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Juan de Oña, Rocío de Oña, Laura Eboli & Gabriella Mazzulla (2013) *Perceived service quality in bus transit service: A structural equation approach*. **Transport Policy, 29, 219-226** DOI: 10.1016/j.tranpol.2013.07.001

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Abstract

This paper proposes a methodology for evaluating the quality of service perceived by users of a bus transit service. A Structural Equation Model (SEM) approach is used to reveal the unobserved latent aspects describing the service and the relationships between these aspects with the Overall Service Quality. Data from a Customer Satisfaction Survey conducted by the Transport Consortium of Granada (Spain) are analysed. A total of 1,200 surveys were collected, and two passengers' statements about the overall service quality were gathered: the first one when passengers have not reflected on the attributes describing the service, and the second one after they have thought about them. This is the first time that the Overall Service Quality of a public transport system has been jointly explained by these two overall evaluations when a SEM approach is adopted.

Some interesting results have been obtained. Three latent variables were identified representing the main characteristics of the service. The unobserved latent construct obtaining the highest weight on Overall Service Quality is Service, while Comfort and Personnel have little influence. The passengers' evaluation better explaining the Overall Service Quality is the evaluation made when passengers have reflected on the service.

The findings of this research can provide operating companies and transport managers valuable information for designing appropriate transport policies attracting new passengers and retaining the current ones.

Keywords: Bus Transit Service; Overall Service Quality; Passengers' Perceptions; Structural Equation Modelling

1. Introduction

Nowadays the success of a public transport system depends on the number of passengers which the system is able to attract and retain. For this reason, the quality of a service becomes an issue of maximum importance because it is known that an improvement in the level of quality of the service leads to a higher satisfaction of the passengers and to an increase of the use of the system.

Service quality is related to a series of attributes describing the Public Transport (PT) service. Berry et al. (1990) point out that "customers are the sole judges of service quality", and many authors have also supported this theory. Therefore, if service quality is measured from the customer's perspective, transit quality depends on the passengers' perceptions about each attribute characterizing the service.

In order to design appropriate transport strategies, operating companies monitor the perceptions of the users about the service every year or with a six-month frequency. These perceptions are usually measured by customer satisfaction surveys, and the data collected are used for developing indices providing useful information about the global quality of service and its evolution along the time. However, for determining these measures, they need not only to know the perceptions about the attributes of quality, but also to identify which attributes have the highest influence on the global assessment of the service. Asking customers to rate each attribute on an importance scale is the method mostly used by the operating companies.

However, previous studies showed that the factors affecting the global evaluation of the passengers about the service can vary when they are provoked into thinking about some attributes of the service which they did not consider before. dell'Olio et al. (2010) demonstrated that passengers may change his overall evaluation when they are made to reflect on the attributes characterizing the service, and de Oña et al. (2012) discovered that the key factors influencing the perception of the passengers about a bus transport service are different before and after their reflection.

So, asking customers to state the importance of each service attribute can lead to erroneous estimation, because some attributes can be rated as important even though they have little influence on overall quality, or they are important only in one of the moments of the assessment (before or after thinking).

For this reason, derived importance methods, which determine the importance of the attribute by statistically testing the strength of the relationship of individual attributes with overall satisfaction, are preferred by researches because of their numerous advantages (Weinstein, 2000), although they are not very used because of their high complexity.

In the field of public transportation and based on customer satisfaction surveys, the derived importance approaches mostly used for investigating on customer satisfaction and transit service quality have been: regression analysis (e.g. Aksoy et al., 2003; Dell'Olio et al., 2010; Huse and Evangelho, 2007; Kim and Lee, 2011; Tyrinopoulos and Aifadopoulou, 2008; Tyrinopoulos and Antoniou, 2008; Weinstein, 2000) and methods based on factor analysis, as Principal Component Analysis (PCA) (e.g. Ching-Chiao et al., 2009; Chin-Shan, 2007; Kolanovic et al., 2008; Lai; 2010; Pantouvakis, 2010; Rahaman and Rahaman, 2009; Sezhian et al., 2011), Confirmatory Factor Analysis (CFA) (e.g. Changa and Chen, 2007; Yu and Lee, 2011) or Structural Equation Models (SEM) (e.g. Andreassen, 1995; Eboli and Mazzulla, 2007, 2012; Irfan et al., 2011; Karlaftis et al., 2001; Ngatia et al., 2010; Stuart et al., 2000).

SEM methodology has been widely applied in several fields of research, and in recent years it has started to be most frequently used in the field of service quality in public transport. This is because service quality is a complex, fuzzy and abstract concept (Carman, 1990; Parasuraman et al., 1985) depending on a series of observed and unobserved variables underlying it. These unobserved variables are commonly denominated dimensions. The dimensions are used for providing a better understanding of how customers perceive various service attributes, by grouping them in a factor representing the attributes similarly considered.

When these dimensions are not previously determined, statistics methods can be used to determine them. The most popular is the factor analysis, which analyses whether a large number of attributes are linearly related with a smaller number of unobserved variables. Various authors have used this methodology in their investigations in a previous step to analyse service quality by other statistics methods, such as Aksoy et al. (2003) who applied this methodology before a discriminant analysis for predicting the satisfaction in airlines; Eboli and Mazzulla (2007) who evaluated the impact of bus transit aspects on global customer satisfaction using factor analysis and SEM; or Kim and Lee (2011) and Weinstein (2000) who used a multiple linear regression technique after a factor analysis. Kim and Lee (2011) assessed the quality of domestic airlines in the South Korean, and Weinstein (2000) investigated the relative importance of service factors on the overall satisfaction of the passengers, on the rapid transit of the district of San Francisco.

Therefore, the main purpose of this study is to determine the influence of a series of characteristics describing the quality of the bus transit service on the Overall Service Quality (OSQ). Another aim of this paper is to reveal which are the unobserved latent aspects representing the main characteristics of the service, characterized by the attributes describing service quality. In this work, factor analysis was not used, and SEM approach was applied for this purpose. Four different models were proposed, and the better fitting structure was found. This is the first time that a SEM analysing SQ in PT uses two different passengers' overall evaluations about the service (before and after reflecting on the service attributes) as observed variables explaining the OSQ. Considering these two evaluations about SQ could help to better understand the OSQ concept. In Eboli and Mazzulla (2007) and Eboli and Mazzulla (2012), OSQ was measured by the only available indicator of satisfaction, and improperly by an indicator of importance. The availability of two different judgement of overall satisfaction represents a good opportunity to better measure the latent construct of OSQ. In addition, we retain that having these two different judgements can be advantageous because allows an interesting investigation on the evaluation of the overall service quality in two different moments of the interview, as we can observe in the section concerning the experimental context.
The paper is structured in five sections. Section 2 describes the methodological approach and then, in Section 3, the collected data used in the work are introduced. Section 4 follows with a discussion of the main results, and finally, in Section 5, the paper concludes displaying some conclusions about the investigation.

2. Methodology

SEM methodology is a powerful multivariate analysis technique allowing the modelling of a phenomenon in which a set of relationships between observed and unobserved variables are established. Even though it is a relatively new method began in the1970s (Fornell & Larcker, 1981), it has been widely applied in an extensive variety of research, including psychology, education, social sciences, economics, statistics, etc. SEM methodology refers to a series of statistics techniques, such as factor analysis, path analysis and regression models, used to analyse data.
SEM consist of two components, a measurement model assessing unobserved latent variables as linear functions of observed variables, and a structural model showing the direction and strengths of the relationships of the latent variables.
The basic equation of the structural model is defined as (Bollen, 1989):

$$\eta = B\eta + \Gamma\xi + \zeta \tag{1}$$

in which η is a $m \times 1$ vector of the latent endogenous variables, ξ is a $n \times 1$ vector of the latent exogenous variables, B is an $m \times m$ matrix of the coefficients associated with the latent endogenous variables, Γ is an $m \times n$ matrix of the coefficients associated with the latent exogenous variables and ζ is an $m \times 1$ vector of error terms associated with the endogenous variables.
The basic equations of the measurement model are the following:

$$x = \Lambda_x \xi + \delta \tag{2}$$

$$y = \Lambda_y \eta + \varepsilon \tag{3}$$

in which x and δ are column q-vectors related to the observed exogenous variables and errors, respectively; Λ_x is a $q \times n$ structural coefficient matrix for the effects of the latent exogenous variables on the observed variables, y and ε are column p-vectors related to

the observed endogenous variables and errors, respectively, and Λ_y is a $p \times m$ structural coefficient matrix for the effects of the latent endogenous variables on the observed ones.
There are different methods for estimating the structural equation system, such as Maximum Likelihood method (ML), Generalized Least Squares (GLS), Weighted Least Squares (WLS), and so on. All of them are based on the covariance analysis method, in which the difference between the sample covariance and the model implied covariance matrices is minimized. The ML method is the most popular, however selecting an appropriate SEM estimation method depends on different assumptions about the probability distribution, the scale properties of the variables, the complexity of the SEM, and the sample size (Golob, 2003).

3. Experimental context

This study analyses the OSQ of the Metropolitan bus transit service operating in the city of Granada (Spain). This public transport service is provided by a bus system in which 15 bus companies operate linking 32 municipalities with the centre of the city of Granada. The data used for the research come from a customer satisfaction survey conducted by the Transport Consortium of Granada in 2007. 1,200 interviews were collected through a face-to-face questionnaire proposed to the users at the bus stops.
The questionnaire was structured into two main sections. The first section gathered general information (e.g. operator, line, time of the interview, origin/destination), demographic characteristics (e.g. sex, age, occupation) and travel habits (e.g. reason for travelling, frequency of use, type of ticket, availability of a private vehicle, complementary modes used for access to/ moves from the bus stop).
The sample is characterized by a higher number of females than males (66.3% vs. 33.7%). More than half of the users are aged between 18 and 30 years old (56.1%), 34.4% between 31 and 60, and only the remaining 9.5% are older than 60 years old. Employees (37.8%) and students (31.1%) constitute more than two thirds of the sample, while pensioners, unemployed, housewives and people who are on sick leave represent the other third (31.1%). Almost half of the passengers use the service daily (46.9%), and about 38.1% take the bus with a weekly frequency. Only 15% of the sample travels occasionally. The type of ticket used by the passengers is almost equally spread between the consortium pass (48%) and the standard ticket (41.3%). Only a little part of the sample uses the senior citizen pass (6.5%) or another type of ticket (4.2%).
Concerning the purpose of the trip, passengers have different reasons for travelling. For 26.1% the main reason is reaching the work place. Another important group (19.5%) travels for studying, and 13.4% of the passengers for going to the doctor. The rest of the sample (41%) stated to travel for holidays, shopping or others personal activities. Out of all the surveyed passengers, only 38.2% could realize the trip in a private vehicle. Also information about the complementary transport modes used by passengers for accessing to/moving from the bus stop was collected. Particularly, most of the sample accesses to the bus stops on foot (78.3%), 16.0% takes the urban bus, and the rest of the sample (only 5.8%) uses other modes (e.g. their own car, motorbike, bicycle, etc). Likewise, travelling on foot is also the complementary mode mostly used for moving from the stops to the destination (94.6%), having the other transport modes a very low percentage.
The second section of the questionnaire focuses on the users' opinions about the service. This part is also divided in 3 main sub-parts: Part A, according to which passengers were asked to state the importance of each of the attributes describing the

service, Part B, referred to the perceptions about the quality of each of these attributes, and Part C, collecting a global evaluation of the service quality. This last question was asked twice during the survey: once at the beginning of the second section (Previous Evaluation) and again at the end of the questionnaire (Later Evaluation), after that the passengers reflected on the attributes describing the service.

The service attributes considered in the survey are the following: frequency of the runs (Frequency), punctuality of the runs (Punctuality), speed of the trip (Speed), proximity of the stops to/from the origin/destination (Proximity), fare of the ticket (Fare), cleanliness of the vehicle (Cleanliness), space in the vehicle (Space), temperature in the vehicle (Temperature), available information (Information), safety on board (Safety), courtesy or kindness of the personnel (Courtesy), and easiness to get on/ off the bus (Accessibility). These are the twelve attributes selected by the operators of the services.

A cardinal scale from 0 to 10 was used for measuring importance and satisfaction with the attributes and for the Later Evaluation of the overall service quality, while a five-point semantic scale (Very poor, Poor, Fair, Good and Very good) was used for the Previous Evaluation. This semantic scale was codified to a 5 point cardinal scale. Also the scales of evaluation were chosen by the operators of the services. The data used in this paper come from a non-research oriented survey carried out by bus service providers, so we have not decided the scale. However, concerning the choice to ask for a later and a previous evaluation of OSQ, we considered as very useful to ask the users for two different items (before and after reflecting on the service attributes) because the user could express an opinion about the overall service depending on certain aspects considered as the most important, but this opinion could change if the user think about the specific aspects investigated by the survey. Table 1 shows the structure of the second section of the survey, the attributes assessed, the scale used to measure the attributes, and the mean and standard deviation for the importance and satisfaction rates stated by the users.

Table 1-. Section 2 of the questionnaire

According to the importance of the attributes, the judgments of the passengers show similar and low values of the standard deviation among the attributes (<1.8), therefore, their opinions are quite homogeneous. Punctuality, Frequency and Safety obtained the highest average rate, while Information, Space and Proximity the lowest ones. However, all the attributes are considered highly important, with average values comprised on the top of the scale (between 8.60 and 9.14). Furthermore, little variation exists among these mean values (only 0.5 points of variation among all the attributes). This insufficient differentiation among the evaluations makes difficult to identify which are the key factors really affecting the OSQ.

On the contrary, the judgments of the perceptions are more heterogeneous among the users, with values of the standard deviation (higher than 1.8 and lower than 2.56) higher than the values obtained for the importance rates. The attribute judged as the most heterogeneous is Fare, which is also the attribute with the lowest average rate (6.06). The average rates of the perceptions are lower than the mean values of the importance rates. They are concentrated in a range from 6 to 8. Nonetheless, these values are quite good, because all the attributes are perceived at least with an adequate quality (>6), and some of them with a quite good quality (>7). The attributes characterized by the highest levels of quality were Courtesy, Safety and Temperature.

By observing the mean rates of the Previous and Later Evaluations, they show similar enough average values, with a value of 3.52 in the Previous Evaluation according to a 5 point scale (which is equivalent to a 7.74 in an eleven point scale) and a value of 7.07 in the Later Evaluation according to the eleven point scale. Then, users evaluate as better the OSQ when they still have not reflected on the different attributes characterizing the service.

4. Results

4.1. Specification of the Latent Constructs

SEM methodology is applied in this research to analyse OSQ for the Metropolitan bus transit service of the metropolitan area of Granada. Two different purposes are pursued. The first target is to reveal which are the unobserved latent constructs representing the main service quality aspects; these constructs are explained by a series of attributes describing the service. In order to achieve this purpose, different models were specified, and the optimal one is found. The second target tries to identify which are the aspects of the service mostly influencing the users when they decide to use the service. The model selected in the previous step is used to extract these outcomes.

The strategy followed in this analysis starts from an initial candidate model in which a set of latent aspects of the service quality is proposed. This model is re-specified in new candidate models, modifying the structure and number of latent constructs, according to the characteristics tried to be explained. At the end, the proposed candidate models are compared and the optimal one is selected. The optimal model is the one best identifying the latent constructs explained by a series of attributes describing the service.

Four different models were proposed (M1, M2, M3 and M4) revealing different unobserved latent constructs. In these models, the structure relates the exogenous latent variables (i.e. the unobserved aspects of the service represented by a series of attributes) with the endogenous latent variable (i.e. OSQ). Fourteen observed variables are used to calibrate the model. Twelve of them concern the characteristics of the service (Item1 - Item12) and the other two (Item13 - Item14) the global evaluation of the service. The Previous Evaluation (Item13) and the Later Evaluation (Item14) items are used to explain the latent endogenous variable (OSQ), while the other observed variables are combined in different ways for revealing different latent exogenous variables as unobserved aspects of the service. These models were calibrated by using the AMOS 4.0 package from Small Waters Corporation (Arbuckle and Wothke, 1995).

For comparing the initial candidate model with the others and then choosing the best one, a number of indices assessing the goodness-of-fit of SEM models were used. Hooper et al. (2008) introduce guidelines for determining model fit in which fit indices are distinguished in absolute, incremental and parsimony indices. The same authors suggest also acceptable thresholds levels for each of the described indices.

Absolute fit indices determine how well a certain model fits the sample data, and allow the model with the superior fit to be chosen. Differently from other indices, absolute indices do not rely on comparison with a baseline model. Hooper et al. (2008) include in this category the chi-squared test, the goodness of fit index (GFI) and the adjusted goodness of fit index (AGFI), the root mean square error of approximation (RMSEA), the root mean square residual (RMR) and the standardised root mean square residual (SRMR).

Incremental fit indices are a group of indices which compare the chi-square value to a baseline model for rejecting the null hypothesis that all variables are uncorrelated. The most used indices are the normed fit index (NFI) and the comparative fit index (CFI).

Parsimony fit indices are used when complex models are compared, because in these cases the estimation process depends on the sample data. Mulaik et al. (1989) have developed two parsimony fit indices: the parsimony goodness-of-fit index (PGFI) and the parsimonious normed fit index (PNFI), respectively based upon the GFI and NFI by adjusting for loss of degree freedom. No thresholds levels have been recommended for these indices; however, the authors indicate that parsimony fit indices can have a value of about 0.50 while other goodness of fit indices achieve values over 0.90. The Akaike Information Criterion (AIC) and other similar criteria based on Bayesian theory are commonly used to compare alternative models of similar dimensionality with different numbers of parameters. The model yielding the smallest value of these criteria is considered as the best one.

The descriptive fit statistics used by the authors are displayed in Table 2.

Table2-. Goodness of fit measures

In the first model (M1), three ξ latent exogenous variables are built, denominated *Service*, *Comfort* and *Others* (see Figure 1). The variable *Service* is explained by five observed variables (Item1-Item5) describing the performance of the service, such as "Frequency", "Punctuality", "Speed", "Proximity" and "Fare". *Comfort* consists of three attributes (Item6-Item8) characterizing the grade of comfort inside the vehicle, as "Cleanliness", "Space" and "Temperature". And the variable *Others* is evaluated by the rest of the attributes (Item9-Item12) not representing jointly a specific aspect of the service; the variables used to explain *Others* are "Information", "Safety", "Courtesy" and "Accessibility".

Model chi-square indicates that the magnitude of discrepancy between the sample and fitted covariance matrix is insignificant at a level of 0.05, the threshold value suggested by several authors (Mulaik et al., 1989; Golob, 2003; Hooper et al., 2008). The same authors indicate that the sample size should be greater than 200 for an acceptable model, as it is. Absolute fit indices like GFI and AGFI have values lower than the one suggested as recommended value, that is 0.90 (GFI = 0.84, AGFI = 0.77); also RMSEA should be a value from 0.08 to 0.10 for a good fit, while the value of the index is 0.13. Incremental fit indices have comparable values (NFI = 0.64 and CFI = 0.65); also in this case a value closer to 1 indicate a good fit. These statistics assume that all the latent variables are uncorrelated (null or independence model), and compare the sample covariance matrix with this null model. In the specific case proposed by the author, SEM was introduced for analysing the relationship among latent variables all representing very similar characteristics of a transit service, although each latent variable is linked to service attributes describing different features of the same service. Therefore, we retain that a similar result is expectable enough. Parsimony fit indices, PGFI and PNFI, have value around 0.5, consistent with the statement expressed by Mulaik et al. (1989).

Figure 1-. Model 1

In the second model (M2), the observed variable "Accessibility" is used to explain the latent construct *Comfort* instead of the construct *Others*. The reason is that "Accessibility" refers to the easiness to get on to or get off from the bus, and therefore, it can be considered by the passengers as an aspect representing their comfort in the access to the vehicle. This model has the same three ξ latent exogenous variables used in M1 (*Service, Comfort* and *Others*), but in this case, the observed variable "Accessibility" is removed from the latent construct *Others*, and incorporated to explain the latent construct *Comfort.* The fit indices in this second model are better, with higher values of GFI, AGFI and CFI, and lower values of the RMSEA. In addition, by considering the lower values of RMR and AIC index, we can retain the model as better than the previous one. This demonstrates that "Accessibility" better explains the *Comfort* latent variable than *Others*.

In Model 3 (M3) four ξ latent exogenous variables were proposed. These variables are named *Service*, *Access, Comfort* and *Others*. *Service* describes the performance of the service using four observed variables ("Frequency", "Punctuality", "Speed" and "Fare"). *Access* variable contains two attributes describing two different moments in the access to or exit from the service: the first one is "Proximity" (expressing the distance which a passenger should travel to reach or leave the service, distance from the origin to the bus stop or from the bus stop to the destination) and the second one is "Accessibility" (representing the last step in the access to the service, getting on to the vehicle, or the first step in the exit, getting off from the vehicle). *Comfort* considers the same observed variables as in M1 ("Cleanliness", "Space" and "Temperature"), and *Others* comprises "Information", "Safety" and "Courtesy". The results of the fit indices in this model are worse than in the previous ones (M1 and M2), reaching high values of the AIC criteria (1,922.90), RMR (0.99) and the RMSEA index (0.14). The other fit indices (GFI, AGFI and CFI) are also minor than in M1 and M2. For this reason, the variable *Access* is rejected as a latent construct of the model.

The last Model (M4) introduces three ξ latent exogenous variables named *Service*, *Comfort* and *Personnel* (Figure 2). This model combines the observed exogenous variables related with the staff in a new latent construct denominated *Personnel*. This latent variable is explained by two attributes related to the behaviour of the personnel involved in the service, as is "Safety" (related to the driver's behaviour) and "Courtesy" (as the kindness of the personnel). The construct *Service* is defined as in M1 but considers also the attribute "Information" as an observed variable of this construct. And finally *Comfort* is considered equal than in M2, because it was previously proved that this latent aspect was better explained when the attribute "Accessibility" takes part of its measurement model. The descriptive fit statistics for this model are the best among all the candidate models (GFI = 0.86, AGFI = 0.80, CFI = 0.71, RMSEA = 0.12, AIC= 1,404.93). Each statistic can be commented with the same observations made for the model M1. In order to justify the values obtained for the goodness-of-fit indices, we can consider that when we adopt the structural equation modelling approach it is not uncommon to find that the fit of a proposed model is poor (Hooper et al., 2008). In addition, we can think that the concept of service quality is complex, fuzzy and abstract because of three properties of service: intangibility, heterogeneity and inseparability (Parasuraman et al., 1985). The relationship between service quality and satisfaction is not clear in the literature, due the similar nature of the two variables. In this context, we seek to explain this relationship by using measures of customer perception about service quality. It should also considered that an improvement of the model fit could be obtained by reducing the number of parameters, and then the number of the observed variables explaining the exogenous latent variables. However, we have retained to not exclude any measured indicators from the analysis. Definitively, assuming the complexity of the phenomenon, we retain that the statistical results of the obtained model can be considered anyway satisfactory, despite the acceptable thresholds suggested in the literature for having a good model.

Figure 2-. Model 4

Then, M4 is the selected optimal model best identifying the unobserved latent aspects of the service. This model comprises three ξ latent exogenous variables (*Service*, *Comfort* and *Personnel*) influencing OSQ. In the next section, the aspects of the service mostly affecting the perception of the users about OSQ are revealed.

4.2.Influence of the service aspects on the OSQ

The results of the selected model (M4) are displayed in Table 3 and Table 4. Table 3 shows the relationships among the latent and observed variables participating in the Measurement model, while Table 4 shows the relationships among the latent variables of the Structural model. In the first and second column of the tables, the variables of the model are shown, while from the second column to the sixth column different statistics of these relationships are shown: the Regression Weights (R.W.), the Standard Error (S.E.), the Probability level (P) and the values of the Standardized Regression Weights (Std. R.W.). The regression weights were obtained by solving a system of 15 equations (12 equations relating to the x exogenous variables, 2 equations to the y endogenous variables and 1 equation relating to the η latent endogenous variable).

Concerning the Measurement model, all the parameters assume a value statistically different from zero at a good level of significance ($P<0.05$). Most of the regression weights are all reasonably high (standardized regression weights over 0.5). Only two of them obtained a lower value. By observing the relationships among the latent exogenous variables and their observed indicators, some interesting results can be highlighted. The latent variable *Service* is better explained by "Speed" (0.659), "Frequency" (0.615), "Punctuality" (0.591) and "Information" (0.579), while "Proximity" and "Fare" have a minor effect on this variable (0.429 and 0.483, respectively). The variable *Comfort* is best understood by the "Temperature" and "Space" on board (0.665 and 0.663), and for *Personnel* the strongest relationship is found with "Safety" in relation to the driver behaviour (0.632).

Table3-. Measurement Model

The endogenous latent variable is well explained by the two observed variables, which obtained high values of the standardized regressions weights. The effect of the "Later Evaluation" (0.778) is higher than the "Previous evaluation" (0.568), suggesting that OSQ is better explained by a judgement given when a passenger has reflected on the characteristics describing the service.

Table4-. Structural Model

The parameters of the Structural model also assume values statistically different from zero. In this case, the strength of the relationship among the latent exogenous variables and OSQ are very different. The exogenous latent variable having the highest positive effect on OSQ is *Service,* with a value of the standard regression weight of 0.823. The other two exogenous latent variables have little effect on OSQ, with a value of 0.253 for Personnel and 0.172 for Comfort. It is important to highlight that the effect of the *Personnel* aspect is higher than the effect of *Comfort.*

5. Conclusions

This research demonstrated that SEM methodology is a powerful tool which can be used as an alternative technique to find out which are the latent aspects that are hidden under a series of attributes describing the quality of the service. We retain that this kind of methodology is very useful for analysing service quality but it's difficult to establish if this tool is better than other methodologies. However, the authors have chosen the SEM methodology because they retain it as appropriate for describing a complex phenomenon like transit passenger perception of the used service. SEM is a technique which can be considered as similar to the regression modelling but more advanced, in fact it permits to introduce latent constructs really appearing in such a phenomenon where there are some latent factors due to the subjectivity of users' perceptions and the variety of the service attributes characterizing a transit service.

After the building of four different models, the best structure of the latent variables was found, and three latent constructs were identified as the main characteristics explaining OSQ. These latent constructs were *Service* (linked to the attributes explaining the performance of the service), *Comfor*t (linked to the attributes influencing comfort in the travel experience) and *Personnel* (linked to the attributes related to the behaviour of the staff).

Furthermore, it was proved that this methodology is appropriate for modelling OSQ in the bus transit service, and for determining the variables which play an important role in passengers' perceptions about the service quality. As an example, the results of the final model (M4) discovered that *Service* is the exogenous latent variable with the major influence on OSQ, being Frequency and Speed the observed variables better explaining this construct, and Proximity and Fare the variables with the lowest weight. On the other hand, a low impact of *Comfort* and *Personnel* on OSQ was deduced. However, passengers are more worried about the personnel behaviour (related with safety and courtesy) than about aspects providing comfort to their trip. It is important to emphasize that although these latent variables are not important as the *Service* construct, they have a decisive role in the global perception of Service Quality anyway; for this reason, planners and managers of PT should not forget about them when they formulate measures for promoting the use of the public transport.

Another important point of this work is to know which global evaluation about the service better explains the OSQ latent construct. The relationship between these observed variables and the latent construct show that the two indicators are adequate for explaining OSQ; however, the Later Evaluation shows a wider explication of OSQ.

The resulting model structure provides valuable information for understanding which are the aspects of the service mostly influencing passengers when they are going to use the service. This information can help transport managers to prepare new strategies and investment plans in order to continually improve the quality perceived by passengers, and consequently the use of the system. Also transit operators can use the findings to attract new passengers and retain the current ones. As an example, considering the results obtained from the final model selected in this work, the operators should improve the service by focusing on improving aspects such as service frequency and speed, because they are considered as the most important for the users, giving a considerable increase to the overall satisfaction of the users and therefore to the overall service quality.

Finally we would like to point out that the data used in this paper come from a customer satisfaction survey that was a non-research oriented survey. A rather simple statistical frequency analysis was the main target. However, the application of more advanced modelling techniques proves that this kind of data can be used to reveal very interesting details for managers and public transport operators and it could increase the collaboration between researchers and the industry.

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-. Section 2 of the questionnaire

Parts	Variables		Mean	Std. Deviation	Scale	
A. Importance of the attributes	Item1	Frequency	9.03	1.54	0 to10	Card scale
	Item2	Punctuality	9.14	1.44	0 to10	Card scale
	Item3	Speed	8.72	1.70	0 to10	Card scale
	Item4	Proximity	8.68	1.77	0 to10	Card scale
	Item5	Fare	8.72	1.80	0 to10	Card scale
	Item6	Cleanliness	8.85	1.47	0 to10	Card scale
	Item7	Space	8.66	1.71	0 to10	Card scale
	Item8	Temperature	8.71	1.62	0 to10	Card scale
	Item9	Information	8.60	1.72	0 to10	Card scale
	Item10	Safety	8.98	1.52	0 to10	Card scale
	Item11	Courtesy	8.74	1.75	0 to10	Card scale
	Item12	Accessibility	8.85	1.78	0 to10	Card scale
B. Satisfaction with the attributes	Item1	Frequency	6.80	2.53	0 to10	Card scale
	Item2	Punctuality	7.28	2.30	0 to10	Card scale
	Item3	Speed	7.23	1.95	0 to10	Card scale
	Item4	Proximity	7.34	2.17	0 to10	Card scale
	Item5	Fare	6.06	2.56	0 to10	Card scale
	Item6	Cleanliness	7.43	1.81	0 to10	Card scale
	Item7	Space	7.14	2.01	0 to10	Card scale
	Item8	Temperature	7.37	1.95	0 to10	Card scale
	Item9	Information	6.62	2.42	0 to10	Card scale
	Item10	Safety	7.65	1.96	0 to10	Card scale
	Item11	Courtesy	7.94	1.80	0 to10	Card scale
	Item12	Accessibility	6.75	2.44	0 to10	Card scale
C. Overall SQ	Item13	Previous Evaluation	3.52	0.83	5 point	Sem scale
	Item14	Later Evaluation	7.07	1.58	0 to10	Card scale

Table2-. Goodness of fit measures

Fit indices	M1	M2	M3	M4
Degree of freedom	74	74	73	74
Sample of size	1,200	1,200	1,200	1,200
Number of parameters	31	31	32	31
Absolute fit indices				
GFI	0.84	0.85	0.80	0.86
AGFI	0.77	0.78	0.71	0.80
RMSEA	0.13	0.13	0.14	0.12
RMR	0.94	0.92	0.99	0.84
Incremental fit indices				
NFI	0.64	0.68	0.59	0.70
CFI	0.65	0.68	0.60	0.71
Parsimony fit indices				
PGFI	0.59	0.60	0.56	0.60
PNFI	0.52	0.54	0.47	0.57
AIC	1,691.33	1,564.27	1,922.90	1,404.93

Table3-. Measurement Model

Latent Variable		*Observed Variable*		R.W.	S.E.	P	st. R.W.
Exogenous variable							
ξ_1	Service	x_1	Frequency (Item1)	1,668	0,136	0.000	0,615
		x_2	Punctuality (Item2)	1,459	0,121	0.000	0,591
		x_3	Speed (Item3)	1,379	0,110	0.000	0,659
		x_4	Proximity (Item4)	1.000	-	-	0,429
		x_5	Fare (Item5)	1,328	0,122	0.000	0,483
		x_6	Information (Item9)	1,504	0,126	0.000	0,579
ξ_2	Comfort	x_7	Cleanliness (Item6)	0,810	0,068	0.000	0,549
		x_8	Space (Item7)	1,083	0,085	0.000	0,663
		x_9	Temperature (Item8)	0,085	0,083	0.000	0,665
		x_{10}	Accessibility (Item12)	1.000	-	-	0,504
ξ_3	Personnel	x_{11}	Safety (Item10)	1,245	0,273	0.000	0,632
		x_{12}	Courtesy (Item11)	1,000	-	-	0,552
Endogenous variable							
η_1	Overall Service	y_1	Previous Evaluation (Item13)	1,000	-	-	0,568
	Quality	y_2	Later Evaluation (Item14)	2,506	0,161	0.000	0,778

Table4-. Structural Model

Latent Variable		*Latent Variable*		R.W.	S.E.	P	st. R.W.
Endogenous variable		**Exogenous variable**					
η_1	Overall Service Quality	ξ_1	Service	0.400	0.037	0.000	0.823
		ξ_2	Comfort	0.064	0.013	0.000	0.172
		ξ_3	Personnel	0.115	0.022	0.000	0.253

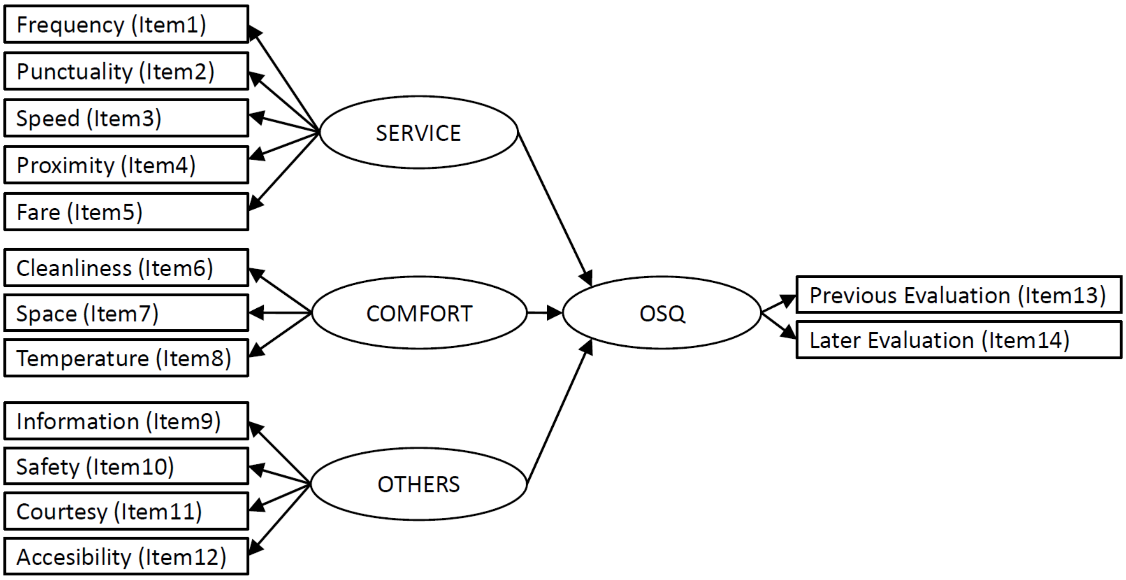

Figure 1-. Model 1

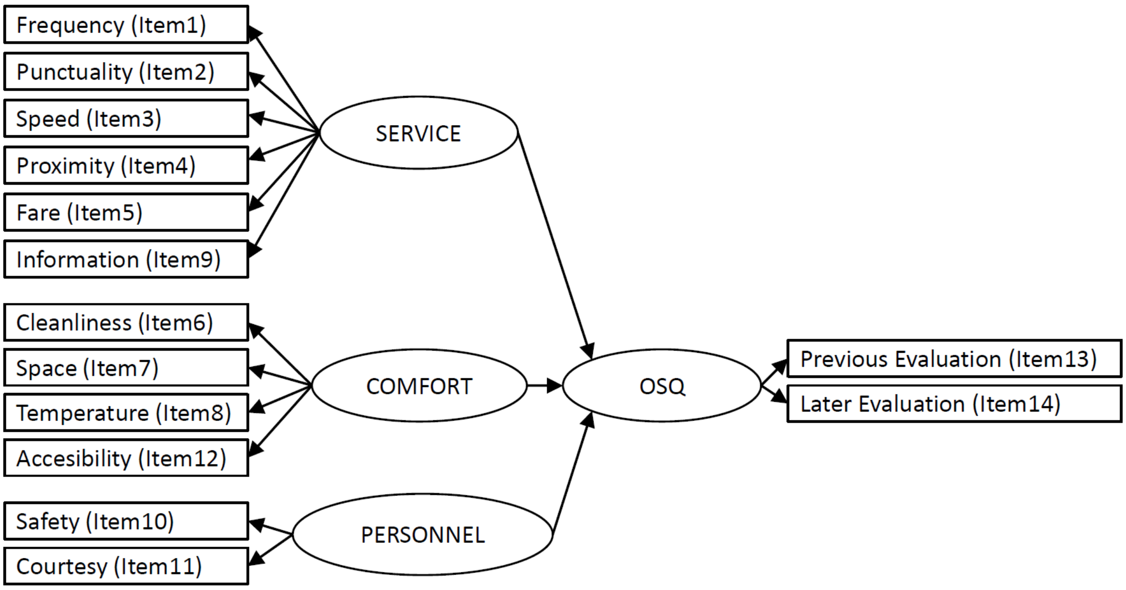

Figure 2-. Model 4