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EVALUATION OF THE CAPABILITY OF THE MOBILE PHONE SERVICE IN SOUTHERN BRAZIL THROUGH THE PERCEPTION OF ITS CUSTOMERS

Abstract: *This study aimed to analyze, in a quantitative and qualitative way, the perception of quality verified by costumers in the mobile phone service in Southern Brazil through the annual quality perception survey conducted by the Brazilian Agency of Telecommunication (Anatel). A questionnaire was applied to obtain the data; it contains the indexes that were compared in the study. The analyzes of the information found were given by using the Statistics Processes Control to determine the capability of the service by using the C_p and C_{pk} indexes. It was found a $C_p = 0.45$ and $C_{pk} = -0.18$ indicating that this service needs great improvement.*

Keywords: *Capability, Continuous quality improvement, Customer satisfaction, Statistical process control*

1. Introduction

Organizations in general tend to adapt to the globalized world and seek constant improvement in their activities, through continuous external and internal evaluations of their products and services. The services sector has a large participation in the composition of the Brazilian Gross Domestic Product (GDP), in the first quarter of 2017 recorded participation of about 62.5%, according to the Brazilian Institute of Geography and Statistics (IBGE, 2017). For organizations to move forward in this industry and achieve excellence in its services, they need to be concerned about the quality of their operations.

Services are tasks for economic purposes that produce value and provide benefits to the

consumer in specific occasions and environments, as an implication of the execution of a desired modification on behalf of the recipient (Lovelock, 2001). For Kaňovská and Tomášková (2015), when customer services are made with quality, they can be considered as strengths against competing companies, as well as ensuring consumer loyalty, differentiating products, reducing marketing costs and broadening their performance.

In this sense, the quality of the service is indispensable for the success of a service provider, due to its influence on the pleasure of consumers. Also, in order for a buyer to purchase a service, it is necessary that it has a high expectation related to quality of service and in the perspective of consumer loyalty, if

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necessary the fulfillment of expectations and needs by the service provider.

There are several factors that incur costs to the organization if the attributes of the service are not compatible with the needs and expectations of the consumer. Thus, the higher the level of quality, the lower the organization's expenses with problems due to the inefficiency of its activities. Therefore, it is also essential to be competent so that competition is not a threat to the survival and growth of the company in a given market niche, as well as if necessary the development of technologies so that customers can be adequately served.

Brazil is 61st in relation to the Index of Information and Communication Technology Development, according to the International Telecommunication Union (ITU) (2015). Also, according to ITU (2015), Brazil was in position 73, out of 167 countries, in 2010, so the country must continue to develop its information and communication technologies so that it can reach levels of excellence in the quality of meeting the requirements of the consumer, according to the world level of development. Among the various areas of the service sector are the Information Services that encompass telecommunications. In this domain there are several variants that condition competitiveness, such as mobile telephone services.

The satisfaction of the population in relation to the service provided by the telephone operators is an issue that must be discussed, due to the great proportion of the use of this service by the Brazilians. The density of mobile telephone lines, according to Anatel (2016), is 125.62 per 100 people in Brazil.

According to ITU (2015), Brazil is the fifth largest in the world in number of mobile phone subscriptions. Due to this great expressiveness, the care with the quality of this service offered must be high. The quality standards of telecommunication services are regulated by the Brazilian Agency of Telecommunication (Anatel).

Vu (2011) suggests that the Information and Communication Technology (ICT) infrastructure causes the propagation of technology and innovation, as well as the quality of decision making by enterprises and families, reduce production costs, and also increase demand. Quah (2002) emphasizes that ICT promotes improved work skills, consumer refinement, and a higher level of education.

In view of these perspectives, this study will use Statistical Process Control in order to determine the Service Capability by means of the C_p and C_{pk} indexes, to verify if this service is capable of meet its specifications.

2. Literature review

2.1. Historical evolution of quality management

Concern about the quality of products began very early in the Middle Ages with artisans when production was small-scale, and inspection consisted of informality. The analysis of the products had no statistical basis until the 1920s, when the "Age of Inspection" began (Gerolamo et al., 2014).

According to Garvin (1988), the need for formal inspection only appeared from the nineteenth century when mass production began, at that time standards were created for manufactured parts and accessories, which were inspected at the end of production, with the use of calibrators. At the beginning of the twentieth century, Frederick W. Taylor, known as the father of "Scientific Management," gave legitimacy to this process by separating one of his supervisors to inspect the quality and measure the agility with which the work was performed by the workers (Maximiano, 2004).

With the advancement of industrialization emerged the "Statistical Quality Control Age", which recognized variability as critical in relation to quality control (Gerolamo, et al., 2014). In 1924 Shewhart developed statistical methods of analysis and quality control, such

as control charts and also the PDCA (Plan - Do - Check - Act) cycle, in addition to the sampling process, which contributed to the evolution of quality processes.

However, for Rocha et al. (2012), process control is considered the basis of statistical quality control, in which it is possible to structure the processes orderly, in order to obtain information to find critical points, fluctuations and variations from normal causes and improvement implementation opportunities. In this age, the American Society for Quality Control (ASQC) and the Japanese Union of Scientists and Engineers (JUSE) were founded to expand and disseminate quality practices (Rocha et al., 2012).

World War II was of great importance for the development of the "Quality Assurance Era" because, due to the concern with the production of arms and ammunition manufactured by various suppliers, a committee was formed to create a quality standard and develop a method of agreement of the product samples in 1942 (Carvalho & Paladini, 2012). By the 1940's and 1950's, quality became an area beyond the factory boundaries addressing both management and statistics.

In the "Total Quality Management Era" quality was defined according to customer needs and seen as excellence. In the beginning, quality could be divided into two approaches: while in the West the concern was related to procedures, quality professionals, quality assurance and technical dimensions of quality principles, the Eastern focus gave more expressiveness to managerial and motivational perspectives, with the integration of all servers aimed at continuous quality improvement.

In that age, a standard of quality acceptance levels was also developed, in which a number of defective products were determined that a supplier could maintain and be considered acceptable (Garvin, 1988). Also, Feigenbaum formulated Total Quality Control (TQC), which would strongly inspire the model

suggested by the International Organization Standardization (ISO). In 1951, a prize was awarded to honor Deming, the Deming Prize, which was to be given to the company that had the most prominence in quality every year (Carvalho & Paladini, 2012).

Ishikawa collaborated in the definition of the Company Wide Quality Control (CWCQ), popularized as "Company-wide Quality Control", and in the dissemination of quality tools that would be widely used by Quality Control Circles (QCCs), known as improvement groups. Also, in 1957, Crosby disseminated artifacts that would produce the Zero Defects program, also at that time, Juran addressed the costs of quality, which given their relevance, will be discussed later (Carpinetti, 2012).

For the authors, Carvalho and Paladini (2012), the emphasis of this era is the attendance to the needs of the client, using the strategic planning for the definition of objectives, including the differentiation of the competition. According to Garvin (1988), the methods used were strategic planning, setting goals, mobilizing the company as a whole, ensuring that all employees, from the shop floor to top management, were committed to promoting quality.

With this great diffusion of the importance of attending to the needs of the clients, the concern with the quality in services appeared. Taguchi focused on the activities of the project, which are extremely important to satisfy consumers and create a robust quality. Integrated Management Systems (GIS) have also been incorporated into quality standards, as well as sustainability, social responsibility and the environment (Carvalho & Paladini, 2012).

For Carpinetti (2012), TQM is seen as a set of improvements that involves all parts of the organization so that the integrated effort produces to performance improvements at every level of the organization, in order to match the designs of quality to increase customer satisfaction. TQM practices reveals that companies prefer to use and give more

importance to practices involving teamwork and focus in the client.

Satisfied employees tend to improve the quality of service or increase their efforts in order to change it to a higher level, so many companies use TQM to provide services to their customers in the best way and thereby reduce uncertainties (TASKOV and MITREVA, 2015). In the case of service organizations using TQM, reliability is of utmost importance for quality and may be more adequately defined in relation to the coherence of the service provided to

customers (Lemak & Reed, 2000).

2.2. Quality in services

Services are the activities that are carried out in the presence of the consumer, having as a priority the direct relations with the client. To reach your goals a company must insert a series of principles, in its day to day, that will contribute to the improvement of the service provided. For Denton (1990), services have twelve principles, which are presented in Table 1.

Table 1. Principles of services

Management perspective	Service managers must create operational and marketing strategies that focus on quality dimensions in services that can increase customer satisfaction (Olorunniwo and HSU, 2006).
Create a strategic niche	The strategy that the company wants to follow must be well defined, so that the company can be ahead of its competitors, yet the strengths must be clarified and the weaknesses recognized for the improvement of its characteristics (Denton,1990).
Administration should provide support	In customer service, employees with direct contact with the consumer provide quality service, which is influenced by the extent to which the organization supports the efforts of employees (Singh, 2000).
Understanding the Business	Managers need to understand the effect of performance on service quality on the level of customer satisfaction (Fin, 2011).
Employ the operational bases	Consideration should be given to the sustaining mechanisms as well as the balances that are required for the provision of high levels of in-service quality to be effective (Jack et al., 2006).
Understand, estimate and accompany the customer	For Freitas (2005), it is necessary to transform the needs and perspectives of the client into conceptions of service that can serve them in the correct way.
Use appropriate technology	The use of technologies can help increase productivity and have a positive impact on company objectives (Jack et al., 2006).
The need to innovate	It is extremely important to explore new ideas and development so that innovations from research can be applied
Hire the right people	Know how to find the people with characteristics that will fit the business best, so that the customer is treated courteously and gets help in solving problems (Denton, 1990).
Provide profile-based training	Investing in employee development through training can increase the quality of services, in addition to enabling greater competitiveness (Fitzsimmons, 2010)
Determine standards, measure performance and act	Work with a hierarchy of activities procedures with the need for procedures that ensure the delivery of correct and reliable services (Olorunniwo & Hsu, 2006)
Instituting incentives	According to Denton (1990), incentives can be financial or non-financial, such as profit sharing, benefit packages and payments. It is imperative that there be clarification that there is a direct connection between performance and results.

The twelve principles of service quality defined by Denton (1990), generally address the importance of administration being aware of its objectives and of the strategy defined by the company, as well as supporting its employees.

2.3. Statistical process control

Statistical Process Control (SPC) can be described as a statistical methodology mainly used for production, allowing a systemic decrease in the quality attributes evaluated, providing data that increase productivity, increase reliability and reduce costs (Carpinetti, 2012).

By using the SPC it is possible to inspect a sample during the production process and analyze if there is any aspect that can be considered as a special cause, characteristics that may cause some damage to the product or service. Therefore, with the identification of these special causes, it is possible to act on them and to improve the process in a continuous way, ensuring that the final product reaches the appropriate quality parameters.

Control charts are used to identify apparent process anomalies. According to Montgomery (2012), control charts can be classified in two ways: control charts by variables and control charts by attributes. The quality characteristic that can be measured and shown as a digit is called a variable, in which case the evaluation can be done through the use of a central tendency measure and a dispersion measure that composes the control graphs for variables.

In cases where it is not possible to quantitatively measure the desired quality characteristic, products should be classified as "compliant" or "non-compliant", depending on their compliance with product specifications. Thus, these characteristics are called attributes and are always classified by only two forms, for example: "conform" / "not conform", "accept" / "fail", "works" / "does not work", "present / absent" ". These

circumstances are particular to control charts for attributes (Joeques & Barbosa, 2013).

For this study, Shewhart Control Chart for Individual Measurements and Moving Range was used. This chart is used in circumstances where the sample volume of the process is equal to 1, so the sample is composed of an individual unit. For the I-MR graph the moving range is given by Equation 1 (Montgomery, 2012):

$$MR_i = |x_i - x_{i-1}| \tag{1}$$

The control limits of the individual measurements are calculated by Equations 2 to 4:

$$UCL = \bar{x} + 3 \frac{\overline{MR}}{d_2} \tag{2}$$

$$Center\ line = \bar{x} \tag{3}$$

$$LCL = \bar{x} - 3 \frac{\overline{MR}}{d_2} \tag{4}$$

where:

- UCL = upper control limit;
- LCL = lower control limit;
- MR = moving range;
- d₂ = constant value.

Therefore, the moving range chart has center line \overline{MR} and the Upper Control Limit as $UCL = D_4\overline{MR}$. In this graph, normally, the lower control limit is zero. Montgomery (2012) emphasizes the importance of checking for normality when using control charts for individual, since this type of chart is very sensitive to lack of normality.

The capability can be expressed by the Process Capability Ratio (PCR) C_p , as shown in Equation 5:

$$C_p = \frac{USL - LSL}{6\sigma} \tag{5}$$

where:

- USL = upper specification limit;
- LSL = lower specification limit;
- σ = standard deviation.

When $C_p > 1$, this means that the process uses less than 100% of the tolerance band. Consequently, few non-conforming units will be produced. This is always the best situation. When $C_p = 1$, means the process use all the tolerance band. Finally, when $C_p < 1$, this means that the process uses more than 100% of the tolerance band. So, a lot of non-conforming parts will be manufactured (Montgomery, 2012).

The C_p index does not take into consideration where the process mean is located relative to the specifications. So, C_{pk} that takes process centering into account was used, as follows in equations 6, 7 and 8:

$$C_{pk} = \min(C_{pu}, C_{pi}) \tag{6}$$

$$C_{pu} = \frac{USL - \mu}{3\sigma} \tag{7}$$

$$C_{pi} = \frac{\mu - LSL}{3\sigma} \tag{8}$$

By using the C_p index it is possible to obtain data to identify the potential capability, that is, how much the process uses its capacity according to specification limits. While the C_{pk} index measures the effective capacity of the process, it then checks whether the activity is centered or not. Thus, the degree of similarity between C_p and C_{pk} has direct relation and indicates the magnitude of the centrality of the process (Montgomery, 2012).

2.3. Telecommunication services

The information technology industry in general, comprising the mobile telecommunications industry, has a unique set of factors that influence consumers and adapt their behavior in relation to other traditional services such as banks and retail activities (Aksoy et al., 2013).

A research developed in relation to the mobile telecommunications area proposes that customer retention is more important than reaching new customers, due to the increase in market saturation (Lee, 2010). For Aksoy

et al (2013), overall consumer satisfaction is positively related to their loyalty intentions.

Since the 1990s, mobile technology has become increasingly popular in the telecommunications industry, with the vast use of mobile technology, industry efficiency and productivity have improved (Aksoy et al., 2013). Brazil has private telecommunication services and there are a considerable number of mobile service providers.

In order to verify the fulfillment of the responsibilities of the services of these providers and also of other telecommunication services, a regulatory agency was created, which is Anatel. This agency has as a regular function and oversee characteristics about the use of services, commercialization, execution, operation and implementation of telecommunications networks in Brazil. Among these functions is the annual creation of a perceived quality indicator according to the mobile phone users (Anatel, 2015).

It is possible to notice that telecommunication companies usually suffer from a lack of homogeneity in terms of coverage, that is, some companies have a larger coverage area in some regions while others are dominant in different regions. According to Feijóo, Gómez-Barroso and Ramos (2016), telecommunication service providers are generally optimistic about the future evolution of the industry and offer a privileged perspective on industry information regarding demand trends.

3. Methods

3.1. Data collection

To collect the survey data, a questionnaire was created according to the Anatel indicators, so that it was possible to compare the results obtained in the questionnaire of this study with the indicators generated by the satisfaction survey conducted by Anatel.

Anatel has seven perceived quality indicators for Personal Mobile Service. The indicators

are: "General Satisfaction", "Supply and Hiring", "Operation", "Recharge", "Customer Service Channels", "Telephone Service" and "Resolution Capability". However, for this study, only quality was analyzed in relation to the Channels of Attendance, Resolution Capability, and Operation in relation to the quality of the calls, in order to compare the

quality of these services through the research applied to mobile users of the state of Paraná, southern Brazil.

The choice of these three indicators (Table 2) is due to the ease of data measurement, as well as the importance of the quality attributed to these services.

Table 2. Anatel's Indicators

Resolution Capability	It is defined as an assessment of the ability of permanently solving telephone networks such as complaints, information requirements and / or user requirements
Channels of Attendance	They are specified as means of interaction provided by operators, which users have at their disposal when there is a need for requesting information, contracting services, requesting claims by the means: store, telephone and website
Operation	It is explained how the quality of use and use of services, including factors such as quality in making and receiving calls

Anatel (2014) establishes, through Resolution "632, of March 7, 2014", in article 27 that the maximum time, in the telephone service channel, to directly contact the attendant, when selecting this service or when exchanging between attendants, should be up to 60 seconds (1 minute).

For the present study the collected sample was 170 responses, in which the questionnaire was published on the internet and demanded a relatively short time of the volunteers who responded. This questionnaire has the same scale of evaluation that Anatel used in its research, the Likert scale. The questionnaire consists of 8 questions. For purposes of data stratification, the first two questions are about the age and sex of the users. The three following questions are for identification of the DDD, the type of plan and the operator used, in order to classify the operators according to the region and the plan.

The DDD, mentioned above, means Direct Dialing Distance. Each state in Brazil has a DDD number, which must be placed if you wish to make a call to a different state or region. This survey analyzed only the DDD 42 to compare with the time data from Anatel.

The DDD 42 belongs to the State of Paraná, in Southern Brazil, as can be seen in Figure 1.

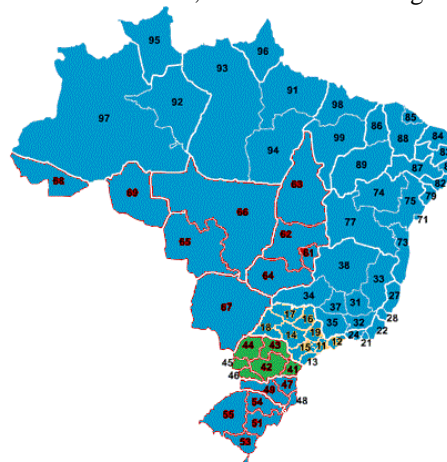


Figure 1. DDD in Brazil

The sixth question involves three questions to be answered by the Likert scale, in which one wishes to know the degree of satisfaction or dissatisfaction with the ability to solve the problems of the operator, the service channels (telephone, internet, shop) and quality of making and receiving calls. The last two questions are related to making calls to the operator and the expected time to be answered

by an employee in that call, in order to analyze if the expected time corresponds to the time that is determined by the legislation. The normality of the number of responses will be verified through the Kolmogorov-Smirnov test, using SPSS software. The quality measurement of the mobile phone service was made by comparing how much time a customer waits to talk with an attendant and the Anatel's Resolution.

3.2. Determining the mobile service capability

The capability of the mobile phone service was measured through the use of Statistical Process Control by using Shewhart Control Chart for Individual Measurements and Moving Range. For the control chart for individual measurements, the parameters were calculated using equations 1-4, as described in section 2.3.

The data used to determine the parameters above were the time the consumer waits to speak with an attendant. Calculations can be performed using \bar{x} which is the mean, MR which is the moving range and d_2 which is a constant value according to the number of observations in the sample. Since the sample size is one, d_2 always takes the value of 1.128.

To determine the C_p and C_{pk} indexes of the service in question, it is necessary to have the upper specification limit and lower specification limit values as these values are external to the service. So, they will be determined as follows: the LSL (lower specification limit) will be considered as the time ideal according to the Anatel resolution; the target value of the specification will be the result obtained as the average of the times that consumers consider acceptable for this service and the USL (upper specification limit) will be the symmetrical end corresponding to the lower limit of specification. Both indexes were determined by using equation 5 to 8, as described in section 2.3.

The analysis of the control charts will be carried out and the special causes will be eliminated from the process until a controlled process is obtained, then the capability indexes will be calculated. The results will be obtained through the use of the software *Excel* and *Action Stat*.

3.3. Results analysis procedures

The verification of the questionnaire's results will be given after the period of data collection, since from the data obtained will happen the conversion of the values into indexes, in the same scale used by Anatel, which will allow the comparison with the indexes made available by this institution. Anatel (2016) calculates these indices using the Likert scale, where 0 = "Totally Unsatisfied" and 10 = "Completely Satisfied", the users judged their degree of satisfaction according to this scale and from the calculation of the average of these notes to find the customer satisfaction index.

In order to achieve the main objective of this research, there will be verification of compliance with Resolution 632, regarding the waiting time of the user in the telephone service, which should be up to 60 seconds after the request of the "speak with the attendant" option, also the use of Statistical Process Control to measure the service capacity using the index C_p and C_{pk} , and the comparison of these indexes.

4. Results and Discussion

4.1. Results obtained from the questionnaire

The questionnaire was answered by 170 people who have direct dialing distance (DDD - 42) in the state of Paraná (Southern Brazil), with 88 females and 82 males. Concerning the age group of the public that answered the questionnaire, people aged 21 to 29 years were the majority with 128 people that correspond to 75% total, followed by 18 people aged between 18 and 20 years, 10

people aged 30 and 39, 8 people aged between 40 and 49 years, 4 people aged 17 years or less and 2 people aged between 50 and 59 years. Therefore, it is possible to verify the heterogeneity that the service possesses, since it must attend to people of different sex and age, being able to thus classify it also as a mass service.

Among the operators in the state of Paraná, Operator A was the most expressive with 99 people, followed by Operator B with 46 people, Operator C with 13 people, Operator D with 11 people and Operator E with 1 person

Regarding the degree of satisfaction with the problem solving capacity of the operators, approximately 67.7% of respondents answered that the level of satisfaction using the Likert scale is between 5 and 8, value considered in the classification of satisfaction as average. While approximately 27.5% have a degree of satisfaction below 4, indicating low satisfaction with the service offered by the operators.

The satisfaction of the mobile phone users, who answered the questionnaire, regarding the service channels (telephone, internet, store) of the operators, can be classified as average, for approximately 62.7% of respondents said that the level of Satisfaction following the Likert scale is between 5 and 8. And, approximately 32.5% of the respondents say they have low satisfaction with the service, because they classified it with a grade lower than 4.

Furthermore, respondents' satisfaction with quality and the ability to receive and make calls should also be classified as average, as approximately 56% of respondents stated that the satisfaction level adopting the Likert scale is between 5 and 8. Also, almost 25.5% of the respondents say they have a degree of satisfaction below 4, which are considered values of low satisfaction.

By means of the data analysis, it is possible to infer that only approximately 4.8% of the mobile phone operators' customers evaluated the problem solving capacity and the service offered with notes 9 and 10, values that indicate a high satisfaction. While in relation to the quality of calls made and received, approximately 19% of respondents say they are satisfied with the service. The index of high satisfaction with the services of the operators is very low in relation to the values classified as of medium and low satisfaction.

Thus, it is possible to verify the need to apply the principles of services such as understanding, estimating and accompanying the customer, using appropriate technology, innovating, hiring correct people, training on the basis of profile, determining standards and performance measures, so that it can increase the quality of services and satisfy customers.

In order to analyze the perception versus the expectation of the mobile telephone user, it was compared the waiting time data to talk with the attendant and the reasonable time for this service according to the answers obtained by the questionnaire. Figure 2 shows that less than 2% of respondents stated that they were answered within 1 minute, which is the time determined in Resolution No. 632, article 27.

Figure 3 shows that only 12.35% of the consumers believe that the waiting time for the service should be 5 minutes. Still, approximately 86% of survey participants believe that 3 minutes or less should be the time to wait to speak to an attendant when in call with the mobile operator they hired.

Only 23.42% of those respondents claim they were served in less than 3 minutes (according to Figure 2). Therefore, there is a great disparity between the consumer's expectation and the reality that is offered.

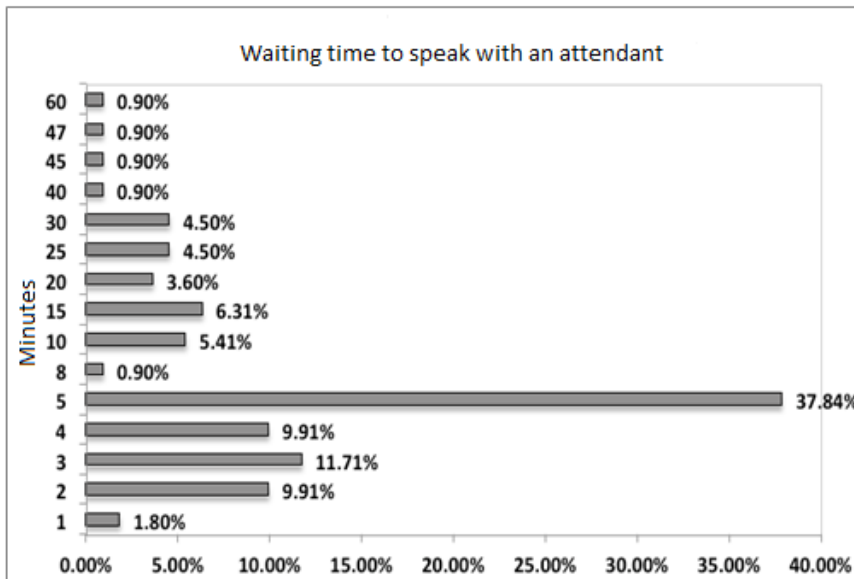


Figure 2. Results of the questionnaire

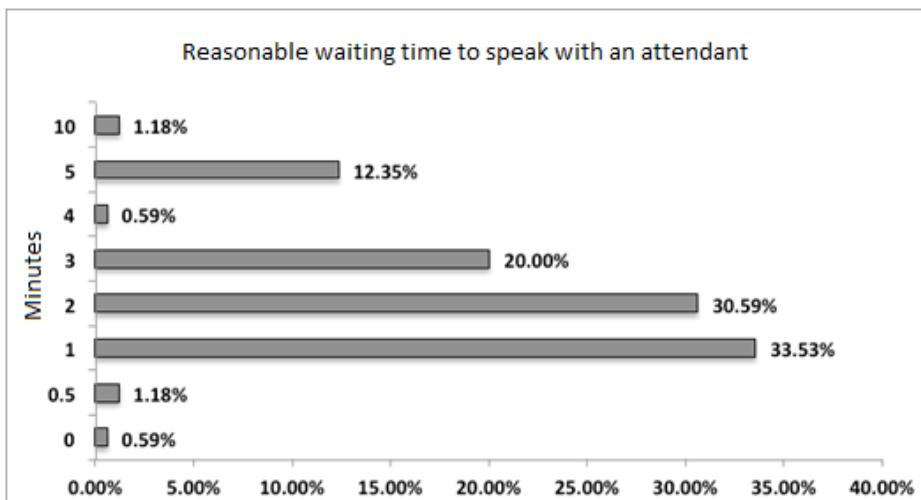


Figure 3. Results of the questionnaire

4.2. Comparison between the data (Anatel x Questionnaire)

Following the classification made by Anatel, through the stratification of the data it was possible to separate the users' evaluations for each question according to their respective

operator. As shown in Figure 4, in the comparison of the customer satisfaction of Operator A, B and D in relation to the Resolution Capability, there was an increase, while for the customers of Operator C this satisfaction decreased.

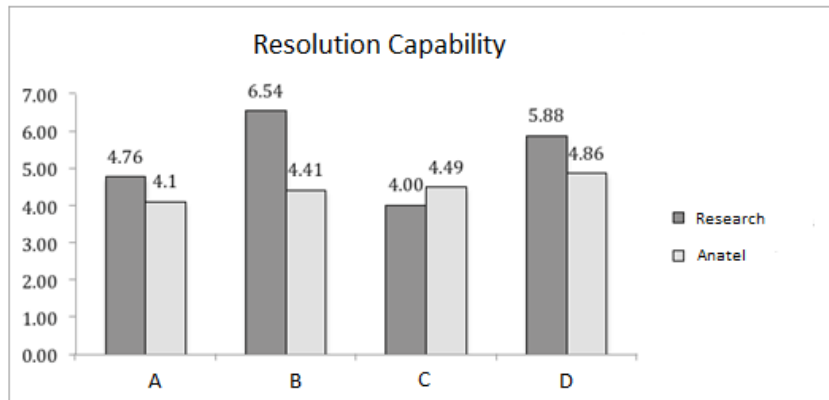


Figure 4. Indicator of Resolution Capability

The same comparison was made to the satisfaction of the users according to the Channels of attendance of the operators through the telephone, internet and store

channels, in which the four service providers decreased the level of service compared to the Anatel survey, as shown in Figure 5.

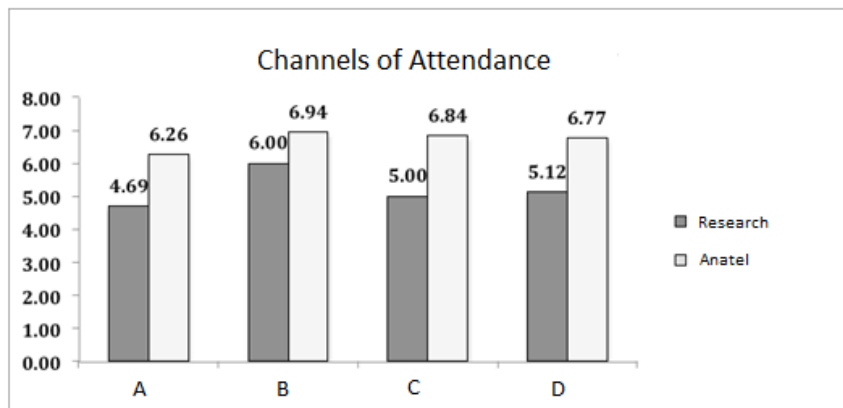


Figure 5. Indicator of Channels of Attendance

Also, a comparison was made between the public evaluation of the questionnaire on the ability to make and receive calls and Anatel's research (Indicator of Operation), and the result was that customer satisfaction with Operators A, C and D decreased, while Operator B customers are more satisfied regarding the attribute shown in Figure 6.

However, it can be inferred that for the most

part customer satisfaction with the mobile service declined in relation to the survey conducted by Anatel. This ratifies the necessity of the application of the dimensions of the service as the service, reliability, competence, consistency, courtesy, credibility, access, communication, convenience, speed, flexibility and understanding of the needs of the customer, by the operators

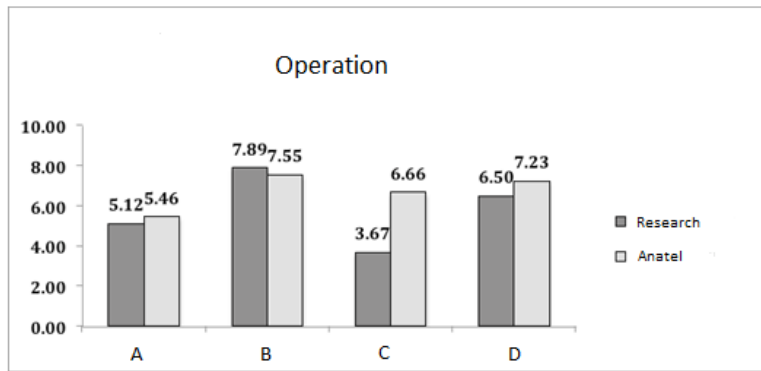


Figure 6. Indicator of Operation

4.3. Statistical analysis of data

By statistical analysis of Kolmogorov-Smirnov, the distribution of the sample, in relation to the time that the public of the questionnaire said to have waited, is normal. Considering that only 110 people out of 170

who answered the questionnaire stated that they had contacted the mobile operator, the average time users waited for the service was $\bar{x} = 9.3818$ min and the standard deviation $s = 10.74302$ min, as can be seen in Table 3.

Table 3. Kolmogorov-Smirnov test for the data

		Time
N		110
Normal Parameters	Mean	9.3818
	Std. Deviation	10.74302
Most Extreme Differences	Absolute	0.367
	Positive	0.367
	Negative	-0.228
Test Statistic		0.367
Asymp. Sig. (2-tailed)		0.001

Also, using the statistical analysis of Kolmogorov-Smirnov the sample distribution in relation to the time considered reasonable to expect according to the audience of the questionnaire is normal. The total of 170 people answered this question, with that the

average of the waiting time considered reasonable by the service is $\bar{x} = 2.3118$ min and the standard deviation $s = 1.54609$ min. Table 4 shows the results.

Table 4. Kolmogorov-Smirnov test for the data

		Time
N		170
Normal Parameters	Mean	2.3118
	Std. Deviation	1.54609
Most Extreme Differences	Absolute	0.239
	Positive	0.239
	Negative	-0.180
Test Statistic		0.239
Asymp. Sig. (2-tailed)		0.000

According to tables 2 and 3 data are normal and the average real time is approximately 4 times higher than the average considered ideal, meaning: people desire to wait 2.31 minutes, but they actually wait 9.38 minutes. The Anatel's resolution recommends that the waiting time is only 1 minute.

4.4. Evaluation of the capability

Using the software Excel and Action Stat, it was possible to analyze the conformity of the mobile service in the state of Paraná,

Southern Brazil. With the inclusion of the data acquired in the questionnaire, the Action Stat generated for the sample of the values of the time that the users waited for the attendance of a telephone operator the following parameters: UCL = 34.18, center line = 9.38 and the LCL = 0 for the Chart of Individual Values.

Using the same data, but for the Moving Range chart, the UCL values = 30.48, the center line = 9.33, the LCL = 0 and the $\sigma = 8.26$. Figure 7 illustrates both graphs:

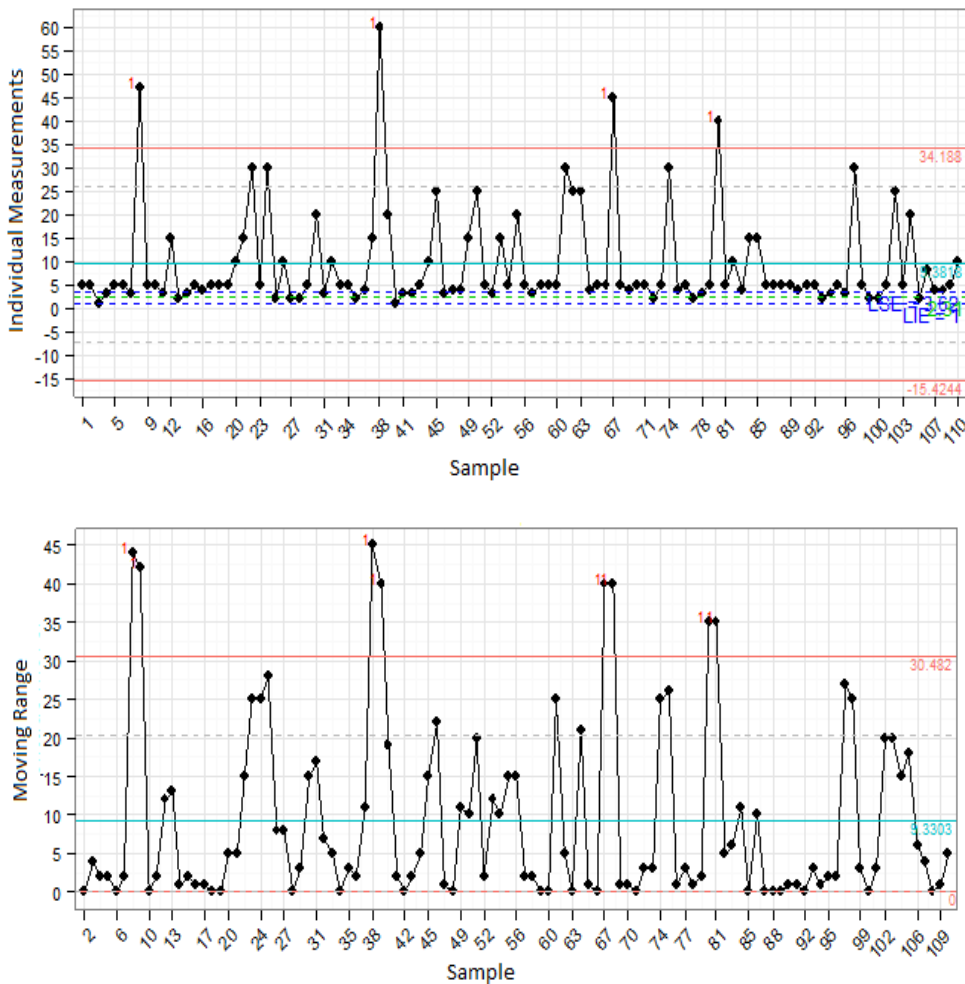


Figure 7. Control charts

It is possible to verify several points outside the control limits for the two graphs, so all the nonconforming points of the both graphs were eliminated until both graphs has all the points within limits. According to Montgomery (2009) the control chart provides information about the value of process parameters and their stability. This allows an estimate of process capability to be made.

The elimination of the points outside the control limits was done initially from the observation of the moving range graph and

later the graph of individual measurements, both generated by the software Action Stat. After the exclusion of the nonconforming samples, new graphs were generated for the individual measurements and the moving range, and again it was observed if the points were within the specified limits. This exclusion process was repeated 13 times, eliminating the total of 69 points, and made it possible to reach a process with all points within the control limits for the two graphs, meaning a stable process. After this procedure, both graphs are shown in Figure 8:

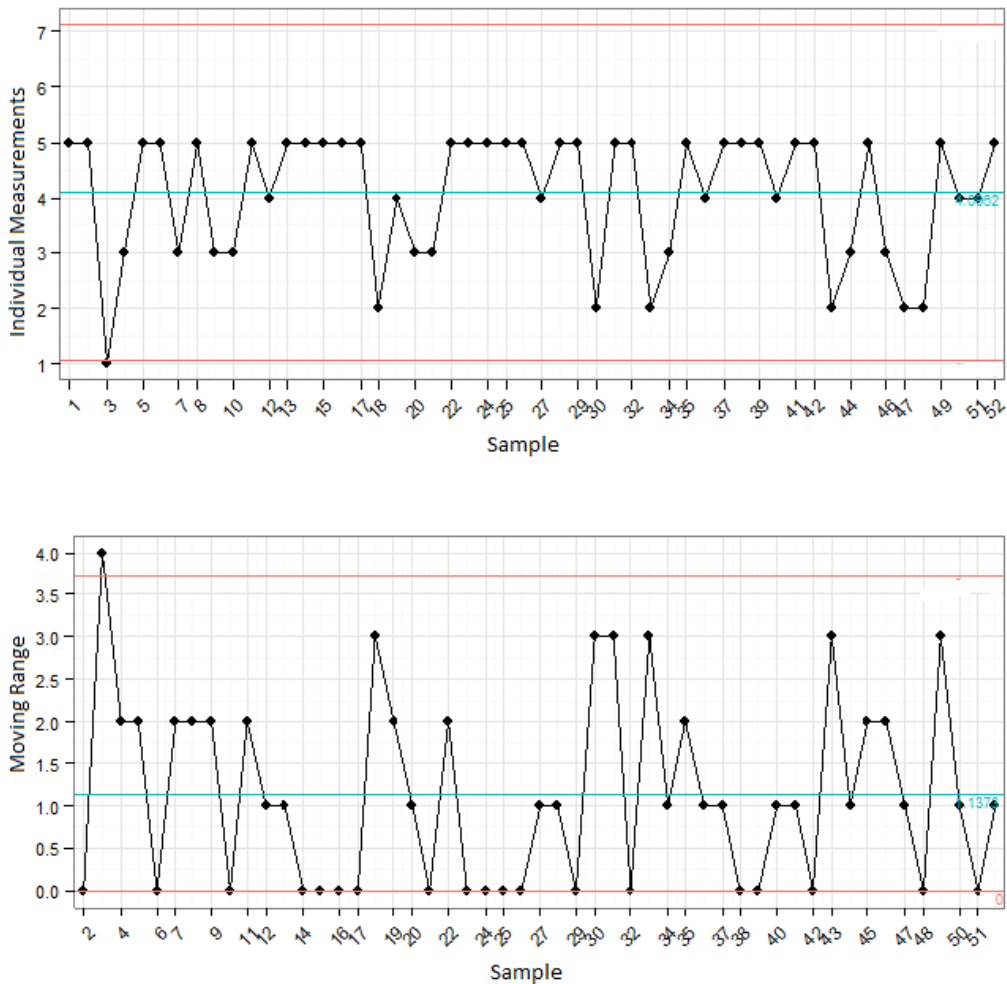


Figure 8. Control charts

The following parameters were obtained: UCL = 7.02, center line = 4.15 and the LCL = 1.28 for the Chart of Individual Values. Using the same data, but for the Moving Range chart, the UCL values = 3.52, the center line = 1.06, the LCL = 0 and the $\sigma = 0.95$.

From the evaluation of these data it is possible to notice that it was necessary to decrease from 110 samples to 51 samples to obtain a service in control. However, despite the reduction of the sample size, the mean of the real time is practically twice as large as the average of the considered ideal time, according to the values expected by the users. Eliminating the points that were above the upper limit control, the average people expect to talk to an attendant is 4.15 min, almost twice as long as people said to be ideal, 2.31 min. This shows the inefficiency of the service provided in relation to the desired by the consumers and also to what is established by Anatel.

After verifying that the service is in statistical control, it was possible to determine the capacity. Values were defined for the mean ($\bar{x} = 2.31$ min), referring to the maximum time that the respondents said was the average time they were willing to wait, also the LSL = 1 minute, since according to Anatel this is the time users should wait for the service and the USL = 3.66 minutes based on the values of the mean and lower control limits.

Service Capability was determined using the C_p and C_{pk} indexes, using Action Stat. The index $C_p = 0.45$ indicates that the service is using more than 100% of its tolerance limits, since it is less than 1; this means that lots of users will be wait for more than 1 minute to talk with an attendant. The index $C_{pk} = -0.18$ demonstrates that the service is not capable to meet users in 1 minute maximum.

Finally, the expected indexes show that for every one million calls made, only 486 will be answered in less than one minute, which is the time set by Anatel and that 712571 calls will be answered with a time higher than the upper limit of specification, which was

defined through the data obtained in the questionnaire.

5. Final considerations

The comparison of Anatel's satisfaction survey and the data obtained in the questionnaire, showed a decrease in the satisfaction of the mobile phone users in Southern Brazil in relation to the perceived quality, implying in the decline of the quality of the service provided by the operators. The regulatory agency should take measures, such as setting customer satisfaction goals for compliance with established laws in relation to this service and also for the appropriate service to the public that uses the mobile services.

The waiting time for the attendance of the users of mobile phones when in connection with the operator could be evaluated through Statistical Process Control. The graphs used were the Individual Measurements and Moving Range, which presented several special causes. After the elimination of the special causes, it can still be verified that the service exceeded the limits of control that were determined according to the needs of the user and delimitation of the Anatel. Therefore, it is possible to affirm by observing the results found using the indexes C_p and C_{pk} that the service has a high number of nonconformities, is not centered and its limits are well above specifications.

The quality of the mobile service was generally evaluated as a poor quality service, since it does not have the capacity to meet the specifications delimited by Anatel, as well as what is demanded by the users. It is recommended that the mobile operators improve the service to the users qualifying its employees and reducing the waiting time in the calls to the operator.

Also, telephony coverage must be increased to cover a greater range of locations and thus ensure that the making and receiving of calls has a high degree of quality. Also, Anatel, as a regulatory and supervisory agency, must

require that companies comply with the laws related to this service and serve the consumer in an adequate way in order to increase satisfaction with the service, by increasing the service capability.

In this way the work contributes to the society being aware of the quality of the service that

is offered and can thus claim their rights with Anatel. Also, companies can evaluate the service provided and obtain savings by reducing their costs of external failures. In addition, minimizing customer waiting time makes it possible to improve the quality of service and increase satisfaction with the service.

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