Transport Policy xxx (xxxx) xxx–xxx

Contents lists available at ScienceDirect

Transport Policy

journal homepage: www.elsevier.com/locate/tranpol

Route effect on the perception of public transport services quality

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ARTICLE INFO

Keywords:
Quality
Transport service
Logit multilevel model
Nonlinear principal component analysis
Bus lines
Satisfaction

ABSTRACT

User satisfaction is a key indicator of public service quality, especially for those services considered basic necessities. The conceptualization and measurement of transport service quality—a fundamental determinant of demand—poses challenges for conducting economic analyses and designing mobility policies.

Several operating companies are involved in the transport sector. In this paper, the bus network of the metropolitan area of Granada, Spain, is taken as a case study. The aim is to design a model of overall satisfaction based on level of satisfaction using a specific set of factors that take into account the individual characteristics of users and the differential effect of using different bus lines.

A combined method using nonlinear principal component analysis (NLPCA) and a logit multilevel model (LMLM) in two steps is applied to a satisfaction survey conducted by the Metropolitan Transport Consortium of Granada (Consorcio de Transporte Metropolitano del área de Granada) in 2013. The survey shows that even though customers within the metropolitan area of Granada are satisfied with the service received (67.26%), the level of satisfaction is not equal for all bus lines, with the perceived quality of some lines being above or below the average. This differential effect is due to different reasons, including the technical and functional performance of the operating companies, commercial speed and length and type of route, among others. Both the operators and the public administration need to focus their attention on these lines in order to design economic policy measures to improve bus lines with below standard compliance.

1. Introduction and literature review

In order to create a new model of mobility and travel in more sustainable ways, city dwellers must modify their usual behaviour, especially within metropolitan areas (Miralles Guasch, 2002; Lizárraga, 2006). As regards public transport, significant changes are needed which cannot be achieved only by improving the efficiency of vehicle design and traffic management. Changes must also be made in the way transport is considered and how solutions are identified and evaluated (Litman, 2003).

The aim of this study is to provide a design model to determine the perceived quality of the public transport service of the metropolitan area of Granada, Spain. To this end, a satisfaction survey of the bus network conducted in 2013 by the Metropolitan Transport Consortium of Granada was used as a case study. It is important to note that the interurban transport service of Granada is heterogeneous because it is managed by several operators with different lines or routes which provide service to fifty-two towns.

The measurement and conceptualization of public transport quality is one of the greatest challenges of economic analyses and mobility policies given the importance of such data for both the companies that provide these services and the public administration (Román et al., 2014). Quality of service, as well as transport fares, price of petrol, personal disposable income, unemployment rates and vehicle ownership, have been considered essential factors that determine public transport demand (Paulley et al., 2006; Holmgren, 2007; Cordera et al., 2015). Public policies aimed at promoting the use of public transport as a means to reduce traffic jams and pollution must create a more appealing image focused on markets in order to make the this type of transport more competitive than private vehicles (Beirão and Cabral, 2007: 478; dell'Olio et al., 2010: 388).

The study of public transport quality forms part of the field of service quality; an ambiguous concept at the crossroads of a wide range of attributes (Grönroos, 1984; Parasuraman et al., 1985; Hensher et al., 2003; Paulley et al., 2006; Beirão and Cabral, 2007; de Oña et al., 2016). For this reason, it opens up and interesting field of research with practical implications for transport suppliers and authorities.

The concept and method of measuring quality have evolved since

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http://dx.doi.org/10.1016/j.tranpol.2017.03.024
Received 25 July 2016; Received in revised form 1 March 2017; Accepted 30 March 2017

marketing began to study goods and services from a different approach. As regards the methods used to measure quality, Grönroos (1984) and Parasuraman et al. (1985) designed service quality models based on the correlation between expected performance and the subjective perception of the product. This approach permits identifying three characteristics of the service analysed here: the intangibility of some service components, the material and temporal heterogeneity in the delivery and reception of the service, and the inseparability of service production and consumption (Parasuraman et al., 1985: 42).

In public transport, tangibles coincide with the technical dimensions of Grönroos' service quality model (facilities, infrastructures, vehicles and staff training). However, intangible aspects are rather difficult to measure since they depend on subjective opinions such as safety, room temperature, drivers' attitude and cleanliness, among others. Unlike the evaluation of the quality of durable goods, the fact that the service (i.e. the displacement of a person between two points in a public transport vehicle) is provided, received and consumed immediately and simultaneously with other users (Grönroos, 1984: 39) implies that close attention should be given to the process of providing and receiving the service (Parasuraman et al., 1985: 42).

Public transport delivery and reception are not uniform; they vary from one day to another, from one operating company to another, from one route to another and even from one vehicle to another. This heterogeneity is due to the transport system organization and the diversity in the performance of each operating company due to material endowment (Grönroos, 1984) and to the attitude and competence of its staff. All these specific characteristics of the transport sector make the complete standardization of services impossible.

The functional quality dimension takes into account the process by which technical components are transferred to the public as a substantial feature. However, because services are produced in interaction with consumers, the technical dimension of quality does not on its own account for the perception of users. Public transport may be considered as a "high contact service" (Parasuraman et al., 1985: 43) in which the relationships between users and staff are very frequent and continuous. Both dimensions, "what is obtained by a service user" and "how it is obtained", are consumed and perceived simultaneously but differently depending on the individual. Perceived quality is determined by comparing the perceived service—a combination of functional and technical dimensions—with the expected service (Grönroos, 1984: 39).[1]

2. Methodology

Level of overall satisfaction is an aggregate measure of how to perceive satisfaction with different aspects of the transport system. Overall aggregate satisfaction, which is referred to here as "quality", is satisfaction with a specific set of features of the system. Satisfaction with specific features of the transportation system may be called "specific satisfactions" (del Castillo and Benitez, 2013). Specific satisfactions can be measured by ordinal categorical variables. The level of specific satisfaction is an example of a phenomenon which cannot be objectively measured but can be evaluated using ordinal variables (Ferrari et al., 2011).

Different methods have been used to study level of satisfaction with public services. A review of these methods can be found in Ferrari and Manzi (2014). According to the authors, the most widely used methods are logit, probit and lineal regression. Nevertheless, other methods such as principal component analysis (PCA) have been used to build synthetic measures of satisfaction for different services. The logit and probit models aim to explain service satisfaction, which is measured as a binary variable from a set of explanatory variables. Jilke and Van de Walle (2013), for instance, evaluated the existence of claims in different public services according to a set of socio-economic factors, while Fiorio et al. (2013) studied satisfaction with public transportation using four sets of explanatory variables (demographic, city-specific aggregate, travel and transportation).

Multilevel models (MLM) are another method that is used to study level of satisfaction. Borra and Chiavarini (2005) fit an ordered logit multilevel model with random intercept to explain the quality of public transport in Rome. The authors showed that quality does not depend only on a set of fixed factors, but also on contextual indicators concerning the demographic and environmental features of the municipality in which citizens live. Ji and Gao (2010) also used an ordered logit multilevel model to evaluate satisfaction with public transport in Beijing. They found that the number of bus stops, the access to the main places of the city, as well as people's socio-economic attributes have a significant effect on residents' satisfaction with public transportation.

In this study, we use a method that combines nonlinear principal component analysis (NLPCA) and a logit multilevel model (LMLM) in two steps. The aim is to explain the quality of service (binary variable) as a function of a set of explanatory variables. In a first step, NLPCA is used because the specific satisfaction variables are ordinal categorical. These variables should not be used directly as explanatory variables in the regression model because the marginal effect is not the same for all the values of these categorical variables. We are also interested in measuring users' satisfaction by reducing the observed multi-dimensional variables into a lower number of numerical variables. In a second step, LMLM is used to model the binary nature of the dependent variable, which depends on the effect that the synthetic variables obtained with NLPCA and other visible variables have on overall satisfaction with the interurban bus transport service in the metropolitan area of Granada. In addition, we attempt to analyse the differential effect of the bus route used by travellers on their perception of quality.

2.1. Nonlinear principal component analysis (NLPCA)

Ferrari et al. (2011) used a combination of two methods in two steps: NLPCA and MLM. In the first step, they used NLPCA to build a synthetic indicator (dependent variable) of overall satisfaction based on four relevant public services: landline telephone, electricity supply, postal service and rail service. In a second step, they used an MLM with random intercept to explain the synthetic indicator through a set of socio-economic variables (gender, age, income, etc.). The MLM included these sets of socio-economic variables, as well as the presence of random effects caused by variability among citizens and across countries.

NLPCA or categorical PCA is an optimal scaling method which belongs to non-linear multivariate analysis techniques. Although the aim of NLPCA is similar to that of the standard PCA, NLPCA allows scaling variables at different levels of measurement and identifying the nonlinear relationships among them. When information needs to be synthesized from a pack of numerical variables into a small set of components, standard PCA is a suitable method. However, when operating with mixed measurement levels (nominal, ordinal, and numerical variables), NLPCA is more appropriate (Ferrari and Manzi, 2014; Linting et al., 2007). Gifi (1990) provides a comprehensive explanation of nonlinear multivariate methods based on optimal scaling.[2]

Several methods can be used to select the number of factors, components and dimensions (Jackson, 1993). One of the most widely used methods consists in reducing an initially large number of dimensions using the Kaiser-Guttman criterion, which permits retain-

[1] Grönroos includes corporate image, that is, the perception consumers have of the company, as the third dimension of his quality model.

[2] An introduction to this method can be found in Linting et al. (2007).