Questionnaires Robustness for Perceptive Evaluation of University Classes Service

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Abstract: An analysis of robustness of the student perception questionnaires evaluating the service of classes in higher education was carried out at Universidad Privada Boliviana (UPB) (Campus La Paz). To this purpose, batteries were designed to measure the global and multidimensional service quality of class (through the tangible, security and result dimensions), the global and multidimensional value of class service (through the functional, social and sacrificial dimensions), student satisfaction and post-class behavior intentions. It was proved that all instruments achieved high validity (content and construct) and reliability (internal consistency). Then, using the hierarchical linear multiple regression technique in successive steps, 22 socio-demographic and academic variables were introduced for both students and teachers that could have an effect on the class service evaluation constructs and affect robustness. The results showed that the subject matter exigency perceived by the students and the teaching time load influenced the evaluation of 5 of the 6 constructs mentioned (except for the multidimensional service quality - MSQ). Other variables influenced specific constructs: teacher contractual relationship in the global value of service (GVS), teaching experience in the UPB and the teacher's marital status, post class behavioral intentions (BI), and complexity of the subject matter perceived by the teacher and semester the student is studying, in the multidimensional service quality (MSQ). The analysis proved that the instruments designed for class service evaluation are robust; that is, they can be applied to a wide variety of conditions. The main contribution of the research is the adaptation of the concept of robustness to perception questionnaires.

Keywords: Robustness, validity, reliability, perception questionnaires, value of class service, quality of class service, student satisfaction, behavioral intentions of postclass.

INTRODUCTION

Generally when a researcher designs questionnaires or perception instruments for the measurement of constructs, in any field of application, he or she must ensure that they meet the criteria of validity and reliability [1].

The reliability of a psychometric instrument is measured by determining the internal consistency, which is the degree to which, under the same conditions, a person can answer the questionnaire questions in a uniform manner when administered several times. Cronbach alpha is used for the measurement. Although the criterion varies, it can generally be said that if the value is greater than 0.7, the questionnaire has a relevant reliability [2, 3].

The validity has several facets, but all of them contribute to ensure that the construct is properly measured by means of the battery designed for the effect: content validity, discriminant, concurrent, convergent, nomological and predictive [1, 4, 5].

However, validity and reliability are not criteria that include or provide an answer to verify whether the instrument designed can be applied under different changing conditions of the respondents and the object being evaluated through the survey.

In this sense, this article aims to introduce a new criterion to improve the design of perceptual instruments for the evaluation of constructs, which is robustness, which is generally used in the scientific discipline of analysis and design of experiments [6].

The article focuses on proposing an appropriate methodology and statistical technique to determine the robustness of questionnaires designed for the evaluation of class service in higher education. This methodology can be used in general to determine the robustness of any perceptual instrument that measures a particular construct.

LITERATURE REVIEW
Instruments for measuring service evaluation construct
Many researchers have designed psychometric scales to measure constructs in service marketing in order to obtain a subjective assessment of service performance. The main constructs that have been measured are: service quality, satisfaction, perceived value, post-consumer behavioural intentions and sacrifice.

Service quality
Quality of service was measured by the SERVQUAL [7-12] and SERVPERF [13, 14] instruments, conceptualized as the gap between performance and consumer expectations, and only by service performance, respectively. Many researchers wanted to adapt the two scales to other service industries, finding that they are not generalizable, but that each industry must design its own scale to achieve high reliability and validity [5, 15-55].

The main conclusions that can be drawn from a review of these measures are shown in Table 1.

Table-1: Characteristics of instruments adapted from SERVQUAL and SERVPERF to other service industries

Characteristics	Results
Countries in which they have been developed	Turkey, Australia, Canada, Croatia, India, United States, Korea, Hong Kong, Belgium, United Arab Emirates, Spain, among others.
Service industries in which they have been applied	Restaurants, banks, health centres and hospitals, internet, hotels, higher education, etc.
Dimensional structure	Most scales are multidimensional (from 2 to 10). For the most part, the dimensions of tangibility and reliability were retained. In addition, new industry-specific dimensions were added.
Gap scores vs. perception scores	Three measurement methods were found in the scales reviewed: (1) performance-only scores; (2) expectation-only scores; and (3) perception scores minus expectations.
Technical dimension vs. functional dimension	Most studies focus on the functional quality of the service delivery process. Very few incorporated the technical dimension (result).
Number of items	It ranged from 14 to 75, depending on the context of the industry. In some cases, SERVQUAL was used as a starting point for the development of the group of items.
Sample Sizes	Sample sizes in the studies ranged from 70 to 5531 service users. Most studies did not provide details of their samples.
Method of Analysis	Several studies used exploratory factor analysis to evaluate their dimensional and item structure; others used confirmatory factor analysis; and very few used a combination of these techniques.
Reliability	The Cronbach alpha was the measure used for the reliability of the scale (the internal homogeneity of a group of items that make up a scale). Most scales showed good reliability (Cronbach alphas greater than 0.60).
Convergent validity (degree to which a group of items converge on the hypothetical construct)	To test it, most studies calculated the average variance extracted (AVE) for each dimension (which should be greater than 0.5). Others considered the fact that all items were highly loaded on the factor to which they were previously assigned in the CFA.
Discriminant validity (degree to which theoretically unrelated constructs do not correlate with each other)	To establish it, several researchers used the CFA and compared whether the AVE for each factor was greater than the variance shared by the other factors. Others showed that the scale did not correlate strongly with other measures from which it is supposed to differ.
Predictive validity (degree to which a construct is empirically related to others)	To demonstrate this, some researchers correlated their dimensions of service quality with global quality. Others correlated the dimensions of service quality with other constructs: satisfaction, word of mouth and loyalty.

Source: Own elaboration from Asubonteng *et al.* [32] and Ladhari [5]

Although most of the instruments analyzed achieved good reliability, measured through Cronbach alpha, not all researchers tested the different facets of construct validity required by any measurement instrument, namely convergent, discriminant and predictive validity.

Satisfaction

Satisfaction, which is considered an affective construct [56-58], was defined as: 1) a global affective response of varying intensity, with a specific time point and limited duration, directed towards focal aspects of the acquisition of a product or service and/or its consumption [59], 2) an evaluation and response based on emotion about a service [60], and 3) the general affective response to a perceived discrepancy between previous expectations and the perception of performance after consumption [61, 62].

Caruana [63] and Chen [61] argue that professionals tend to use the terms service quality and consumer satisfaction indistinctly, because both are assessment variables related to consumer perceptions of a given service. However, other researchers have argued that service quality and consumer satisfaction are different constructs [64-66], but have not always been able to separate them empirically. Spreng and Singh [67] studied service evaluations with bank customers, but found no discriminant validity between service quality and consumer satisfaction. In a study of retail customers, Dabholkar [65] found that both constructs are different for new customers, but that they overlapped in meaning for older customers, since consumer satisfaction assessments became increasingly cognitive over time. Bansal and Taylor [68] found a very high correlation (0.96) between both constructs in a study of bank clients, but reported that the difference test χ^2 found discriminant validity. Brady and Robertson [69] indicated that both constructs have reported that discriminant validity is not met.

Recognizing that service quality and consumer satisfaction are distinct constructs, the question of the causal relationship between the two constructs arises, which has been a subject of considerable debate in the marketing literature [70]. Three main positions have been considered. First, service quality has been identified as an antecedent to satisfaction [7, 8, 13, 60, 63, 71]. Second, satisfaction is an antecedent to service quality [72-74]. The third suggests that neither satisfaction nor service quality can be the antecedents of the other [29, 65]. A summary of the different positions on the causal relationship between service quality and satisfaction is shown in Figure 1.
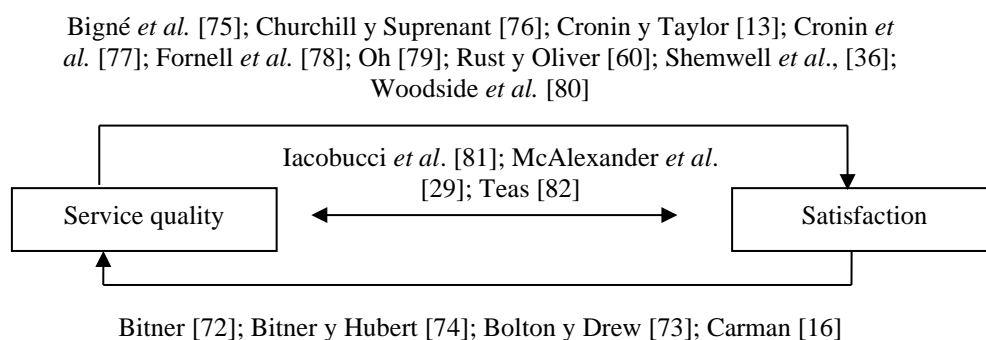
Bigné *et al.* [75]; Churchill y Suprenant [76]; Cronin y Taylor [13]; Cronin *et al.* [77]; Fornell *et al.* [78]; Oh [79]; Rust y Oliver [60]; Shemwell *et al.*, [36]; Woodside *et al.* [80]

Fig-1: Summary of causal relationships between satisfaction and perceived service quality
Source: Adapted from Alén and Fraiz [83]

In summary, although there is a lack of consensus on the specification of the relationship between service quality and satisfaction, the most widely accepted conception suggests that service quality is an antecedent to construct of satisfaction, and this is what will be taken into account in this study.

To measure customer satisfaction, Caruana [63] used the instrument provided by Bitner and Hubbert [74], which consists of a 4-item scale, a compendium of global affective responses measured using a 5-point Likert scale.

Due to the support offered in the literature for operationalizing consumer satisfaction through deficiency measures [60], Brady *et al.* [70] measured satisfaction with a 10-item deficiency scale. The scale was from 1 to 9 to rate whether the service was worse, equal or better than expected.

Dabholkar *et al.* [84], Brady *et al.* [85], Brady and Robertson [69], Olorunniwo and Hsu [58] and Wang and Lo [86], used scales modified to those developed by Westbrook and Oliver [87] in their studies.

Perceived value
Most researchers state that perceived value of service is determined by the difference between profit and loss or, in the case of services, the difference between service quality and sacrifice, i.e. what the client has to deliver to obtain good service [71, 85, 86, 88-90]; that is, a functional and utilitarian view.

Choi *et al*. [71], argue that although service performance superiority is the main component of perceived benefits, clients may consider other factors such as prestige or reputation. Sacrifices can be divided into two types: the price that clients have to pay and the non-monetary costs experienced in receiving care. Like service quality, value is also a cognitive construct.

Some research has corroborated the relationship between service quality and perceived value for health care service [91, 92] and other services [78]. However, fewer studies have studied the functional relationship between perceived value and satisfaction [78, 86, 93, 94], which have shown that consumer satisfaction depends on value to some degree.

Fornell *et al*. [78] and Gooding [92] have proven that there is a causal relationship between value and intention. Several researchers have stated that perceived value of service has been identified as a antecedent to satisfaction and behavioral motivations [61, 77, 95, 96]. Some research has suggested that perceived value may be a better predictor of repurchase intentions than satisfaction or service quality [77, 97].

Perceived value can be analyzed with a one-dimensional measure [98] or a multidimensional scale [99, 100]. The problem with the first is mainly related to its lack of validity. The latter can be operationalized, for example, as a five-dimensional construct consisting of social, emotional, functional, epistemic and conditional responses [99]. A multidimensional framework of client value, including utilitarian and socio-psychological perspectives [99-102], may be more appropriate for measurement of value perceptions, which differ greatly because of the risk and uncertainty faced by consumers [103].

Behavioral intentions of post service
Olorunniwo *et al*. [58] state that some authors [104] have pointed out those behavioral intentions may or may not be good predictors of behavior. However, if they are, the construct of behavioral intentions is important to a service provider.

A concept of service loyalty that incorporates three specific components, purchasing, attitude and cognition, is the degree to which a consumer exhibits a repetitive purchasing behavior of a service provider, has a positive attitudinal disposition toward the provider and considers using only this provider when there is a need for the service [105].

Several studies have examined the direct effects and indirect relationships between value, service quality, satisfaction and post-purchase consequences such as customer loyalty, word of mouth, overpricing and buy-back intentions [8, 9, 13, 86, 103, 106], concluding that the relationships between the constructs are complex, diverse and dynamic.

Alén and Fraiz [83] have compiled a summary table of studies that have related service quality and behavioral intentions (See Table 2).

Tabla-2: Studies that relate service quality and behavioral intentions

Study	Variable outcome studied	Relationship type
Cronin y Taylor [13]	Repurchase	Direct
Boulding *et al.* [106]	Repurchase and recommendation	Direct
Baker y Crompton [107]	Intent to purchase, loyalty and probability of paying more	Direct
Alexandris *et al.* [108]	Mouth-to-mouth communication and purchase intention	Direct
Bou *et al.* [109]	Intention to purchase	Indirect via satisfaction
Woodside *et al.* [80]	Intention to purchase	Indirect via satisfaction
Caruana [94]	Loyalty	Indirect via satisfaction
Gremler y Brown [110]	Loyalty	Indirect via satisfaction
Shemwell *et al.* [111]	Complaint and loyalty behavior	Indirect via satisfaction

Source: Alén and Fraiz [83]

By integrating research findings, the following list of specific indicators of favorable behavioral intentions can be obtained: say positive things about the company to others [106], recommend the company or service to others [8, 9],

pay a preferential price to the company, and remain loyal to the company [112]. Loyalty can be manifested in multiple ways; for example, by expressing a preference for one company over others, continuing to buy from it, or increasing business with it in the future.

Zeithaml *et al*. [113] developed a battery of 13 items to measure a wide range of behavioral intentions, which were grouped into five dimensions: loyalty to the company, propensity to change, willingness to pay more, external response to the problem, and internal response to the problem. Caruana [63] used 12-item scale suggested by Gremler and Brown [105] to measure service loyalty.

The distinction that was made in the constructs related to service quality between cognitive and affective, serves to relate them later in models that have tested the causal sequence suggested by the framework of multi-attribute attitude model; that is, cognition (service quality and value) - affects (satisfaction) - cognate (intention of behavior), as suggested by Choi et al. [71].

Global service quality

Dabholkar *et al*. [84], state that several researchers have measured global service quality directly. However, most of them [8, 13, 21, 73, 106, 113] have used a simple measure of an item that makes it impossible to determine the reliability of this construct. Some of these studies [113] have seen global service quality as only an alternative way of measuring service quality. Parasuraman *et al*. [8] stated that it can be obtained by an average score of the five related dimensions. Only few studies have used multi-item measures of global service quality [33, 67, 114, 115]. For example, Brady *et al*. [70] identified five items to operationalize global service quality construct.

Measurement of global service quality generally serves to test concurrent validity of multidimensional service quality construct [8].

Sacrifice

Brady *et al*. [85], state that sacrifice is defined as that which is given or sacrificed to acquire service. This is consistent with the definitions of Zeithaml [90] and Dodds *et al*. [95].

Wang and Lo [86] state the same definition as above. However, they argue that not only price is considered as an element of sacrifice, but also other non-monetary factors. Therefore, there are two types of sacrifice: monetary costs and non-monetary costs. The former can be evaluated by a direct measure of the dollar price of the service and the latter can be defined as the time, effort, energy, distance and conflict invested by clients to obtain services or to establish a relationship with the provider. They also concluded that perceived sacrifice (including price) has a significant negative impact on the customer's value, and therefore influences the customer's satisfaction and behaviour intentions indirectly and negatively.

Brady *et al*. [85], included sacrifice as antecedent of perceived value in a so-called "comprehensive" model; however, other studies [61, 71] did not consider it essential for establishing a relationship between service quality, value, and behavioral intentions.

Nomological network of perceived service quality

Roest and Pieters [116], state that specifying that service quality is the difference between expectations and performance is not sufficient to discriminate between service quality and satisfaction. Specifying that perceived value is a trade-off between benefits and costs is insufficient to distinguish it from constructs such as satisfaction and attitude. Defining the attitude in terms of a composition of cognitive, affective and conative aspects does not exclude that the construct is confused with a construct as the intention to purchase.

Within the conceptualization of a construct, determining its nomological network is important. A nomological network is "...the predicted pattern of relationships that would make it possible to name a construct" [117, p. 70]. The nomological network is an aspect of construct validity and represents the way in which a construct relates to others and its operationalization potential. The links between the theoretical constructs are of interest because one wants to achieve discriminating validity by specifying what not the objective construct is.

The nomological network of perceived service quality is composed of satisfaction, perceived value, attitude towards the product and post purchase behavioral intentions. The first reason is that they are all constructs that have the same classification principle [118], as they can be classified as 'consumption and behaviour based'. Secondly, they are all subjective; that is, they reside in the client's mind. Third, they are expected to drive acquisition, experience, customer retention and future service choice [60].

Measurement of service evaluation constructs in higher education

Several researchers [4, 5, 32, 119, 120] have reviewed the important aspects of the SERVQUAL measure and its adaptations in various service settings, but few have presented a review of the research on measuring service quality in higher education [121-122]. This may be due to the lack of an agreed conceptual structure for quality management in education or to differences in the characteristics of education compared to general service systems.

Service quality in higher education is a complex, ambiguous and multifaceted concept, and there is a need for a single correct definition of what is truly involved [123-125], with no consensus yet on how best to define and measure it [126]. Each stakeholder (students, government, and professional demanders) has their own point of view on what quality is, because of their particular needs.

Frazer [127] argues that the first important step should be to agree internationally on levels, standards, effectiveness and efficiency. Martens and Prosser [128] emphasize the importance of quality learning, which should be focused on meaning rather than reproduction. Ramsden [129] comments that the core competence in academic disciplines is to understand the way in which students learn and discern the phenomena related to the subject.

Several works have focused on the assessment of the overall experience of students in the university in relation to the set of services it offers [130-133], studying the assessments of students of the determinants of service quality offered by the institution, not only at the teaching level, but also including support services for the study (libraries, laboratories, language services, computer rooms, etc.) and general services (sports, cultural, accommodation, etc.).

On the other hand, some research has compared the instruments proposed in the literature on service quality. For example Li and Kaye [134] and Camisón *et al.* [135], conclude that the perceptions-based approach is superior to the difference between expectations and perceptions in measuring the quality of university teaching.

In summary, a review of the main research findings so far on service quality in the context of higher education is presented [53, 75, 122, 124, 131, 132, 134-142]:

- There is no unanimity on the conceptualization of service quality in the university field from the user's perspective, although it should be noted that most authors are based solely on perceptions.
- There is no generalized standardized scale, as most researchers develop their own set of items or choose to adapt the SERVQUAL scale. Also, the number of scale items varies from work to work (from 3 to 8 dimensions and from 19 to 40 items).
- The scale used is generally the Likert scale, varying from 4, 5, to 7 points.
- The studies are generally focused on a particular discipline, with research in the field of business administration and management predominating.
- The methodology used is similar in almost all cases, since a qualitative or exploratory phase is initially carried out; a factorial analysis is then usually used to determine the dimensions that determine the concept.
- Sample sizes range from 94 to 811 students surveyed.
- The most commonly used sampling techniques are random and stratified sampling, with career fixation.
- The explanatory capacities of the instruments generated vary from 41% to 64%.
- Different results are obtained in terms of the number, content and relative importance of the different dimensions of perceived quality, since the same concept is not always measured. However, the relative importance of the dimension(s) associated with the teaching staff can be stressed.

Measurement of university class service evaluation constructs

Class service in higher education is the service provided by a teacher to students in a classroom, which involves the teaching-learning process.

Understanding class service

Class services are positioned as predominantly intangible, at the end of the line of goods and services [143]. Classes in a course are intended to increase students' cognitive (knowledge, reasoning and thinking), attitudinal (temperament, feelings and values), volitional (connecting thoughts and feelings to action) and behavioral (actions and acts) skills, which the institution and the instructor intend to impart [144] (See Figure 2).
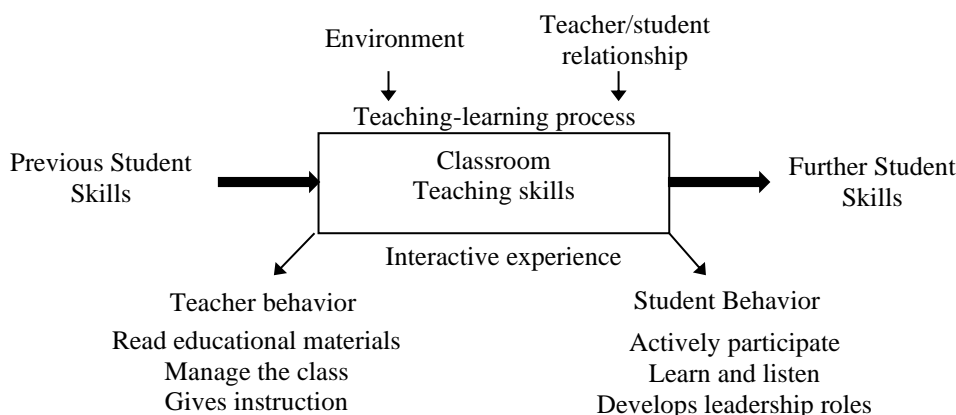
Environment   Teacher/student
relationship

↓   ↓

Teaching-learning process

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Previous Student          ┌─────────────────┐          Further Student
Skills          ═══════▶  │   Classroom     │  ═══════▶  Skills
                          │ Teaching skills │
                          └─────────────────┘
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Interactive experience

Teacher behavior   Student Behavior

Read educational materials   Actively participate
Manage the class   Learn and listen
Gives instruction   Develops leadership roles

Fig-2: Class Service Process
Source: Adapted from Huitt [144, 145]

The teaching-learning process in the classroom transforms previous student skills (entry) into later skills (exit). Student skills (knowledge skills, effectiveness, attention, perception, etc.) are part of the input that is used in the transformation process. The class process consists of the teacher's behavior (reading materials, teaching instruction, managing the class, etc.) and (consequently) the behavior of students in the classroom (actions during learning time), as well as other variables such as the classroom environment, teacher-student relations, and the opportunity for students to fit into leadership roles [145].

At the end of the class (teaching-learning process), students will leave with new skills acquired or modified (intangible results) and possessions (tangible results such as reading material, etc.), which together will constitute the output (result) of the service. Once the class has been taught, students may be satisfied or unsatisfied with the outcome. They can think about the outcome and talk to others about it. This may affect students' interest in the class and their subsequent intention to attend future classes.

Definition of service quality of classes
The perceived service quality of a class is the degree and direction of discrepancy between what the students expects to receive (expectations) and his or her perceptions of current class service performance; it is the student's judgment about the integrity of the excellence or superiority of the class service provided by the teacher and the university.

The quality of a class taught to students in a classroom can be grouped into two dimensions of quality: technical (result) and functional (process) quality [146]. The quality of result can be expressed primarily as the degree of skills or abilities (cognitive, attitudinal, volitional, and behavioral) gained during the class including notes and reading materials received during the class and feedback on student performance. Functional quality (process) can be divided into tangible and intangible quality. Tangible aspects refer to the condition of the classroom, the quality of the presentation and appearance of the teachers. The intangible aspects consist mainly of the teacher's skills in teaching the class. Classroom service will be perceived as quality when the teacher meets or exceeds student expectations [8] (See Figure 3).

Definition of student satisfaction
Just as an employer regularly assesses customer satisfaction, universities and educational institutions conduct student satisfaction surveys to improve the quality of services offered to students [147]. Satisfaction has been defined as an evaluative judgment of the client regarding the pleasure derived from meeting the level of consumption [66] and the person's cognitive state of being adequately rewarded for the sacrifices they have suffered [148].

Allen *et al.* 149] have illustrated that affective and emotional constructs such as satisfaction are better predictors of later behavior than cognitive constructs such as service quality. Global satisfaction has been used as a variable to examine its relationship between class quality and post-class intentions [13, 150].
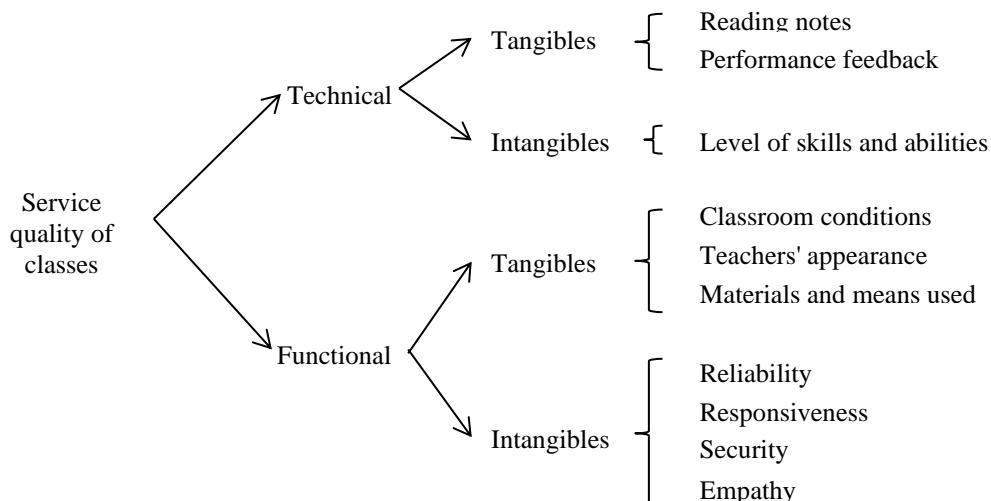
Fig-3: Determinants of service quality of classes

Definition of post class behavioural intentions

Clients remain loyal to an organization if changing service providers is difficult or they are satisfied (or affectionate) with the service [150]. Since intentions can function as predictors of actual behavior [151], positive post-consumer intentions are likely to give rise to congruent intended behavior in the future. While Mittal and Kamakura [104] state that intention-only valuations are insufficient to accurately predict repurchase behavior, intention data are easy to collect and have been widely used in past studies [152]. Satisfied students may like to attend another class taught by the same teacher or choose another course taught by him or her; they may also want to advise other students to attend those classes or make future financial contributions to support the institute [153].

Validity and reliability of perception instruments

Reliability

Reliability is defined as the tendency of a subject to consistency when it has to answer a set of measures of an attribute [1].

Churchill [3] argues that the recommended measure of reliability (internal consistency) of a group of items is provided by the alpha coefficient, which results directly from the assumptions of the sample domain model.

The alpha coefficient should be the first measure calculated to assess the quality of the instrument. It is meaningful because the square root of the alpha coefficient is the estimated correlation of the k-item test with the true error-free scores. Therefore, a low alpha coefficient indicates that the sample of items performs poorly in capturing the construct that motivated the measure. Instead, a large alpha indicates that the k-item test correlates well with the true values.

If alpha is low, what should the analyst do? If the group of items is large enough, this result suggests that some items do not participate equally in the common essence and should be eliminated. The easiest way to find them is to calculate the correlation of each item with the total and draw those correlations in decreasing order of magnitude. Items with near-zero correlations must be deleted. Additionally, items that produce a sudden decrease in the correlations of each item with the total should be eliminated.

If the construct has, for example, five identifiable or determinant dimensions, the alpha coefficient should be calculated for each dimension. The correlations of each item to the total used to eliminate items should also be based on the items in the component and the total score for that dimension. The total score for the construct should be assured by the sum of the total scores of the separate components. The reliability of the total construct should not be measured by the alpha coefficient, but rather by the formula for the reliability of linear combinations (beta coefficient).

Alpha coefficient [1]

Cronbach [154] presented a synthesis and discussion of different methods for calculating reliability as internal consistency and integrated them into a comprehensive formula, the coefficient α:

$$\alpha = \frac{n}{n-1}\left(1 - \frac{\sum \sigma_j^2}{\sigma_x^2}\right)$$

Where:

n is the number of elements of the test.
σ_j^2 is the variance of an item (j = 1, 2, 3, …, n).
σ_x^2 is the variance of the total test.

Beta coefficient

Raju [155] proposed the beta coefficient, expressed in the following equation:

$$\beta = \frac{\sigma_x^2 - \sum_{j=1}^{p} \sigma_j^2}{\sigma_x^2 \left[1 - \sum_{j=1}^{p} \left(\frac{n_j}{n}\right)^2\right]}$$

Where:

p is the subtest number of the battery.
σ_x^2 is the variance of the battery scores.
σ_j^2 is the variance of each subtest j (j = 1, 2, …., p).
n_j is the number of items of each subtest.
n is the number of battery items.

Coefficient of reliability of a multidimensional battery

It may be unweighted:

$$\sigma_{TT'} = 1 - \frac{\sum_{j=1}^{p} \sigma_j^2 - \sum_{j=1}^{p} \sigma_j^2 \, \rho_{jj'}}{\sigma_x^2}$$

Or weighted:

$$\sigma_{TT'} = 1 - \frac{\sum_{j=1}^{p} a_j^2 \sigma_j^2 - \sum_{j=1}^{p} a_j^2 \sigma_j^2 \, \rho_{jj'}}{\sigma_x^2}$$

Where:

p is the number of battery dimensions
a_j^2 is the weight of the dimension j
$\rho_{jj'}$ is the coefficient of reliability of the dimension j

Validity

According to Martínez [1] validity is defined as the degree to which a test measures what it intends to measure. The problem is the operationalization of the degree of relationship. Asubonteng et al. [32], argue that a reliable measure is one that is consistent; if quality has not changed, the measure of quality should not change. A valid measure is a measure in which the score generated by the measurement process reflects the "true" value of the property being measured.

Ladhari [5] states that while the service quality measures reviewed in his study claimed to have shown good reliability, it is important to note that high alpha values may be indicative of deficiencies (rather than reliability) on a scale [3, 156]. As Smith [156] noted, high alpha values can reflect poor measurement instrument design, poor scale content, or data attenuation problems. It is then critical to establish validity (the degree to which an instrument measures what it intends to measure) of any proposed measurement system.

Churchill [3] indicates that specifying the domain of the construct, generating items that exhaust the domain, and subsequently purifying the resulting scale should produce a measure that has content validity and is reliable. However, this may or may not produce a measure that has construct validity. Construct validity, which deals with the depth of the scientific process, is more directly related to the question of what the instrument is actually measuring - what construct, feature, or concept is behind a person's performance or score on the measure. The preceding steps should produce an internally consistent or homogeneous group of items. Consistency is necessary but not sufficient for construct validity. Rather, to establish construct validity of a measure, the analyst must also determine (1) the degree to which the measure correlates with other measures designed to measure the same thing and (2) whether the measure behaves as expected.

Aspects of validity
There are many different forms of validity that can serve as criteria for assessing psychometric strength of a scale: discriminant validity, expression validity, convergent and concurrent validity. Others point to predictive and nomological validity.

According to Martinez [1], the Standards for Psychological and Educational Test, speak of 4 aspects of validity: content, predictive, concurrent and construct. Construct validity is the fundamental and inclusive aspect of the other aspects, which has two important types of evidence: convergent and discriminating validity. The conclusion of many authors was that there is one construct validity and all the others are categories. Content validity would show relevance of the content and predictive and concurrent validities would be predictive and diagnostic usefulness, respectively. Some other forms of validity: convergent, discriminant, factorial, etc., are considered design strategies and data analysis, used to test conceptual connections between the measurement and the construct.

Messick [157] points out that validity is a matter of degree, it is not definitive, and can be modified by new evidence; that is, validity of a test is a continuous, never-ending process.

Validity of expression or content and apparent validity
Validity of expression is a subjective criterion that reflects the degree to which the scale items are significant and represent the construct to be measured. It was explicitly evaluated a priori in most of many studies [8, 16, 21]. Buttle [4], states that validity of expression refers to the degree to which the scale appears to measure what its purpose is to measure.

Martínez [1], states that content validity expresses the degree to which the content of a test constitutes a representative sample of the elements of the construct he intends to evaluate. It emphasizes that to achieve this validity the samples must be relevant and representative. A score is relevant to the intended use when all test items are within the domain of interest, and the concept of representativeness is achieved when the items reproduce the essential characteristics of the universe.

Apparent validity does not represent any form of validity in technical sense; it refers not to what the test measures, but to what it appears to measure superficially.

Construct validity
Buttle [4] states that construct validity are generally used to refer to vertical correspondence between a construct that is at an unobservable conceptual level and a measure that is at an operational level. In an ideal sense, the term means that a measurement evaluates the magnitude and direction of (1) all of its characteristics and (2) only the characteristics of the construct that it is intended to evaluate.

Construct validity is itself a compound of several forms of validity: nomological, convergent, discriminating and predictive validity.

Discriminant validity
Ladhari [5] argues that to establish discriminant validity (that is, the degree to which theoretically unrelated construct measures do not correlate with each other), several researchers, for service quality determinants, used confirmatory factor analysis (CFA) and compared the average variance extracted (AVE) for each factor with the variance shared by the remaining factors (e.g., Wolfinbarger and Gilly [47]; Gounaris [49]; Caro and Garcia [54]). It was confirmed that the two dimensions were different if the AVE estimate was larger than the shared variance estimate. In other studies, discriminant validity was demonstrated simply by showing that the scale does not correlate strongly with other measures from which it is assumed to differ [4, 44].

Convergent validity

It relates to the degree to which the different scale items adopted to represent a construct actually "converge" on the same construct [1]. Reliability of a scale measured by alpha coefficient reflects the degree of cohesion between the items of the scale and is therefore an indirect indicator of convergent validity. A stricter test of convergent validity is whether the items that are expected to load together in a factorial analysis do so [8].

Ladhari [5] points out that to assess convergent validity (i.e., the degree to which a group of items assumed to represent a construct actually converges on the same construct), most studies calculated the average variance extracted (AVE) of each dimension (with an AVE of more than 0.5 to support convergent validity). Examples in their review included Gounaris [49] and Caro y Garcia [54]. Some researchers considered the fact that all items were highly loaded on the factor to which they were assigned as additional evidence of convergent validity (e.g., Dabholkar et al. [33]; Caro and Garcia [54]).

Concurrent validity

It is related to the level to which an instrument's scores are associated with conceptually related measures [1]. Concurrent validity was examined in several studies [17, 21].

Predictive Validity

Ladhari [5] states that to demonstrate predictive validity (that is, the degree to which scores on one construct were empirically related to scores on other conceptually related constructs) some researchers correlated their service quality dimensions with global quality (e.g., Sureshchandar *et al*. [44]; Wolfinbarger and Gilly [47]; Gounaris [49]; Jabnoun and Khalifa [51]; Parasuraman *et al*. [158]). Others correlated their service quality dimensions with other dimensions; these include: satisfaction (e.g., Lam and Zhang [34]; Janda *et al*. [43]; Wolfinbarger and Gilly [47]; Gounaris [49]; word of mouth (e.g. Dabholkar *et al*. [33]; Janda *et al*. [43]); and loyalty (e.g. Janda *et al*. [43]; Sureshchandar *et al*. [44]; Wolfinbarger and Gilly [47]).

However, this definition may be similar to concurrent validity. Martìnez [1] makes the difference between these two types of validity, indicating that predictive validity refers to the degree to which test scores predict measures taken later, i.e. future behaviors of the subject. Concurrent validity, on the other hand, refers to the degree to which test scores correlate with others, measured at the same time.

Nomological validity

Buttle [4] argues that nomological validity is the degree to which a measure correlates in theoretically predictable ways with measures of different but related constructs. Service quality is one of several apparently related constructs whose alignment has not yet been explored. Included in the nomological network are customer (dis)satisfaction, customer retention and defection, behavioral intent, attitude to the service provider or organization and choice of service provider or organization. Some research on these questions has been published [10, 159], but the relationships have not yet been fully explored.

Clarifying the concept, Martinez [1] says that the basic function of nomological validity is to show that the theory of measured construct provides logical bases for establishing empirically demonstrable connections between test scores and the measurements of other constructs.

Ladhari [5] concludes that few studies tested and supported all three types of validity (convergent, discriminant and predictive). These include: Dabholkar *et al*. [33]; Aldlaigan and Buttle [42]); Janda *et al.* [43]; Sureshchandar *et al*. [44]; Wolfinbarger and Gilly [47]; Gounaris [49]; Karatepe *et al*. [50]; and Parasuraman *et al*. [158]. In some studies, all three types of validity were not assessed or even discussed.

Introduction to the concept of robustness in the evaluation of perceptual instruments

The robust design was proposed by the Japanese scientist Genichi Taguchi as part of a philosophy for quality engineering, and more specifically in the design of experiments. The aim of robust parameter design (factors affecting the production process) is to achieve robust or insensitive products to the causes of variability (noise) that affect or compromise product functionality [6].

In this sense, robustness means ensuring that the product is insensitive or resistant to noise factors that can be controlled or not, and that, therefore, its use by the consumer is not compromised or reduced.

For this concept to be used in the design of psychometric questionnaires, it must be adapted to this new use. Then it can be said that a questionnaire designed to measure a construct will be robust if it can be applied or administered

generally in any condition, because it is not affected by noise factors. There are two types of factors in the methodology: control factors (those that can be controlled in the experiment) and noise factors (uncontrollable factors).

Control and noise factors in the evaluation of class service

Snipes *et al*. [160] studied some factors that influence quality of instruction service in Higher Education, concluding that there is a gender bias in the evaluations of students in the service of teachers, in favour of men; this decreases when considering the equity of service; and there is a difference in the perception of equity of service among students, identifying a bias of male "clemency". However, the study by Snipes *et al.* [160] used only 4 control variables (age, student GPA, instructor experience, and class complexity) to test their hypotheses, using hierarchical multiple regression by successive steps, leaving open the question of whether the results would be confirmed by including other more influential control variables on service quality of class. The only control variable that was significant (at the level of $p < 0.01$) was that of teaching experience.

Another study found that male teachers were rated more highly than female teachers for their expressiveness in the classroom, regardless of how the material was presented [161].

Intending to continue the research of Snipes *et al*. [160], Valdivieso *et al*. [162], at UPB University (Campus Cochabamba), wanted to check whether gender (of students and teachers), including as control factors, socio-demographic and academic variables (7 variables for students and 8 for teachers), influence class service evaluations (global and multidimensional service quality, student satisfaction, perceived value and postclass behavioral intentions. Their results showed that there is no gender bias in class service assessments, and those variables such as the teacher's exigency, experience, and workload, the student's semester and GPA score, the number of students, course performance, and the complexity of the subject matter influence class service assessments. Specifically for each construct, the variables shown in Table 3 influences.

Tabla-3: Comparative Results of Multiple Linear Regression of Class Service Evaluation: MQS-Multidimensional Quality of Service; GQS-Global Quality of Service; VAL-Global Perceived Value; SAT-Student Satisfaction; BI-Post Class Behavioural Intentions

Variables	Betas				
	MQS	GQS	VAL	SAT	BI
SEM_S	-0,334	-0,301	-0,288	-0,258	-0,241
EXIG_S	0,209	0,218	0,274	0,162	0,177
EXPDOC_T	-0,162	-0,123	-0,277	-0,223	-0,223
GPA_S	-0,177	-0,151		-0,139	-0,185
WORKLOAD_T	0,137		0,128	0,120	0,137
NUMEST	-0,131	-0,190	-0,155	-0,132	-0,154
COMPLE_T			0,122		
SCHOLARSHIP_S			-0,114		
Significant at the p<0.01 level.					

Source: Valdivieso *et al*. [162]

It can be seen that in practically all service evaluation constructs, the influential factors are the semester in which the student is enrolled, perception of exigency of the subject, years of experience of the teacher, the student's GPA (which does not influence the perceived value), the daily hourly load of classes (which does not influence quality of global service) and the number of students in the class. The variables of complexity of the subject perceived by the teacher, and the percentage of scholarship of the student only affect perceived value.

Robustness analysis technique: multiple hierarchical regressions in successive steps

The statistical technique chosen for the determination of robustness was that of hierarchical multiple regression in successive steps.

The technique of multiple linear regressions is well known. The difference with the hierarchical regression of successive steps is that the researcher does not formulate the model for the corresponding empirical comparison, but a computer program automatically selects the explanatory variables that must appear in the model. This procedure is advisable when the researcher does not have an a priori model and the explanatory variables are too numerous to predict the behavior of the endogenous variable [163].

The stepwise method bases the selection of variables on statistical criterion of significance. This criterion of significance implies that only those variables that contribute significantly to the adjustment are incorporated into the

model (independence hypothesis between this variable and the dependent variable is established by contrasting it with the coefficient R). Thus, to decide whether to reject/accept the independence hypothesis, test F and test t are used. A variable is included in the model, if the critical level associated with its R when contrasting the independence hypothesis is less than 0.05 and is outside the regression model if the critical level is greater than 0.10 [164].

RESEARCH RESULTS
Sampling plan and characteristics and suitability of the simple
In higher education, due to the way in which the academic processes of teaching and learning are structured, it was not feasible to carry out a simple random sampling, opting for a pseudo-random sampling taking advantage of the groups of students formed by subjects. A survey was distributed by career directors to students of Universidad Privada Boliviana (UPB Campus La Paz) during the school year, at the end of the course. 300 surveys were processed in the II-2014 semester. The data collected through the sampling plan present the following demographic and academic characteristics of the students surveyed (Table 4).

Tabla-4: Attributes of the sampled students

Characteristic	Result [%]	
Gender	Male	Female
	54	46
Civil status	Single	Married
	100	0
Nationality	Bolivian	Foreign
	99	1
Faculty	Engineering	Business
	38	62
Scholarship	Yes	No
	27	73
Classroom methodology	Traditional	Not traditional
	53	47
Subject	Numerical	Theoretical
	84	16

These characteristics confirm the population pattern of UPB students at La Paz Campus and the pattern of planned subjects.

Design of measuring instruments
The first step of the research was to obtain valid and reliable instruments of the constructs that are part of the evaluation of class service at UPB. For this purpose, the following methodology was followed:

- Identification of the purpose of the instrument. In this case the batteries can be used as a diagnostic tool (service quality, perceived value, satisfaction) or predictive (behavioral intentions of postclass).
- Identification of the domain of the constructs involved in the model.
- Analysis and choice of the appropriate measurement approach (which in the case of service quality and perceived value are second-order multidimensional models, and in the case of satisfaction and behavioral intentions are one-dimensional models).
- Specification of some external factors of the instrument: a) Characteristics of the population: Students enrolled in the UPB at the undergraduate level, b) Language: Spanish, c) Application time: Approximately 20 minutes, d) Temporal application stage: Last days of teaching a subject.
- Choice and preparation of a sample of items covering the domain of each construct. First, the dimensions that make up the construct and its definitions were determined. Subsequently, items were created, chosen and / or modified based on the literature (revision and analysis of batteries to measure the constructs considered in higher education and other services) to cover the domain of each dimension. This analysis was carried out through expert judgment.
- Specifying the format of the instrument items, indicating the type of response to be given by the examiner and the scoring procedure. The questionnaire measures students' perceptions of the different elements that make up the evaluation of class service, using a 7-point Likert scale, ranging from 1 = "Strongly disagree" to 7 = "Strongly agree", except for service quality, which ranged from 1 = "Much worse than expected" to 7 = "Much better than expected".
- Elimination of irrelevant items to the measurement, obtaining a robust dimensional structure (number of dimensions) of each measurement instrument, using exploratory factor analysis (EFA) (principal component method) and determination of internal consistency or reliability using Cronbach's alpha. To perform the exploratory factor

analysis, the Bartlet sphericity test, the KMO test and the sampling adequacy measures of each item must be performed previously.
- For the second-order multidimensional construct instruments, the determination of goodness of fit indices using confirmatory factor analysis (CFA) (least squares method).
- Determination of the validity (discriminant and predictive) of the instruments designed.

The following instruments were generated for the measurement of class service evaluation constructs, defined as follows:

Multidimensional service quality of classes
Classroom service will be perceived as quality when the teacher meets or exceeds student expectations. The dimensions of service quality are tangible, security and result. The following sources of information were used to generate an instrument that measures service quality of classes perceived by the student and that can be valued by those surveyed: 1) specific scales to measure service quality of a class or instruction [141, 160], 2) general scales to measure service quality in higher education, and 3) expert judgment in the teaching-learning process, in the model of professional competencies and in the intensive modular system used by the UPB.

Multidimensional perceived value of class service
It is conceptualized as the difference between service quality of the classes they receive and the sacrifice they make (cost of registration, time, energy and effort used to attend the class). The dimensions of the perceived value of class service are: functional value, social value and sacrifices. For the generation of an instrument that measures the perceived value of class service, which can be valued by respondents, the following sources of information were used: 1) general scales for measuring the perceived value of service in various service industries ([99, 101, 103, 165-173], 2) general scales for measuring the value of service in higher education [174, 175], and 3) expert judgement in the teaching-learning process, in the professional competence model and in the intensive modular system used by the UPB.

Global service quality of classes
It is a measure of the student's judgment about the integrity of the excellence or superiority of the class service provided by the teacher and the university. It was measured using a battery of 4 items, adapted to the context of higher education, from various sources: Dabholkar [84], Dabholkar [65], Spreng and Mackoy [114] and Wang and Lo [86].

Global perceived value of class service
The perceived value of class service to students is determined by the difference between the quality of class service they receive and the sacrifice they make, which is made up of the cost of enrollment, time, energy, and effort used to pass the class (Adapted from [85, 88-90]). Items for the instrument were adapted for the educational context taking into account the contributions of Brady *et al.* [85], Sweeney *et al.* [89], Sirohi *et al.* [88], Choi *et al.* [71], Wang and Lo [86], Cronin *et al.* [91], and expert judgment.

Global student satisfaction of classes
Classroom student satisfaction is defined as the student's evaluative judgment, emotional reaction, or affective perception regarding the degree of complacency derived from the experience of class service and compliance with its requirements (Adapted from [65-67]). Items to measure this construct were adapted for the educational context using contributions from the following researchers: Brady and Robertson [69], Westbrook and Oliver [87] and Olorunniwo and Hsu [58].

Post class behavioral intentions
A student's behavioral intentions after a class is the grade at which he or she exhibits repetitive behavior toward another class with the same classroom service teacher, has a positive attitudinal disposition toward the teacher, and considers recommending the teacher to others when there is a need for the class (Adapted from [63, 105]). The items to measure this construct were adapted to the educational context of the authors: Gremler and Brown [105], Zeithaml *et al.* [113], Brady *et al.* [85], Dabholkar *et al.* [176], Choi *et al.* [71] and Olorunniwo and Hsu [58].

The characteristics of the instruments designed using the EFA and CFA techniques are shown in Table 5. The instruments designed are shown in the Appendix.

Table-2: Psychometric characteristics of batteries designed for research

Characteristics	Batteries					
	MSQ	MVS	GSQ	VAL	SAT	BI
Source of information	Valdivieso [177]	Valdivieso [178]	Valdivieso [177]			
Number of items	21	23	4	4	4	5
Number of dimensions	3	3	1	1	1	1
Percentage of variance extracted from EFA	67	67	86	86	88	84
Format	1-7 (much worse than much better than expected)	1-7 (strongly disagree to strongly agree)				
Reliability	0.99	0.97	0.95	0.94	0.96	0.95
CFA adjustment indices: NFI, GFI, AGFI, RMR	0.988; 0.990; 0.988; 0.092	0.990; 0.991; 0.990; 0.089	-	-	-	-

Source: Valdivieso *et al.* [179]

It can be observed that the reliability obtained from the different designed instruments is high, achieving a high internal consistency.

On the other hand, it was verified for the set of instruments if they present content and construct validity: discriminant, concurrent, convergent, predictive and nomological.

The discriminant validity (degree to which a measure does not correlate strongly with other measures that are assumed to differ from one another) is confirmed by looking at the correlations between the dimensions of service quality of classes in Table 6 and those of perceived class service value in Table 7.

Table-6: Correlations between the dimensions of service quality of classes

	Result	Security	Tangibles
Result	1		
Security	0.623	1	
Tangibles	0.425	0.273	1

Table-7: Correlations between the dimensions of the perceived value of class service

	Social	Sacrifices	Functional
Social	1		
Sacrifices	0.484	1	
Functional	0.705	0.489	1

In both instruments, their dimensions are correlated, but there is not a very high value to determine that there is no discriminant validity.

Convergent validity (degree to which a group of items assumed to represent a construct actually converges on the same construct) is verified by determining the factorial loads of each item in its dimension (see Table 8 and Table 9), and checking that each item has loaded heavily on the hypothetical dimension. It can be seen that all the items have been strongly loaded in their respective dimensions, thus confirming convergent validity.

Table-8: Factorial loads of the CFA of each item in its dimension (service quality of classes)

Standardized factor loads			Estimated	Standardized factor loads			Estimated
SQ1	<---	Tangibles	0.639	SQ27	<---	Result	0.815
SQ3	<---	Tangibles	0.645	SQ28	<---	Result	0.760
SQ42	<---	Tangibles	0.850	SQ29	<---	Result	0.799
SQ44	<---	Tangibles	0.840	SQ30	<---	Result	0.832
SQ43	<---	Tangibles	0.728	SQ34	<---	Result	0.802
SQ21	<---	Security	0.869	SQ35	<---	Result	0.766
SQ20	<---	Security	0.852	SQ36	<---	Result	0.810
SQ25	<---	Security	0.838	SQ38	<---	Result	0.787
SQ9	<---	Result	0.676	SQ39	<---	Result	0.799
SQ12	<---	Result	0.665	SQ40	<---	Result	0.774
SQ19	<---	Result	0.829				

Table-9: Factorial loads of the CFA of each item in its dimension (service value of classes)

Standardized factor loads			Estimated	Standardized factor loads			Estimated
VS3	<---	Functional	0.787	VS45	<---	Functional	0.789
VS4	<---	Functional	0.707	VS47	<---	Functional	0.764
VS6	<---	Functional	0.835	VS35	<---	Social	0.773
VS10	<---	Functional	0.739	VS41	<---	Social	0.824
VS13	<---	Functional	0.842	VS36	<---	Social	0.751
VS14	<---	Functional	0.812	VS40	<---	Social	0.826
VS15	<---	Functional	0.826	VS37	<---	Social	0.684
VS21	<---	Functional	0.758	VS38	<---	Social	0.714
VS23	<---	Functional	0.818	VS39	<---	Social	0.764
VS29	<---	Functional	0.805	VS49	<---	Sacrifices	0.951
VS43	<---	Functional	0.793	VS50	<---	Sacrifices	0.630
VS44	<---	Functional	0.810				

The factorial loads of the instruments for global service quality, global perceived value, global satisfaction and postclass behavioural intentions are shown in Table 10.

Table-10: Factorial loads of global service quality, global perceived value, global satisfaction, and postclass behavioral intentions

Item	GSQ	Item	VAL	Item	SAT	Item	BI
GSQ1	0.912	VAL1	0.923	SAT1	0.946	BI1	0.931
GSQ2	0.948	VAL2	0.889	SAT2	0.956	BI2	0.948
GSQ3	0.945	VAL3	0.952	SAT3	0.953	BI3	0.907
GSQ4	0.911	VAL4	0.944	SAT4	0.910	BI4	0.919
						BI6	0.880

With the exception of item BI5 which was deleted, all items loaded heavily into their respective constructs, thus proving convergent validity.

Concurrent, predictive and nomological validity are checked with the correlations between constructs related to the evaluation of the class service (See Table 11). Predictive validity is the degree to which the scores of a construct, such as service quality, are associated with conceptually related measures, but related measures must be taken later, not at the same time, such as satisfaction or behavioral intentions. Concurrent validity is the degree to which the scores of an instrument are associated with measures that are conceptually related but occur at the same time, such as perceived value. Nomological validity is the degree to which a measure correlates in theoretically predictable forms with measures of different constructs.

Table-11: Matrix of correlations between service quality of classes, perceived value, satisfaction and post class behavioral intentions

	GSQ	VAL	SAT	BI
GSQ	1			
VAL	0.883	1		
SAT	0.866	0.906	1	
BI	0.869	0.927	0.954	1

Taking into account the above definitions, it is verified that the service quality of classes perceived by the student is related to the perceived value (concurrent validity). The model has predictive validity, since service quality (GSQ) is related to constructs that are its consequence, such as satisfaction (SAT), and behavioral intentions (BI); and it has nomological validity, because it is related to these constructs, which in addition to being empirically related, are theoretically related.

Another more forceful way of verifying the validity of constructs of a nomological network is by means of a modeling of structural equations that shows the relations that exist between them. Valdivieso et al. [179] developed an SEM model between perceived class service quality, perceived value, student satisfaction, and post class behavioral intentions. The model was generated using the AMOS 6.0 software. For the modeling of structural equations, the unweighted least squares method (ULS) was used, as it does not require the assumption of multivariate normality (see Figure 4).
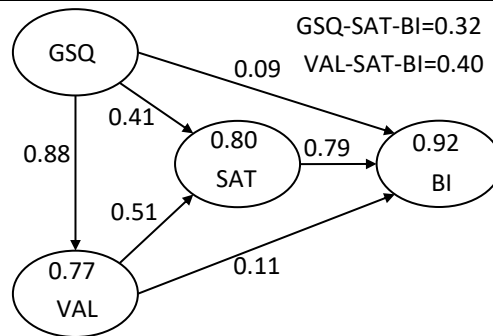
Fig-4: SEM model of the nomological network for service quality of classes
Source: Valdivieso *et al.* [179]

The following characteristics of the SEM model can be observed:

- There is a clear distinction between the 4 constructs involved in the model and the relationship of antecedents and consequents is well defined. The perceived value (VAL) is explained by its antecedent, service quality in 77%. Satisfaction has an 80% explanatory power based on your antecedents, service quality and the perceived value.
- Finally, the predictive power of the model is high (92%). This means that the antecedents (service quality, value and satisfaction) explain 92% of the post class behavioural intentions.

Table 12 shows the model's ad hoc fit indices.

Table-12: Ad hoc goodness-of-fit indices of the SEM model

Group	Index	Independent model	Analyzed model
Adjustment function	F	89217.849	61.255
Comparative fit indices	NFI	0	0.999
Variance ratio indices	GFI	0.103	0.999
	AGFI	0	0.999
Residue-based indices	RMR	1.397	0.037

Source: Valdivieso *et al.* [179]

We can see that NFI, GFI and AGFI indices practically have a value of 1. RMR is very close to zero. This indicates that, in general, the model has good fit indices.

Once it has been verified that the instruments of perception of the evaluation of class service are valid and reliable, it will be verified if these are robust; that is, if they can be applied to any situation within the university because they are insensitive to the control and noise variables.

Robustness analysis of designed instruments
Robustness of measuring instruments designed for this investigation will be analyzed below. Robustness of a perception measuring instrument is achieved when its design allows it to perform or function well (to be insensitive), even if a number of factors (called noise factors) that cannot be controlled vary (without affecting it) [6].

Some noise factors that are generally considered are the type of person surveyed (client) and the type of person being evaluated (service provider), such as their socio-demographic, personal and work characteristics. The environment in which the survey is conducted, the procedures used to provide the service, etc. may also influence.

As part of the survey conducted at the La Paz Campus of Universidad Privada Boliviana, during semester II-2014, a series of questions were asked of both students and teachers about their socio-demographic characteristics, academic information and perceptions of various aspects of the subject they were teaching or studying. This information was used to carry out an analysis of the factors that influence the designed batteries. Of the 300 questionnaires completed, 235 student questionnaires were obtained and paired with questionnaires completed by teachers.

The statistical technique of hierarchical multiple linear regression in successive steps was used for the analysis.

Control and noise variables chosen for analysis
A review of the Literature on Student Assessments indicated several possible variables that may influence the service of instruction [160]: student GPA [180], student age, teacher experience [181], and class complexity [182, 183].

The study by Valdivieso et al. [162] included 15 variables for study. However, UPB expert consultation resulted in the inclusion of 22 control and noise variables, which were coded as follows:

1) For students (10 variables):
- Student's gender (GENDER_S), coded as Male = 0, Female = 1.
- Student's age, in years (AGE_S).
- Career chosen by the student (CAREER_S): FE (Faculty of Engineering) or FBA (Faculty of Business Administration), where the coding was: FE = 0, FBA = 1.
- Semester that the student is attending (SEM_S).
- Percentage of scholarship of the student (SCHOLARSHIP_S).
- Student's PGA score (weighted average score for the entire career) (PGA_S).
- Complexity of the subject perceived by the student (COMPLE_S), measured using a 7-point Likert scale (From 1: "very simple" to 7: "very complex").
- Number of times that the student was repeating the subject (REPEAT_S).
- Prior knowledge of the subject perceived by the student (KNOW_S), measured on a 7-point Likert scale (From 1: "I know nothing" to 7: "I know the subject very well").
- Teacher's exigency of the subject matter perceived by the student (EXIG_S), measured using a Likert scale of 7 points (From 1: "not at all exigent" to 7: "very exigent").

2) For teachers (12 variables):

- Teacher's gender (GENDER_T), coded as Male = 0, Female = 1.
- Teacher's marital status (MS_T), coded as married = 0, single = 1.
- Age of the teacher, in years (AGE_T).
- Teaching experience, in years (EXP_T).
- Teaching experience at university, in years (EXPUPB_T).
- Daily load of classes of the teacher in the module, in hours (LOAD_T).
- Teacher's contractual relationship at the UPB (CONTRACT_T), coded as Independent = 0, Dependent = 1.
- Number of students in the subject being tested (NUMST).
- Complexity of the subject perceived by the teacher (COMPLE_T), measured using a 7-point Likert scale (From 1: "very simple" to 7: "very complex").
- Overall performance of the course being assessed, as perceived by the teacher (PERF_T), measured on a 7-point Likert scale (From 1: "poor" to 7: "excellent").
- Class methodology used by the teacher (METHODOLOGY_T), coded as Non-traditional = 0, Traditional = 1.
- Type of subject taught by the teacher (TYPESUBJECT_T), coded as Numeric = 0, Theoretical = 1.

The dependent variables were as follows:

- Weighted average score of the multidimensional instrument for measuring the perceived service quality of classes (MSQ).
- Average score of the multidimensional instrument for measuring the perceived value of class service (MVS).
- Average score of the one-dimensional instrument for measuring the perceived global service quality of classes (GSQ).
- Average score of the one-dimensional instrument for measuring the perceived value of the class service (VAL).
- Average score of the one-dimensional instrument for measuring satisfaction in class service (SAT).
- Average score of the one-dimensional instrument for measuring class service (BI) behavioral intentions.

Table 13 shows the statistical summary of the variables used in the research.

Table-13: Control and noise variables affecting robustness

N°	Factors	Average	Standard deviation	CV	Scale
1	GENDER_S	-	-	-	Male (0), Female (1)
2	AGE_S	19.24	1.69	8.76	Years
3	CAREER_S	-	-	-	Engineering (0), Business Administration (1)
4	SEM_S	2.83	1.57	55.48	Number
5	SCHOLARSHIP_S	35.21	27.27	77.46	Percentage
6	PGA_S	65.57	29.85	45.53	Average
7	COMPLE_S	4.95	1.06	21.35	Likert scale (1-7)
8	REPET_S	0.25	0.584	233.60	Number
9	KNOW_S	3.39	1.58	46.67	Likert scale (1-7)
10	EXIG_S	5.53	1.11	20.14	Likert scale (1-7)
11	GENDER_T	-	-	-	Male (0), Female (1)
12	MS_T	-	-	-	Married (0), Single (1)
13	AGE_T	48.66	15.14	31.12	Years
14	EXP_T	16.11	14.56	90.38	Years
15	EXPUPB_T	4.55	3.60	79.05	Years
16	LOAD_T	3.16	0.99	31.33	2 hours, 4 hours
17	CONTRACT_T	-	-	-	Independent (0), Dependent (1)
18	NUMST	25.37	9.17	36.15	Number
19	COMPLE_T	4.23	1.63	38.61	Likert scale (1-7)
20	PERF_T	4.92	1.31	26.52	Likert scale (1-7)
21	METHODOLOGY_T	-	-	-	Non traditional (0), Traditional (1)
22	TYPESUBJECT_T	-	-	-	Numeric (0), Theoretical (1)

Results of robustness analysis

The results of the hierarchical multiple regression of successive steps for multidimensional service quality (MSQ) instrument are shown in Table 14. SPSS 21 statistical software was used for data analysis.

Table-14: Multiple regression of multidimensional service quality (MSQ)

Explicative variables	Standardized coefficients Beta	t	Sig.	Colinearity statistics	
				Tolerance	VIF
(Constant)		8.611	0.000		
EXIG_S	0.458	7.822	0.000	0.922	1.085
COMPLE_T	0.376	5.963	0.000	0.796	1.257
SEM_S	-0.277	-4.557	0.000	0.858	1.165

It can be observed that of the 22 explicative variables, only 3 are significant, since they have been retained in the regression. It can be observed that the multidimensional instrument of perceived service quality of classes is only influenced by the exigency of the teacher of the subject, the complexity of the class and the semester in which the student is enrolled.

The same procedure was followed for the other instruments used to evaluate class service: multidimensional perceived value of class service (MVS); global service quality (GSQ); perceived value (VAL); student satisfaction (SAT); and post class behavioural intentions (BI). Table 15 shows the main influential variables using a comparative approach. The Table shows the results of the standardized beta parameters for each class service evaluation construct.

It can be concluded that exigency of the subject matter perceived by the students and teaching load of classes influences all the constructs of evaluation of class service in a positive way; that is to say, to a greater exigency and greater hourly load of classes assigned to the teachers, there is a higher score of the class service.

With respect to the complexity of the subject matter perceived by the teacher, the semester in which the student is attending, contractual status of the teacher, experience of the teacher at the UPB and marital status of the teacher, only affect certain constructs individually.

Table-15: Results of robustness analysis

Factor	MVS	GSQ	VAL	SAT	BI	MSQ
EXIG_S	0.456	0.442	0.436	0.469	0.474	0.458
LOAD_T	0.341	0.212	0.219	0.190	0.342	
CONTRACT_T	-0.236					
EXPUPB_T					-0.299	
MS_T					-0.245	
COMPLE_T						0.376
SEM_S						-0.277
Significant at p<0.01						

In addition to exigency and time load, value of global class service is influenced by the contractual relationship of teachers in a negative way. This means that dependents are worse rated than independents. It is logical that dependent teachers should generate more value in education than independent teachers, but the opposite is true. This phenomenon may be due to the fact that independent teachers can bring more value to the service of classes because of their experience in their professional field.

In addition to exigency and time load, post class behavioural intentions are influenced by the years of experience of the teacher at UPB and his or her marital status, both of which are negatively influenced. Teachers who have been in the institution longer and those who are single are worse evaluated than teachers who have less seniority and are married.

Finally, in addition to exigency, multidimensional service quality is influenced by complexity of the subject perceived by the teacher, in a positive way, and the semester in which the student is enrolled, in a negative way. To the greater complexity of the subject, the teacher has better evaluations of service quality provided, and as the student is in higher semesters, he or she evaluates more drastically for service quality provided by the teacher.

Despite the fact that there are several variables that affect class service assessments, robustness of the 6 instruments designed has been demonstrated, since it has been proven that the questionnaires to measure class service are insensitive to the gender and age of students and teachers, the career, scholarship percentage and PGA score of the students, and complexity of the subject perceived by students, the number of times that the student has repeated the subject, the student's prior knowledge of the content of the subject, the years of experience of the teachers in education, overall performance of the course perceived by the teachers, the number of students in the class, teaching methodology of the teacher and the type or focus of the subject. The summary, the questionnaires can be applied at UPB in all circumstances to evaluate the class service; that is, they can be used generically for any subject, teacher, faculty, methodology, etc.

It is interesting to note the signs of the beta values of the regression, to interpret the influence of each factor:

- Exigency of the teacher teaching the subject (positive sign). The higher the teacher's exigency, the higher the score of the different evaluations of the class service he or she provides.
- Hourly workload of the subject teacher (positive sign). The more time the teacher has in the module, the better he/she is evaluated about the class service he/she provides.
- Complexity of the subject matter (positive sign). The more complex the subject matter, the higher the students score on the service quality provided by the teacher.
- Semester taken by the student (negative sign). The higher the semester in which the student is, the lower the service quality of the classes given by the teacher will be.
- Contractual condition (negative sign). Dependent teachers are given lower scores by students on the value of class service than independent teachers.
- Teaching experience at the UPB (negative sign). The more experience the teacher has in teaching at the UPB, the lower the students' scores are on their positive behavioral intentions after passing the class.
- Marital status of the teacher. Students rate single teachers lower than married teachers in terms of their intentions for positive behavior after class.

Table 16 shows some characteristics and indices to validate the regression technique used for this analysis.

Table-16: Comparison of significance of dependent variables and suitability tests

Characteristics	MSQ	GSQ	MVS	VAL	SAT	BI
R^2	0.27	0.236	0.266	0.233	0.251	0.327
F of ANOVA	28.418	35.764	27.906	35.269	38.976	27.956
Durbin Watson	1.695	1.700	1.791	1.684	1.807	1.947
Minimum tolerance	0.796	0.999	0.541	0.999	0.999	0.664
Maximum VIF	1.257	1.001	1.850	1.001	1.001	1.506
All F statistics are significant at p<0.01						

It was verified (Durbin Watson's statistic) that there is no dependence on residuals (if the value is between 1.5 and 2.5 there is independence) [164] and no variable presents multicollinearity, since the minimum tolerance is not close to 0 and the maximum VIF (variance inflation factor) does not exceed 10 [163].

METHODOLOGY TO OBTAIN ROBUST INSTRUMENTS
If a systematization of the steps to obtain robust instruments for the evaluation of university classes' service is carried out, the following procedure will be followed:

1. Take the following care in formulating the items [184]:

- Avoid statements that can be interpreted in various ways.
- The phrase must express only one idea.
- Phrases should express attitudes or perceptions, never statements of fact.
- Avoid phrases that can be accepted or rejected by the vast majority of students.
- Avoid the use of words of universal meaning (all, always, nobody, never, etc.) or of indefinite meaning (only, barely, simply, sometimes, etc.).
- Use a vocabulary that can be easily understood by students.
- Avoid sexist terminology and any terms that may be exclusive or offensive.

2. The dimensions of the test should be adapted to evaluate the service of classes in any type of subject. Keep the following in mind:

- Basic or professional.
- Abstract or application.
- Of simple or complex content.
- Short, medium or long-lasting.
- Predominantly quantitative or qualitative content.
- From the Faculty of Engineering or Business.
- With few or many students enrolled in the subject.

3. The test should allow the evaluation of the class service of any teaching/learning methodology. Some of them to take into account are:

- Inverted class.
- Problemic method.
- Project method.
- Magistral class.
- Interactive class.
- Personalized class.
- Constructive method.
- Expositive class.

4. The test must be adapted to evaluate the different aspects of class service regardless of the student's condition, such as:

- Gender.
- Age.

- Marital status.
- Whether he has a scholarship or not.
- The semester you are studying.
- General performance in their studies.

5. The test must be adapted to evaluate the different aspects of the class service regardless of the condition of the teacher imparting the subject, such as:

- Gender.
- Age.
- Marital status.
- Hourly load.
- Experience.
- Contractual relationship with the university.
- Academic exigency towards the students.

Taking into account all these aspects mentioned above, when designing and formulating the items of a questionnaire, could ensure the robustness of the instrument.

DISCUSSION OF RESULTS

The dimensional structure of perceived quality instrument of class service retained three dimensions. The first one is called tangible and it groups the functional aspect, attractiveness and cleanliness of the classroom and its elements of academic use. The second dimension called security, formed by the fusion of security and empathy, which exhibits personal characteristics of the teacher. The third dimension called results, which is the union of the dimension of reliability, competence and results shows the importance for the student from La Paz to have a competent teacher.

If this battery is compared with the one obtained by Valdivieso [177] for the evaluation of the class service at the Cochabamba Campus, the substantial difference is that the Cochabamba students prioritize the security that the teacher can give them in the teaching-learning process instead of their competence. This difference confirms once again that the measurement of service quality is both idiosyncratic and cultural.

The dimensional structure of the instrument of perceived value of class service retained three dimensions. One dimension (which was called functional) grouped several a priori formulated: functional, money, emotional, epistemic and reputation or image value. This grouping demonstrates a sense of practicality in assessing the hedonic elements of the value of class service by the student. The second dimension is confirmed by social value items, being the only dimension that retained all the hypothetical items. This shows that students at the UPB in La Paz assign a high cultural priority to the social value of spending time at this university as a guarantee of status awareness [185]. The third dimension retained two items and was called sacrifices.

Analyses to obtain one-dimensional instruments to measure global service quality, global perceived value, satisfaction and post class behavioural intentions resulted in batteries exactly the same as those obtained by Valdivieso [177].

If a review is made of the robustness of the designed instruments, what stands out is that the instrument for measuring postclass behavioural intentions is sensitive to the marital status of the teacher. In general, the instruments designed are sensitive to the exigency of the teacher and his or her time load in the module. This analysis has been a novel and unique contribution to this research.

Finally, it has been found that the measuring instruments of the four constructs investigated are sensitive to the level of exigency of the teacher and his or her time load. In order to make these instruments more robust, action plans should be implemented that establish standard levels of exigency for each group of subjects with similar characteristics in order to minimize the variability of this factor, and on the other hand, policies for full-time teacher recruitment should be implemented, since these are the ones that obtain the highest scores in class service evaluations.

Appendix

Table-A1: Battery for measuring multidimensional perceived service quality of classes (MSQ)

Tangible
The modernity and technical conditions of the classroom equipment are adequate for the development of the class (data show, computer and accessories, projector, video, TV, etc.)
The conditions and elements of the classroom are adequate and functional for teaching (blackboard, curtains, plugs, markers, eraser, etc.)
The physical appearance of the classroom is visually appealing
The desks are comfortable and functional to my work needs
The classroom is usually clean
Security
The teacher is consistently courteous and respectful to me
The teacher maintains a treatment and equal respect
The teacher is very patient and tolerant to explain the subject
Result
The teacher gives the class in the stipulated time
The teacher gives useful practices to face the exams
The teacher motivates me to learn and work in classes
The teacher has the ability and didactics to teach the subject
The teacher shows that he knows and dominates the contents of the subject
The teacher maintains an appropriate organization and administration of the class
The teaching method used by the teacher is adequate to understand the subject
The teacher knows the regulations for the teaching of a class and complies
The degree of acquired skills (cognitive, attitudinal, volitional and behavioral) during the class was high
The teacher gave the subject with an adequate degree of complexity
The objectives, coverage and depth of the issues have been achieved
I acquired professional skills (conceptual, technical, human and competitive) that I can apply to solve problems and make better decisions
The class was oriented towards success, as my leadership and entrepreneurial capacities increased

Source: Own elaboration based on Valdivieso [77]

Table-A2: Batteries for the measurement of global service quality, perceived value, student satisfaction and behavioral intentions of postclass

Global service quality (GSQ)
The teacher provided an excellent global class service
The teacher gave a class service of very high quality
The teacher awarded a high standard of class service
The teacher delivered a higher class service in every way
Perceived value (VAL)
The teaching I received from the teacher has been very valuable and useful
The product I received in this class is worth more than I paid
It was worth giving my time to this class, for the knowledge I got
It was worth spending my energy and effort in this class, because it was a quality class
Student satisfaction (SAT)
I am satisfied that I have taken classes with the teacher
My choice to attend classes with the teacher was wise
I think I did the right thing by choosing to study this subject with the teacher
I think my experience with this teacher has been pleasant
Behavioral intentions of postclass (BI)
I would attend another subject taught by the same teacher
I would recommend and encourage my classmates to take classes with the teacher
I will say positive things about the teacher to my classmates
If it were an academic authority, it would reward the teacher for his or her performance
I would stay at this university until I finished my studies, if all the teachers gave the quality service I received in class

Source: Valdivieso [177]

Table-A3: Battery for measuring multidimensional perceived value of classes (MVS)

Functional
The level of quality of the class service was acceptable
The class service was well planned and organized
The class I attended represented a good investment
The number and convenience of the subjects taught in the class was acceptable
The quality of class service was productive for the price paid
I paid a reasonable price for the service received
I appreciate the class service received as it met my specific needs at a reasonable price
The interaction or relationship with the teacher has produced positive and pleasant feelings
I enjoyed passing classes with the teacher
The contents learned in this course will influence the value of my education
I've heard positive things about the teacher's class
The good reputation of the teacher has influenced the value of the class service
The image projected by the teacher has had a positive influence on the value of the class service
The price paid for the level of quality of the class service I received is high
Social
The bonding that occurred in class with my classmates made me feel accepted
The relationships in the class improved the way I perceive my classmates
I am happy because my friends have been with me in this class
I found this course more interesting because my friends have been with me
Individual or group work developed in this class has had a positive effect on the value of my education
The social interaction developed in this class has made my studies more interesting
Having approved the course with the teacher improved the way I am perceived by my classmates
Sacrifices
It took a lot of effort to understand the contents of the subject
I am exhausted and without energy after passing this class

Source: Own elaboration based on Valdivieso [178]

CONCLUSIONS

In addition to verifying the validity and reliability of a perception questionnaire, it is vital to determine whether it is robust, i.e. whether it can be effectively applied regardless of the existence of noise factors, as it is insensitive to them.

Robustness eliminates or dissipates the fear of the administrators of the perception questionnaires to apply them when some condition is very variable, be it of the respondent, of the object subject to evaluation, or of other variables that may affect the answers.

If a questionnaire is not robust, two actions should be taken: 1) Redesign it, taking into account the noise factors that are affecting it, or 2) limit its administration to sectors or areas where the noise factor is homogeneous.

With respect to the perception questionnaires designed to evaluate the service of classes at Universidad Privada Boliviana, it can be concluded that they are robust, since they are insensitive to 15 of the 22 noise variables under analysis.

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