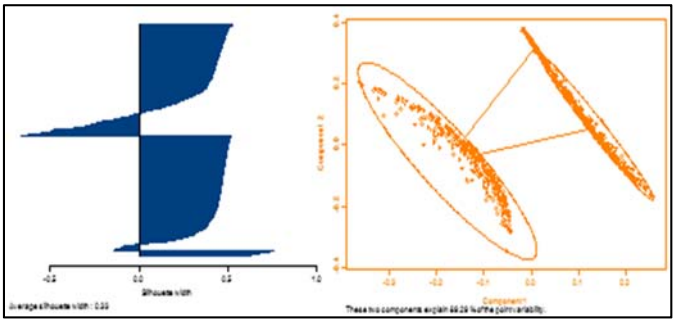

Fig 2: Fuzzy clusters and silhouette indices for three clusters

Between two clusters and three clusters, it can be concluded that two clusters are suitable. Figure 3 is shown the certain clusters based on two variables. It is clear that in three clusters, for example, between fuzzy clustering and certain there is some differences based on two variables there.

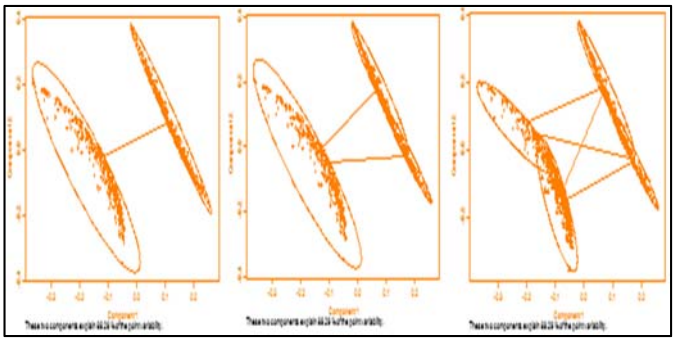

Fig 3: Deterministic cluster for 2, 3 and 4 clusters

In Table *5*, the average values of the indicators for both clusters presented to become clear the differences between clusters by taking two sets.

Table 5: Descriptive information by separate clusters

Row	Data number	Subscription Period (mean)	Age	Income	Duration of service	Gender	Close relatives
Cluster one	*380*	*35.3*	*41.6*	*68.7*	*10.3*	*%95*female	*2.31*
Cluster two	*380*	*35.5*	*41.4*	*81.4*	*11.7*	*%90*male	*2.32*
All data	*760*	*35.4*	*41.5*	*75*	*11.07*	---	*2.3*
Statistical difference	---	meaningless		meaningful	meaningful	---	meaningless
First cluster risk	---	*21*	*11.9*	*75.9*	*8.9*	---	*1.4*
Second cluster risk	---	*21.5*	*13.3*	*115.3*	*11.7*	---	*1.4*

Figure 4 displays comparison of clusters in terms of difference between the indicators. It is clear that the income index and cooperation period are two most important indicators. It is also clear that the majority of the second cluster is men with higher income and job stability than women. However, in view of the risk of two large clusters, the second cluster has higher risk. The accuracy of information in this cluster is lower than the first cluster. In general it can be concluded that the second cluster has the majority of male gender, higher job stability and income and stability.

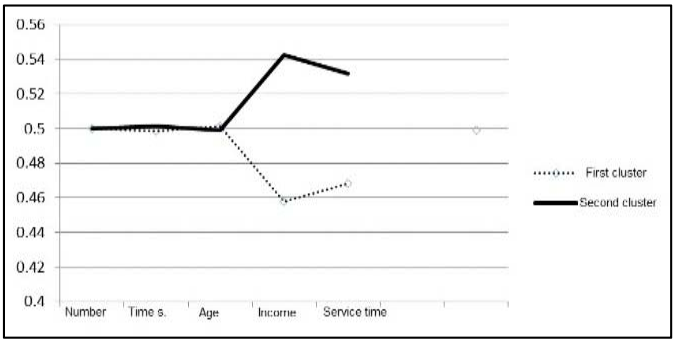

Fig 4: comparison of the two clusters in terms of indices

4.4. Analysis of received services

In this section we consider two clusters have been developed to evaluate received services and the type of services. Two important factors as described in the previous section were Sex and cooperation experiences that can use the information to upgrade more services in the marketing plan for each expanded group of customers. Table 6 describes the application of each cluster with risk beyond.

Table 6: Services consumption

Indicator	Longten		Tollten		Wireten		Cardten	
Clusters	Mean	σ	Mean	σ	Mean	σ	Mean	σ
First cluster	*569.5*	*865*	*566*	*935*	*453.1*	*978*	*606.2*	*828.6*
Second cluster	*583.2*	*750*	*506.2*	*852*	*388.1*	*919*	*576.9*	*843*

It can be seen that the first cluster or in other words, or in other words, women use more free wireless service and phone service and second cluster or men use more long distance phone. However, for closer examination and consideration the coefficient of variation can be used, of course, by calculating the coefficient of variation to-reach similar results.

Also extra services are shown in table 7. This can be judged from the information that each client according to the cluster in which it is placed or additional services from your mobile phone charged during the subscription, it can be used for market anticipating and advertising plan.

As can be seen, based on the statistical analysis, two clusters in term of extra services such as paging services, Internet, call waiting, call transfer, and payment may be varied, but all cases in second cluster are more.

Table 7: Extra service to separate cluster

Title	Multi-line	voicemail	paging	internet	Caller id	Call waiting	Call diversion	Conference call	Electronic payment
Cluster 1	*%51*	*%71*	*%72*	*%64*	*%53*	*%50.20*	*%50*	*%51*	*%61*
Cluster 2	*%52*	*%69*	*%77*	*%61.50*	*%55*	*%55*	*%55.20*	*%51*	*%65*
Assumption equality Certainty (90%)	accept	accept	reject	reject	accept	reject	reject	accept	reject

5. Conclusion

This study is discussed direct marketing and clustering of customers of a mobile phone service. For analysis, two clusters from 6 are chosen for customers. The first cluster includes 95% of women and the second cluster includes 90% men. The first cluster is with less income and less job stability and loyalty, while the second cluster is higher income and job stability and loyalty. The two groups also differ in their use. In general it can be noted the first cluster use free call, wireless networks and card phone while second cluster use more long distance telephone service. In the case of extra services, it can be noted that the paging, voice mail service, internet and e-payment are used more. About clusters, it can be noted that the request paging, internet, call divert and call waiting and electronic payments between two clusters were different, while the three services (ie, voice mail, conference calls and at the same time a few lines) between two clusters were same. Based on the information, it can be promoted marketing strategies.

General advertising and sales contributions on long-distance telephone service can be suggested for better activities in these kinds of companies. Also doing more focus on the service side paging, voice mail, internet and electronic payment in order of importance, can be effective.

For advertising products to women, focus on the use of telephone cards services and long distance and then consider the free call can be useful. As for extra services, focus on voice mail and Internet is acceptable.

Also for men with higher income and job stability, focus on long-distance telephone and special discounts and also the least amount of investment on the use of wireless networks and use our calling cards are effective in this case. In extra services voice mail, paging, call waiting, call transfer and electronic payment is more useful to attract men customer. Based on this definition can be closed with appropriate products for each cluster is encouraging them to increase use of services. Special discount for specific market clusters can play an important role in increasing customer satisfaction and cover their expectations. Totally with regard to two clusters, all amounts are close and this make difficulty in advertising plan but with paying attention to existing risk in each cluster improving strategy can be happened with research results.

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