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Determinants of traveler satisfaction: Evidence for non-linear and asymmetric effects

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ABSTRACT

Classifying public transport service attributes based on their influence on overall traveler satisfaction can assist stakeholders and practitioners in introducing cost-efficient measures. To date most studies employed methods that were based on the assumption that the impact of service attributes on traveler satisfaction is entirely linear and symmetric. This study examines whether service attributes have a non-linear and asymmetric influence on the overall travel experience by employing the Three-factor theory (basic, performance and exciting factors). The analysis is conducted for different traveler segments depending on their level of captivity, travel frequency by public transport and travel mode used, and is based on a relatively large sample size collected for Stockholm County. Moreover, the estimated models control for important socio-demographic and travel characteristics that have been insofar overlooked. Results are presented in the form of a series of multi-level cubes that represent different essentiality of traveler needs which provide a useful methodological framework to further design quality service improvements that can be applied to various geographical contexts. Our findings highlight that a "one size fits all" approach is not adequate for identifying the needs of distinct traveler segments and of travelers using different travel modes. Furthermore, two-thirds of the attributes are consistently classified into the same factor category which entails important policy implications. This research deepens and expands the very limited knowledge of the application of the three-factor theory in the transport field.

1. Introduction

Public Transport (PT) holds an undeniable prominent position in today's urban mobility. PT does not only allow individuals to participate in their daily activities but also positively affects their health by increasing their physical activity (Rissel, Curac, Greenaway, & Bauman, 2012). Moreover, PT use is advantageous for the well-being of society as a whole by contributing to the reduction of both air and noise pollution as well as congestion and travel times (Harford, 2006).

Delivering a satisfactory PT service has been linked to ridership retention and loyalty (Lai & Chen, 2011), recommendation (Lierop, Badami, & El-Geneidy, 2018), ridership increase (Syed & Khan, 2000), and a reduced price elasticity (Matzler,

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Sauerwein, & Heischmidt, 2003). The importance of perceived service quality with PT services led previous researchers to focus on identifying the determinants of travel satisfaction and priority areas. Yet, the vast majority of these studies employed methods that were based on the assumption that the impact of service attributes on traveler satisfaction is entirely linear and symmetric.

There is, however, evidence suggesting that travel satisfaction may not be a linear function of service attributes. Incipient evidence from the transport field (i.e. Cao & Cao, 2017) and evidence from other fields (i.e. Vavra, 1997; Matzler & Sauerwein, 2002; Busacca & Padula, 2005) suggest that it is more than probable that the relation can be described as non-linear and asymmetric for some of the service attributes. It is thus plausible that distinct types of relationships across dependent and independent variables exist, including variables that may either increase and decrease satisfaction while others can either exclusively increase it or decrease it.

Using a relatively large sample size, this work deepens and expands the very limited knowledge (i.e. Cao & Cao, 2017; Zhang, Cao, Nagpure, & Agarwal, 2017; Wu, Cao, & Huting, 2018) on the application of the three-factor theory in the transport field. This is done by attempting to better understand how PT service attributes are characterized in terms of their varying influence on traveler satisfaction. Further addressing to this research gap, we will devise a multi-level cube of traveler needs for different group of travelers. To achieve this objective, this study categorizes service attributes into the three levels of the three-factor theory. A segment-based approach is used to control the influence of travel mode use and traveler characteristics on traveler expectations which in turn affect travelers' subjective evaluation of attribute performance (i.e. Dell'Olio, Ibeas, & Cecin, 2010). By doing so, we will allow deriving different structures of satisfaction determinants for different segments of travelers depending on their level of captivity, travel frequency by PT and travel mode used. The importance of grouping PT service attributes into categories that influence overall travel satisfaction in a similar way - satisfiers, dissatisfiers, and attributes that can do both - can assist stakeholders and practitioners in introducing cost-efficient measures to increase traveler satisfaction with PT services.

This work is organized as follows. We start by outlining traveler satisfaction studies and stressing the importance of segmenting the findings by type of traveler and mode employed (Section 2). The following Section 3 presents the three-factor theory, describing related methods and synthesizing results from previous studies. Then, Section 4, describes and characterizes the data used in this study and explains the specific method of analysis employed, i.e. regression with dummy variables. Findings from bivariate analyses and model estimation results are presented in Section 5. This is followed by a re-organization and discussion of the results into distinct levels of essentiality for the market as a whole as well as for distinctive market segments (Section 6). The paper concludes with a discussion on policy recommendations and directions for future research.

2. Literature review

A wealth of methods have been employed to explore and derive the effects of PT service attributes on the overall travel satisfaction. These methods have comprised varying statistical procedures including structural equation modeling, correlation and regression analyses (De Oña & De Oña, 2014). The results from these statistical procedures yielded differing estimated coefficients and probabilities for each of the attributes that either positively or negatively impacted the overall travel experience. Some examples of these studies include Weinstein (2000), Cantwell, Caulfield, and O'Mahony (2009), Mouwen (2015) and Allen, Muñoz, and Ortúzar (2018).

Most of these previous studies, however, focused on identifying the factors that are more salient in shaping individual traveler needs. For instance, Mouwen (2015) found that for a general traveler and mode on-time performance, speed, frequency and followed at a distance staff behavior and vehicle tidiness had to be prioritized. In contrast, Allen et al. (2018) identified satisfaction with the PT company, with other traveleŕs behavior and with the information provided as the main determinants of travel satisfaction with bus services. Their work also found that infrequent users are less satisfied with bus services than their counterparts. Other studies (e.g. Cats, Abenoza, Liu, & Susilo, 2015; Weinstein, 2000) employed Importance-Performance Analysis (IPA) to present the underlying deficiencies of the service and setting priorities. Cats et al. (2015), in particular, investigated the key determinants of satisfaction using the same datasets but with different study area (Sweden) and period (2001–2013). They found that security, duration of the trip, customer interface, security, and operation were the most relevant attributes to be prioritized. Furthermore, Weinstein (2000) employed bivariate correlation coefficients and satisfaction ratings to identify the train service attributes that needed to be prioritized. From amongst the very large set of service aspects considered he found that the ones that needed special attention were: out-of-service escalators and elevators, problems with ticket-vending machines, on-board cleanliness, easiness to transfer to buses, availability, and responsiveness of staff.

2.1. Differences between travelers and travel modes

Based on findings reported in the literature (e.g. Dell'Olio et al., 2010), it is hypothesized that different travelers have different needs and priorities. On this basis, earlier research segmented travelers in regard of their attitudes and sociodemographic characteristics and the characteristics of their trip (e.g. Krizek & El-Geneidy, 2007; Abenoza, Cats, & Susilo, 2017). From amongst all a priori segmenting options, three are believed to be of special relevance in the context of this study: frequency of travel by PT, PT captivity and travel mode use.

Inherent and perceived differences in terms of infrastructure, operation, information aspects and comfort between travel modes might be perceived differently amongst travelers. This, for example, was made evident in Mouwen (2015) where metro and train travelers placed a higher priority on on-board information compared to bus travelers. In contrast to bus travelers, metro and train travelers attached a higher importance to driver's behavior and on-time performance, respectively. Moreover, St-Louis, Manaugh, Van Lierop, and El-Geneidy (2014) revealed that the determinants of travel satisfaction for commuters varied from mode to mode. Travel time affected more greatly travel satisfaction with metro and bus compared to train trips. Trip characteristics were found to mostly influence travel satisfaction with bus trips. Further, train trips were most impacted by travel preferences which were related to their personal view on their travel time and the effect of one's social environment. In addition, metro trips were most influenced by personal characteristics which have to do with traveler's age, gender, background, and satisfaction with life.

Unlike choice riders, PT captives have no or limited ability to choose their travel mode which may affect their expectations of the existing service. In contrast, choice riders are more sensitive to poor service quality since they have the option to switch to a private mode. Differences between choice riders and PT captives were made patent in a study investigating preferences and choices from travelers that were segmented by their frequency of use and mode choice availability (Krizek & El-Geneidy, 2007). Their results showed that choice riders were concerned about ease of transfers, transfer waiting times and comfort aspects more often than captive riders. Abenoza et al. (2017) found that travelers that were eminently PT captives considered customer interface, information on planned changes and on-board conditions as less important than their counterparts. At the same time, this segment considered ride comfort as more relevant than others.

When considering travelers with contrasting PT frequency of use, it is assumed that frequent PT travelers are more knowledgeable about service aspects related to the operational and comfort side. It is also assumed that their familiarity with the service would reduce the gap between expectations and reality. In contrast, unfamiliarity with schedules, routes, and travel times might result in different perceptions towards certain attributes by infrequent travelers. Furthermore, frequent travelers are more exposed to inconveniences related to the service (i.e. crowdedness, congestion) which may shape their travel experience. Krizek and El-Geneidy (2007) found that travel satisfaction levels for frequent users were negatively affected by feelings of unsafety and discomfort. In addition to those attributes, Cantwell et al. (2009) included unreliability of the service, high level of crowding and long waiting times. Moreover, information for unplanned changes, customer interface (Abenoza et al., 2017), driver's attitude, travel time and reliability (Krizek & El-Geneidy, 2007) were also found to be more impactful amongst infrequent PT users.

In sum, these works show that different travelers have different needs and priorities. Therefore, it is of great relevance to examine the multi-level organization of PT service attributes for different travel modes and market segments.

2.2. Different nature of service attributes

Maslow (1948) proposed that human behavior could be explained by the process of satisfying five different needs. These needs were depicted in the form of a pyramid where lower-level needs (physiological and safety) had to be satisfied first before considering higher-level needs (belongingness, esteem, and self-actualization). In the last decade, there have been several attempts (Alfonzo, 2005; Dft, 2008; SKT, 2013; Van Hagen, 2011; Winters, Cleland, Mierzejewski, & Tucker, 2001) to devise a hierarchy of travelers' needs analogous to Maslow's hierarchy of human needs. As displayed in Table 1 these studies focused on different travel modes and mainly used qualitative methods.

In general, the above studies organized and ranked travelers' needs into five levels of priority. Service attributes were ranked from top (bottom of the hierarchy) to lowermost priority (apex of the pyramid). Attribute priority increases from bottom to top and attributes found at the bottom are to be fulfilled first before moving into the higher levels. Table 1 results

Table 1
Summary of travelers' hierarchies.

Source		Winters, Cleland, Mierzejewski, and Tucker (2001)	Alfonzo (2005)	Dft. Department of Transport (2008) (2008) (2008)	Van Hagen (2011)	SKT (2013)
Mode		All modes	Walking	All PT modes	Train	All PT modes
Type of research		Qualitative	Qualitative	Qualitative	Quantitative & qualitative	Quantitative
Type of method		Advisory committee	Literature review	Panel members	Misc	Cross-correlation
Hierachy's level of attributes	6	na.	na.	Comfort & cleanliness	na.	na.
	5	Comfort & convenience	Pleasurability	Fast	Experience	Quality
	4	Cost	Comfort	Safe	Comfort	Price
	3	Societal acceptance	Safety	Affordable/cheaper	Ease	Reliability
	2	Time	Accessibility	Convenient & easily accessible	Speed	Better utility than other modes
	1	Safety and Security	Feasibility	Reliable, regular & timely	Safety & reliability	Network, dep.time, simplicity & frequency

show that for motorized modes two main types of attributes, operational (i.e. network, reliability, trip duration) and safety-security related dominate the base and most relevant part of the hierarchy. In addition, travel cost can be found at intermediate levels while comfort and delight aspects are mainly located at the top of the hierarchy. In turn, SKT (2013) organized attributes in a hierarchical manner by means of ranking them based on the strength of their cross-correlation coefficient with overall travel satisfaction. However, the nature of the method employed does not allow establishing preferences and priorities amongst attributes. This was also the case of the UNE-EN 13816 standard which classified service attributes into three categories (basic, proportional and attractive), depending on how conformity and non-conformity impacts travel satisfaction (Guirao, García-Pastor, & López-Lambas, 2016).

A more practical conceptualization of Masloẃs hierarchy was posited by Alderfer (1972) with his Existence-Relatedness-Growth (ERG) theory. Alderfer's theory simplified Maslow's needs into three categories. Existence embraced Maslow's safety and physiological needs, and we could assume that refers to travel aspects related to personal and road safety, comfortability, and ease of use. Relatedness, in turn, encompassed belongingness and esteem needs and is pertinent to acceptance of mode choice by others, reciprocity and sense of belongingness while using a given mode. Furthermore, growth is equivalent to Maslow's self-actualization needs and included aspects connected to convenience, cost and aesthetic amenities. In the transport field, Perone, Winters, Read, and Sankah (2005) operationalized ERG theory by developing a stated preference questionnaire that was distributed amongst a small and non-representative sample. The survey tested a combination of questions related to each category of the dyads: E vs. R, R vs. G and E vs. G. Their results proved a hierarchical organization of the level of service by showing that existence aspects were preferred over relatedness and that the former aspects were prioritized over growth.

This section has made evident that most previous studies aiming at organizing service attributes into different levels of priority used qualitative methods, IPA and ERG. Results from qualitative methods, however, cannot be generalized. Moreover, IPA is unable to handle non-linear and asymmetric associations of service attributes with overall satisfaction. Further, ERG studies involve issues related to stated preference surveys such as differences between actual and stated behavior. IPA and ERG issues, therefore, call for the deployment of an alternative method that can guide stakeholders in adopting policy measures.

3. The three-factor structure

3.1. Factor classification

Quality of service studies in the transport field have extensively employed compensatory strategies (i.e. Weinstein, 2000). When evaluating a transport service, this strategy considers the weight of each single attribute on the overall travel satisfaction. Additionally, compensatory studies assume that all travelers make rational decisions and trade-offs between attributes while considering all service attributes equally. However, in reality, travelers may choose different travel alternatives and assess an overall trip by considering a smaller set of attributes. This will result in a non-compensatory relation between satisfaction with individual service attributes and overall satisfaction.

The majority of previous studies assumed that the relationship between attribute-level performance and overall satisfaction is linear and symmetric (i.e. Cats et al., 2015; Mouwen, 2004). However, there is evidence (Johnston, 1995; Kano, Seraku, Takahashi, & Tsuji, 1984; Matzler & Sauerwein, 2002; Mittal, Ross, & Baldasare, 1998) to suggest that service and product attributes have distinct relationship patterns between attribute-level performance and overall travel satisfaction.

To overcome the limitations a new theory, the three-factor theory, was developed and applied in various fields ranging from tourism (i.e. Füller & Matzler, 2008), hospitality (i.e. Matzler & Sauerwein, 2002), banking (i.e. Matzler et al., 2003), to marketing or retail (i.e. Busacca & Padula, 2005). This three-factor theory is still a very novel method in the transport domain.

The three-factor theory conceptualizes that service attributes impact on overall travel satisfaction very differently depending on their performance level. The three factors have been defined by authors Matzler et al. (2003) and Busacca and Padula (2005) as follows:

(a) Basic factor: when attributes belonging to this category are well delivered, they do not positively influence overall satisfaction, yet when delivered poorly, they induce dissatisfaction. They are basic and expected attributes that all service should provide adequately. Their relationship with overall satisfaction is asymmetric and non-linear.
(b) Performance factor: this category of attributes can contribute to both satisfaction and dissatisfaction depending on whether their performance is high or low, respectively. They have a linear and symmetric relationship with overall travel satisfaction.
(c) Exciting factor: This category is the reverse of the basic factor. Attributes belonging to this category are unexpected attributes that can only bring joy and satisfaction with the service. Their relationship with overall satisfaction is asymmetric and non-linear.

3.2. Methods

In other research domains, researchers classified attributes into factors by using a wide range of methods including critical incident technique, analysis of complaints and compliments, Kano's questionnaire, regression with dummy variables and importance grid (Busacca & Padula, 2005). However, most of these methods bear serious limitations such as the use of long, unconventional, and difficult to interpret questionnaires and their impossibility to classify attributes into more than two categories (critical incident technique). Moreover, Johnston (1995) criticizes some of these methods for not being able to represent well an average experience since they are based on incidents and stated preference questions.

From the abovementioned methods, past studies have chiefly employed importance grid and regression with dummy variables to implement the three-factor theory. Importance grid is a method where stated and derived importance are plotted against each other in a grid. The mean (and sometimes median) of the importance is used to divide both axes of the grid into four areas. Two of these areas (high-high and low-low) conform the one-dimensional and performance factor. High implicit and low explicit importance corresponds to the exciting factor while the opposite importance composition (low-high) corresponds with the basic factor (Vavra, 1997).

Regression with dummy variables is a method where low and high attribute performance are recoded into two dummy variables. Regression results (significance levels and magnitude of the estimated coefficients) for both dummies determine the attribute classification into the three-factor structure (see Fig. 1). One-dimensional performance factor comprises attributes where both low and high-performance dummies are significant and have a similar magnitude. Basic factor is formed by attributes with significant low performance and insignificant high-performance dummies. Lastly, the exciting factor is composed of attributes with insignificant low performance and significant high-performance dummies.

Convergent validity of regression with dummy variables and importance grid has been tested in several studies (i.e. Matzler & Sauerwein, 2002; Busacca & Padula, 2005). The works mostly found that regression with dummy variables was superior to importance grid. Matzler and Sauerwein (2002) and Mikulic and Prebezac (2011) provided a good summary of the main disadvantages of importance grid. The disadvantages included: (a) the use of an arbitrary threshold to divide the quadrant map; (b) the unreliability of the answers since they may result from politically correct answers and their ambiguity since the importance assessment may not relate to the same situation (Olivier, 1997); (c) the dependence of the classification of the attributes on the importance evaluations of the other attributes, and; (d) the difficulties experienced by respondents to discern the importance of many and similar attributes.

3.3. Applications in the transport field

The past two years (Cao & Cao, 2017; Wu et al., 2018; Zhang et al., 2017) have witnessed the application of the three-factor theory for different purposes. The importance-grid approach was employed by Zhang et al. (2017) to a set of 13 service attributes and three travel modes (BRT, bus, and van). Across all travel modes, they found that customer service, comfort while riding, safety while waiting, and cost conformed the basic factor. For bus trips, the authors found that comfort while riding, cost, safety while waiting and customer service belonged to the basic factor. For bus and BRT, the performance factor was composed of safety while riding and reliability and exciting factor are convenience, travel time and ease of use. Finally, the exciting attributes included ease of use and time.

A different combination of travel modes (bus, BRT and metro) was considered by Cao and Cao (2017) who compared and contrasted both two IPA specifications and two methods to identify the three factors. About one-third of the attribute quadrant classification obtained from explicit and implicit IPA specifications differed. The authors concluded that implicit IPA was superior to explicit IPA since the former was not based on the unrealistic assumption that stated importance and performance are independent. Further, they concluded that compared to regression with dummy variables, the importance grid method yielded more logical results. However, their main and only argument was the more consistent classification of safety aspects in their case into the basic and performance rather than the excitement factor. Across all modes the importance grid identified safety off and on-board, PT ease of use, reliability, and convenience of service (network) as basic and performance

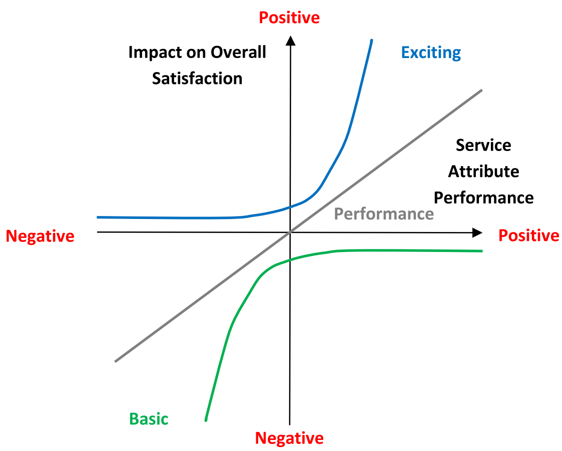

Fig. 1. Kano's three factors (own adaptation).

factors. Moreover, comfort while waiting for the bus and BRT services and door-to-door travel time for metro travelers were identified as performance factors.

Wu et al. (2018) explored the three-factor nature of 24 service attributes for local and express (regional) buses. These scholars also contrasted the results from an implicit IPA with one method to identify the three factors, regression with dummy variables. It is important to highlight that their dummy variable coding scheme included ratings 1–3, instead of 1–2, as low-performance dummy attributes. Based on the attribute performance level and factor structure the authors established priority areas which were compared to those resulting from implicit IPA. IPA, when compared to three-factor theory, yielded a much shorter list of priority attributes. Priority areas were formed by attributes belonging to the basic and performance factor and with a performance level lower than 4 points. Results from regression with dummy variables showed that operation (i.e. frequency, reliability), comfort (i.e. seats, cleanliness) and personal safety aspects needed to be prioritized for bus services. The priority list for express bus services was similar to the one obtained for conventional buses but excluded safety and included information aspects.

To sum up, the main limitations from the transport-related studies are the use of relatively small (n = 500) sample sizes per travel mode (Cao & Cao, 2017; Zhang et al., 2017) and their inability to control for the impact of socio-demographic attributes, travel characteristics, and seasonal variations. The present work overcomes all these limitations and expands the results of previous studies by devising multi-level cubes that represent different essentiality of needs for different segment of travelers and distinct travel modes (commuter train and metro).

4. Methodology and survey descriptions

4.1. Data

This study employs a rolling survey known as the Swedish customer satisfaction barometer. The travel satisfaction survey, collected by *Svensk Kollektivtrafik,* inquiries PT users and non-users and includes questions concerning satisfaction with the overall and with individual service attributes, as well as socio-demographic and travel characteristics. The data collection is carried out via phone calls on a regular basis year-round and comprises an average of 2800 samples per year for Stockholm County.

Respondents were asked to indicate their agreement with statements referring to satisfaction on a 5 point Likert scale. The survey includes questions concerning satisfaction with the overall trip and with individual service attributes. For instance one of the statements reads ‘‘It feels safe to travel by PT” and thus the Likert scale corresponds to 1 (completely disagree), 2 (rather disagree), 3 (neither disagree nor agree), 4 (rather agree) and 5 (completely agree). The set of individual service attributes considered are:

Customer interface: Service provider's responsiveness
Security: Risk perception, personal security
General information: Ease of getting information on departures
Information on planned changes: concerning routes and schedules
Information on unplanned changes: concerning delays
Duration: Speed, directness
Network: the suitability of PT lines to traveler's needs
On-board conditions: cleanliness, vehicle design.
Operations: service frequency and reliability
Ride comfort: seat availability and comfort
Staff and assistance: drivers' and other staff friendliness
Ticket accessibility: ease of purchasing tickets.

This work is based on the most recent set of available samples (from mid-2010 to 2015) of travelers from Stockholm County who travel at least once a month and thus who have some PT user experience. After the data was checked for completeness, correctness, and consistency a randomly distributed sample of 9171 respondents is retained.

Previous works indicated that traveler satisfaction evaluations changed from region to region. The highest PT satisfaction evaluations came from travelers living in low-populated counties (Abenoza et al., 2017) and municipalities (Diana, 2012). This, together with the fact that subjective evaluations of PT services are based on onés experience and expectations this work exclusively employs data from a single Swedish region, Stockholm County (6519 sq.km.). About ¾ of the population of this County lives in very highly urbanized areas (>500 inhab./sq.km.) which are characterized by access to similar transport infrastructure, service provisions, and built-environment characteristics.

4.2. Identification of the three factors

Regression with dummy variables is chosen to discriminate the way service attribute performance impacts overall travel satisfaction. As shown in Section 3.2 this approach has apparent advantages over the alternatives and can be applied to our rich dataset.

To be able to perform the analysis, service attribute performance ratings are recoded to create three dummy variables; low, intermediate and high performance. Considering the 5-point Likert scale nature of the attributes and the sufficient variability of responses of the data we consider ratings 1 and 2 as "*low performance*" and 4 and 5 as "*high performance*". An evaluation of 3 is recoded into an "*intermediate*" dummy variable which is taken as the reference level in the regression models. A standardization of performance coefficients is not carried out due to the negative implications that were found to have in previous studies (Mikulic & Prebezac, 2011).

Ordered Logit Model is then employed to estimate a regression model with dummy variables together with the remaining model specification (see Section 5.2). For a given service attribute are then obtained two parameter estimates (low and high) with their corresponding significance level.

The relationship arising from the amount of positive and negative impact that the low and high dummy variables have on overall travel satisfaction is crucial for identifying the factor structure (basic, performance, exciting) of a given service attribute. For each pair of dummies, when the negative (low) impact of an attribute is predominant over the positive (high), the attribute is classified as basic factor. When the positive (high) is predominant over the negative (low) influence then an attribute is classified as exciting. When both low and high-performance dummy variables have a similar positive and negative effect then they are classified into the performance factor.

The positive or negative sign of the predominance of each service attribute is defined by a combination of two elements. The significance level of the estimated coefficient is the first element. When this falls below 90% confidence level the low or high dummy variable becomes insignificant. And second, a much larger positive than negative effect (or vice-versa) determined by the strength of the estimated coefficient. This occurs when the estimated coefficient from one of the (low or high) performance dummy variable is more than 1.5 larger than the opposing one. We consider that differences of this magnitude are sufficient for measuring the asymmetric impact of low and high dummy variables.

All the statistical analyses were performed and tabulated using SPSS 24 and Microsoft Excel respectively.

5. Analysis and results

5.1. Descriptive analysis

The distribution of socio-demographic and travel characteristics of the sample is presented in Table 2. Among all travelers there is an even distribution of gender that is dominated by workers (65%), followed by students (16%) and retired (13%). Oldest age group is somehow underrepresented but age structure is overall well-aligned with the one for Stockholm County. There is a similar share of travelers frequently (weekly or more often) using car and PT (72%). About one-third of PT trips were made by city bus and metro while commuter train and regional bus represent 23% and 7%, respectively. PT captives, those with no driver license, no access to a car or both, account for 37% of the sample. Some differences exist across segments. For example, the presence of a larger share of young respondents (15–30 years old) amongst frequent and captive users compared to their counterparts.

As shown in Table 2 overall travel satisfaction differs between market segments being highest for PT captives (3.62) and frequent and metro users (3.58), and lowest for infrequent (3.22) and commuter train users (3.30). T-tests identified a significant average difference between both PT captives and choice riders (sig. = 0.000) and frequent and infrequent PT users (sig. = 0.000). In addition, ANOVA revealed significant (sig. < 0.100) average differences when comparing most pair combinations of travel modes. Yet, city bus and regional bus travelers' evaluations were not found significantly different. The results

Table 2
Descriptive statistics of socio-demographic and travel characteristics regarding PT use, captivity and PT modes (in %).

		All travelers	PT use		PT captivity		PT modes			
			Freq.	Infreq.	Yes	No	City Bus	Reg. Bus	Comm. train	Metro
Gender	Male	46.6	44.7	51.5	41.3	49.7	43.9	41.5	47.3	50.2
Age	15–30	28.1	34.4	11.8	51.4	14.5	28.4	29.8	24.3	29.9
	31–45	30.7	28.4	36.5	19.5	37.1	28.6	28	33.7	31.3
	46–65	31.8	29	39.1	21.6	37.7	32	29.1	33.4	31
Occupation	Worker	64.6	61.5	72.6	45.8	75.5	60	58.8	69.6	67.3
	Retired	12.9	11.1	17.4	11.9	13.4	15.2	17.4	11.9	10
	Student	16.3	21.4	3	34.1	5.9	17.3	19.3	13.8	16.1
Car use -	Frequent	70.5	63.2	89.5	42.5	86.8	71.2	81	78.5	62
With	disability	3.4	2.8	4.8	4.1	2.9	3.5	3.4	3.1	3.4
Frequent PT traveler		72.1	100	0	90.8	61.3	71.8	64.2	64.3	79.7
PT captive		36.7	46.2	12.1	100	0	39.8	23.7	27.4	40.7
PT mode	City bus	36.4	36.2	36.8	39.4	34.6	100	0	0	0
	Reg. Bus	7.3	6.5	9.3	6.5	7.7	0	100	0	0
	Commuter train	23.2	20.6	29.7	17.3	26.6	0	0	100	0
	Metro	33.2	36.7	24.2	36.8	31.1	0	0	0	100
Overall travel Sat.		3.48	3.58	3.22	3.62	3.40	3.50	3.48	3.32	3.57

of the t-tests and ANOVA provide evidence that different market segments and travel modes should be examined individually.

The evolution of satisfaction evaluations with PT trips and the 12 service attributes included in the analysis was investigated for the considered period (2010–2015). Service attributes' performance ratings remain very constant (<0.3 points of variation) over time following the same trend from a similar study that considered a longer data period (Cats et al., 2015). Ticket accessibility, however, largely fluctuates from 3.91 in 2010 to 3.17 in 2013, to then start and upwards trend. The satisfaction dip could be explained by, amongst others, price increases (2012), and by issues arising from the introduction of electronic cards and changes in SMS ticketing system (2013). The stability of attribute performance over time strengthens the robustness of the multi-level organization devised in the present paper.

5.2. Model specification

Regression with dummy variables is chosen as the three-factor classification approach due to data availability and the advantages mentioned in Section 3.2. Given the ordinal nature of the dependent variable, overall travel satisfaction, Ordered Logit model was considered to be the most adequate regression method to identify the three-factor structure of PT service attributes. Model estimation consists of 10 models: two general models for the entire sample "linear & symmetric performance" (LSP) and "all travelers" (AT), four market segment and four travel mode-specific models. Model specification contains the 12 service attributes, socio-demographic and travel characteristics as independent variables. As explained in Section 4.2, for each service attribute two performance-related dummy variables (*"low performance"* and *"high performance"*) are included in the models, totaling 24 dummies per model.

For comparison purposes, we also estimate a reference model – LSP – where all service attributes are included as factors while controlling for the same set of socio-demographic and travel characteristics. LSP model is based on the conventional assumption that the relationship between attributes and overall travel satisfaction performances is linear and symmetric.

The estimation of separate models for distinct traveler segments and travel modes is performed in response to the identification in Section 2.1 of differing travelers' needs and expectations and travel modes characteristics that justify a separate investigation. Commuter train and regional bus models may, in addition, reflect the needs of travelers that live in less urbanized areas of the County.

For each of the models, Tables 3A and 3B display the estimated coefficients in one column (Estim.) and the significance values (Sig.) in another. Significance levels are represented in the table by one, two or three asterisks for values of 99%, 95%, and 90% confidence interval, respectively. Insignificant variables (<90%) are displayed in the table without an asterisk. The

Table 3A

Models results for the Linear and Symmetric Performance (all travelers) and for the Regression with Dummy variables (All travelers, by captivity and by frequency of PT use): socio-demographic, travel characteristics and goodness of fit.

	Linear-symmetric performance (LSP)		All travelers – AT		Captives		Non-captives		Frequent traveler		Infrequent traveler	
	Estim.	Sig.	**Estim.**	Sig.	**Estim.**	Sig.	**Estim.**	Sig.	**Estim.**	Sig.	**Estim.**	Sig.
Male[a]	**0.103**	0.022**	**0.094**	0.035	**0.112**	0.127	**0.089**	0.114	**0.119**	0.023**	**0.020**	0.814
15–30[b]	**−0.945**	0.000*	**−0.912**	0.000*	**−0.849**	0.000*	**−0.985**	0.000*	**−1.034**	0.000*	**−0.449**	0.054***
31–45[b]	**−0.399**	0.001*	**−0.416**	0.001*	**−0.389**	0.068***	**−0.524**	0.000*	**−0.429**	0.005*	**−0.431**	0.034**
46–65[b]	**−0.311**	0.007*	**−0.299**	0.008*	**−0.272**	0.167	**−0.382**	0.007*	**−0.289**	0.043**	**−0.332**	0.076***
Worker[c]	**−0.072**	0.446	**−0.095**	0.304	**−0.013**	0.923	**−0.202**	0.111	**−0.170**	0.127	**0.134**	0.430
Retired[c]	**0.111**	0.410	**0.199**	0.132	**0.496**	0.014**	**−0.055**	0.757	**0.236**	0.149	**0.227**	0.319
Student[c]	**0.032**	0.773	**0.023**	0.832	**0.250**	0.091***	**−0.367**	0.039**	**0.056**	0.658	**−0.039**	0.896
Car use -Freq.[d]	**−0.144**	0.012**	**−0.168**	0.003*	**−0.188**	0.015**	**−0.169**	0.048**	**−0.172**	0.005*	**−0.079**	0.615
With disability[e]	**−0.080**	0.518	**0.030**	0.803	**0.261**	0.150	**−0.192**	0.245	**0.115**	0.462	**−0.042**	0.830
PT captivity[f]	**0.058**	0.336	**0.084**	0.152	**na.**	na.	**na.**	na.	**0.070**	0.278	**0.252**	0.104
Freq.PT traveler[g]	**0.341**	0.000*	**0.348**	0.000*	**0.159**	0.211	**0.418**	0.000*	**na.**	na.	**na.**	na.
City bus[h]	**−0.025**	0.779	**−0.043**	0.629	**0.004**	0.981	**−0.067**	0.545	**−0.065**	0.556	**−0.023**	0.881
Metro[h]	**−0.102**	0.269	**−0.096**	0.289	**−0.056**	0.717	**−0.109**	0.339	**−0.086**	0.440	**−0.170**	0.294
Comm. train[h]	**−0.482**	0.000*	**−0.462**	0.000*	**−0.269**	0.098***	**−0.562**	0.000*	**−0.497**	0.000*	**−0.420**	0.007*
Nagelkerke R sq.	0.594		0.555		0.487		0.588		0.521		0.588	
N	9171		9171		3365		5806		6620		2551	

na. not applicable.
[a] Female.
[b] >65.
[c] Other occupation.
[d] Infrequent car traveler (monthly or less).
[e] With no disability.
[f] Non-captive.
[g] Infrequent traveller.
[h] reg.bus.

Table 3B
Models results for the Regression with Dummy variables: socio-demographic, travel characteristics and goodness of fit.

	City bus		Metro		Commuter train		Regional bus	
	Estim.	Sig.	**Estim.**	Sig.	**Estim.**	Sig.	**Estim.**	Sig.
Male[a]	**0.071**	0.338	**0.043**	0.583	**0.178**	0.054***	**0.213**	0.215
15–30[b]	−**1.233**	0.000*	−**0.834**	0.001*	−**0.810**	0.004*	**0.243**	0.603
31–45[b]	−**0.671**	0.000*	−**0.224**	0.338	−**0.333**	0.193	−**0.057**	0.893
46–65[b]	−**0.529**	0.002*	−**0.083**	0.706	−**0.213**	0.380	−**0.051**	0.896
Worker[c]	−**0.163**	0.255	−**0.169**	0.290	−**0.142**	0.514	**0.632**	0.121
Retired[c]	−**0.071**	0.727	**0.263**	0.288	**0.326**	0.275	**1.046**	0.047**
Student[c]	**0.109**	0.529	−**0.017**	0.928	−**0.052**	0.841	−**0.020**	0.967
Car use -Freq.[d]	−**0.157**	0.092***	−**0.127**	0.189	−**0.248**	0.052***	−**0.108**	0.636
With disability[e]	**0.140**	0.479	−**0.127**	0.553	**0.015**	0.956	**0.417**	0.360
PT captivity[f]	**0.053**	0.578	**0.026**	0.800	**0.294**	0.025**	**0.013**	0.952
Freq.PT traveler[g]	**0.313**	0.001*	**0.423**	0.000*	**0.286**	0.009*	**0.442**	0.026**
City bus[h]	**na.**	na.	**na.**	na.	**na.**	na.	**na.**	na.
Metro[h]	**na.**	na.	**na.**	na.	**na.**	na.	**na.**	na.
Comm. train[h]	**na.**	na.	**na.**	na.	**na.**	na.	**na.**	na.
Nagelkerke R sq.	0.564		0.556		0.555		0.522	
N	3333		3049		2123		666	

na. not applicable.
[a] Female.
[b] >65.
[c] Other occupation.
[d] Infrequent car traveler (monthly or less).
[e] With no disability.
[f] Non-captive.
[g] Infrequent traveller.
[h] reg.bus.

sample size for each of the models (N) and the widely used Nagelkerke pseudo R square index are displayed at the end of Tables 3A and 3B.

5.3. Model results and discussion

The goodness of fit of the models implies that between 49 and 59% of the variation in overall trip satisfaction is explained by the explanatory variables. LSP and AT models yield very similar Nagelkerke R square coefficients, 0.59 and 0.56 respectively, which indicates that overall both models are equally good. All models are superior to the intercept-only models based on the log-likelihood ratio test.

Table 3A and 3B show model results of the socio-demographic and travel characteristics control variables. In general, there are no significant differences between male and female. The only exceptions are male commuter train and frequent PT travelers that are found to be significantly more satisfied than their female counterparts. In line with other studies (e.g. Mouwen, 2015), the older the traveler is the more satisfied he/she becomes. In general, occupation levels have no significant effects on traveleŕs satisfaction. Yet, for captives and regional bus models, retired travelers are significantly more satisfied than other travelers. Further, retired and students who travel by PT often (frequent traveler) are more satisfied than those that have "other" occupation. Moreover, having any type of disability that limits the opportunities to travel with PT was found insignificant across all models.

Regarding travel characteristics and concurrent with other studies (e.g. Abenoza, Liu, Cats, & Susilo, 2019), frequent car travelers are found to be less satisfied than other travelers while the opposite occurs for PT frequent users (e.g. Woldeamanuel & Cygansky, 2011). Amongst travel modes, commuter train travelers are consistently less satisfied than regional bus travelers, which contradicts the results of St-Louis et al. (2014).

Results from linear & symmetric performance model (LSP) are shown in Table 4A. While all service attributes are significant at a 99% confidence interval the implicit importance obtained greatly varies amongst them. The attributes that most influence traveleŕs overall satisfaction are Trip duration and Customer interface followed at a distance by Security, Operation and Staff and assistance. On the other end of the spectrum, Ticket accessibility, On-board conditions, and Information with planned and unplanned changes are found to be the least influential ones. If attribute performance and importance were considered together, as in conventional IPA, the priority quadrant would be populated by Customer interface and Trip duration while the second priority quadrant would have consisted of Security, Operation and Staff and assistance.

Tables 4A–4D show model results for the 12 service attributes. For each attribute, a pair of estimated coefficients are presented, one referring to low (1 and 2) and the other to high performance (4 and 5). As described in Section 4.2, the combination of significance level and strength of the coefficient for each attribute determines its classification into the three-factor structure.

Table 4A
Model results for the Linear and Symmetric Performance model (all travelers) and for the Regression with Dummy variables (all travelers, frequent and infrequent travelers).

	Linear and Symmetric Performance - LSP		All travelers – AT					Frequent travelers					Infrequent travelers				
	Estim.	Sig.	**Eval.**	Low performance		High Performance		**Eval.**	Low performance		High Performance		**Eval.**	Low performance		High Performance	
				Estim.	Sig.	**Estim.**	Sig.		**Estim.**	Sig.	**Estim.**	Sig.		**Estim.**	Sig.	**Estim.**	Sig.
Gen. Info.	0.174	0.000*	4.15	−0.236	0.019**	0.346	0.000*	4.18	−0.325	0.007*	0.344	0.000*	4.10	−0.039	0.831	0.313	0.011**
Ticket. Acc.	0.118	0.000*	3.57	−0.298	0.000*	0.090	0.116	3.76	−0.302	0.001*	0.010	0.886	3.13	−0.270	0.016**	0.338	0.002*
Operation	0.373	0.000*	3.54	−0.489	0.000*	0.516	0.000*	3.72	−0.432	0.000*	0.514	0.000*	3.18	−0.595	0.000*	0.520	0.000*
Network	0.179	0.000*	3.39	−0.125	0.064***	0.387	0.000*	3.63	−0.048	0.578	0.357	0.000*	2.83	−0.257	0.021**	0.492	0.000*
On-board Cond.	0.121	0.000*	3.47	−0.127	0.079***	0.243	0.000*	3.51	0.010	0.910	0.259	0.000*	3.41	−0.415	0.002*	0.258	0.008*
Staff Ass.	0.292	0.000*	3.69	−0.548	0.000*	0.316	0.000*	3.72	−0.532	0.000*	0.326	0.000*	3.62	−0.573	0.000*	0.316	0.002*
Ride Comfort	0.150	0.000*	3.60	−0.192	0.014**	0.265	0.000*	3.65	−0.117	0.214	0.350	0.000*	3.50	−0.354	0.011**	0.079	0.435
Duration	0.670	0.000*	3.42	−0.825	0.000*	0.812	0.000*	3.54	−0.887	0.000*	0.854	0.000*	3.16	−0.790	0.000*	0.680	0.000*
Security	0.418	0.000*	3.80	−0.504	0.000*	0.565	0.000*	3.90	−0.474	0.000*	0.591	0.000*	3.58	−0.532	0.000*	0.550	0.000*
Info. planned	0.151	0.000*	3.03	−0.234	0.000*	0.200	0.001*	3.09	−0.267	0.000*	0.207	0.003*	2.91	−0.172	0.136	0.159	0.178
Info. Unplan.	0.173	0.000*	2.71	−0.213	0.000*	0.320	0.000*	2.77	−0.170	0.017**	0.320	0.000*	2.60	−0.297	0.008*	0.299	0.029**
Customer Int.	0.566	0.000*	2.79	−0.669	0.000*	0.768	0.000*	2.85	−0.655	0.000*	0.801	0.000*	2.68	−0.712	0.000*	0.668	0.000*

Table 4B
Model results for the Regression with Dummy variables by level of captivity.

	Captive					Non-captive				
	Eval.	Low performance		High Performance		**Eval.**	Low performance		High Performance	
		Estim.	Sig.	**Estim.**	Sig.		**Estim.**	Sig.	**Estim.**	Sig.
Gen. Info.	4.10	−0.197	0.241	0.277	0.010*	4.14	−0.276	0.028**	0.378	0.000*
Ticket. Acc.	3.13	−0.207	0.108	0.264	0.006*	3.41	−0.366	0.000*	0.001	0.992
Operation	3.18	−0.348	0.008*	0.463	0.000*	3.47	−0.560	0.000*	0.557	0.000*
Network	2.83	−0.158	0.223	0.350	0.000*	3.21	−0.114	0.154	0.412	0.000*
On-board Cond.	3.41	−0.021	0.861	0.307	0.000*	3.46	−0.194	0.033**	0.216	0.001*
Staff Ass.	3.62	−0.417	0.002*	0.464	0.000*	3.69	−0.617	0.000*	0.228	0.001*
Ride Comfort	3.50	0.064	0.654	0.352	0.000*	3.52	−0.317	0.001*	0.226	0.001*
Duration	3.16	−0.732	0.000*	0.800	0.000*	3.32	−0.874	0.000*	0.844	0.000*
Security	3.58	−0.534	0.002*	0.354	0.000*	3.73	−0.485	0.000*	0.690	0.000*
Info. planned	2.91	−0.366	0.001*	0.048	0.614	2.95	−0.149	0.055***	0.318	0.000*
Info. Unplan.	2.60	−0.048	0.625	0.326	0.001*	2.62	−0.311	0.000*	0.303	0.001*
Customer Int.	2.68	−0.613	0.000*	0.766	0.000*	2.72	−0.718	0.000*	0.770	0.000*

Table 4C
Model results for the Regression with Dummy variables by travel mode (City and Regional buses).

	City Bus					Regional Bus				
	Ev.	Low performance		High Performance		**Ev.**	Low performance		High Performance	
		Est.	Sig.	**Est.**	Sig.		**Est.**	Sig.	**Est.**	Sig.
Gen. Info.	4.15	−0.403	0.015**	0.212	0.051***	4.15	0.267	0.459	0.325	0.197
Ticket. Acc.	3.50	−0.270	0.013**	0.181	0.057	3.34	−0.234	0.335	−0.285	0.178
Operation	3.49	−0.486	0.000*	0.514	0.000*	3.31	−0.674	0.006*	0.640	0.002*
Network	3.41	−0.146	0.193	0.417	0.000*	3.34	0.033	0.892	0.689	0.002*
On-board Cond	3.50	−0.162	0.182	0.272	0.001*	3.60	−0.379	0.217	0.279	0.157
Staff Ass.	3.66	−0.387	0.006*	0.464	0.000*	3.68	−1.229	0.000*	0.208	0.326
Ride Com.	3.63	−0.161	0.230	0.149	0.094***	3.62	−0.017	0.954	0.468	0.020**
Duration	3.39	−0.615	0.000*	0.972	0.000*	3.42	−0.958	0.000*	0.510	0.016*
Security	3.83	−0.475	0.003*	0.618	0.000*	3.85	−0.556	0.122	0.374	0.095***
Info. planned	3.04	−0.304	0.003*	0.071	0.47	3.03	0.091	0.697	0.172	0.455
Info. Unplan.	2.69	−0.220	0.027**	0.447	0.000*	2.65	−0.449	0.040**	0.144	0.568
Customer Int.	2.84	−0.649	0.000*	0.715	0.000*	2.79	−0.325	0.112	0.667	0.006*

Table 4D
Model results for the Regression with Dummy variables by travel mode (Metro and Commuter Train).

	Metro					Commuter Train				
	Ev.	Low performance		High Performance		**Ev.**	Low performance		High Performance	
		Est.	Sig.	**Est.**	Sig.		**Est.**	Sig.	**Est.**	Sig.
Gen. Info.	4.20	−0.148	0.427	0.341	0.004*	4.11	−0.261	0.193	0.547	0.000*
Ticket. Acc.	3.72	−0.301	0.018**	0.208	0.043**	3.62	−0.501	0.001*	−0.133	0.264
Operation	3.79	−0.591	0.000*	0.549	0.000*	3.46	−0.345	0.013**	0.446	0.000*
Network	3.53	−0.296	0.019**	0.289	0.004*	3.25	0.060	0.647	0.395	0.001*
On-board Cond	3.47	−0.123	0.340	0.221	0.014**	3.42	−0.013	0.930	0.307	0.004*
Staff Ass.	3.70	−0.712	0.000*	0.251	0.007*	3.74	−0.477	0.010**	0.227	0.039**
Ride Com.	3.61	−0.086	0.517	0.385	0.000*	3.60	−0.457	0.005*	0.224	0.037**
Duration	3.56	−0.866	0.000*	0.772	0.000*	3.32	−1.088	0.000*	0.767	0.000*
Security	3.81	−0.590	0.000*	0.657	0.000*	3.78	−0.386	0.034**	0.451	0.000*
Info. planned	3.11	−0.278	0.013**	0.258	0.017**	2.96	−0.216	0.088***	0.358	0.005*
Info. Unplan	2.84	−0.088	0.416	0.301	0.010**	2.62	−0.227	0.067***	0.175	0.221
Customer Int.	2.82	−0.624	0.000*	0.859	0.000*	2.70	−0.859	0.000*	0.747	0.000*

A summary of the attribute factor structure obtained from Tables 4A–4D is presented in Table 5. Considering all models together about half of the attributes (49) are classified into the performance factor while the remaining are either exciting (32) or basic (22) attributes. For a general traveler (i.e. AT model) most attributes (8) can positively or negatively contribute (performance) to overall travel satisfaction depending on how good or bad the given attribute is perceived to perform. On the contrary, an equal number (2) of attributes can either exclusively exert a negative (basic) or a positive (exciting) influence on the overall experience.

Table 5
Classification of service attributes into different factors (basic, performance and excitement) regarding travelers level of captivity, travel mode used and frequency of PT use.

	All travelers - AT	Frequent PT use?		PT Captivity?		Travel modes				b - basic	p - performance	e - exciting
		Yes	No	Yes	No	City bus	Reg. Bus	Comm. Train	Metro			
Gen. Info.	p	p	e	e	p	b	–	e	e	1	3	4
Ticket. Acc.	b	b	p	e	b	b	b	b	p	5	2	1
Operation	p	p	p	p	p	p	p	p	p	–	9	–
Network	e	e	e	e	e	e	e	e	p	–	1	8
On-board Cond.	e	e	b	e	p	e	–	e	e	1	1	6
Staff Ass.	b	b	b	p	b	p	b	b	b	7	2	–
Ride Comfort	p	p	b	e	p	e	e	b	e	2	3	4
Duration	p	p	p	p	p	e	b	p	p	1	7	1
Security	p	p	p	b	p	p	e	p	p	1	7	1
Info. Planned	p	p	–	b	e	b	–	e	p	2	3	2
Info. Unplan.	p	e	p	e	p	e	b	b	e	2	3	4
Customer Int.	p	p	p	p	p	p	e	p	p	–	8	1
b -basic	2	2	3	2	2	3	3	4	1	22	49	32
p –performance	8	7	6	4	8	4	1	4	7	49		
e -exciting	2	3	2	6	2	5	4	4	4	32		

Note: 1 to 9 shows the recurrence of factor classification amongst attributes and traveler segments.
b = basic, p = performance, e = excitement.

The number of attributes classified into the same factor is very similar among traveler segments and travel modes, especially for travelers with distinct travel frequency and between bus and commuter train travelers. Yet, PT captives perceive a much larger number of attributes as exciting compared with non-captives, which might be explained by the relatively low expectation of the captive travelers towards the given service. For this group of travelers, as long as the travel was as expected (i.e. safe, no disturbance) and within the expected travel duration, it would be considered sufficient and anything additional is perceived as a treat. Further, unlike other modes, metro travelers' factor structure is composed of a single basic attribute and of a larger set of performance attributes (7). In addition, one-fourth of all regional bus attributes are found insignificant for both low and high performance and thus could not be classified into any factor category.

An attribute-level comparison of factor classification among traveler segment and travel modes unveils considerable disparities. When comparing city and regional bus services, classification diverges for 2/3 of all attribute level classifications. The same share of divergence is present amongst captive and non-captive travelers. About half (50–58%) of the attributes are classified into the same factor for travelers with a differing frequency of PT use and between rail mode travelers (commuter train and metro).

All models considered, a large number of service attributes are consistently classified into the same factor category. Ticket accessibility and Staff and assistance are chiefly basic attributes; Operation, Trip duration, Security and Customer interface are primarily performance attributes, while Network and On-board conditions can be overall categorized as exciting attributes. The factor affiliation of information related attributes and ride comfort is, however, less conclusive. Yet, they are predominantly categorized as performance and exciting attributes, respectively.

For a general traveler (AT model), service attributes' classification is aligned to the one exposed for all models together. Only attributes with dubious factor affiliation, such as information related attributes and Ride comfort, are classified in a distinct general factor, the performance.

A number of other differences not previously mentioned exist between traveler segments and travel modes. For instance, bus travelers mainly classify information aspects in the basic factor while they are mostly classified as exciting for rail users. Further, Trip duration is a performance attribute for the more reliable rail modes (SLL, 2014) while it is categorized as exciting for the most unreliable mode (city bus). In addition, comfort-related attributes (Ride comfort and On-board conditions) are regarded as exciting by captives and as performance by non-captives. Thus, care must be taken with regard to how these attributes are provided since choice riders' travel satisfaction and their PT use might be negatively affected.

A comparison of the attribute factor classification obtained in this study with that of previous research reveals many differences for analogous attributes and the same travel mode. For city bus, only three of the ten analogous attributes concurred with previous studies (Cao & Cao, 2017; Wu et al., 2018; Zhang et al., 2017). Trip duration (in 2 out of 3 studies) and Network were classified as exciting attributes while Staff and assistance as performance. For metro, three of the seven comparable attributes fell into the same factor, these being Trip duration, Network, and Safety (Cao & Cao, 2017). For regional bus, from amongst ten attributes only Safety was classified in the same – exciting - factor (Wu et al., 2018). These dissimilarities might be due to differences in traveler expectations, comparing very contrasting PT services and to differences in dummy recoding scheme.

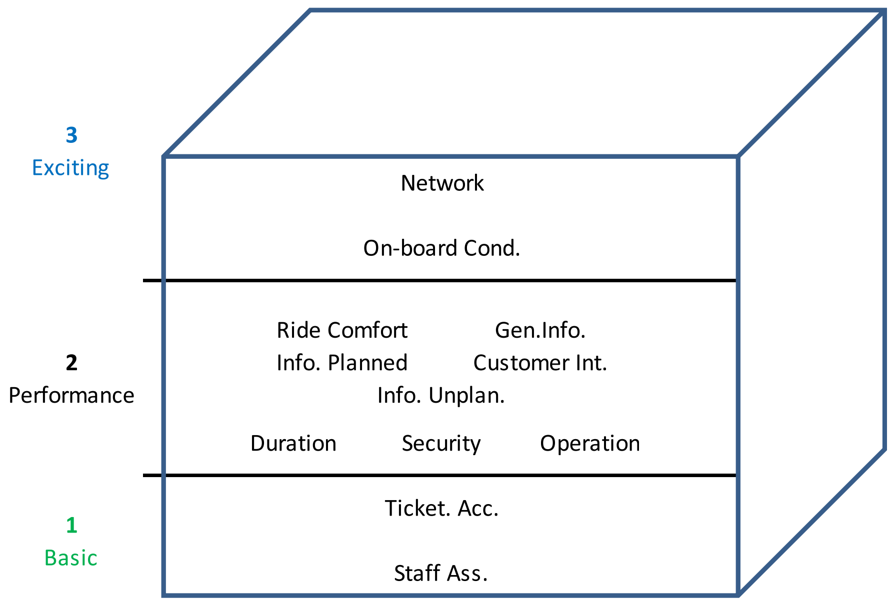

Fig. 2. Multi-level cube of traveler needs for a general traveler.

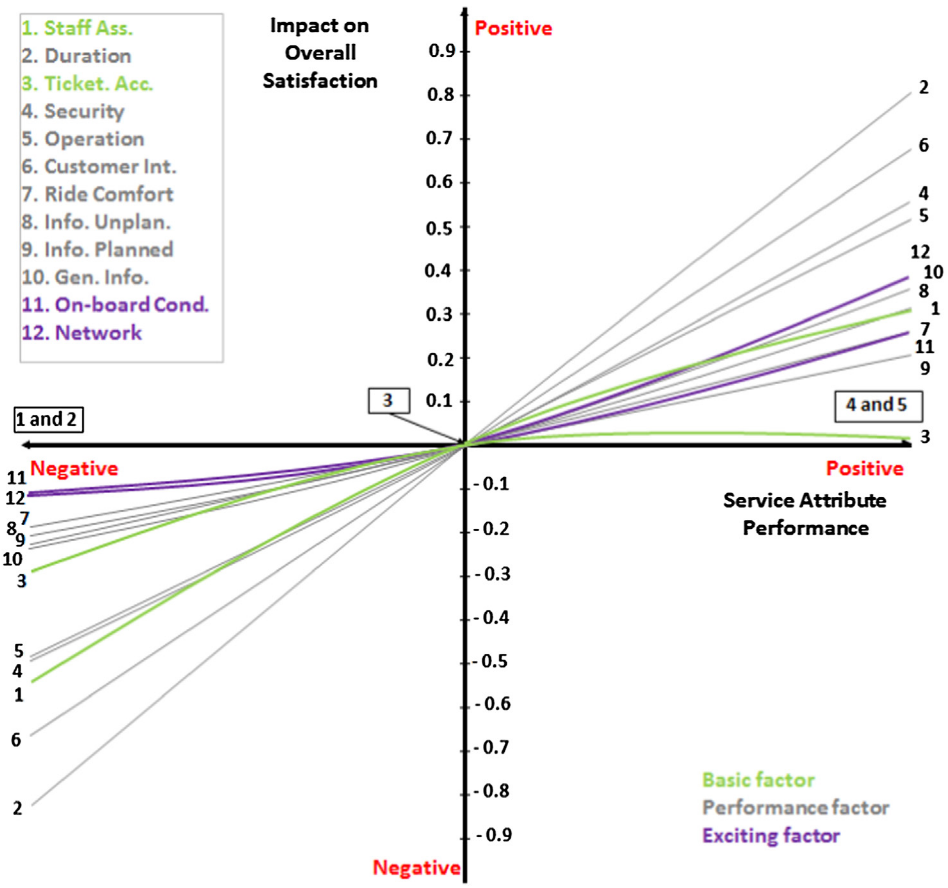

Fig. 3. Shape of the curves of service attributes.

6. A multi-level organization of the essentiality of traveler needs

Service attributes three-factor organization is displayed in cubes (Fig. 2 and Appendix A) consisting in three levels of needs based on their level of essentiality. Essential needs would be formed by those attributes that are expected to be present and well delivered in a given transport service (basic factor) while less essential needs are those that travelers do not feel as an elemental necessity for the service (exciting attributes). The in-between level of essentiality corresponds to performance factor (Kano et al., 1984).

Fig. 2 presents a multi-level organization of service attributes for a general traveler. More essential attributes are located at the bottom (basic factor), moderately essential attributes (performance) at the second level, and less essential attributes at the top (exciting factor). The first level of essential and basic needs is formed by Staff and assistance and Ticket accessibility. The second level of moderately essential traveler needs is formed by safety perceptions while traveling, and operational (Trip Duration and Operation), and information aspects, which all can exert a similar negative and positive effect depending on their performance. Attributes that can mainly bring satisfaction and that ceteris paribus are less essential than all others are Network and On-board conditions. The multi-level cubes of needs for the traveler segments and travel modes considered can be found in Appendix A.

While the nature of the three-factor method alone does not allow establishing preferences and priorities amongst services attributes, the multi-level cubical organization of the three-factors can be employed as a reference point for policy investments. Stakeholders would need to take into account not only the level of essentiality of a given attribute but also some other important aspects, including attributés actual level of performance and the cost of improving it, and the magnitude of its positive and negative impact on the overall travel satisfaction, allowing the identification of priority areas as presented in Cats et al. (2015).

Fig. 3 displays for a general traveler (i.e. AT model) the shape of the curve and factor affiliation of each service attribute. The curves are obtained from plotting the low and high-performance dummy coefficients and represent the relationship between service attribute and overall travel satisfaction. It is worth noting that due to the use of our specific rules (see

Section 4.2) the shapes depicted for the exciting and basic attributes are rather distinct from the conceptual curves exhibited in Fig. 1.

7. Conclusions

This paper aims to classify PT service attributes based on their influence on overall traveler satisfaction. The study examines whether service attributes have a non-linear and asymmetric influence on the overall travel experience. The analysis is done for different traveler segments depending on their level of captivity, travel frequency by PT and travel mode used, and it is based on a relatively large sample size collected for Stockholm County from years 2010 to 2015. Models, in addition, control for important socio-demographic (gender, age, disability) and travel characteristics (trip purpose and car use) that were overlooked in previous studies.

Three-factor theory and regression with dummy variables are employed to identify service attributes' factor structure. Results are presented in the form of a series of 3-level cubes of essential needs for travelers determined by the three-factor nature (basic, performance, and exciting) of the service attributes. The organization of the attribute three-factor structure in 3-levels of essentiality aims to assist stakeholders in the identification of essential areas, and provide a useful methodological framework that can be applied to varied geographical contexts.

Assuming that PT operators and authorities primarily aim at reducing traveler dissatisfaction, first basic attributes are seen as the most essential traveleŕs needs. For a general traveler, these include Staff and assistance and Ticket accessibility. Attribute performance levels and their improvement costs would determine whether these attributes need to be addressed first. For a general traveler, a comparison between the priority areas obtained from conventional IPA and the essentiality areas from the three-factor classification unveils similarities and differences. Both methods yield Staff and assistance as basic and most essential attributes. However, IPA includes Customer interface in the list while three-factor adds Ticket accessibility. Thereby, even though both methods include a very similar set of essentialities, their order changes quite significantly which may result in sub-optimal investments.

Insights have been gained with regard to the categorization of service attributes into the three levels of the three-factor theory where many attributes are persistently classified into the same factor. The consistency by which most service attributes classify into the same factor category also increases the internal and external validity of the study.

The large number of performance attributes found in the general model (AT model) together with the fact that certain attributes (i.e. Operation, Security) are consistently classified into the performance factor concurs with results reported in previous research. Performance attributes have linear and symmetric influence on the overall travel experience and their impact on the overall travel satisfaction is based on their performance. Moreover, our results indicate that the effect of other attributes on overall travel experience might have been over and under-estimated in the past. For instance, the effect on the travel experience of Ticket accessibility and Staff and assistance (basic attributes) has been overestimated in works where these attributes were highly evaluated (e.g. Cats et al., 2015). In turn, the effect of On-board conditions (exciting attributes) has been overestimated in works where their perceived performance was low (e.g. Weinstein, 2000).

The results of this paper demonstrate that a "one size fits all" approach is not adequate for identifying the needs of distinct traveler segments and of travelers using different travel modes. Differences in travelers' needs between traveler segments and travel modes would allow stakeholders to tailor specific measures to improve their travel experience.

Relative to other three-factor methods, regression with dummy variables entails a number of advantages. The method exclusively employs implicit importance and recodes 5-point Likert scale variables into 3 dummy variables (low, medium and high performance). Therefore, customer satisfaction questionnaires could be simplified by decreasing the number of Likert scale points from 5 to 3, and reduced in length by excluding explicit importance questions. In addition, regression with dummy variables can be employed on conventional travel satisfaction surveys, whereas pairwise and multiple comparison matrices require the collection of longer surveys on preference relations. Moreover, compared to other attribute ranking approaches, the beauty of the three-factor theory and in particular of the regression with dummy variables approach is that the inclusion of additional service attributes does not alter the multi-level structure. This is because the three-factor structure is not based on pairwise selection or predicted choice probabilities.

It is worth noting that a given service attribute might be classified into a different factor category depending on changes on travelerś expectations which may vary over a sufficiently long period of time. This attribute factor-category shift would usually occur from exciting to performance and from performance to the basic factor. The speed and the extent to which attributes switch from one-factor category to another could be addressed in future studies.

PT travel costs are omitted from the analysis due to the very low share (<2.5%) of annual income spent in PT in Stockholm (Stad, 2016), and also to the exclusive focus of this study on service attributes. However, when considering other geographical areas future studies may need to include this travel element.

This work contributes to the literature by providing with a number of findings that altogether have important policy implications. The use of a quantitative, simple and versatile method that relaxes the assumptions and overcomes the limitations of previous studies where linearity and symmetry were assumed while enabling to categorize travelers' needs in a list of more essential attributes could assist PT authorities and operators in improving the traveler experience.

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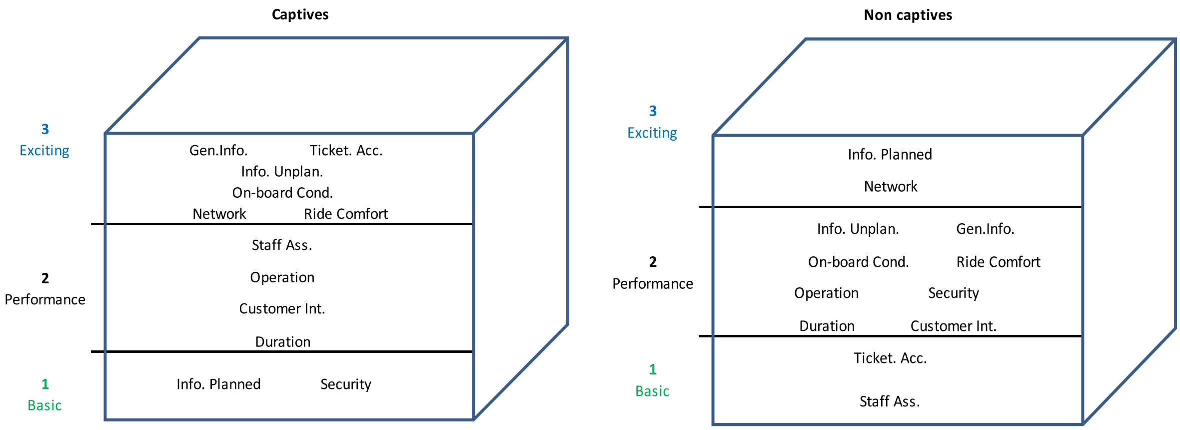
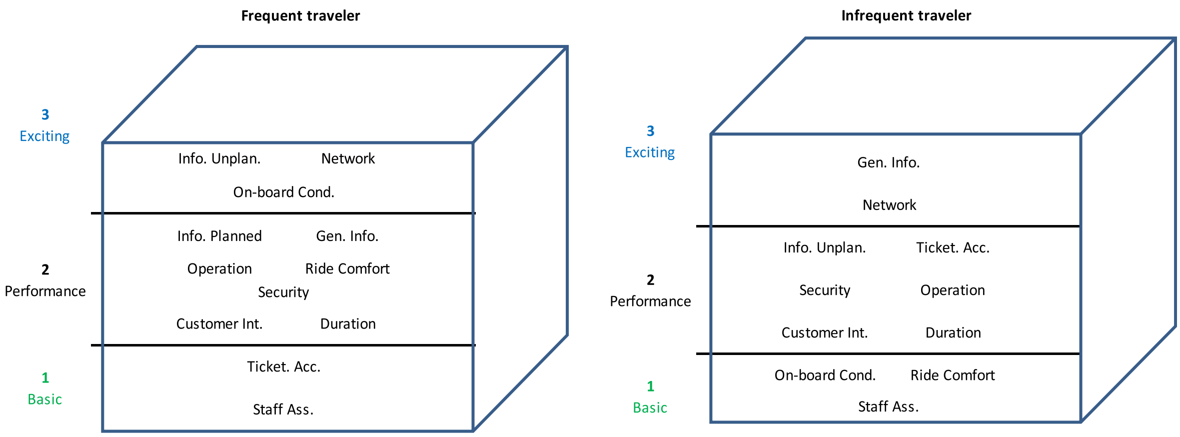
Appendix A

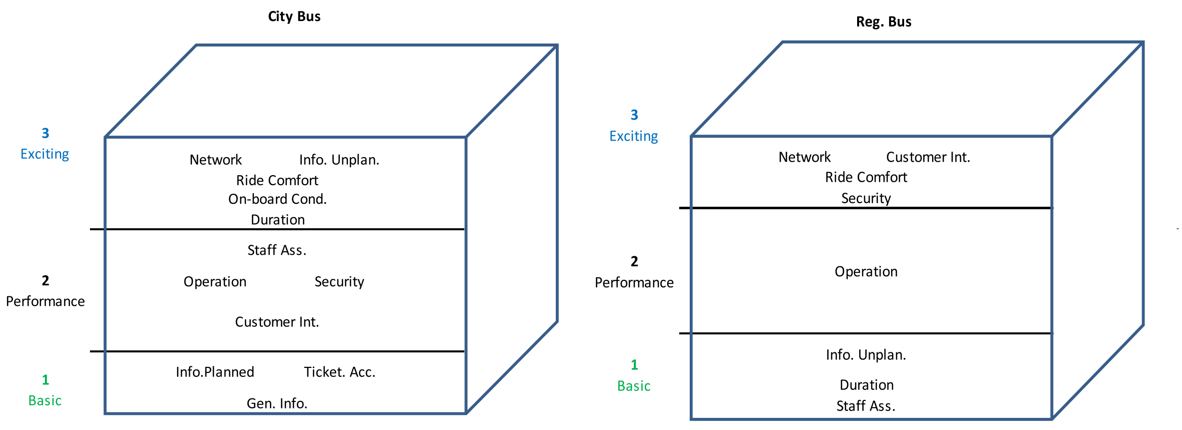
A.1. Multi-level cubes of travelers' needs by level of captivity



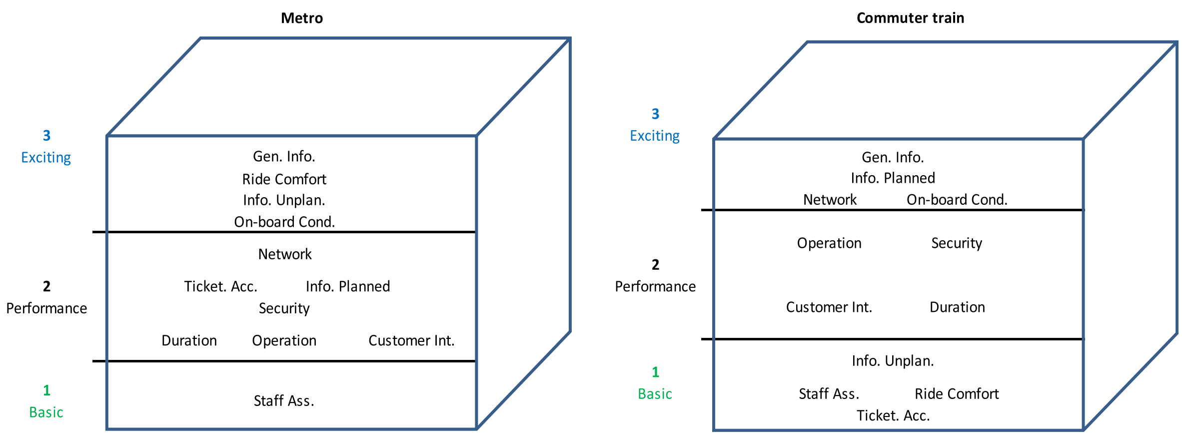
A.2. Multi-level cubes of travelers' needs by frequency of PT use



A.3. Multi-level cubes of travelers' needs by travel mode used: City bus and regional bus (a)



A.4. Multi-level cubes of travelers' needs by travel mode used: Metro and commuter train (b)



Appendix B. Supplementary material

Supplementary data to this article can be found online at https://doi.org/10.1016/j.trf.2019.09.009.

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