Index numbers for monitoring Transit Service Quality

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Juan de Oña, Rocío de Oña, Laura Eboli and Gabriella Mazzulla (in press) *Index numbers for monitoring Transit Service Quality*. **Transportation Research Part A,** DOI: 10.1016/j.tra.2015.05.018.

Direct access to the published version: http://dx.doi.org/10.1016/j.tra.2015.05.018

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Abstract
The measurement of transit service quality is very important for guaranteeing a transport supply characterized by satisfactory service levels for the passengers. Even more important is the monitoring of the levels of service quality over time, which can be very useful to determine if the goals established by the transport planners are being met or exceeded. The status and evolution of transit service quality can be monitored through periodic and regular updating of the opinions expressed by the passengers about the service during the well-known Customer Satisfaction Surveys, allowing the effect of policies to be evaluated and specific interventions to be introduced. In this work, just the issue of monitoring service quality based on users' opinions is approached, and the index numbers usually applied in the economic and industrial field are proposed for this purpose. Index numbers permit to study the fluctuations or variations of a variable or more variables over time, providing a powerful measurement for making comparisons and predictions of the analysed concept. The index numbers were calculated on the basis of data collected from Customer Satisfaction Surveys addressed to the passengers of the metropolitan public service of Granada (Spain). The analysed time period has been established from 2007 to 2013. Interesting results derive from the calculation of the index numbers. Since both perceptions and importance rates are considered in this methodology, the results can inform, not only on the satisfaction tendencies but also on the trend on customers' priorities, which is actually the expected quality. Therefore, policies could more efficiently be designed to adjust the service to the users' real needs.

Keywords: service quality; monitoring; index numbers

Highlights

Monitoring service quality over time can help to improve the service
Index numbers proved a practical tool for evaluating service quality evolution
Simple index numbers emerged as a useful tool for measuring the variation of each service aspect
Composite index numbers turned out suitable for the multidimensional service quality construct
Transport practitioners can easily monitor service quality through the index numbers

1. Introduction

Transit service quality has long been recognized as an important factor in influencing travellers behaviour, and it is one of the main drivers of sustainable transport policies as it encourages travellers towards selecting transport modes that are more efficient in energy and space (European Commission, 2007). Therefore, the transit performance evaluation is needed to capture the existing demand trends, peaks of operation, existing stakeholders concerns, and unmet service needs (Hassan et al., 2013).

For a long time the performance evaluation of public transport has been carried out from the service managers' perspective only (Transport Company and government), based on the cost efficiency and cost effectiveness of public transport services and operations. However, in the last few decades, practitioners, managers and researchers have started to focus on passengers' perspective, given that public transport services are offered directly to customers; so the resultant quality of a service should be seen as an outcome of user perception (Das and Pandit, 2012; 2013; Tyrinopoulos and Antoniou, 2008).

As emphasized in Cascetta and Cartenì (2014), in this lapse of time also the European Union adopted a user-oriented view of service quality, and promoted a quality approach to public transport focused on customers' needs and expectations (e.g., European Commission 1995, 1996, 2001, 2007). In addition, in 2002 the EU Committee on Standardization enacted the standard EN 13816 where passenger and service provider point-of-view was joined in a service quality loop (European Committee for Standardization, 2002).

Customer perception of the quality (perceived service quality) depends on customers' personal experience of the service, on the information they receive about the service and their personal characteristics (e.g., gender, age, socioeconomic group) (European Committee for Standardization, 2002). These perceptions are usually measured by the Customer Satisfaction Surveys (CSS) (de Oña et al. 2014a; 2014b), and the data collected are used for developing indicators providing useful information about the global service quality. The surveys are generally conducted every year or with a 6-month frequency, monitoring users' perception about the service and its evolution along the time.

Quality of service, and particularly the quality of a public transport mode, is considered as a multidimensional construct (Brady and Cronin, 2001; Parasuraman et al., 1985; 1988), evaluated considering a large number of attributes describing the performance of the service. However, when customers evaluate the quality of a service as a whole, some service attributes are considered more important than others (Mokonyama and Venter, 2013), being their influence implicitly taken into account with their global evaluation. Therefore, there are several categories of attributes having a greater or lesser impact on service quality (de Oña et al., 2013; Eboli and Mazzulla, 2012; TRB, 2004; Tripp and Drea, 2002); their influence should be considered when an indicator of the level of quality is calculated.

The relative importance of each attribute as for the overall service quality can be extracted through different ways (de Oña et al., 2012): by considering the importance rates stated by the passengers during the survey (stated importance) or, alternatively, deriving their weight by calculating the correlation between the satisfaction expressed by the users about each attribute and the satisfaction about the overall service (calculated importance). This last one is preferred by researchers and academics because of their numerous advantages (Weinstein, 2000), such as a more reliable evaluation of the users, who otherwise tend to indifferently give importance to all the attributes if they have to directly state a rate of importance.

The importance assigned by the passengers to each service aspect as well as their judgements of satisfaction change across the years, because of changes in the transport system or in the opinions of the passengers who can become more critics towards the service as time goes by.

First of all, transit supply could have improvements or worsening, and passengers' satisfaction with the service is closely connected to these variations.

Also the importance assigned by the passengers to the use of transit system and to the different aspects of the service can change over time; specifically, it can vary due to factors concerning people attitudes towards the transit mode, people sensitization towards economic and environmental aspects, people expectation about the service, who are ever more demanding. As an example, with the improvement of the living-standard of people and the development of transport industry, passengers have put forward higher and higher requirements on some aspects of the service, such as the comfort of their journey (Fu et al. 2012).

In this context, measuring and monitoring quality of supplied services becomes a great priority for all the stakeholders associated with the transport system (dell'Olio et al., 2011); this updated evaluation of the service is fundamental for formulating adequate transport strategies.

Just for this reason, in this paper we deal with the issue of monitoring service quality across the years, on the basis of users' opinions, that are fundamental for the evaluation of service quality, as discussed above. Specifically, we propose the use of the index numbers usually applied in the economic and industrial field for analysing the variation of service quality over time.

The systematic observation of a phenomenon over time permits to construct a time series. The size of the changes in a time series can be easily and conveniently measured by calculating ratios between two or more values of the series. The values obtained from the ratios are just the index numbers. As the governments control the trend of the main macro-economic and socio-demographic variables of their country (e.g. the unemployment rate, inflation, birthrate, immigration rate) we control the trend of transit service quality levels through a simple tool such as index numbers. Index numbers generally refer to the variation of prices or quantity of goods or services, such as the consumer prices, or the output prices, or the quantity of industrial goods. Starting from these concepts, we decided to adopt simple and composite index numbers to analyse the variation of the quality of a service by using the passengers' satisfaction rates as equivalent of the price values.

A reference or base period has to be established in order to measure changes over time referring all the analysis to this base situation. The reference time period can be the same for all the analyses (fixed base index numbers), or can be represented by the time period immediately before the analysed period (chain base index numbers).

As widely treated in the scientific literature, service quality is a multidimensional construct and then the variation of the quality level perceived by the users depends on how passengers' satisfaction with the various service aspects changes over time. The judgements of the users in terms of satisfaction have to be weighted on the importance assigned by the users to each aspect, as the quantities of goods are included in the calculation of the overall price of goods. So, for this analysis, we adopt a composite index number obtained as an aggregation of indices of more attributes characterizing the service, in order to take into account the influence of all the service aspects. The importance rates represent the relative importance of each attribute to the overall quality of the service (calculated importance), and they are obtained using a Pearson Correlation. Considering different weights across the years and across the attributes seems to be the best way of fitting the proposed index, due to results not only inform about satisfaction tendencies, but also on the trend of customers' priorities, permitting to adjust the service to the users' real needs. As a preliminary analysis, also simple index numbers are calculated for evaluating the evolution of each service attribute characterizing the service.

The calculation of the index numbers was made on the basis of data collected in the metropolitan area of Granada (Spain) through CSS addressed to the passengers of the transit service. A time period of seven years (from 2007 to 2013) is considered.

In the following, we propose a brief review of the most important indicators of service quality reported in the literature; according to the authors' knowledge there are no studies proposing indicators aimed to monitor the levels of transit service quality over time. After the review, we propose a section describing the methodology adopted for monitoring service quality, based on the use of the index numbers: a brief theoretical framework is introduced before the description of the

specific framework. Then, there is a section about the application of the proposed methodology, where we describe the surveys and the characteristics of the samples, we analyse the opinions expressed by the passengers, and finally we present the calculation of the index numbers and discuss the results. The paper ends with the conclusions about the work.

2. Literature Review

Service quality indicators have been recognized as powerful tools for measuring transit service quality (Iseki and Taylor, 2010). Researchers and academics have used a wide number of indicators for their analyses: from the most simple indices such as SERVQUAL (Abdlla et al.2007, Chau and Kao, 2009; Chou et al. 2011; Pakdil and Aydin, 2007), SERVPERF (Sánchez et al., 2007), Customer Satisfaction Index, CSI (Hill et al., 2003) or the Heterogeneous Customer Satisfaction Index, HCSI (Eboli and Mazzulla, 2009), until other more complex indices resulting from the application of some statistical and econometric models to the users' perceptions or satisfaction rates, such as regression models (Kim and Lee, 2011; Weinstein, 2000), structural equation models (Eboli and Mazzulla, 2012; Irfan et al., 2011; Ngatia et al., 2010) or discrete choice models (Eboli and Mazzulla, 2010; Hensher, 2001; Hensher and Prioni, 2002; Hensher et al. 2003).
SERVQUAL is the most popular and widely applied technique, which calculates a service quality index as a function of the differences between passengers' expectations and perceptions about the attributes describing the service. This technique was used by many researchers for analyzing service quality in the airline industry in its current form (Abdlla et al., 2007; Chau and Kao, 2009), while others adapted it to a weighted SERVQUAL (Pakdil and Aydin, 2007) or to a fuzzy weighted SERVQUAL (Chou et al. 2011). SERVPERF model is based on measuring the level of service quality by using the performance perceptions only. Sánchez et al. (2007) proposed a weighted SERVPERF model for assessing an urban bus service. CSI and HCSI use the attributes' importance and satisfaction rates for determining service quality. HCSI was introduced by Eboli and Mazzulla (2009) as an improvement of the original CSI, by taking into account the heterogeneity of the passengers' opinions for determining a service quality index for a bus transit service.
All the above mentioned simple indices represent enough practical tools for measuring service quality levels because they have the capability to give a single value of service quality level but including information concerning all the aspects characterizing a service. However, these indices were thought as tools providing for a measure of service quality levels, and not as tools aimed to monitor the levels of quality over the years.
On the other hand, complex indices (based on regression analysis, structural equation models, discrete choice models, etc.) permit to estimate the importance of the service quality attributes by calibrating models based on users' perceptions or satisfaction rates, and subsequently, the global quality of the service can be determined with an index calculated by using the estimated coefficients. As an example, a regression model was used by Kim and Lee (2011) for analyzing the level of quality of three domestic airports, while Weinstein (2000) used this kind of model for evaluating the quality of a Bay Area Rapid Transit. Some authors assessed transit services by using structural equation models (Eboli and Mazzulla, 2012) and discrete choice models (Eboli and Mazzulla, 2010). Hensher (2001), Hensher and Prioni (2002) and Hensher et al. (2003) used Logit models (multinomial logit model, nested-logit model and mixed logit model) for analyzing service quality of some bus services provided by different operators. These complex indices represent a challenge for transport planners and operators, who usually evaluate the quality of the service provided by simple statistical analyses. In spite of the numerous benefits of these more complex indices, they sometimes are not very intuitive. In addition, like the above described simple indices, they are not oriented to the monitoring of service quality over time.
Definitively, all the indicators reported in the literature and briefly described in the proposed literature review, from the most simple to the most complex, are very useful for measuring service

quality levels, but they are not appropriate for studying the evolution of service quality over time, because they were designed with the aim to give only a measure of the quality level at a certain reference period; for this reason, they are not characterized by the convenience and practicalness in monitoring service quality levels over the years, which instead characterize index numbers.
The aim of this paper is just to propose an indicator measuring the variation of service quality over time; we retain that index numbers represent a very simple measure able to easily show the evolution of service quality over the years, and to facilitate transport planners and operators to interpret and understand users' needs. This simple tool can be adopted by the practitioners of the transport sector, who have the possibility to easily monitor the quality levels of the supplied services and to observe the changes year by year.

3. Methodology

3.1. Index numbers: theoretical framework

Economic analysts around the world are concerned with the variation of most variables over time, such as prices paid for raw materials, numbers of employees and customers, or other general economic variables such as national income, gross output, cost of living, value of stock exchange. Index numbers represent a very practical and useful way of describing such changes. An index number can be defined as a single indicator representing the change in the value of a variable relative to its value at a fixed point in time (the base period). The index is often conventionally scaled for obtaining a percentage value (base value of 100).
Index numbers constitute a convenient way to standardize the measurement of numbers so that they are directly comparable. The variables considered represent a number of concepts including prices, quantity, volumes, value of a commodity.
A series of fixed base index numbers expresses the intensity or frequency of a phenomenon in each time period as a share of the intensity or frequency in a reference period named base. So, they are the ratios of the observed values in a series of occasions to the observed value in a reference occasion. On the other hand, a series of chain base index numbers expresses the intensity or frequency of a phenomenon in each time period as a share of the intensity or frequency in the immediately previous period.
Independently of the distinction between fixed and chain base index numbers we can have simple and composite index numbers. A simple index number is a number measuring a relative change in a single variable with respect to a base, whereas a composite index number is a number measuring an average relative change in a group of relative variables with respect to a base.
Index numbers are used in several instances. Some of the most widely known and used indexes include the Consumer Price Index (CPI) and the Producer Price Index (PPI). CPIs are official statistics that are usually produced by national statistical offices, ministries of labour or central banks (Turvey, 2004). Price index numbers measure the relative changes in prices for a given class of goods or services between two periods.
A simple Price fixed base index can be expressed by the formula (1),

$$P = \frac{p_{c,t}}{p_{c,0}} \qquad (1)$$

in which $p_{c,t}$ represents the prevailing price of the goods or service *c* in the period *t*, and $p_{c,0}$ represents the prevailing price of the goods or service *c* in the base period *0*. This index will be greater than 1 if the price in the period *t* is bigger than the price in the base period, and *vice versa*.
A simple Price chain base index, representing the year immediately preceding the one for which price index is calculated, is shown in formula (2):

$$P_t = \frac{p_{c,t}}{p_{c,t-1}} \quad (2)$$

Generally, a fixed amounts of the *n* quantities in the aggregate value are chosen and then the values of this fixed basket of quantities at the prices of period *0* and at the prices of period *t* are calculated. The fixed basket Price index is simply the ratio of these two values where the prices vary but the quantities are held fixed. Two natural choices for the fixed basket are the quantities transacted in the base period, period *0*, or the quantities transacted in the current period, period *t*. These two choices lead to the Laspeyres index (by the economist Etienne Laspeyres) and the Paasche index (by the economist Hermann Paasche) respectively (Turvey, 2004). Both of these indices are composite index numbers.

The Laspeyres index is computed by formula (3):

$$P_L = \frac{\sum_{c=1}^{n} p_{c,t} * q_{c,0}}{\sum_{c=1}^{n} p_{c,0} * q_{c,0}} \quad (3)$$

while the Paasche index is computed by formula (4),

$$P_P = \frac{\sum_{c=1}^{n} p_{c,t} * q_{c,t}}{\sum_{c=1}^{n} p_{c,0} * q_{c,t}} \quad (4)$$

In the formulas, $p_{c,t}$ represents the prevailing price of the goods *c* in the period *t*, whereas $q_{c,t}$ represents the quantity of the goods *c* consumed in the period t; $p_{c,0}$ represents the prevailing price of the goods or service *c* in the base period *0*, whereas $q_{c,0}$ represents the quantity of the goods *c* consumed in the period *0*. *P* is the relative index of the price levels in two periods, *0* is the base period (usually the first year), and t is the period for which the index is computed. Paasche proposed to consider as weights the quantities of each time period, and then the weights are not constant. For this reason, only the comparison between the various periods and the base period is possible. In all the other comparisons, both prices and quantities change; therefore, the observed variation will be due to the conjoint variation of the prices and the quantities (Borra, Di Ciaccio, 2008).

The Laspeyres Price index P_L can be written as an arithmetic average of the *n* price ratios weighted by base period expenditure shares. To implement it, a statistical agency needs only to collect information on expenditure shares for the base period *0*, and then collect information on item prices alone on an ongoing basis. For this reason, the Laspeyres formula has been widely used as Consumer Price indices (CPIs) around the world, because it can be produced on a timely basis without having quantity information for the current period (Turvey, 2004).

The Paasche index can also be written in expenditure share and price ratio form. The Paasche Price index P_P can thus be written as a harmonic average of the *n* item price ratios weighted by current period expenditure shares. The lack of information on current period quantities prevents statistical agencies from producing Paasche indices on a timely basis.

Unfortunately, the Paasche and Laspeyres measures of aggregate price change can differ, sometimes substantially. For this reason, more complex index numbers are often calculated as the average of the previous ones. The arithmetic mean leads to the Drobisch, Sidgwick and Bowley index (P_D), and the geometric mean leads to the Fisher ideal index P_F. In order to determine which of these fixed base indices or which averages of them might be "best", desirable criteria or tests are needed for the price index. According to Turvey (2004), it is very desirable for a price index formula to satisfy the "time reversal test". It should be noted that the Laspeyres and Paasche price indices do not satisfy this time reversal property, while the Fisher price index is the only index that is a homogeneous symmetric average of the Laspeyres and Paasche price indices, and satisfies the time reversal test.

In spite of this, statisticians might prefer fixed basket price indices because of the easiness to explain the concept to the public. The practical problem of picking q remains to be resolved. By using the arithmetic means of the quantities, the Marshall and Edgeworth price index P_{ME} can be obtained; on the other hand, the function could be the geometric mean, in which case equation reduces to the Walsh price index P_W. A potential problem with the use of the Edgeworth-Marshall price index has been noticed in the context of using the formula to make international comparisons of prices. If the price levels of a very large country are compared to the price levels of a small country using P_{ME} formula, then the quantity vector of the large country may totally overwhelm the influence of the quantity vector corresponding to the small country. Walsh Price index, $P_{W,}$ do not have this type of problems (Turvey, 2004).
As just introduced, an alternative way for calculating index numbers is to take the base period for each time period to be the immediately preceding time period. As an example, we can calculate the Laspeyres index referred to the period t_n (chained Laspeyres index) by using formula (5).

$$P_{Lt} = \frac{\sum_{c=1}^{n} p_{c,t1} * q_{c,0}}{\sum_{c=1}^{n} p_{c,0} * q_{c,0}} \times \frac{\sum_{c=1}^{n} p_{c,t2} * q_{c,t1}}{\sum_{c=1}^{n} p_{c,t1} * q_{c,t1}} \times \ldots \times \frac{\sum_{c=1}^{n} p_{c,tn} * q_{c,tn-1}}{\sum_{c=1}^{n} p_{c,tn-1} * q_{c,tn-1}} \qquad (5)$$

The Paasche index can be chained in the same way as the Laspeyres index (as in Equation 5).
The chain system measures the variation in prices from one period to a subsequent period using a bilateral index number formula considering the prices and quantities concerning the two adjacent periods. The main advantage of the chain system is that under normal conditions, chaining will reduce the spread between the Paasche and Laspeyres indices. Turvey (2004) noted that using the chain system when prices oscillate is not appropriate. Basically, chaining is advisable if the prices and quantities of adjacent periods are more similar than the prices and quantities of more distant periods.
The chain-weighted CPI is therefore considered as a more accurate inflation gauge than the traditional fixed-weighted CPI, because it considers the fact that consumers' purchasing decisions change with changes in prices, rather than simply measuring periodic changes in the price of a fixed basket of goods.

3.2. The proposed framework

In this research, we choose to introduce a Service Quality index able to monitor the evolution of the quality levels of a transit service over time. We retain that to control the trend of service quality is very important for many actors: the direct users of the service, who are the passengers, interested in having good transport services; the transit operators, who are directly interested to an ever more increased utilization of the service; the transport planners, who want to plan a sustainable transportation system where transit becomes a competitive transport mode; the community that can indirectly benefit from a transport system characterized by transit services of good quality levels, in terms of reduction of traffic congestion, noise and air pollution, and so on.
For reaching the predefined aim, the authors retained useful to borrow from the Economics the basic index number theory. The concepts of price and quantity appearing in the index numbers formulation are replaced by concepts closely linked to the evaluation of service quality. As we retain that service quality have to be measured by considering the opinions of the passengers, who directly use the services, we decided to include in our Service Quality index number the concepts of satisfaction and importance, described in the introductive section of the paper.
Firstly, we choose to adapt a composite index number because, as before stated, transit service quality is considered as a multidimensional construct evaluated considering a large number of attributes describing the performance of the service. Secondly, we consider the simplest and most widely known Consumer Price indexes (CPI), that is Laspeyres and the Paasche index numbers,

both considering the prevailing price of the goods *c* and the quantity of the goods *c* consumed. The choice was prompted by considering that the quantity of the goods consumed express the weights of the prices of each time period. As well know, when customers evaluate the quality of a service as a whole, they consider some service attributes more important than others. Importance rates are often considered as the weights of the judgements stated in terms of satisfaction rates. Thirdly, in the considered index number formulation *c* represent the goods or service consumed in the analysed period of time; so, in our case the consumed service is "transit service" and, by analogy the prevailing price of the service *c* can be considered as the prevailing level of satisfaction expressed by the customers consuming the "transit service".
Finally, we decided to adapt the Paasche Consumer Price index formulation because, differently from Laspeyres formulation, it consider as weights the quantities at the current period and then, the weights are not constant. Definitively, the Paasche index number is rewritten by considering that: the good or service *c* becomes a service aspect *i* of the transit system; the price of the good *c* is replaced by the satisfaction of the users with the service aspect *i*, while the quantity of the good *c* becomes the weight that the service aspect *i* has for the customers, or how much the service aspect *i* counts for the passenger on the overall service quality. So, as the variation of the price in the original formula of Paasche depends on the variation of the prices and quantities of the various goods influencing the analysed price, in the same way the variation of transit service quality in our following proposed formula depends on the variation of users' satisfaction about the aspects characterizing the service, and on the importance assigned by the users to each service aspect. We retain that the service quality level is a result of how users judge the quality of the service aspects (satisfaction) and how much each service aspect influence the overall service quality (importance). Both these two entities can vary over the years: an improvement or worsening of the service characteristics have direct effects on the satisfaction of the passengers, as well as the variation of other factors such as passengers' attitudes and expectations can change the importance of the service aspects for the users. For these reasons we think that an index number for analysing the evolution of service quality must take into account both satisfaction and importance judgements. Specifically, by adapting the formula 4 to the SQ index number, the equation defining the proposed index is the following:

$$SQ_{t/0} = \frac{\sum_{i=1}^{n} p_{i,t} * w_{i,t}}{\sum_{i=1}^{n} p_{i,0} * w_{i,t}} \qquad (6)$$

where $SQ_{t/0}$ is the Service Quality index number in the year t with respect the base period *0*, $w_{i,t}$ is the weight or the importance of the attribute i in the year t, $p_{i,t}$ is the user perception (satisfaction rate) of the attribute i in the year t, and $p_{i,0}$ is the average rate of satisfaction of the attribute i in the base period. The year 2007 has been established as the base period. We propose also a chain base index, calculated by the same formula 6, where the base period varies from 2007 to 2012.
This is the first time that an index number is proposed for analysing the quality of a transit service. We suppose that this index has the ability of measuring the evolution of service quality over the years, and we demonstrate this assumption in the following sections.

4. Application of the framework: a case study of Granada

4.1 Survey

The methodology proposed in this work for monitoring service quality was applied to a case study represented by the metropolitan public transport (PT) service of the city of Granada (Spain). Granada is a medium-sized city in the southern Spain having 523,845 inhabitants in the metropolitan area. A Granada Area Transport Consortium was created in 2003 to coordinate bus

service management in the Metropolitan Area. The PT service carries more than 10 million passengers every year; fifteen bus companies operate in eighteen independent transport corridors linking the metropolitan municipalities with the centre of the city of Granada. The transit network is established by a radial structure focused on two central areas of Granada, one in the North and the other one in the South of the city, and extending in all directions (corridors) to the rest of the urban agglomeration.

The first CSS for service quality evaluation of the Granada Metropolitan PT system was conducted by the Transport Consortium in 2006. Since this year, an annual CSS was developed to analyze changes in the service quality perceived by the passengers. Each year, more than a thousand users have been interviewed in March or April. Thanks to these recurrent surveys we had the possibility to analyze data collected in a time period of seven years (from 2007 to 2013) and to propose a methodology for measuring the variation of users' perceptions with the final aim to monitor the evolution of service quality over time.

Face-to-face questionnaires were proposed to the users at the main bus stops of the lines. The questionnaire is structured into two main sections. The first section has the aim to collect general information about the service (e.g. operator, line, time of the interview), demographic characteristics of the users (e.g. sex, age) and their travel habits (e.g. reason for travelling, frequency of use, type of ticket, complementary modes used for accessing to/moving from the bus stop). Through the second section of the questionnaire, users' opinions about the service are collected: passengers are asked to state or rank the importance of the attributes describing the service; passengers are also asked to state their perceptions about the quality of each attribute by expressing rates of satisfaction, from 0 to 10; finally, they are asked to express a satisfaction rate about the quality of the overall service, according to a scale from 1 to 5. The way of collecting the rates of importance in the surveys changed several times in the analyzed period of time (from a 5-point scale, to a 11-point scale, to a ranking in which only the three most important attributes were marked, etc), making very difficult to use them for monitoring the quality of the service over the years. For this reason we decided to not include the stated importance in the proposed index numbers, but to introduce a calculated importance, as explained in the following. This decision is also supported by the consideration that the calculated importance can be retained as a more reliable evaluation of the users, who tend to give importance to all the attributes when they have to state a rate of importance (Weinstein, 2000). The investigated service attributes are: frequency, punctuality, speed of the trip, proximity of the stops to/from the origin/destination, fare of the ticket, cleanliness of the vehicle, space in the vehicle, temperature in the vehicle, available information, safety on board, courtesy or kindness of the personnel, easiness to get on/off the bus and timetable of the service.

4.2. Sample characteristics

The characterization of the samples is represented in table 1. For all the samples we can observe (from 2007 to 2013) that more than two thirds of the users are females, even if the gap between males and females has decreased in the most recent years (2011, 2012 and 2013). The samples are mostly composed of users aged between 18 and 30 years old (maybe students for the major part) and then of users between 31 and 60 years old; only a small percentage of users is older than 60 years old; we can observe very similar percentages between young and middle-aged users in the last two years of gathering.

Table 1. Sample characteristics (CSSs for the period 2007-2013)

The major part of users travel almost every day by bus (4 or more times in a week), and about a fifth of the sample takes frequently the bus (from 1 to 3 times a week); however, we can observe a decrease in the use of the bus service over the years if we consider that the percentage of people who use almost every day the service has diminished since 2007. As an example, only 2.5% of the

sample sporadically took the bus in 2007, while in 2013 about 10% of users more or less once a month travelled by bus. In fact, in 2012, the number of passengers carried by the transit service went down until 9 million. Most of the users travel for purposes different from work or study, such as doctor, shopping, holidays or other personal activities; more than one fourth of the sample takes the bus for reaching the work place, while another important percentage for reaching the study place. Most of the entire sample accesses by walking to the bus stop; less than 30% of the sample reach the bus stops by other modes (e.g. car, urban bus, motorbike, bicycle, etc). Concerning the type of ticket used by the passengers, we can observe that passengers mostly use the Consortium Card, especially in the most recent years (about 76%); another important group of users travelled with the Standard ticket, but in the most recent years this percentage is only 15% due to the ever more increased use of the Consortium Card; a very little part of the sample uses the Senior citizen pass or another type of ticket.
So, if we want to give a profile of the passenger we can say that the current passenger travels enough frequently by bus using a travel card, he/she travels for many purposes reaching by walking the bus stop. The main differences between the passenger who used the less recent services and the current passenger concerns gender and type of ticket. The current trend is that males have been ever more using transit systems, although the percentage of females travelling by bus is still higher than males, and users have been ever more oriented to prefer travel card rather than standard tickets.

4.3. Service quality evaluation

In this section we analyse the average satisfaction rates calculated from the perceptions about the service quality attributes stated by the passengers over the years; the obtained values are reported in table 2. Also the average rates of the overall service quality are shown; users expressed these rates according to a 5-point scale, but we recoded the rates into an 11-point scale in order to better compare the values with the rates of satisfaction with the service attributes.

Table 2. Perceptions (satisfaction average rates) of the service quality attributes (CSSs for the period 2007-2013)

From the observation of the satisfaction rates concerning the service quality attributes, we can say that passengers are mostly satisfied with the attribute “Courtesy of the personnel”, which received rates close to 8 every year and upper than 8 in the last two years, and “Safety on board” that shows satisfaction average rates ranging from a minimum of 7.41 in 2009 to a maximum of 7.68 in 2012. Some other attributes registered good opinions (values upper than 6.5): many attributes concerning comfort on board such as “Cleanliness of the vehicle”, “Temperature of the vehicle”, “Easiness to get on/off the bus”, and “Space in the vehicle”; the aspects “Proximity of the stops” “Speed of the trip” and “Punctuality”. On the contrary, passengers are not very much satisfied with “Fare” and “Frequency” (perceptions under 6.5 in almost all the years). Also the aspects concerning information and timetable did not receive high rates. All these least satisfactory attributes show the highest variability of the responses, if we observe the values of the confidence intervals.
The major part of the attributes shows the minimum values of satisfaction in 2008 or 2009. The fall produced in 2008 could be due to the construction work of the metro started in April of 2007 (still not finished) causing some disturbances in the ordinary performance of the service (e.g. frequency, timetable, itinerary, etc). Almost all the attributes registered the highest satisfaction rates in 2010 or 2011, but for some attributes satisfaction remains rather constant also in 2012 and 2013 (e.g. Available information, Courtesy of personnel, Safety on board, Proximity of the stops, Speed of the trip). These good results could be due to the continuous improvement of some aspects by the Transport Consortium of Granada, such as the installation of new informative panels in the main bus stops of the service (that provide passengers the real time of the bus arrival), the motivation of the staff (i.e. bus drivers) for developing a more careful driving and a more kind treatment to

passengers, and so on. By analysing the confidence intervals one can find that the variability of the responses has decreased with the passing of the years.
A particular trend is observed for the service aspect concerning easiness to get on/off the bus, which registered a growing tendency from 2007 to 2010, maybe because in these years the Transport Consortium of Granada started to increase the number of vehicles equipped for people with limited mobility. However, since 2011, the number of new vehicles and the satisfaction with this aspect went slightly down, and in 2012, new vehicles were only 35% of the total. Another particular trend is registered for the attribute regarding fare; in fact, between 2011 and 2012 there was the main significant change produced in its average satisfaction score, when its evaluation fell down to 5.02 in contrast to the value stated in the previous year (6.43); this decrease could be due to the various rises carried out in the price of the ticket in the last periods (in July of 2010, April 2011 and January 2012, with a mean rise of 11.5% in the standard ticket and 8% in the consortium card).
Concerning the overall service, we can observe a light increase of the passengers' satisfaction from 2007 to the most recent years. The rate expressed in 2008 is the lowest of the years analyzed. As specified before, it could be explained by the construction work of the metro. It was observed a little decrease from 2007, but in 2009 satisfaction with the service rises again and remains almost constant in 2010; a new increase is registered in 2011 (with the highest rate of 3.73), and finally a little decrease in 2012 and 2013.
A statistical analysis was performed to confirm the existence of statistical differences between the attribute satisfaction rates over the time. Because of the non-normality of the data, non-parametric techniques were used (Kruskal-Wallis and Dunn test). A Kruskal-Wallis test was performed in order to determine the statistical difference between the values of the satisfaction average rates over time. Results are shown in Table 3, where statistically significant differences between years can be observed (with a 95% confidence level), especially between 2007 and 2008, 2009 and 2010, and 2011 and 2012. The service attributes showing relevant statistically significant differences concern comfort on board in terms of space in vehicle and temperature; also punctuality and frequency registered important significant differences.

Table 3. Kruskal-Wallis test

We obtained the calculated importance by using a Pearson correlation of the satisfaction rates expressed by users for each service attribute with the satisfaction rates expressed about the overall service. The results are shown in Table 4.

Table 4. Importance (calculated as correlation) of the service quality attributes (CSSs for the period 2007-2013)

The analysis of the data can be easily made year by year with the aim to make a list of the most important attributes (the attributes for which satisfaction is mostly correlated to the satisfaction with the overall service). Specifically, we observe that the attributes considered as the most important in almost all the years are: "Frequency", "Timetable of the service", "Punctuality", and "Available Information". Passengers consider the aspects concerning service scheduling, reliability of the service in terms of punctuality of the runs, and availability of information about the service as the most important ones. Other aspects, such as the aspects concerning comfort, or safety and personnel are less important than others; just these attributes were well appreciated by the passengers who expressed high rates of satisfaction. These results justify the differences in the trend of the satisfaction with the single service quality attributes and the satisfaction with the overall service.

4.4. Service Quality index numbers: analysis and discussion of the results

4.4.1. Preliminary remarks

The main objective of the work is to propose a Service Quality index number for monitoring the variation of service quality over the years. We adopt a composite index number, depending service quality by more variables representing the different service attributes. We decided to calculate a composite fixed and a chain base index number, where the fixed base is the year 2007 and the chain base is the year preceding the reference period. The proposed SQ index number expresses the relative change in the overall service quality compared to the base period under consideration. This index number uses the satisfaction rates of the attributes describing the service, as well as the weights of these attributes derived by using Pearson correlation.
We propose also a preliminary analysis of the evolution of service quality consisting in a calculation of simple index numbers, calculated for each attribute characterizing the service, in order to evaluate the changes in their level of quality across the years. We retain that this preliminary analysis can be useful for better understanding the variation of service quality by observing the changes of each service aspect. Also these index numbers were calculated considering a fixed base (the year 2007) and a chain base.

4.4.2. Calculation of the simple index numbers

In this section, we propose an analysis of the satisfaction judgements that can be surely considered as more useful and evident than the simple analysis of the rates reported in table 2. The values shown in the following table 5 and table 6 are derived from the same satisfaction judgements used for obtaining the average rates reported in table 2, but the results are more informative and easy to be adopted for monitoring service quality. Specifically, table 5 shows simple fixed base index numbers, where the base is the year 2007. We can observe that passengers were more dissatisfied with all the service aspects in 2008 than in 2007 (all the index numbers are less than 1), except "Accessibility", which had an improvement of 3%, as we can easily conclude by reading the value of the index, which is 1.03. The situation is very similar in 2009. The trend changed in 2010 when almost all the attributes had improved their quality respect to the level of 2007. In 2011 only "Frequency" and "Proximity" were still under the base reference. However, in 2012 and 2013 some aspects decreased their quality level (such as "Cleanliness", "Space", "Temperature", "Fare", "Speed", "Frequency" and "Proximity") while others remained over the level established in the reference period ("Information", "Punctuality", "Courtesy" and "Accessibility").

Table 5. Simple fixed base index numbers (base 2007)

The calculation of the chain base index numbers certainly gives more convenient information. In fact, when the base period becomes the preceding year of interest, it is possible to observe how the evolution of the service quality attributes is with respect to the year before. Table 6 displayed the variations in the level of quality of the different attributes. Since 2008, when almost all the attributes decreased their quality as regards the year before, most part of the aspects increased their quality in 2009, 2010 and 2011, with respect the previous year. These improvements were high enough (6% on the average) in 2010, up to a maximum increase of 13% in Punctuality. A wide set of attributes diminished their quality in 2012 as for 2011, reaching "Fare of the ticket" the highest fall (21%). The year 2013 remained more or less constant with respect the year 2012, with changes between -2% and +1%.

Table 6. Simple chain base index numbers

This kind of analysis gives the possibility to immediately observe that there was a particular improvement of the service in 2010, and the situation remained constant in the succeeding years, as we already observed by the more difficult and less readable analysis of the rates of satisfaction.

4.4.3. Calculation of the composite index numbers

This section is about the calculation of the composite index numbers, which differently from the simple index numbers give an overall measure of service quality by considering both satisfaction and importance expressed for all the service aspects. Table 7 shows the results of the proposed composite SQ fixed base index number, where the reference year is 2007. The level of service quality has been subjected to some fluctuations between 2008 and 2013, identifying two different periods: a first period with a positive trend from 2008 to 2011, and a second period with a negative trend since 2011 to 2013 (see figure 1). In the first period, the level of service quality increased until 2011, when the highest service quality evaluation was reached, with a percentage change of 2.2% as regards the base year. The evaluation of service quality was quite lower in 2008 and 2009 than 2007 (SQ index number lower than 1), and specifically 6.7% short in 2008, and 4% in 2009. The level of quality was better in 2010 and 2011 than in 2007, with rising percentage changes of 1.9% and 2.2%, respectively. The second period of time is characterized by a decadency trend in the quality of the service: the level of quality in 2012 was 1.6% lower than in 2007, and 2.1% in 2013.

Table 7. SQ index numbers calculated by fixed (base 2007) or chain base methods

SQ chain base index number (table 6) shows some fluctuations in the overall level of service quality. The highest positive percentage change produced in the overall service quality was from 2009 to 2010 (when the level of quality increased by 5.3%), surely because almost all the attributes registered the highest satisfaction rates in 2010. On the contrary, the highest negative percentage change was between 2007 and 2008 (with a decrease of 6.7%) coinciding with the beginning of the construction work of the metro. On the other hand, the minor change produced in service quality evaluation was in 2011 as regards the reference year 2010 (only 0.3%). Three different trends can be identified with this analysis (see figure 1): a first period with a positive tendency between 2008 and 2010; a second period when the trend is negative (between 2010 and 2012); and finally, a third period between 2012 and 2013, registering a slight recovery of service quality with a positive trend. The first period starts with a service evaluation 6.7% lower than in 2007. However, in the subsequent years (2009 and 2010) the percentage of change as regards the previous year becomes positive and growing, of 2.6% and 5.3%, respectively. The service has improved its quality in 2009 with respect the year before, but this level is still lower than in 2007 (see table 6, with an index number of 0.960). Likewise, the increase of quality in 2010 was the highest one in the chain base index numbers, while it reached the highest value of quality in 2011 with respect to 2007. The tendency in the second period is negative: the improvement of service quality in 2011 with respect the year before was only of 0.03%, and in the following year the quality of the service declined of 3.6%. Finally, it is possible to observe a positive tendency in the service quality evaluation, although service quality was 0.5% worse in 2013 than in 2012; but the percentage of change varies towards a better evaluation.

Figure 1. Trend of the SQ index numbers calculated by fixed (base 2007) (a) or chain base methods (b)

Both the two kinds of index numbers provide for useful information, drawing a picture of the changes of each year with respect the first year of analysis (2007) and a more intuitive description of the changes of each year as regards the previous one.
Some differences were observed by making a comparison between the two index numbers. As an example, by using the fixed base method, two different periods were observed in the overall service evaluation, while through the chain base method three different periods were identified. The first

period identified through the fixed base method is represented by a positive trend of service quality (from 2008 to 2011), while by using the chain base method the positive trend finished in 2010, being the year 2011 a period characterized by a negative trend. This means that the level of service quality increased between 2010 and 2011, but this magnitude of change was lower than in the year before, stopping the growing tendency of improvement of the service quality. The second period identified by using the fixed base method represents a decadency of service quality from 2011 to 2013 (figure 1a). However, observing the figure 1b, it is possible to determine that since 2012 the trend of change is positive, diminishing the value of reduction of quality in 2013 (only 0.5 % lower than in 2012).

5. Conclusions

The paper proposes a method to monitor transit users' satisfaction over the years by the assessment of the index numbers commonly used in economics. We retain that the simplicity and potential of the method are the two strengths of our work, since it permits its application straightforwardly. While traditional service quality indicators provide a value of the quality level at a certain reference period, index numbers permit to measure the magnitude of the variation over time of the level of service quality by percentage points. This is one of the main benefits of index numbers, allowing to make comparisons among different services (e.g. different modes of transport, regional context, etc) even though not the same scale, nor the same survey has been analyzed, due to the change in the level of quality is expressed in percentage.

The primary purpose of an index number is to provide a value useful for comparing magnitudes (e.g. service quality). The index number measures the changes in these magnitudes over time, then if two or more time series have the same base period, they could be directly compared.

Particularly, the proposed SQ index number encompasses the different attributes describing the metropolitan public bus service of Granada. The main advantage of this index is that it considers different weights at different years for each service attribute, providing a more accurate evaluation of the service according to passengers' preferences and reflections at each analyzed time (every year or every six months).

The index numbers were calculated on the basis of both perceptions and importance rates; for this reasons the adopted methodology can inform not only about the satisfaction tendencies but also on the trend on customers' priorities, which are actually the expected quality.

The results obtained for the quality of the metropolitan bus service of Granada using two kind of index numbers (simple and composite) and two base methods (fixed and chain base) provide useful and complementary information about the evolution of the level of quality over time. They are calculated considering the satisfaction rates about the service attributes (simple index number), as well as combining the satisfaction rates about the service attributes and their weights (composite index number) for each year under study. From the fixed base method it is possible to observe how many percentage points have the quality of the service increased or decreased with respect the year of reference (2007 in this analysis), and with the chain base method it is determined the trend of change with respect the year before. The chain base method gives a better picture about what is happening than the fixed one. However, both methods contribute to better explain the service.

Index numbers are quite used in the economic and industrial field, but they never were applied for analyzing the quality of a public transport service. This research has proved the usefulness of the index numbers, and the complementary and informative value of using fixed and chain base methods for monitoring the changes on the level of quality a transit service.

Therefore, the proposed SQ index number can be a powerful tool for transport managers and suppliers, for ascertaining the effects that the interventions developed in the service have produced on passengers' satisfaction, and for studying the trend or tendencies in the level of service quality,

in order to make useful predictions. Hence, transport planners and operators can be guided by these values, making decisions about how to allocate their resources in an efficient manner.

Acknowledgements
This study is sponsored by the Consejería de Innovación, Ciencia y Economía of the Junta de Andalucía (Spain) through the Excellence Research Project denominated "Q-METROBUS-Quality of service indicator for METROpolitan public BUS transport services". The authors also acknowledge the Granada Consorcio de Transportes for making the data set available for this study.

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Table 1. Sample characteristics (CSSs for the period 2007-2013)

		2007	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
N. of interviews		1200	1278	1297	1292	1625	1729	1720
Gender	Male	33.6%	28.2%	30.2%	28.9%	37.4%	37.9%	40.8%
	Female	66.4%	71.8%	69.8%	71.1%	62.6%	62.1%	59.2%
Age	{ 18-30 Years Old}	56.1%	51.2%	38.9%	56.1%	41.4%	44.8%	44.0%
	{ 31-60 Years Old}	34.3%	39.0%	50.7%	33.9%	45.6%	44.2%	46.3%
	{ > 60 Years Old}	9.6%	9.8%	10.4%	10.0%	13.0%	11.0%	9.7%
Frequency of Use	Almost Daily	68.0%	53.4%	48.1%	51.3%	58.4%	54.6%	53.1%
	Frequently	20.6%	21.8%	20.4%	21.6%	22.3%	23.4%	24.5%
	Occasionally	8.9%	14.1%	19.5%	15.4%	13.1%	13.8%	12.2%
	Sporadic	2.5%	10.7%	12.0%	11.7%	6.2%	8.2%	10.2%
Travel Reason	Work	26.2%	29.7%	24.1%	27.8%	28.5%	26.8%	22.5%
	Study	19.6%	22.0%	22.1%	23.6%	22.9%	27.6%	31.9%
	Other	54.2%	48.3%	53.8%	48.6%	48.6%	45.6%	45.6%
Mode from origin to the bus stop	Walking	78.3%	67.6%	85.4%	70.6%	79.2%	77.7%	77.0%
	Vehicle	21.7%	32.4%	14.6%	29.4%	20.8%	22.3%	23.0%
Type of Ticket	Standard Ticket	41.5%	40.2%	27.4%	22.8%	14.9%	16.9%	15.5%
	Consortium Card	48.2%	52.7%	64.4%	64.7%	73.1%	73.9%	76.7%
	Senior Citizen Pass	6.6%	6.6%	4.0%	6.6%	9.7%	8.3%	7.7%
	Other	3.7%	0.5%	4.2%	5.9%	2.3%	0.9%	0.1%

Table 2. Perceptions of the service quality attributes (CSSs for the period 2007-2013)

	2007	2008	2009	2010	2011	2012	2013
Frequency	6.80 ±0.15	5.65 ±0.16	6.07 ±0.13	6.37 ± 0.14	6.46 ±0.11	6.13 ±0.11	6.17 ±0.10
Punctuality	7.28 ± 0.13	6.69 ± 0.13	6.81 ± 0.11	7.71 ±0.11	7.73 ±0.09	7.55 ±0.08	7.50 ±0.08
Speed of the trip	7.23 ±0.11	6.62 ±0.12	6.73 ±0.11	7.19 ±0.11	7.20 ±0.11	7.19 ±0.09	7.09 ±0.07
Proximity of the stops	7.34 ±0.13	6.93 ±0.14	6.89 ±0.11	7.08 ± 0.13	7.21 ±0.10	7.22 ±0.10	7.24 ±0.09
Fare of the ticket	6.06 ±0.15	5.84 ±0.14	5.98 ±0.12	6.43 ± 0.13	6.37 ±0.12	5.02 ±0.12	4.93 ±0.11
Cleanliness of the vehicle	7.43 ±0.11	7.28 ±0.11	7.23 ±0.10	7.71 ±0.10	7.66 ±0.08	7.24 ±0.08	7.17 ±0.08
Space in the vehicle	7.14 ±0.12	6.54 ±0.13	7.00 ±0.11	7.46 ±0.11	7.39 ±0.09	7.02 ±0.09	6.96 ±0.08
Temperature in the vehicle	7.37 ±0.11	6.83 ±0.11	7.20 ±0.09	7.63 ±0.10	7.68 ±0.08	7.22 ±0.09	7.13 ±0.07
Available information	6.62 ± 0.14	5.97 ± 0.14	6.22 ± 0.13	6.72 ± 0.14	6.73 ±0.10	6.77 ±0.10	6.79 ±0.09
Safety on board	7.65 ± 0.11	7.48 ± 0.11	7.41 ± 0.10	7.66 ±0.11	7.70 ±0.09	7.68 ±0.08	7.61 ±0.08
Courtesy of personnel	7.94 ±0.10	7.70 ±0.11	7.92 ±0.10	7.95 ±0.11	7.98 ±0.08	8.12 ±0.08	8.08 ±0.07
Easiness to get on/off the bus	6.75 ±0.14	6.99 ±0.13	7.12 ±0.10	7.46 ±0.11	7.39 ±0.09	7.17 ±0.09	7.09 ±0.08
Timetable of the service			6.37 ±0.14	6.30 ±0.15	6.43 ±0.11	6.26 ±0.11	6.33 ±0.10
Overall service (at a 5 point scale)	3.52 ±0.05	3.44 ±0.05	3.59±0.04	3.58 ±0.04	3.73 ±0.03	3.65 ±0.04	3.59 ±0.04
Overall service (at a 11 point scale)	6.29	6.11	6.48	6.45	6.84	6.62	6.48

Table 3. Kruskal-Wallis and Dunn test

	2007-2008	2008-2009	2009-2010	2010-2011	2011-2012	2012-2013
Frequency	-1,15*	0,42	0,3*	0,09	-0,33*	0,04
Punctuality	-0,59*	0,12	0,9*	0,02	-0,18*	-0,05
Speed of the trip	-0,61*	0,11	0,46*	0,01	-0,01	-0,1*
Proximity of the stops	-0,41*	-0,04	0,19*	0,13	0,01	0,02
Fare of the ticket	-0,22	0,14	0,45*	-0,06	-1,35*	-0,09
Cleanliness of the vehicle	-0,15	-0,05	0,48*	-0,05	-0,42*	-0,07
Space in the vehicle	-0,6*	0,46*	0,46*	-0,07	-0,37*	-0,06
Temperature in the vehicle	-0,54*	0,37*	0,43*	0,05	-0,46*	-0,09*
Available information	-0,65	0,25	0,5*	0,01	0,04	0,02
Safety on board	-0,17*	-0,07	0,25*	0,04	-0,02	-0,07
Courtesy of personnel	-0,24	0,22	0,03	0,03	0,14	-0,04
Easiness to get on/off the bus	0,24	0,13	0,34*	-0,07	-0,22*	-0,08*
Timetable of the service			-0,07	0,13	-0,17	0,07
Overall service (at a 5 point scale)	-0,08	0,15*	-0,01	0,15*	-0,08*	-0,06

*Denotes differences statistically significant ($p<0.05$).

Table 4. Importance (calculated as correlation) of the service quality attributes (CSSs for the period 2007-2013)

	2007	2008	2009	2010	2011	2012	2013
Frequency	0.48	0.44	0.38	0.44	0.34	0.35	0.50
Punctuality	0.43	0.43	0.40	0.29	0.30	0.33	0.46
Speed of the trip	0.48	0.41	0.39	0.28	0.31	0.42	0.34
Proximity of the stops	0.36	0.29	0.27	0.32	0.29	0.23	0.45
Fare of the ticket	0.35	0.29	0.29	0.37	0.30	0.29	0.37
Cleanliness of the vehicle	0.33	0.27	0.24	0.26	0.38	0.23	0.49
Space in the vehicle	0.36	0.34	0.30	0.33	0.34	0.27	0.45
Temperature in the vehicle	0.40	0.32	0.28	0.24	0.44	0.29	0.44

Available information	0.44	0.37	0.32	0.40	0.38	0.29	0.46
Safety on board	0.40	0.30	0.36	0.29	0.37	0.33	0.45
Courtesy of personnel	0.39	0.34	0.26	0.20	0.31	0.31	0.41
Easiness to get on/off the bus	0.27	0.24	0.27	0.35	0.32	0.23	0.39
Timetable of the service			0.36	0.41	0.50	0.32	0.50

Table 5. Simple fixed base index numbers (base 2007)

	2008	2009	2010	2011	2012	2013
Frequency	0.83	0.89	0.94	0.95	0.90	0.91
Punctuality	0.92	0.93	1.06	1.06	1.04	1.03
Speed of the trip	0.92	0.93	0.99	1.00	0.99	0.98
Proximity of the stops	0.94	0.94	0.96	0.98	0.98	0.99
Fare of the ticket	0.96	0.99	1.06	1.05	0.83	0.81
Cleanliness of the vehicle	0.98	0.97	1.04	1.03	0.97	0.97
Space in the vehicle	0.92	0.98	1.04	1.03	0.98	0.97
Temperature in the vehicle	0.93	0.98	1.04	1.04	0.98	0.97
Available information	0.90	0.94	1.01	1.02	1.02	1.03
Safety on board	0.98	0.97	1.00	1.01	1.00	0.99
Courtesy of personnel	0.97	1.00	1.00	1.00	1.02	1.02
Easiness to get on/off the bus	1.03	1.05	1.11	1.09	1.06	1.05
Timetable of the service*						

*Simple index numbers at a fixed base cannot be calculated because the attribute was introduced in the survey starting from 2008

Table 6. Simple index numbers for a chain base period

YEAR	2008	2009	2010	2011	2012	2013
Frequency	0.83	1.07	1.05	1.01	0.95	1.01
Punctuality	0.92	1.02	1.13	1.00	0.98	0.99
Speed of the trip	0.92	1.02	1.07	1.00	1.00	0.99
Proximity of the stops	0.94	0.99	1.03	1.02	1.00	1.00
Fare of the ticket	0.96	1.02	1.08	0.99	0.79	0.98
Cleanliness of the vehicle	0.98	0.99	1.07	0.99	0.94	0.99
Space in the vehicle	0.92	1.07	1.07	0.99	0.95	0.99
Temperature in the vehicle	0.93	1.05	1.06	1.01	0.94	0.99
Available Information	0.90	1.04	1.08	1.00	1.01	1.00
Safety on board	0.98	0.99	1.03	1.01	1.00	0.99
Courtesy of personnel	0.97	1.03	1.00	1.00	1.02	0.99
Easiness to get on/off the bus	1.03	1.02	1.05	0.99	0.97	0.99
Timetable of the service			0.99	1.02	0.97	1.01

Table 7. SQ index numbers calculated by fixed (base 2007) or chain base methods

Year/base period	SQ index number fixed base	Year/base period	SQ index number chain base
2008/B2007	0.93	2008/B2007	0.93
2009/B2007	0.96	2009/B2008	1.03
2010/B2007	1.02	2010/B2009	1.05
2011/B2007	1.02	2011/B2010	1.00
2012/B2007	0.98	2012/B2011	0.97
2013/B2007	0.98	2013/B2012	0.99