An Extended LibQUAL+ Model Based on Fuzzy Linguistic Information

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Abstract. LibQUAL+ model is a web-based survey to measure the library service quality according to the users' perceptions. Although it is the most popular method, it presents two major drawbacks: (i) it is devised on cardinal scale to measure the library service quality (from 1 to 9), but, due to the subjectivity, impression and vagueness of the human beings when attempting to qualify phenomena related to human perception, it seems natural that they use words in natural language (linguistic terms) instead of numerical values to provide their preferences, and (ii) it considers that all the users' opinions on the library services are equally important, however, some users should be more influential than others in some questions as they do not play equal roles in measuring library service quality. The aim of this paper is to present an extended LibQUAL+ model based on fuzzy linguistic information overcoming the above drawbacks.

Keywords: Academic library, quality evaluation, LibQUAL+, fuzzy linguistic modeling.

1 Introduction

The evaluation of academic libraries is a topic and an activity of importance in all countries with established library services. Academic libraries play a notable role in the educational progress and their evaluation is essential to improve their services as an important part of a learning environment [1]. Since the mission of an academic library is to resolve user's expectations, one of the appropriate evaluation methods is the based on the feedback or comments point of the users. Academic libraries are service institutions, and better service will be provided if the nature and needs of users are known. According to user comments, observed weaknesses and strengths can be understood and, in order to eliminate

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defects and develop strengths, proposals can be provided to this end. Furthermore, focusing on users in the academic libraries and the efforts to resolve their expectations, it makes the academic libraries more dynamic [2].

One of the most important methods for evaluating the library service quality using user's perceptions is the survey method, because detailed information is provided about user comments, it makes clear the concept of service, it shows the problems, and it offers possible solutions [2]. Among the survey methods, LibQUAL+ model [3] is the most popular and the best-known one. It was developed in the US in order to collect data on the quality of library services. The aim of its designers was to develop a tool that would help libraries better understand their user's perceptions of service quality and to use this information in planning their operations. The survey data allow identification of areas in which service levels should be improved, and they have also been used to identify best practices and reallocate resources accordingly [5]. Since 2000, more than 1.100 libraries have participated in LibQUAL+, including college and university libraries, community college libraries, health sciences libraries, academic law libraries, and public libraries [2,4,5,6,7,8].

However, the LibQUAL+ model has some drawbacks that should be addressed. On the one hand, users answer each question giving a score from one to nine on a 9-points Likert scale [9]. Most of the criticism about scale based on measurement is that scores do not necessarily represent user's preference. This is because respondents have to internally convert preference to scores and the conversion may introduce misrepresentation of the preference being captured [10]. In view of the fact that user service evaluation depends largely on what users perceived, linguistics judgement is a good option in avoiding such inconvenience. The use of words in natural language rather than numerical values is, in general, a less specific, more flexible, direct, realistic, and adequate form to express judgments. Thus, linguistic terms as for example, "satisfied", "fair", "dissatisfied", are regarded as the natural representation of the preference or judgment. These characteristics indicate the applicability of fuzzy set theory [11] in capturing the user's preference, which aids in measuring the ambiguity of concepts that are associated with human being's subjective judgment. Since the evaluation is resulted from the different evaluator's view of linguistic variables, its evaluation must therefore be conducted in an uncertain, fuzzy environment. On the other hand, LibQUAL+ model considers that all the users have the same importance in evaluating each question on the library service levels, but in the quality evaluation of library services, the information handled is not equally important, i.e., the framework is heterogeneous. For example, when a group of users expresses its opinions on the community space for group learning, its assessments must not be considered with equal relevance, given that, there will be users, such as students, with more knowledge on the community space for group learning than others, such as professors, and therefore, all the opinions shall not be equally reliable; although a final and global assessment must be made using the initial and individual assessments.

The aim of this paper is to present an extended LibQUAL+ model based on fuzzy linguistic information, which overcomes the above drawbacks of the LibQUAL+ model, to evaluate the quality of academic libraries according to user's satisfaction. To do so, our proposed model uses the ordinal fuzzy linguistic modeling [12] to represent the user's perceptions and takes into account that the users' opinions on the library service levels are not equally important. To do so, tools of computing with words based on the linguistic aggregation operators LOWA [12] and LWA [13] to compute the quality assessments are used.

The rest of this paper is set out as follows. In Section 2, the tools used for developing our model are presented. Section 3 describes the extended LibQUAL+ model based on fuzzy linguistic information to evaluate the quality of academic libraries. Finally, some conclusions are drawn in Section. 4.

2 Preliminaries

In this section, the LibQUAL+ model is described and the fuzzy linguistic approach for computing with words, which is used to design our fuzzy linguistic extended LibQUAL+ model, is presented.

2.1 The LibQUAL+ Model

In 1999, a major project to develop a standardized measure of library service quality was undertaken by the Association of Research Libraries (ARL) in collaboration with Texas A&M University. The result of this project was LibQUAL+ [3], which is an extension of the SERVQUAL (for SERVice QUALity) tool [14]. SERVQUAL has been carefully tested and widely accepted after a dozen years of application in the private sector and elsewhere. Grounded in the gap theory of service quality, the singular percept of SERVQUAL is that "only customers judge quality; all other judgments are essentially irrelevant" [15]. According to the gap model, service quality is the gap between customer's expectations and perceptions. When experiences exceed expectations, the quality of the service is high, and vice versa [5]. Service quality is conceptualized as a gap between customers' minimum/desired expectations of service quality and their perceptions of the service quality actually received. A positive gap indicates that the service performance has exceeded customers' expectations, whereas a negative gap indicates that the service performance has fallen short of the expected service. Gap models are intuitively appealing to many research consumers [16] since its interpretation is straightforward. For instance, if the perceived rating on a item is below the minimum, it clearly indicates that the subject the item evaluates needs improvement. On the other hand, if the perceived rating on an item is very above the desired level of service, it may suggest that the item is not a concern to consumers.

Following that idea, LibQUAL+ is a survey administered by the ARL to measure library user's perception of library service quality and to help libraries identify service areas needing improvement [3]. To do so, the LibQUAL+ survey

is composed of 22 core questions that measure perceptions concerning three dimensions of library service quality [4]:

- *Affect of service*. This dimension assesses empathy, responsiveness, assurance, and reliability of library employees. It includes the following nine questions:
  - q_1: Employees who instill confidence in users.
  - q_2: Giving users individual attention.
  - q_3: Employees who are consistently courteous.
  - q_4: Readiness to respond to users' questions.
  - q_5: Employees who have the knowledge to answer user questions.
  - q_6: Employees who deal with users in a caring fashion.
  - q_7: Employees who understand the needs of their users.
  - q_8: Willingness to help users.
  - q_9: Dependability in handling users' service problems.
- *Library as place*. This dimension measures the usefulness of space, the symbolic value of the library, and the library as a refuge for word of study. It includes the following five questions:
  - q_{10}: Library space that inspires study and learning.
  - q_{11}: Quiet space for individual activities.
  - q_{12}: A comfortable and inviting location.
  - q_{13}: A getaway for study, learning, or research.
  - q_{14}: Community space for group learning and group study.
- *Information control*. This dimension measures how users want to interact with the modern library and include scope, timeliness and convenience, ease of navigation, modern equipment, and self-reliance. It includes the following eight questions:
  - q_{15}: Making electronic resources accessible from my home or office.
  - q_{16}: A library Web site enabling me to locate information on my own.
  - q_{17}: Printed library materials I need for my work.
  - q_{18}: The electronic information resources I need.
  - q_{19}: Modern equipment that lets me easily access needed information.
  - q_{20}: Easy-to-use access tools that allow me to find things on my own.
  - q_{21}: Making information easily accessible for independent use.
  - q_{22}: Print and/or electronic journal collections I require for my work.

For each question, respondents are asked to indicate their minimum acceptable service level, their desired service level, and the perception of the actual service provided by the library by giving a score from one to nine. The minimum service level and the desired service level reflect the importance of that service to the user: a low level means that it is not considered very important, and vice versa – when the minimum or desired service level receive high scores, the issue is important. An adequacy gap (the perceived quality in relation to the accepted minimum level) and a superiority gap (the perceived quality in relation to the desired service) are determined based on the answers [5].

2.2 A Fuzzy Linguistic Approach for Computing with Words

Many problems present fuzzy and vague qualitative aspects (decision making, risk assessment, information retrieval, etc.). In such problems, the information cannot be assessed precisely in a quantitative form, but it may be done in a qualitative one, and thus, the use of a linguistic approach is necessary. For example, when attempting to qualify phenomena related to human perception, we are often led to use words in natural language instead of numerical values. The fuzzy linguistic approach is an approximate technique appropriate to deal with fuzzy and vague qualitative aspects of problems. It models linguistic information by means of linguistic terms supported by linguistic variables [17,18,19], whose values are not numbers but words or sentences in a natural or artificial language.

The ordinal fuzzy linguistic approach [12,13] is a very useful kind of fuzzy linguistic approach used for modeling the computing with words process as well as linguistic aspects of problems. It facilitates the fuzzy linguistic modeling very much because it simplifies the definition of the semantic and syntactic rules. It is defined by considering a finite and totally ordered label set $S = \{s_i\}$, $i \in \{0, \ldots, \mathcal{T}\}$, in the usual sense, i.e., $s_i \geq s_j$ if $i \geq j$, and with odd cardinality. Typical values of cardinality used in the linguistic models are odd values, such as 7 or 9, with an upper limit of granularity of 11 or no more than 13, where the mid term represents an assessment of "approximately 0.5", and the rest of the terms being placed symmetrically around it. The semantics of the linguistic term set is established from the ordered structure of the label set by considering that each linguistic term for the pair $(s_i, s_{\mathcal{T}-i})$ is equally informative. For example, we can use the following set of nine labels to provide the user evaluations: $\{N = None, EL = Extremely\ Low, VL = Very\ Low, L = Low, M = Medium, H = High, VH = Very\ High, EH = Extremely\ High, T = Total\}$.

An advantage of the ordinal fuzzy linguistic approach is the simplicity and quickness of its computational model. It is based on the symbolic computation [12,13] and acts by direct computation on labels by taking into account the order of such linguistic assessments in the ordered structure of linguistic terms. This symbolic tool seems natural when using the fuzzy linguistic approach, because the linguistic assessments are simply approximations which are given and handled when it is impossible or unnecessary to obtain more accurate values. Usually, the ordinal fuzzy linguistic model for computing with words is defined by establishing (i) a negation operator, $Neg(s_i) = s_j \mid j = \mathcal{T} - i$, (ii) comparison operators based on the ordered structure of linguistic terms: Maximization operator: $MAX(s_i, s_j) = s_i$ if $s_i \geq s_j$; and Minimization operator: $MIN(s_i, s_j) = s_i$ if $s_i \leq s_j$, and (iii) adequate aggregation operators. In the following, we present two aggregation operators based on symbolic computation to complete the ordinal fuzzy linguistic computational model.

The LOWA Operator. An important aggregation operator of ordinal linguistic values based on symbolic computation is the LOWA operator [12]. The *Linguistic Ordered Weighted Averaging* (LOWA) is an operator used to aggregate

non-weighted ordinal linguistic information, i.e., linguistic information values with equal importance [12].

Definition 1. *Let $A = \{a_1, \ldots, a_m\}$ be a set of labels to be aggregated, then the LOWA operator, ϕ, is defined as:*

$$\begin{aligned} &\phi(a_1, \ldots, a_m) = W \cdot B^T = \mathcal{C}^m\{w_k,\ b_k,\ k = 1, \ldots, m\} \\ &= w_1 \odot b_1 \oplus (1 - w_1) \odot \mathcal{C}^{m-1}\{\beta_h,\ b_h,\ h = 2, \ldots, m\}\ , \end{aligned} \tag{1}$$

where $W = [w_1, \ldots, w_m]$ is a weighting vector, such that, $w_i \in [0, 1]$ and $\Sigma_i w_i = 1$. $\beta_h = w_h / \Sigma_2^m w_k$, $h = 2, \ldots, m$, and $B = \{b_1, \ldots, b_m\}$ is a vector associated to A, such that, $B = \sigma(A) = \{a_{\sigma(1)}, \ldots, a_{\sigma(m)}\}$, where, $a_{\sigma(j)} \leq a_{\sigma(i)}\ \forall\ i \leq j$, with σ being a permutation over the set of labels A. $\mathcal{C}^m$ is the convex combination operator of m labels and if $m = 2$, then it is defined as:

$$\mathcal{C}^2\{w_i,\ b_i,\ i = 1, 2\} = w_1 \odot s_j \oplus (1 - w_1) \odot s_i = s_k\ , \tag{2}$$

such that, $k = min\{\mathcal{T},\ i + round(w_1 \cdot (j - i))\}$, $s_j, s_i \in S$, $(j \geq i)$, where "round" *is the usual round operation, and $b_1 = s_j$, $b_2 = s_i$. If $w_j = 1$ and $w_i = 0$, with $i \neq j$, $\forall i$, then the convex combination is defined as: $\mathcal{C}^m\{w_i,\ b_i,\ i = 1, \ldots, m\} = b_j$.*

The LOWA operator is an "or-and" operator [12] and its behavior can be controlled by means of W. In order to classify OWA operators with regards to their localization between "or" and "and", Yager [20] introduced a measure of *orness*, associated with any vector W : $orness(W) = \frac{1}{m-1} \sum_{i=1}^{m} (m - i) w_i$. This measure characterizes the degree to which the aggregation is like an "or" (MAX) operation. Note that an OWA operator with $orness(W) \geq 0.5$ will be an *orlike*, and with $orness(W) < 0.5$ will be an *andlike* operator.

An important question of the LOWA operator is the determination of the weighting vector W. In [20], it was defined an expression to obtain W that allows to represent the concept of fuzzy majority [21] by means of a fuzzy linguistic nondecreasing quantifier Q [22]:

$$w_i = Q(i/n) - Q((i - 1)/n),\ i = 1, \ldots, n\ . \tag{3}$$

When a fuzzy linguistic quantifier Q is used to compute the weights of LOWA operator ϕ, it is symbolized by ϕ_Q.

The LWA Operator. Another important aggregation operator of ordinal linguistic values is the *Linguistic Weighted Averaging* (LWA) operator [13]. It is based on the LOWA operator and is defined to aggregate weighted ordinal fuzzy linguistic information, i.e., linguistic information values with not equal importance.

Definition 2. *The aggregation of a set of weighted linguistic opinions, $\{(c_1, a_1), \ldots, (c_m, a_m,)\}$, $c_i, a_i \in S$, according to the LWA operator, Φ, is defined as:*

$$\Phi[(c_1, a_1), \ldots, (c_m, a_m)] = \phi(h(c_1, a_1), \ldots, h(c_m, a_m))\ , \tag{4}$$

where a_i represents the weighted opinion, c_i the importance degree of a_i, and h is the transformation function defined depending on the weighting vector W used for the LOWA operator ϕ, such that, $h = MIN(c_i, a_i)$ if $orness(W) \geq 0.5$, and $h = MAX(Neg(c_i), a_i)$ if $orness(W) < 0.5$.

We should point out that the LOWA and LWA operators are the basis of the fuzzy linguistic extended LibQUAL+ model. We have chosen these operators due to the following reasons:

- Both operators are complementary (the LWA operator is defined from the LOWA operator) and this simplifies the design of the evaluation model.
- Both operators act by symbolic computation and, therefore, linguistic approximation processes are unnecessary and this simplifies the processes of computing with words.
- The concept of fuzzy majority represented by linguistic quantifiers acts in their processes of computation and, in such a way, the assessments on academic libraries are obtained according to the majority of evaluations provided by the users.

3 An Extended LibQUAL+ Model Based on Fuzzy Linguistic Information

In this section, we present the extended LibQUAL+ model based on fuzzy linguistic information to evaluate the quality of academic libraries according to user's satisfaction. It is developed with the aim of solving the drawbacks of the LibQUAL+ model shown in Section 1. To do so, we define a quality evaluation model of academic libraries which presents two elements: (i) an evaluation scheme that contains the twenty-two questions relating to three dimensions of library service quality, and (ii) a computation method to generate quality assessments of academic libraries and to obtain their weaknesses and strengths.

3.1 Evaluation Scheme

The evaluation scheme is based on a set of twenty-two questions relating to three dimensions of library service quality: (i) affect of service, which relates to user interactions with, and the general helpfulness and competency of academic library staff, (ii) library as a place, which deals with the physical environment of the academic library as a place for individual study, group work, and inspiration, and (iii) information control, which relates to whether users are able to find the required information in the academic library in the format of their choosing. It presents the following characteristics:

- *It is user driven.* The evaluation scheme necessarily requires the inclusion of questions about library service quality easily understandable to any user rather than questions that can be measures objectively independently of users. As the basis of our model is the LibQUAL+ model, we use the same

twenty-two questions relating to the three dimensions of library service quality (see Section 2.1), which are easily understandable to any user. This number of questions is not excessive in order to help users in understanding it and avoiding confusion. It is due to long and complex evaluation schemes cause user idleness and limit their own application possibilities.
- *It is weighted.* The users of the academic library do not play equal roles in measuring library service quality: i.e., some users should be more influential than others in some questions as it is not always valid that all group of users have equal importance with respect to the decision being made. This is because the degree of relevancy, knowledge, and experience may not be equal among them. For example, the student's opinion on the community space for group learning and group study should be more important that the professor's opinion. Therefore, there must be an allowance for such differences in weight or importance as the framework is heterogeneous.

3.2 Computation Method

We have designed a computation method to generate quality assessment in academic libraries that has two main characteristics:

- *It is a user-centered computation method.* The quality assessment in academic libraries is obtained from individual linguistic judgments provided by their users rather than from assessments obtained objectively by means of the direct observation of the academic libraries characteristics.
- *It is a majority guided computation method.* The quality assessments are values representative of the majority of individual judgments provided by the users of the academic library. The aggregation to compute the quality assessments is developed by means of the LOWA and LWA operators.

First, a quality evaluation questionnaire based on the LibQUAL+ model is defined, which consists of twenty-two questions relating to three dimensions of library service quality described in Section 2.1. Users are asked for impressions about the twenty-two questions according to minimum service level they are willing to accept, desired service level they would like to receive, and perceived performance level, that is, actual level of service they perceive to have been rendered. The minimum service level, the desired service level, and the perceived performance level behind each question are rated on a linguistic term set S. For instance, the linguistic term set presented in Section 2 can be used. We use fuzzy linguistic variables to represent user's opinions by mean of linguistic labels because they are more easily understood by the users than numerical ones. In addition, we assume that each user does not have the same importance in the evaluation scheme. It is assigned a relative linguistic importance degree, $I(e_l, q_i) \in S$, for each user, e_l, on each question, q_i. This importance degree could be obtained from a set of experts or the staff members of the academic library and it may be different for each academic library.

Once the group of users, $\{e_1, \ldots, e_L\}$, have filled all the questionnaires for a given academic library, the model calculates the quality assessments of the

academic library and obtains its weaknesses and strengths using the linguistic aggregation operators LWA and LOWA in the following steps:

– For each question, q_i, its global quality assessment of the minimum service level, MSL_i, its global quality assessment of the desired service level, DSL_i, and its global quality assessment of the perceived performance level, PPL_i, are obtained by aggregating the evaluation judgments provided by the group of users on the question, q_i, by means of the LWA operator Φ:

$$\begin{array}{l} MSL_i = \Phi_Q((I(e_1,q_i),e_1(q_i^{MSL})),\ldots,((I(e_L,q_i),e_L(q_i^{MSL}))) \ , \\ DSL_i = \Phi_Q((I(e_1,q_i),e_1(q_i^{DSL})),\ldots,((I(e_L,q_i),e_L(q_i^{DSL}))) \ , \\ PPL_i = \Phi_Q((I(e_1,q_i),e_1(q_i^{PPL})),\ldots,((I(e_L,q_i),e_L(q_i^{PPL}))) \ , \end{array} \tag{5}$$

where $e_l(q_i^{MSL}) \in S$ is the minimum service level provided by the user e_l on question, q_i, $e_l(q_i^{DSL}) \in S$ is the desired service level provided by the user e_l on question, q_i, $e_l(q_i^{PPL}) \in S$ is the perceived performance level provided by the user e_l on question, q_i, and $I(e_l, q_i) \in S$ is the linguistic importance degree of the user, e_l, on question, q_i. Therefore, MSL_i, DSL_i and PPL_i, are the linguistic measures that represents the minimum service level, the desired service level and the perceived performance level, respectively, with respect to question, q_i, according to the majority (represented by the fuzzy linguistic quantifier Q) of linguistic evaluation judgments provided by the group of users.

Then, gap analysis is done for each item. According to LibQUAL+ model, the minimum and the desired scores establish the boundaries of a zone of tolerance within which the perceived scores should desirably float. The difference between the perceived and minimum scores is called the service adequacy gap, and the difference between the desired and perceived scores is called the service superiority gap. Taking into account these considerations, it is defined two scores which can obtain the strengths and weaknesses of an academic library according to the users' answers:

$$\begin{array}{l} SA_i = J(PPL_i) - J(MSL_i) \ , \\ SS_i = J(PPL_i) - J(DSL_i) \ , \end{array} \tag{6}$$

where SA_i is the service adequacy score on question, q_i, SS_i is the service superiority score on the question, q_i, and

$$J : S \to \{0,\ldots,\mathcal{T}\} \mid J(s_i) = i, \ \forall s_i \in S \ . \tag{7}$$

The SA is calculated by subtracting the minimum score from the perceived score on any given question. It is an indicator of the extent to which academic libraries are meeting the minimum expectations of their users. The SS is calculated by subtracting the desired score from the perceived score on any given question and is an indicator of the extent to which academic libraries are exceeding the desired expectations of their users. Figure 1 depicts the three possible cases for gaps SA and SS. The cases when the perceived

level of service falls out of the zone of tolerance are denoted as SA^- and SS^+. SA^- means that the academic library is not meeting its users minimum expectations, i.e., the perceived score is lower than the minimum one. Likewise, SS^+ means that the academic library is exceeding its users desired expectations, i.e., the perceived score is higher than the desired one. Therefore, SA^- can be used to identify academic library functionalities needing improvement, whereas SS^+ is an indicator of the extent to which academic library functionalities are exceeding the desired expectations of the users.

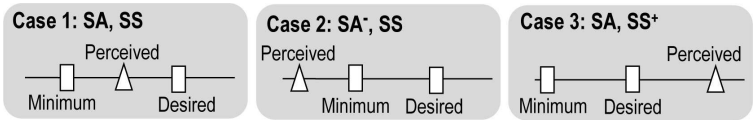

Fig. 1. Possible cases for gaps SA and SS

– Finally, for the academic library, the following quality assessments are calculated:
  - Its quality assessment on the affect of service dimension, ASD, by aggregating the perceived performance level, PPL_i, from questions q_1 to q_9, by means of the LOWA operator ϕ:

$$ASD = \phi_Q(PPL_1, \ldots, PPL_9) \ , \tag{8}$$

    where ASD is a measure that represents the quality assessment of the affect of service dimension for the academic library, according to the majority (represented by the fuzzy linguistic quantifier Q) of linguistic evaluation judgments provided by the group of users about questions $\{q_1, \ldots, q_9\}$.
  - Its quality assessment on the library as place dimension, LPD, by aggregating the perceived performance level, PPL_i, from questions q_{10} to q_{14}, by means of the LOWA operator ϕ:

$$LPD = \phi_Q(PPL_{10}, \ldots, PPL_{14}) \ , \tag{9}$$

    where LPD is a measure that represents the quality assessment of the library as place dimension for the academic library, according to the majority (represented by the fuzzy linguistic quantifier Q) of linguistic evaluation judgments provided by the group of users about questions $\{q_{10}, \ldots, q_{14}\}$.
  - Its quality assessment on the information control dimension, ICD, by aggregating the perceived performance level, PPL_i, from questions q_{15} to q_{22}, by means of the LOWA operator ϕ:

$$ICD = \phi_Q(PPL_{15}, \ldots, PPL_{22}) \ , \tag{10}$$

where ICD is a measure that represents the quality assessment of the information control dimension for the academic library, according to the majority (represented by the fuzzy linguistic quantifier Q) of linguistic evaluation judgments provided by the group of users about questions $\{q_{15}, \ldots, q_{22}\}$.

- Its global quality assessment, r, by aggregating the perceived performance level, PPL_i, from all questions, by means of the LOWA operator ϕ:

$$r = \phi_Q(PPL_1, \ldots, PPL_{22}) \,, \tag{11}$$

where r is a measure that represents the global quality assessment for the academic library, according to the majority (represented by the fuzzy linguistic quantifier Q) of linguistic evaluation judgments provided by the group of users about questions $\{q_1, \ldots, q_{22}\}$.

4 Conclusions

In this paper we have presented an extended LibQUAL+ model based on fuzzy linguistic information to obtain both the strengths and the weaknesses of the academic library services according to user satisfaction. Using the ordinal fuzzy linguistic modeling to represent the user's perceptions and taking into account that the users' opinions on the library service levels are not equally important, some drawbacks of the LibQUAL+ model have been overcome. Considerable use has been made of fuzzy set technology to provide the ability to describe the information by using linguistic label in a way that is particularly user friendly. Furthermore, we have applied automatic tools of fuzzy computing with words based on the LOWA and LWA operators to compute quality assessments of academic libraries. In the future, we will extend the concept of quality to other new services of the academic libraries, such as Library 2.0.

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