

Framework to manage academic administrative processes, validating it from the students' perspective.

Case study: Faculty of Engineering of a Public University

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Abstract

It will be seen in this research article:

Process management.- In order to properly manage the academic administrative processes related to the services provided to the student, the processes were ordered using the international standard ISO 9001: 2015, as well as the administration of knowledge to achieve the expected results.

Measure quality. - The indicators of the processes on the dashboard are not enough, therefore it was compared with the opinion of the students; to perform this measurement, a questionnaire validated by expert judgment was prepared based on the ServQual model.

Fuzzy logic.-

Quality in its various dimensions and sub-dimensions, being subjective, was clarified using fuzzy algorithms based on a membership function, in order to have a certain level of certainty in relation to students' perceptions.

Results: After applying the fuzzy logic to the survey carried out with the students, it was visualized in a perceptions dashboard and the non-conformities were analyzed, which constitute the new baseline to improve.

Keywords:

Process Management, ISO 9001: 2015, Fuzzy Logic, ServQual Model, key performance indicators.

1. Introduction

According to Vergara and Quesada (2011) point out that the quality of the service of an educational establishment is reflected in the conformity and satisfaction experienced by the academic community about the different services provided by it.

When the processes of an organization are disorganized, the improvisation and the chaos originates, therefore there will be users or dissatisfied customers. One of the ways to manage quality is to use the ISO 9001: 2015 technical standard, which in its various items promotes the quality of services and products, facing the scenarios under a risk strategy and with a culture based on leadership of senior management.

Quality in higher education is estimated by quality assurance systems using self-assessment processes. Higher Education Institutions (HEIs) conceive it as a stakeholders' active participation process of identifying strengths and

possibilities for improvement both for institutions and for academic programs aimed at the fulfillment of their mission and continued improvement (Vera, A. et al. 2018).

The classical logic regarding a variable as it is known handles two values, whether true or false, when an argument is constructed, a conclusion or thesis is reached, to formalize and demonstrate the thesis, the premises are operated with the laws and logical inferences making use of propositional calculation or demonstration methods, whether direct, indirect, absurd or mathematical induction, it is possible to verify the truth or falsity of the thesis; however, many times we face a problem of which we do not clearly have certainty, for this the fuzzy logic is useful because it approximates us to determine the degree of belonging of a variable, and thus have the proximity to a quality value, according to the dimensions used to measure the quality.

The method that uses fuzzy or fuzzy logic consists in defining rules and assigning a range of values or conditions so that the membership function can be constructed for the problem to be investigated, these values will allow us to determine the propensity at a point in the function or trend of the variable in the period studied.

In this article, the fuzzy logic will be seen in conjunction with the Servqual technique applied to University Quality Management, measuring quality in the various dimensions as proposed by the Servqual model, in a Faculty of Engineering of a public University.

1.1 Objectives

General purpose

Develop a framework to manage and validate the quality of academic-administrative processes in a Faculty of Engineering of a public university; using Iso 9001: 2015, knowledge management, fuzzy logic and the servqual model.

2. Literature Review

2.1 Process Management

It is an approach that seeks to improve the quality of processes and integrate the different functions of the company (Heredia 2000).

The processes receive inputs and produce outputs, activating indicators. The administration of the processes is through their indicators, which collected in a dashboard, will allow to manage the continuous improvement oriented to the quality of the service or the product and in general to the government strategies of the company or organization.

2.2 ISO 9001: 2015

This standard describes the fundamental concepts and principles of quality management and includes terms and definitions that apply to all quality management standards (López 2015).

According to Watkins and Orchiston (2016), they express, that ISO 9001: 2015 is the internationally recognized standard for quality management systems. A quality management system (QMS) is a framework that organisations use to ensure consistent results when designing, developing, and delivering products and services. According to the Equipo de Tutores (2015), ISO 9001: 2015, has been developed based on the principles of ISO 9000: 2000, the seven principles, such as: customer approach, process-based approach, continuous improvement, fact-based approach to making of decisions, mutually beneficial relationships with the provider.

A very important section in the ISO 9001: 2015 Standard is risk management, prevention is important since there are always factors that could cause the lack of compliance with the process.

Roque et al. (2016) point out that, the increase in uncertainty associated with changes in the context of organizations makes it necessary to strengthen their management systems, so that the risks that may threaten sustainability are minimized and the improvement of its performance.

2.3 Fuzzy Logic

According to Barragan (2009) in his thesis he expresses that fuzzy logic is a multivalued logic that allows intermediate values to be able to define conventional evaluations. This way, it is not determined whether or not an element belongs to a set, but the quality of belonging evaluated in a complete range from non-membership with the highest possible quality. This characteristic allows the analysis of the approximate reasoning, much less strict than the traditional bivariate logic.

According to Escolano et.al (2003), they indicate that, diffuse logic is an extension of classical logic in which the propositions have a value of truth in the interval $[0,1]$. Fuzzy logic is not fuzzy. Basically, fuzzy logic is a precise logic of imprecision and approximate reasoning (Zadeh 2008).

Measuring the quality of the management of academic processes is more difficult because the perception of quality is subjective, it is heterogeneous; because there are opinions, different economic strata, diverse ethnic backgrounds, budgetary conditions and if we talk about public universities, bureaucracy and political positions that are often barriers to good quality management.

2.4 Membership function

The m_A function: $X \rightarrow [0,1]$. $m_A(x)$ indicates the degree of belonging of each element x to the fuzzy set A , which is represented as $A = \{(x, m_A(x)) \mid x \in X\}$. (Huapaya and Lizarralde 2012).

Being the function of subjective belonging, qualitatively the elements of the universe of discourse we can approximate it to one of the quality scales as we are evaluating in the present case study.

The membership function is built on the basis of expert judgment based on the algorithms that will be seen later in the development of the paper.

2.5 Management of Academic-Administrative Quality

It is based on ordered processes which if you have the corresponding monitoring you can achieve the quality objectives for the benefit of users or customers.

Understanding by process a set of structured activities and intended to result in a specific product for a particular customer or market (Chiavenato 2007).

In order to manage quality, it is necessary to normalize, being understood by normalizing, according to Publicaciones Vértice (2010) it is an activity that consists of elaborating, disseminating and applying norms. Therefore, it is an activity that offers solutions to repetitive situations.

This order of processes involves in our case the administrative academic processes.

As indicated by Fontalvo and De la Hoz. (2018): Until very recently, quality management in educational institutions was not a topic addressed in their development plans. Most governments gave priority to coverage, financing, decentralization, etc. as aspects of service improvement and national development. However, the landscape has changed and the quality of education is a topic of growing interest in the academic and governmental context.

The term quality assurance in higher education is increasingly used to denote the practices whereby academic standards, that is, the level of academic achievement attained by higher education graduates, are maintained and improved (Dill 2010).

Ramírez (2004) points out that one of the factors that affects the effectiveness of the educational system is good or bad administrative management, whatever its level. In general, those responsible for the operation of organizations dedicated to teaching, take little account of the administrative factor in its incidence on teaching, and end up managing it empirically, either because they are not prepared as administrators, or because in his empiricism does not measure the value of modern administration as an organizational, leadership and control discipline.

2.6 ServQual Model

Since 1985, Professors Parasuraman, Zeithaml and Berry develop several qualitative and quantitative studies that give rise to the ServQual scale. This Scale measures the quality of service through customer perceptions and expectations. The quality of service is evaluated from the customer's perspective. If the value of the perceptions equals or exceeds that of the expectations, the service is considered of good quality, while if the value of the perceptions is lower than that of the expectations, the service is said to have quality deficiencies (Miranda et. al. 2007).

On the other hand, according to Naranjo (2011) ServQual is an instrument in the form of a questionnaire, developed whose purpose is to evaluate the quality of service offered by an organization along five dimensions: Reliability, Sensitivity or Responsibility, Security, Empathy, Tangible elements. It consists of a multiple response scale designed to understand the expectations of customers regarding a service.

In this regard, Inquilla et al. (2017) in the research article The educational and administrative quality seen from within: case of Universidad Nacional del Altiplano, Puno-Perú 2017, one of the objectives was to identify the attributes of the academic and administrative services that allow validate the reliability and internal consistency for the evaluation of the level of quality and determinants of the perceived service. Which coincides with part of the research in this article.

2.7 Performance key indicators.

Also called KPIs. The key performance indicators (KPI) are those indicators that focus on aspects of organizational performance that are the most critical to the current and future success of the organization (Parmenter 2020).

Higher education institutions (HEIs) are trying to ensure a high level of quality by following standards and using a sophisticated quality management system (QMS).

Obtain uniform performance indicators for each process and a single integrated result of the activity as a whole (Konik et. al. 2019).

2.8 Dashboard or Monitoring Panels.

University instrument panels are management tools that present critical information in a concise, easy-to-understand and visually appealing format (Terkla et al. 2012). A dashboard is a visual display of the most important information needed to achieve one or more objectives; consolidated and arranged on a single screen so the information can be monitored at a glance (Few 2007).

2.9 Knowledge Management

Knowledge Management is the art of creating value by taking advantage of intangible assets (Sveiby 1997).

It is seen in the research that this methodology should be complementary to the iso 9001: 2015 technical standard, without applying knowledge management continuity management is difficult, given that with the dynamics of personnel when it changes or in personnel turnover it becomes difficult maintain the ISO 9001: 2015 certification.

3. Methods

The applied research was used and from the technical point of view the technical standard ISO 9001: 2015 to model processes, the fuzzy logic to clarify the uncertainty and the survey method based on the ServQual model designed by experts to know the perceptions of the student

Hypothesis:

The quality of the academic-administrative processes has an impact on the satisfaction of the students

Figure 1, shows the methodology to follow to improve quality management, with the baseline changing over time, it will always be the beginning of a new iteration.

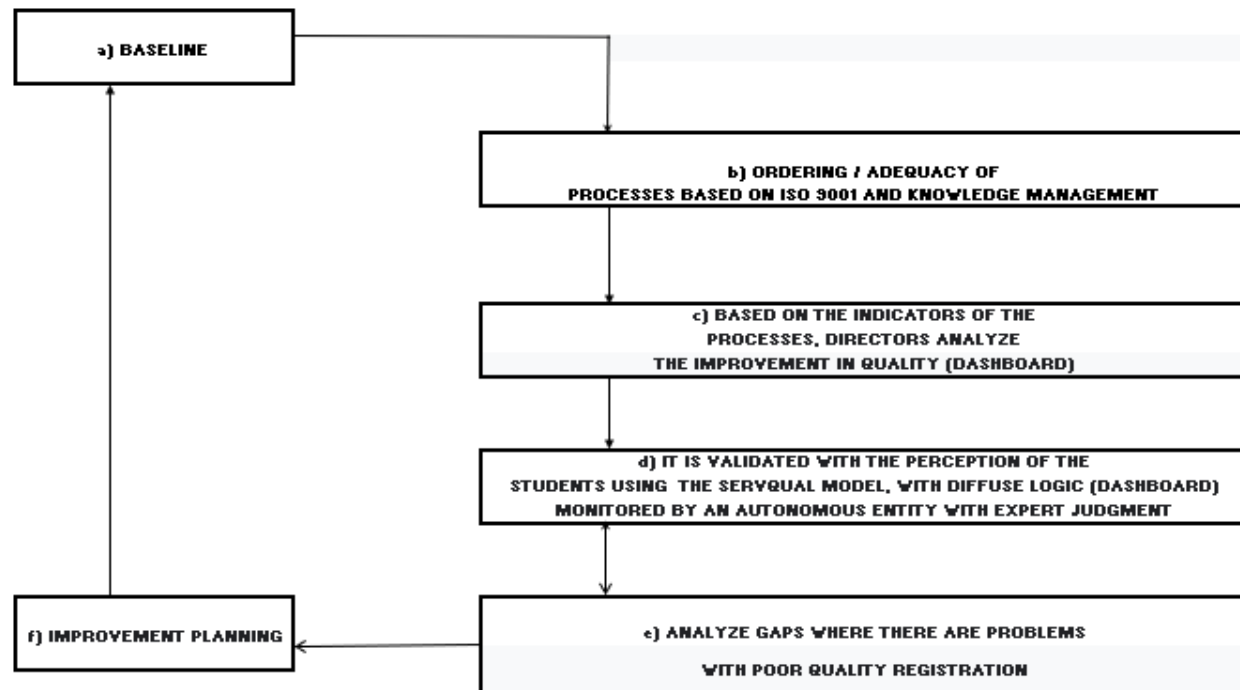


Figure 1: Summary of the methodology to be performed

Seeing the model we proceed to detail as follows:

a) BaseLine : In any project to be initiated, a state of affairs diagnosis must be made at the beginning of the project, for the case study it was observed that the academic processes and related services were not ordered, which impacted on the basic quality conditions.

Before starting the cycle, a randomly selected sample was surveyed to observe the perspective about the services academic-administrative processes that its Faculty provides, this same sample with the same students will be surveyed after the cycle. For this, a survey was designed with the advice of experts.

These are shown in Table 1 before starting the 2019-II semester and after semester 2019-II.

b) Standardization of the processes based on the ISO 9001: 2015 technical standard; for this there was the commitment of the entire organization, with a strong leadership of the maximum entity of the organization, the technique used to relieve the processes was the process analysis , it was mapped, the analysis was done and the processes were designed in accordance with the users and stakeholders. All processes were documented in a quality manual, arranged in the cloud and systematized so that it serves to manage knowledge either with new staff or when rotating to another office.

c) Based on the KPIs of the processes, the directors analyze the improvement. These are the kpis of the accredited processes.

d) Students are surveyed based on the ServQual model using fuzzy logic to improve the certainty of opinions.

e) Analyze the gaps where there is a low perception of quality.

f) Plan the improvement again, the current state will be our new baseline.

One of the many processes that was implemented and can be taken as an example for this article: Induction or teacher training.

3.1.1 Example Improvement of the teaching induction process *P-FSI-SGC-03*

1. Objective

Describe the methodology to train new and old teachers of the Faculty of Engineering of a public University.

2. Scopes

This process is related to the training and induction of new and old teacher. Considered as a Missionary process for the development of the semester.

3 References

3.1 ISO 9001: 2015 Standard - Quality Management Systems -Requirements

3.2 ISO 9000: 2005 Standard - Quality Management Systems - Fundamentals and Vocabulary

3.3 Faculty Teacher Manual.

4. Definitions

4.1 Teacher Quality Manual: document specifying the norms and rules

What the teacher must fulfill during a specific academic period.

5. Roles and Functional Responsibility

5.1 ISO Management Representative: ensure compliance with the present proceeding.

5.2 Dean: responsible authority of the Faculty of Engineering.

5.3 Director of the career(Academic Coordination): responsible for the supervision of compliance with the procedure.

5.4 The Figure 2 refers to the detail of the procedure. It is part of the knowledge management that is done with teachers every semester.

This process is very important, so that the teacher must know the responsibilities to be fulfilled.

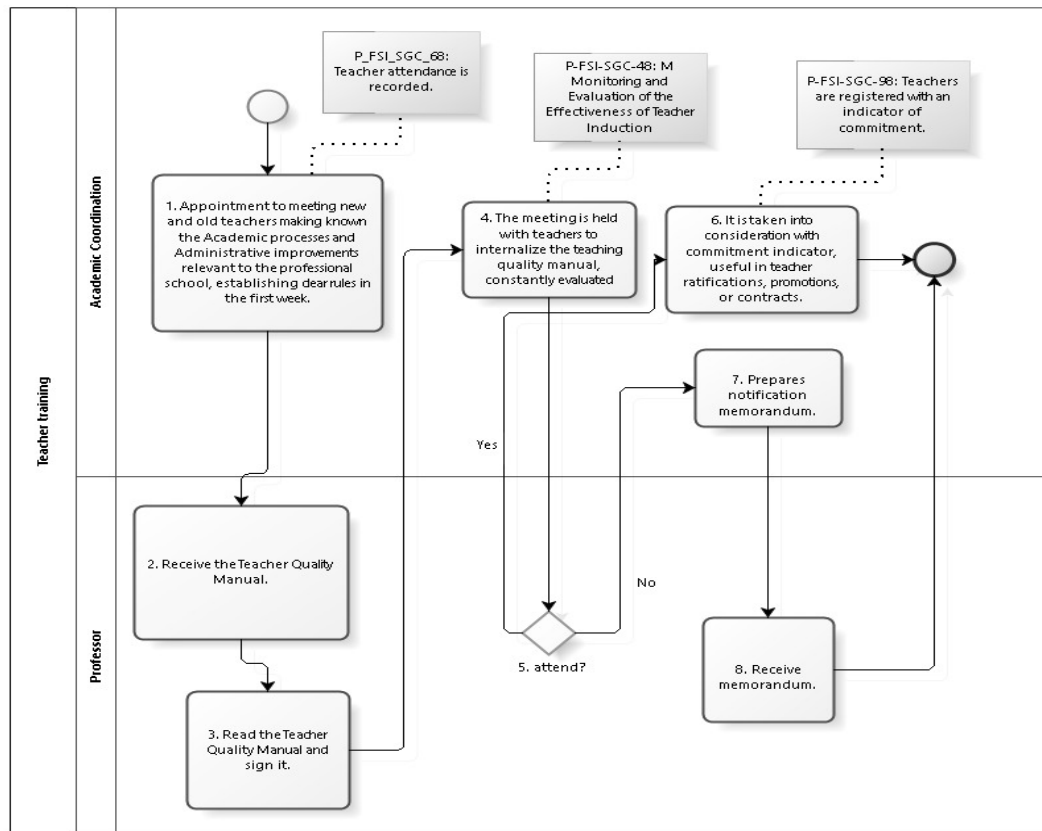


Figure 2: Teaching induction process

6. Supervisión and measurement of KPIs

Ratio=NDA/NDEP (number of teaching assistants/Number of teachers in the career)

Ratio=NDC /NDEP(Number of teachers of the career who comply and fill out the form /Number of teachers in the career)

Teaching induction indicators measure attendance and compliance.

The latter is a sum of compliance according to the teaching quality manual.

These ratios must be shown on the administrative academic dashboard.

These indicators are calculated by the system and are monitored by academic coordinators

7. Records or Evidences

There must always be evidence of the processes, in this case.

Memorandum

Reports

8. Risk Management

If the teacher does not attend the meeting for any reason, he agrees to follow the rules, with reminders and confirmation by mail. However, it is registered as a non-assistant.

The evaluation is an elementary discipline that is related to many human activities and that tries to improve the conditions and results of the evaluated area (Flores and García 2013).

The Performance indicators are drawn from each of the critical processes that have to do with administrative academic quality management, which, visualized on a dashboard, are used for monitoring, in this way quality management will be validated from the perspective of stakeholders or managers, which under the ISO 9001: 2015 scheme will serve to validate the quality and also to make continuous improvement. For this reason, it is very important to make traceability, the dashboard facilitates visualization for decision making. And in general, based on the process indicators, it becomes the comprehensive scorecard that according to Kaplan and Norton (1990), the scorecard provides managers with the equipment they need to navigate towards future competitive success.

Now we will see the sample of the enrolled population to observe their perceptions under the ServQual model.

4. Data collection

Target population

The survey is conducted on a sample of the student population that is going to enroll; it should be noted that the surveys are carried out based on the ServQual model.

Being the same students of the preliminary survey (semester 2019-II).

The faculty has 1544 enrolled students, of which 850 are Systems Engineering and 694 are Software Engineering.

$$n = \frac{Z^2 pq N}{e^2(N-1) + Z^2 pq}$$

$$N=1544, Z=1.96, e=5\%, p=50\%, q=50\%$$

After operating is: $n = 308$ the sample that are people who stratify them by professional career. Therefore, after calculating the stratified sampling.

Giving 170 students from the Systems Engineering career and 138 from the Software Engineering career.

1) Expert judgment at the level of Academic Directors

The authority argument has always been taken into account when assessing (Pérez 2006). According to the Project Management Institute (2017), expert judgment is defined as the judgment that is provided based on experience in an area of application, area of knowledge, discipline, industry, etc.

To carry out the design of the survey in the research expressed in this paper, a Delphi was carried out among the current academic directors, who not only had to design the survey but also punctuate the ranges from 0 to 1 with respect to the scores of the degrees of quality, observing similarity biases in their opinions in relation to the various evaluation items. It is at this point that fuzzy logic comes into play, to build the membership function, given the different perspectives of experts.

2) Membership function

Prepared based on expert judgment to catalog the degree of quality:

These ranges are the expectations of the experts. It is represented in Figure 3

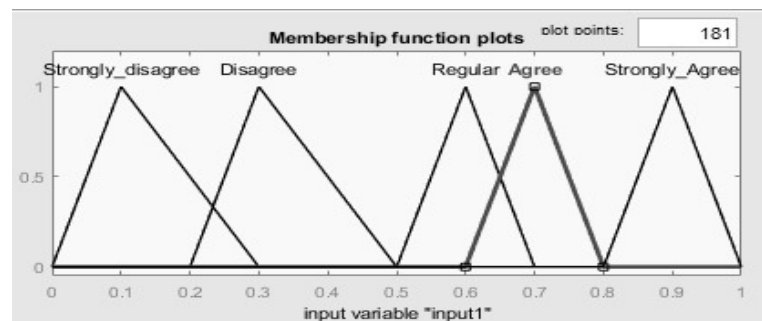


Figure 3: fuzzy graphic, on which the algorithm works

3) Rules and Inference

If quality in range $[0,0.3]$ then Very Bad quality or Strongly disagreement

If quality in range $[0.2,0.5]$ then Bad quality or Disagree

If quality in range $[0.5,0.7]$ then Regular quality

If quality in range $[0.6,0.8]$ then Good quality or Agree

If quality in range $[0.8,1]$ then Very Good Quality or Strongly agree

4) Design of the survey carried out validated by experts based on the model Servqual

To observe the perceptions of the students, a survey designed by experts was carried out, both at the beginning and at the end of the semester with the same sample, this survey has a multiple response scale to understand the student's expectations regarding academic and administrative services provided by the Faculty. The steps in a summarized way to save the perceptions in the database can be seen in Figure 4.

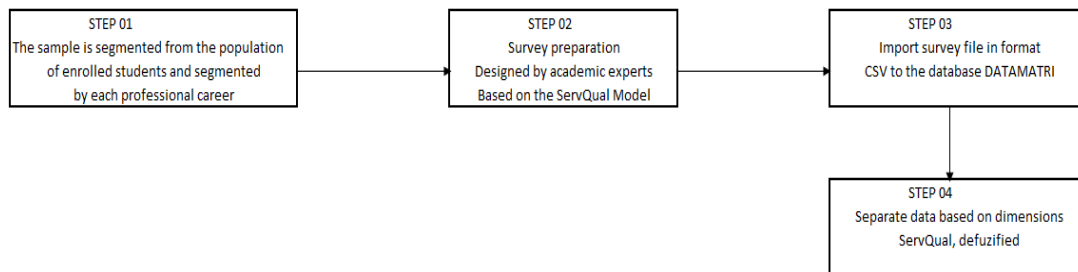


Figure 4: Data selection process to conduct the survey

In step 1, the respondents are segmented by professional career.

In step 2, the survey is designed by academic experts based on the ServQual model.

In step 3: the survey is completed, it is downloaded in csv format and taken to the database.

In step 4: The data is processed and separated based on the ServQual dimensions applying certainty with fuzzy logic..

Database model and Algorithm using fuzzy logic in each of the indicators of the various dimensions

The logic that is followed in the algorithm is: if a perception corresponds to 2 intervals of different ranges, the value must be stored in 2 different attributes of subdimensions, that is, in 2 perceptions, and then when averaging the data of the attributes of the subdimensions, the It will locate in the corresponding range according to the fuzzy scale, the average in each subdimension of the corresponding dimension, it will be totaled and divided over the total of subdimensions of said dimension so that it gives the average of each dimension.

Average Subdimension_i = $\sum_1^n \text{Attributes of the subdimension} / n$ in $[0,1]$. Where n is the number of students.

Average Dimension = $\sum_1^s \text{Average Subdimension}_i / s$ in $[0,1]$. Where s is the number of subdimensions of each dimension.

A part of the algorithm is shown below and the information of the perceptions will be recorded in the tables of the model shown in Figure 5.

Algorithm according to dimensions, sub-dimensions and fuzzy scale

If atb_dim_01 >= 0 and atb_dim_01 <= 0.3 and atbf_dim = 1 then

Insert record in campo valor_AC1_atributo in tabla_detalle

End if

If atb_dim_01 >= 0.2 and atb_dim_01 <= 0.5 and atbf_dim = 1 then

Insert record in campo valor_AC2_atributo in tabla_detalle

End if

If atb_dim_01 >= 0.5 and atb_dim_01 <= 0.7 and atbf_dim = 1 then

Insert record in campo valor_AC3_atributo in tabla_detalle

End if

If atb_dim_01 >= 0.6 and atb_dim_01 <= 0.8 and atbf_dim = 1 then

Insert record in campo valor_AC4_atributo in tabla_detalle

End if

If atb_dim_01 >= 0.8 and atb_dim_01 <= 1 and atbf_dim = 1 then

Insert record in campo valor_AC5_atributo in tabla_detalle

End if

.....

If atbf_dim_14 >= 0.8 and atb_dim_14 <= 1 and atbf_dim = 5 then

Insert record in campo valor_AC14_atributo in tabla_detalle

End if

*Brief comment:

If the value belongs to two scales, it must be recorded in the two attributes of the detail table; that is, the one that corresponds to the first scale and the one that corresponds to the second scale.

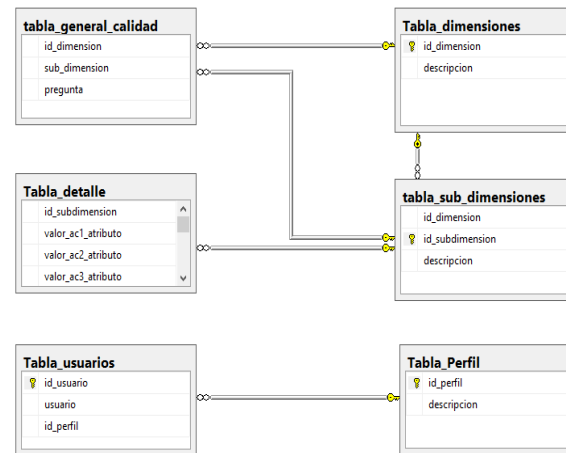


Figure 5: Database model summary

5 Results and Discussion.

5.1. Numerical Results

Table 1 shows the perceptions of the surveys taken before and after the 2019 semester with the same sample of students.

Table 1: Main perceptions as a whole of the students, result of the survey after defuzzifying.

Item	Dimension ServQual	Indicators	Disagreement After Semester 2019-II	Disagreement Base Line before semester 2019-II	Difference in perceptions before and after the 2019-II semester
	Reliability				
1	Knowledge of the Administrative Staff	IND1	34,80%	64,60%	30,00%
2	Silabo Compliance	IND2	42,80%	50,80%	8,00%
3	Mastery of the professorship taught by the teacher	IND3	10,70%	30,70%	20,00%
	Answers's capacity				
4	Compliance with the dates in your paperwork	IND4	69,00%	72,20%	3,20%
	Security				
5	Teacher Assistance	IND5	32%	23%	-9%
6	Library service	IND6	0%	0%	0%
	Tangibility				
7	Equipment (machines)	IND7	50%	50%	0%
8	WiFi service	IND8	65,00%	61,60%	-3,40%
9	Computer Furniture	IND9	20,80%	30,80%	10,00%
10	Sports Services	IND10	13,1%	23,1%	10,00%
	Empathy				
11	Convenient hours	IND11	30,00%	43,30%	13,30%
12	Appropriate exam schedule	IND12	25,00%	26,30%	1,90%
13	The treatment of staff when you ask questions	IND13	32,00%	26,90%	-5,10%
14	The staff regarding empathy	IND14	34,00%	26,90%	-7,10%

From Table 1, in relation to Item 7, it is observed that there is a high degree of disagreement with the computer equipment, both at the beginning of the cycle and at the end, which is an item to improve. In Item 8, Wi-Fi needs to be improved buy and implement more access points and / or expand bandwidth coverage; likewise, in item 14, it is observed that empathy with the student should be improved in the various procedures that the student does. Although it is true that the syllable is delivered, the lack of monitoring of compliance with the syllable is observed (Item 2), it also implies automating compliance through artificial algorithms, in order to notify the teacher, delegate and academic coordinators, the delay of teacher.

In item 13 it is observed that more induction should be done to improve the treatment of young university students. Finally, from Table 1, it is observed that despite having improved many indicators from the student's perspective, it is necessary to continue analyzing the causes of the disagreement and making the respective improvements.

5.2 Results Graphical

Only 10.7% of disagreement is observed with respect to teaching, as shown in Figure 6.

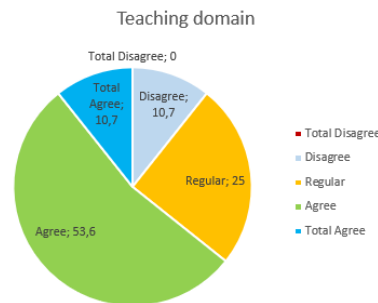


Figure 6: Teaching Skills

Where if there is a high percentage of nonconformity and to which attention must be paid, it is the computer equipment, which can be seen in Figure 7, there is 47 % of nonconformity.

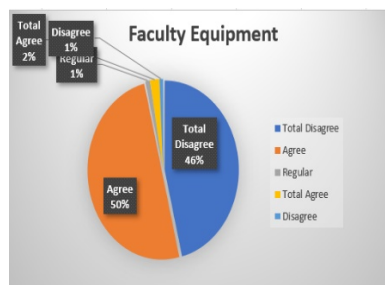


Figure 7: Computer equipment of the Faculty

Specifying that these are results of the students' perceptions, which must be crossed with the accreditation indicators managed by the directors based on the ISO accreditation. To carry out this assessment of perceptions it must be carried out by an autonomous entity of the accreditation area, other than those responsible for the professional careers, so that there is impartiality.

5.3 Proposed Improvements

As quality is subjective and dynamic, it is always required to be monitoring it by the plan, do, check, act (PDCA) cycle, it will always be a constant that should not be neglected. The dashboard is an important tool, especially if it comes from the perspective of the student as in this case. The perspective of the quality of the directors goes by separate strings with that of the students, these gaps must be observed and improved.

5.4 Validating

The impact of quality improvement from the perspective of the "student" client It is not enough to implement the processes and order them under the ISO scheme, the quality must be cyclically validated, it is typical of the Deming cycle, rethinking strategies for continuous improvement, it is advised as in this case, the expert opinion was seen. The survey was carried out based on the ServQual model in its various dimensions. To validate the survey, Cronbach's alpha was used, which gave a 93% acceptance, validated the questionnaire designed by the experts.

$$CEFC = \left[\frac{k}{k-1} \right] \left[1 - \frac{\sum_{i=1}^k S_i}{St} \right] \quad k: \text{number of ítems, } S_i: \text{Variance of each item, } St: \text{Variance of the sum of all ítems.}$$

From 14 questions, working with 3 expert judges.

The hypothesis is validated given that by implementing orderly processes, the quality of administrative processes is being improved as seen in Table 1, which is the students' perspective, however there is much to improve which will be seen according to the model until reaching an ideal state of quality of service in a comprehensive manner.

6. Conclusions

The model to manage quality and validate it, leads to the following conclusions:

The implementation of administrative academic processes using the ISO 9001:2015 standard improved student satisfaction levels, as seen in the results of Table 1. As the perception of quality is subjective, it was necessary to clarify through fuzzy logic implemented by means of a fuzzy logic algorithm.

Education, being constantly evolving, influences processes, therefore student satisfaction, so each academic semester has to iterate the improvement in the quality of the educational product and its services.

Improving administrative academic processes is not enough, it is necessary to go further, it is very important, the personal attention service, the level of empathy, the infrastructure, the feeling of security, the reliability, that the student perceives, for that reason it was used the ServQual model, to measure these perceptions which is also seen in the Table 1, Figure 6 and Figure 7, these indicators must be crossed with the accreditation indicators, it was also observed that to implement processes according to the ISO 9001 standard : 2015, to provide a quality service, knowledge must be constantly managed, that is, information must be administered to all personnel involved in the processes and services, with talks and induction workshops.

As a suggestion or recommendation, the perceptions survey should be conducted by an autonomous entity of the accreditation area or an external entity that does not belong to the Faculty, and not by the directors of the professional careers, since there is a conflict of interest. Then the perceptions report should be delivered to the dean and the directors of the professional careers to make the respective improvements, currently it is handled internally.

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