



A Service Quality experimental measure for public transport

Gabriella Mazzulla ^{1*}, Laura Eboli ¹

¹ University of Calabria – Faculty of Engineering
Department of Territorial Planning

Abstract

In this paper the importance of service quality attributes for public transport is established by Importance Value calculation. Attribute weights (IV) are calculated by a specific empirical procedure in which a rate is assigned to each attribute according to the preferences of passengers.

Finally, a Service Quality Index (SQI) for measuring the effectiveness of supplied services is calculated according to the main service quality attributes and their weights. This index can be useful to planners to choose more appropriate public transport agencies. Furthermore, it can be used by transport agencies to improve supplied service regarding more convenient service quality attributes.

Keywords: public transport; service quality attributes importance value; service quality index.

Introduction

Over the last few years, the public transport industry in many countries has been involved in a process of deep transformation. At the moment, individual is used more than public transport. This fact causes many problems like traffic congestion, air and noise pollution, energy consumption and therefore serious consequences on the environment.

In Italy, public transport transformation is linked to a normative reform; one of the most important aspects of reform is service management reorganization by changing from a concessionary to a competitive system. Therefore, transit agencies are becoming more competitive and are concerning themselves with service quality and customer satisfaction.

Service quality measurement is one of the most important practical themes for service providers and regulatory agencies, but it also continues to be a challenging research theme.

For these reasons, it is important to identify service quality attributes and to establish their importance and influence on customer behaviour.

* Corresponding author: Gabriella Mazzulla (g.mazzulla@unical.it)

This paper deals with the experimental results of a sample survey conducted on University of Calabria students. Then, a statistical data analysis was carried out.

In addition, a way of identifying the importance of service quality attributes on global customer satisfaction is proposed. Further, a Service Quality Index (SQI) has been calculated, which provides an operationally appealing measure of current or potential service effectiveness.

1. Service quality measure for public transport

Generally, transit agencies have given too much importance to saving money at the expense of service quality levels; therefore they have essentially focused on cost efficiency and cost effectiveness. A measure of cost efficiency is typically defined as produced services (e.g. vehicle kilometres), while a measure of service effectiveness is defined as consumed service (e.g. passenger kilometres) (see figure 1).

However, transit agencies actually have an interest in obtaining a high service quality level, taking into account passengers priorities and requirements (Bertini and El-Geneidy, 2003).

For this reason, the necessity of using techniques to identify the importance of service quality attributes on global satisfaction and to assess service quality, increases.

In the literature there are many techniques for measuring service quality and customer satisfaction, for public transport as in other service industries. These techniques are based on customer evaluation. The evaluation of service quality and customer satisfaction can be obtained according to different methods: by asking customers the perception/satisfaction on service quality, by asking the expectation/importance, or by asking both perception and expectation; in addition, perception can be compared with the zone of tolerance of expectations (the range defined by the maximum desired level and minimum acceptable level of expectations). (Figini, 2003). A rating or ranking of individual service attributes can be asked to customers. Furthermore, a rating on overall satisfaction can be asked.

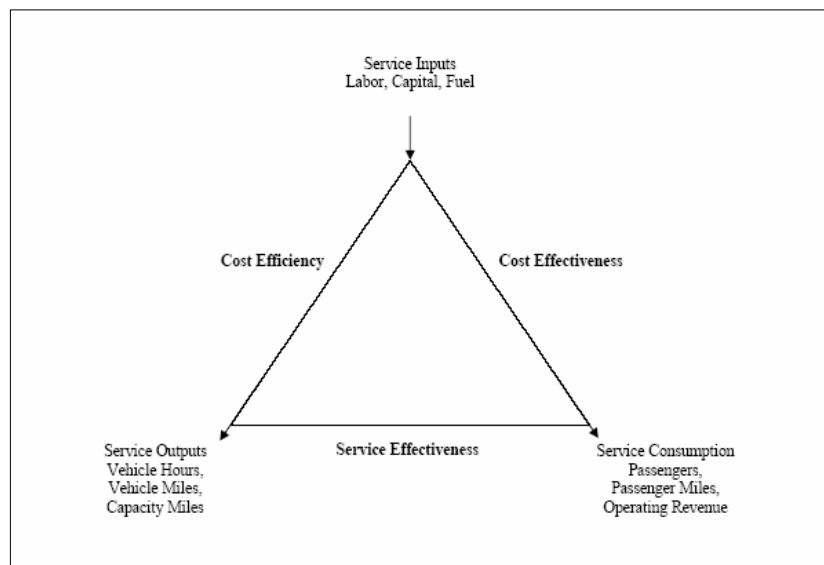


Figure 1: Relationship between efficiency and effectiveness indicators.

Source: Bertini R.L., El-Geneidy A., TRB, 2003.

The techniques for measuring service quality and customer satisfaction can be identified in two different categories.

The first one includes methods of statistical analysis, such as quadrant and gap analysis, factor analysis, scattergrams, bivariate correlation, cluster analysis, and conjoint analysis. Some of these provide an evaluation of the individual service attributes, others provide the relationship of attributes with overall satisfaction.

Many authors have introduced some indexes for measuring overall satisfaction or service quality. On the basis of the method introduced by Kano (Kano, 1984), some indexes (Better, Worse and Quality Improvement) were proposed by Berger (Berger, 1993). One of the best-known indexes is the SERVQUAL, a service quality evaluation method developed by marketing academics. It produces a subjective measure of the gap between expectations and perceptions in five service quality dimensions common to all services. (Zeithaml et alii, 1986). This technique was applied in several research fields, see for example Hartikainen et alii (2003) and Akan (1995). A Customer Satisfaction Index (CSI) was adopted by Bhave; this index is calculated by using an importance weighting based on an average of 1. The customers assign a rate of importance (weighting) and a rate of satisfaction (score) to each service attribute. Each weighting is divided by the average of the weightings expressed by customers. In this way, average weightings based on an average of 1 are obtained. Then, a weighted score is calculated for each attribute as a product of score and average weighting. Finally, the CSI is the sum of all weighted scores. (Bhave, 2002). Many others techniques are reported in the literature, see for example Hill (2000), Cuomo (2000), Hill (2003).

The second category of techniques consists in estimation of the coefficients by modelling. The models relate global service quality (dependent variable) to some attributes (independent variables). There are linear models, like multiple regression models, and non-linear models, like the structural equation model (SEM) (Bollen, 1989) and Logit models in which all random components are independently and identically distributed according to a Gumbel random variable (Cascetta, 2001).

Examples of SEM are reported in Vilares, Coelho (2003) and in Grønholdt and Martensen (2005). An ordinal regression technique has been proposed by Siskos et alii (1997).

As far as the authors' know, not many techniques for measuring customer satisfaction and service quality in public transport are reported in the literature.

In the "Handbook for Measuring Customer Satisfaction and Service Quality", published by the Transportation Research Board, the "impact score" technique is described (TRB, 1999). "Impact score" is the impact of each service quality attribute on global customer satisfaction. For each attribute, the sample is divided into two categories, those respondents who have not recently experienced a problem with the attribute and those respondents who have had a recent problem with it. The mean satisfaction rating of each attribute of the two groups of respondents are compared. The difference between the two mean satisfaction rates, called "gap score", is multiplied by the percentage of passengers who have had a problem with an attribute.

An example of modelling for public transport is proposed by Hensher (Prioni and Hensher, 2000; Hensher, 2001; Hensher and Prioni, 2002; Hensher *et alii*, 2003). By the estimation of coefficients of discrete choice models, like Multinomial Logit or Mixed Logit, the importance of service quality attributes on global customer satisfaction is evaluated. A Service Quality Index (SQI) is calculated by using estimated coefficients. This index, as the utility related to each alternative of choice, is calculated like a linear

combination of attributes, each one weighted on its importance; each alternative represents a service package. For models calibration the combination of RP (Revealed Preferences) and SP (Stated Preferences) data is used; the major advantage of SP data compared with RP data is that they exploit a more extensive attributes space. Furthermore, today some attributes do not exist on many urban buses so we are unable to establish their influence. Thirteen service quality attributes were selected: each attribute varying on three levels. This variation produces different alternatives (bus packages). Attribute weights were estimated according to users choices, and then current and potential service quality levels were calculated. A similar method was proposed by Jones (Swanson et al., 1997), in which a linear regression model for each interviewed user was calibrated; for each coefficient, a mean of estimated coefficients from individual models was calculated. In addition, the monetary value of each attribute was calculated. This value enables the measurement of the user's availability to pay an additional fare for a better service.

The use of these techniques presumes the selection of some service quality attributes. By consulting the literature it is possible to identify a large set of attributes (see, for example, TRB, 1999; Prioni and Hensher, 2000). Generally, all the attributes are grouped in macro-factors defined by one or more attributes. Examples of these are transport network design (e.g. number and regularity of bus stops, having stops near destination), service supply and reliability (e.g. frequency, regularity and punctuality of rides), comfort (e.g. availability of seats on bus, bus overcrowding), fare (e.g. fairness/consistency of fare structure, ease of paying fare), information (e.g. availability of information on schedules/maps, explanation and announcement of delays), safety (e.g. safe and competent drivers, security against crimes), relationship with personnel (e.g. friendly, courteous personnel), customer preservation (e.g. repayment, complaint number), environmental protection (e.g. use of vehicles with low environmental impact), quality of system (quality of stops furniture, cleanliness of bus exterior).

All the attributes contribute to global service quality, each one in a different measure. Therefore there is the necessity to quantify the importance of each one.

2. The sample survey: statistical analysis of results

2.1 Experimental context

A sample survey of the University of Calabria students was conducted. The campus is sited in the urban area of Cosenza, in the South of Italy. It is attended by 32,000 students and 2,000 members of staff approximately (December 2004). Currently the University is served by a bus service, which does not resolve the students' mobility demand in a suitable way; where possible, they prefer to use individual transport, producing congestion both on the access and on the internal campus road networks. In a working day, about 10,000 students travel by bus, 8,800 by urban and 1,200 by extra-urban bus (AA. VV., 2006).

Respondents were asked to provide information about their trip and transport mode to get to the university and, in addition, about some service quality attributes.

Specifically, the part of the interview on service quality is divided into three sections; the first one is addressed to public transport non-users asked to rank, in descending order, non-use reasons; the second section is addressed to public transport users which were

asked to rank use reasons; finally, in the third section, both users and non-users were asked to rank service quality attributes according to their importance. Among the interviewed students there were some of them that are both regular users and non-users, and therefore they have answered all the sections of the interview. The users had the possibility of ranking not all the attributes, but only some of them.

The reasons for public transport non-use to ranking are:

- Long wait at bus stops;
- Overcrowded buses;
- Low frequency;
- Slowness of vehicles;
- Service unreliability;
- Need for transfers;
- Difficulty of carrying loads;
- High fare;
- Poor accessibility to bus stops;
- Other reasons.

The reasons for public transport use to ranking are:

- Inexpensive service;
- Quick service;
- Car nonavailability;
- Lower risk of road accidents;
- Difficulty of car parking;
- Practicality (less tiring trip);
- No driving licence;
- Other reasons.

Service quality attribute to ranking are:

- Frequency;
- Number of bus stops;
- Cleanliness of interior, seats, etc.;
- Comfort on bus;
- Security against crimes on bus;
- Availability of shelter and benches at stops;
- Information on services;
- Availability of seats on bus;
- Other reasons.

The interviews were proposed to a sample of 382 students of all different faculties, who live out of the urban area of Cosenza and who have expressed their choices on the extra-urban public transport services that allow the university campus to be reached. In some cases, access to the campus also involves the use of both urban and extra-urban buses.

The sample is composed of 257 females and 125 males. The age range is between 18 and 37, but 72.5% of the sample is between 19 and 23. About 40% of interviewed students have a low income and about 40% a medium income. The majority of the sampled students lives inside the Cosenza traffic basin (65% of the total). 53% of the students have the possibility of using the car to reach the campus.

The results regarding service quality are reported in the following paragraphs.

2.2 Statistical analysis for public transport non-use reasons

A statistical-descriptive analysis of public transport non-use reasons is performed. Interviewed students who answered this section are 176, out of the 382 students undertaking the interview (sampling rate equal to 14.6%). We consider that the most significant data relate to the first chosen factors. In figure 2 the number of consumers who preferred one of the factors as their first chosen factor is shown.

from an analysis of the stated preferences the main public transport non-use reason proves to be low service frequency (70 preferences on 176, equal to 39.8%), followed by vehicle overcrowding, chosen as the first reason by 15.9% of respondents (28 preferences out of 176). The third chosen factor is slowness of the vehicles (12.5%, 22 preferences out of 176), while approximately 9% of students (16 preferences out of 176) indicated long waits at bus stops and the necessity of transferring to reach their final destination. The other factors were chosen with very small percentages.

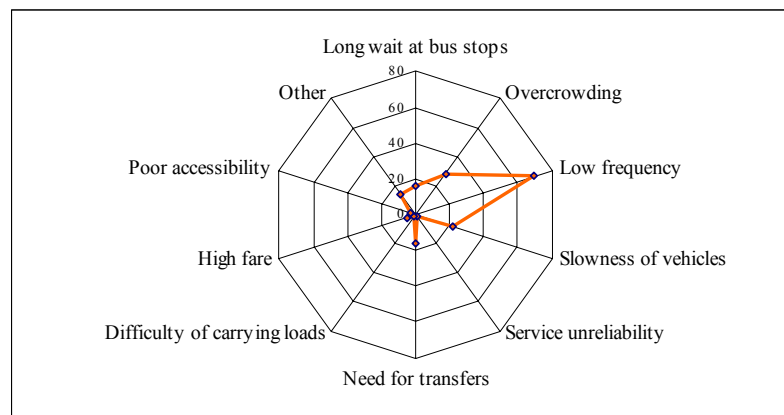


Figure 2: Statistical analysis for public transport non-use reasons.

An additional analysis was made considering all data independently of ranking. In this case, only the times that each factor was chosen are examined and the information about preference level is lost. The results are similar to the previous ones.

2.3 Statistical analysis for public transport use reasons

Similarly, a statistical-descriptive analysis of public transport use reasons is performed. 220 out of 382 sampled students living out of the urban area (sampling rate equal to 18.3%) answered this section.

Also in this case the number of consumers who preferred one of the factors as their first chosen factor is drawn. The headings “car nonavailability” (36.8%, equal to 81 preferences out of 220), “no driving licence” (15.5%, equal to 34 preferences) and “difficulty of car parking” (3.6%, equal to 8 preferences) are excluded from the graph (figure 3); these headings represent the 55.9% of the chosen reasons. In total, 97 preferences are only drawn.

The percentages of stated preferences on the headings excluded from the analysis indicates that public transport is primarily used for reasons not related to service quality, but only to a difficulty in the use of the private car.

Service quality factors that have been significantly chosen are service inexpensiveness, indicated by 45.4% of total (44 preferences out of 97), and practicality

in terms of a less tiring trip, chosen by 36.1% of all the consumers (35 preferences out of 97). Additionally, a considerable percentage is represented by lower risk of road accidents, chosen in 10.3% of the cases.

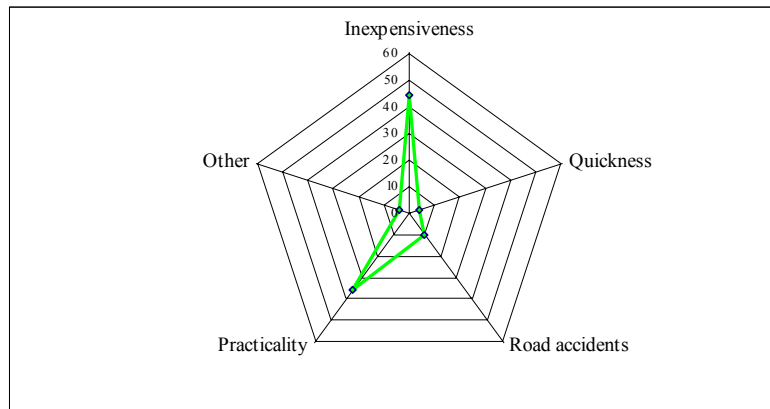


Figure 3: Statistical analysis for public transport use reasons.

2.4 Statistical analysis for service quality attributes

A number of 341 students, out of 382, answered the last section (sampling rate equal to 28.4%). In figure 4 the number of consumers who have indicated one of the listed service quality attributes as their first chosen factor is reported.

The most chosen attributes are frequency (51.3%, 175 preferences out of 341), availability of seats on bus (17.9%, 61 preferences) and number of bus stops (6.2%, 21 preferences). The attribute “cleanliness of the vehicles” is chosen by 4,7% of respondents, while the attribute “information on services” is indicated in small measure (3.5%), because extra-urban public transport passengers are generally habitual and informed.

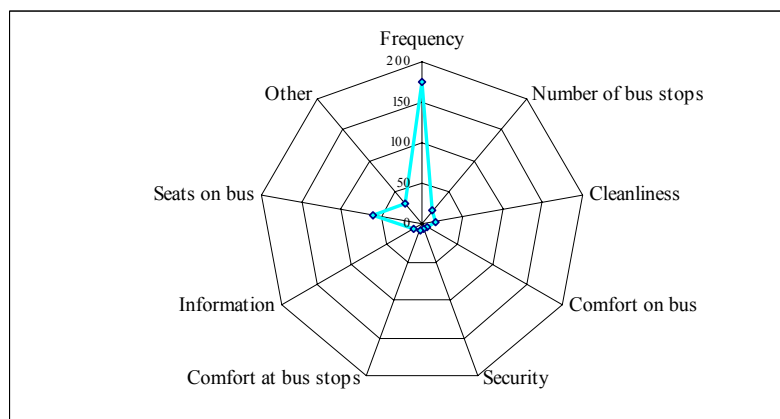


Figure 4: Statistical analysis for service quality attributes.

3. The calculation of Importance Value and of Service Quality Index

Generally, the techniques for measuring service quality and customer satisfaction are based on rating data and calculate the average values of expressed rates to define a

classification of service quality attributes (see Impact Score technique) or aggregate index, like CSI and SERVQUAL (TRB, 1999; Hill, 2000; Zeithalm, 1986).

With the aim of determining the relative weights of all the attributes on global customer satisfaction, a technique to calculate an Importance Value (IV) of each service quality attribute is proposed, according only to public transport users stated preferences on some service quality attributes.

In this case, it was decided to use a ranking, because generally rank data is arguably simpler and more reliable than rating data. Individuals are expected to be able to say that they prefer A to C and C to B with greater confidence and consistency than they can have in assigning scores to each alternative. (Ortúzar and Willumsen, 1994). In order to apply the IV technique, rank data were transformed into rate data. The rates were weighted on the percentage of users indicating that attribute. The preferences expressed by users in terms of descending ranking was changed into a rating by a specific empirical procedure. The adopted methodology can be debatable because transforming ranking into rating involves a degree of discretionality. However, the statistical methods of analysing ranking data do not provide a quantitative measure of the degree of preference expressed by the users. In addition, the users had the possibility of ranking not all the attributes, but only some of them. Therefore, the users implicitly chose the most important attributes; in this way the risk of making errors in the assignment of the rates is reduced.

In order to assign a rate, the stated choices were divided into sets according to the number of expressed preferences (i.e. factors indicated in order of importance), which can vary from 1 up to 5. In each choice set a rate was assigned in descending order to each factor, so that inside each set the sum of the rates is equal to 100. As an example, in the case in which only one preference is expressed, the corresponding rate is assumed equal to 100; in the case of two preferences, a rate equal to 60 is assigned to the first chosen factor and a rate equal to 40 to the second factor, and so on, as reported in table 1.

Table 1: Factor rates of each preference sets.

Sets	Rate					
	<i>1st factor</i>	<i>2nd factor</i>	<i>3rd factor</i>	<i>4th factor</i>	<i>5th factor</i>	<i>Total</i>
<i>Set with 1 preference</i>	100					100
<i>Set with 2 preferences</i>	60	40				100
<i>Set with 3 preferences</i>	50	32	18			100
<i>Set with 4 preferences</i>	46	30	15	9		100
<i>Set with 5 preferences</i>	43	29	14	8	6	100

Inside every set of preferences, each rate differs from the following one by a quantity that decreases from the first to the last chosen factor. Besides, a higher rate has been assigned to a factor within a set with a smaller number of preferences, while the same factor assumes a lower rate within a set with a greater number of preferences.

The Importance Value is calculated through the following formula:

$$IV(X_i) = \sum_j [IV(X_i)]_j = \sum_j \left(\sum_k W_k \cdot \%US_k \right)_j \quad (1)$$

with:

X_i i-th factor, in which i varies from 1 to n (number of factors, in the specific case equal to 9);

j, that varies from 1 to m (number of set of preferences, in the specific case equal to 5);

W factor weight, in which k varies from 1 to j;

%US percentage of users who expressed a preference for factor X_i within a set with j preferences.

The Importance Value calculated for each service quality attribute is reported in table 2. These factors can be grouped in service quality macro-factors, usually adopted in customer satisfaction surveys by transit agencies. In many cases, macro-factors correspond to service quality attributes analyzed within the surveys; only “comfort on board” macro-factor is defined by more service quality attributes.

As a result it emerges that service quality attributes with a major weight are service frequency (IV equal to 38.3), seats on bus (IV equal to 21.9). Considering all the factors that can be grouped in “comfort on board” the IV is equal to 31.9; in any case this value is lower than the frequency Importance Value. Among the other attributes that have a minor weight, information has a respectable value. It should be noted that the factors not considered in this analysis have a considerable weight, equal to 7.5; this means that among the omitted factors there could be factors with a weight comparable to others, like security against crimes that has an IV equal to 2.2.

Table 2: Importance Value of quality factors and macro-factors.

Macro-factor	Factor	Importance	
Transport network design	Number of bus stops	6.2	6.2
Service supply and reliability	Frequency	38.3	38.3
Comfort on board	Cleanliness	6.9	
	Comfort on bus	3.1	
	Seats on bus	21.9	31.9
Comfort at bus stops	Comfort at bus stops	4.9	4.9
Safety	Security against crimes	2.2	2.2
Information	Information	9.1	9.1
Other	Other	7.5	7.5
<i>Total</i>		<i>100.0</i>	<i>100.0</i>

Finally, SQI has been calculated. A linear relation between SQI and the attributes is supposed. This index allows an operational measure of the services effectiveness according to the weight assigned to each factor (Importance Value). SQI is calculated by the following formula:

$$SQI = \sum_i [IV(X_i) \cdot X_i] \quad (2)$$

in which:

IV(X_i) is the i-th factor Importance Value;

X_i is the value assumed by the i-th factor.

As an example, SQI was calculated for different scenarios of extra-urban public transport service to get to university campus. The attributes levels have been established *a priori*. The weights of each factors are the same as shown in table 2; the values assumed by factors are assigned on a scale of three levels (low level 0,

intermediate level 0.5 and high level 1). This assumption implies a linear effect going from a level to another.

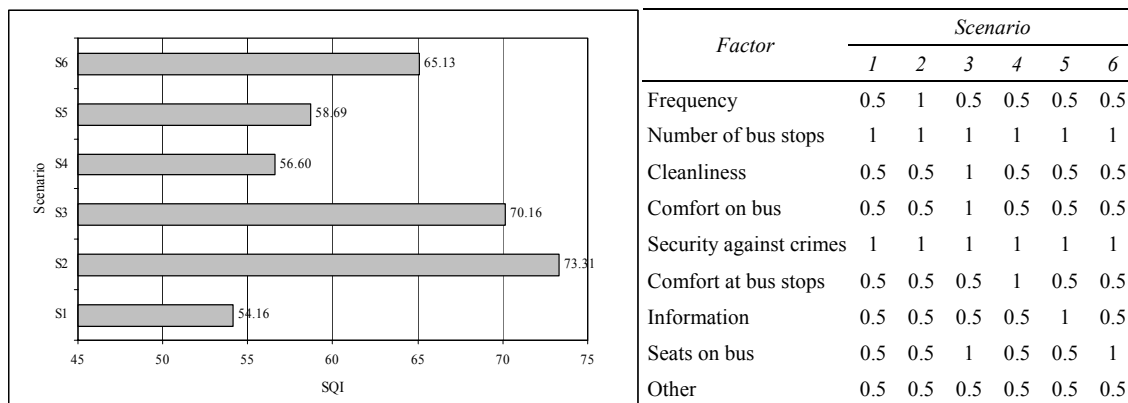


Figure 5: SQI for different service quality scenarios.

SQI assumes values between 54.16 and 73.31. In figure 5 service quality scenarios are shown.

As expected, the highest index values were obtained by improving the frequency (scenario 2) or, alternatively, the comfort factors (scenario 3). Obviously, by assigning the highest level to a major number of attributes SQI has a higher value. In addition, SQI with reference to the real situation in this experimental context has been calculated. For this aim, a perceived level of each attribute was asked a reduced sample of users. In reference to the attributes reported in figure 5, the average perceived levels are equal to 0.75, 0.65, 0.69, 0.69, 0.85, 0.36, 0.37, 0.73, 0.66 respectively. The value of SQI is equal to 67.59. Finally, the improvement of the SQI produced by an increase of the level of an attribute has been calculated. As an example, the SQI improvement by considering an increase of the frequency (the attribute with the highest value of the IV) and the security against crimes (the attribute with the highest level perceived by the users) has been calculated. Specifically, a 10% improvement of the level of the frequency determines an SQI increase of 4%, but a 10% improvement of the level of the security against crimes determines an SQI increase of 0.27%.

4. Conclusions

In this paper transport service quality attributes which influence global customer satisfaction have been analysed.

The importance of each attribute perceived by the University of Calabria students has been evaluated, particularly the students who do not live in the urban area of Cosenza.

With the aim of determining the relative weights of all the attributes on global customer satisfaction, the Importance Value (IV) technique has been proposed.

As a result it emerges that service quality attributes with a major weight on global customer satisfaction are service frequency and seats on the bus.

The introduced technique can be debatable, because it uses rank data transformed into rate data. Nevertheless, the results are realistic and frequency, as expected, has the major weight.

The degree of discretionality introduced by the transformation of ranking in rating could be compensated by asking the users both ranking and rating preferences. In this way, some checks can be carry out. Firstly, the correspondence between ranking and rating data can be verified. Secondly, the degree of discretionality of assigned rates from the IV procedure can be measured by comparing assigned rates with rates expressed by users. Finally, the IV procedure can be also verified by using expressed rather than assigned rates.

Moreover, unlike the statistical analysis techniques for measuring service quality and customer satisfaction, IV technique allows the relative weights of all the attribute on global customer satisfaction to be determined. Furthermore, by using these weights an aggregate index can be calculated (Service Quality Index). This index permits supplied services effectiveness to be measured and service quality attributes to be identified to improve it.

As an example, SQI with reference to the real situation has been calculated. For this aim, a perceived level of each attribute was asked the users. From the results, it is deduced that the actual public transport service used by students to reach the campus is satisfactory because SQI has a value higher than 60, on a scale from 1 to 100. SQI can be useful to planners to choose more appropriate public transport agencies and to the said agencies to improve supplied service regarding suitable service quality attributes.

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