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Do travel options influence how commute time satisfaction relates to the residential built environment?

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ABSTRACT

Although previous studies have explored how satisfied people are with their travel, the link with the built environment and available travel options is unclear. This research investigates whether travel options influence how commute time satisfaction relates to the built environment. First, profiles among commuters in terms of commute time satisfaction (CTS) and residential built environment (RBE) were identified by performing a cluster analysis using a large European sample with the European Union Statistics on Income and Living Conditions (EU-SILC) 2013 survey. Following, whether travel options (mode availability) could inform differences among CTS-RBE profiles was investigated, while accounting for neighborhood characteristics and satisfaction with life and life domains, by performing logistic regression analyses. Travel options were found to indicate CTS-RBE profiles. This research supports the idea that travel options can affect the CTS-RBE relationship, and can therefore be useful to measuring and correcting travel option unavailability or travel captivity. The contributions of this study to the travel behavior field, in addition to being the first study to examine CTS, is important to urban planning and policy to not only identify the places in which travel options can be improved, but for whom.

1. Introduction

This paper aims to examine how commuter satisfaction is related to the residential built environment (RBE), and how travel options (mode availability) affect this relationship. Since the RBE has an important effect on how people travel, it is likely that commute satisfaction differs according to where people live. Travel mode choice, travel distance, and travel duration, for instance, are all affected by the built environment, but also have proven to influence travel satisfaction. This study explores these links by using commuter profiles determined by commute time satisfaction (CTS) and residential built environment (RBE) variables. Travel option variables are then analyzed for their ability to inform CTS-RBE profiles. The CTS-RBE profiles provide an opportunity to investigate travel option differences between, for example, high- and low-satisfied rural residents, and can therefore inform circumstances or definitions of travel captivity. This is important to urban planning and policy to not only identify the places where travel options can be improved, but for whom. What is known thus far about the relationship between travel and commute satisfaction, the built environment, and travel options will be discussed through literature review, and subsequently this paper will investigate travel options among individuals of varying categories of CTS and RBE.

There is extensive existing literature examining individuals' travel satisfaction (see Friman et al., 2018 for a review). Active versus motorized modes, time and distance to destination, the impact of destination-specific activities, and attitudes toward travel are all well-researched topics in relation with travel satisfaction. However, satisfaction with travel time, specifically commute time, has thus-far been neglected. It is important to investigate satisfaction with travel time because though trip time typically has a negative relationship with travel satisfaction, individuals do not report a desire to eliminate their commutes completely (Redmond and Mokhtarian, 2001). This indicates that CTS is more complex than analyses using a single variable can investigate, providing justification for its combination with the RBE variable for this analysis.

The built environment has a substantial relationship with and influence on commuting time (Ewing and Cervero, 2001; Ewing et al., 1994; Khattak and Rodriguez, 2005; Schwanen et al., 2005), but this

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relationship is far from straightforward (Ewing and Cervero, 2010). RBE, walkability, and regional accessibility directly affect active travel mode options and distance traveled, while residential self-selection, the choice to live in a certain neighborhood, has an indirect effect on travel attitudes and travel satisfaction, making the causes of observed patterns of travel behavior less discernable (Cao et al., 2009). For example, someone preferring to commute by car may choose to live in a rural neighborhood with more space and infrastructure for their vehicle but fewer transit connections, low active travel options, and a long commute time, though still have high travel satisfaction. Many empirical travel behavior studies try to disentangle these influences, finding that the built environment itself remains significant to travel behavior after self-selection is accounted for (see Cao et al., 2009, for a review). This is now also being explored in travel satisfaction literature (e.g. Cao and Ettema, 2014). The CTS and RBE profiles created in this analysis provide more information about different types of respondents and allow for investigation of the complex relationship between the built environment and travel satisfaction.

Though neighborhood choice or preference can partially inform these profiles, not all individuals are able to self-select into their preferred residential neighborhood and consequently not everyone is able to travel in their preferred way. This refers to ‘travel captivity’, which remains relatively less studied, also in travel satisfaction literature. Traditional definitions of travel captivity have assumed that it is reliant on private car access or not (though there are exceptions, e.g. Beimborn et al., 2003; Jacques et al., 2013), but this research uses the definition of travel options in general. Therefore, this paper will explore the relationship of travel captivity (Jacques et al., 2013), a circumstance wherein individuals are forced to travel in a way that they do not prefer, to the CTS-RBE profiles by means of travel options (private car and public transportation) variables.

This paper aims to investigate whether travel options influence how CTS relates to the RBE. By using a large European sample instead of a city- or country-specific model, the European Union Statistics on Income and Living Conditions (EU-SILC) 2013 survey offers an opportunity to explore this connection. This study will identify which profiles exist among commuters in terms of CTS and RBE by performing a cluster analysis. Then, it will examine how these profiles are informed by differences in travel options, neighborhood characteristics, and satisfaction with life and life domains by performing logistic regression analyses. The main goal of this study is to investigate whether travel options can inform differences in CTS and RBE. By investigating the options among [un]happy commuters in different urban areas, policy initiatives can attempt to improve travel equity and satisfaction.

2. Literature review

The literature review section is organized as follows: First, what is known about travel satisfaction and its complex relationships to trip characteristics, travel attitudes, and satisfaction with life and life domains is discussed. Specifically, the relationship between travel time (particularly commuting time) and travel satisfaction is elaborated, clarifying the value of the CTS variable. Following, an explanation of the complex relationship between the built environment and travel satisfaction, as well as overall life and domain satisfaction, illuminates the importance of creating commuter profiles for analysis in lieu of simply analyzing the relationship between them. Next, travel options and captivity research is linked to the built environment and travel satisfaction. Further, justification for additional explanatory neighborhood characteristics of pollution and crime is provided. Finally, the general aims of this research are discussed and the dataset used is introduced.

2.1. Travel behavior, travel satisfaction, and well-being

The literature on travel satisfaction accelerated with the development of a standardized measurement scale, the ‘Satisfaction with Travel Scale’ (STS; Ettema et al., 2011), inspired by measurements of experienced utility (i.e. Ettema et al., 2010; Kahneman and Krueger, 2006; Kahneman et al., 1997) and psychological scales to measure subjective well-being (i.e. Diener et al., 1985; Diener et al., 2010; Västfjäll et al., 2002; Watson et al., 1988). Following this, travel satisfaction has been extensively examined over the past decade in relation to trip characteristics, e.g. mode, duration, distance, and travel attitudes. Active modes consistently present greater satisfaction while motorized and public modes present lower satisfaction, with evidence that active travelers are comparatively unaffected by traffic congestion (e.g. De Vos et al., 2016; De Vos et al., 2019; Friman et al., 2013; Gatersleben and Uzzell, 2007; Mouratidis et al., 2019; Morris and Guerra, 2015b; Paez and Whalen, 2010; Smith, 2017). Trip time negatively affects satisfaction (De Vos et al., 2019; Higgins et al., 2018; Morris and Guerra, 2015a) and trip distance affects satisfaction both positively or negatively, depending on factors like the built environment (Handy and Thigpen, 2018) or travel attitudes (De Vos et al., 2016; De Vos et al., 2019; Mokhtarian et al., 2015). Other trip characteristics such as accessibility, service quality, socialization and entertainment opportunity, and perception of value positively affect satisfaction (Cao, 2013; Ettema et al., 2012; Olsson et al., 2013; Paez and Whalen, 2010; St-Louis et al., 2014). Attitudes toward travel regarding environmentalism, physical activity, or past travel experiences also have an effect on satisfaction (Manaugh and El-Geneidy, 2013; St-Louis et al., 2014). Commute-specific (as opposed to non-work or undirected travel) satisfaction research agrees with the aforementioned studies (Gatersleben and Uzzell, 2007; Singer et al., 1978; Smith, 2017; Anable and Carreno, 2007; Wener et al., 2003), and is important to measure as there is unique stress experienced during travel to work that does not exist in other travel purposes (see Novaco and Gonzales, 2009, for review).

Travel satisfaction and commuting satisfaction have further important relationships with satisfaction with life domains and life in general. The cost of commuting can negatively affect satisfaction with domains and in general due to missing time that cannot be spent on other activities (Clark et al., 2019; Stutzer and Frey, 2008; Ye et al., 2020). However, Mouratidis (2020) found that commuting satisfaction may only have indirect effects on life satisfaction and subjective well-being, mainly through neighborhood and job satisfaction. Finally, relationships between travel satisfaction and life satisfaction are bidirectional: from a bottom-up perspective, the perceived quality of travel could influence the level of life satisfaction, while from a top-down perspective, the level of life satisfaction could cause a level of satisfaction with travel (Diener, 1984). De Vos (2019) found effects of the latter stronger than the former.

Although studies have indicated that trip duration mostly has a negative effect on travel satisfaction, no studies have explored satisfaction with travel time. While the positive utility of commuting cannot be ignored (i.e. benefits associated with the destination, activities conducted while traveling, and enjoyment of travel itself), most people desire a shorter commuting time than their current situation (Redmond and Mokhtarian, 2001). In a recent study, Ye et al. (2020) found that over 80% of people are not traveling with their ideal commute time, and that this has a significant effect on their satisfaction with travel. However, due to the aforementioned positive aspects of travel, most people desire some sort of commute and would not, if given the choice, instantaneously arrive at their workplace (Mokhtarian and Salomon, 2001; Redmond and Mokhtarian, 2001; Russell and Mokhtarian, 2015). Examining satisfaction with the time characteristic of commuting trips can create more specific commuter profiles.

2.2. The built environment, travel satisfaction, and well-being

The residential built environment and spatial structure have a direct effect on commuting *distance*, but the link of the built environment to commuting *time* is not as straightforward. High density, mixed-use areas reduce distance to destinations (Cervero and Kockelman, 1997; Frank and Pivo, 1994), and studies have shown that indeed those living in suburban areas have longer travel times (Ewing and Cervero, 2001; Ewing et al., 1994; Khattak and Rodriguez, 2005; Schwanen et al., 2005). However, this can be affected by regional accessibility, i.e. the amount of major employment centers, city size, dispersion, and mono- or polycentricity (Gordon et al., 1989). Individuals living in areas that are not urban and highly dense often must travel a distance too far for active modes to accommodate, and therefore turn to faster, motorized modes, possibly resulting in a travel time that is comparable to those using active travel in urban areas (De Vos and Witlox, 2016).

The residential built environment therefore has a further important link to travel satisfaction. Mouratidis et al. (2019) found that travel satisfaction is higher for those in compact urban areas, specifically for commuters due to shorter trips and more active travel. Alternatively, there is evidence (using built environment and travel attitude explanatory variables) that, though their trips are longer, suburban residents are the most positive about travel, possibly reflecting residential self-selection and travel preferences (De Vos et al., 2016; De Vos and Witlox, 2016). Friman et al. (2013) found that travel satisfaction was lower among residents in large urban areas than those in medium-large or small urban areas. Additional research states that residential location and distance to workplace/school are characteristics important to commute quality and satisfaction (Handy and Thigpen, 2018; Schneider and Willman, 2019), though Ye and Titheridge (2017) found only indirect effects of the built environment. It is clear that the relationship between the built environment and travel satisfaction is complex, and therefore requires a more complex analyses than a simple investigation of the directional relationship between these two variables.

Other than travel satisfaction, the effect of the built environment on satisfaction with life domains and life in general has been well-documented. Urban planners tend to find that several aspects of the built environment related to walkability (e.g. land use mix, street network connectivity, and density) have a significant relationship to satisfaction, though whether positive or negative is domain-dependent. Cao (2016) found that increased land use mix positively affects life satisfaction, and increased population density negatively affects it. More dense built environment factors have been found to have a positive effect on personal relationship, job, and family satisfaction (Bernini and Tampieri, 2017; Mouratidis, 2019). Conversely, though dense urban areas are often considered to be more socially and environmentally sustainable, density has been found to negatively affect residential, leisure, health, friendship, spare time, and environment satisfaction (Bernini and Tampieri, 2017; Hand, 2017; Rodgers, 1982). Though Bernini and Tampieri (2017) found that urban density was negatively related to subjective well-being, Mouratidis (2019) found that by improving problems of fear of crime, noise, and litter in urban areas, life satisfaction can be higher and moderate- to high-density areas can actually promote subjective well-being. The complicated relationship between the built environment and life and domain satisfaction justifies the use of these measures as exploratory variables, and the creation of commuter profiles in order to analyze complex relationships therein.

2.3. The built environment, mode availability, and travel captivity

Finally, the built environment (particularly residential urban density) has a substantial effect on access to different transport modes, e.g. increase of active and public modes as density and land use mix increase, and decrease of private vehicles (Frank and Pivo, 1994; Millward and Spinney, 2011). Though no studies have yet evaluated the effect of the RBE on travel captivity, transportation literature overwhelmingly assumes that private car accessibility is the determining factor between captive and choice users, (e.g. de Ona et al., 2016; Garrett and Taylor, 1999; Polzin et al., 2000; van Lierop and El-Geneidy, 2017), although notable exceptions exist (Beimborn et al., 2003; Jacques et al., 2013). This would mean that the majority of literature assumes that captive travelers can be found in urban areas where there is less car access, but this research argues that travel captivity consists of more than just car-access factors and therefore employs both private vehicle and public transport access to explain urban density and travel satisfaction. Access to modes affects factors influencing commuting satisfaction (e.g. freedom) (Anable and Gatersleben, 2005), though applications of Festinger's (1957) cognitive dissonance theory within the scope of travel satisfaction (see De Vos and Singleton (2020) for review) more aptly theorize travel captivity. Instead of using car-access alone, redefining captive travelers as those whose preferences and behavior do not match (travel mode dissonance) – either for economic, circumstantial, or other reasons – and who can or will not change their behavior or attitudes, not only provides a more appropriate and complex definition but also allows for various captivity situations to be found within any RBE. While certainly there are, for example, individuals captive to public transit because they cannot afford a private vehicle, definitions of the past fail to recognize additional captivity situations. Individuals preferring to cycle to work but who must take a car due to distance are also captive commuters, as are those preferring to use public transit due to en route activity opportunities or expensive parking, but who do not have a station available to them. Investigating the extent to which travel options are an explanatory variable for individuals in different CTS-RBE profiles is valuable to address the gap in literature regarding where and for whom a lack of public or private availability contributes to travel captivity.

Of further importance to satisfaction, well-being, and quality of life, and intrinsically linked to the built environment, urban density, and travel behavior, are neighborhood characteristics of pollution and crime. Besides the obvious direct effect of auto emissions from car use increasing in heavily congested traffic (urban) areas, pollution can affect commuting behavior in that individuals may choose (or prefer to choose) less pollutive modes so as to decrease the levels of CO_2 in their neighborhoods, also known as the value-belief-norm theory of environmentalism (Lind et al., 2015; Stern and Dietz, 1994). High levels of neighborhood crime (found with higher urban density) may deter individuals from using public transportation or active travel modes because of the threats posed by exposure when using non-automotive modes (Ferrell and Mathur, 2012). An inability to choose sustainable or safe modes can cause transit unavailability, therefore neighborhood characteristics have an important link to this research.

Since the RBE has an important effect on commute options and time, it is likely that it has a complex relationship to CTS. However, studies focusing on the link between the built environment and travel satisfaction are limited and often focus on causality, while studies on satisfaction with travel time are non-existent. The general aim of this study is to explore whether the RBE affects how travel options influence CTS. This will be accomplished by first identifying CTS-RBE profiles, allowing for an investigation of their complex relationships, and second exploring the relationship of travel options to these profiles within a large European population. Secondary exploratory variables include life and domain satisfaction (using a top-down approach) and neighborhood characteristics because of their strong relationships to the RBE and (short-term) CTS found in previous research. The EU-SILC (European Union Statistics on Income and Living Conditions) provides an opportunity to explore multinational data and an opportunity to explore this relationship at a European scale for the first time. This research hypothesizes that vehicle and transit options can inform CTS-RBE profiles.

3. Data

The source of data for this study is the 2013 European Commission wave of EU-SILC (European Union Statistics on Income and Living Conditions) conducted by EUROSTAT(Eurostat, 2013), and the responsibility for all conclusions drawn from the data lies entirely with the authors. This annual questionnaire provides both cross-sectional data regarding income, poverty, social exclusion, and other living conditions and longitudinal data from individuals and households. The 2013 survey covered information from 32 European countries. In total, more than

600,000 individuals (from almost 250,000 households) were interviewed. The individual questionnaire of the 2013 responses included secondary target variables over quality of life and subjective well-being. Responses for nine items (5- or 11-point Likert scales, i.e. *very good* to *very bad*) about overall life and domain satisfaction in the last four weeks, referred to later as the 'satisfaction module' were collected.

Legislation for the EU-SILC survey states that sampling must be nationally representative of all private households and individuals aged 16 and over, irrespective of nationality, residence status, and language. The sample design is country-specific and undertaken at their own discretion, depending on the population structure, existing census information, and budgetary constraints. Most commonly, stratified multistage sampling is used, though there are exceptions: Luxembourg, Germany, Cyprus, Slovakia, Switzerland, Austria, and Lithuania used stratified simple random sampling; Estonia used a systematic stratified sample; Malta, Denmark, Iceland, and Norway used simple random sampling; Sweden used a systematic sample; Hungary used a unique stratified design by rotational group (Eurostat, 2016).

The main advantage of this dataset is that it is perhaps a first study of its kind at a European scale. Most studies focus on a single study area, and the opportunity to identify profiles using CTS and RBE and further explore the link to travel options among a geographically diverse sample can detect patterns that are indistinguishable in a single-city or country study. Another advantage offered by this dataset is the ability to control for the interaction of CTS with satisfaction with other life domains, as well as with satisfaction with life in general. However, the survey responses are limited to strictly satisfaction with commute time which does not allow for a more robust evaluation of travel satisfaction (i.e. mode, distance, non-work travel, etc.).

Non-working (unemployed, retired, unable to work, other inactive) respondents were not included in this sample, as those respondents would not have a daily commute and would therefore be unable to report on CTS. Countries for which only country-level data instead of NUTS1-level (major socio-economic regions, population 3–7 million) data was provided (Germany, Portugal, the Netherlands, and Slovenia) were also omitted because RBE was not be included. The geographic boundaries for NUTS1-level regions can be seen in Fig. 1, along with the average participant RBE per EU-SILC definitions (an in-depth explanation is provided in the following paragraph). Using NUTS1-level data instead of country-level data allows for more distinct analysis regarding participant RBE because areas with different socio-economic profiles are separated. Remaining respondents ($n = 157{,}615$) included in this study were 49.7% female, aged 15–80 ($\mu = 43.72$), and 39.1% university educated, with a mean household annual disposable (equivalized by EUROSTAT) income of €20,000, 85% of whom worked full-time.

Key dependent variables for this study included CTS ('Overall, how satisfied are you with your commute time?'; 11-point Likert scale: *not at all satisfied* to *completely satisfied*) and RBE (3-level scale - Level 1 (urban): 1500 inhabitants per km^2, minimum population 150,000; Level 2 (suburban): 300 inhabitants per km^2, minimum population 5000; Level 3 (rural): those found outside Levels 1 and 2). 'Commute time' was one of the nine variables from the satisfaction module, though it has been extracted and use as a dependent variable (while the other eight will be discussed as independent variables below). Interview

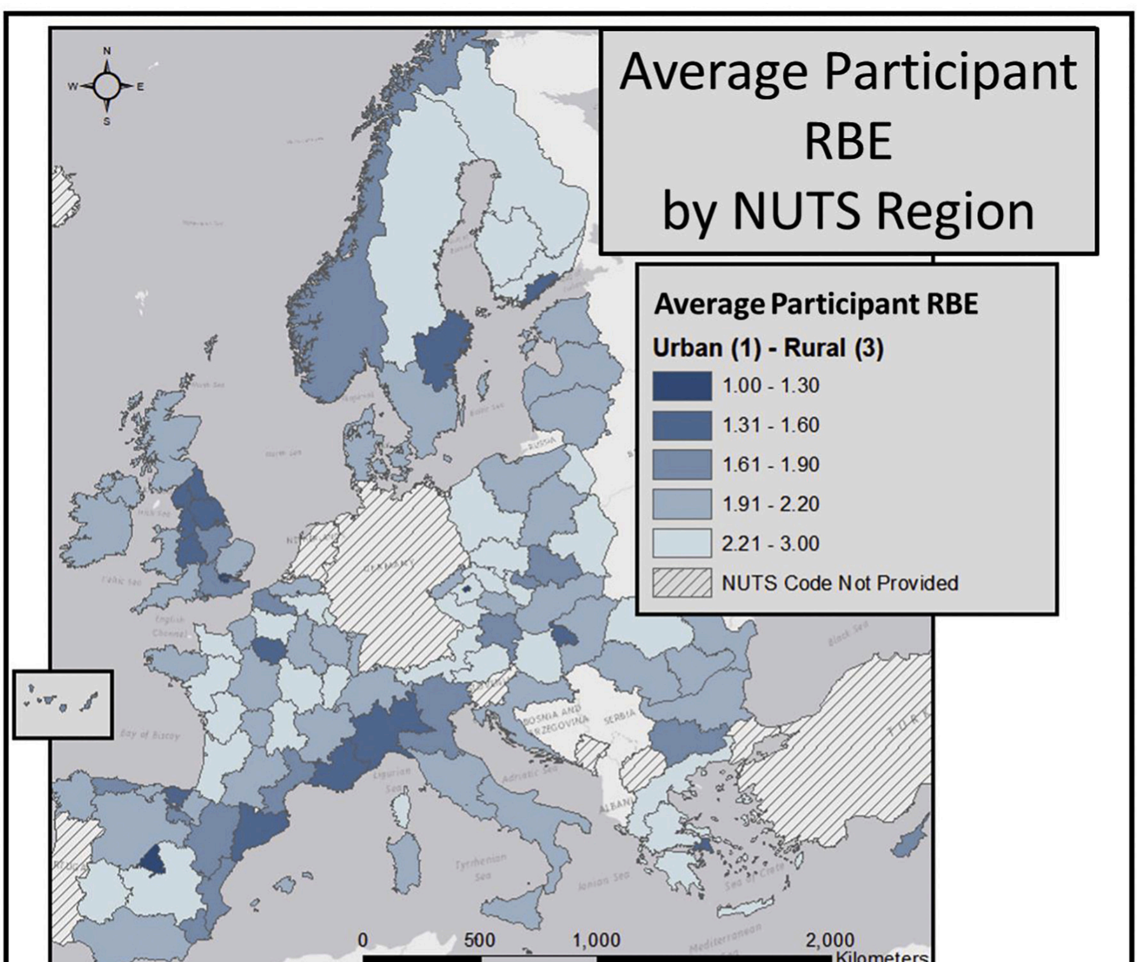

Fig. 1. Average participant RBE (Urban-1, Rural-3) per NUTS1 region.

coordinators reported that 33.9% of respondents lived in rural areas, 27.4% in suburban areas, and 38.7% in urban areas. Respondents had an average CTS of 7.45 (0–10 scale). It was hypothesized that RBE could be the most important factor in determining CTS, therefore in order to maximize inter-cluster differences and intra-cluster similarities a cluster analysis was performed. A cluster analysis was chosen over using CTS alone as a dependent variable in a regression analysis because it provides more information over different types of respondents and potentially analyzes more complex relationships as, for example, rural residents can be both satisfied and dissatisfied.

Using the EU-SILC 2013 data, a first objective of this study is to determine CTS-RBE profiles by means of cluster analysis. To find the optimal cluster number, options for 2 to 8 clusters were attempted. A k-means cluster analysis was selected over a hierarchical cluster analysis as, required by the size of the dataset, it is less computationally demanding (Mooi and Sarstedt, 2010). Due to high significant *($p = .000$)* ratios of variance (CTS $F = 61{,}717.303$; RBE $F = 1{,}178{,}253.512$), a five-cluster analysis was the optimal choice. This was confirmed with both the Elbow Method (calculating the within cluster sum of squares for each attempt) and by creating a dendrogram from a hierarchical cluster analysis with a 1% random sample (5 being the approximate level at which clusters evened). Further evidence confirming the choice is a lack of variance ($F = 0$) among urban density characteristics within the 6-, 7-, and 8-cluster attempts. The final cluster centers can be seen in Table 1, showing their CTS and RBE levels on −1 to 1 scales, having normalized both distributions over 0. CTS scores closer to 1 meant higher satisfaction, and scores closer to −1 meant lower satisfaction; a RBE score closer to 1 meant higher urban density and a score closer to −1 meant lower urban density. The RBE score of the final cluster fell at 0.45, almost evenly between 0 and 1 (unlike all other clusters falling exactly at whole numbers), indicating that this cluster was comprised of both urban and suburban residents.

Table 2 shows demographic information over the five clusters. The urban mid-satisfied cluster was the largest (34.4%), and the (sub)urban dissatisfied cluster was the smallest (9.5%). Most clusters were approximately half-female, with the rural-low satisfied cluster having the greatest gender difference (45.4% female). Average age for all clusters was around 43 or 44 years old. The urban mid-satisfied group reported the lowest car access (81.9%), and the suburban mid-satisfied group reported the most car access (90.4%). Alternatively, the urban mid-satisfied group reported the most regular public transit use (44.7%), and the rural high-satisfied group reported the least regular public transit use (20.9%).

A second objective of this paper was to determine the role of travel options in informing these five CTS-RBE clusters by means of logistic regression. The key independent variables explored in this study were car access and public transit use (Table 3). In the EU-SILC questionnaire, Public Transit Use was determined by the question, 'Could you please tell me if you use regularly public transport?', with answers including, 'Yes', 'No, ticket expensive', 'No, station far', 'No, access difficult', 'No, private transport', and 'No, other reason'. 'No, station far' and 'No, access difficult' differed in that the former refers to the lack of a station nearby and the latter refers to difficulties getting to the station. The variables 'No, private transport' and 'No, other reason' are vague catch-all statements. The former means a personal choice in using private transport, such as car, motorcycle, bicycle, etc., and the latter refers to both active modes of transit (i.e. walking, jogging, or community bicycles) and completely different circumstances such as an unsuitable timetable making public transport inconvenient. Car Access was determined by the question, 'Does your household have a car/van for private use?' and answer options were 'Yes', 'No, cannot afford', and 'No, other reason'.

Table 1
CTS/RBE cluster centers.

	Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5
CTS	High-Satisfied	Mid-Satisfied	Mid-Satisfied	Low-Satisfied	Dissatisfied
RBE	Rural	Suburban	Urban	Rural	(Sub) Urban
Commute Time Satisfaction (−1 to 1)	0.75	0.69	0.59	−0.12	−0.35
Residential Built Environment (−1 to 1)	−1.00	0.00	1.00	−1.00	0.45

Table 2
Demographic information by CTS/RBE cluster.

	Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5
CTS	High-Satisfied	Mid-Satisfied	Mid-Satisfied	Low-Satisfied	Dissatisfied
RBE	Rural	Suburban	Urban	Rural	(Sub) Urban
N	37,386	35,014	54,241	16,059	14,915
%Sample	23.7	22.2	34.4	10.2	9.5
%Female	49.6	50.6	51.1	45.4	47.7
μAge	44.4	43.9	43.6	43.2	42.8
%Car Access	89.0	90.4	81.9	84	82.6
%Public Transit Use	20.9	25.3	44.7	29.4	42.8

The results of the logistic regressions were controlled for two additional independent variables, satisfaction with life domains and neighborhood characteristics. Satisfaction ('Overall, how satisfied are you with…?; 11-point Likert scale, *not at all satisfied* to *completely satisfied*) was averaged (0−10) based on the following factors:

1. Your life these days.
2. The financial situation of your household.
3. Your accommodation.
4. Your present work.
5. The amount of time you have to do things you like doing.
6. Your personal relationships.
7. The recreational or green areas in the place where you live.
8. The quality of your living environment.

Neighborhood characteristics were assessed based on participants perceptions of 'pollution, grime, or other environmental problems' and 'crime, violence, or vandalism in the area' with dichotomized yes/no answer options. Average scores for satisfaction and neighborhood characteristics can be seen in Table 4 (Results) with inter-cluster comparisons. The demographic variables this study controlled for included age, gender, income, and education level.

4. Results

4.1. Inter-cluster comparisons

Following the cluster analysis, inter-cluster comparison tests (ANOVA and Chi^2) were completed to analyze the following exploratory factors: satisfaction module (overall, financial situation, accommodation, job, time use, personal relationships, green areas, living environment), neighborhood characteristics (pollution, crime), and travel captivity (car access, public transit use). ANOVA tests for the satisfaction module and neighborhood characteristics found all factors were significant ($p = .000$) with high variances (range from $F = 203.581$ to $F = 3852.023$). As the tests did not meet the assumption of homogeneity of variances, Games Howell post-hoc tests were selected to investigate specific intercluster differences (Table 4). The variables denoting travel

Table 3
Exploratory travel captivity factors: percentages of each cluster with car access, public transit use.

		Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5
		High-Satisfied Rural	Mid-Satisfied Suburban	Mid-Satisfied Urban	Low-Satisfied Rural	Dissatisfied (Sub)Urban
%Car Access	Yes	89.0	90.4	81.9	84.0	82.6
	No, cannot afford	6.3	5.3	8.9	10.7	10.7
	No, other reason	4.7	4.3	9.3	5.3	6.7
%Public Transit Use	Yes	20.9	25.3	44.7	29.4	42.8
	No, ticket expensive	1.0	1.1	1.0	2.3	2.2
	No, station far	3.2	1.7	0.7	2.0	1.4
	No, access difficult	1.9	1.8	0.7	1.9	1.7
	No, private transport	51.3	54.1	39.9	42.1	37.6
	No, other reason	21.7	16.0	13.0	22.3	14.4

Table 4
Average (μ) satisfaction (0–10) and neighborhood characteristics (0–1) by cluster.

		Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5
		High-Sat. Rural	Mid-Sat. Suburb.	Mid-Sat. Urban	Low-Sat. Rural	Dissat. (Sub) Urban
μSatisfaction (range 0–10)	Overall	$7.59^{2,3,4,5}$	$7.55^{1,3,4,5}$	$7.36^{1,2,4,5}$	$6.49^{1,2,3}$	$6.43^{1,2,3}$
	Financial situation	$6.56^{2,3,4,5}$	$6.62^{1,3,4,5}$	$6.43^{1,2,4,5}$	$5.30^{1,2,3}$	$5.26^{1,2,3}$
	Accommodation	$7.94^{2,3,4,5}$	$7.88^{1,3,4,5}$	$7.56^{1,2,4,5}$	$6.91^{1,2,3,5}$	$6.76^{1,2,3,4}$
	Job	$7.70^{2,3,4,5}$	$7.59^{1,3,4,5}$	$7.40^{1,2,4,5}$	$6.11^{1,2,3,5}$	$5.91^{1,2,3,4}$
	Time Use	$6.81^{2,3,4,5}$	$6.62^{1,3,4,5}$	$6.47^{1,2,4,5}$	$5.43^{1,2,3,5}$	$4.92^{1,2,3,4}$
	Personal relationships	$8.24^{2,3,4,5}$	$8.16^{1,3,4,5}$	$8.01^{1,2,4,5}$	$7.34^{1,2,3,5}$	$7.20^{1,2,3,4}$
	Green areas	$7.53^{2,3,4,5}$	$7.46^{1,3,4,5}$	$7.05^{1,2,4,5}$	$6.65^{1,2,3,5}$	$6.18^{1,2,3,4}$
	Living environment	$7.70^{3,4,5}$	$7.52^{3,4,5}$	$7.35^{1,2,4,5}$	$6.45^{1,2,3,5}$	$6.35^{1,2,3,4}$
μNeighborhood Characteristics (range 0–1)	Pollution	$0.08^{2,3,4,5}$	$0.12^{1,3,4,5}$	$0.17^{1,2,4,5}$	$0.10^{1,2,3,5}$	$0.20^{1,2,3,4}$
	Crime	$0.07^{2,3,4,5}$	$0.11^{1,3,4,5}$	$0.16^{1,2,4,5}$	$0.08^{1,2,3,5}$	$0.19^{1,2,3,4}$

Note: ^{1,2,3,4,5} = signficantly different from groups 1,2,3,4,5 respectively at $p < .05$ using one-way ANOVAs with post-hoc multiple comparison analysis using the Games-Howell method.

captivity, car access and regular public transit use, were categorical variables and therefore Chi^2 tests (Public Transport Use: Pearson Chi^2 = 4168.10, $p = .000$; Car Access: Pearson Chi^2 = 2177.65, $p = .000$) with a Bonferroni correction (Table 5) were completed to observe significant intercluster differences between categorical answers. Proportions for each answer category for car access and regular PT use per cluster can be seen in Figs. 2 and 3. Significance at the $p > .05$ level was found between nearly all factors in all clusters in both Tables 4 and 5.

4.2. Binary logistic regression

In order to analyze important determinants of belonging to a certain cluster, a hierarchical binary logistic regression was performed for each cluster. Explanatory variables were added block by block, starting with covariates for which the study controlled (gender, age, income, education). Differences in neighborhood characteristics (pollution and crime) were analyzed in the second block, the satisfaction module in the third block, and travel captivity (car access: 3 variables and public transit use: 6 variables) in the fourth block. Results from the regression analyses can be seen in Table 6, and public transport use and car access for the five clusters in detail can be visualized in Figs. 4 and 5 as to highlight factors of travel captivity. Multicollinearity for all independent variables within each cluster were tested, with most VIF values under 2.0 and no VIF values found higher than 2.3.

Cluster 1: High-Satisfied Rural.

The likelihood of belonging to cluster 1 decreases with more neighborhood pollution and crime, and increases with higher satisfaction with life overall and most life domains, but decreases with higher satisfaction with living environment. The likelihood of belonging to the high-satisfied rural cluster increases with not using public transit regularly due to access being difficult or using private transport, but decreases with not using public transit regularly due to tickets being expensive, stations being far, or an unlisted reason. Likelihood of belonging to cluster 1 did not increase or decrease significantly depending on car access.

4.2.1. Cluster 2: mid-satisfied suburban

The likelihood of belonging to cluster 2 decreases with more neighborhood pollution, but not significantly with more neighborhood crime. Likelihood increases with higher satisfaction with all life domains

Table 5
Participant counts (N) for travel captivity measures (car access and public transport use) by cluster.

		Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5
		High-Sat. Rural	Mid-Sat. Suburb.	Mid-Sat. Urban	Low-Sat. Rural	Dissat. (Sub) Urban
Regular Public Transport Use	Yes	$3322^{2,3,4,5}$	$4548^{1,3,4,5}$	$10314^{1,2,4,5}$	$2261^{1,2,3,5}$	$3108^{1,2,3,4}$
	No - Ticket Expensive	$152^{4,5}$	$191^{4,5}$	$226^{4,5}$	$173^{1,2,3}$	$163^{1,2,3}$
	No - Station Far	$508^{2,3,4,5}$	$298^{1,3}$	$156^{1,2,4,5}$	$156^{1,3,5}$	$102^{1,3,4}$
	No - Access Difficult	308^{3}	328^{3}	$170^{1,2,4,5}$	148^{3}	120^{3}
	No - Private Transportation	$8174^{2,3,4,5}$	$9715^{1,3,4,5}$	$9191^{1,2,4,5}$	$3231^{1,2,3,5}$	$2729^{1,2,3,4}$
	No - Other	$3456^{2,3,5}$	$2880^{1,3,4,5}$	$2992^{1,2,4,5}$	$1711^{2,3,5}$	$1043^{1,2,3,4}$
Car Access	Yes	$33252^{2,3,4,5}$	$31637^{1,3,4,5}$	$44377^{1,2,4}$	$13482^{1,2,3,5}$	$12309^{1,2,4}$
	No – Cannot Afford	$2363^{2,3,4,5}$	$1857^{1,3,4,5}$	$4816^{1,2,4,5}$	$1724^{1,2,3}$	$1599^{1,2,3}$
	No – Other Reason	$1758^{3,4,5}$	$1508^{3,4,5}$	$5015^{1,2,4,5}$	$849^{1,2,3,5}$	$996^{1,2,3,4}$

Note: ^{1,2,3,4,5} = signficantly different from groups 1,2,3,4,5 respectively at p < .05 using Chi^2 tests with a Bonferroni correction.

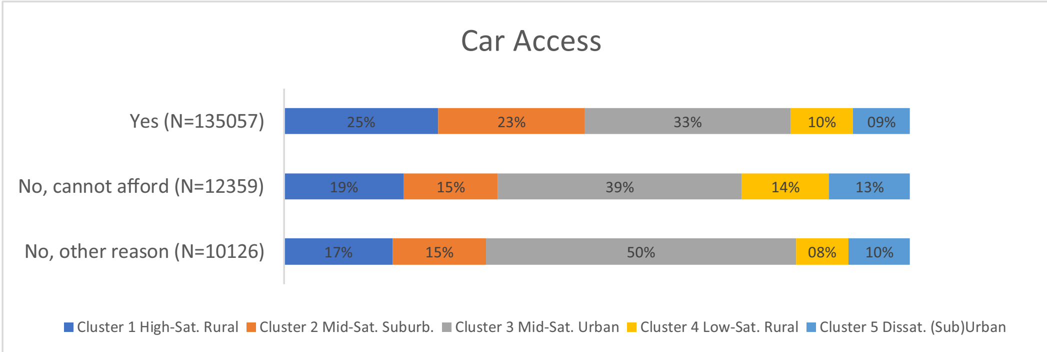

Fig. 2. Proportions of each Car Access answer category by cluster.

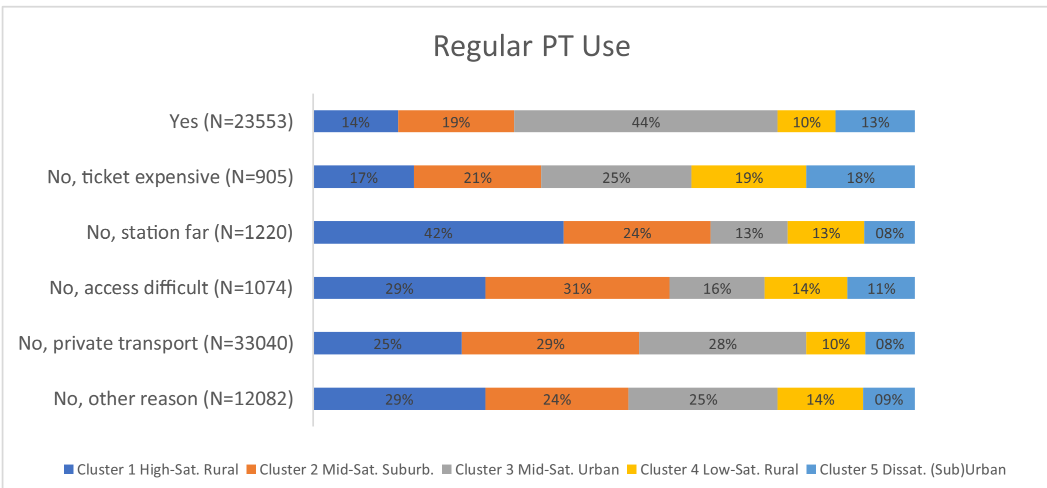

Fig. 3. Proportions of each Regular PT Use answer category by cluster.

(except living environment), but decreases with higher satisfaction with life overall. The likelihood of belonging to the mid-satisfied suburban cluster increases with not using public transit regularly due to an unlisted reason, but decreases with not using public transit regularly due to tickets being expensive and access being dificult. The likelihood of belonging to cluster 2 increases with a lack of car access for both economic and non-economic reasons.

4.2.2. *Cluster 3: mid-satisfied urban*

The likelihood of belonging to cluster 3 increases with more neighborhood pollution and crime, and increases with higher satisfaction with financial situation, job, time use, and living environment, but decreases with higher satisfaction with accommodation and green space. The likelihood of belonging to the mid-satisfied urban cluster increases with not using public transit regularly due to tickets being expensive and an unlisted reason, but decreases with not using public transit regularly due to access being difficult or using private transportation. The likelihood of belonging to cluster 3 decreases with car access.

4.2.3. *Cluster 4: low-satisfied rural*

The likelihood of belonging to cluster 4 decreases with more neighborhood pollution and crime, and increases with lower satisfaction in all life domains except green space (though not significantly with financial situaion or overall satisfaction). The likelihood of belonging to the low-satisfied rural cluster increases with not using public transit regularly due to access being difficult, but decreases with finding tickets expensive and unlisted reasons. The likelihood of belonging to cluster 2 increases with a lack of car access for both economic and non-economic reasons.

4.2.4. *Cluster 5: dissatisfied (sub)urban*

The likelihood of belonging to cluster 5 increases with more neighborhood pollution and crime, and increases with lower satisfaction all life domains (though not with overall satisfaction). The likelihood of belonging to the dissatisfied (sub)urban cluster increases with not using public transit regularly for all reasons except access being difficult. The likelihood of belonging to cluster 2 increases with a lack of car access for economic reasons, but not significantly for non-economic reasons.

5. Discussion

In this section, travel options (public transport use and car availability) for the five clusters will be analyzed in detail. This research finds that profiles defined by RBE and CTS can indeed be predicted by differences in travel options. Though all groups displayed some form of travel exclusion, the most ‘captive’ profiles (i.e. those with the fewest options) were the low-satisfied rural and dissatisfied (sub)urban groups. The former displayed a relationship with car unavailability for all reasons, and using public transport despite finding access difficult (i.e. captive transit-users). According to urban literature, this lower-urban-density group would normally have greater private vehicle and less public transportation use, making a further case for travel captivity/ unavailability. The latter were more likely to report private vehicle use than public transit use as they found it expensive and stations far, despite reporting car unavailability for economic reasons (i.e. captive car-users). This category of captive travelers has not been previously

Table 6

Exponentiated Beta values and significance from binary logistic regression for each cluster (reference: those not in cluster); significant relationships ($p < .05$) in bold; R^2 refers to Nagelkerke R^2.

		Cluster 1			Cluster 2			Cluster 3			Cluster 4			Cluster 5		
		High-Sat			Mid-Sat			Mid-Sat			Low-Sat			Dissatisfied		
		Rural			Suburban			Urban			Rural			(Sub)Urban		
		R^2	Exp(B)	p	R^2	Exp(B)	p	R^2	Exp(B)	p	R^2	Exp(B)	p	R^2	Exp(B)	p
Block 1		0.020			0.032			0.031			0.051			0.003		
Covariates	Female		0.977	0.211		**0.860**	**0.000**		1.034	0.052		**1.206**	**0.000**		**1.123**	**0.000**
	Income		**1.000**	**0.000**		**1.000**	**0.000**		**1.000**	**0.000**		**1.000**	**0.000**		**1.000**	**0.000**
	Age		**1.003**	**0.002**		**0.996**	**0.000**		**1.007**	**0.000**		**0.994**	**0.000**		**0.991**	**0.000**
	Education		**0.827**	**0.000**		**0.937**	**0.000**		**1.277**	**0.000**		**0.834**	**0.000**		**1.118**	**0.000**
Block 2 (+Block 1)		0.042			0.034			0.048			0.060			0.020		
Neighborhood Characteristics	Pollution		**0.643**	**0.000**		**0.902**	**0.000**		**1.465**	**0.000**		**0.619**	**0.000**		**1.272**	**0.000**
	Crime		**0.597**	**0.000**		0.986	0.609		**1.515**	**0.000**		**0.459**	**0.000**		**1.335**	**0.000**
Block 3 (+Blocks 1,2)		0.097			0.059			0.068			0.141			0.149		
Satisfaction Module	Overall		**1.023**	**0.002**		**0.980**	**0.006**		1.012	0.084		0.989	0.247		1.011	0.229
	Financial		**1.013**	**0.033**		**1.012**	**0.048**		**1.026**	**0.000**		0.996	0.635		**0.943**	**0.000**
	Accommodation		**1.063**	**0.000**		**1.032**	**0.000**		**0.949**	**0.000**		**0.980**	**0.009**		**0.982**	**0.021**
	Job		**1.107**	**0.000**		**1.087**	**0.000**		**1.049**	**0.000**		**0.829**	**0.000**		**0.837**	**0.000**
	Time Use		**1.036**	**0.000**		**1.044**	**0.000**		**1.031**	**0.000**		**0.926**	**0.000**		**0.857**	**0.000**
	Personal Life		**1.062**	**0.000**		**1.025**	**0.000**		1.001	0.844		**0.945**	**0.000**		**0.939**	**0.000**
	Green Space		**1.093**	**0.000**		**1.043**	**0.000**		**0.896**	**0.000**		**1.048**	**0.000**		**0.976**	**0.001**
	Living Environment		**0.974**	**0.000**		0.999	0.852		**1.114**	**0.000**		**0.903**	**0.000**		**0.936**	**0.000**
Block 4 (+Blocks 1,2,3)		0.125			0.075			0.108			0.144			0.158		
Regular PT Use	Yes			**0.000**			**0.000**			**0.000**			**0.000**			**0.000**
	N-Ticket Expensive		**0.427**	**0.000**		**0.685**	**0.000**		**2.240**	**0.000**		**0.766**	**0.000**		**1.818**	**0.000**
	N-Station Far		**0.630**	**0.000**		0.987	0.886		1.097	0.269		0.917	0.387		**1.608**	**0.000**
	N-Access Difficult		**1.883**	**0.000**		**0.742**	**0.000**		**0.472**	**0.000**		**1.261**	**0.015**		1.249	0.051
	N-Private Transportation		**1.173**	**0.032**		1.121	0.115		**0.614**	**0.000**		1.201	0.066		**1.361**	**0.004**
	N-Other		**0.811**	**0.000**		**1.133**	**0.000**		**1.188**	**0.000**		**0.809**	**0.000**		**1.120**	**0.007**
Car Access	Yes			0.305			**0.000**			**0.000**			**0.026**			**0.000**
	N-Cannot Afford		1.069	0.125		**1.484**	**0.000**		**0.660**	**0.000**		**1.163**	**0.009**		**1.242**	**0.000**
	N-Other Reason		1.066	0.233		**1.270**	**0.000**		**0.704**	**0.000**		**1.172**	**0.017**		1.067	0.343

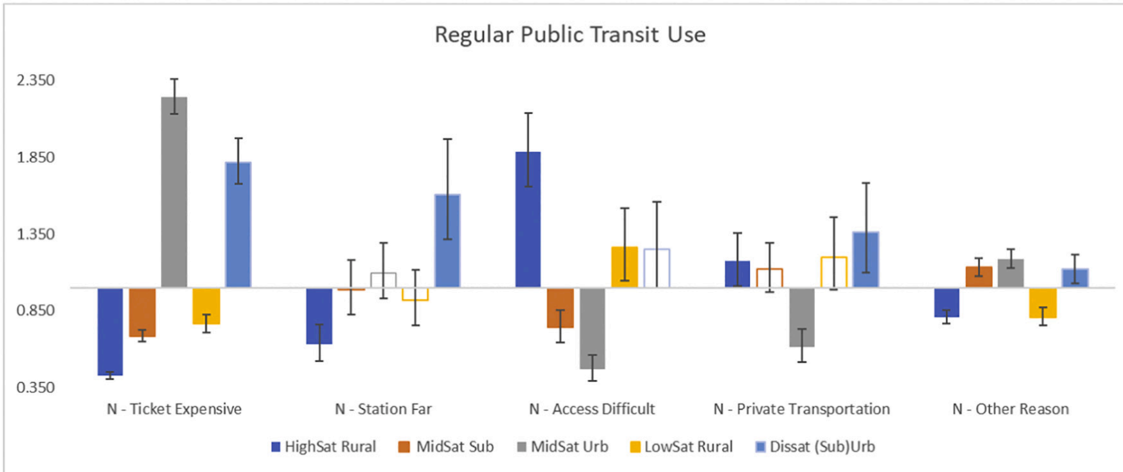

Fig. 4. Exponentiated Beta values with 95% confidence intervals for reasons not to use public transit regularly (yes: reference category) for each of the 5 clusters; non-significant Beta values are empty bars.

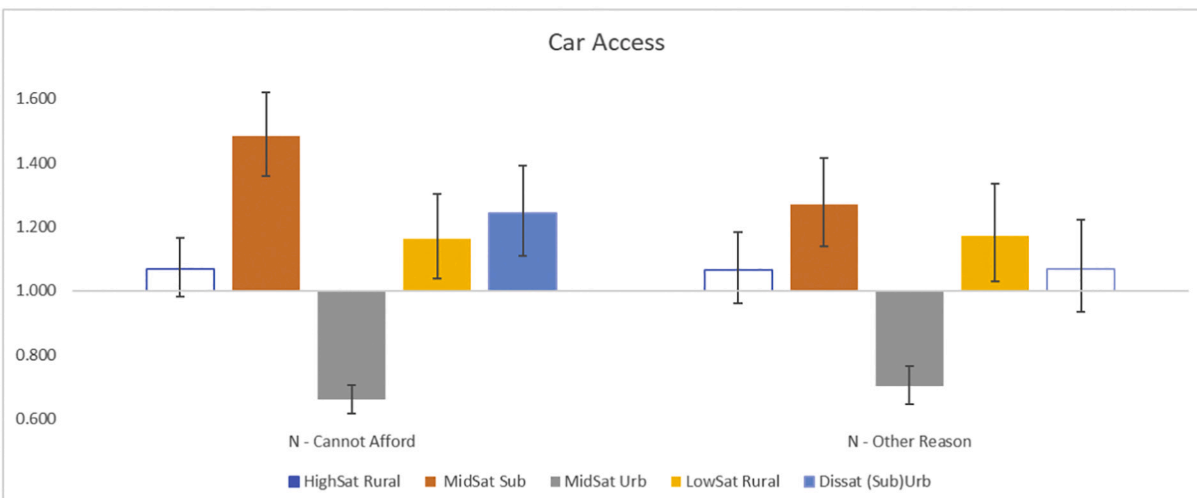

Fig. 5. Exponentiated Beta values with 95% confidence intervals for reasons not to have access to a car (yes: reference category) for each of the 5 clusters; non-significant Beta values are empty bars.

discussed in relevant travel behavior literature. These findings indicate that having fewer travel options is a better indication of low CTS than RBE. However, perhaps the most interesting finding in this study was that, regardless of the RBE, likelihood of belonging to a higher-satisfied group did not necessarily increase with car access. Though research on captive commuting thus far is limited, assuming that those with higher CTS experience actual times closer to their ideal commute time, this research suggests that car access may not be an element influencing non-captive commuting. In other words, car unavailability likely contributes to captive commuting (agreeing with the majority of previous travel captivity research), but car access does not necessary bring one out of travel captivity.

Though the groups with higher CTS were not captive travelers, lack of travel options nonetheless presented differently among varying RBEs. This indicates that though travel options may better indicate CTS, it still has a relationship to the RBE. First, the higher-satisfied suburban group had a relationship with car unavailability for all reasons and were public transport users. This is surprising as suburban residency is normally associated with car use. This result argues that travel unavailability/ captivity is not necessarily a dichotomization between car users and non-car users but instead a more intricate concept relying on access to many modes. Second, the higher-satisfied urban group had a relationship to public transport unavailability due to expensive tickets and were car users. However, there was a higher likelihood of being in this group by public transport unavailability for 'other' reasons, which could indicate active commuting (e.g. walking) as this is normally more common in higher-density areas. This is logical, because within the densest RBE many different modal options are accessible. Third, the high-satisfied rural group had a relationship with both public transport and car unavailability. Though these residents were more likely to use private than public transportation, car access could not necessarily be assumed, reemphasizing the complicated relationship between travel captivity and mode options.

Surprisingly, finding public transit expensive and stations being too far both had a positive effect on belonging to the urban clusters (3 and 5). Meanwhile, finding access difficult had a positive effect on belonging to the rural clusters (1 and 4). As mentioned previously, the distinction between far stations and stations that are difficult to access is that the former implies actual distance, while the latter implies that the station is hard to get to. Urban dwellers perceiving a station as far away may be relative to the destination they must access (for example, the station is too far so they walk to work instead). Similarly, for this group, the cost of the ticket might be expensive compared to a free alternative like walking whereas this option is not always available in less-dense areas. Using private means of transport was something seen in all clusters, though to a lesser extent in the urban cluster (5).

The additional explanatory variables of neighborhood characteristics, life satisfaction, and domain satisfaction will be discussed here. As expected, pollution and crime seem to be typical for urban areas, clusters 3 and 4, with low coefficients for other non-urban clusters. Satisfaction with different life domains generally shared the same direction as CTS, though specific domains varied by cluster. The group with high CTS also had high overall life satisfaction, though there was not a significant relationship to those groups with lower-satisfaction. Whether this is a bottom-up (CTS influences life and domain satisfaction) or top-down (life and domain satisfaction influences CTS) affect is impossible to say, though (in agreement with satisfaction literature) it can be inferred that people who are satisfied in more aspects of life, or perhaps happy people, will report higher CTS regardless of their RBE.

It is important to bear in mind the limitations of this study while discussing these results. First, the travel satisfaction variable is limited specifically to CTS, which does not allow for an analysis of other aspects of commuting trips such as length, mode, etc. The only findings this study can speak to regards commute *time*. Second, the NUTS1 geographic boundaries of the survey generally divide countries into sections, which does not allow for a more precise assessment of RBE. For example, population-dense spots within a majority-sparsely-populated area, or farm areas within areas of high polycentricity, could not be specifically identified. Finally, there is no information on active travel or leisure trips, limiting the study specifically to commuting, nor a more detailed investigation of commuting trips themselves.

Future research studying the connections between travel options, the built environment, and travel satisfaction would ideally incorporate other travel modes than were used in this study, public transportation and car use. A more robust definition of travel captivity than travel mode availability or options is needed in order to investigate its effect, particularly on urban density, and this might be accomplished by identifying additional situations in which individuals find themselves captive. This would ideally include surveyed feelings of captivity, instead of relying on car access and public transit use variables, to explore the link between travel captivity, travel satisfaction, residential urban density, and the built environment.

Effective policy to improve satisfaction with commute time regardless of level of residential urban density would aim to provide individuals with access to all types of transportation. Two policy implications can be identified from these findings. First, because finding public transport access difficult had a positive effect on belonging to a rural cluster, perhaps integrating mobility-on-demand solutions with traditional public transport services could be an opportunity to provide easier access to stations. This would mainly include ensuring that public transportation stops are proximate and accessible for those in less urban areas, as well as ensuring that ticket pricing for public transportation systems is affordable as this was an accessibility barrier for those in more urban areas. Second, because not having car access could result in very low CTS, perhaps further investments into alternatives to private car ownership (i.e. car sharing or ride sharing) in urban as well as suburban and rural areas could be an opportunity to increase car access and alleviate low CTS. Policy to accomplish this would further ensure that automobiles are accessible to those with varying RBEs, ideally with an affordable car-sharing service as this is more environmentally conscious than private vehicle use. Findings suggest that policy implementation to improve CTS could, from a bottom-up well-being perspective, in turn improve satisfaction with other life domains and satisfaction with life in general.

6. Conclusion

The aims of this research was to first analyze the link between travel satisfaction and the built environment, and second to investigate how this link is affected by travel options. Profiles were created instead of simply looking at the relationship between RBE and CTS because this method provided the opportunity to explore the complex relationships between these two variables as individuals within the same RBE could have different levels of satisfaction, or those with the same satisfaction could live in different areas. Varying travel options (car and public transit) among profiles indicates that a more robust study is necessary to help define travel captivity. This research aims to address the gap in literature regarding where and for whom a lack of public or private travel options contributes to travel captivity.

In sum, transportation mode availability was an indicator of CTS, and this was dependent on the RBE. Suburban residents had a higher relative satisfaction and were more likely to use public transit and have less car access than their rural or urban counterparts. The lower-satisfied urban and rural residents were less likely to have car access, but the higher-satisfied urban and rural residents were not necessarily more likely to have car access. This research supports the idea that travel options can predict CTS-RBE profiles, and can therefore be useful to measuring and correcting travel captivity. The contribution of this study to the travel behavior field, in addition to being the first study to examine satisfaction with commute time, are the insights into the link between the residential built environment and travel satisfaction as well as travel options. The built environment plays an important role when determining travel satisfaction because access to modes, distance, speed, and traffic congestion are highly variant depending on residential circumstance. Measures of travel satisfaction that do not take the residential built environment into account are incomplete.

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Declaration of Competing Interest

None.

References

Anable, J., Gatersleben, B., 2005. All work and no play? The role of instrumental and affective factors in work and leisure journeys by different travel modes. Transp. Res. A 39 (2–3), 163–181. https://doi.org/10.1016/j.tra.2004.09.008.

Beimborn, E.A., Greenwalk, M.J., Jin, X., 2003. Accessibility, connectivity, and captivity: impacts on transit choice. Transp. Res. Rec. 1835 (03–2336), 1–9. https://doi.org/10.3141/1835-01.

Bernini, C., Tampieri, A., 2017. Urbanization and its effects on the happiness domains. In: CREA Discussion Paper Series 17–10, Center for Research in Economic Analysis. University of Luxembourg.

Cao, X., 2013. The association between light rail transit and satisfactions with travel and life: evidence from twin cities. Transportation 40, 921–933. https://doi.org/10.1007/s11116-013-9455-8.

Cao, X., 2016. How does neighborhood design affect life satisfaction? Evidence from Twin Cities. Travel Behav. Soc. 5, 68–76. https://doi.org/10.1016/j.tbs.2015.07.001.

Cao, X., Ettema, D.F., 2014. Satisfaction with travel and residential self-selection: how do preferences moderate the impact of the Hiawatha Light Rain Transit line? J. Transp. Land Use 7 (3), 93–108.

Cao, X., Mokhtarian, P., Handy, S.L., 2009. Examining the impacts of residential self-selection on travel behaviour: a focus on empirical findings. Transp. Rev. 29 (3), 359–395. https://doi.org/10.1080/01441640802539195.

Cervero, R., Kockelman, K., 1997. Travel demand and the 3Ds: density, diversity, and design. Transp. Res. D 2 (3), 199–219.

Clark, B., Chatterjee, K., Martin, A., Davis, A., 2019. How commuting affects subjective wellbeing. Transportation. https://doi.org/10.1007/s11116-019-09983-9.

de Ona, J., De Ona, R., Diez-Mesa, F., 2016. A composite index for evaluating transit service quality across different user profiles. J. Pub. Transp. 19 (2), 128–153. https://doi.org/10.5038/2375-0901.19.2.8.

De Vos, J., 2019. Analysing the effect of trip satisfaction on satisfaction with the leisure activity at the destination of the trip, in relationship with life satisfaction. Transportation 46, 623–645. https://doi.org/10.1007/s11116-017-9812-0.

De Vos, J., Singleton, P.A., 2020. Travel and cognitive dissonance. Transp. Res. A 138, 525–536. https://doi.org/10.1016/j.tra.2020.06.014.

De Vos, J., Witlox, F., 2016. Do people live in urban neighborhoods because they do not like to travel? Analysing an alternative residential self-selection hypothesis. Travel Behav. Soc. 4, 29–39. https://doi.org/10.1016/j.tbs.2015.12.002.

De Vos, J., Mokhtarian, P., Schwanen, T., Van Acker, V., Witlox, F., 2016. Travel mode choice and travel satisfaction: bridging the gap between decision utility and experienced utility. Transportation 43, 771–796. https://doi.org/10.1007/s11116-015-9619-9.

De Vos, J., Ettema, D., Witlox, F., 2019. Effects of changing travel patterns on travel satisfaction. Travel Behav. Soc. 16, 42–49. https://doi.org/10.1016/j.tbs.2019.04.001.

Diener, E., 1984. Subjective well-being. Psychol. Bull. 95 (3), 542–575. https://doi.org/10.1037/0033-2909.95.3.542.

Diener, E., Emmons, R.A., Larsen, R.J., Griffen, S., 1985. The satisfaction with life scale. J. Personality Assess. 49 (1), 71–75. https://doi.org/10.1207/s15327752jpa4901_13.

Diener, E., Wirtz, D., Tov, W., Kim-Prieto, C., Choi, D.-W., Oishi, S., Diener-Biswar, R., 2010. New well-being measures: short scales to assess flourishing and positive and negative feelings. Soc. Indic. Res. 97 (2), 143–156. https://doi.org/10.1007/s11205-009-9493-y.

Ettema, D., Garling, T., Olsson, L.E., Friman, M., 2010. Out-of-home activities, daily travel, and subjective well-being. Transp. Res. A 44 (9), 723–732. https://doi.org/10.1016/j.tra.2010.07.005.

Ettema, D., Garling, T., Eriksson, L., Friman, M., 2011. Satisfaction with travel and subjective well-being (SWB): development and tests of a measurement tool. Transp. Res. F 14 (3), 167–175. https://doi.org/10.1016/j.trf.2010.11.002.

Ettema, D., Friman, M., Garling, T., Olsson, L., Fujii, S., 2012. How in-vehicle activities affect work commuters' satisfaction with public transport. J. Transp. Geogr. 24, 215–222. https://doi.org/10.1016/j.jtrangeo.2012.02.007.

Eurostat, 2013. European Commission. European Union Statistics on Income and Living Conditions. S-CIRCABC. Version.

Eurostat, 2016. EU statistics on income and living conditions (EU-SILC) methodology – sampling. Retrieved from. ec.europa.eu (16 November 2020).

Ewing, R., Cervero, R., 2001. Travel and the built environment - a synthesis. Transp. Res. Rec. 1780, 87–114. https://doi.org/10.3141/1780-10.

Ewing, R., Cervero, R., 2010. Travel and the built environment: a meta-analysis. J. Am. Plan. Assoc. 76 (3), 265–294. https://doi.org/10.1080/01944361003766766.

Ewing, R., Haliyur, P., Page, G.W., 1994. Getting around a traditional city, a suburban planned unit development, and everything in between. Transp. Res. Rec. 1466, 53–62.

Ferrell, C.E., Mathur, S., 2012. Influences of neighborhood crime on mode choice. Transp. Res. Rec. 2320, 55–63. https://doi.org/10.3141/2320-07.

Festinger, L., 1957. Theory of Cognitive Dissonance. Standford University Press, Stanford.

Frank, L.D., Pivo, G., 1994. Impacts of mixed use and density on utilization of three modes of travel: single-occupant vehicle, transit, and walking. Transp. Res. Rec. 1466, 44–52.

Friman, M., Fujii, S., Ettema, D., Garling, T., Olsson, L., 2013. Psychometric analysis of the satisfaction with travel scale. Transp. Res. A 48, 132–145. https://doi.org/10.1016/j.tra.2012.10.012.

Friman, M., Ettema, D., Olsson, L.E., 2018. Quality of Life and Well Being. Springer International Publishing. https://doi.org/10.1007/978-3-319-76623-2.

Garrett, M., Taylor, B., 1999. Reconsidering social equity in public transit. Berkeley plan. J. 13 (1), 6–27. https://doi.org/10.5070/BP313113028.

Gatersleben, B., Uzzell, D., 2007. Affective appraisals of the daily commute: comparing perceptions of drivers, cyclists, walkers, and users of public transport. Environ. Behav. 39 (3), 416–431. https://doi.org/10.1177/0013916506294032.

Gordon, P., Kumar, A., Richardson, H.S., 1989. The influence of metropolitan spatial structure on commuting time. J. Urban Econ. 26, 138–151.

Hand, C., 2017. Spatial influences on domains of life satisfaction in the UK. Reg. Stud. 54 (6), 802–813. https://doi.org/10.1080/00343404.2019.1645953.

Handy, S., Thigpen, C., 2018. Commute quality and its implications for commute satisfaction: exploring the role of mode, location, and other factors. Travel Behav. Soc. 16, 241–248. https://doi.org/10.1016/j.tbs.2018.03.001.

Higgins, C.D., Sweet, M.N., Kanaroglou, P.S., 2018. All minutes are not equal: travel time and the effects of congestion on commute satisfaction in Canadian cities. Transportation 45, 1249–1268. https://doi.org/10.1007/s11116-017-9766-2.

Jacques, C., Manaugh, K., El-Geneidy, A., 2013. Rescuing the captive [mode] user: an alternative approach to transport market segmentation. Transportation 40, 625–645. https://doi.org/10.1007/s11116-012-9437-2.

Kahneman, D., Krueger, A.B., 2006. Developments in the measurement of subjective well-being. J. Economic Perspectives 20 (1), 3–24. https://doi.org/10.1257/089533006776526030.

Kahneman, D., Wakker, P.P., Sarin, R., 1997. Back to Bentham? Explorations of experienced utility. Q. J. Economics 112 (2), 375–405. https://doi.org/10.1162/003355397555235.

Khattak, A.J., Rodriguez, D., 2005. Travel behavior in neo-traditional neighborhood developments: a case study in USA. Transp. Res. A 39, 481–500. https://doi.org/10.1016/j.tra.2005.02.009.

Lind, H.B., Nordfjaern, T., Jorgensen, S.H., Rundmo, T., 2015. The value-belief-norm theory, personal norms and sustainable travel mode choice in urban areas. J. Environ. Psychol. 44, 119–125. https://doi.org/10.1016/j.jenvp.2015.06.001.

Manaugh, K., El-Geneidy, A.M., 2013. Does distance matter? Exploring the links among values, motivations, home location, and satisfaction in walking trips. Transp. Res. A 50, 198–208. https://doi.org/10.1016/j.tra.2013.01.044.

Millward, H., Spinney, J., 2011. Time use, travel behavior, and the rural-urban continuum: results from the Halifax STAR project. J. Transp. Geogr. 19, 51–58. https://doi.org/10.1016/j.jtrangeo.2009.12.005.

Mokhtarian, P., Salomon, I., 2001. How derived is the demand for travel? Some conceptual and measurement considerations. Transp. Res. A 35, 695–719. https://doi.org/10.1016/S0965-8564(00)00013-6.

Mokhtarian, P., Papon, F., Goulard, M., Diana, M., 2015. What makes travel pleasant and/or tiring? An investigation based on the French National Travel Survey. Transportation 42, 1103–1128. https://doi.org/10.1007/s11116-014-9557-y.

Mooi, E., Sarstedt, M., 2010. Cluster analysis. In: A Concise Guide to Market Research. Springer, Berlin, Heidelberg.

Morris, E., Guerra, E., 2015a. Are we there yet? Trip duration and mood during travel. Transp. Res. F 33, 38–47. https://doi.org/10.1016/j.trf.2015.06.003.

Morris, E., Guerra, E., 2015b. Mood and mode: does how we travel affect how we feel? Transportation 42, 25–43. https://doi.org/10.1007/s11116-014-9521-x.

Mouratidis, K., 2019. Compacy city, urban sprawl, and subjective well-being. Cities 92, 261–272. https://doi.org/10.1016/j.cities.2019.04.013.

Mouratidis, K., 2020. Commute satisfaction, neighborhood satisfaction, and housing satisfaction as predictors of subjective well-being and indicators of urban livability. Travel Behav. Soc. 21, 265–278. https://doi.org/10.1016/j.tbs.2020.07.006.

Mouratidis, K., Ettema, D., Naess, P., 2019. Urban form, travel behavior, and travel satisfaction. Transp. Res. A 129, 306–320. https://doi.org/10.1016/j.tra.2019.09.002.

Novaco, R.W., Gonzales, O.J., 2009. Commuting and well-being. In: Amichai-Hamburger, Y. (Ed.), Technology and Well-Being. Cambridge University Press, New York, pp. 174–205.

Olsson, L., Garling, T., Ettema, D., Frimann, M., Fujii, S., 2013. Happiness and satisfaction with work commute. Soc. Indic. Res. 111, 255–263. https://doi.org/10.1007/s11205-012-0003-2.

Paez, A., Whalen, K., 2010. Enjoyment of commute: a comparison of different transportation modes. Transp. Res. A 44, 537–549. https://doi.org/10.1016/j.tra.2010.04.003.

Polzin, S.E., Chu, X., Rey, J.R., 2000. Density and captivity in public transit success: observations from the 1995 nationwide personal transportation study. Transp. Res. Rec. 1735 (00–0891), 10–18. https://doi.org/10.3141/1735-02.

Redmond, L.S., Mokhtarian, P.L., 2001. The positive utility of the commute: modeling ideal commute time and relative desired commute amount. Transportation 28, 179–205. https://doi.org/10.1023/A:1010366321778.

Rodgers, W.L., 1982. Density, crowding, and satisfaction with the residential environment. Soc. Ind. Res. 10, 75–102. https://doi.org/10.1007/BF00287219.

Russell, M., Mokhtarian, P.L., 2015. How real is a reported desire to travel for its own sake? Exploring the 'teleportation' concept in travel behaviour research. Transportation 42, 333–345. https://doi.org/10.1007/s11116-014-9546-1.

Schneider, R.J., Willman, J.L., 2019. Move closer and get active: how to make urban university commutes more satisfying. Transp. Res. F 60, 462–473. https://doi.org/10.1016/j.trf.2018.11.001.

Schwanen, T., Dijst, M., Dieleman, F.M., 2005. The relationship between land use and travel patterns: variations by household type. In: Williams, K. (Ed.), Spatial Planning, Urban Form and Sustainable Transport, Ashgate, Burlington, pp. 17–41.

Singer, J.E., Lundberg, U., Frankenhaeuser, M., 1978. Stress on the train: A study of urban commuting. In: Baum, A., Singer, J.E., Valins, S. (Eds.), Advances in Environmental Psychol. Erlbaum, Hillsdale, NJ, pp. 41–56.

Smith, O., 2017. Commute well-being differences by mode: evidence from Portland, Oregon, USA. J. Transp. Health 4, 246–254. https://doi.org/10.1016/j.jth.2016.08.005.

Stern, P.C., Dietz, T., 1994. The value basis of environmental concern. J. Soc. Issues 50 (3), 65–84. https://doi.org/10.1111/j.1540-4560.1994.tb02420.x.

St-Louis, E., Manaugh, K., van Lierop, D., El-Geneidy, A., 2014. The happy commuter: a comparison of commuter satisfaction across modes. Transp. Res. F 26, 160–170. https://doi.org/10.1016/j.trf.2014.07.004.

Stradling, S.G., Anable, J., Carreno, M., 2007. Performance, importance and user disgruntlement: a six-step method for measuring satisfaction with travel modes. Transp. Res. A 41, 98–106. https://doi.org/10.1016/j.tra.2006.05.013.

Stutzer, A., Frey, B., 2008. Stress that doesn't pay: the commuting paradox. Scandinavian J. Economics 110 (2), 339–366. https://doi.org/10.1111/j.1467-9442.2008.00542.x.

van Lierop, D., El-Geneidy, A., 2017. A New Market segmentation approach: evidence from two Canadian cities. J. Public Transp. 20 (1), 20–43. https://doi.org/10.5038/2375-0901.20.1.2.

Västfjäll, D., Friman, M., Garling, T., Kleiner, M., 2002. The measurement of core affect: a Swedish self-report measure. Scandinavian J. Psychol. 43 (1), 19–31. https://doi.org/10.1111/1467-9450.00265.

Watson, D., Clark, L.A., Tellegen, A., 1988. Development and validation of brief measures of positive and negative affect: the PANAS scales. J. Pers. Soc. Psychol. 54 (6), 1063–1070.

Wener, R.E., Evans, G.W., Phillips, D., Nadler, N., 2003. Running for the 7:45: the effects of public transit improvements on commuter stress. Transportation 30, 203–220. https://doi.org/10.1023/A:1022516221808.

Ye, R., Titheridge, H., 2017. Satisfaction with the commute: the role of travel mode choice, built environment and attitudes. Transp. Res. D 52, 535–547. https://doi.org/10.1016/j.trd.2016.06.011.

Ye, R., De Vos, J., Ma, Liang, 2020. Analysing the association of dissonance between actual and ideal commute time and commute satisfaction. Transp. Res. A 132, 47–60. https://doi.org/10.1016/j.tra.2019.10.011.