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DETERMINATION OF FACTORS THAT MEASURE THE QUALITY OF SERVICE IN COMPUTER CENTERS OF THE CABORCA CAMPUS OF ``UNIVERSIDAD DE SONORA``

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Abstract: The purpose of this work is to identify the factors that determine the quality of the services offered by the computer centers of the Caborca Campus of ``Universidad de Sonora``, Mexico. For this purpose, a survey was designed to find out the perception of the services from the point of view of the users. This instrument consists of twenty-four variables that constitute SERVQUALing (which is also a variation of SERVQUAL, a model that measures service quality), and was applied to users of computer centers, seeking to determine the dimensions that constitute the quality of services construct for the computer centers under study. Thus, the variables and criteria that allowed measuring the quality of the service were established, from which the survey was designed, which was applied to 181 users, out of the 1,201 that make up the population, which allowed determining the structure of the variables using the multivariate statistical method of Factor Analysis. The results indicate that the scale obtained is reliable and valid to evaluate the quality of service in information centers and the construct is made up of three dimensions, which were called elementary services, complementary services and tangible elements and image.
Keywords: Quality of Service, factor analysis, perception, surveys.

INTRODUCTION

Service quality is of paramount importance to achieve efficiency and effectiveness in organizations, both public and private. Therefore, measuring and evaluating the results of this is the basis for diagnosing the problems of companies to design and implement strategies to achieve competitive advantages.

The study that is reported had the objective of determining the number of factors as the construct of quality is integrated in the service of an Information Center of a Higher Education Institution in order to group the variables more efficiently.

One of the models to explain the quality of service is the SERVQUAL proposed by Parasuraman, Zeithmal and Berry (1988, 1991, 1994); taken up by Mejías and Manrique (2011) and Torres-Rodríguez et al. (2018). They maintain that the quality offered is represented by the amplitude of the difference that exists between the expectations or desires of the clients (expected service) and their perceptions (received service). For the development of this study, an adaptation of the SERVQUAL scale was used, called SERVQUALing, which considers only perceptions and which, according to Mejías (2005), Mejías Reyes and Maneiro (2006), is the most used, reliable and accepted scale for measuring the quality of services.

SERVQUALing consists of 22 items related to the five dimensions (tangible elements, reliability, responsiveness, security, and empathy) plus two general questions about the quality of services, giving a total of 24 items.

This article is structured as follows: background, key terms, in the introduction, the methodological framework is indicated; Then, as part of the results and discussion, the analysis of the factors is carried out, after demonstrating the adequacy of the data; Likewise, the respective reliability and validity analyzes of the scale used are carried out, the dimensions are determined, to end with the conclusions of the investigation and the respective references.

METHODOLOGY

This research, of a descriptive nature and of a mixed nature (qualitative-quantitative), begins, however, with a review of the literature, to support the factors that determine the quality of the services in the computer centers

in the case study.

Subsequently, the information was obtained directly from the users, through the application of a survey, previously designed based on the SERVQUAL model and specifically SERVQUALing, which considers only perceptions. The five dimensions of this instrument are: Tangible Elements (ET), Reliability (FI), Response Capacity (CR), Security (SE) and Empathy (EM) as shown in Table 1.

The population under study was made up of those users who visited the computer centers. Said population is finite, according to figures provided by the school services department at Campus Caborca, there are around 1201, so a sample of 181 was selected.

In this research, the multivariate statistical technique of Factor Analysis was applied to identify the dimensions that characterize the quality of services in the case under study. To facilitate the analysis of the data, the SPSS® software and the Office® Excel spreadsheet were used.

PROCEDURE

Once the literature review was carried out to support the research, a questionnaire was designed based on the SERVQUAL and SERVQUALing models, where the items were adapted to the computer context, and which only contemplates the measurement of the perceptions of Service Quality. The designed questionnaire included 24 items intended to measure the quality of service. The respondents were in charge of evaluating the different items through a Likert scale of 5 categories, with 1 being the lowest possible value and 5 the highest value. Additional questions were added to the SERVQUAL model, to determine if they are also representative of the Quality of Service provided by the computer centers under study. A sample of 181 users of the 1201 that make up the population was selected, which represents 15% of it.

FACTOR ANALYSIS

Research studies are often made up of multivariate data, so it is necessary to use multivariate statistical techniques. Among these techniques is the factorial analysis (FA) that is characterized by its multiple uses. In general, two types of factor analysis are known: exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) (Hair et al. 2010; Vega, 2014).

Factor Analysis aims to reduce or condense the information contained in a series of original variables into a smaller number of new dimensions (or factors) with the least possible loss of information (Mínguez and Fuentes, 2004). It is a statistical technique of multivariate analysis to determine the structure of interrelationships between a large number of variables to determine a set of common underlying dimensions called factors (Fernández, 2009). The basic condition for the applicability of Factor Analysis is focused on making sure that there is a sufficient number of correlations between the variables.

On the other hand, in the CFA, the extent to which a theoretically organized set of factors fits the data is evaluated. In this type of analysis, the researcher plays a much more important role, since the greater the knowledge of the problem, the greater the ability to formulate and test much more concrete and specific hypotheses (Hair et al., 2010; Hernández and Espinoza, 2017). In this type of analysis, a level of confidence must be established in order to evaluate whether or not the hypotheses proposed are rejected.

The application of factor analysis for this research is developed according to the stages considered by Salvador and Gallardo (2006):

Item	Description
ET_1	The center has equipment with a modern and attractive appearance.
ET_2	The physical facilities of this center are visually attractive
ET_3	The staff at this center look neat.
ET_4	The issued documents (Letters, reports, etc.) are visually attractive
FI_5	When the manager promises to do something by a certain time, he does it
FI_6	The staff notifies you when the service provided will end
FI_7	The manager performs the service well from the first time
FI_8	The person in charge of this center concludes the service in the promised time
FI_9	The manager strives to keep your file (records) free of errors
CR_10	When you have a problem, a sincere interest in solving it is shown
CR_11	This center offers you a punctual service
CR_12	The manager of this center is always available to assist you
CR_13	The manager of this center is always willing to help you
SE_14	The behavior of the person in charge of the center inspires you confidence
SE_15	Do you feel safe in your procedures carried out in this center
SE_16	The manager who provides services in this center is always kind to you
SE_17	The manager has enough knowledge to answer your questions
EM_18	The manager of this center gives you individualized attention
EM_19	The center has convenient working hours for all its users
EM_20	This center has staff that offers you personalized attention
EM_21	The computer center cares about the best interests of its users
EM_22	This center understands your specific needs
General1	Users of this center are satisfied with the services provided
General2	The knowledge acquired will help you increase your standard of living

Table 1. Original scale structure: SERVQUALing.

Source: Adaptation of Mejías (2005).

1 elementary services. Own and minimum necessary assistance from the main means of the business such as human resources.	
EM_21	The computer center cares about the best interests of its users
SE_17	The behavior of our staff inspires you confidence
CR_13	When our staff promise to do something by a certain time, they do it
SE_14	The behavior of the person in charge of the center inspires you confidence
FI_5	When the manager promises to do something by a certain time, he does it
FI_8	The person in charge of this center concludes the service in the promised time
2 complementary service. Competitive options that give extra added value to the customer	
FI_7	The manager performs the service well from the first time
CR_11	This center offers you a punctual service
SE_16	The manager who provides services in this center is always kind to you
CR_10	When you have a problem, a sincere interest in solving it is shown
EM_19	The center has convenient working hours for all its users
ET_2	The physical facilities of this center are visually attractive
CR_12	The manager of this center is always available to assist you
EM_18	The manager of this center gives you individualized attention
3 tangible elements and image. Visualization of the facilities, equipment and material with information	
ET_1	The center has equipment with a modern and attractive appearance.
ET_2	The physical facilities of this center are visually attractive
ET_4	The issued documents (Letters, reports, etc.) are visually attractive
EM_20	This center has staff that offers you personalized attention
FI_6	The staff notifies you when the service provided will end
FI_9	The manager strives to keep your file (records) free of errors

Table 5. Factors that determine the quality of computer services.

Source: Own elaboration from factorial analysis.

a. Problem formulation

As a first step, a selection of the variables to be analyzed must be made, as well as the elements of the population in which said variables are going to be observed. It is essential that the variables collect special aspects of the subject to be investigated and their selection must be marked by the underlying theory of the problem. In this investigation, the following preliminary factors were chosen to evaluate the quality of computer services: tangible elements, reliability, response capacity, security and empathy; which are assumptions of the latent variables in which the variables of the applied survey could be grouped.

b. Analysis of the correlation matrix

After formulating the problem, we proceed to obtain the sample correlation matrix from the sample data, to then proceed to analyze said matrix and decide if the factorial model is adequate.

For the use of the technique to be pertinent, it is convenient that said matrix contain groups of variables that are strongly correlated with each other (Pardo and Ruiz, 2002; Hair et al., 2010; Hernández and Espinoza, 2017). The determinant of the correlation matrix is an indicator of the degree of intercorrelations (Martín, Caberos and de Paz, 2008), if the determinant is very low, the correlations are very high; the value of the

determinant presented is small for the case studied (Det=1.43E-10), which is evidence of the adequacy of the analysis, since when the variables of a matrix are linearly related, the value of the determinant approaches zero, which means that Factor Analysis is a pertinent technique to analyze these variables.

Additionally, a measure that indicates the appropriateness of the application of Factor Analysis is calculated: the Kaiser-Meyer-Olkin (KMO) sample adequacy measure, which is an index that compares the magnitudes of the observed correlation coefficients with the magnitudes of the partial correlation coefficients. From Vicente and Oliva and Manera (2003); (Hair et al., 2010); Vega (2014); Hernández and Espinoza (2017) and Tabachnick and Fidell (2019) consider KMO values between 0.8 and 0.9 to be very good; and those greater than 0.5 are considered acceptable. The result for the KMO measure (0.953) is considered very good and verifies the use of the technique to explain the data, so the principal component extraction method can be applied to find the factors.

For this research, the principal component method was used as the extraction method. Which consists of obtaining inter-correlated factors that were a linear combination of the original variables, so that by selecting a small number of them they would explain the total variability of these variables (Kaiser, 1960; Carrasco, 2004; Tabachnick and Fidell 2019). In obtaining the number of factors, the explained variance is around 60% (Morales, 2011) and the initial eigenvalues greater than one (De Vicente and Oliva and Manera, 2003; Tapia, 2007; Vega, 2014) are normally used as criteria. The total explained variance of the three factors or dimensions obtained accumulates 68.456%, which meets the established criteria.

To facilitate the interpretation of the solution obtained from said analysis, the VARIMAX Rotation method was used, which aims to minimize the number of variables that have high loads on a factor. If the contribution is high, it is indicative that a large part of the variance of each variable is collected in the selected factors, and by using these factors instead of the variables, not much information is lost. In the rotated component matrix of the applied model, the load for the first factor with a total of 10 variables, the second with 6 and the third with 6.

	Component		
	1	2	3
FI_7	.755	.417	
SE_16	.713	.417	
CR_11	.710	.373	
CR_10	.699	.410	.385
EM_19	.678		
ET_3	.678		
CR_12	.647	.324	.329
EM_22	.609		.598
EM_18	.564	.436	.412
SE_15	.544		.470
EM_21		.846	
SE_17	.317	.821	.319
SE_14	.426	.785	
CR_13	.420	.778	
FI_5		.714	.366
FI_8	.379	.702	.338
ET_1			.712
ET_2	.558		.681
ET_4		.572	.633
EM_20		.493	.607
FI_6		.409	.563
FI_9			.544

Table 2. Array of rotated components [a]

Principal component analysis. Varimax normalization with Kaiser.

a) The rotation has converged in 7 iterations.

Source: Own elaboration based on factor analysis.

As it can be seen in Table 2, there are four variables EM_22, SE_15, which point to two factors at the same time with a difference in

loads of less than 0.10, so it has been decided to eliminate them and run the factorial analysis again with the 20 variables that remained in Table 3. When analyzing this last Table, it can be observed that there are no items that point to two factors at the same time, nor differences between loads of less than 0.10. This indicates that this Table is the one that represents the factors and items for the quality construct in the services of the computer centers in this study.

	Component		
	1	2	3
EM_21	.846		
SE_17	.815	.316	.330
CR_13	.791	.407	
SE_14	.784	.421	
FI_5	.715		.369
FI_8	.704	.375	.339
FI_7	.426	.752	
CR_11	.367	.719	
SE_16	.408	.719	
CR_10	.420	.696	.372
EM_19		.692	
ET_3		.686	
CR_12	.332	.647	.319
EM_18	.458	.554	.386
ET_1			.716
ET_2		.565	.676
ET_4	.568		.635
EM_20	.486		.612
FI_6	.367		.607
FI_9			.543

Table 3. Array of rotated components [a]

Extraction method: Principal component analysis. Varimax normalization with Kaiser.

a) The rotation has converged in 9 iterations.

Source: Own elaboration based on factor analysis.

MODEL PROPOSED FOR ANALYSIS

After the identification of the factors as a whole, the meaning of the variables is interpreted and searched to describe each dimension. These were the steps that made it possible to specify the final model, grouping the variables into the corresponding factors, as can be seen in Table 5.

Reliability was also determined with Cronbach's Alpha, resulting in an Alpha of 0.965 globally and by dimensions as shown in Table 4.

Factor	Cronbach's Alpha
1	0,954
2	0,929
3	0,856

Table 4. Reliability by dimension of the construct.

Source: self made.

As it can be seen both globally and by dimension, Cronbach's Alpha results were obtained above acceptable levels (Caetano, 2003; Vega, 2014; Hernández and Espinoza, 2017).

INSTRUMENT VALIDITY

Validity indicates the degree to which conclusions can be inferred from the results obtained; It is the degree to which an instrument actually measures the variable that it seeks to measure (Hernández, Fernández and Baptista, 2010; Abascal and Grande, 2005), when it measures what it is intended for, in this case, the quality of computer services.

Reliability analysis must be carried out to prove that a set of elements (items) of a scale can lead to highly results if the test is repeated. That is, to achieve similar results with the scale in different contexts (Merino & Lautenschlager, 2003; Hernández & Espinoza,

2017). An instrument is reliable when very similar results are obtained when applying it two or more times to the same group of individuals or when it is applied using alternative forms of the instrument (Visauta & Martori, 2013); Hernandez and Espinoza, 2017).

To determine the validity of the survey used in this research, different perspectives are used (Martín, 2004; Oliden, 2003; Babbie, 2009; Hair et al., 2010; Vega, 2014; Hernández and Espinoza, 2017), which can be summarized in the following approaches: content validity, criterion validity and concept validity.

A scale presents content validity if the items that compose it are relevant and are also representative of the defined attribute. In order for this criterion to be met, it is necessary that each variable to be measured in the instrument is supported by its respective conceptual definition or previously cited theory.

Content validity is represented by references to specialized literature and background information on the subject (López and Serrano, 2001; Acerenza, 2003; Alén, and Rodríguez, 2004; Alén, and Fraiz, 2004; Altés, 2006; Morillo, 2007, 2009; D'Armas, Barreto, and Mejías, 2011; Hernández-Sa mpieri, Fernández-Collado, and Baptista-Lucio, 2014, where indicators and data present in these investigations were reviewed from this material, which served for its subsequent adaptation in the proposed instrument and this way evaluate the quality offered by computer services.Taking into account the phases followed in the research process, it is considered that the content validity is evidenced.

Criterion Validity establishes the validity of a measurement instrument by comparing it with some external criterion applied to the same sample at the same time. Criterion validity can be classified as concurrent and predictive (Wiersma & Jurs, 2008; Hernández-Sampieri, Fernández-Collado & Baptista-Lucio, 2014).

To determine if the instrument presents *concurrent validity*, the respondents are classified into two groups as suggested by Mejías and Manrique, (2011), the first formed by those whose mean scores are below the general average (low perception) and the other with mean scores that were above the average (high perception); then the existence of significant differences between both groups is determined, using an auxiliary question that was included in the survey that measures the quality of service in general. To determine whether or not there is a significant difference between the groups, the Mann Whitney U test (Montgomery & Runger, 2011; Wackerly, Mendenhall & Sheaffer, 2008) is applied, which is a non-parametric test that analyzes the degree of separation of the samples. The smaller this separation, the more reasonable the underlying explanation will be considered. This test does not require normality of the data and is a good alternative to the student's T test for testing for mean differences. The significance level of the test was less than 0.01 and it obtained a Z value of -8.884, thus demonstrating the concurrent validity.

To determine the *predictive validity*, a multiple regression analysis was performed between variables (Montgomery & Runger, 2011; Wackerly, Mendenhall & Sheaffer, 2008), between the variable that measures satisfaction with the service (dependent variable) and the average of the scores for factors of the model (independent variables). The results obtained reflect a determination coefficient (R2) of 0.745, demonstrating that there is a high relationship between the general service satisfaction variable with the group of variables belonging to the proposed model. A significance level of less than 0.001 of the F statistic was also obtained, which

corroborates the relationship between the variables.

Concept validity refers to the degree to which a measurement is consistently related to other measurements, in accordance with theoretically derived hypotheses concerning the concepts (or constructs) being measured. In this research, convergent validity is considered. There is convergent validity when the same phenomenon is measured in different ways and yields similar results. To test it, the Spearman correlation test was used (Wackerly, Mendenhall, & Sheaffer, 2008; Montgomery & Runger, 2011; Hernández-Sampieri, Fernández-Collado, & Baptista-Lucio, 2014; Vega, 2014; Hernández & Espinoza, 2017) and it was applied to the service quality item and the satisfaction item. The correlation coefficients obtained are 0.856 and 0.818 for the proposed model. The p-value for the model was less than 0.001, which reflects a significant relationship between the variables, which proves the convergent validity.

Full validity: it is evaluated considering all types of evidence. To the extent that the evidence of content validity, criterion validity, and construct validity is greater in an instrument, it will represent more of the variables it intends to measure.

Total validity = *content validity + criterion validity + construct validity.*

RELATIONSHIP BETWEEN RELIABILITY AND VALIDITY

A measuring instrument can be reliable, although not necessarily valid. It may be consistent in the results it produces, but it may not measure what is intended. It is required to prove that the measurement instrument is reliable and valid. Otherwise the results must not be taken very seriously.

RELIABILITY ANALYSIS

The reliability of the scale used was determined using Cronbach's Alpha coefficient. The result achieved for this analysis was 0.967 for the case under study, which indicates internal consistency of the responses. The values of Cronbach's Alpha coefficient are expressed on a scale from 0 to 1, where values close to the extremes express low or high internal consistency (Prat and Doval, 2003; Abascal and Grande, 2005; Hernández, Fernández and Baptista, 2010). The scale used measures the Quality of Service characteristic, which is interpreted as a guarantee of a high reliability of the instrument, taking into account previous research that considers values greater than 0.80 as good (Caetano, 2003; Vega, 2014; Hernández and Espinoza, 2017).

CONCLUSIONS

The factorial analysis is considered valid since the determinant of the correlation matrix obtained a value of 0.000000000143. Bartlett's sphericity test was significant, the KMO sample adequacy test was 0.953, and the Kolmovorov-Smirnov detailed Normality test was significant for all items. With these results it was valid to carry out a factorial analysis of the correlation matrix, in addition to the fact that, in relation to the Reliability of the instrument, a Cronbach's Alpha of 0.967 was obtained.

It is also valid to use the method of Principal Components with Varimax Rotation for factoring since the factors are independent. First, three factors with factor loads greater than 1 were obtained and that explain 65% of the total variance. Assigning an item to the factor with factor load greater than 0.5 was determined as a criterion. The load for the first factor was 10 variables, for the second it was 6 and the third with 6. The variables EM_22, SE_15, pointed to two factors at the same time

with a difference in loads of less than 0.10, resulting in redundancy, so it was decided to eliminate them and run the factorial analysis again with the 20 remaining variables.

With the new analysis, the factors were identified, interpreted and the meaning of the variables was sought to describe each dimension. These were the steps that allowed us to specify the final model, grouping the variables into the factors as follows:

Factor 1 Elementary Services. Own and minimum necessary assistance from the main means of the business such as human resources, with 6 variables.

Factor 2 Complementary Service. Competitiveness options that give extra added value to the customer, with 8 variables.

Factor 3 Tangible Elements and Image. Visualization of the facilities, equipment and material with information, with 6 variables.

This proposed model resulted in an explained variance of 68.46% and a reliability of 0.967, very adequate values for this type of study. For the validity of the instrument, the *concurrent validity* was analyzed with the Mann Whitney U test, the significance level of the test was less than 0.01 and a Z value of -8.884 was obtained, thus demonstrating the concurrent validity.

For the validity of the instrument, content validity, **criterion validity** and **construct validity** were considered. **Content validity** complies with the state of the art of this writing, and criterion validity is made up of concurrent validity and predictive validity.

Regarding the concurrent validity with the Mann Whitney U test, the significance level of the test was less than 0.01 and a Z value of -8.884 was obtained, thus demonstrating the concurrent validity. To determine the predictive validity, a multiple regression analysis was carried out between the variable that measures satisfaction with the service and the average of the scores by factors of the model and a coefficient of determination was obtained. (R^2) de 0,745, therefore, it is concluded that there is a **high relationship** between the service satisfaction variable and the group of variables belonging to the proposed model. A significance level of less than 0.001 of the F statistic was also obtained, which corroborates the existing relationship between the variables.

Concept validity refers to the degree to which a measurement is consistently related to other measurements. In this research, convergent validity was analyzed. There is convergent validity when the same phenomenon is measured in different ways and yields similar results. From the Spearman correlation test that was applied to the service quality and satisfaction items, the correlation coefficients obtained were 0.856 and 0.818 for the proposed model. The p-value for the model was less than 0.001, which reflects a significant relationship between the variables, which proves the convergent validity.

As the content validity, criterion validity and construct validity were high in the instrument of the proposed model, it represents more the variables that it intends to measure. In addition, since it was possible to prove that the measurement instrument is reliable and valid, it can be concluded that the proposed factors of e**lementary Services, Complementary Service and Tangible Elements and Image,**these are the factors that determine the quality of the services offered by the computer centers of the Caborca Campus of ``Universidad de Sonora``, Mexico.

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