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TRAVEL SATISFACTION WITH PUBLIC TRANSPORT: DETERMINANTS, USER CLASSES, REGIONAL DISPARITIES AND THEIR EVOLUTION

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Abstract

Increasing public transport ridership while providing a service that better caters to individual travelers poses an important goal and challenge for society, particularly public transport authorities and operators. This study identifies and characterizes current and potential users of public transport in Sweden and identifies the most important determinants of travel satisfaction with Public Transport services for each segment of travelers. In addition, it investigates the changes over time of attribute importance amongst the different segments and the inter-segment geographical variation of overall satisfaction. The analysis is based on a dataset of almost half a million records. Travelers were clustered based on their socio-demographics, travel patterns and accessibility measures to enable the analysis of determinants of satisfaction for different market segments. The cluster analysis results with five segments of Swedish travelers include: (i) inactive travelers; (ii) long distance commuters; (iii) urban motorist commuters; (iv) rural motorist commuters and; (v) students. By contrasting satisfaction with the importance of each quality of service attribute, three key attributes that should be prioritized by stakeholders are identified: *customer interface, operation, network and length of trip time*. Interestingly, the results suggest an overall similarity in the importance of service attributes amongst traveler segments. Nevertheless, some noticeable differences could be observed. The quality of service attributes' importance levels reveal overall changes in appreciations and consumption goals over time. The more frequent public transport user segments are more satisfied across the board and are characterized by a more balanced distribution of attribute importance whilst rural motorist commuters are markedly dissatisfied with service operation attributes. This work can help authorities to tailor their policies to specific traveler groups.

Keywords:
Customer Satisfaction, Service Quality, Public Transport, Market Segmentation, User Profiles, Geographical Variations

1. INTRODUCTION

Continuous urban growth, environmental issues, competition for limited space, longer commuting distances as well as the need to promote equity and equality in society are the primary reasons that make the use of Public Transport (PT) a priority in today´s world. Customer retention and the attraction of new users can be accomplished by increasing customer satisfaction with PT services and improving their public image, which are widely believed to play decisive roles in rising ridership (TCRP Report 47, 1999). Customer satisfaction is defined as the extent to which service delivery fulfils customers' expectations (Morfoulaki et al., 2007) and it is believed to be a driver of individual attitudes towards PT which in turn influences travel choice, mainly for short distance and urban trips (Diana, 2012).

In recent years, a large number of PT authorities have introduced quality-based incentive payments (Trafikanalys, 2013; Van de Velde et al., 2008; Hensher and Houghton, 2004) in order to monitor and better align the quality of service provided with their customers' needs and expectations. However, different travelers have different needs and priorities. Therefore, there is a need to understand how expectations and satisfaction with quality of service attributes (QoSA), as well as the importance attached to them, varies for different market segments. Furthermore, identifying users' priority areas will help stakeholders to prioritise their investment. This is especially important for making PT more attractive to travelers who do not use it frequently. Evidence-based knowledge on such patterns will facilitate the planning and operations of PT services to better tailor them to travelers' needs. This would help the authorities to concentrate their policies towards a manageable group of travelers, rather than performing market segmentation based on numerous combinations of traveler groups' socio-demographic and external characteristics. In addition, benchmarking similar geographical regions through the comparison of their perceived performance may allow regional stakeholders to transfer best practices.

Determinants of travel satisfaction may vary not only among individuals but also between different geographical regions and over long time periods. Since individuals are capable of learning and adapting over time, their appreciation towards service provision may also change over time. In addition, factors such as urban form, transport accessibility and climate also impact individual travel needs (Liu et al., 2014). Thus, it is of the utmost importance to understand how satisfaction with regard to specific service indicators evolves over time and varies among geographical contexts. To this end, this study is based on the analysis of a very large dataset which consists of almost half a million respondents. The dataset contains cross-sectional data collected over a long period of 14 years from across Sweden. Sweden encompasses different climates from continental to sub-arctic conditions and consists of various regions with uneven population density. In addition, local governments in Sweden have a high degree of autonomy to develop their own land use and PT policies. The size and diversity of the data used in this analysis underpins the representativeness, relevance and robustness of study results.

This paper proposes an analysis approach for analyzing service quality in any given country, region or concession area. The analysis consists of market segmentation, estimating the importance of satisfaction determinants, identifying priority areas and investigating how they evolve over time and vary across spatial units. More specifically this paper makes the following contributions to the growing research on travelers' satisfaction: (i) it segments travelers into PT market segments based on their socio-economic, geographical attributes and travel patterns, including *both* users and non-users of the existing PT services; (ii) it identifies the determinants of satisfaction for each traveler segment, (iii) it explores whether service

attributes' importance changes over time for each segment; (iv) and it investigates whether overall satisfaction varies for different geographical regions.

In the next section, a literature review of travel experience assessment and its determinants with a special focus on socio-demographic and accessibility measures, followed by market segmentation techniques, is provided. We then discuss how Swedish PT users and non-users are segmented in regard of their socio-demographic and accessibility measures. The main determinants of travel satisfaction with PT for each of the traveler's segments are then investigated. Next, we identify the priority areas for each of the segments. This is followed by an investigation of the importance of each attribute and the geographical distribution of overall satisfaction over time and by segment. Finally, we discuss policy recommendations and directions for future research.

2. LITERATURE REVIEW

2.1 Travel Satisfaction and Its Determinants

Researchers have defined travel satisfaction with PT as the overall level of fulfilment with travelers' expectations (Tyrinopoulos and Antoniou, 2008), the completion and fulfilment of needs and the outcome of cumulative and single-experiences. The most negative PT experiences have been shown to be particularly memorable (Friman and Fellesson, 2009). Customer satisfaction is a function of the image of the operator, travelers' expectations, the perceived quality of service and the perceived price-quality ratio (Fornell, 1992).

The relation between service quality and customer satisfaction has been largely controversial. The assertion that an increase in supply leads to an improvement in satisfaction has proved to have its supporters (Barabino et al., 2012) and critics (Friman and Fellesson, 2009). Notwithstanding, there is a general agreement that an increase in overall satisfaction leads to an increase in customer loyalty, which can result in customer retention. Data on subjective traveler perceptions is usually collected through customer satisfaction surveys (on-board, online, phone or focus groups), whereas objective performance measurements are typically conducted by automated data collection techniques and mystery shopping surveys.

Travel satisfaction is commonly measured through overall satisfaction with the service and satisfaction with a range of individuals' QoSA. Overall satisfaction could be interpreted as a measure of how travelers assess the whole package of QoSA (Hensher et al., 2003) while the influence of each of the QoSA on overall satisfaction differs and has been object of study during the last years. Methods for evaluating the importance of each QoSA on overall satisfaction that have been used in the literature can be classified into two main categories: (a) explicitly asking respondents in the customer satisfaction survey for indicating the importance they attach to each QoSA (Tyrinopoulos and Aifadopoulou, 2008; Eboli and Mazzulla, 2009; Guirao et al., 2016); (b) and inferring the importance by modeling the implicit contribution of each QoSA for the overall satisfaction. The following modeling techniques have been employed by researchers: bivariate Pearson correlation, regression analysis of different types, structural equation modelling, path analysis and neural networks (de Oña and de Oña, 2014).

2.2 Attributes influencing satisfaction with the overall experience and with QoSA

Travelers' behavior, experience and satisfaction are believed to depend on individual attributes, contextual variables and attitudes. Previous studies found that socio-demographic characteristics such as gender, age, occupation, income, car availability and education play an important role. For instance, stated importance studies for bus services show that in lines used predominantly by workers, some service attributes such as punctuality, frequency, bus driving security and information service are most important (Guirao et al., 2016). Alternatively, ease of ticket purchase, on-board security and reliability are regarded are the most important

attributes in predominantly transporting students (Eboli and Mazzulla, 2009). In turn, derived importance studies show that comfort is the most relevant attribute for riders over 65 (Dell'Olio et al., 2011) while sense of security (Yavuz and Welch, 2010) and cleanliness (Dell'Olio et al., 2011) are important factors in determining travel satisfaction for women. Trip purpose, frequency of travel and time spent in the travel mode are also key determinants of travel experience. Leisure travelers in Manchester prioritized ease of use over efficiency measures (Thompson and Schofield, 2007). Commuters in Dublin valued reliability of service, waiting times and comfort as their top priorities (Cantwell et al., 2009). In contrast, comfort was found to be most valued by non-frequent PT users (Dell'Olio et al., 2011). In the same vein, researchers reported that overall satisfaction is higher for riders over 65 (Mouwen, 2015) and for young travelers. In addition, more frequent users (Susilo and Cats 2014), women and non-PT users (Beirão and Cabral, 2008) were found to be less satisfied than their counterparts. Satisfaction with different transport modes was also found to be influenced by different individual and travel attributes (Susilo and Cats, 2014).

Travel satisfaction and its determinants change from region to region. There is a disparity in overall satisfaction levels depending on the urban area/community size and on the socio-demographic profile (Friman and Fellesson, 2009). Similarly, Diana (2012) concluded that frequency of use is linked with the size of the urban area, being higher for dwellers of city centers and the most populated municipalities, whilst, on average, overall satisfaction is highest in smaller municipalities. Furthermore, other geographical factors as well as differences in PT service and infrastructure, culture and tradition, influence overall travel satisfaction (Fellesson and Friman, 2008). Accessibility measures defined as proximity and availability to PT are important drivers of satisfaction and frequency of use. Thus, low accessibility measures negatively affect the overall assessment of the travel experience (Woldeamanuel and Cygansky, 2011) and the PT usage frequency (Brons et al., 2009).

2.3 Market Segmentation methods and their spatial and temporal components

The heterogeneity in travelers' evaluation of PT services can be investigated by applying market segmentation techniques. Segmentation is a data mining technique used to identify groups of respondents who have similar characteristics. Segmentation can be either applied a priori or ad-hoc (TCRP Report 47, 1999). The former is based on user-defined segmentation assumptions and criteria for example that different pre-defined segments of travelers (commuters, women, etc.) have different needs (Dell'Olio et al., 2011; Cantwell et al., 2009; Susilo and Cats, 2014). The latter is an unsupervised data-driven segmentation, although the variables considered are based on previous research and can be based on geographic, demographic, behavioural or psychographic variables (Sullivan and O'Fallon, 2009). The stratification techniques include correspondence analysis, decision tree algorithms (ie: chi square automatic interaction detection), discriminant analysis, MNL and cluster analysis. Previous studies examined the determinants of travel satisfaction for different user groups. Krizek and El-Geneidy (2007) stratified urban commuters based on their travel habits and preferences. Their main objective was to identify segments that should be targeted by PT authorities' marketing plans. They found that drivers' attitudes, values of time, safety, comfort and travel time were the most important problem areas. Bhat (1997) performed an endogenous segmentation based on socio-demographic and trip characteristics with the aim of estimating inter-city travel mode choice in the Toronto-Montreal corridor. His approach involved testing different segmentation algorithms and resulted in a three-segment solution with very different intrinsic preferences for modes and level-of-service sensitivity. Factor analysis and structural equation modeling were employed by Shiftan et al. (2008) to first reduce the set of travel attitude variables and then cluster the population based on socio-economic attributes and travel attitudes. The analysis resulted in eight traveler groups

characterized by their sensitivity to time, need for fixed schedule and willingness to use PT, which were found to be the best attitudinal factors in defining market segments. In addition, Jacques et al. (2009) identified 21 groups of travelers by partitioning the population in regard to their travel characteristics, trip satisfaction, trip practicality (a ratio between travel time of the alternative mode and the chosen mode), familiarity and age. These traveler groups were further categorized into four final clusters based on their trip satisfaction and practicality scores, which were labeled as: utilitarianism, convenience, dedication and true captivity.

Spatial aspects were also considered by Badoe and Miller (1998) in their analysis for the city of Toronto. They employed an automatic interaction detection segmentation procedure to determine the relative influence of spatial factors, level of service and socioeconomic characteristics in influencing travel behavior. De Oña et al. (2014) clustered PT users in a medium sized Spanish city based on socio-demographic and travel characteristics. Based on a cross-correlation analysis, they found that frequent service was preferred by middle aged women who ride by choice, while young students value punctuality the most.

Several studies explored alternative approaches to the traditional dichotomy between captive and choice riders. Anable (2005) linked attitudes and behavior to determine the motivation and the profile of potential mode switchers. Her study provided an insight to the intentions, behaviors, drivers and constraints for modal shift of different groups of travelers and revealed a larger than expected proportion of mode switchers. Another set of travel attitude variables was used by Beirão and Cabral (2008) to define six segments with different behavior, preferences and levels of car usage. A multimodal perspective was adopted by Diana and Mokhtarian (2009) when considering objective and subjective multimodal mobility levels, desired modal changes and socio-demographic attributes as clustering variables. Their findings include the desire of heavy travelers of a particular mode to bring some more balance into their modal consumption and the importance of including mobility levels and desired changes in modal use to predict travel behavior.

To the best of our knowledge, no previous research has stratified travelers based on a combination of their socio-demographic attributes, travel characteristics and accessibility measures, using such an extensive and comprehensive dataset that encompasses diverse traveler groups including non-PT users from different geographical contexts similar to the one analyzed in this study. Furthermore, previous studies considered customer satisfaction of PT services in a cross sectional manner only.

The time-series analysis approach taken in this paper allows a unique comparison of different traveler segments with respect to derived importance of each QoSA and the regional variability of overall satisfaction. This enables investigation of whether the importance attached to the service attributes evolves with time as suggested by Mittal et al. (2001). The study of De oña et al. (2016) proposes a methodology to monitor the evolution over time of satisfaction and importance values for a given PT area. Their method involves the calculation of simple and composite index numbers by fixed and chain-based methods where service attribute importance values are obtained from Pearson correlation with overall satisfaction. Fixed and chain based methods provide a good picture of whether the service quality is improving or worsening over time through comparison with prior year. Cats et al. (2015) investigated the changes in attribute level importance from 2001 to 2013 for an average Swedish PT user, disregarding non-PT users. They concluded that even though attribute importance varies considerably over time for some QoSAs, their overall positioning in an importance performance analysis was not affected. Kano et al. (1984) argued that a negative perception towards the performance of certain service attributes may raise their relative importance. They claimed that fulfilment of these basic service attributes will result in a decrease of their perceived importance. Alternatively different service attributes that are

perceived to be modern and fashionable, such as low-floor vehicles and real-time information displays, may become prominent, but may be taken for granted with time. (Kano et al., 1984; Diana, 2008; Susilo et al., 2012). Thus, one of the original contributions of this study is to investigate how the importance of service attributes and their inter-segment variability have evolved over a 14 years' time span.

3. METHODOLOGY AND SURVEY DESCRIPTIONS

The Swedish Public Transport Association (*Svensk Kollektivtrafik -SKT*), a trade organization representing the regional PT agencies of the 21 Swedish counties, has conducted a rolling survey, known as the Swedish Public Transport Barometer (SPTB) since 2001.The SPTB is aimed at monitoring developments in the PT market. Different respondents are interviewed on a regular basis year-round (SKT, 2013) and therefore seasonal variability is averaged out. The analysis in this paper considers the SPTB dataset from 2001 to 2014.

To achieve our research objective, we first examined descriptive statistics to understand and characterize the dataset. We then employed an ad-hoc cluster analysis technique to partition respondents into meaningful segments. We constructed a detailed profile for each of the segments by means of cross-tabulation and bivariate analysis. Subsequently, we employed ordered logit regression models to determine the underlying importance of each of the QoSA in determining overall satisfaction. We then displayed the relative importance and satisfaction of each of the QoSAs to identify priority areas. Lastly, we investigated the changes in attribute importance over time among the different segments and the inter-segment geographical variation of overall satisfaction. The above is instrumental in revealing the differences and similarities in user group needs and the extent to which they are satisfied with PT services. The statistical analyses were performed using Microsoft Excel, SPSS 22.0 and a tailored script written in Matlab. Table 1 presents all of the variables used in this study and their respective sources and roles in the analysis.

Table -1: Swedish Public Transport Barometer and additional data sources

Type of variable	Source/ Year	Variables	Used in*			
			S	R	W	O
Service & Quality	SPTB 2001-2014	**Overall satisfaction with PT**		x		
		Customer interface (service providers' responsiveness) *The PT company is responsive to feedback and suggestions.*		x		
		Freedom from crime (risk perception, security) *It feels secure by traveling with PT.*		x		
		General information (ease of getting info. on departures) *It is easy to get information on departure times.*		x		
		Information on planned changes (of routes & schedules) *Information on changes of schedules and routes are good.*		x		
		Information on unplanned changes (with respect to delays) *Information for delays and stops works well.*		x		
		Length of trip time (speed, directness) *Traveling with PT is fast.*		x		
		Network (the suitability of PT lines to passengers' needs) *PT lines/routes run through the best way for me.*		x		
		On-board conditions (cleanliness, vehicle design) *It is clean and tidy on-board.*		x		
		Operations (service frequency) *Departure times fits your needs.*		x		
		Ride comfort (seat availability and comfort) *It sits comfortably while traveling.*		x		
		Staff and assistance (drivers' and other staff friendliness) *The driver´s and the staff´s behaviour are nice.*		x		
		Ticket accessibility (ease of purchasing tickets) *It is easy to buy PT tickets or cards.*		x		
Service & Quality	SPTB 2001 to mid-2010	**Reliability** (Adherence to schedule) *It is reliable to travel by PT.*				x
		Station maintenance *Stops and stations are well maintained.*				x
		Proximity *It is close to stops and stations.*				x
Individual attributes	SPTB 2001-2014	**Gender**	x			
		Age	x			
		Occupation	x			
		Driving license	x			
		Car availability at household	x			
	2010-2014	**Frequency of travel by PT**	x			
		Distance to work or school	x			
		Frequency of travel by car				x
Accessibility measures	Trafik analys 2011	**Job accessibility** (% of jobs located within a km. from a stop which is served between 6 and 9 am at least 3 days per week)	x			
		Proximity to amenities (index from 0 to 1 calculated on the population´s proximity to grocery stores, schools & health care centers	x			
Population composition	SCB 2001-2014	**Density of population** at municipality and county level			x	
		Gender distribution			x	
Perceptions & attitudes	SPTB 2007-2014	Loyalty, knowledge, competitiveness, relevance, quality, value for money, recommendation				x
Post codes	Geonames	**Geocoded postcodes**				x

*S: Segmentation; R: Regression model; W: Weighting; O: Other

The SPTB is the primary data source from which service quality, individual attributes, perceptions and attitudes are available at the individual level. A phone survey is performed based on a cluster sampling technique. Sample size increases over the years from 13,000 respondents in 2001 to more than 50,000 respondents in 2010 onwards. The survey is not limited to only PT users[1]. Between 2001 and 2014, 563,855 respondents were interviewed, which is roughly 38,000 respondents per year. Due to the impossibility of linking all postcodes with a particular municipality, 453,564 respondents were retained in the analysis after the data cleaning stage. The survey includes questions concerning general satisfaction with PT for the entire analysis period (SKT, 2013). In the case of sections related to service quality (table 1), perceptions and attitudes, respondents were asked to indicate their satisfaction/agreement with statements on a likert scale from 1 (very dissatisfied/strongly disagree) to 5 (very satisfied/strongly agree). For example, one of the service quality statements reads "*I sit comfortably when travelling by public transport*", for which the given likert scale corresponds to a scale including: very dissatisfied [1], rather dissatisfied [2], neither dissatisfied nor satisfied [3], fairly satisfied [4] and very satisfied [5].

In order to correct any potential geographic distortion between the survey sample and the general population, proportional weights were assigned based on the year-specific ratios between both county and gender in the survey sample when compared with the general population based on SCB (*Statistiska centralbyrån*, Statistics Sweden) data (Table 1). Although the representation of most counties corresponds reasonably well to their respective share of the population, some counties, including the three metropolitan areas, are underrepresented for most of the years while others are overrepresented. This is especially relevant in providing a more realistic proportion represented by each traveler segment.

Travelers' segmentation is performed based on individual attributes available from the SPTB in addition to data concerning proximity to amenities and job accessibility within their geographical area made available by *Trafikanalys*, a governmental agency responsible for transport analysis policy.

The variables categorized as "other" were either used as evaluation variables for the segments (frequency of travel by car, perception and attitudes), to carry out additional analysis or to link individual samples to accessibility measures and municipalities (based on Geonames database[2]).

4. ANALYSIS AND RESULTS

4.1 Descriptive Analysis

Figure 1 presents summary statistics of the socio-demographic characteristics and mobility patterns of the dataset. Among our sample, we have a balanced distribution of gender and age that is dominated by workers (63%), followed by people who are retired or on permanent sick leave (18%) and students (12%). Approximately two thirds of the sample lives in municipalities with at least twice the Swedish average population density (21.5 inhab/sq.km). PT captives, those with no driver license or access to a car, account for 23% of the sample, while 3% of the sample has a travel-limiting disability.

[1] A comparison between the Swedish National Travel survey from 2011-2014 and our dataset showed that the shares of daily users and non-users were similar. Thus, verifying the representativeness of the survey sample composition.

[2] A worldwide geographical database with geocoded postcodes

The sample has a preponderance of car intensive over PT intensive users, as observed by the 85% frequency of travel by car (travelling at least once a week), compared with the corresponding figure for PT of 32%. In addition, one third of the respondents travelled by PT very seldomly (one or few times per year) and 12% did not use PT during the last year. Thus, a sizeable share of respondents likely based their evaluation on very distant memories and might be greatly influenced by mass-media or friends' and relatives' opinions in forming their own perception. The large majority of PT trips were made by urban and regional PT modes where city buses represent 57% of all trips made.

The average overall satisfaction with PT is 3.51 on a 1 to 5 scale. However, a close examination of this variable and the individual attributes reveals that it varies considerably for different socio-demographic groups. In line with previous research (Mouwen, 2015), women and the youngest and oldest groups of travelers are more satisfied with PT than others. The longer one travels, the lower their satisfaction with PT. Furthermore, more frequent PT users are significantly more satisfied (3.72) than non-PT users (2.92). In the same vein, PT captives are more satisfied than choice riders, 3.73 and 3.44 respectively. Different occupational profiles yield different satisfaction levels with retired and students having much higher levels of satisfaction. Lastly, higher proximity to amenities is associated with higher satisfaction rates while satisfaction remains unchanged for different job accessibility levels, except for in the case of exceptionally low job accessibility where it decreases.

Figure 1: The whole Sample profile (N=453,560)

4.2 Market Segmentation

The market segmentation was based on socio-demographic variables (gender, age, occupation, driving license, car availability), travel patterns (frequency of travel by PT and distance to work/school) and accessibility measures (proximity to amenities and job accessibility). The correlations between all variables were lower than 0.7 and thus suitable for analysis. We applied a two-steps cluster analysis, which is a combination of hierarchical and non-hierarchical methods. This technique allows the combination of continuous and categorical variables and can handle a large amount of data. In addition, this technique employs a similar approach to BIRCH (balanced iterative reducing and clustering using hierarchies) to start pre-clustering the data records and constructing a data structure called a cluster feature (CF) tree (Zhang et al., 1996). Each CF contains a number of leaf nodes and each leaf node a number of leaf entries (sub-clusters). The maximum number of branches per leaf node is set to eight and the maximum number of levels that the CF tree can have is set to three. In case that some records do not fit well into any leaf node, they form a new cluster consisting of outliers. The size of the outlier cluster was limited to a maximum of 14% of the size of the largest sub-cluster. When the pre-clustering is finished the clustering step starts. In this stage the sub-clusters obtained in the first step are grouped using an agglomerative hierarchical method. The distance between clusters is calculated using Log-likelihood distance, because it is suitable for both continuous and categorical QoSA variables.

We tested and investigated the outcomes of a large number of cluster analyses that were obtained by employing Bayesian Information and Akaike Information criteria. A preliminary set of cluster solutions of between 5 and 7 groups yielded the best and most meaningful results and were further studied. Considering previous research, statistical criteria and the stability of the results, a partitioning solution with 5 traveler groups was selected[3].

[3] In order to test how the inclusion of a relevant variable "frequency of travel by car", only available from mid-2010 to 2014, would affect the cluster results this variable was included in an additional segmentation process

The selected solution had the largest silhouette coefficient (a measure of clustering quality) with a value of 0.3, the ratio between the largest and the smallest clusters was below 2.11 (below the threshold of 3). All variables included in the analysis had the same importance and thus all of them had an equal contribution to the cluster formation, and the 5-cluster solution had the lowest number of cases that could not be segmented (noise). In addition, an ANOVA confirmed at the 99% confidence level that the cluster mean differences were not simply due to random variation. The stability of the result was tested by individually replicating the analysis for each of the 14 years with satisfactory results. The latter was done to determine whether perceptions changed or were consistent over time. In addition, we tested a random sample of 1,000 respondents with a hierarchical cluster algorithm, producing similar satisfactory results. Furthermore, discriminant analysis, which is a probabilistic method, corroborated and supported the group membership of the cluster analysis with 92.7% of the cases correctly classified. The clustering solution thus satisfied the criteria outlined in Tonks (2009) including: being substantial (large and practical enough), accessible (characterized by observable variables), differentiable (distinct), actionable (policies can be attract and serve them), stable over time (robust), managerially meaningful, familiar (comprehensible composition) and compact (internally homogenous and externally heterogeneous).

The clustering analysis segmented the population into five traveler segments (figures 2a to 2e), as follows:

1. Inactive travelers (23.6% of the travelers): Predominantly women and respondents over 65 years old, primarily pensioners or those on disability pension (75%). However, it embraces other types of non-active roles such as unemployed or users on paternal leave. They hold a driver license and a car. Their transit use is mixed and they live in areas with medium-low accessibility measures.

2. Long distance commuters (28.2%): Middle aged workers. Half of them commute long to very long distances (>30km), 70% are frequent PT users (travel daily or weekly) while 32% never uses it. Their driver license and car availability levels are the lowest amongst the commuter segments (87% and 83% respectively). They live in areas with the highest accessibility levels.

3. Urban motorist commuters (14.3%): Middle-age workers with a large share of short trips (<5 km) who travel at least once per month by PT (100%). They live in highly accessible municipalities.

4. Rural motorist commuters (21.8%): Middle-age workers (100%) with the most balanced gender composition (50% male). The vast majority (97%) holds a driver licence and they all use PT very seldomly. They are residents of municipalities with the lowest accessibility measures and lowest density of population.

5. Students (12.1%): Students (100%), of which 76.7% are less than 24 years old. It is a group with a low rate of driver licence holders (41%) and a high share of PT and soft modes, i.e. walking and cycling. They live in municipalities with average accessibility levels.

Unlike studies from North America (Krizek and El-Geneidy, 2007), travelers from all segments, including the car-oriented segment 4, have a first-hand-experience with PT and therefore their satisfaction with PT can evolve as was found by Cats et al. (2015) and Ferris et al. (2010). However, segment 2 is characterized by its large share of travelers (32%) that have not used PT in the last year. Thus, part of this segment lacks a recent direct PT

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yielding two optimal cluster solutions. The solutions are made up of 5 and 6 traveler's segments. The traveler segment composition of the 5 cluster solution is analogous to that of the main body of analysis while the 6 cluster solution resembles it. The main difference between the 6 cluster solution and that of the main body of analysis is the formation of two segments which main distinctive feature is the higher and lower frequency of car use. The results above demonstrate that the 5 cluster solution of the main body of analysis (2001-2014) is robust and represents well the composition of Swedish travelers.

experience, and therefore might base their assessment on old memories, other´s people opinions and mass media. Based on previous studies, the joint effect of these factors is presumably negative. For example: past experiences memories bring about cognitive bias such as the peak-end-rule (Kahneman, 2000) or negative critical incidents (Friman et al., 2001); mass-media news focus on exceptional disruptions that cause long delays and dissatisfaction; and, hearsay most often disseminates negative experiences than positive ones (Bougie et al., 2003).

A rudimentary estimation of the share of PT captives, based on the availability of car in the household and driver license possession, shows that the amount of PT captives varies greatly between clusters, from 4.5% for rural motorist commuters to 72% for students. Concurrent with previous research, captive riders are mostly people who are too young or too old to drive (segments 5 and 1), with disability (segment 1) as well as women or young workers (Rosenbloom and Fielding, 1998) that dominate segment 2. In contrast, segment 4 can be considered the more car-captive group, due to its low accessibility scores and a mere 25% of its members asserting that PT service is relevant to their needs. In general, the size of traveler segments has remained relatively constant over time, in particular for segments 2 (25-30% of the travelers), 3 (15%) and 4 (20-25%). S1 and S5, however, experienced a simultaneous increase and decrease of their share size respectively between 2006 and 2011 but in general their size moved between 20-30% (S1) and between 8-15% (S5).

Figure 2a: Segment 1=Inactive travelers (N=107,243)

Figure 2b: Segment 2=Long distance commuters (N=127,759) Figure 2c: Segment 3=Urban motorist comm. (N=64,734)

Figure 2d: Segment 4=Rural motorist commuters (N=99,034) Figure 2e: Segment 5=Students (N=54,791)

Even though each segment is found in each of the regions (21 counties and 3 municipalities), segmentation results follow a very particular spatial distribution. This geographical distribution is depicted by the region's percent deviation from the corresponding share at the national level (figure 3). A larger share of inactive travelers live in rural and aging areas (i.e. Jämtlands +15%, Gävleborg and Västernorrland +13%), whereas long distance commuters have a much larger presence primarily in Stockholm (+73%) and in Västra Götaland (+9%), where the largest Swedish cities are located. Urban motorist commuters are prevalent in more densely populated and accessible counties with medium to large cities such as Skåne (+26%) and Uppsala (+13%), and in medium-sized municipalities such as Karlstad and Umeå. Intuitively, rural motorist commuters are predominantly found in the most peripheral rural areas, while students prevail in the three municipalities including Umeå (+47%), Luleå and Karlstad (+20%); and the counties hosting large universities including Västerbotten (+27%) and Uppsala (+16%).

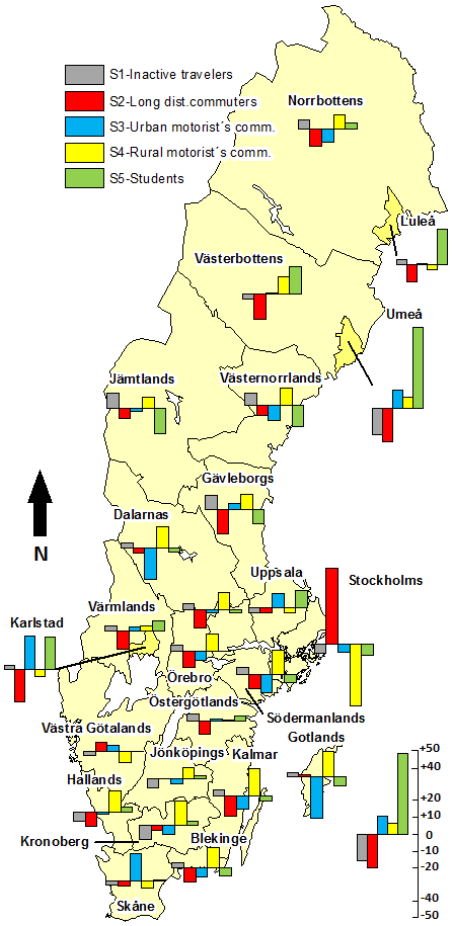

Figure 3: Percent deviation from the mean of each of the segments by region

Prior to next section´s in-depth statistical modeling of the needs and priorities of each of the traveler segments, an exploration of overall satisfaction with PT scores across and within traveler segments was performed, obtaining the following findings:

a) Average overall satisfaction across traveler segments ranges between 3.32 and 3.68, and is lowest amongst rural motorist commuters and highest amongst inactive travelers (for over 65: Van't Hart, 2012; TfL, 2012).

b) For all traveler segments considered, satisfaction exhibited consistently higher levels above the mean in certain regions (i.e. Norrbotten, Värmlands, Jämtlands, Karlstad) or well below the mean in other regions (i.e. Gotland, Västernorrland or Västmanland). These differences could either be attributed to objective differences in the quality of PT service or to subjective differences in the expectations of their inhabitants which we will estimate in the models (sections 4.3 and 4.4) by including region-specific dummy variables

c) Within segments and across regions the range in overall satisfaction was on average 0.6 points, being largest for long distance commuters (0.93) and smallest for students (0.35).

d) The temporal evolution of overall satisfaction followed a generally positive trend, peaking in 2006 (3.62). From that year it decreased, bottoming out in 2012 (3.41), when it started slowly rebounding. These temporal differences call for the inclusion of year-specific dummy variables in the models (section 4.3 and 4.4)

4.3 Service Satisfaction Models

In order to systematically investigate both the determinants of the overall journey experience among the different traveler segments and whether the importance attached to each QoSA in each segment varied over time, alternative ordered logit regression models were specified and estimated. Model estimation consists of: a general model for the entire

sample and time-frame (2001-2014), a joint model estimated for each of the segments (5 in total) and the entire dataset (2001-2014), as well as a year-based model estimated separately for each year and segment (14 years*5 segments = 70 models in total). Presentation and discussion on the results of the year-based models will be presented in section 4.5.

The general and the joint cluster models' specification contained overall satisfaction as their dependent variable and the 12 QoSAs, 14 year-specific and 5 region-specific dummy variables as independent variables. The counties of Stockholm, Västra Götaland (where Gothenburg is situated) and Skåne (which includes the city of Malmö) constitute a region each, while the remaining regions are clustered into medium-density and low-density urban areas based on Jenks natural breaks[4] classification method for their population density. Population density affects travel attitudes and PT use with most densely populated areas characterized by lower per capita vehicle travel, higher PT accessibility, lower parking availability, and shorter journey times (Litman, 2010). The reference cases for the dummy variables are 2014 and the low density region. The year-based model specification mirrors the general and joint models' specification with the only exception being non-inclusion of the year dummies. In both conceptual models, individual attributes (socio-demographic and travel behavior) were left out since they already underpinned the market segmentation. In the models, the independent variables, QoSAs, are treated as if they were continuous variables. This is advantageous because variables´ categories do not lose their order and thus "4" is larger than "1". In addition, we assume that the independent variables have a linear impact across their increments. Therefore the incremental changes between categories of a QoSA, from "1" to "2" or from "4" to "5", would be the same. Moreover, treating independent variables as continuous variables produce an average incremental change that shows the general trend which is of relevance for policy implications. However, some caution is needed since our assumption may not hold if the distance between the QoSA's categories is not the same. The independent variables were tested for multi-collinearity issues with no positive results. Since overall satisfaction is an ordinal variable, ranging from 1 (very unsatisfied) to 5 (very satisfied), ordered logit models are most adequate. In general, order logit model can be expressed as:

$$y_k^* = X_k \beta + \varepsilon_k \tag{1}$$

Where y_k^* is the latent dependent variable of individual *k*. X_k is the explanatory variable set of individual *k*, which consists of the QoSAs values and the respective dummy variables for the region and year associated with this individual. Note that the intercept is dropped for identification issues. β is the corresponding parameter to be estimated. ε_k is the error term which is assumed as an identically distributed logistic error-term. The latent dependent variable is then associated with the observed dependent variable, y_k (5 likert scale overall satisfaction), with m=1..5, defined as follows:

$$y_k = \begin{cases} 1, & \text{if } -\infty < y_k^* < \mu_1 \\ 2, & \text{if } \mu_1 < y_k^* < \mu_2 \\ & \cdots \\ m, & \text{if } \mu_{m-1} < y_k^* < +\infty \end{cases} \tag{2}$$

Note that the parameter estimates obtained from different ordered logit models cannot be directly compared. Instead, the marginal effects on the expected value of the dependent variable (overall satisfaction) were derived from the parameter estimates. For a given explanatory variable *i*, the marginal effect on the probability of observing individual *k* having an overall satisfaction equal to *n* is:

[4] This is a method reduces the variance within groups and maximise it between groups.

$$M_{k,i,n} = -\beta_i \left[\frac{e^{-(\mu_n - X_k\beta)}}{\left(1+e^{-(\mu_n - X_k\beta)}\right)^2} - \frac{e^{-(\mu_{n-1} - X_k\beta)}}{\left(1+e^{-(\mu_{n-1} - X_k\beta)}\right)^2} \right] \quad (3)$$

The marginal effect of the explanatory variable i on the expected value $E(y_k)$ for a given individual k is then:

$$E_{k,i} = \sum_{n=1}^{m} M_{k,i,n} \times n \quad (4)$$

This marginal effect at sample mean is then derived:

$$E_i = \left(\sum_{k=1}^{Nobs} E_{k,i} \times weight_k\right) / \sum_{k=1}^{Nobs} weight_k \quad (5)$$

Table 2 shows the results of the estimated coefficients and the marginal effects $E_{k,i}$ of the joint models. All the QoSAs were significant at the 99% confidence level. Most of the dummy variables were also significant at the 99% confidence level with exceptions indicated otherwise. The insignificant variables (<90%) are marked with 'ns'.

As observed in table 2, satisfaction with *customer interface*, *length of trip time*, *freedom from crime* and *operation* were found to consistently have the largest impact on overall satisfaction for all traveler groups. Furthermore, *staff and assistance* and *network* have a moderate to high impact on overall satisfaction across market segments. In general, the estimated marginal effect coefficients do not vary much across segments (<20%) and the QoSA rank in a similar order of importance. However there exist some differences between traveler groups which are calculated by taking the percentage of change from the smallest value (ie: for *on-board conditions* we divide the largest M.Eff. coefficient obtained for S3, 0.48, with the smallest attained by segment 5, 0.27, obtaining 1.78 which implies a 78% difference). The differences between the marginal effect coefficients of some QoSAs vary considerably for different segments including: *on-board conditions* (78%), *ride comfort* (70%) and *information on planned changes* (62%). *Network* has the highest impact on overall satisfaction for inactive travelers and rural motorist commuters who live in municipalities with the lowest level of accessibility. In contrast to Dell'Olio et al. (2011) and Cantwell et al. (2009), *ride comfort* is more valued by students than by old and inactive travelers and is one of the least important QoSAs.

A comparison of the general model with the segments' models (table 2) reveals an overall similarity between them in terms of sign, strength and order of priority of the QoSAs´ marginal effects coefficients. However, certain segment-based models resemble more the general model than others. The differences between models are calculated by taking the cumulative percentage of change, either positive or negative, of the QoSAs' marginal effects by segment, from the general model´s coefficients. Results show that segment-based models are progressively dissimilar from S1 to S5, with S1-inactive travelers being the most similar (34.2% of cumulative change) and S5-students the least (179.2%). In addition, all segments-based models considered, some QoSAs present a greater divergence (including *info. on unplanned changes* 94.6%, *network* 76.6% and *on-board conditions* 74.4%) with respect to the general model marginal effects' coefficients than others (*operation* 18.5% and *staff and assistance* 29.9%). Consequently, these results indicate that the general model is useful to understand what S1 travelers regard as important and, in general, to obtain the importance ratings of some QoSAs (*operation* and *staff and assistance*).

The county-region and year dummy variables obtained similar values for all market segments. In line with Diana (2012), travelers in large urban agglomerations, particularly those who live in Stockholm and Västra Götaland counties, are less satisfied with PT than those who live in low-density regions. All significant year dummy variables imply a higher overall satisfaction level than in 2014. This negative trend was identified in Cats et al. (2015) and should be further investigated by PT operators and authorities. This trend is however not

equally exhibited by all traveler groups and is least pronounced for inactive travelers and most evident among students.

Table 2: Service Satisfaction Models

	Segment 1 Inactive travelers		**Segment 2** Long dist. commuters		**Segment 3** Urban motorist commuters		**Segment 4** Rural motorist commuters		**Segment 5** Students		**General model**	
	Estim.	M.Eff.	Estim.	M.Eff.	Estim.	M.Eff.	Estim.	M.Eff.	Estim.	M.Eff.	Estim	M.Eff.
General info.	**.123**	.038	**.168**	.049	**.169**	.044	**.138**	.041	**.157**	.043	**.147**	.039
Ticket Acc.	**.142**	.044	**.126**	.036	**.165**	.043	**.160**	.048	**.149**	.041	**.147**	.045
Operation	**.359**	.111	**.427**	.124	**.446**	.115	**.392**	.118	**.400**	.111	**.412**	.114
Network	**.294**	.091	**.277**	.080	**.278**	.072	**.250**	.075	**.289**	.080	**.281**	.094
On-board conditions	**.122**	.038	**.129**	.037	**.186**	.048	**.113**	.034	**.096**	.027	**.123**	.039
Staff &Assist.	**.273**	.084	**.261**	.076	**.319**	.082	**.265**	.080	**.313**	.087	**.281**	.087
Ride Comfort	**.079**	.024	**.089**	.026	**.096**	.025	**.066**	.020	**.121**	.034	**.086**	.025
Length of Trip time	**.407**	.126	**.475**	.138	**.550**	.142	**.474**	.143	**.448**	.124	**.469**	.130
Freedom from crime	**.417**	.129	**.451**	.131	**.455**	.118	**.422**	.127	**.411**	.114	**.430**	.133
Info.planned changes	**.177**	.055	**.176**	.051	**.177**	.046	**.137**	.041	**.123**	.034	**.165**	.056
Info. unplanned changes	**.155**	.048	**.173**	.050	**.228**	.059	**.217**	.065	**.173**	.048	**.176**	.049
Customer interface	**.427**	.131	**.488**	0.141	**.530**	.137	**.502**	.151	**.414**	.115	**.466**	.136
2001	ns.	ns.	**.106***	.031*	**.160***	.041*	**.105***	.032*	**.441**	.122	**.125**	-.016
2002	ns.	ns.	**.130**	.038	**.177**	.046	**.095**	.029	**.351**	.097	**.128**	.001
2003	ns.	ns.	**.143**	.042	**.175**	.045	ns.	ns.	**.382**	.106	**.124**	-.006
2004	**.056****	.017**	**.217**	.063	**.220**	.057	**.160**	.048	**.430**	.119	**.197**	.018
2005	**.075***	.023*	**.175**	.051	**.249**	.064	**.089**	.027	**.244**	.068	**.150**	.024
2006	ns.	ns.	**.193**	.056	**.210**	.054	**.135**	.041	**.356**	.099	**.170**	.016
2007	**.131**	.04	**.222**	.064	**.314**	.081	**.241**	.073	**.378**	.105	**.239**	.042
2008	**.125**	.038	**.260**	.075	**.366**	.095	**.352**	.106	**.486**	.135	**.291**	.040
2009	**.133**	.041	**.242**	.070	**.286**	.074	**.225**	.068	**.367**	.102	**.240**	.042
2010	ns.	ns.	**.163**	.047	**.183**	.047	**.162**	.049	**.315**	.087	**.158**	.012
2011	ns.	ns.	**.064***	.019*	ns.	ns.	ns.	ns.	**.140**	.039	**.048**	-.003
2012	ns.	ns.	ns.	ns.	ns.	ns.	ns.	ns.	ns.	ns.	ns.	ns.
2013	ns.	ns.	ns.	ns.	**.064****	.017**	ns.	ns.	ns.	ns.	**.035**	.006
2014	**Ref. value**		**Ref. value**		**Ref. value**		**Ref. value**		**Ref. value**		**Ref. value**	
Stockholm	**-.154**	-.048	**-.272**	-.079	**-.378**	-.098	**-.287**	-.086	**-.441**	-.122	**-.252**	-.049
Västra Götaland	**-.207**	-.064	**-.237**	-.069	**-.332**	-.086	**-.241**	-.072	**-.331**	-.092	**-.243**	-.066
Skåne	ns.	ns.	**-.101**	-.029	**-.064***	-.017*	ns.	ns.	**-.163**	-.045	**-.060**	-.009
Med. Dens.	**-.104**	-.032	**-.116**	-.034	**-.186**	-.048	**-.148**	-.045	**-.162**	-.045	**-.131**	-.033
Low Dens.	**Ref. value**		**Ref. value**		**Ref. value**		**Ref. value**		**Ref. value**		**Ref. value**	
Log-LL zero	290045.4		302998.1		149159.4		265561.4		124738.4		1144446.9	
Log-LL final	206990.8		207750.7		105176.0		200702.3		94770.4		813078.0	
Nagelkerke	**0.566**		**0.604**		**0.549**		**0.495**		**0.470**		**0.562**	
Nº obs(N)	111529		115512		64413		107393		54711		453564	

Significance levels: ns. Not significant // **: 90% // *: 95% // Otherwise 99%

The widely used Nagelkerke pseudo R square index show how all satisfaction models have a very high goodness of fit, explaining between a 47% (students -S5) and a 60% (long distance commuters –S2) of the variation in overall satisfaction. For the general model and for each market segment the proposed models are superior to the intercept-only models according to the log-likelihood ratio test (see table 2).

4.4 Identifying Priority Service Areas

Understanding the level and determinants of satisfaction for different traveler segments is of utmost importance for transport authorities and operators. A two-fold figure (figures 4 and 5) is employed to map and visualize the importance and evaluation of the service attributes for each of the five traveler segments.

Figure 4 depicts the importance attached to each of the QoSAs. This importance is represented by the marginal effect obtained for every QoSA from the models' output (table 2). In addition, figure 5 displays the satisfaction across all QoSAs obtained from descriptive statistics. The average values of the marginal effects and satisfaction valuations of all QoSAs are represented with a black dotted line in both figures. In figure 5, the horizontal dashed red line corresponds to the middle satisfaction score of 3 and thus represents the satisfaction/dissatisfaction threshold. In brief, these sub-figures allow the observation of intra-segment differences, while their combination demonstrates the assessment of satisfaction against the average and across different segments. Additionally these figures provide a baseline for future trend analysis.

Figure 4: Importance of the QoSAs across different segment of travelers

Figure 5: Satisfaction with the QoSAs for each segment

As can be seen in figure 4, there are three clear distinct areas (High, Medium, Low) of importance among different QoSAs and different traveler groups. First, the group of QoSA in the High area is located well above the average value (0.0765) and is composed of *customer interface*, *length of trip time*, *freedom from crime* and *operation*. At a distance, in the Medium interval, *staff and assistance* and *network* constitute the second group of QoSAs to be targeted, since their importance varies around the average. The rest of QoSAs are situated in the Low areas where they fall below the average and thus are less consequential. The derived importance coefficients of the general model move around the average values with the exceptions of *freedom from crime, network* and *information on unplanned changes* which receive higher evaluations. This means that at an aggregate level, for an average traveler, a general model seems to overestimate the importance attached to some service attributes which may cause non optimal investments.

The relative satisfaction attached to each of the QoSAs greatly varies (figure 5). The disgruntlement area (below the red line) includes *information on unplanned changes* and *customer interface* for the segments with a large amount of motorists (2 to 4) and *network* and *operation* for rural motorist commuters. *Network*, *operation* and *length of trip time* together with *information on planned changes* bear lower satisfaction ratings than the average values but are still on average above the dissatisfaction threshold. The remaining QoSAs received satisfaction evaluations well above the average. The general model satisfaction ratings mirror the assessment of S3 travelers while largely diverge with some QoSAs (ie: *operation* and *length of trip time*) of segments 1 and 4 (inactive travelers and rural motorist commuters).

Therefore, the general model might be of use to illustrate the satisfaction levels of S3 and S2 but inadequate to portrait that of S1 and S4, a fact which calls for market segmentation.

From an inter-segment perspective, there are considerable differences in both relative importance and perceived satisfaction levels. The largest contrasts (>0.02) in importance (figure 4) emerge in *customer interface*, *information on planned changes* and *on-board conditions*, where Students (segment 5) hold much lower values than their counterparts. Rural motorist commuters (segment 4) attribute a larger importance than other segments to the responsiveness of the PT company to feedback and suggestions from users (*customer interface*) and to *information on unplanned changes*. In line with previous research (EMTA, 2007), the *network* is of greater importance for inactive travelers (segment 1). As for urban choice riders (segment 3), *on-board conditions* play a more relevant role than for other segments, presumably due to congestion in the largest cities and the longer commuting distances of this group. The relative importance associated with some QoSAs diverges mainly due to the contrast between two segments, 1 and 4. Rural motorists (segment 4) assess *ticket accessibility* and *length of trip time* very poorly and especially *network* and *operation* when compared with other segments' travelers. Also, inactive travelers (segment 1) are most satisfied with all QoSAs.

An examination of figures 4 and 5 as a whole reveals three levels of priority[5]. *Operation* for rural motorist commuters only and *customer interface* for all segments stand out as the top priority attributes since they are regarded as important while travelers are dissatisfied. The large importance and relatively low satisfaction provides *length of trip time* with a second order of priority for all segments except for inactive travelers. *Operation* for the remaining segments falls into the same order of priority. *Network* can be considered a third-level priority due to an intermediate importance level combined with poor satisfaction ratings. Finally, *travel information on unplanned changes* is very badly perceived but has a lower priority.

4.5 Evolution of importance of QoSAs over time and across regions

As satisfaction with service provision and its underlying factors may evolve over time, the variability and/or stability of the importance attributed to each QoSA on the whole travel experience was examined. To this end, year-based models were specified and estimated for each of the traveler segments. In addition, for each of the segments, year-based models highlight the difference in overall satisfaction between different county regions after controlling for all the independent variables and error terms.

As mentioned in section 4.3, the marginal effects of the estimated coefficient of the year-based models were calculated for both the QoSAs and the county region dummy variables. Segment-wise Nagelkerke pseudo R square values do not experience substantial changes over time, slightly fluctuating around the values of the joint models.

Figure 6 depicts the variability of the QoSAs' derived importance at an inter-segment level. The variability is represented by the percent variation from the reference year, 2001=100, which is the initial year of the data series. The values shown on figure 6 are significant at a 95% while insignificant values are not shown.

Figure 6 presents the percent change variability of derived QoSA importance with regard to 2001. Traveler segments are displayed in different colors: grey (S1-Inactive

[5] An investigation of three QoSAs only available from 2001 to mid-2010 attained the following results. The inclusion of *reliability*, *station maintenance* and *proximity* revealed that these variables do not fall into any priority area. In addition, a comparison of the estimated coefficient of the general model (.438) with that of the segment specific models (joint models) showed that the importance of *reliability* is largely over-estimated for some segments: 0.200 for S1: Inactive travelers and 0.184 for S4: Rural motorist commuters. Lastly, *operation* is seen as a more important QosA than reliability by all traveler's segments.

traveler), red (S2-Long distance commuters), blue (S3-Urban motorist commuters), yellow (S4-Rural motorist commuters) and green (S5-Students). A number of trends are clearly visible. Two attributes, *network* and *length of trip time*, gain importance over time, especially among urban and rural motorist commuters (S3 and S4). *Operation* and *customer interface* remain constant over time for all segments. The evolution of *general information* and *ticket accessibility* follow a generally negative trend with the only exception being the higher weight given by the unexperienced and very seldom PT users of segment 4 (rural motorist commuters). Larger yearly fluctuations and inter-segment differences are observed for *information with planned* and *unplanned changes*, however both QoSAs maintain an overall rising trend. Over time, *on-board conditions* and *ride comfort*, which are more related to the aesthetics, maintenance and the pleasure of travelling, largely decline in influence on overall satisfaction. Lastly, *staff and assistance* and *freedom from crime* experience a moderate fall in their influence on the overall experience. In summary, attributes related to information and the functional and operational aspects of the service gain importance while those related to comfort, image and the services provided around the product become less influential[6].

Figure 6: Comparison amongst clusters of the percent change variability of QoSA importance with respect to 2001.

Table 3 displays the marginal effects of the region dummy variables over time by segment. Only significant coefficients (>95%) are reported while the insignificant variables are marked with 'ns'. With the exception of several years, including 2007 and 2011 to 2014, and most years for Stockholm county, the majority of regional dummy variables are insignificant. This indicates that the null hypothesis that individual regions do not divert from the general model of overall satisfaction cannot be rejected. Interestingly, table 3 makes evident that the satisfaction with PT performance in all regions is worse compared with smaller counties, which is the reference case. The lower satisfaction in larger counties, significant in 12 out of 14 years for Stockholm and in 8 years for Västra Götaland (Gothenburg´s county), might be counterintuitive since the largest counties, which are home to the largest cities, have a more extensive and frequent service. Nonetheless, travelers living in these areas might also be exposed to congestion, crowding and stress that may affect specific QoSAs such as *length of trip time*, *ride comfort* or *customer interface,* which may eventually impact their overall satisfaction. Additionally, dissimilarities in prior expectations between smaller and larger counties may influence travelers' evaluation (Fornell, 1992; Morfoulaki et al., 2007; Tyrinopoulos and Antoniou, 2008). The residents of the urban areas tend to be more ambitious and well-travelled than those living in small and medium sized counties (Gordon, 2012; Quaglia and Perry, 1995) and thus the expectations of the urban dwellers might be higher. Despite the aforementioned insight, it is not possible to draw clear conclusions on the distinction between urban and rural populations because medium-sized cities are present in each county. Only an analysis at a municipality or urban continuum level (in swedish: *tätort*) could possibly shed light on this issue.

[6] The investigation of three QoSAs indicates that *reliability* gains importance over time, along with the rest of the functional and operational QoSAs. In contrast, *proximity* to the PT network becomes less important. *Station maintenance* becomes less important over time which is in line with our analysis, which shows how soft attributes related to comfort, image and the services provided around the main product (the trip itself) become less relevant over time.

Table 3: Region dummies' marginal effects per segment

		2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	Avg.
Segment 1 Inactive travelers	Stockholm	ns.	-0.09	ns.	ns.	ns.	ns.	-0.05*	-0.07	ns.	ns.	ns.	ns.	-0.06*	-0.09	-0.07
	Västra Göt.	ns.	ns.	ns.	ns.	ns.	ns.	-0.07	ns.	ns.	ns.	-0.10	-0.10	-0.11	-0.11	-0.10
	Skåne	ns.	ns.	ns.	ns.	ns.	ns.	0.05*	ns.	ns.	ns.	ns.	-0.04*	ns.	-0.06	-0.02
	Medium size	ns.	ns.	ns.	ns.	ns.	ns.	ns.	ns.	ns.	ns.	-0.06	-0.05	-0.05	-0.04	-0.05
Segment 2 Long distance commuters	Stockholm	ns.	-0.09	-0.09	-0.04*	-0.10	-0.07	-0.10	-0.08	-0.07	ns.	ns.	-0.12	-0.08	ns.	-0.08
	Västra Göt.	ns.	ns.	ns.	ns.	ns.	-0.05*	-0.07	-0.05*	-0.06*	ns.	-0.06	-0.11	-0.12	-0.08	-0.07
	Skåne	ns.	-0.09*	ns.	0.11	ns.	ns.	ns.	ns.	ns.	ns.	ns.	-0.11	-0.07	-0.06	-0.04
	Medium size	ns.	-0.07	ns.	ns.	ns.	-0.07	-0.04*	ns.	ns.	ns.	-0.04	-0.06	-0.04	ns.	-0.05
Segment 3 Urban motorist commuters	Stockholm	ns.	-0.13	-0.11	ns.	-0.14	-0.10	-0.15	-0.12	ns.	ns.	ns.	-0.14	-0.11	-0.10	-0.12
	Västra Göt.	ns.	ns.	ns.	ns.	ns.	ns.	-0.07*	-0.10	-0.06*	ns.	-0.15	-0.17	-0.13	-0.08	-0.11
	Skåne	ns.	-0.12*	0.12*	ns.	ns.	ns.	ns.	ns.	ns.	ns.	ns.	-0.10	ns.	-0.05	-0.04
	Medium size	-0.06*	-0.08	ns.	ns.	ns.	ns.	-0.06	-0.06	ns.	ns.	-0.07	-0.10	ns.	-0.04*	-0.07
Segment 4 Rural motorist commuters	Stockholm	ns.	-0.13	-0.10	-0.09	-0.12	-0.10	-0.07*	-0.15	-0.07*	ns.	ns.	-0.10	ns.	-0.12	-0.11
	Västra Göt.	ns.	ns.	ns.	ns.	ns.	ns.	-0.08	-0.07	-0.06	ns.	-0.07	-0.12	-0.08	-0.12	-0.08
	Skåne	ns.	ns.	ns.	ns.	ns.	0.07*	ns.	ns.	ns.	ns.	ns.	ns.	ns.	-0.07	0.00
	Medium size	ns.	-0.08	ns.	-0.05	-0.06	ns.	ns.	-0.05	ns.	ns.	-0.08	-0.06*	-0.03*	-0.05	-0.06
Segment 5 Students	Stockholm	ns.	-0.09	-0.18	-0.09	-0.17	-0.18	-0.11	-0.11	-0.08*	ns.	-0.08*	-0.15	-0.12	-0.07*	-0.12
	Västra Göt.	ns.	ns.	ns.	ns.	ns.	-0.08*	-0.07*	ns.	-0.11	-0.07*	-0.11	-0.12	-0.11	-0.13	-0.10
	Skåne	ns.	ns.	ns.	0.09*	ns.	0.09	ns.	ns.	ns.	-0.07	-0.05*	-0.10	-0.13	-0.05*	-0.03
	Medium size	ns.	-0.05*	-0.07	ns.	-0.05*	ns.	ns.	ns.	ns.	-0.06*	-0.08	-0.04*	ns.	-0.06	-0.06
Average per year all clusters		-0.06	-0.09	-0.07	-0.01	-0.11	-0.05	-0.07	-0.09	-0.07	-0.07	-0.08	-0.10	-0.09	-0.08	

Note: Significance level: ns. Not significant // *95% // Otherwise 99%

5. DISCUSSION AND CONCLUSION

The attainment of higher levels of PT use and the provision of a service that better caters to individual travelers are of utmost importance for PT authorities and operators as well as society at large. This paper proposes a useful methodological framework that can be applied to different and varied geographical contexts which allows to: disentangle the intrinsic complexities of Swedish travelers by reducing traveler heterogeneity into a small number of coherent traveler segments; to determine the importance attached by each travelers´ group to PT service attributes and, to investigate whether their importance ratings vary over time.

5.1 Discussion of the main findings

The market segmentation strategy adopted was based on socio-demographic attributes, travel characteristics and accessibility measures, which were found in previous research to influence travelers' expectations and needs. The cluster analysis results classify Swedish travelers into five groups: (i) inactive travelers; (ii) long distance commuters; (iii) urban motorist commuters; (iv) rural motorist commuters; and (v) students. The results of the discriminant analysis allow practitioners to relate market segments to any of the user segments. Moreover, the geographical distribution of the segments allows an intuitive interpretation of the extent to which each segment is relevant for each PT authority and operator. In addition, the results allow stakeholders to apply policies directed to increase the frequency of PT use (segment 4), to retain current users (segments 5 and 3), to attract new users (segment 1 and 2) and/or to address the preferences of travelers with special and low mobility needs (segment 1). Furthermore, it was demonstrated that the inclusion of *frequency of car use*, a traditionally important segmenting variable, did not greatly alter the number of optimal cluster solutions

and their internal composition which eases the data collection by simplifying the analysis and reducing the survey costs.

The contrast of perceived satisfaction and relative importance of the QoSAs reveals the existence of four attributes that should be prioritized by stakeholders: *customer interface*, *operation*, *network* and *length of trip time*. The robustness over time of these results was tested by Cats et al. (2015), who concluded that the year-on-year fluctuations in relative importance of QoSAs and satisfaction did not change the order or composition of attributes to be prioritized. Improving the perception that traveling by PT is fast (*length of trip time*) involves both shortening nominal on-board travel time and improving seat availability, on-board comfort and travel time usability (Transek, 2004; Susilo et al., 2012). This work adds to the literature by including *customer interface* and *freedom from crime* to the set of QoSA that are known to influence travel satisfaction. This list set includes; duration of the trip (*length of trip time*), frequency (*operation*), reliability of the service and cost (Tirachini et al., 2013).

Interestingly, the results suggest an overall similarity in the importance of QoSAs between traveler segments. Nevertheless, some noteworthy differences can be observed. For example, the more PT intensive user segments (inactive and students) are more satisfied across the board and are characterized by a more balanced distribution of QoSA importance. This might be due to a higher evaluation of more recent experiences and a more integrative knowledge of the service components. Rural motorist commuters are markedly dissatisfied with service operation attributes (*length of trip time*, *network* and *operation*). Moreover, they consider these QoSAs to be more important compared with other traveler groups.

A comparison of segment based models with the general model reveals an overall similarity between them in terms of sign, strength and order of priority of the QoSAs´s marginal effects coefficients. However, there are noteworthy differences between S1-inactive travelers and S5-students which are the most similar and dissimilar models respectively (34.2% and 179.2% respectively of cumulative change). The latter dissimilarity stems the distinctive characteristics and QoSA importance associated with this user group as well as the relatively small share of this user group in the population.

The investigation of variability over time and space across segments of overall satisfaction revealed that the smaller county regions have the largest overall satisfaction. These findings are in line with previous research (Diana, 2012; Cats et al., 2015). Additionally, the results of this study suggest that the sign and strength of this relation remain stable over time and across travelers' groups. The variability over time and across segments of QoSA importance levels unveils an overall change in appreciation and consumption goals. In brief, attributes related to information and the functional and operational aspects of the service have gained importance whilst those related to comfortability, image and the services provided around the product have become less influential. However, caution is needed since the time-series analysis does not allow assessment of whether changes in prevalence reflect a trend or simply differences between different groups of participants sampled from the population. In addition, cohort effects may alter the results.

Interestingly, PT captives are more satisfied with the overall travel experience than choice riders, 3.73 and 3.44 respectively. This is in contrast to previous studies where for example; both transit and private vehicle captives are more dissatisfied than choice riders when stating that they would like to use more an alternative travel mode (St-Louis et al., 2014). While a lower overall satisfaction might be true among captives in the North-American context (ie: Zhao et al., 2014), the extensive coverage and good level of service of PT in Sweden (and Europe), make some people choose to rely solely on PT out of their own-choice and lifestyle preferences, more than due to the circumstances (lack of parking, income, disability, etc.). Therefore, some PT captives should be better referred as PT exclusives

instead. Additionally, as a result of self-selection process, PT captives/exclusives may tend to live in more accessible and better covered areas which may increase their satisfaction levels.

5.2 Policy implications

Market segmentation processes for different geographical areas where different sets of service attributes are included may produce different results. In general, a number of policy actions directed to improve the quality of different traveler groups' priorities can be undertaken. However, measures aimed at tackling sparsely populated geographies offer very complex and unrewarding solutions. Improvement measures may include increasing land use mix, applying densification policies or adopting more transit oriented developments, exploring the viability of deploying new routes and increasing the frequency of the current ones through the investigation of major routes and the willingness to change commuting patterns. Furthermore, information and marketing campaigns have proven to be cost-efficient measures to increase ridership (Transek, 2004; TRL, 2004). The former would increase the knowledge of non-PT users in terms of tickets, timetables, transfers and service characteristics, while the latter would focus on personal advantages attained from using PT.

The fact that all traveler's' segments regard *operation* as a more important QoSA than *Network* suggests that stakeholders could do better by providing direct and frequent services rather than a large number of low-frequency lines in the hope of minimizing the number of transfers required. The former offers economical and operational benefits in addition to the higher importance attached to it in forming travel satisfaction. Given that the QoSA's priority list shows an overall similarity across traveler's segments, successful measures are expected to contribute to traveler's satisfaction across the board. Notwithstanding, the existence of certain differences among user classes calls for the deployment of measures that cater for their specific priorities. For example, inactive travelers are most keen on direct connections while and infrequent public transport users such as rural motorists attach great importance to ticket accessibility. Efforts and measures to improve these dimensions should be therefore made in relation to the specific target group.

To a greater or lesser extent non-PT users will be present in every market segmentation. The lack of direct experience with PT of this group might be caused by the absence of real alternatives, by the existence of die-hard drivers or by the difficulties in changing already established travel habits. If the lack of willingness to ride PT derives from resistance to changing travel behavior, the adoption of free public transport trial periods, especially for commuters, might be an efficient measure to increase PT ridership (Dickinson and Wretstrand, 2015; Thøgersen and Møller, 2008).

5.3 Recommendations for future studies

Future studies would benefit from some issues raised by this research. First, the inclusion of PT sub-modes in the segmentation process would enable unveiling segments that relate to particular modes and focus on mode-specific market analysis. Second, conducting a longitudinal study of the attribute importance would be useful to infer causal relations. Third, the inclusion of interaction effects between regions, segments and attributes in the models would allow the identification of service attributes that may have a larger impact in certain regions and segments. A final recommendation is to enrich the customer satisfaction barometer such as the one used in this study with more in-depth travel attitude variables. This would facilitate the identification and prioritization of travelers' segments that are most inclined to switch to or from PT.

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REFERENCES

Anable, J. Complacent car addicts' or 'aspiring environmentalists'? Identifying travel behaviour segments using attitude theory. *Transport Policy,* Vol. 12, No. 1, 2005, pp. 65–78.

Badoe, D.A. and Miller, E.J. An automated segmentation procedure for studying variations in mode choice behavior. *Journal of Advanced Transportation,* Vol. 32, No. 2, 1998, pp. 190–215.

Barabino, B., Deiana, E. and Tilocca, P. Measuring service quality in urban bus transport: a modified SERVQUAL approach. *International Journal of Quality and Service Sciences,* Vol. 4, No. 3, 2012, pp. 238-252.

Beirão, G. and Cabral J. S. A market segmentation analysis using attitudes towards transportation: Exploring the differences between men and women. In *Transportation Research Record: Journal of the Transportation Research Board*, No. 2067, Transportation Research Board of the National Academies, Washington, D.C., 2008, pp. 56–64.

Bhat, C.R. An endogenous segmentation mode choice model with an application to intercity travel. *Transportation Science,* Vol. 31, No.1, 1997, pp. 34–48.

Bougie, R., Pieters, R., Zeelenberg, M. Angry customers don't come back, they get back: the experience and behavioral implications of anger and dissatisfaction in services. *Journal of the Academy Marketing Science*, Vol. 31, No. 4, 2003, pp. 377–393.

Brons, M., Givoni, M. and Rietveld, P. Access to railway stations and its potential in increasing rail use. *Transportation Research Part A,* Vol. 43, No. 2, 2009, pp. 136–149.

Cantwell, M., Caulfield, B. and O'Mahony, M. Examining the Factors that Impact Public Transport Commuting. *Journal of Public Transportation,* Vol. 12, No. 2, 2009, pp. 1-21.

Cats, O., Abenoza, R., Liu, C. and Susilo, Y. Identifying Priority Areas based on a Thirteen Years Evolution of Satisfaction with Public Transport and Its Determinants. In *Transportation Research Record: Journal of the Transportation Research Board,* Vol. 2, No. 2323, Transportation Research Board of the National Academies, Washington, D.C., 2015, pp. 99-109.

De Oña, J. and de Oña, R. Quality of service in public transport based on customer satisfaction surveys: a review and assessment of methodological approaches. *Transportation Science*, 2014, pp. 1-18.

De Oña, R., López, G., De los Rios, F.J.D. and Oña, J. Cluster analysis for diminishing heterogeneous opinions of service quality public transport passengers. *Procedia-Social and Behavioral Sciences,* Vol. 162, 2014, pp. 459-466.

De Oña J., de Oña R., Eboli L., Mazzulla G. Index numbers for monitoring Transit Service Quality, *Transportation Research Part A, Vol.* 84, 2016, pp. 18-30.

Dell'Olio, L., Ibeas, A. and Cecin, P. The quality of service desired by public transport users. *Transport Policy,* Vol. 18, No. 1, 2011, pp. 217-227.

Diana, M. and Mokhtarian, L.P. Grouping travelers on the basis of their different car and transit levels of use. *Transportation*, Vol. 36, No. 4, 2009, pp 455-467.

Diana M. Measuring the satisfaction of multimodal travelers for local transit services in different urban contexts. *Transportation Research*, Vol. 46, No. 1, 2012, pp. 1-11.

Dickinson, J. and Wretstrand, A. Att styra mot ökad kollektivtrafikandel. En kunskapsöversikt. 2015, K2 Research 2015:2 [in Swedish].

Eboli, L. and Mazzulla, G. A New Customer Satisfaction Index for Evaluating Transit Service Quality. *Journal of Public Transportation,* Vol. 12, No. 3, 2009, pp. 21-38.

EMTA – European Metropolitan Transport Authorities. Older people and public transport. Challenges and changes of an ageing society. 2007. Rupprecht Consult.

Fellesson, M. and Friman, M. Perceived satisfaction with public transport services in nine European cities. *The Journal of Transportation Research Forum*, Vol. 47, No. 3, 2008, pp. 93-103.

Ferris, B., Watkins, K. and Borning, A. OneBusAway: Results from providing real-time arrival information for public transit. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI'10)*. ACM, New York, 2010, pp. 1807–1816.

Fornell, C. A. National Customer Satisfaction Barometer: The Swedish Experience. *Journal of Marketing*, Vol. 56, No. 1, 1992, pp. 1–18.

Friman, M., Edvardsson, B., Garling, T., Frequency of negative critical ¨ incidents and satisfaction with public transport services, I. *Journal of Retailing and Consumer Services*, Vol. 8, 2001, pp. 95–104.

Friman, M. and Fellesson, M. Service Supply and Customer satisfaction in Public Transportation: The Quality Paradox. *Journal of Public Transportation,* Vol. 12, No. 4, 2009, pp. 57-69.

Gordon, I. Ambition, Human Capital Acquisition and the Metropolitan Escalator. 2012. SERC discussion paper.

Guirao, B., García-Pastor, A., López-Lambas, M.E. The importance of service quality attributes in public transportation: Narrowing the gap between scientific research and practitioners´s needs. *Transport Policy*, Vol. 49, 2016, pp. 68-77.

Hensher, D. A., Stopher, P. and Bullock, P. Service quality - developing a service quality index in the provision of commercial bus contracts. *Transportation Research Part A*: *Policy and Practice*, Vol. 37, No. 6, 2003, pp. 499-517.

Hensher D. A. and Houghton, E. Performance-Based Quality Contracts for the Bus Sector: Delivering Social and Commercial Value for Money. *Transportation Research B*, Vol. 38, No. 2, 2004, pp. 123–46.

Jacques, C, Manaugh, K., and El-Geneidy, A. Rescuing the captive [mode] user: An alternative approach to transport market segmentation. *Transportation*, Vol. 40, No.3, 2013, pp. 625-645

Kahneman, D., Evaluation by moments: past and future. In: Kahneman, D., Tversky, A. (Eds.), Choices Values and Frames. Cambridge University Press, Cambridge, 2000, pp. 693–708.

Kano, N., Seraku, F., Takahashi, F. and Tsuji, S. Attractive quality and must-be quality. *The Journal of the Japanese Society for Quality Control,* Vol. 14, No. 2, 1984, pp. 39-48.

Krizek, K. and El-Geneidy, A. Segmenting preferences and habits of transit users and non-users. *Journal of Public Transportation,* Vol. 10, No. 3, 2007, pp.71-94.

Litman, T. Land use impact on transport: How land use factors affect travel behaviour. Victoria Transport Policy Institute, 2010.

Liu, C., Susilo, Y.O. and Karlström, A. Examining the impact of weather variability on non-commuters' daily activity-travel patterns in different regions of Sweden. *Journal of Transportation Geography,* Vol. 39, 2014, pp. 36–48.

Mittal, V.J., Katrichis, M., Kumar, P. Attribute performance and customer satisfaction over time: evidence from two field studies. *Journal of Services Marketing*, Vol. 15, No 5, 2001, pp. 343 – 356.

Morfoulaki, M., Tyrinopoulos, Y. and Aifadopoulou, G. Estimation of satisfied customers in public transport systems: a new methodological approach. *Journal of the Transportation Research Forum,* Vol. 46, No. 1, 2007, pp. 63–72.

Mouwen, A. Drivers of customer satisfaction with public transport services. *Transportation Research Part A*, Vol. 78, 2015, pp. 1-20.

Quaglia, R. J. and Perry, C. M. A study of underlying variables affecting aspirations of rural adolescents. *Adolescence*, Vol. 30, No. 117, 1995, pp. 233-244.

Rosenbloom, S. and Fielding, G. J. TCRP Report 28: Transit Markets of the Future: The Challenge of Change. TRB, National Research Council, Washington, D.C., 1998.

Shiftan Y., Outwater M. L., and Zhou, Y. Transit market research using structural equation modeling and attitudinal market segmentation. *Transport Policy*, Vol. 15, No. 3, 2008, pp. 186–195.

SKT – Swedish Public Transport Association Annual Public Transport Barometer for 2013 [in Swedish].

St-Louis, E., Manaugh, K., van Lierop, D., and El-Geneidy, A. The happy commuter: A comparison of commuter satisfaction across modes. *Transportation Research Part F: Traffic and Psychology and Behaviour*, Vol. 26, 2014, pp. 160-170.

Sullivan, C. and O'Fallon, C. Segmentation research for sustainable transport: do's and don'ts. Presented at 32st Australasian Transport Research Forum, Auckland, 2009.

Susilo, Y.O., Lyons, G., Jain, J. and Atkins, S. Rail Passengers' time use and utility assessment. Transportation Research Record: Journal of the Transportation Research Board 2, No. 2323, 2012, pp. 99-109.

Susilo, Y.O. and Cats, O. Exploring key determinants of travel satisfaction for multi-modal trips by different traveller's groups. *Transportation Research Part A: Policy and Practice*, Vol. 67, 2014, pp. 366-380.

TCRP Report 47: A Handbook for Measuring Customer Satisfaction and Service Quality. *Transportation Research Board of the National Academies*, Washington, D.C., 1999.

TfL – Transport for London. Understanding the travel needs of London's diverse communities. Older people, 2012. TfL number: 10038

Thompson, K. and Schofield, P. An investigation of the relationship between public transport performance and destination satisfaction. *Journal of transport geography,* Vol. 15, No. 2, 2007, pp. 136-144.

Thøgersen, J. and Møller, B. Breaking car use habits: The effectiveness of a fare one-month travelcard. *Transportation,* Vol. 35, No. 3, 2008, pp. 329-345.

Tirachini, A., Hensher, D. and Rose, J. Crowding in public transport systems: Effects on users, operation and implications for the estimation of demand. *Transportation Research Part A*. Vol. 53, 2013, pp. 36–52

Tonks, D. G. Validity and the design of market segments. *Journal of Marketing Management*, Vol. 25, No. 3-4, 2009, pp. 341–356.

Trafikanalys (TRAFA – Transport Analysis). Utvärdering av marknadsöppningar i kollektivtrafiken, 2013. Report 2012:13 [in Swedish].

Transek. Bättre kollektivtrafik i framtiden. Hur kan kollektivtrafiken bli kostnadseffektiv och svara mot kundernas önskemål? 2004, Transek Rapport 2004:8. Stockholm: Transek [in Swedish].

TRL. The demand for public transport: a practical guide. 2004, TRL Report 593.

Tyrinopoulos, Y. and Aifadopoulou, G. A complete methodology for the quality control of passenger services in the public transport business. *European Transport\ Trasporti Europei,* Vol. *38*, 2008, pp. 1-16.

Tyrinopoulos, Y. and Antoniou, C. Public transit user satisfaction: Variability and policy implications. *Transport Policy,* Vol. 15, No. 4, 2008, pp. 260-272.

Van de Velde, D., Beck, A., Van Elburg, C. and Terschüren, K. Contracting in urban public transport. 2008, EU Commission-DG TREN.

Van't Hart, J. Increasing customer satisfaction with public transport. Master Thesis, TU Delft, 2012.

Woldeamanuel, M.G. and Cygansky, R. Factors affecting traveller's satisfaction with accessibility to public transportation. Presented at European Transport Conference, Glasgow, 2011.

Yavuz, N. and Welch, E.W. Addressing Fear of Crime in Public Space: Gender Differences in Reaction to Safety Measures in Train Transit. Urban studies Journal, Vol. 47, No. 12, 2010, pp. 2491-2515.

Zhang, T., Ramakrishnon, R. and M. Livny. BIRCH: An efficient data clustering method for very large databases. *Proceedings of the ACM SIGMOD Conference on Management of Data*. Montreal, Canada: ACM. 1996

Zhao, J., Webb, V. and Shah, P. Customer loyalty differences between captive and choice transit riders. In *Transportation Research Record: Journal of the Transportation Research Board*, No. 2415, Transportation Research Board of the National Academies, Washington, D.C., 2014, pp. 80–88.