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The relationship between norms, satisfaction and public transport use: A comparison across six European cities using structural equation modelling

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Abstract

Understanding the motivators of travel satisfaction is essential for designing attractive public transport systems. This study investigates the key drivers of satisfaction with public transport and their relationship with travel frequency and willingness to recommend public transport to others, hence contributing specifically by analysing the influence of social norms in travel use. A large-scale passenger satisfaction survey collected in six European cities and structural equation modelling validates the framework across different travel cultures. The study found that travel satisfaction is positively related to i) accessibility measures, e.g. extent of network coverage, travel speed and service frequency, ii) perceived costs, e.g. reasonable ticket prices, and iii) norms, i.e. perceived societal and environmental importance of public transport. These findings were consistent across all six cities and across different user types based on use frequency of public transport and private car. Specifically, the willingness to recommend public transport to others was significantly related to public transport use at a similar level as overall satisfaction. Finally, the study found significant differences in satisfaction across respondents' socio-economic characteristics as young respondents and students were less satisfied with service quality than middle-aged and elderly respondents despite more frequent use. This suggests structural problems in public transport because travel habits formed in early life shape travel behaviour throughout life. Hence, it is important to address the needs of these user groups to ensure public transport ridership

in the future. The results bear important policy implications for planners in not only focusing on traditional measures for optimising operations, but also branding public transport as an environmentally and socially important transport mode in metropolitan areas.

Key words

Public transport satisfaction, structural equation modelling, knowledge propagation, public transport recommendation, norms, service quality

Highlights

- Analysis of large-scale PT passenger satisfaction survey from six European cities
- High accessibility and low perceived costs most important drivers of satisfaction
- Perceived societal and environmental importance of PT is also a key factor
- Younger generations less satisfied despite increased PT usage
- Findings highlight the importance of branding PT to attract younger generations

1 Introduction

The long-term effectiveness of transit systems depends on a shared-responsibility between transit operators and users. From the operator perspective, such systems should rely on a coherent planning and policy approach to ensure an advanced solution that is attractive, easy, and efficient, and facilitates the needs of travellers. Improving service quality is a powerful tool to increase the competitive edge of public transport against other travel modes (Randheer et al., 2011). However, public transport also serves other purposes such as ensuring mobility for all communities in society (Lucas, 2006; Welch and Mishra, 2013), reducing congestion in metropolitan areas (Eboli and Mazzulla, 2015), and ensuring sustainable transport with less environmental impacts (Mees, 2000). From the user perspective, a durable and sustainable transition towards higher ridership can be achieved through an evolutionary process of knowledge propagation and habit formation. Ensuring durable transit systems is grounded in passenger satisfaction as key to shared-responsibility, because passengers are co-producers of the service quality output through their satisfaction from system-user interaction (Randheer et al., 2011). Several studies have shown this by highlighting the importance of social norms in influencing use frequency, hence pointing towards the importance of peer acceptance (Bamberg et al., 2007; Heath and Gifford, 2002).

This study explores the influence of norms in the relationship between the perceived passenger satisfaction, perceived level-of-service, transit use frequency, and knowledge propagation by means of recommending travelling by public transport to others. The objective is to analyse the key drivers for creating a positive process of passenger satisfaction, transit use frequency and recommendation to others in public transport systems. The importance of this issue is three-fold. Firstly, the contribution stems from the role of satisfaction in facilitating the formation of transit use habits and a shift in habits towards transit use by future passengers as suggested by De Vos and Witlox (2017). Secondly, satisfaction is a multi-dimensional construct because transit systems comprise of multiple operative dimensions including service characteristics and coverage, fleet management, passenger flows, advanced public transport systems (APTS) and human interaction. Thirdly, service disruptions result in heavy burden on transit passengers, as sources of travel time uncertainty constitute up to 50% of the total travel time by buses in Copenhagen (Ingvardson et al., 2017a). Hence, the drivers of satisfaction and their individual significance in attracting ridership are important to investigate further.

The contribution of this study is two-fold. *Firstly*, the present study investigates the drivers of passenger satisfaction in public transport across six European cities using a large-scale satisfaction survey while simultaneously accounting for user heterogeneity. Such international comparison was conducted by Fellesson and Friman (2012) focusing on identifying various dimensions of passenger satisfaction, and Trompet et al. (2014) analysed which characteristics passengers found most important in public transport by comparing satisfaction surveys across operators from different cities. While these studies analysed and compared the importance of various service quality elements of public transport, they did not focus on their influence on overall satisfaction and use frequency. Hence, this study extends

previous research by analysing the relationship between satisfaction with various service characteristics, overall satisfaction levels and use frequency across six European cities using Structural Equation Modelling (SEM). This ensures not only a validation of the applied approach, but also makes it possible to compare the importance put on various service characteristics as well as the general satisfaction levels across cities of different sizes from six European countries.

Secondly, this study investigates the mutual relationships between travel use, travel satisfaction and knowledge propagation in terms of recommendation to others. Previous studies have confirmed the importance of social norms in explaining mode choice and intentions to use public transport (Chen and Chao, 2011). Furthermore, previous studies have found loyalty in terms of recommendation to others important for satisfaction levels, e.g. Figler et al. (2011) and van Lierop et al. (2017). Lai and Chen (2011) defined loyalty as passenger behavioural intentions, which was found to rely on passenger satisfaction. This present study further investigates the importance of various attitudes in choosing public transport by simultaneously comparing satisfaction levels with the desire to recommend public transport to others. This includes specific emphasis on the importance of norms in terms of perceived value of public transport for the society and the environment, which are often mentioned arguments for investing in public transport systems.

The remainder of this paper is structured as follows. In section 2 relevant literature is reviewed. Section 3 contains a description of the methodology including the data used and modelling approach while the model results are presented in section 4. In section 5 findings and limitations of the study are discussed while section 6 concludes the work by suggesting policy implications.

2 Literature review

The perceived attractiveness of transit can be investigated by analysing passenger satisfaction. Previous studies have primarily analysed the key service characteristics that influence satisfaction levels, e.g. Cao et al. (2015), de Oña et al. (2015), de Oña et al. (2016), Eboli and Mazzulla (2007), Felleson and Friman (2012), Mouwen (2015).

Most studies find that accessibility measures including *on-time performance*, *reliability*, *service frequency* and *travel speed* are the most important characteristics for user satisfaction (de Oña et al., 2015, 2013, Eboli and Mazzulla, 2015, 2007; Felleson and Friman, 2012; Friman and Gärling, 2001; van Lierop et al., 2017; Mouwen, 2015; Shen et al., 2016; Stuart et al., 2000; Tyrinopoulos and Antoniou, 2008; Weinstein, 2000; dell'Olio et al., 2011; Redman et al., 2013; Allen et al., 2018a, 2018b; Guirao et al., 2016). However, studies also highlight the importance of other characteristics such as *comfort* (de Oña et al., 2013; Felleson and Friman, 2012; van Lierop et al., 2017; Weinstein, 2000; Redman et al., 2013; dell'Olio et al., 2011; Allen et al., 2018a; Guirao et al., 2016), *staff behavior* (de Oña et al., 2013; Felleson and Friman, 2012; Friman and Gärling, 2001; van Lierop et al., 2017; Allen et al., 2018a), *safety* and *security* (Felleson and Friman, 2012; Spears et al., 2013; Stuart et al., 2000; van Lierop et al., 2017; Allen et al., 2018b; Guirao et al., 2016), *cleanliness* (Eboli and Mazzulla, 2015;

Tyrinopoulos and Antoniou, 2008; van Lierop et al., 2017; Weinstein, 2000; dell'Olio et al., 2011; Allen et al., 2018a), and *availability of information* (Allen et al., 2018a, 2018b; Eboli and Mazzulla, 2015; Friman and Gärling, 2001; van Lierop et al., 2017; Weinstein, 2000).

Other studies have also highlighted that time spent travelling can be used *productively*, e.g. for working or studying, which induced an increased level of satisfaction as perceived by the travellers (Ettema et al., 2012; Lyons et al., 2007). Hence, studies point towards great diversity in which service aspects create an attractive public transport system, thus highlighting the multidimensionality of public transport systems. Such diversity was also suggested by Felleson and Friman (2012) which identified four dimensions of passenger satisfaction using data from eight European cities. The study found that characteristics related to system, comfort, staff and safety were important across most, but not all cities indicating differences in how public transport is perceived across different travel cultures. Similarly, Trompet et al. (2014) analysed passengers' most valued service characteristics and their satisfaction with performance as well as proposing a method for benchmarking across cities using survey data from public transport operators from ten cities covering North America, Europe, Asia and Oceania. Some studies have directly analysed the influence of observed service characteristics on *satisfaction levels*. Friman and Felleson (2009) found that the consistency between satisfaction and level-of-service was far from perfect by analysing objective public transport performance measures from the Millennium Cities Database. Similarly, Friman (2004) did not find increased satisfaction after service improvements to public transport were implemented on various public transport lines in Sweden, hence highlighting the difficulty in comparing aggregate system-wide characteristics and satisfaction. However, in Carrel et al. (2016) the relationship was analysed in greater detail by linking trip-specific service characteristics and satisfaction data collected from AVL and respondents' smartphones. The study found a strong sensitivity towards in-vehicle delays, which were bigger for metro trips than bus trips, and suggested that satisfaction could be modelled as the sum of a general baseline satisfaction level and a variable component based on previous experiences. The importance of past experiences in explaining satisfaction was also highlighted in Friman et al. (2001) where previous negative experiences, e.g. travel incidents and disruptions, also affected satisfaction levels negatively among Swedish travellers. Similar results were highlighted in Allen et al. (2018a), which found substantial negative effects of attribute-specific critical incidents on satisfaction levels of those attributes. Kahneman et al. (1997) indicate that remembered utility was more dominant than experienced utility, hence highlighting the importance of past experiences also in a choice context. As these studies suggest, satisfaction levels and mode choices are not only related to service characteristics, but perhaps even more to psychological aspects of the users (Carrel et al., 2016; De Vos et al., 2013; Susilo and Cats, 2014). This is in line with the expectation confirmation theory (Oliver, 1977), which states that general satisfaction can be defined as a function of expectations, perceived performance and disconfirmation of beliefs. Hence, in public transport overall satisfaction can be considered as the difference between expected performance and the perceived or experienced performance.

Another approach to measure satisfaction was proposed in Ettema et al. (2011), namely the *Satisfaction with Travel Scale (STS)*, which incorporated subjective well-being directly in the framework of travel satisfaction. The STS consists of an affective component related to experienced feelings of the traveller during the trip and a cognitive component related to how the traveller would evaluate the trip (De Vos et al., 2016). The method has been applied in several studies confirming satisfactory fit on real data across travel modes and study areas (Friman et al., 2013). These studies found that satisfaction was higher for active modes, i.e. walking and bicycling, than public transport, hence suggesting the importance of short distances and performing health activities in attractive work commutes. Similar results have been found by numerous other studies (Morris and Guerra, 2015; Páez and Whalen, 2010; St-Louis et al., 2014; Ye and Titheridge, 2017). Another study deployed the STS for analysing the relationships between different travel modes, satisfaction with travel and general satisfaction, and found significant effects of the travel mode on the mood of the travellers thereby influencing general satisfaction with the day as a whole (Eriksson et al., 2013).

Some studies even found significant positive effects of travel satisfaction on *general life satisfaction*, both directly and indirectly. De Vos (2017) found that life satisfaction has an important effect on travel and activity satisfaction, and that travel satisfaction has an indirect effect on life satisfaction through participation in and satisfaction with leisure activities. Bergstad et al. (2011) found similar results for work activities where satisfaction with daily travel influenced subjective well-being both directly and indirectly through satisfaction with performance of activities. In addition, that travel satisfaction influences the performance of the activity at the destination is supported by multiple studies, e.g. Loong et al. (2017).

Several studies applied the *Theory of Planned Behaviour* (TPB, Ajzen (1991)) to investigate social norms in public transport focusing on the influence on use frequency. According to the TPB subjective norms, and hence social norms, are important motivators for behaviour. Together with attitudes and perceived behavioural control (i.e. ease or difficulty of performing the behaviour), subjective norms influence the intention to perform the behaviour, which then influences actually performing the behaviour, e.g. using public transport. Heath and Gifford (2002) applied the TPB to explain bus use among university students before and after implementing a bus pass scheme. The study found that both subjective norms, i.e. what significant others do, and descriptive norms, i.e. what most people do, significantly explained ridership. Bamberg et al. (2007) similarly found that personal norms including anticipated feelings of guilt and perceived social norms predicted public transport use. Chen and Chao (2011) found a similar positive influence of social norms on intention to shift to public transport among car and motorcycle users in Taiwan. Hence, there is strong evidence that norms are important in explaining behaviour concerning mode choice and use frequency.

While these studies show the broad and extensive research conducted within public transport passenger satisfaction and use, no studies have focused on analysing the influence of *social norms* on public transport passenger satisfaction while deploying a sample of both public transport users and non-

users. This present study focuses on these main limitations by analysing various attitudes including norms, overall satisfaction and willingness to recommend to others using a large-scale passenger satisfaction survey from six large European cities, namely Stockholm, Oslo, Helsinki, Copenhagen, Vienna and Geneva.

3 Methodology

3.1 Survey description

The BEST questionnaire data was used as data source for this study. This survey is administered among a sample of 1,000 interviews per year per participating city, and is not restricted to only public transport users thereby ensuring a large sample of both users and non-users. The survey data measured the participants' satisfaction with the quality of service using 27 attitudinal items related to different service aspects as well as two items related to overall satisfaction and willingness to recommend public transport to others. All items were measured on a 5-point Likert scale ranging from totally disagree to fully agree. Furthermore, background information on the participants were collected, i.e. age, gender, occupation and most used transport mode for all trips and specifically for public transport trips. Finally, the questionnaire measured the use frequency of public transport ranging from daily to never with a few times per week, a few times per month, and less than monthly as intermediate points. A thorough description of the survey can be found in Friman and Felleson (2009).

The full dataset included respondents from 12 cities in the period 2001-2015, however with some cities only participating few years. As several important questions related to travel use frequency were added in the period 2007-2009, this study included data from the period 2009-2015. This resulted in 44,956 observations from six cities¹, namely Stockholm (STO), Oslo (OSL), Helsinki (HEL), Copenhagen (CPH), Vienna (VIE) and Geneva (GVA).

3.2 Research hypotheses

Several research hypotheses were tested. Firstly, a positive correlation was expected between transit use frequency, general satisfaction, recommendation to others, and the service quality attitudes. This included a comparison of the relative role of the various attitudes to identify the strongest predictors of overall satisfaction. From the questionnaire this included characteristics related to both service coverage and service quality as well as respondents' social norms.

Secondly, the study analysed the stability of the model structure across countries and user types. The general model structure was proposed for all cities, but by analysing each city separately, it was possible to compare differences across cities specifically. Similarly for user types, which were defined

¹ No observations for Barcelona, Manchester, London, Berlin and Prague were available during the period 2009-2015 whereas Bergen only had observations for two years; hence, these were excluded.

based on the respondents' use frequency of public transport as well as whether respondents' used car or not for their daily trips.

Thirdly, the willingness to recommend public transport to others was analysed explicitly in terms of its relative importance on use frequency compared to overall satisfaction.

Fourthly, it was tested whether overall satisfaction acted as mediator between perceived service quality and loyalty in terms of willingness to recommend public transport to others (Frank et al., 2014). Such relationship is proposed due to two reasons, i) because traditional marketing research treats willingness to recommend as an often used indicator of behavioural loyalty (e.g Bowen and Chen, 2001; Lam et al., 2004), and ii) because loyalty is not well defined within transport literature and no consensus on how to measure it exists (van Lierop et al., 2017). Finally, attitudes, overall satisfaction, willingness to recommend to others, and travel use frequency are influenced by respondents' individual socio-demographic characteristics and travel habits, which is explicitly taken into account in the framework, as also proposed by previous public transport satisfaction studies, e.g. Allen et al. (2018a;2018b). These five research hypotheses are illustrated in the overall model framework shown in Figure 1.

Lastly, an alternative model framework was tested based on a general cyclical relationship between mode use frequency and travel satisfaction, as proposed by De Vos et al. (2016). This alternative framework is illustrated as the dotted feedback line from travel use frequency to attitudes, cf. Figure 1. Such framework was also tested in Ingvardson et al. (2017b) by applying the ERG theory of human needs to evaluate travel satisfaction supporting the existence of a feedback loop between travel mode choice and travel satisfaction. As the data used in this paper were cross-sectional, such feedback relationship was analysed by testing an alternative reversed model setup where travel use frequency influences satisfaction with individual public transport service elements, which then influences overall satisfaction and recommendation to others.

Figure 1; The general model framework relating attitudes to travel use frequency with overall satisfaction and loyalty as mediators (Model I), including visualization of the cyclical relationship between attitudes, travel satisfaction, and travel use frequency, as also proposed by De Vos et al. (2016) illustrated by the dotted connection from travel use frequency to attitudes (Model II).

3.3 Structural equation modelling

The research hypotheses were evaluated using structural equation modelling (SEM) through a Multiple Indicators Multiple Cause (MIMIC) model setup. The model setup investigated the relationship between the service quality items, individual socio-economic characteristics and overall passenger satisfaction, willingness to recommend public transport to others and transit use frequency. This approach was chosen because SEM allows for accommodating measurement errors when the explanatory and the dependent variables are latent multi-dimensional constructs, and modelling simultaneously endogenous latent constructs, their relationship with exogenous observed variables, and their correlation pattern. The approach was based on creating latent factors from the questionnaire based on an exploratory factor analysis. The resulting factors were then evaluated in terms of their influence on the dependent variables in a MIMIC model setup.

Four sets of equations were included in the full model, namely i) measurement equations (eq. 1) which link the measurement indicators (survey items) to the latent factors, ii) MIMIC equations (eq. 2) which associate the latent factors with individuals' background characteristics, iii) structural equations (eq. 3) which relate the explanatory and the mediator variables, and iv) structural equations (eq. 4) which link the mediators to the dependent variable(s).

$$I_{rn} = Z_{ln}^* \alpha_r + v_{rn} \quad \text{and} \quad v_n \sim N(0, \Sigma_v) \quad \text{for} \quad r = 1, \dots, R \quad (1)$$

$$Z_{ln}^* = S_{ln} \beta_l + \omega_{ln} \quad \text{and} \quad \omega_n \sim N(0, \Sigma_\omega) \quad \text{for} \quad l = 1, \dots, L \quad (2)$$

$$Z_l^* = Z_i \beta_i + \varphi_l \quad \text{and} \quad \varphi_l \sim N(0, \Sigma_\varphi) \quad \text{for} \quad l = 1, \dots, L, i = 1, \dots, K \quad (3)$$

$$Y_{in} = Z_{ln}^* \beta_z + \xi_{in} \quad \text{and} \quad \xi_n \sim N(0, \Sigma_\xi) \quad \text{for} \quad i = 1, \dots, I \quad (4)$$

where I_{rn} is the value of an indicator r of the latent construct Z_{ln}^* as perceived by respondent n , Z_{ln}^* is the value of latent construct l for respondent n , S_{ln} is a vector of M respondents' observed individual characteristics, and Y_{in} is a vector of travel users' satisfaction levels. Error terms are expressed as elements ω_{ln} , v_{rn} , ξ_{in} of the vectors following a normal distribution with respective covariance matrix Σ_ω , Σ_v , Σ_ξ , while parameters to be estimated are α_r , β_l , β_i , and β_z . Considering R indicators translates into writing R measurement equations and estimating an $(R \times I)$ vector α of parameters (i.e., one parameter is estimated for each equation), while considering L latent constructs translates into writing L structural equations and estimating an $(M \times L)$ matrix of β parameters (i.e., M parameters are estimated for each equation).

The MIMIC models were estimated using *Mplus* 7.2 (Muthén and Muthén, 2017). The assessment of model fit was done using the relative CFI (Comparable Fit Index) and the absolute RMSEA (Root Mean Square of Approximation).

4 Results

4.1 Descriptive statistics

Basic descriptive statistics, as can be seen in Table 1, shows that the survey items are not normally distributed. Generally, respondents consider public transport as being good for the environment and for society as well as being attractive within city centre areas. On the other hand, satisfaction with fare levels, information during disruptions, and for trips outside city centres are lower. In Table 2 characteristics of the respondents' are shown for each city in the sample. Generally, the samples are similar concerning gender and age distributions. However, for occupation the samples are quite different. This is probably due to different job markets across the six cities. For example there is a high share of part time workers among respondents in Geneva, which is possibly linked to average working hours being higher in Switzerland and that many women works part time due to expensive child-care options.

There also seems to be differences across cities in terms of general public transport satisfaction levels and frequency of use, cf. Figure 2. The respondents from Copenhagen stand out by being less satisfied with public transport and using the system less than respondents from the other cities. On the other hand, Helsinki has the fewest dissatisfied respondents and the highest number of daily users. In addition, car users are least satisfied with public transport, public transport users were most satisfied, and the satisfaction levels of bicyclists and pedestrians are in between. As travel satisfaction levels for other modes were not available it was not possible to analyse differences in travel satisfaction across modes, which has been highlighted by multiple studies, e.g. (De Vos et al., 2016; Morris and Guerra, 2015; St-Louis et al., 2014; Ye and Titheridge, 2017).

Category	Variable	N	Mean	St. Dev.	Skewness	Kurtosis
Location and purpose	Public transport (PT) is good for work/school trips	41,737	3.65	1.24	-0.69	-0.49
	PT is good for shopping, leisure etc.	43,952	3.53	1.23	-0.56	-0.67
	PT is good for trips in the city centre	43,345	4.27	0.92	-1.37	1.70
	PT is good for trips outside the city centre	41,852	3.34	1.13	-0.34	-0.64
Accessibility measures	Nearest stop is close to where I live	44,849	4.38	1.06	-1.84	2.55
	Travel time on public transport is reasonable	44,355	3.79	1.09	-0.81	0.03
	Waiting time is short at transfers	42,758	3.43	1.04	-0.40	-0.34
	I am satisfied with the number of departures	44,197	3.56	1.20	-0.59	-0.59
	PT mostly runs on schedule	44,123	3.55	1.06	-0.64	-0.20
	Transfers are easy	43,689	3.69	0.97	-0.61	0.06
Information	It is easy to get the information needed before a trip	43,846	3.95	1.04	-0.95	0.38
	The information is good when problems occur	42,434	2.93	1.14	0.02	-0.77
	The information is good in stops and terminals	43,788	3.40	1.15	-0.37	-0.70
	The staff answers my questions correctly	41,346	3.66	1.00	-0.44	-0.24
	The staff behaves nicely and correctly	43,580	3.84	0.96	-0.68	0.16
Safety and security	I feel secure at stations and bus stops	44,605	3.78	1.04	-0.69	-0.12
	I feel secure on board busses and trains	44,634	4.00	0.97	-0.93	0.48
	I am not afraid of traffic accidents when using PT	44,689	4.26	0.93	-1.40	1.81
Comfort	Travelling with PT is comfortable	44,635	3.68	0.99	-0.62	0.00
	The busses and trains are modern	44,569	3.80	0.93	-0.65	0.19
	The busses and trains are clean	44,571	3.40	1.01	-0.39	-0.42
	I normally get a seat when I travel with PT	44,503	3.72	1.04	-0.72	-0.02
Norms	More people will travel with PT in the future	43,424	3.96	1.00	-0.78	0.10
	PT is good for the environment	44,362	4.44	0.82	-1.64	2.72
	PT is beneficial to society	44,736	4.57	0.72	-1.93	4.24
Costs	PT gives value for money	44,365	3.26	1.20	-0.27	-0.85
	PT fares are reasonable	44,357	2.77	1.28	0.16	-1.10
Satisfaction	I gladly recommend travelling with PT to others	44,356	3.86	1.11	-0.82	0.03
	How satisfied are you with PT in general	44,730	3.73	0.85	-0.89	0.98

Table 1; Basic descriptive statistics, aggregated for all six cities. All items measured on the 5-point Likert scale.

Variable	Stockholm	Oslo	Helsinki	Copenhagen	Vienna	Geneva
Men	46%	48%	44%	45%	47%	45%
Women	54%	52%	56%	55%	53%	55%
Age						
16-24	11%	11%	13%	12%	11%	12%
25-44	31%	41%	34%	34%	36%	34%
45-64	35%	33%	34%	33%	34%	35%
65-79	19%	13%	18%	17%	15%	14%
> 80	4%	2%	2%	3%	3%	5%
Employment status						
Full time	53%	62%	50%	50%	44%	39%
Part time	10%	7%	6%	7%	13%	21%
Student	9%	11%	12%	14%	8%	11%
Retired	24%	16%	25%	23%	28%	22%
Other	4%	3%	8%	5%	7%	7%

Table 2; Sample characteristics.

Figure 2; Frequency of public transport use for the sample.

Figure 3; Satisfaction with public transport across cities and user groups.

4.2 Factor analysis

An exploratory factor analysis was performed on the data to obtain the main determinants for public transport satisfaction and use frequency. This was at first performed using subsets of the full dataset in order to investigate possible structural deviations across cities and user groups. The factor analyses resulted in similar factor structures across the cities of Oslo, Helsinki, Copenhagen and Geneva, but with the Stockholm and Vienna datasets each having slightly different factor structures as two-three survey items were moved from one factor to another. Similarly, when analysing subsets of the data in terms of frequent (at least weekly) public transport users vs. infrequent public transport users (monthly or less) the factor structures were predominantly similar. Due to this high degree of similarities

across subsets of the dataset, it was decided to maintain the same structure in the subsequent structural equation models.

The full survey dataset showed good sampling adequacy (Kaiser-Meyer-Olkin (KMO) = 0.915). The hypothesis of an identity correlation matrix was rejected using the Bartlett's test of sphericity. The factor analysis resulted in seven factors based on principal axis factoring with orthogonal Varimax rotation, cf. Table 3. Dominant items were defined as those with an absolute value greater than 0.30 with each item only being allowed in one factor (Kline, 1994). The resulting factors also showed good internal consistency as Cronbach's alpha's were above 0.70 for five of the factors whereas the remaining two were above 0.60 (Miller, 1995). The seven factors based on the 44,956 observations are listed in Table 3.

Factor name	Item	Factor loading
F1 Accessibility (0.81)	I am satisfied with the number of departures	0.61
	Travel time on public transport is reasonable	0.60
	Public transport (PT) is good for work/school trips	0.42
	PT is good for shopping, leisure, etc.	0.56
	Waiting time is short at transfers	0.55
	PT is good for trips outside the city centre	0.40
	Transfers are easy	0.46
	PT is good for trips in the city centre	0.36
	PT mostly runs on schedule	0.38
F2 Information (0.61)	Nearest stop is close to where I live	0.36
	The information is good in stops and terminals	0.50
	The information is good when problems occur	0.58
F3 Staff behaviour (0.70)	It is easy to get the information needed before a trip	0.29
	The staff behaves nicely and correctly	0.65
F4 Safety and security (0.76)	The staff answers my questions correctly	0.70
	I feel secure on board busses and trains	0.83
	I feel secure at stations and bus stops	0.64
F5 Comfort (0.72)	I am not afraid of traffic accidents when using PT	0.48
	Travelling with PT is comfortable	0.60
	The busses and trains are modern	0.52
	The busses and trains are clean	0.53
F6 Norms (0.64)	I normally get a seat when I travel with PT	0.42
	PT is beneficial to society	0.67
	PT is good for the environment	0.63
F7 Costs (0.83)	More people will travel with PT in the future	0.40
	PT fares are reasonable	0.79
	PT gives value for money	0.76

Table 3; Rotated factor analysis. Cronbach's alpha in parenthesis.

Factor F1 "accessibility" contains items related to service frequency, travel time, waiting time, and ease and attractiveness of using the public transport system. Factor F2 "information" is related to the quality of information en-route when using public transport, and when planning a trip. Factor F3 "staff" incorporates the statements related to the helpfulness of the staff. F4 "safety" is associated with safety and security of the public transport system. F5 "comfort" is related to the comfort and cleanliness of public transport vehicles. F6 "norms" includes statements related to personal beliefs about the environmental and societal importance of public transport as well as the perceived importance in the future.

Factor F7 “costs” includes the last two statements related to the costs and perceived value of the public transport system.

4.3 Model estimation results

The structural equation models were estimated using the WLSMV estimator due to the violation of normally distributed data for all constructs according to the Kolmogorov-Smirnov test, and because it provides the best option when modelling categorical or ordered data (Brown, 2006). As the dataset had many missing values for some respondents, it was decided to remove observations with missing values on more than ten percent of the survey items, i.e. a maximum of two missing values were accepted for each observation. Hence, the remaining 38,537 observations were used for the model estimations.

The relationship between attitudes, satisfaction, willingness to recommend public transport to others, and use frequency was evaluated using data from all cities, but as the datasets for each city showed differences in terms of significant factors influencing satisfaction, recommendation and public transport use it was decided to also evaluate separate models for each city. Furthermore, several model estimations were performed to test the differences across different user types. Specifically, separate models were estimated based on data for car users and non-car users as well as for public transport users with varying use frequency (rarely, few times per month, few times per week, and daily) to capture possible structural differences across these user types. Finally, as data spanned the period 2009-2015, separate model estimations were performed for each year for each city to also test for possible structural variations over time.

While the results did show statistically significant differences over time in terms of parameter estimates no differences to general findings, ranking of most important parameters nor model fit were identified. Hence, it was decided to use a general model formulation which was estimated on seven datasets, namely for each city separately and one combined which included data for all years and all respondents. For these models mean differences across years and between car users and non-car users were taken into account by adding dummy variables. Finally, differences across user types were estimated using the entire dataset for all cities. Hence, the following three sets of results are reported for Model I; i) results using data for all respondents from all six cities, ii) results using data for each city separately, but not separating between user types, and iii) results using data for all six cities, but separated based on public transport use frequency. Finally, a fourth set of results is provided for Model II using all data.

The initial model estimations included all seven identified service quality dimensions from the factor analysis. However, three factors were not significantly related to overall satisfaction and recommendation to others, namely information, staff behaviour and safety. Hence, these were removed in the final models. Thus, the final path diagram of the MIMIC model, Model I, is as shown in Figure 4.

Figure 4; Path diagram for the MIMIC model (Model I) relating the factors, overall satisfaction, recommendation to others and travel use frequency (solid black lines denote positive relationships). Respondents' socio-economic characteristics are treated as categorical regressors on both latent variables, mediators and dependent variables.

4.3.1 Aggregate model

The initial model using the full dataset of 38,537 observations from all six cities during the period 2009-2015 showed goodness-of-fit measures in terms of RMSEA equal to 0.030 which is consistent with the recommended maximum of 0.050 (Hu and Bentler, 1999), and CFI equal to 0.951 which is above the recommended minimum value of 0.900 (Browne and Cudeck, 1992). The main results in terms of parameter estimates for the main relationships between service factors, overall satisfaction, willingness to recommend public transport to others and public transport use are shown in Table 4 while the influence of respondents' socio-economic characteristics on these factors are shown in Table 5. Estimates of the measurement equations of the service quality constructs are shown in Appendix I.

Dependent (mediator) variables	Explanatory variable	Direct effect		Total effect		R^2
		est.	C.R.	est.	C.R.	
Overall satisfaction	Accessibility (F1)	0.58	78.05	0.58	78.05	0.61
	Norms (F6)	0.10	10.95	0.10	10.95	
	Costs (F7)	0.20	28.19	0.20	28.19	
Recommendation to others	Accessibility (F1)	0.11	10.29	0.30	37.89	0.65
	Norms (F6)	0.34	41.25	0.37	45.36	
	Costs (F7)	0.15	19.56	0.21	29.37	
	Satisfaction	0.32	26.07	0.32	26.07	
Public transport use	Accessibility (F1)	-	-	0.13	28.59	0.34
	Norms (F6)	-	-	0.09	23.13	
	Costs (F7)	-	-	0.07	29.72	
	Overall satisfaction	0.11	9.58	0.17	20.38	
	Recommendation to others	0.21	18.93	0.21	18.93	

Table 4; Estimates of the structural equations for Model 1 relating travel use frequency with the travel satisfaction factors, overall satisfaction, and recommendation to others.

It can be seen that accessibility measures (F1) are the most important characteristics for achieving high level of satisfaction with public transport whereas the perceived value of the public transport system (F7) and the norms (F6), i.e. the perceived importance of public transport to society and the environment, were also positively significant. Whether respondents recommend public transport to others is mostly related to the norms, which suggests the importance of personal beliefs when people consider recommending services. However, accessibility measures and overall satisfaction are not surprisingly almost similarly positively related to recommendation. Finally, perceived value of the public transport system is also positively related to higher likelihood of recommending public transport to others.

The frequency of use is positively related to overall satisfaction and willingness to recommend to others with the latter having slightly larger influence. This confirms the importance of peer acceptance in affecting travel use with public transport as also found in other studies (Bamberg et al., 2007; Chen and Chao, 2011). In terms of attitudes, accessibility has the highest influence whereas the influences from norms and costs are slightly lower.

Factor name	<i>est.</i>
Accessibility (F1)	Age (45-64)
	-0.05*
	Age (65-79)
	0.10**
	Age (+80)
	0.26**
	Occupation (part-time)
	0.08**
Norms (F6)	Occupation (retired)
	0.17**
	Occupation (student)
	0.09**
	Occupation (other)
	0.10**
	Car driver
	-0.42**
Costs (F7)	Age (25-44)
	0.17**
	Age (45-64)
	0.18**
	Age (65-79)
	0.30**
	Age (+80)
	0.36**
Satisfaction	Occupation (student)
	0.09**
	Car driver
	-0.30**
	Male
	0.09**
	Age (25-44)
	0.18**
Recommendation	Age (45-64)
	0.30**
	Age (65-79)
	0.54**
	Age (+80)
	0.80**
	Occupation (other)
	-0.12**
Use frequency	Car driver
	-0.23**
	Age (25-44)
	-0.09**
	Age (45-64)
	-0.06*
	Car driver
	-0.06**
Use frequency	Occupation (student)
	0.07**
	Car driver
	-0.16**
	Male
	-0.09**
	Age (25-44)
	-0.29**
	Age (45-64)
	-0.37**
	Age (65-79)
	-0.35**
	Age (+80)
	-0.44**
	Occupation (part-time)
	-0.10**
	Occupation (retired)
	-0.41**
	Occupation (student)
	0.19**
	Occupation (other)
	-0.28**
	Car driver
	-0.64**

Table 5: Estimates of the MIMIC equations linking the satisfaction constructs, overall satisfaction, recommendation and use frequency to the socio-economic characteristics. ($p < 0.05$, ** $p < 0.01$.)*

When taking into account the characteristics of the respondents several findings can be highlighted. Firstly, men use public transport less than women which is consistent with findings using the Danish National Travel Survey (Christiansen, 2015). Secondly, the use frequency decreases with age. Respondents under 24 years of age and students are the most frequent users, which is probably because of the lack of other travel alternatives. For respondents in the middle age categories public transport use is lower, probably due to different travel patterns often requiring more independence, e.g. travelling with children. Moreover, the elderly travels the least which is possibly related to a generally fewer number of trips. This could also be the reason why the retired respondents and those categorised with other occupations, e.g. unemployed respondents, travel less, both generally and with public transport. On the other hand students travelled more with public transport which is consistent with previous findings (Taylor et al., 2009).

Overall satisfaction was lower for the middle age groups. This might be explained by the expectation confirmation theory (Oliver, 1977), as these users are likely more choice riders, hence possibly having higher level-of-service expectations, which are not being met by the service experienced by the public transport system. On the other hand, young and elderly users are more often captive users, hence possibly having lower expectations. These findings are in line with Allen et al. (2018a), which also found higher overall satisfaction for elderly. The identified seven service quality dimensions of public transport satisfaction from the survey were significantly related to respondents' characteristics, cf. Tables 11-17 in Appendix I. Satisfaction with accessibility measures was higher for elderly and retired respondents. This could be due to these passenger groups focusing less on minimising travel times which is also reflected in lower value of time. Satisfaction with information is higher for students and lower for respondents in the middle age groups. Satisfaction with staff is higher for men, students and the retired respondents, and increases notably with age, similarly to in Allen et al. (2018b). Safety is also perceived more positively for the elderly, students and men. Men and respondents belonging to the older age categories perceive comfort as more satisfying whereas full time workers seem to be less satisfied than all other occupation groups. This could again be related to a larger focus on minimising travel time. The perceived importance of public transport to society and the environment is emphasised more with age of the respondents and by students. Finally, men are more positive towards public transport's value whereas respondents categorised with other occupations are negative. This could be an income effect, but could not be taken into account directly as income was not included in the survey data. The perceived value of public transport is also seen to be positively related with age.

Generally, higher satisfaction on all factors were negatively related to using a car for usual trips. This could be because the car fulfils complex travel patterns, but it also suggests a reinforcing loop where car drivers remembers public transport as being worse than it actually is as found in Pedersen et al. (2011). However, it was not possible to investigate this specifically in this study.

4.3.2 City-specific effects

The model results using datasets for each of the six cities separately showed similarly goodness-of-fit measures, i.e. RMSEA in the range 0.029-0.036 and CFI at 0.956-0.975, for all cities, which are all satisfactory fits.

The main results in terms of parameter estimates for the main relationships between service factors, overall satisfaction, willingness to recommend public transport to others and public transport use are shown in Figure 5 where each column represents a parameter estimate, significant at the 95% level. Detailed results are shown in Appendix I, which also includes estimates of the measurement equations of the service quality constructs and the influence of socio-economic characteristics, cf. Table 7-Table 17. Note that the control variables taking into account mean differences across years are not reported due to space constraints.

Figure 5; Main parameter estimates for Model 1 relating public transport use to factors (above), and factors to overall satisfaction (middle) and willingness to recommend to others (below). Only significant parameters reported.

The results across cities show similar trends, however with some notable differences. Accessibility measures are clearly the most important characteristics for achieving high level of satisfaction with public transport across all cities, whereas the perceived value of the public transport system and the perceived importance to society and the environment were also positively significant for most cities, but with the importance varying notably across cities. Only for Stockholm was comfort a marginally important issue for overall satisfaction, and in Copenhagen the behaviour and service level from the staff was marginally important. Notably, the costs and perceived value of the system were not significant for overall satisfaction for travellers in Helsinki.

Measures related to norms had the highest correlation with willingness to recommend public transport to others across all cities. When considering the indirect effects from accessibility measures to recommendation through overall satisfaction, accessibility is almost equally important – and for Vienna and Helsinki it is more important than norms. However, for Stockholm there were no significant

direct effects from accessibility to recommendation. Only for the Copenhagen data safety was marginally important, and for the Helsinki data costs were insignificant. Finally, the willingness to recommend had a larger influence on use frequency than overall satisfaction across most cities, except for Copenhagen, and for Stockholm satisfaction did not have any significant direct effect on use frequency.

4.3.3 User-specific models

The model estimations for subsets of the dataset based on how often the user travel on public transport and whether they use private car were slightly differently formulated than the previous models as this did not allow for including public transport use frequency in the MIMIC model structure. Hence, the path diagrams were similar to Model I, depicted in Figure 4, however without use frequency. The model estimations showed similarly goodness-of-fit measures, i.e. in the range 0.027-0.030 for RMSEA and 0.949-0.961 for CFI, hence all within excellent fit. Significant coefficient estimates are reported in Figure 6 for all groups of respondents as well as for the full sample whereas full results can be seen in Tables 18-26 in Appendix I.

Figure 6; Main parameter estimates for Model I relating public transport use to factors (above), and factors to overall satisfaction (middle) and willingness to recommend to others (below). Only significant parameters reported.

When comparing the results across user groups the changes seem to be relatively small. The overall trends are similar with accessibility measures and perceived value of the system being most important across all user groups. However, in terms of overall satisfaction comfort was significantly important for very infrequent public transport users, but also for daily users, whereas norms were least important for infrequent users. For all cities, overall satisfaction is highly correlated with willingness to recommend to others with norms being similarly correlated. Accessibility is directly significant for most groups, but significant for all groups through indirect effects via overall satisfaction, hence total effects are highly significant and of notable size for all groups. Again, comfort is only marginally significant for some user groups. Thus, respondents' preferences did not show to vary notably across user types.

4.3.4 The feedback between satisfaction and travel use

The hypothesis of a feedback loop between travel satisfaction and travel use was investigated by formulating a MIMIC model as illustrated in Figure 7 (Model II).

Figure 7; Path diagram for the MIMIC model (Model II) relating public transport use, service quality dimensions, overall satisfaction and recommendation to others (solid black lines denote positive relationships). Respondents' socio-economic characteristics are treated as categorical regressors on both latent variables, mediators and dependent variables.

A joint model using data from all six cities was estimated. The goodness-of-fit measures proved a good fit with RMSEA at 0.031 and CFI at 0.949. Hence, similar fit as compared to the traditional model and well within the acceptance of a good fit (Browne and Cudeck, 1992; Hu and Bentler, 1999).

From the results shown in Table 6 accessibility is the most important characteristic in terms of correlation with public transport use frequency and overall satisfaction whereas the two factors related to perceived importance to society and the environment and perceived value of the system are almost equally important, similarly as in Model I. Perceived safety also showed notable significance consistent with much previous literature highlighting the importance of safety and security (Felleson and Friman, 2012; van Lierop et al., 2017). The factors related to information, staff behaviour and comfort also influenced public transport use of respondents, however at a smaller relative magnitude.

Overall satisfaction with public transport and willingness to recommend it to others showed similar results where measures related to accessibility were most important to respondents followed by perceived costs and societal importance. In addition, generally car drivers were significantly less satisfied and willing to recommend public transport.

The influence of respondents' socio-economic characteristics on satisfaction with individual service characteristics showed that satisfaction with all service attributes, except information, increased with age of the respondent. Nevertheless, public transport use was lower for these age groups as compared to younger respondents. The effects of occupational status were similar as in Model I.

Dependent variables	Explanatory variable	Direct effect		Total effect		R^2
		est.	C.R.	est.	C.R.	
Accessibility (F1)		0.28	44.82	0.28	44.82	0.14
Information (F2)		0.07	9.21	0.07	9.21	0.08
Staff (F3)		0.06	7.77	0.06	7.77	0.08
Safety (F4)	Use frequency	0.14	20.96	0.14	20.96	0.09
Comfort (F5)		0.07	10.03	0.07	10.03	0.08
Norms (F6)		0.27	38.79	0.27	38.79	0.15
Costs (F7)		0.20	31.20	0.20	31.20	0.16
Overall satisfaction	Use frequency	-	-	0.23	42.86	0.63
	Accessibility (F1)	0.56	55.96	0.56	55.96	
	Comfort (F5)	0.03	2.67	0.03	2.67	
	Norms (F6)	0.09	9.75	0.09	9.75	
	Costs (F7)	0.20	28.07	0.20	28.07	
Recommendation to others	Use frequency	-	-	0.23	47.02	0.65
	Accessibility (F1)	0.10	9.50	0.29	35.08	
	Comfort (F5)	-	-	0.01	2.65	
	Norms (F6)	0.34	41.12	0.37	44.66	
	Costs (F7)	0.15	19.79	0.22	29.88	
	Overall satisfaction	0.33	28.00	0.33	28.00	
Use frequency	-	-	-	-	-	0.28

Table 6: Estimates of the structural equations for Model II relating travel use frequency with the travel satisfaction factors, overall satisfaction, and recommendation to others.

5 Discussion

This study investigated the relationship between satisfaction with various service elements of public transport, overall satisfaction levels, willingness to recommend public transport to others, and travel use frequency by use of a large-scale satisfaction survey across six European cities.

The study identified seven dimensions of public transport satisfaction using the BEST survey data from 2009-2015. On top of the four dimensions also identified in Felleson and Friman (2012) using data from 2009 (i.e. *system* (denoted as accessibility in this study), *comfort*, *staff behaviour* and *safety/security*), we identified three dimensions, namely *information provision*, *costs* and *norms*. While (Felleson and Friman, 2012) did not analyse the relationship between the identified dimensions and overall satisfaction, the cross-sectional comparison across cities and user types performed by this study showed consistently that characteristics related to *accessibility* and speed of the public transport system were most important for passengers followed by *costs* in terms of perceived value and personal *norms* in terms of perceived societal and environmental importance of public transport. While the two most important determinants are in line with other studies highlighting the importance of accessibility, speed and costs when designing attractive public transport systems (Mouwen, 2015; van Lierop et al., 2017), it is noteworthy that respondents' personal beliefs regarding the societal and environmental importance of public transport is a significant contributor to increased satisfaction and travel use frequency. Interestingly, this was evident across all included cities, thus highlighting the general importance of norms in public transport satisfaction, loyalty and use frequency. Hence, when public transport is perceived as more than just a travel option satisfaction and use frequency is higher. This could be due to the increased focus on the importance of sustainable transport in solving mobility issues in metropolitan areas, and is

in line with previous research finding evidence of a positive relationship between perceived fairness, travel satisfaction and frequency of use (Kaplan et al., 2014).

This study also found significantly lower satisfaction with public transport for younger respondents despite more frequent use. This is in line with previous research finding that satisfaction with most service quality elements is higher for elderly users (Allen et al., 2018a). Younger users can often be described as captive users as they do not have other travel alternatives, e.g. due to lower car ownership. Hence, their use of public transport is more by need rather than an actual choice. As satisfaction for these user groups are lower it points towards a fundamental problem where public transport has not succeeded in creating an attractive system for its main users. It is therefore important that public transport becomes a more satisfying choice of transport if it is to be attractive for generations to come.

The various model estimations using two distinct model structures had similarly good goodness-of-fit measures confirming the hypothesized relationships between attitudes, satisfaction, knowledge propagation and travel use frequency. Several other model formulations based on model structures with opposite effects were tested. This included model structures where travel use frequency influenced overall satisfaction and recommendation, which then influenced personal attitudes. These models had slightly worse fit indices or did not converge for which reason they are not reported.

5.1 Limitations

While the study provided important insights by comparing satisfaction levels across six European cities and across users with varying use frequency of public transport, it is however not without limitations, which future studies should analyse further. Firstly, as the data is cross-sectional it is not possible to detect changes in attitudes over time. Despite being a continuously running survey, respondents are sampled every year, hence it is not panel data. The results of the analysed models relating the latent constructs of attitudes, overall satisfaction and travel use frequency should therefore be interpreted as more of a correlational nature than directed causalities. Future studies are encouraged to use longitudinal data to overcome this limitation.

Secondly, the study included respondents across six cities, which made it possible to compare travel preferences across different travel cultures. While the results showed mostly similarity across cities, this could be related to cities being more similar than diverse. Specifically, four cities were from Scandinavia, which are similar in terms of large public transport modal shares and relatively low car usage. The results from Vienna and Geneva did show differences compared to the Scandinavian capitals, hence suggesting differences in travel preferences between Scandinavian cities and Central European cities. However, general conclusions cannot be inferred from this study alone.

6 Conclusions and implications

The study has important implications for policy and practice. The findings confirm the importance of prioritising accessibility measures in terms of travel speed, ease of access and service frequency, and ensuring reasonable costs and a high perceived value when designing public transport systems. But the results also showed that respondents' perceived societal and environmental importance of public transport were significant sources for overall satisfaction and use frequency of the public transport system. As this was found across all six cities it suggests the importance of also focusing on public transport as being environmentally sustainable when improving the perceived attractiveness of public transport. Hence, public transport agencies could consider these issues in their branding to both attract more passengers, but also to keep existing passengers more satisfied.

Furthermore, younger passengers and students were systematically less satisfied despite using public transport more frequently. This could be due to these users being captive rather than choice users, but also suggests a structural problem with public transport as travel habits formed in early life shapes travel behaviour throughout life. Hence, public transport should focus on the specific needs of young travellers to ensure a high level of satisfaction among these groups of travellers. This requires a constant focus on efficient operations ensuring fast and reliable public transport, and, as suggested by this study, a stronger focus on sustainability.

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Conflicts of interest statement

On behalf of all authors, the corresponding author states that there is no conflict of interest.

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Appendix I

This appendix includes the detailed results from Model I relating the service quality dimensions to overall satisfaction, willingness to recommend to others and use frequency as described in section 4.3 of the paper. Table 7 shows the estimates of the measurement equations of the latent constructs of service quality dimensions for the combined dataset and separated for all six cities. Table 8-Table 10 show detailed results of the parameter estimates of the links between factors, overall satisfaction, recommendation to others and use frequency. Table 11-Table 17 show the influence of background variables on the seven service quality dimensions. Detailed results for the user-specific models are reported in Table 18-Table 26. Note that binary variables for each year was also included to take into account variations across years, but these are not reported.

	All	Stock- holm	Oslo	Helsinki	Copen- hagen	Vienna	Geneva
Public transport (PT) is good for work/school trips	1.000	1.000	1.000	1.000	1.000	1.000	1.000
PT is good for shopping, leisure etc.	0.965	1.113	0.937	1.067	0.883	0.914	0.910
PT is good for trips in the city centre	0.819	0.937	0.965	0.630	0.807	0.641	1.080
PT is good for trips outside the city centre	0.910	1.053	0.847	1.037	0.837	1.035	0.809
Nearest stop is close to where I live	0.553	0.554	0.585	0.557	0.567	0.648	0.499
Travel time on public transport is reasonable	1.183	1.317	1.107	1.144	1.302	1.290	1.101
Waiting time is short at transfers	1.048	1.083	0.937	1.056	1.162	1.174	0.990
I am satisfied with the number of departures	1.063	1.061	0.899	1.139	1.071	1.277	1.079
PT mostly runs on schedule	0.990	1.089	0.965	0.887	1.079	1.210	0.922
Transfers are easy	1.288	1.279	1.176	1.300	1.449	1.460	1.232
It is easy to get the information needed before a trip	1.000	1.000	1.000	1.000	1.000	1.000	1.000
The information is good when problems occur	1.016	0.946	0.870	0.887	1.245	0.973	1.051
The information is good in stops and terminals	1.092	1.022	0.953	0.917	1.228	1.168	1.158
The staff answers my questions correctly	1.000	1.000	1.000	1.000	1.000	1.000	1.000
The staff behaves nicely and correctly	1.055	0.950	1.069	1.274	0.998	0.918	1.099
I feel secure at stations and bus stops	1.000	1.000	1.000	1.000	1.000	1.000	1.000
I feel secure on board busses and trains	1.283	1.416	1.594	1.073	1.338	1.231	1.394
I am not afraid of traffic accidents when using PT	0.827	0.781	0.879	0.818	0.763	0.661	0.976
Travelling with PT is comfortable	1.000	1.000	1.000	1.000	1.000	1.000	1.000
The busses and trains are modern	0.646	0.545	0.770	0.486	0.747	0.737	0.691
The busses and trains are clean	0.560	0.497	0.726	0.428	0.546	0.662	0.626
I normally get a seat when I travel with PT	0.456	0.392	0.510	0.368	0.557	0.551	0.516
More people will travel with PT in the future	1.000	1.000	1.000	1.000	1.000	1.000	1.000
PT is good for the environment	1.192	1.148	1.660	1.412	1.175	1.000	0.935
PT is beneficial to society	1.713	1.768	2.400	1.789	1.944	1.610	1.284
PT gives value for money	1.000	1.000	1.000	1.000	1.000	1.000	1.000
PT fares are reasonable	0.268	0.306	0.207	0.062	0.276	0.328	0.367

Table 7; Estimates of the measurement equations of the latent constructs of Model I. All estimates are significant at the 99% level.

Overall satisfaction	All	Stock-holm	Oslo	Helsinki	Copen-hagen	Vienna	Geneva
F1 – Accessibility	0.58**	0.53**	0.64**	0.68**	0.58**	0.46**	0.57**
F3 – Staff	-	-	-	-	0.04*	-	-
F5 – Comfort	-	0.16**	-	-	-	-	-
F6 – Norms	0.10**	-	0.07**	0.16**	0.07**	0.26**	0.09**
F7 – Cost	0.20**	0.26**	0.20**	-	0.21**	0.15**	0.23**
Male	-	0.11**	-0.08*	-	-	0.12*	-
Age 25-44	-0.09**	-	-	-	-0.13*	-	-0.23**
Age 45-64	-0.06*	-	-	-	-	-	-0.29**
Age 65-79	-	-	0.34**	-	-	-	-0.30**
Age 80+	-	-	0.33*	-	-0.28**	-	-0.37**
Car driver	-0.06**	-	-0.08**	-0.06**	-	-0.19**	-0.10**

Table 8; Parameter estimates of the structural equations linking the factors to overall satisfaction and socio-economic characteristics in Model I. * $p < 0.05$. ** $p < 0.01$.

Recommendation to others	All	Stock-holm	Oslo	Helsinki	Copen-hagen	Vienna	Geneva
Satisfaction	0.32**	0.50**	0.36**	0.22**	0.31**	0.35**	0.35**
F1 – Accessibility	0.11**	-	0.07*	0.22**	0.11**	0.26**	0.11**
F4 – Safety	-	-	-	-	0.04*	-	-
F6 – Norms	0.34**	0.33**	0.36**	0.47**	0.28**	0.26**	0.36**
F7 – Cost	0.15**	0.12**	0.16**	-	0.15**	0.15**	0.05*
Age 25-44	-	-	-	-0.12*	-	-	-
Age 45-64	-	-	0.16*	-	-	-	-
Occupation (Student)	0.07**	-	0.31**	-	-	-	-
Occupation (Other)	-	-	-	0.09*	-	-	-
Car driver	-0.16**	-0.13	-0.20	-0.20	-0.19	-	-0.15

Table 9; Parameter estimates of the structural equations linking the factors to willingness to recommend public transport to others and socio-economic characteristics in Model I. * $p < 0.05$. ** $p < 0.01$.

Use frequency	All	Stock-holm	Oslo	Helsinki	Copen-hagen	Vienna	Geneva
Overall satisfaction	0.11**	-	0.13**	0.12**	0.19**	0.09*	0.09**
Recommendation	0.21**	0.22**	0.23**	0.21**	0.15**	0.18**	0.21**
Male	-0.09**	-0.07**	-	-0.15**	-	-	-0.13**
Age 25-44	-0.29**	-0.38**	-0.33**	-0.24**	-0.22**	-0.18*	-0.29**
Age 45-64	-0.37**	-0.46**	-0.52**	-0.35**	-0.30**	-0.29**	-0.34**
Age 65-79	-0.35**	-0.40**	-0.49**	-0.35**	-0.17*	-0.34**	-0.35**
Age 80+	-0.44**	-0.56**	-0.56**	-0.42**	-	-0.48**	-0.41**
Occupation (Part-time)	-0.10**	-0.12**	-0.18**	-	-	-0.18**	-
Occupation (Retired)	-0.41**	-0.58**	-0.57**	-0.45**	-0.20**	-0.42**	-0.20**
Occupation (Student)	0.19**	0.22**	-	0.26**	0.23**	0.35**	0.33**
Occupation (Other)	-0.28**	-0.37**	-0.41**	-0.29**	-	-0.31**	-0.34**
Car driver	-0.64**	-0.69**	-0.68**	-0.68**	-0.62**	-0.69**	-0.59**

Table 10; Parameter estimates of the structural equations linking overall satisfaction and willingness to recommend public transport to others to socio-economic characteristics in Model I. * $p < 0.05$. ** $p < 0.01$.

F1 – Accessibility	All	Stock-holm	Oslo	Helsinki	Copen-hagen	Vienna	Geneva
Male	-	-	-	-	-	-	-0.07*
Age 25-44	-	-	-	-	-	-	-
Age 45-64	-0.05*	-	-	-0.11*	-	-	-
Age 65-79	0.10**	0.43**	-	-	-	-	0.22*
Age 80+	0.26**	0.65**	-	-	0.22*	-	0.38**
Occupation, part time	0.08**	-	-	-	0.12*	-	-
Occupation, retired	0.17**	-	0.24**	0.17**	0.19**	0.30**	-
Occupation, student	0.09**	-	-	0.12**	-	-	-
Occupation, other	0.10**	-0.15*	-	0.08*	0.21**	-	0.18**
Car driver	-0.42**	-0.34**	-0.41**	-0.39**	-0.60**	-0.47**	-0.37**

Table 11; Parameter estimates for factor 1 “accessibility” in Model I. * $p < 0.05$ ** $p < 0.01$.

F2 – Information	All	Stock-holm	Oslo	Helsinki	Copen-hagen	Vienna	Geneva
Male	-	-	-	-	0.09**	-	-0.08*
Age 25-44	-0.11**	-	-	-0.22**	-	-	-0.21**
Age 45-64	-0.24**	-0.17**	-0.16*	-0.31**	-0.17*	-0.30**	-0.32**
Age 65-79	-0.18**	-	-	-0.19**	-0.19*	-0.42**	-
Age 80+	-	0.35**	-	-	-	-0.58**	-
Occupation, part time	0.08**	-	-	0.11*	-	-	-
Occupation, retired	-	-	-	-	-	-	-
Occupation, student	0.09**	-	0.13*	0.09*	-	-	-
Occupation, other	0.06*	-	-	-	-	-	0.13*
Car driver	-0.12**	-	-0.12**	-0.13**	-0.16**	-0.23**	-0.12**

Table 12; Parameter estimates for factor 2 “information” in Model I. * $p < 0.05$ ** $p < 0.01$.

F3 – Staff behaviour	All	Stock-holm	Oslo	Helsinki	Copen-hagen	Vienna	Geneva
Male	0.05**	-	-	0.13**	0.09**	-	-0.15**
Age 25-44	0.06*	-	-	-	0.20**	-	-
Age 45-64	0.18**	0.28**	0.23**	0.15**	0.30**	-	-
Age 65-79	0.36**	0.63**	0.38**	0.26**	0.52**	-	-
Age 80+	0.75**	1.15**	0.98**	0.41**	0.74**	0.54**	0.55**
Occupation, part time	0.05*	0.11*	-	-	-	-	-
Occupation, retired	0.10**	-	0.14*	0.12**	-	-	-
Occupation, student	0.07**	0.13*	-	-	-	-	-
Occupation, other	-	-	-	-	-	-	-
Car driver	-0.13**	-0.13**	-	-0.12**	-0.23**	-0.20**	-0.12**

Table 13; Parameter estimates for factor 3 “staff behaviour” in Model I. * $p < 0.05$ ** $p < 0.01$.

F4 – Safety and security	All	Stock-holm	Oslo	Helsinki	Copen-hagen	Vienna	Geneva
Male	0.34**	0.29**	0.30**	0.38**	0.40**	0.33**	0.24**
Age 25-44	-	-	-	-0.10*	-	0.28**	-
Age 45-64	-	-	-	-	-	0.25**	-
Age 65-79	0.25**	0.52**	0.20*	0.19**	0.30**	-	0.24*
Age 80+	0.49**	0.97**	0.78**	0.48**	0.40**	-	0.35**
Occupation, part time	-	-	-	-	-	-	-
Occupation, retired	-0.06**	-0.36**	-	-	-0.11*	-	-
Occupation, student	0.18**	-	0.21**	0.20**	-	0.28**	0.27**
Occupation, other	-0.08**	-0.30**	-0.21*	-	-	-	-
Car driver	-0.19**	-0.21**	-0.13**	-0.17**	-0.28**	-0.23**	-0.15**

Table 14; Parameter estimates for factor 4 “safety and security” in Model I. * $p < 0.05$ ** $p < 0.01$.

F5 – Comfort	All	Stock-holm	Oslo	Helsinki	Copen-hagen	Vienna	Geneva
Male	0.06**	-	0.08**	0.06*	0.11**	-	-
Age 25-44	-	-	-	-0.10*	-	-	-
Age 45-64	-	0.15*	-	-	0.13*	-	-
Age 65-79	0.25**	0.43**	0.31**	0.15*	0.34**	-	0.24*
Age 80+	0.54**	0.82**	0.76**	0.44**	0.48**	-	0.55**
Occupation, part time	0.10**	-	0.18**	0.13**	-	-	-
Occupation, retired	0.16**	-	0.25**	0.19**	0.13*	0.17*	-
Occupation, student	0.11**	0.15*	0.21**	-	-	-	0.17*
Occupation, other	0.13**	-	-	-	-	-	0.28**
Car driver	-0.19**	-0.17**	-0.14**	-0.23**	-0.24**	-0.30**	-0.12**

Table 15; Parameter estimates for factor 5 “comfort” in Model I. * $p < 0.05$ ** $p < 0.01$.

F6 – Norms	All	Stock-holm	Oslo	Helsinki	Copen-hagen	Vienna	Geneva
Male	-	0.07*	-	-0.16**	0.17**	0.19**	-
Age 25-44	0.17**	0.19**	0.28**	0.14**	0.17**	-	0.19*
Age 45-64	0.18**	0.27**	0.16*	-	0.29**	0.21*	0.22**
Age 65-79	0.30**	0.48**	0.32**	0.20**	0.30**	-	0.49**
Age 80+	0.36**	0.55**	0.45**	-	0.40**	-	0.52**
Occupation, part time	-	-	-	-	-	0.17*	-
Occupation, retired	-	-0.16*	-	-	-	-	-
Occupation, student	0.09**	-	-	0.16**	0.14*	-	-
Occupation, other	-	-0.18*	-0.25**	-	-	-	-
Car driver	-0.30**	-0.27**	-0.27**	-0.32**	-0.38**	-0.30**	-0.26**

Table 16; Parameter estimates for factor 6 “norms” in Model I. * $p < 0.05$ ** $p < 0.01$.

F7 – Costs	All	Stock- holm	Oslo	Helsinki	Copen- hagen	Vienna	Geneva
Male	0.09**	0.10**	0.11**	-	0.14**	0.10*	0.09**
Age 25-44	0.18**	0.37**	0.28**	-	0.22**	-	0.17*
Age 45-64	0.30**	0.53**	0.29**	-	0.31**	-	0.32**
Age 65-79	0.54**	0.99**	0.65**	-	0.62**	0.35**	0.55**
Age 80+	0.80**	1.15**	0.98**	-	1.00**	0.40*	0.78**
Occupation, part time	-	-	-	-	-	-	-
Occupation, retired	-	-0.17**	0.15*	-	-	-	-
Occupation, student	-	-	-	-	-	-	-
Occupation, other	-0.12**	-0.23**	-	-	-	-0.23**	-
Car driver	-0.23**	-0.19**	-0.27**	-	-0.30**	-0.20**	-0.21**

Table 17; Parameter estimates for factor 7 “costs” in Model I. * $p < 0.05$ ** $p < 0.01$.

Overall satisfaction	Rarely	Monthly	Weekly	Daily	Car user	Car non-user
F1 – Accessibility	0.51**	0.55**	0.59**	0.54**	0.53**	0.56**
F5 – Comfort	0.10**	0.08**	-	0.09**	0.05**	0.06**
F6 – Norms	-	0.08**	0.07**	0.07**	0.07**	0.08**
F7 – Cost	0.21**	0.20**	0.21**	0.22**	0.22**	0.19**
Age 25-44	-	-	-	-	-0.09*	-
Age 65-79	-	0.15*	-	-	-	-
Age 80+	-	-	-	-0.29*	-0.14*	-
Occupation (Part-time)	-	0.13*	-	-	-	-
Occupation (Student)	-0.26*	-	-	-	-	-

Table 18; Parameter estimates of the structural equations linking the factors to overall satisfaction and socio-economic characteristics in Model I. * $p < 0.05$. ** $p < 0.01$.

Recommendation to others	Rarely	Monthly	Weekly	Daily	Car user	Car non-user
Overall satisfaction	0.39	0.33	0.38	0.35	0.35	0.36
F1 – Accessibility	-	0.06	-	0.08	0.08	0.11
F5 – Comfort	-	0.05	0.09	0.06	-	-
F6 – Norms	0.31	0.33	0.35	0.34	0.37	0.32
F7 – Cost	0.18	0.15	0.14	0.12	0.14	0.16
Age 45-64	-	-	-	0.10	-	-
Occupation (Retired)	0.20	-	-	-	-	-
Occupation (Student)	-	-	-	0.11	0.12	-
Occupation (Other)	-	0.11	-	0.12	-	-
Car driver	-0.13	-0.14	-0.10	-0.11	N/A	N/A

Table 19; Parameter estimates of the structural equations linking the factors to willingness to recommend public transport to others and socio-economic characteristics in Model I. * $p < 0.05$. ** $p < 0.01$.

F1 – Accessibility	Rarely	Monthly	Weekly	Daily	Car user	Car non-user
Male	-	0.05*	-	-	-	-
Age 25-44	-0.17*	-	-	0.07*	-	-0.08*
Age 45-64	-0.21**	-	-	-	-	-0.14**
Age 65-79	-	-	0.12*	0.34**	0.16**	-
Age 80+	-	0.29**	0.21**	0.57**	0.35**	0.19*
Occupation, part time	0.12**	-	0.08*	-	-	0.11**
Occupation, retired	0.27**	0.26**	0.25**	0.16**	0.12**	0.22**
Occupation, student	-	-	-	-	-	0.14**
Occupation, other	-	0.20**	0.16**	0.09*	0.07*	0.12**
Car driver	-0.34**	-0.33**	-0.23**	-0.15**	-	-

Table 20; Parameter estimates for factor 1 “accessibility” in Model I. * $p < 0.05$ ** $p < 0.01$.

F2 – Information	Rarely	Monthly	Weekly	Daily	Car user	Car non-user
Male	-	-	-	-	-	-
Age 25-44	-0.33**	-	-	-0.09*	-0.11**	-0.11**
Age 45-64	-0.46**	-0.25**	-0.17**	-0.22**	-0.24**	-0.24**
Age 65-79	-0.45**	-	-0.18**	-	-0.23**	-0.11*
Age 80+	-0.31*	-	-	-	-	-
Occupation, part time	-	-	-	0.11**	0.06*	0.10**
Occupation, retired	-	-	-	-	0.07*	-
Occupation, student	-	-	-	0.12**	0.11**	-
Occupation, other	-	-	-	-	-	0.07*
Car driver	-0.16**	-0.09**	-0.08**	-	-	-

Table 21; Parameter estimates for factor 2 “information” in Model I. * $p < 0.05$ ** $p < 0.01$.

F3 – Staff behaviour	Rarely	Monthly	Weekly	Daily	Car user	Car non-user
Male	-	-	0.05*	0.07**	0.07**	-
Age 25-44	-	-	-	0.08*	-	0.13**
Age 45-64	0.21**	0.13*	0.20**	0.18**	0.15**	0.23**
Age 65-79	0.43**	0.31**	0.26**	0.51**	0.28**	0.48**
Age 80+	0.79**	0.84**	0.61**	0.83**	0.69**	0.84**
Occupation, part time	-	-	-	-	-	-
Occupation, retired	-	0.13**	0.16**	-	0.14**	-
Occupation, student	-	-	-	-	0.09**	-
Occupation, other	-	-	-	-	-	-
Car driver	-0.13**	-0.13**	-0.11**	-	-	-

Table 22; Parameter estimates for factor 3 “staff behaviour” in Model I. * $p < 0.05$ ** $p < 0.01$.

F4 – Safety and security	Rarely	Monthly	Weekly	Daily	Car user	Car non-user
Male	0.28**	0.35**	0.34**	0.38**	0.38**	0.29**
Age 25-44	-	-	-	-	-	-
Age 45-64	-	-	-	0.10**	-	-
Age 65-79	0.24*	0.21**	0.18**	0.40**	0.27**	0.25**
Age 80+	0.49**	0.59**	0.36**	0.54**	0.48**	0.54**
Occupation, part time	-	-	-	-	-	-
Occupation, retired	-0.11*	-	-	-	-0.08*	-
Occupation, student	-	-	-0.10**	0.19**	0.17**	0.17**
Occupation, other	-0.15**	-	-	-	-	-0.12**
Car driver	-0.43**	-0.13**	-	-	-	-

Table 23; Parameter estimates for factor 4 “safety and security” in Model I. * $p < 0.05$ ** $p < 0.01$.

F5 – Comfort	Rarely	Monthly	Weekly	Daily	Car user	Car non-user
Male	0.07*	0.07**	0.05*	0.08**	0.08**	0.06**
Age 25-44	-	-	-	-	-	-
Age 45-64	-	-	-	-	-	-
Age 65-79	0.22*	0.28**	0.17**	0.38**	0.26**	0.26**
Age 80+	0.40**	0.71**	0.49**	0.51**	0.55**	0.56**
Occupation, part time	0.13*	-	-	0.12**	0.08**	0.12**
Occupation, retired	0.12*	0.17**	0.19**	0.16**	0.16**	0.16**
Occupation, student	-	-	0.11*	0.11**	0.11**	0.09*
Occupation, other	-	0.16**	0.14**	0.16**	0.14**	0.12**
Car driver	-	-0.18**	-0.17**	-0.09**	-	-

Table 24; Parameter estimates for factor 5 “comfort” in Model I. * $p < 0.05$ ** $p < 0.01$.

F6 – Norms	Rarely	Monthly	Weekly	Daily	Car user	Car non-user
Male	-	0.05*	-	0.06**	0.05**	-
Age 25-44	-	0.17**	0.27**	0.22**	0.19**	0.13**
Age 45-64	-	0.20**	0.33**	0.22**	0.21**	0.14**
Age 65-79	0.29**	0.25**	0.44**	0.40**	0.34**	0.26**
Age 80+	0.41**	0.45**	0.43**	0.41**	0.38**	0.44**
Occupation, part time	-	-	-	0.08*	-	-
Occupation, retired	-	-	-	-	-0.11**	-
Occupation, student	-	-	-	-	-	0.15**
Occupation, other	-	-	-	-	-0.11**	-
Car driver	-0.21**	-0.17**	-0.13**	-0.06*	-	-

Table 25; Parameter estimates for factor 6 “norms” in Model I. * $p < 0.05$ ** $p < 0.01$.

F7 – Costs	Rarely	Monthly	Weekly	Daily	Car user	Car non-user
Male	0.10**	0.12**	0.11**	0.11**	0.09**	0.11**
Age 25-44	-	0.31**	0.20**	0.23**	0.13**	0.25**
Age 45-64	-	0.40**	0.33**	0.41**	0.29**	0.32**
Age 65-79	-	0.64**	0.53**	0.77**	0.57**	0.55**
Age 80+	0.59**	0.92**	0.83**	0.93**	0.80**	0.88**
Occupation, part time	-	-	-	-	-	-
Occupation, retired	-	-	0.13**	-	-	-
Occupation, student	-	-	-	-	-	-
Occupation, other	-	-	-0.12**	-0.14**	-0.17**	-
Car driver	0.16**	-0.13**	-0.09**	-0.07**	-	-

*Table 26; Parameter estimates for factor 7 “costs” in Model 1. * $p < 0.05$ ** $p < 0.01$.*