CUSTOMER SATISFACTION MEASUREMENT – CLUSTERING APPROACH

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Abstract

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The paper deals with the issue of customer satisfaction measurement. The aim of this study is to determine the importance of the individual factors and their impact on total customer satisfaction for multiple segments by using linear regression and hierarchical clustering. This study is focused on the market of café establishment.
We applied hierarchical clustering with Ward's criterion to partition customers into segments and then we developed linear regression models for each segment. Linear models for partitioned data showed higher coefficient of determination than the model for the whole market. The results revealed that there are quite significant differences in rankings of customer satisfaction factors among the segments. This is caused by the different preferences of customers. The clustered data allows to achieve a higher homogeneity of data within the segment, which is crucial both for marketing theory and practice. The approach i.e. partitioning the market into smaller more specific segments could become perspective for marketing use in different economic sectors. This attitude can allow marketers to target better on customer segments according to the importance of individual factors.

Keywords: customer satisfaction, linear regression, hierarchical clustering, importance of factors

INTRODUCTION

The paper deals with the issue of customer satisfaction measurement. The aim of this study is to determine the importance of the individual factors and their impact on total customer satisfaction for multiple segments by using linear regression and hierarchical clustering. In terms of the introduction to this issue, the theoretical background is provided.

Satisfaction has its roots in Latin. The word is derived from the two Latin expressions satis and facere. The word satis means "enough" in Latin. The word facere indicated doing.

Satisfaction appears most commonly in the context of the customer stakeholder where the satisfaction with services is being evaluated (Kotler and Armstrong, 2015). The results of Cronin and Taylor's (1992) research prove that the quality of a service is closely bound with customer satisfaction. The notion of customer satisfaction in connection to marketing appeared in scientific studies in the 1960's (Levitt, 1960; Keith, 1960). In the 1970's, 1980's and 1990's, more and more studies dealt with this subject. In the early 1990's, Peterson and Wilson (1992) estimated that the number of articles dealing with this subject exceeded 15,000. At the beginning of the third millennium, Parker and Mathews' article (2001) may be considered revolutionary. These authors draw attention to the fact that the expression of satisfaction may have a different meaning depending on the purpose of use. In the marketing field, Parker and Mathews refer to two approaches to the definition of customer satisfaction. The first notion leads to the definition where satisfaction is understood as a result of consumption. In the second notion, satisfaction is understood as a process.

Satisfaction as a result is interpreted based on performance of an analysis of the effects of certain activities or experiences on the feelings of an individual (Chalupský, 2001). It may involve:

Emotion – satisfaction is understood as an emotional reaction to a certain experience with the use of a product.

Fulfilment – motivation theory states that people are guided either by a desire for satisfaction of their needs (e.g. Maslow) or by an effort to achieve their preferred or set objectives.

It is important that in both cases satisfaction is understood as the final point of the motivation process.

Satisfaction as a process is based on the theory of conflict (Porter, 1961). This concept can be characterized briefly with the following steps:

The quality of services precedes customer satisfaction.

The customer has formed a certain expectation about the attributes of a product or service.

After the purchase, this expectation is compared with the attributes of the obtained product or service, and this leads to a situation when the customer either feels harmony or feels that there is a conflict between expectations and acquired experience.

In the case of conflict, two situations can be identified: positive and negative conflict.

If positive conflict is involved, the customer's expectations are overcome, and the customer feels satisfaction. For negative conflict, the attributes of the product or service do not reach the customer's expectations.

Definition of Quality of Services

Quality of services is closely related to satisfaction The issue of quality of services of universities very much remains currently relevant, which is evidenced by the large number of professional publications focused on research of this area in various parts of the world. Kotler *et al.* (2007) define

quality as: "the sum of elements and characteristics of a product or service, which make it possible to satisfy expressed or implied needs." These authors state that customer satisfaction and profitability are closely tied to the quality of products and services. A higher level of quality leads to greater customer satisfaction. The expert authors have created multiple definitions of quality of services. The following table contains a narrower selection from these definitions.

Measuring of Quality of Services

Troy (2008) points out that the concepts for measuring of quality of services belong to quality management systems. He adds that these concepts have the potential to be used in an inter-disciplinary manner.

Kotler *et al.* (2007) emphasise that quality management as a whole is essential. Tools for Total Quality Management (TQM) serve for this purpose. These authors define Total Quality Management (TQM) as: "programs created for constant improvement of the quality of products, services and marketing processes."

These authors also emphasis that TQM plays an important role, because it teaches companies that quality is more than just a production approach. Quality is related to the aim of marketing from the very beginning, which is customer satisfaction. TQM expands the view of marketing in connection with the fact that it is necessary to realise the crucial relationship between employee satisfaction and customer satisfaction. Acquisition, retention and satisfaction of quality personnel are a necessary condition for acquisition, retention and satisfaction of clients.

Kotler *et al.* (2007) add: "TQM is crucial for creating value and satisfaction for the customer. It is everyone's goal, just like marketing."

For measuring of the quality of services itself, several concepts have been created by professional authors. The table below presents some of the most

I: *Definition of quality of services*

Author	Definition
Grönroos (1984)	The result of the evaluation process, when a consumer compares the level of expectation with the perceived level of services actually received
Parasuraman, Zeithaml and Berry (1988)	Comparison between the customer's expectations combined with a service and perceived as an experience tied to purchasing of a service
Bitner, Booms, and Tetreault (1990)	The customer's overall impressed linked to the relative subordination or superiority of an organisation and its services
Asubonteng, MCCleary and Swan(1996)	The difference between a customer's expectations related initially with the level of service performance (rather than with encounters and interactions involving service encounters) and experiences related to purchasing of a service
Zeithaml, Bitner and Gremler (2005)	This is a targeted evaluation, which reflects the customer's perception in terms of the following dimensions: reliability, responsibility, certainty, empathy and substance

Source: Author's own work

well known concepts for measuring the quality of services.

Methodological Background

For the purposes of the paper the marketing methodological background is given.

To produce accurate measurement of customer satisfaction it is necessary to identify which factors are important for them (Hill *et al.*, 2007).

Is not as simple as it may occur to understand what is really important for customers. In fact marketers have discussed this issue more than almost other issue of customer satisfaction measuring (CSM). The core of this debate is the relative merits of stated or direct measures of importance versus derived so called indirect methods (Griffin and Hauser, 1993; Gustafsson and Johnson, 2004).

Stated Importance

The easiest way to understand which factors are important for customers is to ask them. It is very straightforward approach but has been criticised because of two reasons. The first point is that customers tend to give high importance scores to almost all factors – average scores about 7 or 8 points out of 10. Secondly the stated importance is criticised as the customers are used to emphasising the importance of certain (selected) factors. For these reasons it is recommended to use derived (indirect methods) that are able to measure the impact of each factor (Hill *et al.*, 2007).

Measuring Impact

This methods are based on the correlation between the individual factors and the judgement of overall customer satisfaction. The overall satisfaction question has to be scored on the same scale as the other satisfaction questions focusing on individual factors – preferably a 10-point numerical scale (Hill *et al.*, 2007).

The use of statistical methods to derive important factors for customers is widely supported in CSM literature (Schneider and White, 2004). However, there is not general agreement which statistical method is the most appropriate one. The most often used methods are factor analysis (Pearsons's correlation coefficient), linear and multiple regression (Hill *et al.*, 2007).

Within this study the linear regression in combination with hierarchical clustering is used to derive the importance of individual factors for customers.

II: *Concepts for measuring the quality of products and services*

Model	Author	Description
Technical-functional model	Grönroos (1984)	This model focuses on three dimensions of quality: technical quality, functional quality and quality of the image.
SERVQUAL	Parasurman, Zeithaml and Berry (1988)	This method is a multidimensional research instrument which is proposed to measure service quality by capturing respondents' expectations and perceptions within the five dimensions. This method use the questionnaire technique. The questionnaire contains the following five dimensions – tangibility, reliability, responsiveness, assurance and empathy. Each dimension includes relevant questions. There are 44 questions in total which are organised into matched pairs of items – 22 expectation items and 22 perceptions items.
SERVPERF method	Cronin and Taylor (1992)	These authors have created their own SERVPERF method, which is based on measuring of performance.
Sequential Incident Technique (SIT) method	Strauss and Weinlich (1997)	This method is based on phase-oriented research of customer perception. The customer evaluates his positive, negative or neutral relationship to the particular service. The SIT method is based on the Critical Incident Method (CIT).
PCP model of attributes	Philip and Hazlett (1997)	They have proposed a model with a hierarchic structure based on three basic attributes. These involve crucial, main and secondary characteristics.
Internal model of quality of services	Frost and Kumar (2000)	They have developed a model of quality of services based on the concept of gaps in the SERVQUAL method. In this case, the evaluators are employees.
HEdPERF method	Firdaus (2006)	This involves modification of the SEFVPERF method. The HEdPERF method accents the area of university education.
Concept of forward and backward gaps	Seth, Deshmukh and Vrat (2006)	They have proposed a theoretical framework for the method for measuring the quality of services in supply chains.
SERVQUAL method	Hu, Lee and Yen (2009)	They have modified the SERVQUAL method for measuring patients' satisfaction with the quality of services in the hospital
BSQ Index	Abdullah, Suhaimi, Saban and Hamali (2011)	They have compiled an index for measuring the quality of services in the banking sector. In their research, they have identified 29 factors relevant for this area.

Source: Author's own work

MATERIALS AND METHODS

In the first step the focus group technique was used to identify all relevant factors that influence the customer satisfaction. In total three repetitions of focus groups were conducted. The number of respondents in each focus group ranged from 5–7. The list of factors identified within this procedure is shown in the Tab. III.

In the second step the questionnaire technique was carried out. For the purposes of questioning the technique of quota sample selection was used so that the sample of respondents could reflect the reality of entire population. The sample was described by the demographic characteristics – age and gender. Fig. 1 shows the age distribution of respondents

The sample was gender balanced when 54% were men and 46% women. The research was done on the territory of the Czech Republic. A dataset from 182 cafe customers was collected, where the respondents were asked to rate their satisfaction with individual factors related to the cafe as well as their overall satisfaction with the cafe. They rated their satisfaction on a scale from 1 to 10, where

1 was completely unsatisfied and 10 was completely satisfied. Individual factors were of different types. On the one hand there were more objective factors like location or coffee quality, on the other hand there were rather subjective, service related factors like daily press or friendly staff. The list of all asked factors goes as follows:

The aim is to determine the importance of the individual factors (model's independent input variables), which discovers their impact on total satisfaction (model's dependent output variable). The most straightforward way is to assume, that the total satisfaction is a linear function of n individual factors. In this sense we can employ n-dimensional linear regression to find the coefficients of such function. These coefficients are then going to be factor weights representing relative strength (importance) of individual factors.

We can also assume that there is not a single linear model of customers' preferences for whole market. This means, that customers of the café may fall into more than one segment and each segment has its individual satisfaction function (which is still assumed to be linear). In that case it is necessary to partition the customers into segments, which can
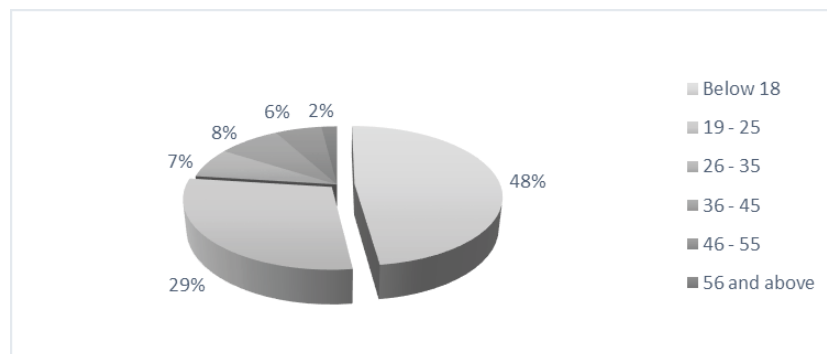
1: *The age distribution of respondents*
Source: Author's own work

III: *The List of factors*

Number	Factor
1	Coffee Quality
2	Desserts
3	Wide Range of Products
4	Special Offers
5	Price/Quality Ratio
6	Location
7	Atmosphere
8	Cleanness
9	Friendly Staff
10	Fast Order Execution
11	Internet Connection
12	Daily Press
13	Annual Events

Source: Author's own work

IV: *The results of linear regression clustering and none-clustered regression models*

Data type	Linear regression	Number of samples	R^2	Error variance
Clustered data	LRC_1	76	0.292208	1.104948
	LRC_2	45	0.454374	0.302734
	LRC_3	51	0.602609	1.247558
Non-clustered data	LRNC	172	0.496273	1.102857

Source: Author's own work

be done by clustering. Since no prior knowledge of number of segments is known, some kind of hierarchical clustering is suitable for this task. An alternative way is to gradually increase the number of clusters in any non-hierarchical clustering method and stop when the stopping criterion is met. Such natural criterion is the case, when rank of a matrix containing data from one cluster becomes smaller than *n*. In such case this cluster is unusable for n-dimensional linear regression and therefore further partitioning must stop.

To measure how well the model fit the data we use R² statistics and the error variance to compare original full dataset to individual clusters in terms of model fit to the data. Totally we then have two models Linear Regression Clustering (LRC) and Linear Regression None-clustered (LRNC).

Before the clustering is started, constant data samples are removed from original data set and total of 172 samples is obtained. We denote a linear regression model of the whole non-clustered dataset as LRNC and determine its R² and the error variance.

Then we use hierarchical cluster analysis of the dataset in order to concentrate the similarity among customer responses to find more homogenous data clusters. To stop further partitioning of the dataset Ward's criterion in hierarchical clustering and a condition of necessary matrix rank is used. The advantage of Ward's criterion is that it produces a cluster tree that is compact and monotonic. This is the result of its incremental design in the definition of distance and it means (in contrast to a non-monotonic tree) that

the sections of the dendrogram do not change direction (Alikhanian *et al.*, 2013). Ward's criterion was proposed to calculate the distance between two clusters within the agglomerative hierarchy clustering method. The K-means sum of squared error criterion is used to determine the distance. The sum of the squared error criterion for any two clusters C_a and C_b is computed by measuring the increase in the value of Ward's criterion for the clustering obtained by merging them into $C_a \cup C_b$ (Ward, 1963). There are certain implementations of Ward's criterion which differ in terms of the distance metric δ.

The distance metric used in this paper is defined as the squared Euclidean distance between the two centroids of the merged clusters C_a and C_b weighted by a proportional factor to the product of cardinalities of the merged clusters (Aggarwal and Reddy, 2013) and is defined as follows:

$$\delta\left(C_a, C_b\right) = \frac{N_a N_b}{N_a + N_b} \sum_{v=1}^{M} \left(c_{av} - c_{bv}\right)^2 =$$

$$= \frac{N_a N_b}{N_a + N_b} d\left(c_a, c_b\right), \tag{1}$$

where:
N_a and N_b are the cardinalities of the clusters C_a and C_b,
C_a and C_b are elements of C_a and C_b respectively,
v iterates up to the total number of elements in the cluster union , and
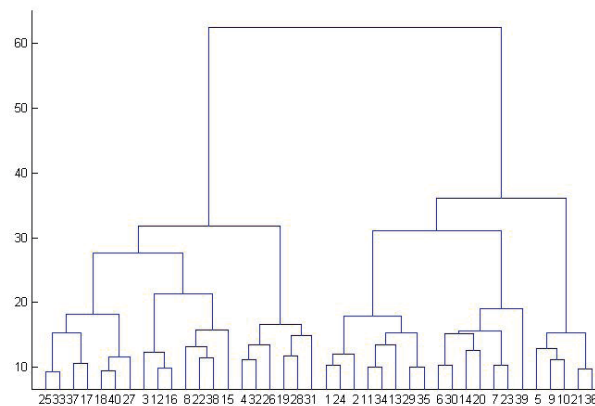
2: *Initial hierarchical clustering*
Source: Author's own work

d is the squared Euclidean distance between the two centroids.

In this manner 3 clusters were obtained with, $n_1 = 76$, $n_2 = 45$ and $n_3 = 51$ data samples respectively.

If we partition data further, there would emerge a fourth cluster with 8 samples. But since this fourth cluster would had less samples than the number of model inputs, it would not provide enough information for linear regression to estimate all 13 coefficients. Therefore we must stop the partitioning process at 3 clusters.

For all clusters a linear regression model denoted as LRC_j is made, where *j* denotes the cluster number.

RESULTS AND DISCUSSION

When the results are compared, we can observe, how the models perform against each other in the Tab. IV. LRNC model has R^2 equal to 0.496, which means that the model is suitable for nearly 50% of the data samples. For clustered data represented by LRC models we can see, that their R^2 varies. For LRC_1 is its value very low, only less than 30% of the data samples are explained by the model. LRC_2 performs similarly to LRNC in terms of R^2, but better in terms of error variance (LRC_2 has much lower, i.e. more consistent variance of an error). LRC_3 has the best R^2 value, it explains a little more than 60% of data samples.

From these partial results we can conclude, that creation of multiple segments for linear regression model is beneficial only for some segments, namely segment 3 has more consistent model LRC_3, than the overall model LRNC for full dataset has. Unfortunately other segments don't exhibit better results in terms of model fit. Minor

improvement can be seen in second cluster as the error variance lowers, but this is not the key metric, which we use for model fit comparison.

At this point we can dig down into the worst first cluster and find out, why it performs so poorly. Total of 76 data samples can be in fact a heterogeneous group, which can contain two similarly sized clusters. One overall model for this cluster performs poorly, as was discovered. A second wave of partitioning, this time only of this cluster, can discover cluster, which are more homogenous, than the original one. A condition of necessary matrix rank must be satisfied this time as well.

Applying Ward's criterion on hierarchical clustering of 76 data samples we obtain two clusters of 45 and 51 samples respectively, for which a linear regression models are made.

Overall results of model fit statistics can be found in Tab. V. The first model LRC_1 has been replaced by two models $LRC_{1.1}$ and $LRC_{1.2}$. Their value of R_2 is much higher, than the original R_2 of LRC_1 model, hence they are much better fit for given data, than the original model.

Further partitioning of the original first cluster to more than two sub-clusters is not possible due to the fact, that third cluster would have had only 6 samples, which is insufficient for the linear regression. Similarly, if we wanted to apply the described process of further partitioning to original clusters 2 or 3 and divide them into more sub-clusters, we faced the same problem as before. The original cluster no. 2 breaks down to two clusters, while one of them has only 11 samples, the original cluster no. 3 breaks down and smaller of the clusters has only 9 samples.

Since these are all possible options, how to divide the data by the described method, it is possible to conclude, that obtained four linear regression models based on the four clusters span the final state of precision improvement, that can be achieved by data partitioning. However, the partitioning process was successful. Given data were approximated by LRNC, who explained 49.6% of them. When repeatedly partitioned, four clusters from the data were obtained and four LRC models were developed. These models explain 56.3% of the data, which is computed as a weighted average by the eq. 2. R_T^2 is overall statistic, *m* is number of clusters, R_i^2 is statistic of *i*-th cluster model, n_i is number of samples in *i*-th cluster and *n* is total number of samples: $n = \sum_{i=1}^{m} n_i$.

$$R_T^2 = \frac{1}{n} \sum_{i=1}^{m} n_i R_i^2 \qquad (2)$$

Using partitioning process was achieved higher precision of the linear regression model and thus more precise linear coefficient were obtained. The coefficients can be sorted decreasingly, which is logically equivalent to the determination of parameter importance, i.e. the higher in the VI

V: *The final results*

Data type	Linear regression	Number of samples	R^2	Error variance
Clustered data	$LRC_{1.1}$	45	06028	0.5279
	$LRC_{1.2}$	31	0.5985	1.3121
	LRC_2	45	0.4544	0.3027
	LRC_3	51	0.6026	1.2476
Non-clustered data	LRNC	172	0.4963	1.1029

Source: Author's own work

VI: *Parameter importance for each regression model*

Order	LRNC	LRC$_1$	LRC$_{1.2}$	LRC$_2$	LRC$_3$
Coffee quality	7	10	9	7	7
Desserts	10	5	7	10	10
Wide Range of Products	5	2	5	11	5
Special Offers	9	7	11	3	8
Price/Quality Ratio	2	6	1	4	9
Location	3	8	12	6	3
Atmosphere	1	3	2	1	13
Cleanness	13	13	4	8	2
Friendly Staff	12	12	3	13	11
Fast Order Execution	4	4	6	12	12
Internet Connection	6	1	13	5	1
Daily Press	11	11	10	2	6
Annual Events	8	9	8	9	4

Source: Author's own work

the parameter is, the higher is its importance for the overall satisfaction.

Tab. VI sums up the results. It is possible to observe how the clusters differ in parameter importance. From LRNC model, the most important parameters are 7 (Atmosphere), 10 (Fast Order Execution) and 5 (Price/Quality Ratio). Compared to the LRC model, these three are also the most important parameters for LRC$_3$ model. Minor differences in these three most important factors can be seen in remaining models LRC$_{1.1}$, LRC$_{1.2}$ and LRC$_2$, where only two of them are present from the LRNC most important triplet. An interesting feature reveals when we examine the missing important factor from each clustered model. LRC$_{1.1}$ ranks parameter no. 2 (Desserts) quite high (3rd position) and in LRNC it sits also in quite high, 5th position. No big surprise here. Similar situation is in LRC$_{1.2}$ model (no. 9 – Friendly Staff is ranked as the most important parameter and in LRNC model it sits on 4th place), but LRC$_2$ model ranks parameter no. 11 (Internet Connection) very high (4th position), whilst in LRNC it is almost the least important parameter (12th position). When examined this parameter further, we can see, that also in LRC$_{1.2}$ it sits quite high (4th place). On the other hand, for LRC$_3$ it is unimportant (9th place) and very unimportant for LRC$_{1.1}$ (12th place). Examining the results further, we discover, that this situation is common for other parameters too. For instance, parameter 5 (Price/Quality Ratio) is very important in LRNC model as well as LRC$_{1.1}$, LRC$_{1.2}$ and LRC$_3$, but completely unimportant for LRC$_2$ (11th place). Similar situation for parameter no. 9 (Friendly Staff), where the differences are even more striking: the least important for LRC$_{1.1}$ and LRC$_2$, but the most important for LRC$_{1.2}$.

The outcomes of the factor importance analysis shows that Cleanness is the most significant factor contributing to the overall satisfaction in the model LRNC and LRC$_{1.1}$. Internet connection is the most important for the overall satisfaction in LRC$_{1.2}$, the factor Friendly staff in LRC$_2$ and the factor Atmosphere in LRC$_3$ model.

Generally, the factor Friendly Staff most significantly contributes to the overall customers' satisfaction. However it is more efficient to monitor and manage the customers' satisfaction for each segment individually on the basis of the results of this study.

CONCLUSION

The paper deals with the issue of the customer satisfaction measurement. The aim of this study is to find important satisfaction factors, with high impact on overall customers' satisfaction within examined the café establishment. An attempt to construct a single linear regression model for whole market (all respondents) hasn't proved to have sufficient explanatory power. Hence, we applied hierarchical clustering with Ward's criterion to partition customers into segments and then we developed linear regression models for each segment. Linear models for partitioned data showed higher coefficient of determination than the model for the whole market.

Coefficient of determination R^2 of the non-clustered data model LRNC equals to 0,496, which means that the model is suitable for nearly 50 % of the data samples. When repeatedly partitioned, resulting models have higher R^2: 56.3 % of the data, which was computed as a weighted average of individual models' R^2. We consider this increase in R^2 significant enough to justify such measure.

Using this method we are able to find only limited number of different customer segments. This limit is given by the number of available data samples. More data samples would allow us to continue in

hierarchical clustering process further and the condition of necessary cluster size would be hit later, with more clusters identified. Of course, there is practical limit, how many segments can be considered when the marketing strategy is formulated. Nevertheless, the marketing specialist can always step in and merge two or more similar segments into one in order to reduce their number. Of course, if such a measure is to be done must be assessed case by case. For the case of café, the identified four segments are still manageable.

The conducted analysis showed that the most important factors vary according to segments. Respondents of two of four clusters marked Atmosphere as the most important factor, which also resulted from whole market solution model. Respondents in next two clusters marked Fast Order Execution and Friendly Staff respectively as the most important satisfaction factors.

It is possible to conclude, that the differences in rankings are due to the differences in customers' preferences. These preferences vary among the groups of customers, which defines these groups and allows marketing segmentation. This indistinguishability which is inherent to the LRNC model is caused by mixing together groups of customers with different tastes. In such case only common important parameters can be found, but the parameters important to specific customer groups are completely indistinguishable and appear unimportant.

The originality of the study lies in the determination of the importance of customer satisfaction factors in the café establishment. It is not possible to generalize the result for other economic sectors as the study was conducted within one company with the limited amount of data. However in future research this approach i.e. partition the market into smaller more specific segments could become perspective for marketing use in different economic sectors. This attitude can allow marketers to target better on customer segments according to the importance of individual factors.

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