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A neutrosophic SERVQUAL model approach to study the quality of teaching support services at a technological institute in Ecuador

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Abstract. In this paper we present the results of the determination of dissatisfactions based on the gaps detected in the students' expectations about the services offered by the different departments of the "Instituto Superior Tecnológico Bolivariano" (ITB) and what each of them perceives concerning those services, so, we delve into the root causes that provoke them. With this point of reference, in the future it is intended focusing on the management towards the continuous improvement of the involved processes, guaranteeing the satisfaction and fulfillment of the institutional strategic objectives. SERVQUAL model is used for allowing us to measure the quality of the service and determine the existing gaps between expectations and perceptions in each of the dimensions under study, namely: tangibility, reliability, response capacity, security, and empathy. SERVQUAL model is applied in a neutrosophic framework to deal with the indeterminacy and uncertainty of students' opinions. Thus, we convert a Likert-type scale into triple membership functions of single-valued triangular neutrosophic numbers per interviewed, to represent: agreement, indeterminacy, and disagreement. The comparison lead to in a decrease in the quality of the services perceived against expectations in the period evaluated. We provide a partial result that constitutes the continuity of the application of the approach within the institutional scheme started in 2017.

Keywords: Service quality, SERVQUAL, institutional management, single-valued triangular neutrosophic number.

1 Introduction

Improving quality standards in higher education has become a worldwide requirement. Those who are dedicated to quality assessment for accreditation purposes constantly refine their models and focus them on measuring management and results indicators that make it possible to obtain judgments on the effectiveness and efficiency of professional training. This new reality has boosted competitiveness among educational institutions.

The challenges faced by higher education institutions (HEIs) are increasingly growing and demanding as they are not only subjected to external and structured evaluation processes, but also to those internal and not so structured, but as demanding as the previous ones in which the students themselves play a very important role as clients of the educational services, and the third element and not least important is the competition.

Even though self-financed HEIs are by law non-profit institutions, performance in environments under pressure places them in the constant search for methods, approaches, or philosophies that guarantee the continuous entry and retention of students to maintain stability in the income and with this, strengthen learning environments, train professionals capable of responding to the demands imposed by society and be competitive in the market. Educational management that identifies and applies models and strategies focused on processes and continuous improvement, is therefore essential and aligned with the fulfillment of the strategic objectives and goals planned by the institution.

Institutional management focused on quality teaching processes breaks the traditional paradigms and places the student at the highest level of attention, just at the center, placing institutional strategies, established procedures, and systems at the extremes, and finally the students, teachers, and staff of the support processes, converging towards the center of attention that is the student.

Getting applicants for the higher education service to choose a certain institution requires a lot of resources and human efforts, but the most complicated matter is to manage keeping the students so that they fulfill all their academic processes satisfactorily. This is the point where the competitive advantage must go beyond the benefits that are offered, the quality of the services must be added, both academic and non-academic, which allows to

generate confidence in the students.

According to the state of opinions, we have perceived a negative judgment about the teaching support services at an Ecuadorian higher educational institution, the "Instituto Superior Tecnológico Bolivariano" (ITB). Therefore, we propose to study how to qualify the student's general opinion on the teaching received at ITB. Thus, we applied a survey to measure the quality of teaching at this institute. We decided to apply the SERVQUAL model, which is classical to studying the quality of services ([1]). On the other hand, because we are dealing with uncertainty and indeterminacy, we used single-valued triangular neutrosophic numbers for approaching to the neutrosophic framework the crisp values obtained in a crisp Likert scale ([2]). Thus, we applied SERVQUAL model to the de-neutrosified results. In literature SERVQUAL has been extended in many uncertainty frameworks as can be read in ([3-10]).

The paper has the following structure, first, there is a materials and methods section concerning to SERVQUAL model and single-valued triangular neutrosophic numbers. Section 3 is dedicated to showing the results of our study. Finally, Section 4 concludes this paper.

2 Materials and Methods

2.1. On the SERVQUAL model

Two models are known that can be used to measure the quality of service. The first of them is the SERVPERF model, which only works under the results of perceptions, and the second one is the SERVQUAL model, which allows expectations to be compared with perceptions ([1, 11-13]).

The SERVQUAL model is one of the main tools for measuring service quality. This model attempts to answer three essential questions: When is a service perceived as being of quality? What dimensions make up quality? And, what questions should be included in the quality questionnaire? The model was illustrated so that consumers' perceptions of quality are influenced by five gaps that occur in organizations as described below.

The first gap is related to the expectations of the clients and the perceptions of the company, they are based on the fact that the managers or administrators of the organizations do not always recognize which of the client's needs they have to satisfy. This prevents the generation of actions that make it possible to meet expectations about the service offered.

The second one is defined by the managers' perceptions and the quality specifications of the service offered. Even if the administration is clear about the expectations of the clients, that could be useless, since they do not know the standards of quality or norms that allow them to increase the level of quality.

On the other hand, the third of the gaps which includes quality specifications and service delivery, emphasizes ensuring that the service provided complies with all quality specifications and standards.

The penultimate gap is identified with the delivery of the service and what is communicated about it to customers. In this sense, advertising allows to create expectations among consumers, but it will depend on the organization if it can deliver what it is communicating.

The fifth gap marks the difference between the expectation of the service and the quality perceived by the customer. This gap is considered for the measurement of quality because consumer perceptions will depend on the causes that generate the four previous gaps.

The quality assessment questionnaire is made up of five dimensions, which are: reliability, responsiveness, security, empathy, and tangibility. "Reliability" refers to providing the service carefully and reliably. Whereas, "response capacity" is the willingness of staff to help or quickly solve customer requirements. The "security" consists of the trust generated by the service received. "Empathy" focuses on identifying alternatives to provide personalized attention. Lastly, "tangibility" relates to the appearance and functionality of physical facilities, equipment, personnel, and materials, and communication channels.

The SERVQUAL model is made up of two questionnaires with 22 items each of them, and they are assessed using a Likert scale. The first questionnaire is focused on knowing what the clients' expectations are about the service and the second questionnaire focuses on the perceptions of the quality of the service received.

2.2. The single-valued triangular neutrosophic numbers

Definition 1: ([14-17]) The *Neutrosophic set* N is characterized by three membership functions, which are the truth-membership function T_A, indeterminacy-membership function I_A, and falsity-membership function F_A, where U is the Universe of Discourse and $\forall x \in U$, $T_A(x), I_A(x), F_A(x) \subseteq]^-0, 1^+[$, and $^-0 \leq \inf T_A(x) + \inf I_A(x) + \inf F_A(x) \leq \sup T_A(x) + \sup I_A(x) + \sup F_A(x) \leq 3^+$.

See that according to Definition 1, $T_A(x), I_A(x), F_A(x)$ are real standard or non-standard subsets of $]^-0, 1^+[$ and hence, $T_A(x), I_A(x), F_A(x)$ can be subintervals of $[0, 1]$.

Definition 2: ([14-17]) The *Single-Valued Neutrosophic Set* (SVNS) N over U is $A = \{< x; T_A(x), I_A(x), F_A(x) > : x \in U\}$, where $T_A: U \to [0,1]$, $I_A: U \to [0,1]$, and $F_A: U \to [0,1]$, $0 \leq T_A(x) + I_A(x) + F_A(x) \leq 3$.

The *Single-Valued Neutrosophic number* (SVNN) is symbolized by $N = (t, i, f)$, such that $0 \leq t, i, f \leq 1$ and $0 \leq t + i + f \leq 3$.

Definition 3: ([14-17-21-22]) The *single-valued triangular neutrosophic number* $\tilde{a} = \langle (a_1, a_2. a_3); \alpha_{\tilde{a}}, \beta_{\tilde{a}}, \gamma_{\tilde{a}} \rangle$, is a neutrosophic set on $\mathbb{R}$, whose truth, indeterminacy, and falsity membership functions are defined as follows, respectively:

$$T_{\tilde{a}}(x) = \begin{cases} \alpha_{\tilde{a}}\left(\frac{x-a_1}{a_2-a_1}\right), & a_1 \leq x \leq a_2 \\ \alpha_{\tilde{a}}, & x = a_2 \\ \alpha_{\tilde{a}}\left(\frac{a_3-x}{a_3-a_2}\right), & a_2 < x \leq a_3 \\ 0, & \text{otherwise} \end{cases} \quad (1)$$

$$I_{\tilde{a}}(x) = \begin{cases} \frac{(a_2 - x + \beta_{\tilde{a}}(x-a_1))}{a_2-a_1}, & a_1 \leq x \leq a_2 \\ \beta_{\tilde{a}}, & x = a_2 \\ \frac{(x - a_2 + \beta_{\tilde{a}}(a_3-x))}{a_3-a_2}, & a_2 < x \leq a_3 \\ 1, & \text{otherwise} \end{cases} \quad (2)$$

$$F_{\tilde{a}}(x) = \begin{cases} \frac{(a_2 - x + \gamma_{\tilde{a}}(x-a_1))}{a_2-a_1}, & a_1 \leq x \leq a_2 \\ \gamma_{\tilde{a}}, & x = a_2 \\ \frac{(x - a_2 + \gamma_{\tilde{a}}(a_3-x))}{a_3-a_2}, & a_2 < x \leq a_3 \\ 1, & \text{otherwise} \end{cases} \quad (3)$$

Where $\alpha_{\tilde{a}}, \beta_{\tilde{a}}, \gamma_{\tilde{a}} \in [0,1]$, $a_1, a_2, a_3 \in \mathbb{R}$ and $a_1 \leq a_2 \leq a_3$.

Definition 4: ([14-17]) Given $\tilde{a} = \langle (a_1, a_2, a_3); \alpha_{\tilde{a}}, \beta_{\tilde{a}}, \gamma_{\tilde{a}} \rangle$ and $\tilde{b} = \langle (b_1, b_2, b_3); \alpha_{\tilde{b}}, \beta_{\tilde{b}}, \gamma_{\tilde{b}} \rangle$ two single-valued triangular neutrosophic numbers and λ any non-null number in the real line. Then, the following operations are defined:

1. Addition: $\tilde{a} + \tilde{b} = \langle (a_1 + b_1, a_2 + b_2, a_3 + b_3); \alpha_{\tilde{a}} \wedge \alpha_{\tilde{b}}, \beta_{\tilde{a}} \vee \beta_{\tilde{b}}, \gamma_{\tilde{a}} \vee \gamma_{\tilde{b}} \rangle$
2. Subtraction: $\tilde{a} - \tilde{b} = \langle (a_1 - b_3, a_2 - b_2, a_3 - b_1); \alpha_{\tilde{a}} \wedge \alpha_{\tilde{b}}, \beta_{\tilde{a}} \vee \beta_{\tilde{b}}, \gamma_{\tilde{a}} \vee \gamma_{\tilde{b}} \rangle$
3. Inversion: $\tilde{a}^{-1} = \langle ({a_3}^{-1}, {a_2}^{-1}, {a_1}^{-1}); \alpha_{\tilde{a}}, \beta_{\tilde{a}}, \gamma_{\tilde{a}} \rangle$, where $a_1, a_2, a_3 \neq 0$.
4. Multiplication by a scalar number:
$$\lambda\tilde{a} = \begin{cases} \langle (\lambda a_1, \lambda a_2, \lambda a_3); \alpha_{\tilde{a}}, \beta_{\tilde{a}}, \gamma_{\tilde{a}} \rangle, & \lambda > 0 \\ \langle (\lambda a_3, \lambda a_2, \lambda a_1); \alpha_{\tilde{a}}, \beta_{\tilde{a}}, \gamma_{\tilde{a}} \rangle, & \lambda < 0 \end{cases}$$
5. Division of two triangular neutrosophic numbers:
$$\frac{\tilde{a}}{\tilde{b}} = \begin{cases} \langle \left(\frac{a_1}{b_3}, \frac{a_2}{b_2}, \frac{a_3}{b_1}\right); \alpha_{\tilde{a}} \wedge \alpha_{\tilde{b}}, \beta_{\tilde{a}} \vee \beta_{\tilde{b}}, \gamma_{\tilde{a}} \vee \gamma_{\tilde{b}} \rangle, a_3 > 0 \; and \; b_3 > 0 \\ \langle \left(\frac{a_3}{b_3}, \frac{a_2}{b_2}, \frac{a_1}{b_1}\right); \alpha_{\tilde{a}} \wedge \alpha_{\tilde{b}}, \beta_{\tilde{a}} \vee \beta_{\tilde{b}}, \gamma_{\tilde{a}} \vee \gamma_{\tilde{b}} \rangle, a_3 < 0 \; and \; b_3 > 0 \\ \langle \left(\frac{a_3}{b_1}, \frac{a_2}{b_2}, \frac{a_1}{b_3}\right); \alpha_{\tilde{a}} \wedge \alpha_{\tilde{b}}, \beta_{\tilde{a}} \vee \beta_{\tilde{b}}, \gamma_{\tilde{a}} \vee \gamma_{\tilde{b}} \rangle, a_3 < 0 \; and \; b_3 < 0 \end{cases}$$
6. Multiplication of two triangular neutrosophic numbers:
$$\tilde{a}\tilde{b} = \begin{cases} \langle (a_1 b_1, a_2 b_2, a_3 b_3); \alpha_{\tilde{a}} \wedge \alpha_{\tilde{b}}, \beta_{\tilde{a}} \vee \beta_{\tilde{b}}, \gamma_{\tilde{a}} \vee \gamma_{\tilde{b}} \rangle, & a_3 > 0 \; and \; b_3 > 0 \\ \langle (a_1 b_3, a_2 b_2, a_3 b_1); \alpha_{\tilde{a}} \wedge \alpha_{\tilde{b}}, \beta_{\tilde{a}} \vee \beta_{\tilde{b}}, \gamma_{\tilde{a}} \vee \gamma_{\tilde{b}} \rangle, & a_3 < 0 \; and \; b_3 > 0 \\ \langle (a_3 b_3, a_2 b_2, a_1 b_1); \alpha_{\tilde{a}} \wedge \alpha_{\tilde{b}}, \beta_{\tilde{a}} \vee \beta_{\tilde{b}}, \gamma_{\tilde{a}} \vee \gamma_{\tilde{b}} \rangle, & a_3 < 0 \; and \; b_3 < 0 \end{cases}$$

Where, $\wedge$ is a t-norm and $\vee$ is a t-conorm.

Let $\tilde{a} = \langle (a_1, a_2, a_3); \alpha_{\tilde{a}}, \beta_{\tilde{a}}, \gamma_{\tilde{a}} \rangle$ be a single-valued triangular neutrosophic number, then,

$$S(\tilde{a}) = \frac{1}{8}[a_1 + a_2 + a_3](2 + \alpha_{\tilde{a}} - \beta_{\tilde{a}} - \gamma_{\tilde{a}}) \quad (4)$$

$$\mathbf{A}(\tilde{a}) = \frac{1}{8}[a_1 + a_2 + a_3](2 + \alpha_{\tilde{a}} - \beta_{\tilde{a}} + \gamma_{\tilde{a}}) \quad (5)$$

They are called the score and accuracy degrees of ã, respectively.

Let $\{\widetilde{A}_1, \widetilde{A}_2, \cdots, \widetilde{A}_n\}$ be a set of n SVTNNs, where $\widetilde{A}_j = \langle (a_j, b_j, c_j); \alpha_{\tilde{a}_j}, \beta_{\tilde{a}_j}, \gamma_{\tilde{a}_j} \rangle$ (j = 1, 2, …, n), then the *weighted mean of the SVTNNs* is calculated with the following Equation:

$$\widetilde{A} = \sum_{j=1}^{n} \lambda_j \widetilde{A}_j \quad (6)$$

Where λ_j is the weight of A_j, $\lambda_j \in [0, 1]$ and $\sum_{j=1}^{n} \lambda_j = 1$.

3 Results

The present work was carried out with a quantitative descriptive approach. The results obtained in the research will allow us for defining the existing gaps in the expectations and perception of the service that students receive during the second academic period that began in September 2019 and that lasted until February 2020, just before the beginning of the scourge of the pandemic caused by the COVID 19 virus.

The SERVQUAL model was used, specifically in the analysis of the fifth gap (expectations versus perception) where statistical indicators were obtained for each question and dimension, in turn, comparisons were made between the measurements.

The scope of the research is descriptive since this type of analysis is based on the description of the characteristics of the population under analysis concerning the variables under study. It is the non-experimental design of a transectional type since it analyzes the phenomenon in its natural context and the information is collected in a single moment.

Table 1 contains the questions asked in the SEVQUAL model.

Table 1. Questions asked in the SERVQUAL model, classified according to the corresponding dimensions.

	Dimension	Question
P1	Tangibility	Premises and facilities in good condition
P2	Tangibility	State-of-the-art classrooms and laboratories
P3	Tangibility	Properly uniformed and impeccable staff
P4	Tangibility	Enough attractive and explicit advertising
P5	Reliability	The staff shows interest in solving requirements
P6	Reliability	The staff undertakes to comply in the shortest time and does so
P7	Reliability	The staff offers good service at all times
P8	Reliability	The staff complies with the service in the established time
P9	Reliability	There are documents and student files in order and without failures
P10	Response Capacity	The solution/response time of the request is reported
P11	Response Capacity	Service is provided promptly
P12	Response Capacity	The staff is always ready to help
P13	Response Capacity	Staff always available to help with requirements
P14	Security	The staff transmits confidence
P15	Security	One feels secure when carrying out a procedure
P16	Security	Staff is friendly
P17	Security	Trained personnel to give reliable answers to requirements
P18	Empathy	The staff gives you personalized attention.
P19	Empathy	Adequate staff to offer personalized attention.
P20	Empathy	Customer service hours are appropriate.
P21	Empathy	The staff cares about offering well-being.
P22	Empathy	The staff understands the requirements.

The unit of analysis is made up of the ITB, and the target population is that of active students from the careers of Nursing, Administration, Accounting, Software Development, Land Transport, Trichology and Cosmetics, Older Adults, and Podiatry. Table 2 summarizes the number of surveyed students per career.

Table 2. Distribution of the sample by type of career and year.

Careers	September 2019 – February 2020
Nursing	157
Administration	102
Accounting	54
Software development	27
Land Transport	15
Trichology and Cosmetics	6
Elderly care	5
Podiatry	4
Total	370

The items that make up the SERVQUAL model questionnaire were measured on a Likert scale where the respondent had to indicate his/her agreement or disagreement with the statement presented to him/her. To this end, an orderly and one-dimensional scale from 1 to 7 is used. In the case of the expectations questionnaire, it is assumed that a score of 7 corresponds to "Extremely important" and 1 to "Extremely unimportant". For the questionnaire on perceptions, a score of 7 represents "that the evaluation is always fulfilled" and 1 that "it is never fulfilled".

The numerical results in the Likert scale were neutrosophied using the triangular neutrosophic numbers scale in Table 3.

Table 3. Importance weight as linguistic variables and their associated SVTNNs for expectations and perceptions. Source: [18].

Likert scale	Linguistic terms for expectations	Linguistic terms for perceptions	SVTNN
1	Extremely unimportant (EU)	Never fulfilled (NF)	$\langle(0,0,1);0.00,1.00,1.00\rangle$
2	Not very important (NVI)	Few times fulfilled (FTF)	$\langle(0,1,3);0.17,0.85,0.83\rangle$
3	Not important (NI)	Sometimes fulfilled (STF)	$\langle(1,3,5);0.33,0.75,0.67\rangle$
4	Medium (M)	Medium (M)	$\langle(3,5,7);0.50,0.50,0.50\rangle$
5	Important (I)	More fulfilled than not (MF)	$\langle(5,7,9);0.67,0.25,0.33\rangle$
6	Very important (VI)	Most of times fulfilled (MTF)	$\langle(7,9,10);0.83,0.15,0.17\rangle$
7	Extremely important (EI)	Always fulfilled (AF)	$\langle(9,10,10);1.00,0.00,0.00\rangle$

To measure the reliability of the instrument, Cronbach's Alpha coefficient or internal consistency index was used, which is an indicator that assumes values between 0 and 1, [19, 20]. Below 0.7 is considered that the instrument is not reliable. Cronbach's Alpha values between 0.7 and 1 indicate that the construct is reliable. Table 4 presents the results obtained in both measurements.

Table 4. Cronbach's alpha coefficients for both questionnaires.

		Total sample (n= 370)
Expectations	Cronbach's Alpha	0.939
Perceptions	Cronbach's Alpha	0.944

From Table 4 it can be concluded that the instrument used is reliable since, for the total sample, in both questionnaires, the coefficient of Cronbach's Alpha is close to 1.

For processing the data we proceed with collecting the responses to the survey. Let us suppose for the dimension P_i (i =1,2, …, 22) in Table 1, we have both, $\upsilon_{ij} = \frac{\#\{Respondents\ having\ response\ Likert=j\}}{370}$ and $\omega_{ij} = \frac{\#\{Respondents\ having\ response\ Likert=j\}}{370}$, for j = 1,2,…,7 the answers in the Likert scale concerning i dimension, where υ_{ij} is expectation and ω_{ij} is perception.

Next, we calculate:

$$\Upsilon_i = (v_{i1}\langle((0,0,1);0.00,1.00,1.00\rangle) + (v_{i2}\langle((0,1,3);0.17,0.85,0.83\rangle) + (v_{i3}\langle((1,3,5);0.33,0.75,0.67\rangle) + (v_{i4}\langle((3,5,7);0.50,0.50,0.50\rangle) + (v_{i5}\langle((5,7,9);0.67,0.25,0.33\rangle) + (v_{i6}\langle((7,9,10);0.83,0.15,0.17\rangle) + (v_{i7}\langle((9,10,10);1.00,0.00,0.00\rangle) \quad (7)$$

$$\Omega_i = (\omega_{i1}\langle((0,0,1);0.00,1.00,1.00\rangle) + (\omega_{i2}\langle((0,1,3);0.17,0.85,0.83\rangle) + (\omega_{i3}\langle((1,3,5);0.33,0.75,0.67\rangle) + (\omega_{i4}\langle((3,5,7);0.50,0.50,0.50\rangle) + (\omega_{i5}\langle((5,7,9);0.67,0.25,0.33\rangle) + (\omega_{i6}\langle((7,9,10);0.83,0.15,0.17\rangle) + (\omega_{i7}\langle((9,10,10);1.00,0.00,0.00\rangle) \quad (8)$$

See that in Equations 7 and 8, we used the addition and the product by a scalar defined in Definition 4. They are the weighted mean of the survey results for SVTNNs for each dimension, so they are SVTNNs based on a 0-10 scale. Later we apply Formula 5 of accuracy for de-neutrosophication.

Table 5 shows the responses after the data were de-neutrosophied, according to the responses to each question of the expectations questionnaire and the one that mediates the perceptions, and a contrast is made between them to determine the gaps with what is expected and what is perceived about the services by the users, the students enrolled in the period September 2019 to February 2020 at the ITB.

Table 5. Results of processing the de-neutrosofied data from the survey in the period 2019-2020. We compare with the results obtained in 2017.

		Average of measurements sept. 2019–feb. 2020			Average of measurements 2017	Change in expectation
	Dimension	Expectative	Perception	Gap	Expectative	
P1	Tangibility	9.17	7.9	-1.29	8.3	0.87
P2	Tangibility	9.16	8.14	-1.01	8.51	0.64
P3	Tangibility	8.31	8.01	-0.3	8.3	0.01
P4	Tangibility	8.59	8.33	-0.26	7.96	0.63
P5	Reliability	9.03	8.23	-0.8	8.51	0.51
P6	Reliability	9.06	8.31	-0.74	8.3	0.76
P7	Reliability	9.37	8.66	-0.71	8.79	0.59
P8	Reliability	9.21	8.44	-0.76	8.76	0.46
P9	Reliability	9.21	8.8	-0.4	8.83	0.39
P10	Response Capacity	9.3	8.37	-0.93	8.61	0.69
P11	Response Capacity	9.27	8.31	-0.96	8.77	0.5
P12	Response Capacity	9.33	8.63	-0.7	8.64	0.69
P13	Response Capacity	9.29	8.27	-1	8.51	0.77
P14	Security	9.26	8.56	-0.7	8.8	0.46
P15	Security	9.5	8.61	-0.89	8.94	0.56
P16	Security	9.3	8.31	-0.99	8.8	0.5
P17	Security	9.37	8.5	-0.87	8.79	0.59
P18	Empathy	9.06	8.44	-0.61	8.61	0.44
P19	Empathy	9.16	8.27	-0.89	8.61	0.54
P20	Empathy	9.43	8.51	-0.91	8.9	0.53
P21	Empathy	9.33	8.4	-0.93	8.79	0.54
P22	Empathy	9.47	8.37	-1.1	8.51	0.96

The penultimate column in Table 5 contains the values of the students' expectations corresponding to the similar study carried out at the ITB in 2017. This preliminary study was exclusively dedicated to identifying the expectation about the support service for the training processes. The last column shows the change in students' expectation comparing the first period of 2017 with those enrolled two years later (late 2019 and early 2020).

The results show that the mean of the expectations is higher than the mean of the perception according to the responses given to the questionnaires by the students enrolled in the second academic period of 2019. This indicates that there are dissatisfactions in each of the observed dimensions or what is the same, that the level of satisfaction with the different services does not reach the expectations of the clients (students). The items that present the greatest gap are facilities (P1), the perception that the staff does not understand the requirements made by the students (P22), classrooms and equipment with state-of-the-art technology (P2), and the availability of staff in

quantity necessary to expedite the procedures (P13).

Table 5 also shows that an analysis of the expectations declared by the students in 2017 and 2019 indicates that the dimensions which had more increments are those related to the "tangibility" dimension relative to physical facilities in good condition (P1), the one related to the dimension of "reliability" corresponding to the fact that the staff agrees to comply in the shortest time and does so (P6), the one related to the dimension of "response capacity" which refers to the availability of the staff to help with the requirements (P13), and the one corresponding to the dimension "empathy" about the understanding of the personnel about the nature and type of requirements (P22). The foregoing results lead to the need for further analysis of the results obtained for each of the dimensions to be deepened. Therefore, we can infer from our study that the gaps declared in 2017 have significantly been increased comparing with 2019-2020.

Conclusion

This paper combines the SERVQUAL model, which is used to measure the gaps between the expectation and the perception of 22 dimensions in teaching support services at the “Instituto Superior Tecnológico Bolivariano” (ITB) in Ecuador. 370 students of this institute were surveyed on 22 dimensions in the SERVQUAL model according to a Likert scale. The reliability of the survey was approved because it has obtained a Cronbach’s Alpha bigger than 0.9. The results were neutrosophied and aggregated utilizing Single-Valued Triangular Neutrosophic Numbers to incorporate the uncertainty and indetermination in classification. Later, they were de-neutrosophied to obtain a group assessment per dimension.

In the 2019 study, perceptions are lower than expectations, therefore, the ITB should focus on deepening the subject to implement improvements that can modify the perception of students about the teaching support services that they generally receive.

The general average of expectations in students enrolled in the first period of 2017 amounted to 8.61 and that of those enrolled in the second period of 2019 amounted to 9.19. This means that the expectations of students enrolled in the second semester of 2019 increased, on average, almost 7% compared to what students enrolled in early 2017 had on the same services, which is probably supported by the change in cohorts and in the influence of the different evaluation processes for accreditation purposes that have taken off in the country in recent years.

The general index of expectations for the year 2019 is 9.19 and the perception index is 8.37, which generates an average gap of -0.82 between them, together with the fact that for the 22 items the individuals gaps are negative, this is an indicator of the existence of problems in the level of complementary service to the training that the ITB offers to students.

It is recommended to accelerate the identification of the inputs and outputs of all the processes that occur in the institution to determine the control and management indicators and to be able to define the level of service that is given in each of them. The present study was carried out with a general approach and not related to the processes defined within the institutional management model, therefore it is recommended to carry out a broader study that includes all the processes.

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