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ASSESSING CUSTOMER SATISFACTION BASED ON QoS PARAMETERS

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Abstract: *Measurement of customer sastisfaction is an efficient tool to detect problems in SP (Services Provider) and their relationship with customers. Based on this measurement a relationship between customer satisfaction and loyalty can be established. It can determine the influence of key parameters on the number of users of services. The parameters of customer satisfaction and loyalty are numerous and depend on the network (network quality of services parameters), the client (the perception, expectations, beliefs, etc.), employees (implementation of activities), technological developments, organizational structure, etc. This paper aims to show the way to identify key indicators and their weighted factors that affect customer satisfaction. This paper intends to emphasize relationship between quality of services, customer perception and loyalty and to present a model for examining the key parameters that significantly influence customer satisfaction and how these parameters influence customer loyalty.*

Keywords: *Quality, Loyalty, Satisfaction, Quality of Service, Quality of Experience*

1. Introduction

Measuring customer satisfaction is *very important* for successful management and improvement of businesses. In highly competitive industrial sectors, such as telecommunication, customer satisfaction and their loyalty have been identified as critical success factors (Oghojafor e*t al*., 2014). The users of telecommunication services are more demanding in term of QoS (*Quality of Services*) and this is key indicator of customer satisfaction. In many cases satisfaction and loyalty are not simply based on quality. Besides network QoS parameters there are some other parameters such as the parameters relating to the procedures of service and support, e.g. parameters that determine the quality of CRM (*Customer Relationship Management*). QoE (*Quality of Experience*) is a term that refers to the perception of customers regarding the QoS. This means that there are a number of parameters and activities related to the provision of services that affect customer perception and satisfaction, such as price, support, reliability, repairs procedures, etc. Measurement of all parameters of customer perception is practically unmanageable process and it is impossible to identify all relevant parameters. Because of that it is very important to determine the key parameters in ensuring customer satisfaction and their loyalty.

In addition to determine the key parameters we must use an appropriate model. This paper emphasizes the problems in the

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processes of examining customer perception and indicates key parameters of customer satisfaction and loyalty. There is a correlation between customer satisfaction, loyalty and profitability and this paper intends to emphasize this relationship. Paper proposes a possible approach (model) for testing and evaluating customer perception and satisfaction and its influence on loyalty. The significance of the model presented in this paper is that it will enable SP (*Service Provider*) and other stakeholders to indicate key parameters of customer satisfaction and loyalty. The proposed model enables practical implementation of certain recommendations and statistical tools which open the possibility for specific proposals for improving customer satisfaction and loyalty. For the assessment of customer satisfaction we used an approach where the starting point is customer expectations.

The paper is organized as follows: the second chapter explains the concepts of customer satisfaction and loyalty and sets out key parameters of customer perception. The third chapter presents the concept of quality as one of the key parameters of customer satisfaction. The fourth chapter presents some of the methods and methodologies for measuring customer perception. It also provides an overview of specific guidelines for measuring customer satisfaction according to ISO standard. The fifth chapter proposes a practical model for examining customer satisfaction and presents a method of defining key parameters, selecting the appropriate data sources, ways of grouping parameters and statistics. Concluding observations give guidelines for future research.

2. Literature review

In order to attain customer satisfaction it is necessary to meet their expectations. According to earlier study (Čolaković et al., 2013) the starting point in the process of defining and ensuring QoS parameters should be the users. Earlier studies have suggested a numerous indicators of customer satisfaction. Rousseau et al. (1998) and Anderson et al. (1994) marked quality as key indicator of customer satisfaction. Stranjancevic and Bulatovic (2015) concluded that quality of service has a direct impact on customer satisfaction and positively influences perceived value while it has an indirect impact on customer loyalty. Also, there are some other indicators of customer satisfaction such as price, support, etc. Cheng et al. (2008) indicated that price plays a major role in customer satisfaction and Olatokun and Nwonne (2012) emphasize the price and company image as a particularly important as well.

Studies have shown that there is a correlation between customer's satisfaction, loyalty and profitability (Hallowell, 1996). Findings of earlier research (Jahanshahi et al., 2011) show that there is a positive relationship between customer service and quality with customer satisfaction and loyalty. Nourikhah and Akbar (2016) have studied relation between customer satisfaction and QoS while modeling and estimating distribution of QoE using Bayesian data analysis. It is important to note that authors have different points of view what loyalty means. Uncles, et al. (2003) advocate the absence of a single definition of loyalty and distinguish three approaches for defining the notion of loyalty. Leverin and Liljander (2006) defined customer loyalty as a commitment to repurchase or re-use service or particular product from the same SP, despite different influences that could potentially lead to changes in customers behavior. In this paper we will give our definition of satisfaction and loyalty. Previous studies have shown that satisfied customer become loyal over time and thus enables better sales results (H. Kuč and A. Kuč 2013). This means that we need an appropriate model for measuring customer satisfaction and its influence on loyalty.

In previous studies it has been proposed different models and methods to measure customer satisfaction, which especially point

out the importance of QoS to customer satisfaction. Methods used for the evaluation of customer satisfaction can be divided into different groups, for example: partial methods, desktop survey methods, research and survey methods, internet methods, other methods (Naumann and Giel, 1995). Aigbavboa and Thwala (2013) have presented some theoretical framework of users' satisfaction theories and models. Parasuraman et al. (1985) have proposed a model for measuring the gaps of the expected and the perceived service quality. To obtain the human user's view of the quality MOS (*Mean Opinion Score*) is often used. Some authors propose examination based on objective models e.g. models based on network QoS parameters (jitter, delays, packet loss, throughput, etc) while MOS is a subjective measurement method. For example, Nuhbegović et al. (2014) have described QoS/QoE correlation model of predicting interactions between measurable QoS parameters of network (objective parameters) and QoE (subjective parameters). Suki (2011) used structural equation modelling (SEM) supported by AMOS 5.0 with maximum likelihood estimation in order to provide an explanation of factors influencing customer satisfaction and trust in vendors involved in mobile commerce (m-commerce). Lewis and Mazvancheryl (2011) have proposed a model for measuring the efficiency of the customer satisfaction process while applied the Network DEA (Network Data Envelopment Analysis) methodology to the American Customer Satisfaction Index framework. Gupta (2013) have done an empirical study to customer satisfaction level for E-tailing using ASCI's (American Customer's Satisfaction Index) model. Kabare and Kibera (2014) have done a study to assess the key strengths and weaknesses of the current satisfaction index models over the last four decades.

This paper presents a model for investigating the key parameters that significantly influence customer satisfaction and how these parameters influence customer loyalty. Presented model enable research based on different methods and parameters while presupposes that the customers should be the starting point of research. We used some Recommendations and Standards to present framework of user satisfaction assessment based on QoS and some other parameters.

3. Customer satisfaction and loyalty

Customer satisfaction (Table 1) has the key role on retaining existing and attracting new customers. It is essential that customer expectations are met and even better that they are exceeded. According to ISO 9001:2000 measurement of user satisfaction enables:

- Identification of user requirements and the relative importance,
- Understand whether the company meets user requirements,
- Identify areas of improvements to increase users satisfaction,
- Improving services and monitoring users relationship,
- Increase profits through increasing customer loyalty.

Satisfaction (S) can be represented as a function of experienced and tested services performance (P) and user expectations (E) and it can be determined by following relation:

$$S = \frac{P(P_1,P_2,\dots,P_n)}{E(P_1,P_2,\dots,P_n)} \quad (1)$$

S is parameter of customer satisfaction, $P(P_1, P_2, \dots, P_n)$ is parameter of customer perception and $E(P_1, P_2, \dots, P_n)$ is customers expectation for parameters $P_1, P_2, \dots, P_n$.

Table 1. Customer satisfaction levels

EXPERIENCE	USER PERCEPTION	SATISFACTION LEVEL	RESULTS
The actual value of the service	Better than expected	Keenness	User will recommend to others and repeat the purchase if able (loyalty)
	Expected	Satisfaction	User will recommend to others but user might move to competition for further benefit
	Worse than expected	Discontentment	User will move to competition if he has any possibility

Customers usually assess their satisfaction based on service quality and price. Their expectations are varied and often different before use, during use and after use of certain services. To estimate customer expectations it is essential to detect differences of their expectations and perceptions. We can observe two aspects: the initial purchase (subscription service) based on the expected value, and the repeated purchase that was made on experience (perceived value). During the initial purchase, the user has no real experience with the service and its cognitive value is mainly a result of what they hear, see or feel. In order to retain existing customers and gain new, it is necessary that users get higher expected value of the service than for the same services provided by other SPs. This means that SP must constantly maintain the attractiveness of its services.

Customer loyalty is based on previous experience, which plays a major role in the cognitive value when returning the services of previously used SP. Customer loyalty is a customer commitment to one SP and it is manifested in the continuous use of service provided by the SP. Retaining existing customers is usually more profitable because of lower costs than attracting new users. The customer must feel satisfied while using the service and the satisfaction must be based on fulfillment of their expectations. This means that customer satisfaction determines customer loyalty but we consider that customer satisfaction is not sufficient for their loyalty.

4. Quality of Service and customer satisfaction

It is not possible to accurately determine the level of customer satisfaction, but it is possible to continuously monitor certain factors to assess the impact of certain factors on satisfaction and uncover opportunities for improvement. QoS is one of the most important factors for customer satisfaction. One of the problems in determining correlation between quality of services and customer satisfaction is subjective perception of quality while each customer or SP addresses various aspects and definitions of quality. We consider that quality should be defined by customer and not by SP. According to that we can use ISO 9000's quality management system standards where quality is defined as degree to which a set of inherent characteristics fulfils customers requirement.

4.1. QoS (Quality of Service)

QoS has various means and interpretations. One of the most commonly used definition of QoS is according to ITU Recommendation E.800 (2008) where QoS is defined as the totality of characteristics of an entity that bear on its ability to satisfy stated and implied needs. This definition is used in other releases of this recommendation and some other

recommendations such as: 3GPP (3rd Generation Partnership Project) specification 3GPP TS 22.105 (2015), ETSI (*European Telecommunications Standards Institute*) recommendation ETSI ETR 003 (1994), MMCF (*Multimedia Communications Forum Inc*.) document under the symbol MMCF/95-010 (1995), etc. The disadvantage of this definition is the use of the term degree of customer satisfaction, which leads to the conclusion that there is no clearly defined objective parameters and a set of parameters that define the quality of service.

The ITU-T Recommendation G.1000 (2001) emphasizes the distinction network performance and service quality. According to this Recommendation four aspects of quality can be considered (also used in ETSI E.800 (2008) which is shown in Figure 1.

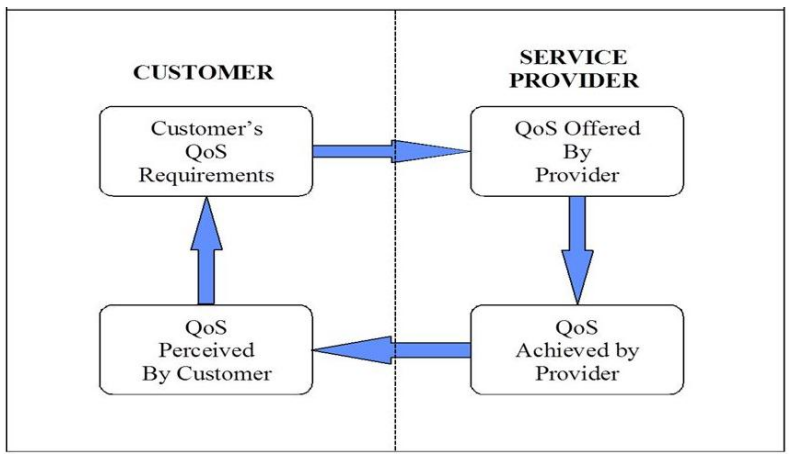

Figure 1. G.1000 - The four viewpoints of QoS (ITU-T G.1000, 2001)

Some recommendations consider QoS through network and non-network criteria. IETF (*Internet Engineering Task Force*) define QoS through measurable technical parameters and consider that QoS allows bandwidth to application requirements and network management settings.

Some authors point out three types of QoS: perceived, assessed and intrinsic. Perceived QoS is the quality evaluated by the user and depends on network performance. This type of measure uses "average opinion" and frequently used method of assessment is MOS. Assessed QoS refers to the willingness of users to continue the use of particular service. It is associated with the perceived QoS and depends on the mechanism of assessment, the level of support and other marketing and commercial aspects (Marchese, 2007, p.1). Intrinsic QoS depends on a network and can be described by using objective networks parameters that can be measured (e.g. bandwidth, delay, jitter, losses, etc.).

QoS perceived by the customer is a statement about the quality for which the customer is convinced that he is experiencing. This statement provides a subjective evaluation of the level of satisfaction with the service. In an ideal case, there should be correspondence between generated and perceived quality.

4.2. QoE (Quality of Experience)

QoE is a term that refers to the perception of users regarding the quality of service. We will consider QoE as the the overall acceptability of a service as perceived subjectively by the customer. QoE concept is

known as PQoS (*Perceptual QoS*) in the context that it represents a QoS perceived by users. Perception of service quality imply the parameters that are descriptive expressed by the user, such as the quality of the media (e.g. excellent, good, satisfactory, bad), the size of the video window (e.g. the big screen, small screen), response time (e.g. whether it is interactive service or not), the degree of protection (e.g. high, satisfactory, low) and other perceptual parameters that are not directly connected with the provision of services, or contribute significantly to the "mood" in the user experience of services.

The goal of the network should be to achieve the desired QoE while QoS is major element in achieving this goal. QoE can express human emotions such as 'excellent', 'good', 'bad', and so on, while QoS is essentially technical concept and is usually measured in terms of the network parameters and its elements. Based on ETSI E.800 (2008) QoS includes network and non-network criteria. Various issues related to QoS are brought together in ITU-T E.802. (2007) and this recommendation also shows the inter-relationship between various QoS aspects. Soldani et al. (2006) distinguish technical (mainly QoS) and non-technical (subjective) parameters of QoE.

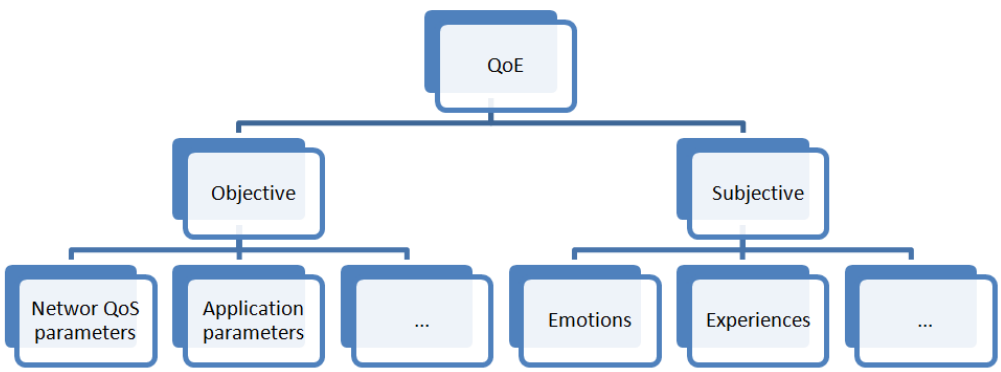

Figure 2. QoE Dimensions

User perception is individual for each user and it is very difficult to describe the technical parameters that can be measured. There are some models that describe measuring the perceptual parameters from the user's perspective. All these models are based on the assessment of the perceived QoS and can be grouped as: the subjective and objective methods. The principles of objective methods include users and their realistic perception of service. That means they are based on measurements of QoS parameters such as packet loss (packet loss), delay (latency), delay variation (jitter), bandwidth, etc. The concept of subjective methods is that they depend on the opinion of customers. Example of QoE multidimensional conceptual model that includes various aspects of observation and which seeks to establish a framework is proposed by Baraković et al. (2010). QoE is often measured by carefully controlled subjective tests such as MOS.

5. Methods for measuring customer satisfaction

Since the procedure of customer satisfaction surveys is complex process, various models and approaches have been developed for collecting data, assessments, etc. Methods for measuring customer satisfaction can be grouped into two general categories according to the method of data collection. If we analyze the data collected directly from the user it is a direct methods, e.g. collect

responses by users via surveys. If we are using the data available from SP it is indirect method e.g. analysis of sales revenue, the analysis of complaints, the collection and analysis of comments, index retained and lost customers, etc. Some of methods that can be used for measuring user satisfaction are: SERVQUAL, the method of Leadershipfactor Company, CIM College method, Nigel Hill method, NCS Persues company method, AUTODATA company methods, Walker Smartloyalty Inc. method, the National Satisfaction Index (American – ACSI, European – ECSI). Kabare and Kibera (2014) have made an overview of some models including their key strengths and weaknesses.

5.1. SERVQUAL service quality model

Parasuraman et al. (1985) have developed a model based on gaps and have put together the SERVQUAL instrument which has become the most popular model of measuring the quality of services. Later there have been some modifications and improvements as SERVPERF (Cronin and Taylor, 1992). The SERVQUAL is a concise scale which serves SP to better understand users' expectations and perceptions of services. It is designed to be effective for a variety of services, and can be customized and supplemented depending on the characteristics of services and SP.
SERVQUAL use Likert scale grading and quality is measured as the difference (gap) between perception and expectations. SERVQUAL is a useful tool for evaluating the quality of the provided telecommunications services from the perspective of the user. It is very useful to discover areas where improvements are needed.

5.2. MOS

MOS is a subjective measurement method that can be used for different types of services. MOS is a scale that quantifies the customers experience based on their opinions. Most often, the MOS score is based on subjective parameters, but in addition it can be used for assessment based on objective models or models for network planning (ITU-T P 800.1, 2006*)*. The MOS is generated by averaging the results obtained by customers' scores for quality. Scores are in the range 1 to 5, where 1 is lowest and 5 is the highest score of the perceived quality. Certain standards provide recommendations for calculations, eg. ITU-T P.862 (2001) defines how to perform the calculation and measurement of VoIP services where calculations are based on objective parameters and measuring the performance of IP networks.

Some researches focus on establishing relations between the assessment based on objective and subjective parameters. MOS test requires a large sample so it is very useful to have some approaches for assessment of MOS value. With the establishment of relations between the objective and subjective parameters and mapping results in the MOS scale it is possible to assess how changing some of the parameters affects the user perception.

5.3. Network based measurements

Performance measurement based on the measurements from the network can use systems like EMS (*Element Management System*) and NMS (*Network Management System*). Using this approach requires determination and aggregation of KPI-KQI (*Key Performance Indicators - Key Quality Indicators*), analysis, diagnostics, control and sets up certain rules. It is necessary to continuously collect, aggregate and archive KPI-KQI data for the future analysis and comparison. The advantages of this method are possibility of existence of an automated system (e.g. the software solutions) that allows continuous monitoring of parameters. The disadvantage is that assessments are not based on the user opinion.

It would be useful to make an algorithm

where QoE is estimated or calculated based on the measured QoS KPI and KQI value. There are numerous studies showing possible ways of establishing QoS/QoE correlation model. For example Nuhbegović et al. (2014) have proposed a model based on QoS metrics in order to evaluate and predict the MOS.

5.4. Measuring customer satisfaction according to ISO standard

Standard ISO 9000:2000 requires from organizations to implement a program of measuring customer satisfaction, but does not prescribe the method that would apply. The task of each SP is to develop and implement its own program of measuring customer satisfaction. This standard is set by the user at the center of the quality management system. Standard very clearly says that the central purpose of the quality management system is to create services that satisfy customers. There is a need to set up a customer requests by using a corresponding survey on focus groups or personal interview. The goal is to find the most important customer requirements. Useful addition is the so-called "mirror" research, where the same survey is used on employees to reveal whether they understand what is important to customers

ISO/IEC 20000 is the first international standard for IT Service Management. ISO 20000-1 defines the requirements for the SP to deliver a managed service that will be satisfactory for the user, e.g. acceptable quality. The standard defines SLA (*Service Level Agreement*) in the form of a written agreement between the service provider and the user. The concept of service is defined by ISO 9001 that indicates some overlapping areas of these two standards. ISO 20000-1 is a process-oriented, fully compatible with ISO 9001 and it contains the specification required for the management system of IT services. ISO 20000-2 specification represents best practices in the delivery of IT services, regardless of available technology solutions and fully based on ITIL (*Information Technology Infrastructure Library*).

6. Satisfaction measurement model

For customer satisfaction measurement it is useful to apply the principles recommended in ISO 9001: 2000 standard, which is based on the process approach. The process is continuous and dynamic and it is necessary to divide it into logical phases. Realization of phases should occur iteratively and it can be used a partial or full incremental model based on William Edwards Deming PDCA model (*Plan-Do-Check-Act Cycle*).

Customized model shown in Figure 3 implies that each defined phase must be completed before the start of the next one.

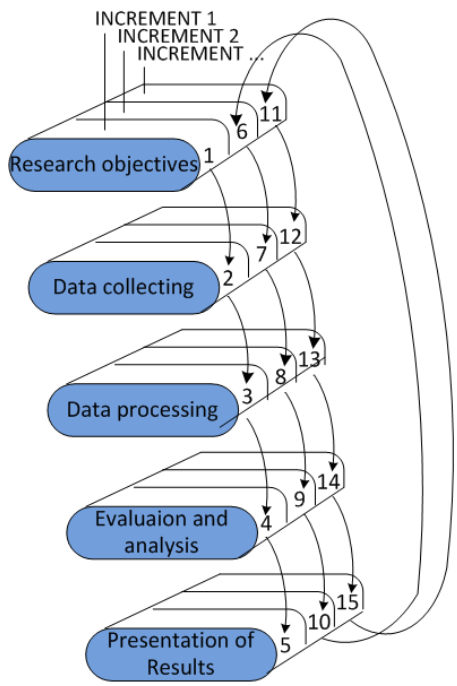

Figure 3. The proposed incremental model of phase implementation

Due to the complexity of the process it can be divided into each phase increments (sub-phases that will be implemented in parallel).

Results of each phase represent input for the next phase. Because of the representativeness of the results IT is not allowed to modify the results of the previous phase. This means that the implementation of each phase must be approached with a high degree of precision.

6.1. Research objectives

The first phase of customer satisfaction assessment should include a precise definition of goals, e.g. determination and assessment of key parameters that affect customer satisfaction and assessment of how the customer satisfaction affects their loyalty. Goals can be viewed separately or grouped and therefore each objective within the proposed model can be viewed as a separate increment.

6.2. Data collecting

It is necessary to determine which data are needed, what sources can be used to collect that data and to assess the representativeness of the samples and data. Internal and external sources can be used to collect the data. Analysis of lost customers, tracking of complaints and an increase in the number of beneficiaries are examples for internal sources while direct survey of users is the main source of external data. This list of data sources is not exclusive and may be extended.

The size and quality of the sample and the quality of the questions are very important for the representativeness of the results. Two main factors of the research accuracy are: selecting the users sample and survey with the right questions. The accuracy of the sample depends on size and representatives which must be chosen randomly. Increasing sample size and its representativeness it will increase sampling accuracy.

In order to get results for a particular segment of customers (target group) it is useful to specify the period of data collecting as well as a structure of the sample, for example age structure, gender structure, etc. Some analysts use the so-called Pareto Principle also known as a general rule 80:20, according to which 20% of users inflicts 80% of the problem, 20% of users account for 80% of profits, 20% of users provide 80% of the business. If 20% of users who "cause trouble" are seen as extremely dissatisfied users then research can focus on exploring the reasons of such results. As a rule in the choice of data sample we can take the statement that: "*It cannot be accurately predicted what users want (their expectations) and therefore the data should be obtained directly from the user*." For that purpose online surveys can be used to ease of collecting and processing data. Some tips for assembling survey are:

- Simple, brief and understandable questions.
- Unbiased questions which must not be suggestive.
- Question must not contain double negative.
- Avoid jargon.
- Avoid sophisticated words which may be unintelligible to the user.
- Avoid ambiguous words.

The order of questions may be different and they can be grouped into two categories: structured or closed questions which offer possible answers and unstructured or open questions where there are no answers offered. For the assessment some scales can be used such as Likert scale, scale ranges, etc.

6.2.1. Key parameters of customer satisfaction

According to previous research the key parameters that affect customer satisfaction are: service quality, price and SP image and these parameters are taken as KPI:

$$KPI = \{quality, price, image\} \quad (1)$$

It is possible to research weighted factors for each parameter. Table 2 shows an example

of surveys that can be used for data collecting. Users give two grades for each parameter: score which reflects the expectations of users and assessment of the current situation which reflects the user perception. In addition to this survey, another survey can be used to examine certain factors within these parameters, for example the importance of customer support in the context of assessment of the overall quality.

For the purpose of better understanding the questionnaire it is useful to use Likert scale that enables mapping descriptive marks to an appropriate numerical scale (quantitative values). To determine key quality parameters different aspects of quality can be used as discussed in previous chapters.

Quality parameters can be divided into general and specific service. General quality parameters are applicable to all services and specific properties of services which cause specific parameters for each service. Testing can be performed on all the services of an SP or the individual services, but because of costs general values that would apply for all or individual services can be obtained. Examples of the parameters that affect the overall quality are: quality of service, quality equipment, quality of support, etc.

Table 2. An example of a survey to determine the weighted parameters

Encircle the importance of the parameters in the decision to use the services of an SP		
PARAMETER	**PARAMETER IMPORTANCE**	**CURRENT SITUATION**
QUALITY (Quality of service, quality of support, quality of equipment, etc.).	• Not important • Moderately unimportant • Slightly unimportant • Neither important nor unimportant • Slightly important • Moderately important • Extremely important	• Extremely Dissatisfied • Moderately Dissatisfied • Slightly Dissatisfied • Neither Satisfied nor Dissatisfied • Slightly Satisfied • Moderately Satisfied • Extremely Satisfied
Costs (Cost of service)	• Not important • Moderately unimportant • Slightly unimportant • Neither important nor unimportant • Slightly important • Moderately important • Extremely important	• Extremely Dissatisfied • Moderately Dissatisfied • Slightly Dissatisfied • Neither Satisfied nor Dissatisfied • Slightly Satisfied • Moderately Satisfied • Extremely Satisfied
IMAGE (SP size, number of users, advertising, etc)	• Not important • Moderately unimportant • Slightly unimportant • Neither important nor unimportant • Slightly important • Moderately important • Extremely important	• Extremely Dissatisfied • Moderately Dissatisfied • Slightly Dissatisfied • Neither Satisfied nor Dissatisfied • Slightly Satisfied • Moderately Satisfied • Extremely Satisfied

Example of documents that can be used for definitions and lists of quality parameters are:

- *ETSI EG 202 057-1 and ETSI 201 769-1* define the general parameters of quality
- *ETSI EG 202 057-2* defines the parameters of services based on voice transmission, 3G fax, data transmission via modem and SMS.
- *ETSI EG 202 057-3* defines the parameters of mobile networks.
- *ETSI EG 202 057-4* defines the parameters of services based on Internet access.
- *ITU-T G.1080* defines the parameters for IPTV / triple play service.
- *ETSI EG 202 009-2* the systematization and review of parameters for each service.

Using these standards we can mark off KQI:

$$KQI = \{Q_1, Q_2, \dots, Q_n\} \quad (2)$$

Q_i – Quality parameters defined in the specific recommendation. After determining KQI surveys to collect the necessary data can be carried out. To estimate how customer satisfaction is reflected in the customer loyalty it is necessary to analyze internal data for the number of users for specific services or all services of SP for some period. In the case of internal data various reports and statistics available to the SP can be used.

6.3. Data processing

It is necessary to use statistical methods and tools, and according to the large number of data it is useful to use graphs to present gaps between the target and achieved results. With regard to the objective of the analysis and the nature of the data an appropriate data mining methods should be used (neural networks, decision trees, nonlinear regression, etc.). The collected data will be adjusted and transformed in the way that correspond the objectives and the method (Kovač, 2014). Computer data processing facilitates the process of analysis. For the data analysis it is useful to group data according to different groups of users.

Table 3. Example of mapping semi polar to a bipolar scale and associated descriptive rating

Semi polar scale	Bipolar scale	Likert scale for expectation	Likert scale for perception
0	-3	Not important	Extremely Dissatisfied
1	-2	Moderately unimportant	Moderately Dissatisfied
2	-1	Slightly unimportant	Slightly Dissatisfied
3	0	Neither important nor unimportant	Neither Satisfied nor Dissatisfied
4	1	Slightly important	Slightly Satisfied
5	2	Moderately important	Moderately Satisfied
6	3	Extremely important	Extremely Satisfied

It is useful to put essay questions in surveys so the data would be understandable. However, statistical analysis requires numeric values and we can use different scale to convert descriptive ratings to numerical values. Names in the framework of the rating can be changed to match the certain qualitative criteria of the survey.

For statistical purposes, the scales can be mapped into each other (Figure 4). For overall assessment of the performance aggregation of performance (parameters) may sometimes be helpful to get AR (aggregate ratings). The aggregate of the

individual ratings of the constituent parameter indicators is estimated by calculating a weighted factor to represent their relative importance in the performance category (ETSI EG 202 843, 2011).
Equation for the aggregate rating:

$$AR = w_1 \, x \, p_1 + \, w_2 \, x \, p_2 + \, w_3 \, x \, p_3 + \cdots + w_n \, x \, p_n = \sum_{i=1}^{n} w_i \, x \, p_i \qquad (2)$$

Where: p_i – is the performance parameter result with index i, w_i – is the weighted performance parameter result expressed as percentage, n is the number of assessed performance parameters in this category.

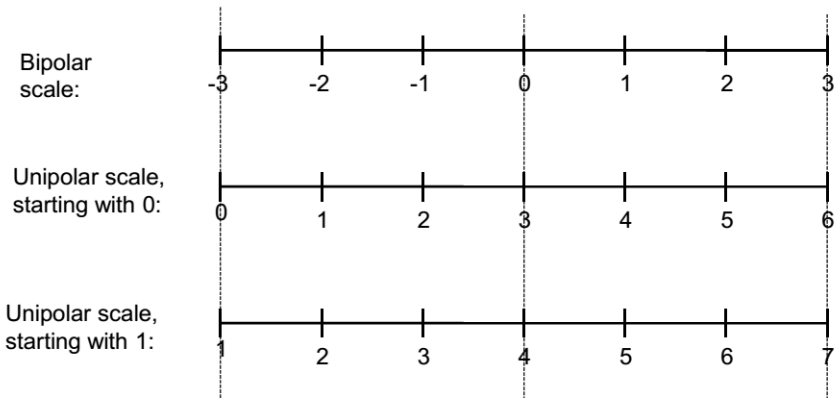

Figure 4. Example of simple linear transformation of bipolar and semi polar scales (ETSI EG 202 843, 2011)

The weighted is expressed as a percentage:

$$\sum_{i=1}^{n} w_i \, = 100\% \qquad (3)$$

SEM (*Structural Equation Modeling*) can be used to determine which theoretical model is supported by data from the sample. This is a multivariate statistical technique which combines CFA (Confirmatory Factor Analysis), PA (path analysis) and regression analysis and is applied in the analysis of hypothetical relations between latent and manifest variables or indicators. For calculations software tools and SEM software such as EQS, LISREL and AMOS can be used. Dimensions of functional quality can be measured using the adapted SERVQUAL measurement instrument. One of the best statistical tools that can be used is the SPSS (*Statistical Package for the Social Sciences*), which provides: frequency distribution, descriptive statistics, t-test for paired samples and checking the reliability of the scale.

6.3.1. Processing KPI data

Customer satisfaction represents the ratio of the measured performance of key parameters (customer perceptions) and expectations for these parameters. That means that if user expectations are higher it is more difficult to achieve their satisfaction. If we include weighted factors key of individual parameters (KPI), an equation for calculating customer satisfaction can be written in the following form:

$$S = \frac{\sum_{i=1}^{n} w_i \cdot P_i}{\sum_{i=1}^{n} w_i \cdot P_{oi}} \qquad (4)$$

where P_i is measured value of parameter i (according to user ratings), w_i is weighted factor for parameter P_i, P_{oi} is expectation for parameter P_i, n is number of assessed parameters.

Quality criteria of a telecommunications service may be derived from a matrix

defined in recommendations such as (ITU-T G.1000, p. 9*)*. The principle of creating a matrix means that we first identify the different functions that a user experiences (function of customer perceptions) and then make a list of criteria (parameters) according to which the user evaluates the level of quality with which each of these functions is performed. After combining of service functions (Sales and Pre-Contracts, Offer, Change, repair, termination, establish a connection, data transfer, connection release, Billing / Billing and Network Management / Services) and the list of quality parameters (speed, accuracy, availability, reliability, security, simplicity and flexibility) in the matrix, the next step is to update the matrix of QoS parameters. The matrix can be further expanded in order to be adapted to a variety of services. For example a list of necessary technical functions ACF (*Accessibility, Continuity and Fulfillment*) is added in model developed by IETF.

A large number of parameters can be observed but in this paper we focus on the quality (Q), cost (C) and the image (I) of SP as a key factors of user satisfaction. Every factor can include a large number of parameters. Used approach is shown in the Figure 5 and using this model can evaluate customer satisfaction and monitor the correlation between satisfaction and loyalty.

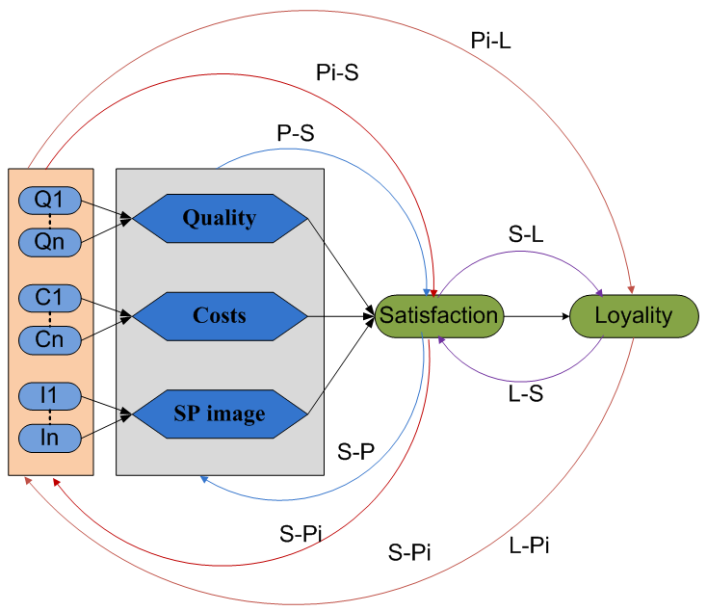

Figure 5. The proposed model for customer satisfaction and loyalty estimation

Q_1,..,Q_n, C_1,...C_n, I_1,....,I_n correspond to the parameters which determine Quality (Q), Costs (C) and Image of SP (I). In addition to determining the values of the above parameters, it is necessary to examine and user expectations. If the Q, C and I are used as KPI and if we use equation 4, we will get the following equation:

$$S = \frac{w_q \cdot Q_P + w_c \cdot C_P + w_i \cdot I_P}{w_q \cdot Q_o + w_c \cdot C_o + w_i \cdot I_o} \quad (5)$$

Q_P is measured value (perceived) of user perception for the *Quality*, w_q is weighted factor for Q, Q_o is user expectations for Q, C_P is measured value (level) of user perception for the *Costs*, w_c is weighted factor for C, C_o is user expectations for C, I_P is measured value (level) of user perception

for *SP image*, w_i is weighted factor for I, I_o is user expectations for I.

By applying statistical tests and analysis we can monitor level of user satisfaction in relation to the individual parameters and how it affects their loyalty. For this purpose, user loyalty can be observed as the usage of services for some specified period of time. The question is how to determine the values of key parameters of quality, cost and image, as well as their weighted factors. After the survey and translation rating to the semi polar Likert scale, the results can be displayed as in Table 4.

Table 4. Example of survey results

$\mathbf{x_{Pi}}$	x_1	x_2	x_3	...	x_n
$\mathbf{f_{Pi}}$	f_1	f_2	f_3	...	f_n

- x_{Pi} are ratings for parameters *P (Q, C, I)* by using some scale (eg. 1-7 on semi polar scale)
- f_i *is* frequency of ratings (the number of users who have rated some parameter with value x_i)
- n is number of rating levels (e.g. 7 levels from semi polar scale).

The table is created separately for assessment of perceived and expected values as well as for each parameter separately. Based on the results of the survey estimated value expectations and performance parameters can be obtained. Results can be obtained on the basis of the mean value, which is calculated as follows:

$$\bar{X}_j = \frac{\sum_{i=1}^{n}(x_{Pi} \cdot f_{Pi})}{N} \quad (6)$$

$\bar{X}_j$ is mean value (score) for each parameter *P (Q, C, I)*, j is label for type of results (expectation or perceived) and N is number of ratings while:

$$N = \sum_{i=1}^{n} f_{Pi} \quad (7)$$

For example, mean value $\bar{X}_j$ for perceived Quality is:

$$\bar{X}_{Qp} = Q_P = \frac{\sum_{i=1}^{n}(x_{Qi} \cdot f_{Qi})}{\sum_{i=1}^{n} f_{Qi}} \quad (8)$$

In similar way we can obtain performance (expected and perceived) of other parameters such as C and I.

Surveys for user expectation are used to obtain the weighted factors while weighting is expressed as a percentage and will add up to 100%:

$$\sum_{i=1}^{n} w_i = 100\% \quad (9)$$

To determine weighted factors value we can use the following equation:

$$w_i = \frac{P_{oi}}{\sum_{i=1}^{n} P_{oi}} \quad (10)$$

P_{oi} is the expected value of the performance for some parameter *i*. The following table (Table 5) provides a list of all the equations for assessments of performance parameters, expected performance and their weighted factors.

Table 5. Terms for performance parameters, their expected values and weighted factors

	QUALITY	COST	SP IMAGE
USER EXPECTATIONS	$Q_O = \frac{\sum_{i=1}^{n}(x_{Qoi} \cdot f_{Qoi})}{\sum_{i=1}^{n} f_{Qoi}}$	$C_O = \frac{\sum_{i=1}^{n}(x_{Coi} \cdot f_{Coi})}{\sum_{i=1}^{n} f_{Coi}}$	$I_O = \frac{\sum_{i=1}^{n}(x_{Ioi} \cdot f_{Ioi})}{\sum_{i=1}^{n} f_{Ioi}}$
PERCEIVED PERFORMANCES	$Q_P = \frac{\sum_{i=1}^{n}(x_{Qi} \cdot f_{Qi})}{\sum_{i=1}^{n} f_{Qi}}$	$C_P = \frac{\sum_{i=1}^{n}(x_{Ci} \cdot f_{Ci})}{\sum_{i=1}^{n} f_{Ci}}$	$I_P = \frac{\sum_{i=1}^{n}(x_{Ii} \cdot f_{Ii})}{\sum_{i=1}^{n} f_{Ii}}$
WEIGHTED FACTORS	$w_q = \frac{Q_O}{Q_O + C_O + I_O}$	$w_C = \frac{C_O}{Q_O + C_O + I_O}$	$w_I = \frac{I_O}{Q_O + C_O + I_O}$

Using equations from Table 5 we can get results and by inserting values in the equation (5), we can get quantitative value which is an indicator of the level of customer satisfaction. If S > 1 results indicate that the user is given a better service than expected. Otherwise, if S <1 services did not met the expectations of users. Scenario when S = 1 is unlikely, but means that the user provided the level of service as they expected.

6.3.2. Processing KQI data

There is a numerous of QoS parameters. To identify KQI we can use some recommendations such as ETSI EG 202 843 or another recommendations according to own assessment and objectives. Also, it can be used some other parameters that are obtained by some other research. By using ETSI EG 202 843 recommendation where the parameters are divided into 10 groups we can propose a model for customer satisfaction assessment as shown in the Figure 6.

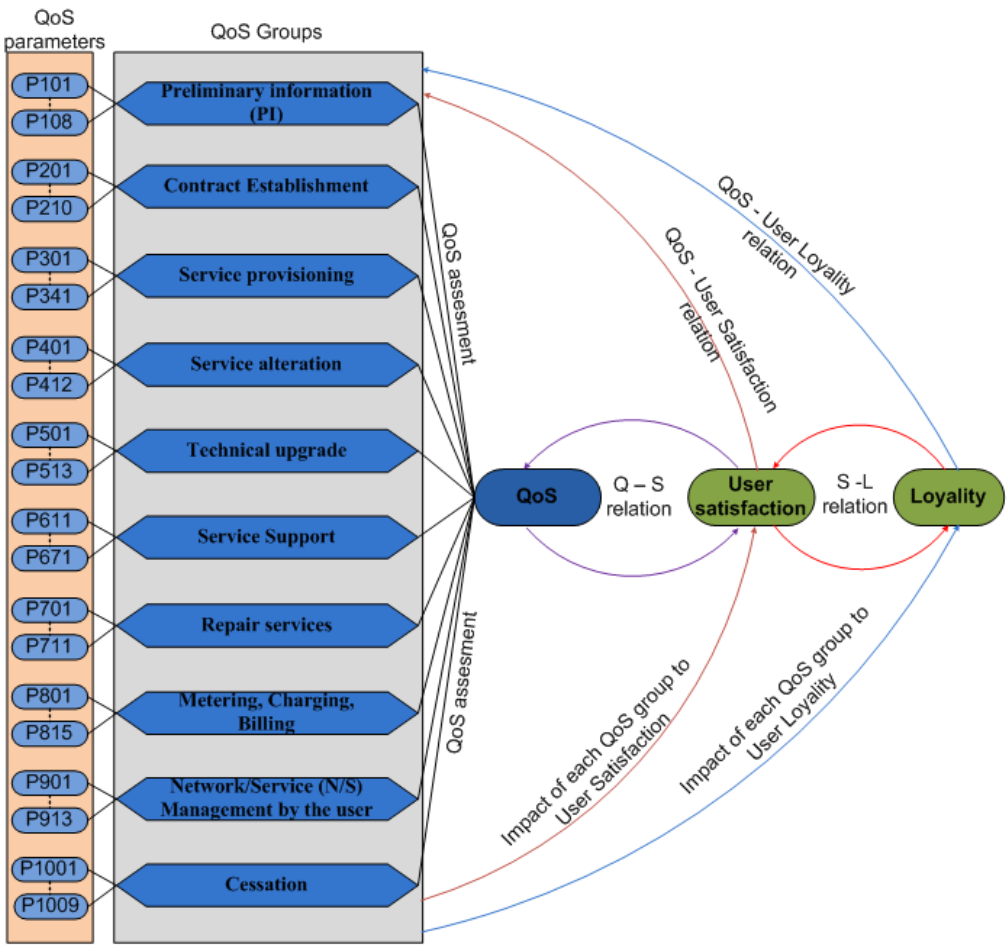

Figure 6. The proposed model for QoS assessment and impact to customer satisfaction and loyalty

In survey users evaluate groups of parameters according to their relevance for them (to determine the expectations of users) and the perceive performance of services of parameters. Using similar procedure it may be determined values of each parameter group (expectation and perception).

It can be assessed how individual quality parameters influence on customer satisfaction and their loyalty. According to this approach it is obvious that it is necessary to perform aggregation of parameters in order to simplify the process. Research conducted on the basis of expert panels can be used for aggregation.

QoS can be calculated using the following equation:

$$Q = \frac{\sum_{i=1}^{n} w_{Qi} \cdot P_{Qi}}{\sum_{i=1}^{n} w_{Qi} \cdot P_{Qoi}} \quad (11)$$

P_{Qi} is measured value of the quality parameter i, w_{Qi} is weighted factor for each parameter of quality P_{Qi}, P_{Qoi} is expected value of the quality parameter P_{Qi}, n – number of parameters that are observed. In the model in this paper we used ETSI EG 202 843 to determine P_{Qi}.

6.4. Evaluation data analysis

User perception measurements indicate possible problems and their causes in the process of service provisioning. This allows the SP to react and improve the necessary parameters. The research process should be controlled through all phases because of representativeness of the results. It is necessary to define the target values, and often national regulators for specific services have defined minimum values of certain parameters. Also, some values in recommendations can be used as target values of the parameters but some parameter values are given in a certain range and should be more precisely defined. SP can create reports for some period (e.g. annual reports) in order to monitor parameters. Based on the reference parameters can determined whether the result is satisfactory or not. For each level of user satisfaction reference value can be determined as shown on hierarchical model (Figure 7).

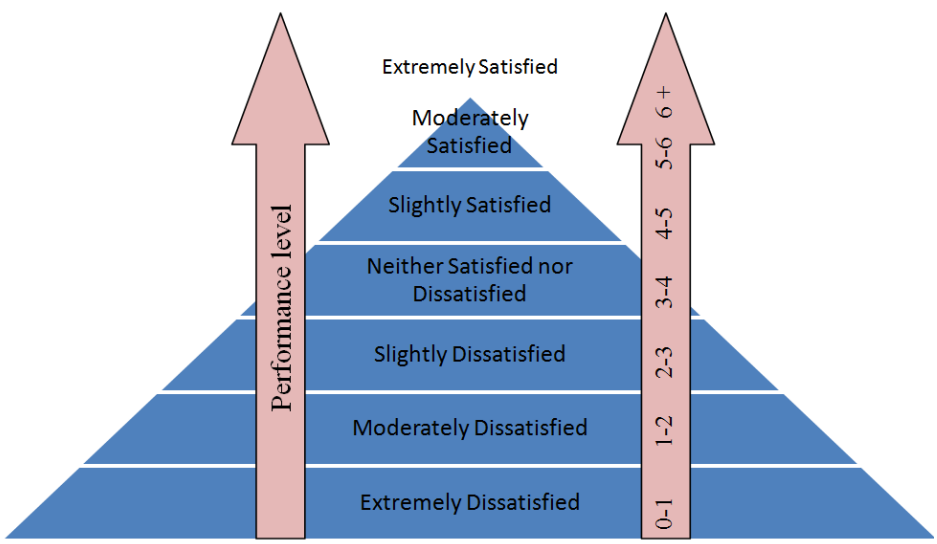

Figure 7. Example of hierarchical scale for particular parameter

It is necessary to aspire to higher values in order to keep users loyalty. However, some parameters result could be acceptable but other could significantly deviate. Therefore, it is necessary to evaluate the individual parameters and not only the cumulative result. This will help understanding of user satisfaction and behavior, improvement of users support, generate results for decision support, optimization of operational processes, etc.

6.5. Presentation of results

It is necessary to determine to whom and how the results should be presented. For the presentation of the results different tabular views, different graphs, etc. can be used. For example, depending on the sample size per assessed customer segment we can use histograms, PDF (*Probability Distribution Function*), CDF (*Cumulative Distribution Function*) or Quantile values.

Employees' acquaintance with the results can have positive effects on improvements of quality and customer satisfaction. The results can be presented to employees by using the internal reports, workshops, mailing lists or similar. All employees should work on improving the process for which they are responsible. It is more sensitive decision whether to present results to users and how to present certain results. According to results users can change their expectations and perception. If the results are presented to users it may be viral spread that could have major consequences (positive or negative) on user loyalty. For example, the summary results could be considerably better than user expectation which may affect that users change their opinion about the service or the SP.

7. Conclusions

It is very important for the SP to assess the level of user satisfaction. Users often use the services of several operators at the same time and a lot of SPs are investing in testing user expectations and satisfaction. Using this assessments SP can gain insight into the current situation on market and can use assessments to increase user satisfaction and their loyalty. User satisfaction is impossible to assess and improve without empirical research and adequately performed the statistical analysis. This paper identified a number of problems related to this topic including understanding and defining concepts, ways of performing assessments, and large range of parameters that impact on user perception and satisfaction, and so on. The customers should be the starting point of research and it is impossible to carry out the assessment of customer perception and satisfaction without the involvement of the beneficiaries in the research process.

Due to the complexity of the process of research user perceptions it requires adequate methods and methodology. An important assumption involves the collection of data by the user in a way that users are motivated to give relevant answers that do not have a sense of "loss of time". Approach proposed in this paper implies a limit on the key parameters which simplifies measurements and assessments. Based on earlier research three key parameters that affect user perception are: quality, costs and SP image but it is possible to include other parameters. The paper explains the way to determine key parameters and weighted factors of individual parameters. A focus is placed on the parameter of quality and its impact on user perception. Using the proposed model user satisfaction can be determined and a relationship between satisfaction and loyalty can be established.

The model presented in this paper enables the use of statistical analysis to get an appropriate results, conclusions and assessments that could help with appropriate decisions. Research by using this model can help identify potential problems in the services provisioning, ie. insufficient levels of certain QoS parameters. This may contribute to improvement of user perceptions, satisfaction and loyalty and to

contribute to a better market position and business efficiency of SP. The entire process of research could use the recommendations such as ISO 9000: 2000, ETSI recommendations, etc.

Future research can focus on the application of statistical analysis to find relations between certain parameters such as: quality, satisfaction, loyalty. If it is determined that a particular data complies with some distribution then assessment of impact certain parameters on the results of other can be carried out (e.g. impact of QoS on users satisfaction or loyalty). In addition to the above the relevance of certain parameters of quality, customer perception can be researched. The research can also focus on a certain segment of users observed by various criteria (e.g. geographical, interests, etc). Future research could be carried out in order to improve the proposed model as well as to determine the expected values for each parameter to determine the KPI and KQI or their weighted factors.

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