The value of aesthetics in public transportation: A quantitative analysis of perceived quality for railways travel

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1 Introduction

Service quality indicators of Public Transportation (PT) and related measurement methods are important both for service providers in designing and monitoring their services, and for the authorities and agencies responsible for the procurement of PT services in tendering and controlling these services. Their use promotes the translation of customer expectations and perceptions of quality into measurable and manageable quality parameters. Several definitions and measurement methods have been proposed for service quality both as objective indicators (e.g. Transportation Research Board, 1999 and 2003) and behavioural utility- based indicators (e.g. Hensher and Prioni, 2002; Hensher et al.; 2003; Cascetta and Cartenì, 2012; Gatta and Marcucci, 2007; for an updated review see Eboli and Mazulla, 2008)).

There is an ongoing debate in the scientific community about what is the best quality definition of PT service quality and how it should be measured. There is also a continued debate as to whether quality indicators should be objective and/or subjective. It seems appropriate to define both objective and subjective measures of transit quality, since they are relevant to different purposes. The former are direct measures of indicators perceived as significant by the customers (e.g. in-vehicle time or percentage of services departing/arriving early/late). By contrast, subjective measures are based on direct (statements) and indirect (choices) customer perception of service quality. In the literature many techniques for measuring subjective indicators have been proposed using both RP and SP surveys (e.g. Ben-Akiva and Morikawa, 1990; Bradley and Daly, 1991; Cascetta 2009).

It is worth noting that the effects of non-quantitative aspects of service quality such as esthetic values in stations and vehicles, riding conditions etc., in terms of quality perception, actual user behaviour and transit ridership haven't been investigated in the literature. This contrasts with a number of transit promotion policies explicitly based on qualitative factors which are increasingly included in designing new urban and metropolitan services and infrastructures (see for example the metro lines in several european and north America cities).

Service quality of Public Transportation is one of the main research area of the Department of Transportation Engineering of the University of Napoli since 2001. The overall research activities are:

a) propose a methodology integrating the EU standard (EN 13816) in the PT planning process. In particular the relationships between service providers, customers' reactions, demand flows, planning activities, system monitoring as well as the updating of standardized quality indicators were studied as described in Cascetta and Cartenì (2012);

b) investigate the effects of a set of large-scale consistent transport policies in terms of service quality variations, as defined by EU standards, and in terms of actual user behaviour and transit ridership (for the results see: Cascetta and Cartenì, 2012);

c) advocate the crucial role of reliable, system-wide simulation models to assess quality indicators both for existing systems (in addition to direct measures of customer satisfaction) and for planning purposes;

In this framework, this paper proposes a quantitative analysis of perceived estetic value of stations for railways travel as compared to other quality variables such as travel time, access time, service frequency and monetary cost (the value of aesthetics). A service choice model, simulating the choice between traditional rail services and the new high aesthetic standards line open since 2009 in the northen area of Neaples, was specified and estimated for trips having both options. This is the first time, to the authors' knowledge, that the effect of overall ambient quality and ride comfort has been measured in term of users' perceived quality indicators based on both actual behaviour (RP surveys) and answers to hypothetic scenarios (SP surveys).

2 The case study and data collection

The case study is part of the Campania Regional Metro System (RMS), which can be considered one of the most ambitious examples of rail-based PPT policies currently implemented in Italy. The project started in 2000, the total size of the RMS project in terms of total investment for the infrastructures and rolling stock is €9,140 million (€3,115 million already completed, €2,525 million under construction and €3,500 million to be funded). In addition to the physical infrastructures (new railway lines, new stations and parking facilities) a number of other features were implemented in order to improve the "system-wide" quality of the public transport service such as an integrated (bus and rail) fare system, high frequencies for rail services, high quality standards the rolling stock (Cascetta and Pagliara, 2008).

Comparison between the base scenario (2001) and the first stage scenario (2011) shows an impressive increase in PT service quality in terms of objective indicators estimated and/or measured as well as significant impacts on transit ridership (Cascetta and Carteni, 2012).

As said, the service choice model was estimated taking advantage of the opening, in 2009, of the new Arcobaleno "high quality" metro line, 10.5 km long with 5 stations, opened to serve the Aversa - Napoli corridor. The opening of this line has significantly changed the behaviour of systematic users. Two RP Customer Satisfaction Surveys were conducted in 2009 and 2010 (about 1,000 mobility diary surveys). The results of the interviews showed:

- 29.8% of users increased their trip frequency, generating a new demand equal to 10.7% of line ridership;
- 84.2% of users changed transport mode; specifically 49.9% before the introduction of the new service used individual modes, 34.3% used buses and 15.8 used traditional rail lines.

Within the Aversa - Napoli corridor there are some origin-destination (O-D) pairs with two possible routing options: new high Aesthetic Quality Lines - AQL (Arcobaleno Regional line + Metro line 1) and Traditional Railway Lines - TRL (Trenitalia Regional line + Metro line 2). These O-D pairs are relative to the trips from Aversa city centre to Napoli historical centre. These two routing options are in competition with respect to the level of services attributes (table 1). Both the services have the same fare (integrated) and one transfer; the average waiting time is 15 minutes for AQL while 14 minutes for TRL; the average in-vehicle time is 45 minutes for AQL and 43 minutes for TRL; the average access + egress and transfer time is 36 minutes for both services.

Although the total travel time is very similar (96 min. for AQL against 93 min. for TRL, -3.1%), the number of users who choose the two services is quite different. Every weekday day, more than 900 users move between these specific O-D pairs (table 2), the 25% of the total train demand form the Aversa basin to the Napoli basin. The 69% of these users choose the AQL (627 passenger/day) while the 31% choose the TRL (282 passengers/day).

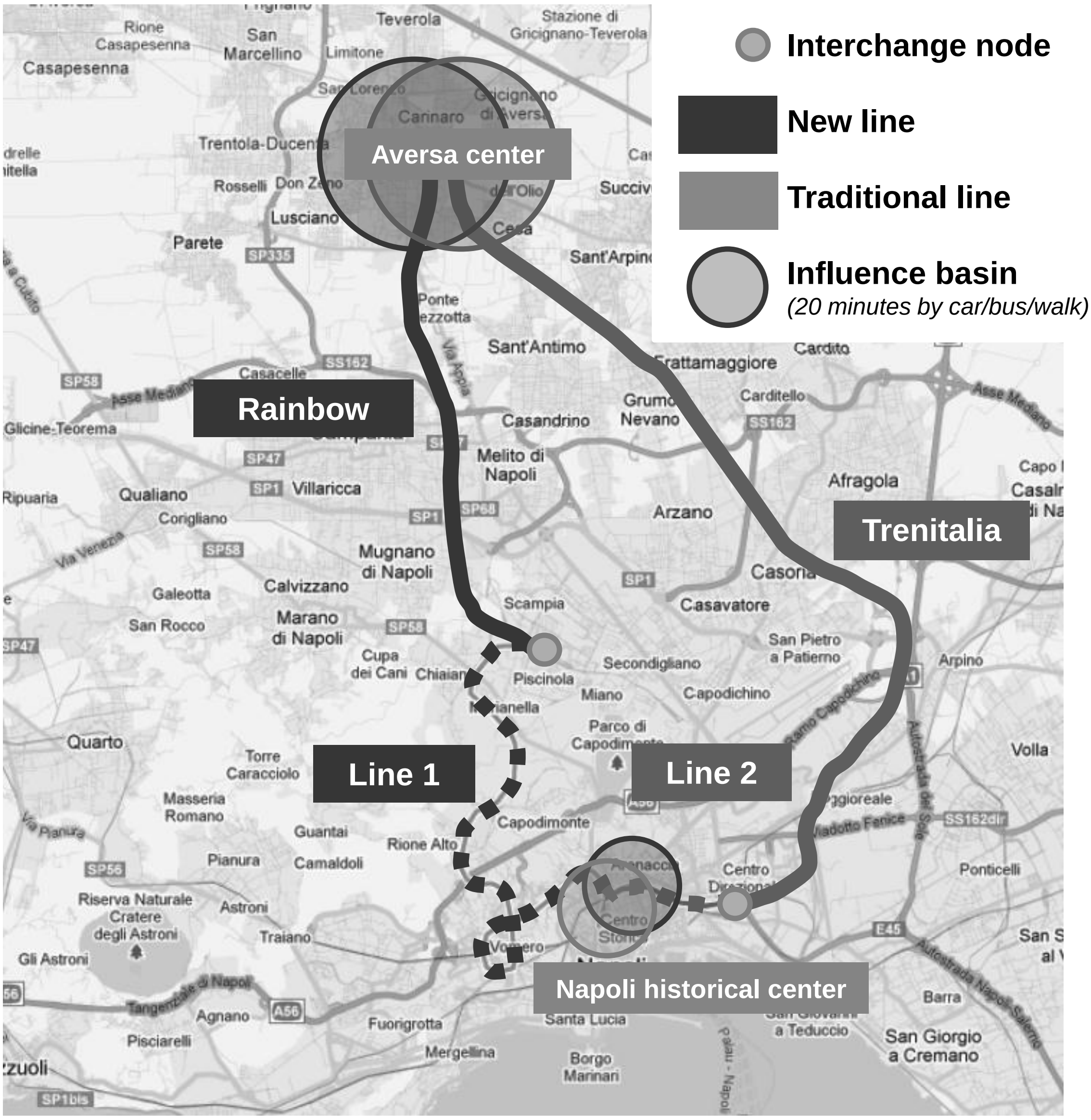

Figure 1 – Real life laboratory experiment in the Aversa – Napoli corridor

Table 1 – Level of services attributes relative to trips from Aversa city center to Napoli historical center (estimated)

LOS attribuites	Arcobaleno	Trenitalia	% variation
Fare (integrated)	€ 0,8	€ 0,8	0.0%
Num. of transfer	1	1	0.0%
Total waiting time	15 min.	14 min.	- 6.7%
Total on board time	45 min.	43 min.	-4.4%
Access + egress time	36 min.	36 min.	0.0%
Total travel time	**96 min.**	**93 min.**	**-3.1%**

Table 2 - Daily train demand from Aversa city center to Napoli historical center (counted)

Metro line	Pass./day	Total
Arcobaleno	627	***69%***
Trenitalia	282	***31%***
Total	**908**	***100%***

In 2012 a RP & SP survey was carried out to measure differences in perceived service quality between TRL and AQL. With respect to the RP customer satisfaction (about 128 surveys, sampling rate equal to 14%), results related to the customer's perceived quality show that AQL is always better than the TRL. The high aesthetic standard of the stations and of the rolling stock (cleanliness, perception of security etc.), related to the AQL, influence the higher perceived quality by the customers. A significant and somehow unexpected "context effect" was also observed. Users were asked the perceived values of quantitative and qualitative quality variables. It was observed that users of the new AQL underestimate level of service attributes (service irregularity and delay, average access/egress and interchange time) with respect to "objective" measures (between 10% - 60%), while the opposite held for users of the traditional line. This result is similar to others obtained in behavioural economics and poses new challenges for modelling user behaviour and quality-related measures.

The 128 interviewees were also proposed a SP questionnaire for considering a more extensive attributes space with respect to the level of service attributes. For each respondent were shown 7 scenarios which differ from the own travel experience for a percentage increase and decrease (about ±15%, ±30%, ±60% and ±90%) of four level of service attributes (waiting time, in-vehicle time, access + egress and transfer time, difference in fare) as generated by a Fractional Factorial Design scheme. Each user was asked for each hypothetical scenario if he/she would change their current choice of service (AQL vs. TRL).

3 Service choice model estimation

A Binomial Logit choice model with serial correlation (panel data) for multiple responses of the generic individual was calibrated using a Exogenous Weighted Maximum Likelihood estimator using a student RP-based SP surveys. Several specifications were tested starting from a simple one with generic LOS coefficients and Alternative Specific Constant to more complex models including alternative specific quality parameters interacting with individual socioeconomic characteristics. For both choice alternative, an inertia dummy variable was also considered in the systematic utilities for take into account possible justification bias of the responses (e.g. proposed in Morikawa 1994, Bradley and Daly 1997).

The calibration results show that:

- Adjusted rho-square always greater than 0.34;
- Inertia parameter positive but not statistically significant
    - no justification bias phenomenon in the sample
    - although more accurate models will be tested (e.g. inertia thresholds, that reflects the reluctance to change proposed by Cantillo et alii, 2007)
- variance of serial correlation statistically significant and between 1.84 to 2.43
- the economic value of aesthetic quality for a student is 35 Euro cents per trip; this means that an AQL user is willing to wait about 6 minutes more for a train or walk up to 9 minutes longer to reach an AQL station
- the value of waiting time for the TL is greater than the 32% wrt HQL one
- the value of ASC decrease from 0.35 euro to 0.20 euro considering HQL specific waiting time coefficient
- no appreciable differences are observed considering specific coefficients for the HQL access/egress time or in-vehicle time (this problem could be overcome increasing the sample size)

4 Conclusions

The results obtained are potentially very significant for service planning and should be further investigated. If confirmed, they would show that aesthetic and environmental quality of terminals and rolling stock should be considered as explicit design variables for high-quality PT services with quantifiable trade-offs with other more traditional attributes e.g. frequency, accessibility etc.

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