Assessing the passengers' perception of implemented advanced management measures in bus service

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ABSTRACT

The provision of high quality bus services is vital for improving the image of bus systems, increasing its attractiveness and attracting people out of their cars. In recent years the use of ITS in public transport has been widely extended in order to reduce the uncertainty of passengers, and to improve the reliability and punctuality of the bus services. In the frame of an European Research Project (EBSF – European Bus System of the Future), some advanced management measures were implemented in the Madrid bus system.

The aim of this investigation is to evaluate the passenger's perception of some attributes related to quality of bus services, and how this perception changes with the implementation of different measures. Surveys to passengers riding different bus lines were conducted in two scenarios: before the implementation of the measures and after the measures were implemented. The results of the passenger surveys were statistically analysed; then, an ordered logit model was used to analyse the differences between surveys thanks to the implemented measures. Finally, a factor analysis was done to identify the underlying unobserved factors (latent variables) that the respondents perceived.

The findings reveal that there is a general improvement in the passengers' perception of the overall satisfaction of the bus service, specially the attribute "getting information while travelling", showing that the implementation of multimodal real-time passenger information measures in bus services is a way to improve the satisfaction of passengers, thus attracting further users.

1. INTRODUCTION

Many researchers have investigated the importance of understanding the consumers' perceptions of the quality of service provided. Quality of service reflects the passenger's perception of transit performance and it depends to a great extent on the operating decisions made by a transit system within the constraints of its budget, particularly decisions on where transit service should be provided, how often and how long it is provided, and the kind of service that is provided (TRB, 2003). The need to maintain market share and increase profitability is the main driving force to improve quality in a transit service (Pullen, 1993). This is why it is very important to study the perception that passengers have about a transit service. But the improvement of service quality cannot be successful without accurately assessing customers' quality perceptions (Cunningham et al., 2000). On the other hand, satisfaction is an overall affective response to a perceived discrepancy between prior expectations and perceived performance after consumption (Lai et al., 2011). Tyrinopoulous and Antoniou (2008) define customer satisfaction as the overall level of attainment of a customer's expectations, measured as the percentage of the customer expectations, which have actually been fulfilled. They conclude that the analysis of the variability of user's level of satisfaction from the use of transit systems may provide useful insight about the strengths and weakness of a given transit service, and recognize qualitative attributes that need special attention. In practice, service quality and satisfaction are often used interchangeably, but differences between service quality and customer satisfaction are also clarified in the literature. Oliver (1997) suggests that service quality judgments are more specific, and related to cognitive judgments, while customer satisfaction judgments are more holistic, and associated with affective judgments.

Past studies have shown evidence that customer satisfaction significantly affects customer loyalty and behaviour intentions in public transit services (Joewono and Kubota, 2007 and Nathanail, 2008). In fact, the way that an agency provides service to its customer has ridership implications (TRB, 2003). It means that is very important to determine the factors influencing the passenger satisfaction of a transit service in order to improve the supplied service quality for attracting further users.

The European Bus System of the Future (EBSF) project, from the EU R&D Seventh Framework Program, was launched in order to increase the attractiveness and raise the image of the bus systems in urban areas. The EBSF project was conceived in order to design and validate a new ground-breaking generation of bus systems which will stimulate European cities to improve their existing services and make public transport more attractive (EBSF, 2008). A number of measures were implemented within this project and tested in several use cases (UC). One of these UC was Madrid, in which multimodal real-time information measures were implemented in some metropolitan bus lines.

The aim of this study is to evaluate the passenger satisfaction and perception of the

measures implemented in Madrid. The paper will analyse the factors influencing the quality of bus service perceived by the passengers and how this perception changes with the implementation of different measures. It will be done by using the results of the passenger surveys conducted in two scenarios: before the implementation of the measures and once the measures have been implemented.

The satisfaction of public transport users has been widely investigated for a long time. Different techniques are used for investigating on customer satisfaction and transit service quality. Lai and Chen (2011) study the behavioural intentions and explore the relationships between passenger behavioural intentions and the various factors that affect them through a structural equation model (SEM). This method has also been used in other studies (De Oña et al, 2013; Joewono et al, 2012; Lai and Chen, 2011; Chen, 2008; Eboli and Mazzulla, 2007, 2012; Karlaftis et al. 2001). Some other authors have used factor analysis (FA) techniques, as Principal Component Analysis (PCA), in order to determine the underlying unobserved factors perceived by passengers (Lai and Chen, 2011; Tyrinopoulos and Antonious, 2008; Krizek and El-Geneidy, 2007; Stradling et al., 2007). Joewono and Kubota (2007) measured the service quality of Indonesian paratransit systems by using path analysis technique. They explored user-perceived service quality and overall satisfaction with the paratransit service in order to make forecasts with regard to competition from motor vehicles in Bandung, Indonesia. The results showed that service quality has positive effects on both overall satisfaction and customer loyalty, and overall satisfaction has a positive impact on customer loyalty. Other authors have used multicriteria techniques for evaluating the impacts of some measures implemented in transport systems (Cascajo, 2004; Monzon et al, 2013; Cascajo and Monzon, 2014) or for estimating an overall performance index for the quality of services provided by a transit operator (Nathanail, 2008). The use of the ordered logit model (or proportional odds method) has been found in Saxe et al (2007) and in Tyrinopoulos and Antonious (2008). Qualitative methods, based on in-depth interviews, are used for allowing a better understanding of people's attitudes and perceptions towards transport (see Beirao et al, 2007; Clifton and Handy, 2003; Guiver, 2007; Jensen, 1999). Other statistical techniques have been also proposed in other studies (Deng and Nelson, 2012).

In spite of this wide range of investigations, the assessment of the changes in passengers' perception of the service performance due to concrete measures has not been dealt too much. Saxe et al (2007) analyse the changes in attitudes among passengers towards the fuel cell bus and the hydrogen technology implemented in some buses in Stockholm. They compare the results of two surveys conducted to passengers: the first one was performed once the measures were implemented and the second one when the buses were operating on a regular route for one year. They apply the proportional odds method to indicate differences in the full scale (1-7) distribution between the two surveys. In addition, a one-tail test of hypothesis for proportions of the answers on a reduced scale is conducted, which make easier the detection of differences between the two surveys. Wall and Mc

Donald (2007) assess passenger's views to a package of measures designed to improve bus service quality and information on three city centre bus services in Winchester. Results of the surveys conducted before and after the implementation of the measures show that there is an increase in passenger bus use: the percentage of new users is 8% in route X1 and 12% in route X5; and the percentage of passengers that use more the bus services since the changes were introduced is 10% in route X1 and 19% in route X5. The three attributes that most positive influence new users and more frequent users to encourage their use are the frequency of the service, the comfort of travel on the new buses and the information provided to travellers.

2. A CASE STUDY: MADRID METROPOLITAN BUS SYSTEM

Madrid Region is one of 17 autonomous communities existing in Spain, composed by 179 municipalities, with a population of 6.5 million inhabitants in an area of 8,028 km^2. The Region has a very good public transport offer coordinated by the Madrid Public Transport Authority. The public transport system in the region of Madrid consists of five modes:

- Two urban modes in the city of Madrid: metro and urban bus (EMT)
- Three metropolitan modes in the region: bus, light rail and commuter railways (Cercanías)
- 5 main intermodal hubs connecting these modes

The case study is the A-6 corridor, where some 565,808 people live (data 2009). It is located in Madrid Region Northwest sector and one of the main radial accesses to the City of Madrid. It has experienced a consistent population growth over the last years (65% from 1996 to 2009). It also has a number of other characteristics like its high environmental standards, lower housing density (540 inhabitants/km^2), higher motorization rates (700 vehicles/1,000 inhabitants) and higher income-level than the rest of the Region. For this reason it was selected to test measures to foster higher public transport patronage. Within the EBSF project a number of measures were implemented in some bus lines along this corridor, between the city of Madrid and Majadahonda, a town located 18 km west of Madrid centre. A good offer of metropolitan buses serves the capital relationships and communicates it with the nearby municipalities. Six bus lines connect Majadahonda with the Moncloa interchange, located in Madrid. Five of them -651, 652, 653, 654 and 655- use a HOV (high occupancy vehicle) lane and one, 651A, not using it. The demand in these bus lines a labour day is about 30,000 passengers (more than 50% of the total PT users for Majadahonda).

The main objective of the measures implemented was to provide with multimodal real-time information to the users. It is widely accepted that travellers significantly value the information provided from transit services (Syed and Khan, 2000). Moreover, the value of this information is higher for commuting, special event trips, and when there is heavy congestion (Littman, 2008). In recent times, the use of Intelligent Transport Systems (ITS)

has become very popular for providing real time passenger information (RTPI) both at bus stops and on board buses. RTPI offers significant benefits to PT users, present and potential, by providing a wide spectrum of information (Monzón et al, 2013). According to Litman (2008), real-time transit vehicle arrival signs reduce perceived wait times by approximately 20 percent. These signs also reduce unit costs of the time spent waiting because passengers experience less stress and are better able to organize their trips. Several studies have dealt with the benefits provided by RTPI systems to PT users (Lappin, 2000; Turnbull and Pratt 2003; Tang & Thakuriah, 2012) concluding that the majority of users are quite satisfied with them.

Due to the fact that real-time transit information systems can increase transit ridership levels and improve customer satisfaction, the Madrid Public Transport Authority decided to implement such kind of measures in some metropolitan bus lines in the A-6 corridor. The measures provide multimodal, real-time passenger information (including buses, trains and traffic) along the corridor, on board the vehicles, at stops and at interchange stations via SMS messaging or the web, Bluetooth and displays (EBSF, 2012). To this end, 40 existing buses from the above mentioned six bus lines were equipped with an Advanced Vehicle Management System (AVMS) and radio frequency system to ensure underground vehicle location inside the interchange station where the route ends, including on-board screens and an audio information system. Moreover, four time-information displays and Bluetooth devises were also implemented at some bus stops in Majadahonda, and one screen at the Moncloa transport interchange to provide information on forthcoming departures and breakdowns or delays. The back office consisted in a multimodal integrator centre in which there was integration with highway information, with suburban railway information and incidents information. The test took place between October 2011 and March 2012 (6 months).

3. METHODOLOGY

3.1 Research method

Within the EBSF project, it was designed a questionnaire survey in order to collect empirical data from bus passengers in two scenarios: before the implementation of the measures and once the measures have been implemented. The results are used for evaluating the passenger satisfaction and perception of the measures implemented in some metropolitan bus lines in Madrid. The paper will also analyse the factors influencing the quality of bus service perceived by the passengers and how this perception changes with the implementation of different measures.

3.2 Survey design

The questionnaire is structured in three parts:

- Part 1) concerns respondents' trip information. They were asked to indicate the travel frequency and type of ticket used.

- Part 2) includes questions about passengers' perceptions. They were asked to provide their satisfaction to some attributes, based on a six-point Lickert scale ranging from very satisfied (6) to very unsatisfied (1). The attributes included in this part were related to quality of service (QoS). They are listed and described in Table 1. Passengers were also asked to rate the overall satisfaction with the general service of the bus line.
- Part 3) concerns customers' profile. Respondents were asked to provide socio-economic information including gender, age-range, education, occupation, personal income and whether they have a car alternative.

Table 1 – QoS attributes included in the passengers' perception survey (part 2)

Attribute	Description
Waiting time	Waiting time at bus stops
Operating hours	Bus service operating hours
Intermodality	Bus service integration with other lines or other public transport modes
Reliability	Fulfilment of schedules
Ease of paying fare	Easiness of paying fare during the trip (on board or at bus stop)
Quality of bus stops	Overall quality of bus stops (shelter, seats, lighting)
Get information	Possibility to get trip information while travelling
Frequency	Service frequency

The survey was conducted to a sample of bus users of six bus lines in Madrid, during a working day, in two scenarios: before the implementation of the measures (February-April 2011) and once they were implemented (February 2012). The sample size of the survey was 2,122 for the first wave and 2,234 in the second one. It was a face to face 15-minute questionnaire, so interviewers in some cases collected the data at bus stops but in other cases they had to go with the interviewee in his bus journey. Prior to data collection, a pilot survey was carried out to test the effectiveness and understanding of the questionnaire, on 22 July 2009. A total of 30 answers were collected from 33 passengers randomly chosen. The initial questionnaire was refined and finalised based on the feedback from passengers and consultation with transport surveys professionals.

4. ANALYSIS AND DISCUSSION

The outcome of a Likert scale is ordinal data. The Likert scales are convenient and often used for surveys but the statistical analysis must be different from those with nominal data (Saxe et al., 2007).

4.1. Respondent characteristics

Tables 2 and 3 provide the main characteristics, trip-related and socio-economic, respectively, of the respondents to the two surveys conducted to bus passengers in the A-6 corridor of Madrid. According to the structure of the questionnaire, Table 2 presents the results of Part 1 of the survey and Table 2 presents the results of Part 3 of the survey.

In Table 2 it can be seen that both the frequency of travelling by bus and the ticket used in the trip is similar in the two surveys: most respondents use the bus daily (63%) while a small percentage (less than 7%) use the bus once a week, and less frequently (around 13%); it is consistent with the ticket used (66-68% uses monthly pass, which indicates that the majority of respondents are regular bus users).

Table 2 – Travel-related characteristics of the respondents

Travel-related characteristics		**Survey 1 (N=2122)**		**Survey 2 (N=2234)**	
		N	**%**	**N**	**%**
Frequency of travel	Every weekday (5 days)	1346	63.4	1415	63.4
	Some weekdays (2-4 days)	365	17.2	357	16.0
	Once a week (1 day)	118	5.6	147	6.6
	Weekend only	3	0.1	7	0.3
	Less frequently	289	13.6	306	13.7
Ticket used	Single ticket	243	11.5	229	10.3
	10 trips-ticket	244	11.5	249	11.2
	Monthly pass	1402	66.1	1515	68.0
	Yearly pass	29	1.4	52	2.3
	Student pass	200	9.4	175	7.9
	Social ticket	3	0.1	9	0.4

Concerning the socio-economic characteristics (Table 3), male respondents in the first survey and in the second survey represent 32.3% and 36.5% of the samples, respectively. It is remarkable the higher proportion of women travelling in these bus lines, almost doubling the rate of men. The range of ages is similar in both surveys; the majority of the respondents consist of people whose age is between 26 and 40 years old (one third part, approximately). More than a half of the respondents in both surveys do not pose driving license, and from those who do pose it, almost the 40% cannot make the trip by riding their own car. It means that there is a high percentage of respondents who are captive to public transport: 69.5% in Survey 1, and 67.2% in Survey 2. Most of the respondents present an educational level higher that High School in both surveys, and nearly 40% had completed University grade. The occupation is similar in both surveys, being almost the 70% employed, around 20% students, 6% retired and 4% unemployed. The annual incomes of the respondents are dominated (approx. 80% of the respondents) by the lower economic groups (those with incomes lower than 20,000 €).

Table 3 – Socio-economic characteristics of the respondents

Socio-economic characteristics		Survey 1 (N=2122)		Survey 2 (N=2234)	
		N	%	N	%
Gender	Male	684	32.3	816	36.5
	Female	1436	67.7	1417	63.5
Age (years)	< 18	49	2.3	53	2.4
	18 – 25	622	29.3	559	25.0
	26 – 40	757	35.7	843	37.7
	41 – 65	570	26.9	602	26.9
	> 65	114	5.4	163	7.3
Driving license	Yes	959	45.3	1056	47.3
	No	1159	54.7	1177	52.7
Riding car	Yes	625	29.5	723	32.3
	No	315	14.8	323	14.5
Education level	Less than High School	298	14.0	348	15.6
	High School	784	37.0	908	40.6
	University graduate	907	42.8	829	37.1
	Postgraduate	107	5.0	97	4.3
	Other	5	0.2	11	0.5
	Don’t know / Refuse	21	1.0	41	1.8
Occupation	Employed	1475	69.5	1522	68.1
	Unemployed	60	2.8	95	4.3
	Retired	123	5.8	152	6.8
	Student	425	20.0	403	18.0
	Housewife/-man	27	1.3	43	1.9
	Other	12	0.5	19	0.9
Annual Income level	< 10.000 €	710	33.4	615	27.5
	10.000 - 20.000 €	439	20.7	415	18.6
	20.000 - 30.000 €	176	8.3	171	7.7
	30.000 - 40.000 €	67	3.2	63	2.8
	> 40.000 €	36	1.7	58	2.6
	Don’t know / Refuse	694	32.7	912	40.8

The responses “Don’t know / Refuse” have been eliminated in the table. when % is lower than 1.0.

The survey included an open-ended question (or non-structured question) only for respondents who were able to make the trip by riding their car. In this case, they were simply asked to answer why they chose travelling by bus instead of riding their car. There are some differences between Survey 1 and Survey 2 (c.f. Table 4). For instance, in Survey 1, the answer most popular was “I haven’t got a parking space at destination”, endorsed by one-third, while in Survey 2 it was “Bus is cheaper”. It can be explained because there is an increase in the fuel price, around 6.3%, between the time the two surveys were conducted (2011 and 2012). People feel that travelling by bus is much cheaper than car in survey 2. The third response in both surveys was “I travel more relaxed by bus, without stress”, being more frequent in Survey 1.

According to Steg (2003), who analysed the opinion that Dutch people had about public transport and car depending on whether they were car drivers or public transport users, in

general the car is more attractive than public transport because of its convenience, independence, flexibility, comfort, speed, reliability and because driving is perceived to be more pleasurable. However, travelling by public transport is perceived to be safer than driving a car. Respondents who usually do not drive think public transport is safer, cosier, less costly and it delivers varied experiences than travelling by car.

Table 4 – Answers to the open question to those having car availability for the trip

Why did you choose travelling by bus?	**Survey 1 (N=622) %**	**Survey 2 (N=722) %**
Bus is cheaper	24.8	**33.0**
Bus is faster	17.5	12.2
I haven't got a parking space at the destination	**26.5**	26.0
I travel more relaxed by bus, without stress	20.4	17.5
I don't have to drive	4.7	6.1
Other reasons (avoid congestion, I don't like driving, environmental concern, injured)	6.1	5.3

Hine and Scott (2000) found that travelling on public transport was easier if you lived near to a major traffic corridor where there was a higher frequency and choice of bus services. Public transport journeys were also seen as an opportunity to meet people, especially for older people. The use of time spent on public transport was described positively by some respondents who saw the journey as an opportunity to read, fall asleep, relax after work and listen to music. Beirao and Sarsfield (2007) reported the main advantages of using public transport indicated by the participants in a survey. They were cost, less stress, no need to drive, be able to relax, to rest or read, less pollution, talk to other persons on the vehicle, and travel time when the line was provided with specific bus lane. Most of these advantages have been also achieved in our study (see Table 4). Concerning the unavailability of parking space at destination, being the first reason for using bus in Survey 1 and the second reason in Survey 2, Beirao and Sarsfield (2007) also reported the difficulty and cost of parking as perceived one important disadvantage of car use.

4.2 Analysis of passengers' satisfaction (part 2 of the survey)

Table 5 provides descriptive statistics pertaining to the service quality attributes and the overall satisfaction for the data sets of the two stages, Survey 1 and 2. For the first survey, the mean and standard deviation range from 3.73 to 4.52 and from 0.998 to 1.356, respectively. The attribute "ease of paying fare" has the highest mean value (4.52), and the attribute "getting information while travelling" has the lowest mean value (3.73). For the second survey, the means and standard deviation range from 3.93 to 4.70 and from 1.117 to 1.327, respectively. The attribute "waiting time" has the highest mean value (4.70), and the attribute "frequency" has the lowest mean value (3.93). It is remarkable the fact that the attribute "get information while travelling" presents the lowest means in Survey 1. However, its perception is the most enhanced with the implementation of the measures (+0.34), which was one of the objectives of the Madrid Public Transport Authority. The

attribute “Frequency” also presents the lowest means in both surveys. It can be explained because the bus lines considered are metropolitan lines, with lower frequencies than those operating in urban areas. Frequency is one of the most important features of the bus services (Wall and Mc Donald, 2007; Paulley et al, 2007) and passenger are really critics with it. Finally, the attribute “easy of paying fare” has been the only one that has been rated less in Survey 2 (only -0.02, in differences mean).

All these results are in line with the means obtained for the “overall satisfaction with the bus service”, whose means are 4.36 (survey 1) and 4.55 (survey 2), showing the lowest S.D. in both cases.

Table 5 – Descriptive statistics of the QoS attributes and overall satisfaction

	Survey 1 (N=2122)		**Survey 2 (N=2234)**		**Differences Mean 2-1**
	Mean	**S.D.**	**Mean**	**S.D.**	
QoS Attributes:					
Waiting time	4.43	*1.154*	**4.70**	*1.150*	0.27
Operating hours	4.09	*1.214*	4.25	*1.233*	0.16
Intermodality	4.42	*1.127*	4.46	*1.126*	0.04
Reliability	4.32	*1.133*	4.52	*1.117*	0.20
Ease of paying fare	**4.52**	*1.173*	4.49	*1.243*	**-0.02**
Quality of bus stops	4.06	*1.177*	4.32	*1.219*	0.26
Get information while travelling	**3.73**	*1.356*	**4.07**	*1.327*	**0.34**
Frequency	**3.76**	*1.301*	**3.93**	*1.338*	0.17
Overall satisfaction with the bus service	**4.36**	*.998*	**4.55**	*1.004*	0.20

The scale (6-ponit) used for stating the passengers’ satisfaction with different attributes of the quality of bus service was reduced in order to be easier to interpret the results. It was a 3-point semantic scale, comprising Dissatisfied (D), Neutral (N) and Satisfied (S), as levels of satisfaction. So, the codification of the attributes was performed according to: rates 1 and 2 as Dissatisfied, 3 and 4 as Neutral and 5 and 6 as Satisfied. The recodification of the target variable in a more reduced scale was also performed by Huang and Hsueh (2010), who converted the four classes of the target variable into two classes (Bad and Good) in order to find out more applicable association rules, and also in De Oña (2013), who converted 5 classes into three classes (poor, fair and good) as levels of the service quality.

A brief analysis of the attributes’ values recoded to the new scale is presented. Figure 1 shows that the rates assigned to the overall satisfaction with the service changes among scenarios (Survey 1 and Survey 2). In Survey 1 there are more passengers dissatisfied and with a neutral feeling, while in Survey 2, once the measures have been implemented, the proportion of passengers who are satisfied with the bus service is much higher. It shows that there is a clear improvement of the overall satisfaction with the bus service thanks to the implementation of the measures related to improve the provision of multimodal real-time information to passengers.

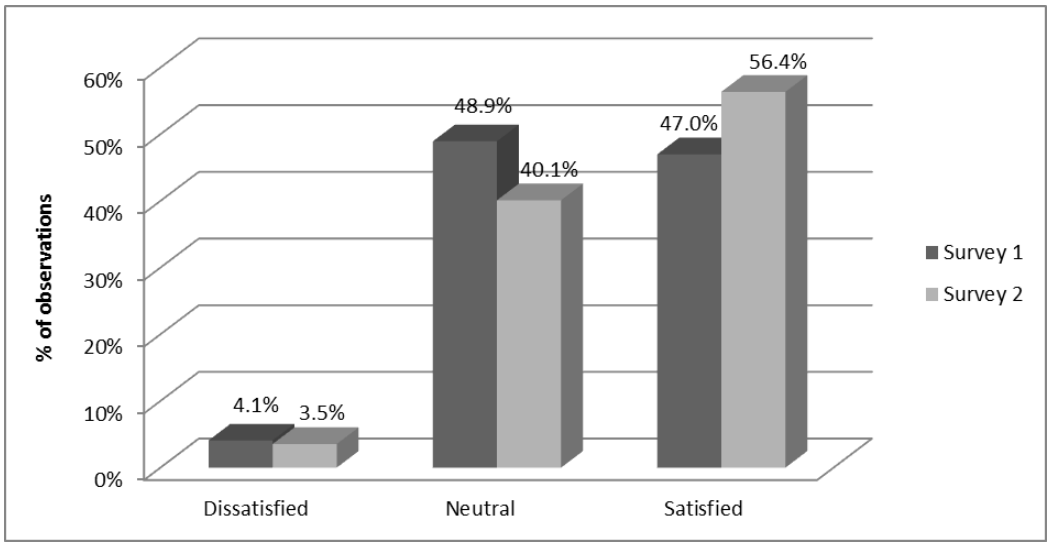

Figure 1 – Overall satisfaction with the bus service perceived by passengers in each survey

The ordered logit model, also known as the *proportional odds model*, is a popular method for analysing ordinal dependent variables (McCullagh, 1980). Within this investigation, it has been used to indicate differences in the reduced scale (D, N, S) distribution between the first and the second surveys. Table 6 shows the odds ratio for the overall satisfaction variable in surveys 1 and 2. The odds ratio of 1.16 means that the odds of a respondent in the second survey to be more dissatisfied with the overall service is 1.16 of the odds of a respondent in the first survey. It also illustrates that in the second survey respondents are more satisfied by 1.46 than in the first survey.

Table 6 – Odds ratio for surveys 1 and 2 concerning overall satisfaction

	D vs N, S	D, N vs S
Odds1	23.52	0.89
Odds2	27.21	1.29
OR (Odds2/Odds1)	1.16	1.46

Table 7 presents the results of the two surveys segmented by gender. The results show that in Survey 1 men are more dissatisfied than women with the general bus service, while in Survey 2 the opposite occurs: women are more dissatisfied by 1.19 than men. It seems that there is no significant difference between the answers by gender when S option is compared with the other two (D and N).

Table 7 – Odds ratio for male and female concerning overall satisfaction

Survey 1			**Survey 2**		
	D vs N, S	D, N vs S		D vs N, S	D, N vs S
OddsM	27.65	0.90	OddsM	24.55	1.32
OddsF	21.9	0.88	OddsF	29.1	1.28
OR (OddsF/OddsM)	0.79	0.98	OR (OddsF/OddsM)	1.19	0.97

In addition, differences in the two surveys have been analysed with a *t-test for independents samples*. The results show that in Survey 1 two attributes, waiting time and frequency, have been found to be significantly different between male and female users within a 95% confidence interval. However, in Survey 2 only the attribute "Get information while travelling" is found to be significantly different between male and female users within a 95% confidence interval.

Finally, a *factor analysis* (FA) has been applied to define the unobserved service quality aspects that can be explained by the observed variables. Prior to the extraction of the factors, several tests should be used to assess the suitability of the respondent data for FA, as Kaiser-Meyer-Olkin (KMO) index and the Barlett spherity test. The KMO index ranges from 0 to 1, with 0.50 is considered suitable for factor analysis. There are numerous ways to extract factors: Principal Component Analysis (PCA), Principal Axis Factoring (PAF) and others. PCA and PAF are used most commonly in the published literature (Tabachnick and Fidell, 2007), but PCA is recommended when no priori theory or model exists (Gorsuch, 1983). An oblique rotated solution (oblimin) was adopted due to the correlation between factors (Hair et al, 2009). Moreover, factors should be stopped when at least 50-60% of the variance is explained (for social sciences). The results are summarised in Table 8. Loadings above 0.6 are highlighted in bold. As the number of observed variables is small (8), only two factors are expected.

Table 8 – Factor analysis results by survey

	Survey 1 + 2	
	Factor 1	**Factor 2**
Waiting time	**0.872**	
Reliability	**0.852**	
Operating hours	**0.664**	
Frequency	**0.642**	
Intermodality	0.570	
Ease of ticket purchase		**0.817**
Quality of bus stops		**0.761**
Get information		0.498
KMO	0.843	
Bartlett sig.	0.000	
Proportion variance (%)	42.964	12.089
Total variance explained (%)	55.053	

Factor 1 includes the variables waiting time, reliability, operating hours, frequency and intermodality. All these variables are related with **travel time and service planning**. Factor 2 is explained by three variables: ease of ticket purchase, quality of bus stops and getting information while travelling. These variables are related to **customer services and comfort**. Due to the variance for the respective model explained by each factor, travel time and service planning factor is perceived as the most important for bus users. Within this

factor, the most important components are the waiting time and reliability, with loadings higher than 0.8. It indicates that passenger consider travel time as one of the main variables in their satisfaction of the overall bus service. These results are also achieved in Eboli and Mazulla (2007), where service planning and reliability is the factor having a greater effect on global satisfaction, and in Diab and El-Geneidy (2012), where users overestimated their travel time savings thanks to the implementation of various strategies in the public transport system, indicating that passengers have a positive attitude towards the improvements in service and overestimate them. Eboli and Mazulla (2010) also confirmed that service reliability is one of the most important service aspects for the users

5. CONCLUSIONS

This paper has presented how the implementation of real-time passenger information measures in a range of metropolitan bus lines in Madrid has changed the perception that passengers have about some service quality-related attributes and about the overall satisfaction of the service. A survey was conducted among passengers in two scenarios, before the implementation of the measures and once the measures were implemented, in order to capture the perception changes. Although the percentage of respondents who were captive to public transport in both surveys was very high (69.5% in Survey 1, and 67.2% in Survey 2) there were important reasons that non-captive users travelled by bus instead of riding their car: the lack of parking space at destination, the lower cost of travelling by bus and the feeling of being relaxed, without stress, travelling by bus.

The results of the descriptive statistic indicate that the perception of the attributes related to quality of service are enhanced with the implementation of the measures, especially the attribute “get information while travelling”, which was one of the objectives of the Madrid Transport Authority. The implementation of multimodal real-time information measures has also influenced the positive perception of the attributes “waiting time” and “quality of bus stops”. Users are more satisfied and perceive lower waiting times in the bus stops because they know exactly the time of next bus arrival. They also perceive a higher quality of bus stop due to the new devices installed, providing a feeling of new and even cool. One of the attributes less enhanced is the “Intermodality”. It means that passengers haven’t perceived the implementation of the multimodal RTPI measures as a way to foster the integration between modes, but only a way to be better informed. It explains that the most important issue for improving the trip is to reduce the total travel time. This statement has also been found in the importance of the factor **travel time and service planning,** which includes the waiting time and reliability as the most important components.

The “overall satisfaction with the bus service” has also been improved with the implementation of the measures. The proportional odds method has shown that bus users are more satisfied by 1.46 than before the implementation of the measures. It has been found that the overall satisfaction depends on the gender in some degree: in Survey 1 men

are more dissatisfied with the general bus service by 1.26 than women, while in Survey 2 women are more dissatisfied by 1.19 than men.

Considering the findings of the analysis, it can be concluded that the implementation of real-time information measures in bus services remove the uncertainty when using public transit, improving the passenger satisfaction, so public transport operators, authorities and policy makers may take into account especially in those routes with low frequency of services. It has been proved that passengers have a positive attitude towards the improvements in service and overestimate them, perceiving not only a reduction in travel time, but also an enhancement of the comfort and customer-related services.

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