Extended abstract for hEART 2018: 7th Symposium of the European Association for Research in Transportation, September 5th-7th. Athens, Greece

What is the role of weather, built-environment and accessibility geographical characteristics in influencing travelers' experience?

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KEYWORDS: customer satisfaction, built-environment, accessibility, weather, crime

Abstract:

1. Background, aim and purpose:

Providing an accessible and inclusive transport service for all is important in ensuring people are not excluded from reaching places of employment, health, education and leisure services, and simultaneously in ensuring equal life opportunities for our diverse communities. However, at the same time, urban form, land use and mix, level of accessibility to public transport and the type of the available infrastructure influence travel behavior and the quality of the service (Cao et al., 2007; Litman, 2015). In order to provide a transport service that meets travelers´ needs, it is important to understand how the characteristics of the built-environment, weather and the service provided affect travelers' overall travel satisfaction, needs and priorities.

In recent years there have been a large number of studies focusing on different aspects of the traveler experience. Of special interest, has been the investigation of the service attributes that influence overall travel satisfaction. The primary focus of researchers has been on studying general travelers' population, different user groups (Dell'Olio et al, 2011), different trip purposes (Cantwell et al., 2009) and different travel modes (Susilo and Cats, 2014) which have yielded a different combination of key determinants. Other works have examined the impact on traveler's satisfaction of mediator and non-instrumental variables such as subjective well-being (Friman et al., 2013), mood and personality (Gao et al., 2017) showing that the more alert, happy and relaxed the traveler is, the more satisfied with the travel service he/she becomes.

Urban and rural environments are contrasting geographical contexts which tend to be considered internally homogenous when, in reality, urban environments encompass very different and varying settings. As a result, travel satisfaction changes within a given region. Disparity in overall satisfaction levels depends on the urban area 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 centres and the most populated municipalities, while, on average, overall satisfaction is highest in smaller municipalities. Furthermore, other geographical factors as well as differences in public transport service and infrastructure influence overall travel satisfaction (Fellesson and Friman, 2008). Accessibility measures defined as proximity and availability of public transport are important drivers of satisfaction and frequency of use. It was found that low accessibility measures negatively affect the overall assessment of the travel experience (Woldeamanuel and Cygansky, 2011) and the public transport usage frequency (Brons et al., 2009).

Additionally, dissimilarities in prior expectations between urban, sub-urban and rural travelers may influence their travel evaluations (eg. Tyrinopoulos and Antoniou, 2008). Residents of the urban areas tend to be more ambitious and well-travelled than those living in more rural areas (eg. Gordon, 2012) and thus the expectations of the urban travelers might be higher.

It is still unclear how accessibility, physical and non-physical built-environment and weather characteristics impact on the overall travelers´satisfaction when considered all together. In addition, no previous studies have looked into the impact of travelers' expectations on travelers' evaluations. These knowledge gaps may actually lead to an unfair evaluation of the service provided by public transport operators and can undermine the impacts of well-designed transit oriented areas and first-mile facilities on traveler's overall travel satisfaction.

In order to address this problem, this study aims to examine whether overall travelers' satisfaction varies as a function of the characteristics (types of built environment, level of accessibility and service) of the geographical units where travelers start their trips and thus of the first-mile impact on door-to-door trips. In addition, this study will investigate the impact of weather conditions on the traveler experience.

The results of this ongoing study will help regional public transport providers, public transport authorities and municipalities to provide a service that better suits their customer needs and design geographically-tailored investments that will foster satisfaction in the future.

2. Theoretical Background and Hypotheses

Based on previous literature, it is hypothesized that travelers starting their trip in different geographical units will have distinct needs and priorities. In addition, considering previous results (Woldeamanuel and Cygansky, 2011; Brons et al., 2009), and after controlling for all individual socio-demographic and travel characteristics variables, it is expected to find lower levels of reported travel satisfaction in geographical units with the lowest levels of accessibility.

Previous research has shown that weather characteristics influence travel behaviour and satisfaction (St-Louis et al., 2014; Chengxi et al., 2015; Ettema et al., 2017). For example, ground covered with snow negatively influences the number of trips chained (Chengxi et al., 2015), winter plays a negative role on satisfaction with slow modes (St-Louis et al., 2014) and sunshine has a positive effect on mood and thus on the way travelers evaluate their trip (Ettema et al., 2017). Therefore, we would expect that travelers using travel modes more exposed to inclement weather (bus and tram) would show lower satisfaction evaluations when the weather negatively diverges from the seasonal average values.

Physical and non-physical built-environment may also influence the traveler experience. The results of previous research show that an interesting and busy built-environment increases the probability of walking longer distances (Jiang et al., 2012), that there is an association between travel mode choice and walkability and the density of population and land use characteristics (Zhang, 2004). The influence of land-use on travel behaviour has been controversial. While some authors postulate that land use does not sway the capacity to walk and cycle of travelers living in an area (eg. Cervero et al., 2006) some authors found the opposite (Saelens et al., 2003).

Non-physical built-environment characteristics such as crime perceptions have been found to negatively influence not only the starting time of the trip, but also route and travel mode choice (eg. Loukaitou-Sideris et al., 2009). Furthermore, presence of real or perceived crime has been proved be an important determinant of travel satisfaction (Cats et al., 2015). Therefore, we would expect that areas that are perceived as less safe would have lower satisfaction evaluations.

3. Data

This ongoing study employs a rolling survey known as the Swedish customer satisfaction barometer from the years 2009 to 2015. The travel satisfaction survey, collected by *Svensk Kollektivtrafik,* inquiries public transport users and non-users and includes questions concerning satisfaction with the overall and last trip and with individual service attributes, as well as travel characteristics, perceptions and attitudes. The data collection is carried out via phone calls on a regular basis year-round and comprises 14 122 samples which are randomly distributed across the entire Stockholm County and 5 526 samples for Stockholm city. A county formed by 26 municipalities and 1 960 five-digit postcode areas that encompass from highly urbanized to rural areas which are characterized by having a very different transport infrastructure, service provisions and built environment.

Individual and geographically based data will be included in the models. Individual related data includes socio-demographic characteristics and travel characteristics. Geographically based characteristics include accessibility measures, weather characteristics, physical and non-physical built-environment characteristics. All the variables belonging to each category can be found in the table below.

Table 1: Data, data sources and year of origin

Variable Category	Variable	Source	Geographical availability	Year
Customer satisfaction perceptions	Overall trip and last trip satisfactions	SKT (Swedish customer satisfaction barometer	Postcode area	2009-2015
Socio-demographic characteristics	Age, gender, Car in HH, Occupation and Driving license	SKT (Swedish customer satisfaction barometer	Postcode area	2009-2015
Travel characteristics	Travel mode, Frequency of travel by car and by PT	SKT (Swedish customer satisfaction barometer	Postcode area	2009-2015
Non-physical built-environment characteristics (perceptions)	Previous victimization Referring to neighborhood: Safety perceptions at day and night for PT and non PT	Trygghetsundersökning Stockholm (Safety Perceptions survey Stockholm)	Postcode area	2014
	Cleaning, maintenance and lighting	Trygghetsundersökning Stockholm (Safety Perceptions survey Stockholm)	Postcode area	2014
Physical built-environment characteristics	Density of population	SCB (Statistics Sweden)	Postcode area	2012
	Purchasing power	SCB (Statistics Sweden)	Samscode area	2013
	Land Use	Corine Land Cover	Continuous data	2012
Weather characteristics	Temperature, Rainfall, Wind speed, Snow depth, % coverage days, Humidity	SMHI (Swedish Meteorological and Hydrological Institute)	4 weather stations in Stockholm County	2009-2015
Accessibility measures	Generalized costs from one to all postcodes and from O to D	Tailored made and based on PT service frequencies from SL (Stockholm's PT authority)	Postcode area	2014
	Proximity to high capacity PT	Tailored made based on location of PT stops	Continuous data	2009-2015

A visual examination of the geographical distribution of overall travel satisfaction and high capacity PT modes (commuter train, metro and tram), see figure below, seems to show a correlation between highly accessible postcode areas and highly satisfied trips.

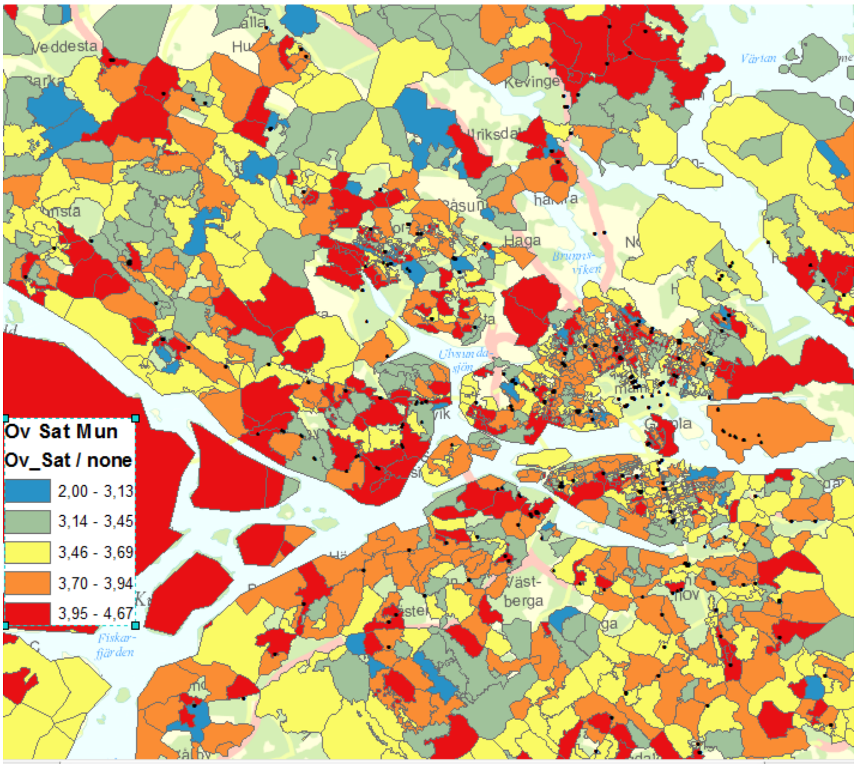

Figure 1: Geographical distribution of overall travel satisfaction in Stockholm city and surroundings. Black dots are high capacity PT stations.

A number of software are employed in in this study. ArcGis is used to obtain geographical distributions and to aggregate the data into the same geographical units. Transcad is used to calculate the accessibility measures and SPSS to run the multivariate statistical analyses.

4. Model specification

Based on the previous set of variables, descriptive statistics and correlation analyses will be presented. Then Ordered Logit regression Models (OLM) will be employed to systematically investigate the influence of weather characteristics, built-environment and accessibility measures on the traveler experience. OLM is deemed to be the most adequate technique to handle the ordinal nature (from 1-very dissatisfied to 5-very satisfied) of the models' dependent variables assuming that the incremental change between the categories of the service attributes are linear and the same.

A total of 4 different conceptual models (M1-M4) will be specified. The main differences across the models are: the geographical scope (Stockholm City and County) and the travel experience they refer to (overall and last trip) and the set of explanatory included. See table below for more information.

Table 2: Model specification M1-M4

		M1	M2	M3	M4
Geographical extent	**Stockholm City**	x	x		
	Stockholm County			x	x
Dependent variable	**Overall trip**	x		x	
	Last trip		x		x
Independent variables	**Socio-demographic characteristics** (age, gender, car in HH, occupation, driving license)	x	x	x	x
	Travel characteristics (travel mode, frequency of travel by car and by PT)	x	x	x	x
	Safety perceptions (previous victimization, referring to neighborhood: safety perceptions at day and night)	x	x		
	Non-physical built-environment (perceptions)	x	x		
	Weather characteristics (temperature, rainfall, wind speed, snow depth, % coverage days, humidity)		x		x
	Physical built-environment characteristics (land-use, density of population, purchasing power)	x	x	x	x
	Accessibility measures				
	Generalized costs from one to all postcodes	x		x	
	Generalized cost from Origin to Destination		x		x
	Proximity to high capacity PT	x	x	x	x

This different model specification is due to: **a)** data limitation; **b)** the impossibility to link weather characteristics of an average overall trip to specific weather conditions, and **c)** Different accessibility measures included for overall (M1&M3) and last trip (M2&M4) models.

The authors are currently working on the analysis section of the paper.

Acknowledgment

The authors would like to thank Stockholm County's (SLL) Research Development Funding in supporting the authors' research activities.

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