TOWARDS A BETTER UNDERSTANDING OF MODAL CHOCIES FOR LEISURE TRIPS

VAN ACKER Veronique, Ghent University, veronique.vanacker@ugent.be
MOKHTARIAN Patricia L., University of California-Davis, plmokhtarian@ucdavis.edu
WITLOX Frank, Ghent University, frank.witlox@ugent.be

ABSTRACT

Most studies on the link between the built environment and travel behaviour use objective or "hard" variables to estimate and model this relationship. For example, the built environment is usually characterized by such variables as population density, land use mix, jobs-housing balance and accessibility. Recently, an increasing number of researchers argue in favour of including more subjective or "soft" variables as well. After all, it is possible that different travel patterns exist within socio-economically and socio-demographically homogeneous population groups. Transport behavioural analysts have been aware of this for some time, and many studies discuss the role of attitudes in travel behaviour decisions. However, these studies tend to neglect the link with the built environment. Only recently, subjective variables were introduced in empirical work on the relationship between the built environment and travel behaviour. Most of these studies focus on the subjective perception of the built environment and the inclusion of location attitudes only, resulting in models that both take account of the objective and subjective characteristics of the built environment. Expanding the analysis to also include both objective and subjective personal characteristics (i.e., stage of life, gender and lifestyles) and travel characteristics (i.e., car availability, general travel attitudes and specific travel mode attitudes) is the purpose of this paper. Moreover, we are aware of the increasing complexity of travel models due to issues such as residential self-selection, mediating variables such as car ownership, and bidirectional relationships between attitudes and behaviours. The aim of this paper is to unravel these complex relationships using structural equations models, and to discuss the added value of including subjective variables into the analysis. Our results suggest that objective spatial characteristics remain important in the discussion on the link between the built environment and daily modal choices for leisure trips. Spatial planning can contribute to a more sustainable mobility by means of (i) densifying, (ii) fostering residential developments close to town and city centres, and (iii) providing facilities at neighbourhood-level. However, our results point out that these suggested spatial planning policies would only be successful for a specific group of respondents with lifestyles and attitudes that are associated with living in urban neighbourhoods. The suggested spatial planning policies seem likely to be unsuccessful for other lifestyles groups and people with a positive attitude toward open space and quietness, who prefer a suburban or rural neighbourhood. These neighbourhoods are generally associated with more car use and less use of car alternatives. However, there still exist some

possibilities to reduce car use, especially by means of transport planning and more specifically by improving the image of travelling by public transport or cycling and walking. This can be done by underlining their comfort, their positive effects for the environment and their relaxing effects. Consequently, an integration of spatial planning and transport planning seems useful. Moreover, policy should not only focus on designing and developing objective plans (e.g., a more sustainable lay-out of residential neighbourhoods), but should also be aware of their subjective implications (e.g., image building of travel modes).

Keywords: attitudes, lifestyles, self-selection, modal choice, leisure, structural equations models

1. INTRODUCTION

Like in many countries, car travel in Belgium has more than doubled between 1970 and 1990, from 40 billion to 90 billion passenger-km's (http://www.mobilit.fgov.be). Nowadays, travel is still rising although at a decelerating rate, and this increase likely continues. Prognosis studies predict another 30% increase in passenger-km's by 2030 (http://www.plan.be). Without doubt, widespread mobility encourages social and economic development (Church *et al*., 2000; Preston and Rajé, 2007; Cebollada, 2009), but it is nowadays also perceived as undesirable because of the related negative impacts on the environment, traffic safety and congestion. Therefore policy makers seek for solutions and spatial planning seems one of the possible options. Considering that most travel is utilitarian or purposive, it seems logical that an enhanced organization of the locations to which people travel might result in more efficient travel patterns. However, there is no such unambiguous and one-way relation between daily travel behaviour and the spatial characteristics of important activity locations such as the residence and the workplace. Only considering a direct interaction between the built environment and travel behaviour might come across as very deterministically without taking into account underlying personal motivations. Attitudes are one example of such subjective influences. By categorizing, transforming and interpreting information, an individual evaluates various aspects of a specific issue such as the built environment (of the residence) or owning and using a car. The sum of all these related evaluations then determines the general attitude toward that issue (Golledge and Stimson, 1997) and influences the individual's behaviour (Gärling *et al*., 1998; Brehn *et al*., 2005). Consequently, attitudes can be considered as cognitive, affective, normative, and intentional influences underlying decisions such as residential location, car ownership and car use.

The attention to attitudes in travel behaviour research is not completely new: transport behavioural analysts have been aware of this for some time and many studies have discussed the role of attitudes in travel behaviour decisions (e.g., Tardiff, 1977; Dobson *et al*., 1978; Golob *et al*., 1979; Lyon, 1984; Gauthier and Shaw, 1986; Gärling *et al*., 1998; and more recently Parkany *et al*., 2004, and Thogersen, 2006). However, these studies tend to neglect the link with the spatial context. Only recently, additional subjective variables were introduced in empirical work on the relationship between the built environment and travel behaviour (e.g., Kitamura *et al*., 1997; van Wee *et al*., 2002; Handy *et al*., 2005; Schwanen and Mokhtarian, 2005) and especially in those studies that question the issue of causation.

People often select themselves into a residential location that matches not only their residential attitudes but also their travel attitudes (Handy *et al*., 2005; Bhat and Guo, 2007; Mokhtarian and Cao, 2008). For example, people residing in a high-density neighbourhood with nearby grocery stores and public services may choose to walk to them not simply because the spatial lay-out itself encourages them to do so, but rather because they just prefer to walk to these locations instead of using their cars every time and this was an important factor in their initial decision to reside in that neighbourhood. A similar self-selection process exists with respect to other aspects such as car ownership and modal choices (van Wee, 2009). Efforts to use urban planning policies to discourage car ownership and car use might be ineffective for people with an overall preference for auto-oriented travel and behaviour. Or as Krizek puts it: “You can take the family out of the suburbs but you can’t take reliance on the Chevy Suburban out of the family” (Krizek, 2006). However, travel-related self-selection has received less attention compared to the issue of residential self-selection. Therefore, this paper analyzes the spatial effects on modal choices for different leisure trips, while accounting for attitudinal influences fundamental to the complex relationships between the built environment and modal choices.

The paper is organized as follows. Section 2 briefly summarizes the literature on the interaction between modal choices, car ownership, land use characteristics of the residence, lifestyles and fundamental residential and travel attitudes. Section 3 discusses the research design and the measurement of attitudes. Section 4 discusses some important modelling issues and presents the empirical results. The final section summarizes the main findings of the research and points out some policy implications.

2. LITERATURE REVIEW

This section presents a brief review of the literature on modal choices and summarizes some aspects which are relevant to our analysis (see Figure 1). Various studies argue that modal choices are significantly influenced by the built environment. Research findings indicate that car use is lower in urban and traditional areas characterized by high densities, more diversity and easy access to various opportunities (for a review, see, e.g., Ewing and Cervero, 2001; Handy, 2002; 2005). After all, in high-density and mixed-use neighbourhoods public transport can be organized more efficiently, and activity locations are within walking and cycling distance. Consequently, other alternatives for car use exist and the need to own a car might be reduced. Moreover, car ownership is more expensive in urban areas due to more congestion, limited parking space and more expensive parking (Schwanen *et al*., 2004; Giuliano and Dargay, 2006). Furthermore, some studies point out that car ownership is an important decisive factor of modal choices that mediates the interaction between the built environment and modal choices. Ignoring car ownership as a mediating variable is likely to result in an overestimation of the effect of the built environment on car use (Van Acker and Witlox, 2010). Nevertheless, the majority of empirical studies points out relationships of association rather than causality (Handy *et al*., 2005). Although there are indications that the built environment matters, it is not necessarily true that the spatial characteristics themselves have a causal effect on modal choices. As already mentioned, residential and travel attitudes are fundamental to residential location choices, decisions on car ownership and modal choices. These attitudes are as important as the objectively measured spatial characteristics, indicating the significance of residential and travel-related self-selection. Based on a cross-sectional analysis, Cao *et al.* (2007) noticed that the initially observed correlation between spatial characteristics of the residence and car ownership disappeared if the model was controlled for residential and travel attitudes fundamental to the residential location choice. This finding suggested that the association between the built environment and car ownership is primarily the result of residential self-selection. On the other hand, their analysis based on quasi-panel data suggested that spatial characteristics such as outdoor spaciousness and land use mix remain significant, but their effects were found marginal compared to other socio-economic and demographic (SED) variables. Consequently, no strong evidence was found supporting the causal relationship between the built environment and car ownership. On the other hand, Bhat and Guo (2007) for example found that, while controlling for the effects of residential self-selection, car ownership is still significantly influenced by the built environment. This suggests that the empirically measured correlation between the built environment and car ownership is not simply a spurious one caused by the intervening interaction between the built environment and the residential attitudes of people who choose to live in a particular neighbourhood. Both studies accounted for residential self-selection, or in other words, the indirect influence of attitudes through the residential location choice. Nevertheless, it might be important to consider the direct influence of (travel) attitudes on modal choices as well, referring to the influence of travel-related self-selection. A few studies have related travel attitudes to the vehicle type choice (Kuppam *et al.*, 1999; Johansson *et al*., 2006; Ben and Potter, 2007), but these studies did not control for differences in residential neighbourhoods. Thus, studies that account for travel-related self-selection as well remain so far scarce (e.g., Choo and Mokhtarian, 2004; Cao *et al*., 2006, 2007).

Furthermore, there is no such unambiguous and one-way relation between daily travel behaviour and the spatial characteristics of important activity locations such as the residence. Daily travel decisions should be considered within a hierarchy of medium-term decisions on car ownership and residential location (as could be deduced from the above paragraphs) but also long-term lifestyle decisions (Ben-Akiva, 1973; Salomon, 1981; Salomon and Ben-Akiva, 1983; Van Acker *et al*., 2010a). Lifestyles refer to opinions and motivations underlying patterns of behaviour by which someone tries to elucidate his or her social position (Munters, 1992). Within this respect, modal choices, car ownership and residential location choices are examples of behaviours in which lifestyles are reflected. For example, a low-budget lifestyle or a non-traditional culture-lover lifestyle might be reflected in using public transport more often, contrary to a car-oriented family lifestyle (Lanzendorf, 2002; Scheiner and Holz-Rau, 2007; Van Acker *et al*., 2010b).

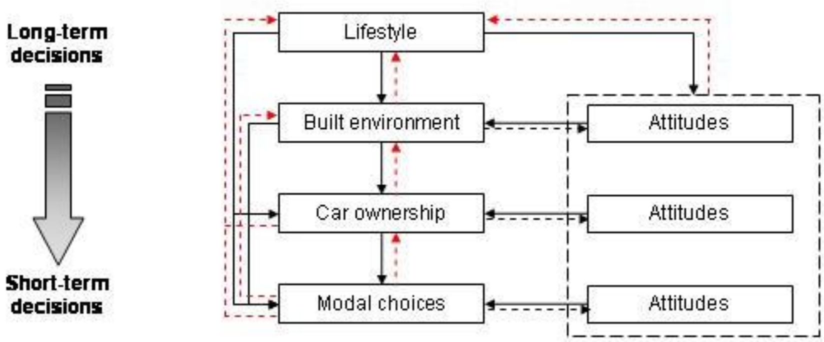

Figure 1 – Complex relationships between modal choices, the built environment and attitudes

The dotted arrows in Figure 1 represent feedback mechanisms. For example, a dual relationship exists between attitudes and behaviour. We already discussed how residential and travel attitudes might influence modal choices and decisions on car ownership and residential location, but once decisions are made and people become more familiar with the alternatives, attitudes about the choice and alternatives might change (Dobson *et al*., 1978; Lyon, 1984; Bohte *et al*., 2009) For example, having a positive attitude toward public transport might justify someone's decision on not owning a car, but since that person does not own a car and must rely on, e.g., public transport, the attitude toward public transport is strengthened. These attitudinal changes might also have repercussions for other decisions. For example, a positive attitude toward public transport might be reinforced by the lack of cars in the household, but in turn this attitude (and also the initial 'no-car' ownership decision) might influence the decision to reside in a neighbourhood with easy access to public transportation. The feedback mechanisms between attitudes and behaviour will be modelled. However, the feedback loops between behaviours at various time-scales (indicated in red in Figure 1) are not considered due to issues such as model complexity and identification. Moreover, only cross-sectional data are available, whereas the feedback across time scales suggests a dynamic, longer-term process for which panel data would be needed. For example, residential location changes occur on much longer time frame than the impact of behaviour on underlying attitudes, and cannot be captured in cross-sectional data.

3. MEASURING ATTITUDES

This paper aims at measuring the influence of the built environment on modal choices for leisure trips, simultaneously with accounting for residential and travel-related self-selection and considering the hierarchy between decisions on lifestyles, residential location, car ownership and modal choices. Current travel behaviour surveys, however, do not offer all the necessary information and generally lack data on attitudes and lifestyles. For that reason, we conducted an Internet survey between May 2007 and October 2007. For practical reasons, the survey was initially made known to students and staff members of the University of Antwerp and the Faculty of Sciences at Ghent University, and secondly an announcement was published in regional information magazines of several villages in the larger urban region of Ghent (Flanders, Belgium). In total, 2,363 persons completed the survey, of which (after data cleaning) 1,878 were retained for further analyses. Despite our efforts, we did not obtain a well-balanced sample and especially education was found unrepresentative for the whole population (for a more complete overview of sample characteristics, see Van Acker *et al*., 2010c). Respondents in our sample have a higher education than the average inhabitant of Flanders or Belgium. However, the focus of our research is on modelling relationships among modal choices and other key variables, and not on describing modal choices as such. Similar to Van Acker *et al*. (2010b) who discussed the concept of lifestyles and found five distinct lifestyle types (culture lover, friends and trends, home-oriented but active family, home-oriented traditional family, low-budget but active/creative), this section describes the measurement of residential and travel-related attitudes, and the correlations between these attitudes and other key variables.

The Internet survey contained various questions on attitudes toward residential locations, travel in general, and travel modes specifically. These questions were inspired by previous research on lifestyles, attitudes and mobility (see, e.g., Bohte *et al*., 2008, for the Netherlands; Bagley and Mokhtarian, 1999, for the USA). The responses on these survey items were factor analyzed in SPSS 15.0 (SPSS Inc., 2006) to extract the fundamental attitudes. In each factor analysis, the number of factors was determined based on interpretability of the factors, combined with interpretation of the scree plot and eigenvalues larger than one. The factor scores will then be used as input for further analyses concerning the complex relationships between modal choices, car ownership, residential location, lifestyles and attitudes.

3.1.1 Residential attitudes

The survey included 16 statements on attitudes toward residential locations. Respondents were asked to indicate on a five-point Likert scale ranging from ‘unimportant’ to ‘very important’ which aspects (except price) influence their supposed residential location choice. These 16 variables were then factor analyzed (principal axis factoring, promax rotation, 61.6% variance explained) into five underlying dimensions: car alternatives, open space and quietness, safety and neatness, accessibility, and social contact. Table 1 presents the pattern matrix indicating which location statements are most strongly associated with each factor.

Two residential attitudes refer to mobility aspects within the residential location. The evaluation of the available transport infrastructure (especially non-car based infrastructure) is incorporated into the attitude toward car alternatives, whereas the aspect of having easy access to various activity locations determines the attitude toward accessibility. The attitude toward open space and quietness is associated with high scores on aspects of the natural environment, in contrast to the attitude toward social contact in which the social environment of neighbours is rated as important. Safety (i.e., social, traffic) and aesthetic aspects (i.e., architecture, neatness) are combined into a fifth residential attitude labelled ‘safety and neatness’.

Since we used an oblique rotation procedure, attitudinal factors were allowed to be correlated. The two most highly-correlated factors were open spaces and quietness, and safety and neatness (0.518). These residential attitudes are probably associated with residential preferences toward residing in more suburban areas or in the country. No other correlation exceeded 0.395, and thus none are high enough to trigger multicollinearity concerns.

Table 1 – Pattern matrix for residential attitudes

Factors on residential attitudes → **Suppose you have to choose a new residential location. What aspects are important to you ? ↓**	**Car alternatives**	**Open space and quietness**	**Safety and neatness**	**Accessibility**	**Social contact**
Presence of bike paths	0.863				
Presence of sidewalks	0.822				
Traffic safety	0.420		0.403		
Close to public transport	0.375			0.334	
Presence of green areas		0.918			
Quietness		0.793			
Social safety, no crimes			0.766		
Neatness, tidiness		0.286	0.552		
Sufficient parking places			0.454		
Outlook of buildings, architecture			0.318		
Close to shops, groceries				0.738	
Close to leisure activities				0.687	
Close to family and friends				0.391	
Close to work				0.349	
Frequent contact with neighbours					0.777
Good contact with neighbours					0.761

Only factor loadings higher than 0.200 (in magnitude) are reported: loadings higher than 0.300 characterize the factors to a large extent, and values between 0.200 and 0.300 are also reported because they enrich the interpretation of certain factors.

3.1.2 Travel attitudes and travel mode attitudes

The Internet survey included 13 statements related to travel in general for which a factor analysis (principal axis factoring, promax rotation) resulted in three general travel attitudes (see pattern matrix reported in Table 2). Furthermore, the survey also included 12 statements related to four specific travel modes (car, public transport, cycling and walking). Specific travel mode attitudes were obtained from factor analyses (principal axis factoring, promax rotation) for each separate travel mode (cycling and walking were combined). The pattern matrices of these analyses are reported in Table 3.

Turning first to the general attitudes, the frustrated traveller scale is based on statements such as ‘Daily travel is boring’ (loading = 0.876) and ‘I love being on the road’ (loading = -0.757). It seems self-evident that frustrated travellers do not enjoy travelling and being on the road. This is in contrast with frequent car users (or car addicts) who indicate that they should use their car less often according to their family and friends. Since this travel attitude refers to the opinion of family and friends, it also includes an aspect of social norms as perceived by the respondent. A third travel attitude refers to a pro-environment orientation. Pro-environment respondents are aware of the problems caused by traffic and they consider themselves able to contribute to a solution for these problems.

Table 2 – Pattern matrix for general travel attitudes

Factors on general travel attitudes → **Do you agree with the next statements on mobility ↓**	**Frustrated traveller**	**Pro-environment**	**Frequent car user**
Daily travel is boring	0.876		
I love being on the road	-0.757		
Travel time is wasted time	0.643		
Arriving at my destination is the only good thing about daily travel	0.562		
Traffic makes me nervous	0.368	0.270	
I like to discover new and unfamiliar places	-0.294		
Car traffic causes serious problems		0.637	
I myself can contribute to a solution for traffic problems		0.596	
It does not matter whether I use my car or not. Other people still drive their cars.		-0.486	
According to family and friends, traffic problems are over exaggerated		-0.263	
According to family and friends, I should use public transport more often			0.757
According to family and friends, I should bike more often			0.724
According to family and friends, I should use my car only when absolutely necessary		0.301	0.323

Only factor loadings higher than 0.200 (in magnitude) are reported: loadings higher than 0.300 characterize the factors to a large extent, and values between 0.200 and 0.300 are also reported because they enrich the interpretation of certain factors.

Respondents were also asked to indicate the aspects that characterize car, public transport, and cycling and walking. Factor analyses for each transport mode separately found similar travel mode attitudes in each case. All three modes can be perceived as comfortable. Another recurring issue is the consequences (whether positive or not) of using cars, public transport or cycling and walking on the environment but also on someone's image or health. The attitudes toward public transport produce a third factor, time-saving, which did not emerge as a separate dimension in the analysis of car attitudes and attitudes toward cycling and walking (the relevant items loaded on the comfort factor in the latter cases).

Correlations between general travel attitudes are low (less than 0.152), whereas moderately strong correlations are exhibited between travel mode attitudes. Except for the car, a positive attitude on the comfort factor seems to be correlated with a positive attitude on the positive effects factor ($R_{comfort\ x\ positive\ effects}$ = 0.551 for public transport, $R_{comfort\ x\ positive\ effects}$ = 0.475 for cycling/walking). Still, however, these correlations are not alarmingly high.

Table 3 – Pattern matrix for specific travel mode attitudes

CAR ATTITUDES			
Factors on car attitudes → **Which aspects characterize car use ? ↓**	**Comfort**	**Negative effects**	
Reliable	0.625		
Comfortable	0.616		
Flexible	0.596		
Time-saving	0.582		
Privacy-offering	0.472		
Safe	0.454		
Relaxing	0.372		
Good for image	0.294		
Activities while travelling	0.207		
Healthy		-0.677	
Cheap		-0.483	
Environment-friendly		-0.480	
CYCLING/WALKING			
Factors on cycling/walking attitudes → **Which aspects characterize cycling/walking ? ↓**	**Comfort**	**Positive effects**	
Privacy-offering (cycling)	0.634		
Privacy-offering (walking)	0.606		
Comfortable (cycling)	0.515		
Comfortable (walking)	0.461		
Time-saving (cycling)	0.374		
Time-saving (walking)	0.223		
Safe (cycling)	0.357		
Safe (walking)	0.331		
Flexible (cycling)	0.353	0.322	
Flexible (walking)	0.346	0.215	
Reliable (cycling)	0.331		
Reliable (walking)	0.321	0.333	
Good for image (cycling)	0.233		
Good for image (walking)	0.267		
Cheap (cycling)		0.658	
Cheap (walking)		0.615	
Healthy (cycling)		0.618	
Healthy (walking)		0.650	
Environment-friendly (cycling)		0.626	
Environment-friendly (walking)		0.557	
Relaxing (cycling)		0.265	
Relaxing (walking)		0.304	
PUBLIC TRANSPORT			
Factors on public transport attitudes → **Which aspects characterize public transport ? ↓**	**Comfort**	**Positive effects**	**Time-saving**
Comfortable	0.781		
Relaxing	0.471		
Environment-friendly		0.650	
Activities while travelling		0.340	
Safe	0.296	0.319	
Cheap		0.301	0.218
Good for image		0.249	
Healthy		0.248	
Flexible			0.633
Time-saving			0.323
Reliable			0.284
Privacy-offering			0.249

Only factor loadings higher than 0.200 (in magnitude) are reported: loadings higher than 0.300 characterize the factors to a large extent, and values between 0.200 and 0.300 are also reported because they enrich the interpretation of certain factors.

3.1.3 Correlations between attitudes and other key variables

The Internet survey also provided information on other (objective) key variables. For example, it is common practice to control the modelling results for differences in personal socio-economic and demographic (SED) characteristics. A factor analysis of these SED variables provided three factors, all referring to stages of life: students living at home, older family with employed adults, and a young family. By geocoding the respondents' addresses in ArcGIS 9.2, we could add spatial information from various land use and transportation databases (for more information on these databases, see Van Acker and Witlox, 2010a, b). Similar to the SED characteristics, spatial characteristics such as density, diversity and accessibility are often related to each other (Cervero and Kockelman, 1997), and a factor analysis might provide interesting new spatial factors. In our case, we extracted five spatial factor: location relative to a local centre, location relative to a regional centre, local accessibility, regional accessibility, and density. Car ownership is in our model a mediating variable between the built environment and modal choice. The Internet survey not only provided information on car ownership, but also on the possession of a driving license or a public transport pass, and the temporary availability of a car. We felt that it might be useful to combine these four characteristics into one general car availability factor, especially with regard to analyses of modal choices. More information on the calculation and construction of the stage of life, spatial and car availability factors can be found in Van Acker *et al.* (2010b). Modal choice is the final outcome variable in our analyses. In our Internet survey, respondents had to report what kind of leisure trips they perform on a monthly basis and which travel mode they generally use for this. In this paper, we focus on the modal choices for active leisure activities such as practicing sports (instead of watching sports games) and playing theatre (instead of attending a theatre play), family visits and fun shopping. We performed three separate analyses: one for car use, one for public transport, and one for cycling/walking. In each of these analyses, modal choice is defined as a binary variable.

Calculating correlations between these key variables and attitudes already reveals a number of interesting results (see Tables 4 and 5). Urban living is more likely related with a positive attitude toward accessibility. Travel attitudes might also be associated with the decision to reside in an urban neighbourhood. Especially a general pro-environment travel attitude, and to a lesser degree the positive evaluation of public transport, and cycling and walking, correlates with urban living. On the contrary, preferring open spaces and quietness, or safety and neatness is negatively associated with density, which might indicate suburban or rural living (the correlation with safety and neatness is moderate though significant). This is also suggested to some extent by car-oriented travel attitudes. Residential and travel attitudes might also differ among population groups. Non-traditional lifestyle groups such as culture lovers are associated with urban residential attitudes and a negative evaluation of the car, whereas the opposite holds for family-oriented lifestyles and older families. A young family might also appreciate the comfort aspect of public transport, and cycling and walking. Furthermore, urban residential attitudes are more likely to be associated with lower car availability compared to suburban or rural residential attitudes. Table 5 shows that having lower car availability is also associated with a positive attitude toward car alternatives and a pro-environment attitude. Note that these correlations only refer to associations and not to causal relations among variables. None of these correlations appears to be greater than 0.2 in magnitude indicating that the direct relationships discussed so far are not overly strong in any case. Nevertheless, controlling for other characteristics, as we are able to do in the subsequent multivariate analysis, can reveal relationships that are suppressed when just considering pairwise association. Section 4 will therefore discuss causality among lifestyles, stages of life, spatial characteristics, residential and travel attitudes, car availability and modal choices.

Table 4 – Correlations between residential attitudes and other key variables

	Residential attitudes				
	Car alternatives	**Open space and quietness**	**Safety and neatness**	**Accessibility**	**Social contact**
Lifestyles					
Culture lover	0.124*	-0.009	-0.123*	0.120*	-0.035
Friends-and-trends	-0.102*	-0.064*	0.037	0.040	0.072*
Home-oriented but active family	0.033	0.169*	0.035	-0.018	0.083*
Low-budget and active/creative	-0.009	0.002	-0.119*	-0.016	0.003
Home-oriented traditional family	-0.077*	-0.151*	0.181*	0.175*	0.001
SED characteristics					
Student living at home	-0.009	-0.073*	0.093*	-0.038	0.097*
Older family, working adults	0.040	0.082*	0.053	-0.063**	0.006
Young family	0.013	-0.047	-0.007	-0.023	0.075*
Gender (female)	0.071*	-0.012	0.067*	0.127*	0.018
Residential neighbourhood					
Location relative to local centre	-0.023	-0.005	0.005	0.037	0.044
Location relative to regional centre	0.029	0.015	0.004	-0.026	0.046
Local accessibility	0.028	-0.028	0.033	-0.030	0.015
Regional accessibility	0.058**	-0.018	-0.030	-0.011	0.008
Density	0.036	-0.104*	-0.072*	0.156*	-0.030
Car availability	-0.150*	0.023	0.182*	-0.068*	0.059**

* = significant at α = 0.01, ** = significant at α = 0.05

Table 5 – Correlations between travel (mode) attitudes and other key variables

	Travel attitudes			**Car attitudes**		**Public transport attitudes**			**Cycling/walking attitudes**	
	Frustrated traveller	**Pro-environment**	**Frequent car user**	**Comfort**	**Negative effects**	**Comfort**	**Positive effects**	**Time-saving**	**Comfort**	**Positive effects**
Lifestyles										
Culture lover	-0.071*	0.174*	0.025	-0.118*	0.052**	0.081*	0.060*	0.007	-0.001	0.050**
Friends-and-trends	-0.038	-0.105*	0.046	0.081*	-0.009	0.019	-0.113*	0.025	0.028	-0.104*
Home-oriented but active family	-0.028	0.063*	0.049**	0.032	-0.021	-0.078*	-0.026	0.012	-0.036	0.005
Low-budget and active/creative	-0.081*	0.056**	-0.057**	-0.020	-0.021	0.040	0.054**	0.014	0.064*	0.073*
Home-oriented traditional family	-0.054**	-0.188*	-0.021	0.237*	0.001	0.099*	-0.074*	-0.028	0.161*	-0.071*
SED characteristics										
Student living at home	0.004	-0.141*	0.028	0.107*	-0.033	0.057**	-0.061**	0.005	0.050	-0.038
Older family, working adults	0.042	0.031	0.100*	-0.092*	-0.037	-0.114*	-0.002	0.023	-0.160*	-0.006
Young family	0.015	0.010	-0.036	0.031	0.046	0.054**	0.001	-0.014	0.072*	0.025
Gender (female)	0.053**	-0.041	-0.006	0.046**	0.062*	-0.015	-0.044	-0.022	0.081*	-0.106*
Land use										
Location relative to local centre	0.018	-0.071*	0.010	0.038	0.004	0.006	-0.113*	0.011	0.019	-0.004
Location relative to regional centre	-0.012	-0.009	0.020	0.077*	0.005	0.010	-0.006	0.019	0.009	-0.052**
Local accessibility	0.024	-0.043	-0.005	0.059**	-0.023	0.014	-0.024	0.035	-0.008	0.003
Regional accessibility	0.020	0.025	0.006	-0.035	0.023	-0.060**	-0.016	-0.045	-0.024	-0.004
Density	0.002	0.136*	-0.004	-0.121*	0.025	0.050**	0.038	0.020	0.032	0.071*
Car availability	-0.021	-0.156*	0.190*	0.135*	-0.044	-0.142*	-0.131*	-0.048**	-0.134*	-0.113*

* = significant at α = 0.01, ** = significant at α = 0.05

4. STRUCTURAL EQUATIONS MODELLING AND RESULTS

The complex relationships, as depicted in Figure 1, between modal choices and various subjective and objective variables can be formalized as a series of regression equations. We use structural equation modelling (SEM) to simultaneously estimate these equations. In such an approach, a variable can be an explanatory variable in one equation (e.g., car ownership influencing modal choices) but an outcome variable in another equation (e.g., car ownership influenced by the built environment). Therefore, the concepts 'endogenous' and 'exogenous' variables are used (Byrne, 2001; Kline, 2005; Raykov and Marcoulides, 2000). Exogenous variables are not influenced by any other variable in the model, but instead exogenous variables influence other variables. Endogenous variables are influenced by exogenous variables, either directly or indirectly through other endogenous variables.

4.1 Model specification issues

Structural equation models are estimated by finding the coefficients that best match the resulting model-implied covariance matrix to the empirically-based covariance matrix for the data. As in other statistical techniques, a standard estimation technique in SEM is maximum likelihood (ML), which assumes a multivariate normal distribution of all endogenous variables in the model (Bentler and Dudgeon, 1996; Kline, 2005). However, our final outcome variable, modal choice, is binary and, thus, not normally distributed. We used the software package M-plus 4.21 because of its ability to model categorical endogenous variables. By default, M-plus then uses an alternative estimator: a mean- and variance-adjusted weighted least squares parameter estimator (WLSMV) which we used instead of ML. WLSMV is an estimator generating robust standard errors that does not require extensive computations or enormous sample sizes. In addition to robust estimation, a robust mean-adjusted and mean- and variance-adjusted chi-square test statistic can be produced (Muthén, 1983; Satorra, 1992; Yu and Bentler, 2000).

Another model specification issue is the effect of outliers. Outliers are commonly detected by calculating the Mahalanobis distance and the loglikelihood for each observation. The Mahalanobis distance requires continuous endogenous variables and the loglikelihood assumes ML-estimators, two assumptions that are not fulfilled in our model. However, M-plus also calculates Cook's D (Cook, 1977, 1979) and a loglikelihood distance influence measure adjusted for weighted least squares estimators (Cook and Weisberg, 1982) for each observation. By plotting these outlier scores against the scores for modal choice, we were able to detect outliers for each model presented in Section 4.2. Removing the outliers led to changes in the overall model fit and individual parameter estimates, but the effects were only minimal. The overall model fit did not change considerably in any of the models and only a limited number of individual parameter estimates became insignificant. However, by removing outliers the means and variances of all variables in the reduced samples were different from the ones in the original sample. Outliers generally correspond to respondents with a pronounced lifestyle or to respondents living in a residential neighbourhood with, for this analysis, interesting spatial traits (especially neighbourhoods with good local accessibility and neighbourhoods distant from a regional city centre). Those outliers are interesting for our analysis. After all, we want to estimate the influence of lifestyles and the built environment on modal choices. Consequently, we decided to retain all outliers and model results in Section 4 are based on the full dataset.

Table 6 – Model fit

	χ^2 (df) p	χ^2 / df	CFI	TLI	RMSEA	WRMR
Desired values	p > 0.05	< 2	> 0.95	> 0.95	< 0.05	< 1.00
car use for AL	184.63 (142) 0.01	1.30	0.96	0.96	0.02	1.02
car use for FV	243.66 (151) 0.00	1.61	0.94	0.94	0.03	1.12
car use for FS	190.66 (128) 0.00	1.49	0.92	0.93	0.03	1.09
public transport for AL	187.55 (146) 0.01	1.28	0.95	0.96	0.02	1.02
public transport for FV	229.13 (148) 0.00	1.55	0.94	0.94	0.03	1.11
public transport for FS	188.18 (126) 0.00	1.49	0.92	0.92	0.03	1.10
cycling/walking for AL	190.25 (146) 0.01	1.30	0.95	0.95	0.02	1.02
cycling/walking for FV	237.54 (153) 0.00	1.55	0.94	0.94	0.03	1.12
cycling/walking for FS	191.93 (130) 0.0	1.48	0.92	0.93	0.03	1.08

Note: AL = active leisure activities, FV = family visits, FS = fun shopping

Finally, the quality of the model specifications has to be assessed before the model results can be interpreted. Most SEM software packages report a large variety of model fit indices. The χ^2-statistic is a commonly used model fit index which measures the discrepancy between the empirically-based and the model-based covariance matrices. However, χ^2 values increase with sample size and, thus, models based on large sample sizes might be rejected based on their χ^2 value even though only small differences exist between the empirically-based and model-based covariance matrices. The standard χ^2-statistic is, therefore, transformed into a dozen alternative model fit indices. The simplest transformation is to divide the χ^2 value by the degrees of freedom (χ^2/df), but more sophisticated fit indices exist as well. For example, the Comparative Fit Index (CFI) assesses the improvement of the hypothesized model over the independence model with only unrelated variables. It ranges from 0 to 1, with 1 indicating perfect model fit. Another comparative fit index is the Tucker-Lewis Index (TLI). It indicates where the fitted model is situated on a continuum between two hypothetical models: an independence model with only unrelated variables and an ideal model that fits perfectly. Doing so, TLI corrects for model complexity and it favours simpler models. TLI also ranges from 0 to 1 with larger values indicating better model fit. Values above 1 are possible, but remain rare. Another widely used model fit index is the Root Mean Square Error of Approximation (RMSEA). The RMSEA measures the degree of discrepancy between the hypothesized model and the observed data per degree of freedom, while controlling for sample size. It ranges from 0 to very large values, where small values are preferred. The Weighted Root Mean Square Residual (WRMR) is a residual-based model fit index and measures the weighted average differences between the sample and the estimated population variances and covariances. It ranges from 0 to very large, with smaller values preferred. Studies such as Bollen (1989), Kline (2005) and Hu and Bentler (1999) suggest cut-off values for these model fit indices: χ^2/df < 2.0, CFI and TLI > 0.95, RMSEA < 0.05 and WRMR < 1.00 for adequate model fit. Yu (2002) confirmed these cut-off values for models with categorical outcomes. In correspondence with various scholars (Byrne, 2001, Hu and Bentler, 1999; Kline, 2005; Yu, 2002), Table 2 reports model fit indices from several different index families (i.e., indices of comparative fit to a baseline model, error-of-approximation-based indices, and residual-based indices). According to most indices, model fit is generally adequate.

4.2 Model results

Having specified the measurement of the key variables and some important model specification issues, we now turn our attention to the model results. The aim of this paper is to assess the objective and subjective influences on modal choices for leisure trips, while accounting for the complex interrelations among these influences. Table 7 summarizes the results. The explained variance values for each model are quite large for models on disaggregate data. This suggests that the hypothesized models account for a significant amount of variation in modal choice for leisure trips, especially for car use for fun shopping (R^2 = 80.5%).

For each travel mode, the influences of objective and subjective variables tend to be similar for active leisure activities and family visits as well as fun shopping. Moreover, the modelling results for public transport generally resemble the results for cycling and walking, but are opposite to those for car use. Unlike the findings of other studies (e.g., Scheiner and Holz-Rau, 2007), this suggests a dichotomy in modal choice between cars and car alternatives rather than between motorised and non-motorised transport or between public and individual transport.

4.2.1 The causal influence of the built environment

The built environment has the expected influence on modal choice. High densities, good accessibility and a short distance between the residence and the city or town centre seem to discourage car use and to encourage public transport as well as cycling and walking. Based on the standardized total effects, the built environment seems to considerably influence modal choices but especially the decision to drive by car for leisure trips, to use public transport for family visits, and to cycle or walk for active leisure activities and for fun shopping. This suggests that spatial planning policies encouraging further densification, developing residential quarters near town or city centres, and providing facilities such as shops and leisure activities within the residential neighbourhood might have the desired effect on modal choices.

However, the question remains whether it is really the built environment itself that influences modal choices more than, or as much as, the underlying residential attitudes and preferences in the first place. Table 7 illustrates that residential and travel attitudes fundamental to the residential location choices have small but significant indirect effects on modal choices (for more details, see Van Acker et al., 2010b). Car use is positively associated with the importance of open space and quietness (typically for suburban and rural residents with high levels of car availability), and negatively associated with the importance of having access to locations such as workplaces and shops (typically for urban residents with low levels of car availability). The opposite is true for public transport use, and cycling and walking. This finding indicates that residential self-selection occurs to some extent. This is also supported by the influence of lifestyles on modal choice. Table 7 indicates that lifestyles exhibit a consistent influence on modal choice for leisure trips. For all leisure activity types, non-traditional (i.e., culture lover) and low-budget (i.e., low-budget and active) lifestyles seem to be associated with less car use, and more public transport use and especially more cycling and walking. The opposite is true for family-oriented (i.e., active family, traditional family) and active (i.e., friends and trends, active family) lifestyles. The interrelations between lifestyles and modal choice are not always that strong. It depends on which travel mode and which leisure activity type is considered. For example, a traditional-family lifestyle is likely to have a strong direct (positive) effect on car use for family visits, whereas a low-budget-and-active/creative lifestyle tends to strongly (positively) influence cycling and walking for active leisure activities. It is no surprise that these two lifestyles have an important effect on these leisure trips in particular. After all, these leisure trips (family visits, and active leisure activities) are an essential part of the lifestyles concerned (traditional family, and low-budget and active/creative respectively). However, because of the interaction with among others the built environment, the influence of lifestyles is in many cases mainly indirect. Van Acker et al. (2010b) pointed out that non-traditional lifestyles such as culture lovers might prefer to reside in an urban neighbourhood, whereas active lifestyles tend to reside in suburban or rural neighbourhoods. Consequently, the supposed influence of the built environment on modal choice is partly explained by residential preferences of particular lifestyles.

4.2.2 Other important influences on modal choice for leisure trips

Modal choices seem to be mainly influenced by car availability. High levels of car availability are associated with more car use, less public transport use, and less cycling and walking. In other words, car use tends to be higher for respondents who have several cars, who possess a driving license (and not a public transport pass) and/or who have cars permanently available. Our results suggest that car availability has a strong effect on car use and public transport use, but a less strong effect on cycling and walking (probably reflecting that those modes are often adjuncts or supplements to driving, not just substitutes for it). Other variables have a comparable effect or even a more pronounced effect on cycling and walking for leisure trips, especially the built environment for fun shopping.

Again, the causal relation between car availability and modal choice can be questioned. Car availability generally has a strong direct effect on modal choice. Nevertheless, general travel attitudes and specific travel mode attitudes underlie the decision to own a car. Van Acker et al. (2010b) found that a pro-environment travel attitude has an important negative direct influence on car availability, whereas car availability was found positively associated with the perception of a car as a comfortable transport mode. Table 7 indicates an important indirect effect of these travel (mode) attitudes on modal choices for leisure trips, indicating that travel-related self-selection occurs to some extent in addition to the direct effect of car availability on modal choices. Respondents with a pro-environment attitude are more likely than their less supportive counterparts to use public transport and to cycle and walk, and less likely to drive their cars, and our results also indicate that perceiving driving a car as comfortable is associated with more car use and less use of car alternatives. This seems to confirm the dichotomy between cars and car alternatives. Other travel (mode) attitudes only have a small effect on modal choice. A frustrated travel attitude is associated with more car use. This indicates that frustrated travellers, who do not enjoy being on the road, tend to use travel modes that might be perceived as more private than public transport or faster than cycling and walking. Frequent car users, according to the respondent's family and friends, also tend to use their cars more often which possibly refers to the existence of habits in modal choices. Interesting to note is that public transport as well as cycling and walking are not significantly influenced by travel mode attitudes specifically toward public transport (respectively cycling and walking), but only by the specific attitude of cars as comfortable transport modes. It indicates that car attitudes not only explain car use, but also dominate the decision of using car alternatives.

Furthermore, our results suggest that stage of life and gender influence modal choice for leisure trips, but mainly indirectly. Students living at home are likely to use travel modes other than cars. They are more likely than others to use public transport for active leisure activities and fun shopping, and to cycle and walk more often for family visits. Contrary to students, young and older families seem to prefer their car for all types of leisure trips. A remarkable difference in modal choice can be noticed between women and men. Women are significantly less likely than men to cycle or walk for leisure, whereas the opposite holds for car use for active leisure activities and family visits, and for public transport for fun shopping. However, the relationship between gender and modal choice is negligible compared to other objective and subjective variables (except for public transport for fun shopping).

4.2.3 Attitudes and behaviour

We also simultaneously estimated reverse relationships, to test whether travel attitudes are influenced by modal choices (see Table 8). The effect of modal choices on travel (mode) attitudes is generally small and, moreover, the use of public transport does not seem to significantly influence travel-related attitudes. However, car use and cycling and walking do have a significant direct effect on some particular travel (mode) attitudes which is even more important than the reverse effect. We found that a pro-environment attitude is significantly influenced by modal choices. Cycling and walking encourages a pro-environment attitude, whereas a pro-environment attitude is reduced by car use. Initial car use also encourages frequent car use, especially for family visits, whereas cycling and walking prevent frequent car use (according to family and friends). Furthermore, using cars seems to result in a positive perception of the car as a comfortable transport mode, whereas the opposite holds for cycling and walking.

Table 7 – Standardized direct and total effects on modal choice for different leisure trips

	Car use			**Public transport**			**Cycling and walking**		
	AL N = 633 (53.7% no, 46.3% yes)	**FV** N = 903 (25.2% no, 74.8% yes)	**FS** N = 577 (46.8% no, 53.2% yes)	**AL** N = 633 (90.4% no, 9.6% yes)	**FV** N = 903 (87.4% no, 12.6% yes)	**FS** N = 577 (62.0% no, 38.0% yes)	**AL** N = 633 (37.3% no, 62.7% yes)	**FV** N = 903 (68.5% no, 31.5% yes)	**FS** N = 577 (56.0% no, 44.0% yes)
SED characteristics									
student living at	-0.031	0.005	0.019	0.133*	-0.043	0.416*	0.029	0.241*	-0.130*
home	-	-	-	-	-	*0.242**	-	*0.189**	-
older family,	0.235*	0.125*	0.228**	-0.213*	-0.184*	-0.293*	-0.144*	-0.109*	-0.044
working	-	-	-	-	-	-	-	-	-
young family	0.222*	0.103*	0.137*	-0.081*	-0.123*	-0.110*	-0.101*	-0.061*	-0.071*
	-	-	-	-	-	-	-	-	-
Gender (female)	0.046*	0.090*	0.006	-0.005*		0.259*	-0.051*	-0.060*	-0.024
	-	-	-	-	-	*0.274**	-	-	-
Lifestyles									
culture lover	-0.136*	-0.014	-0.069*	-0.004*	0.072*	-0.013*	0.032*	0.006	0.078*
	*-0.142**	-	-	-	-	-	-	-	-
friends & trends	0.025*	-0.004	-0.008	-0.011*	0.008**	-0.008*	-0.012*	-0.161*	-0.137*
	-	-	-	-	-	-	-	*-0.153**	*-0.137**
home-oriented	0.068*	0.058*	0.114*	-0.013*	-0.112*	-0.034*	-0.040*	-0.018*	-0.080*
but active family	-	-	-	-	-	-	-	-	-
low-budget &	0.001	-0.144*	0.016*	0.004*	-0.018*	0.006*	0.137*	0.169*	0.108*
active/creative	-	*-0.150**	-	-	-	-	*0.131**	*0.166**	0.124*
home-oriented	0.157*	0.096*	-0.047*	0.001*	0.058*	-0.008*	-0.019	-0.020**	0.061*
traditional family	*0.207**	*0.139**	-	-	-	-	-	-	-
Built environment									
location relative to	0.229*	0.087	0.449*	0.006*	-0.239*	0.019*	-0.153*	0.003*	-0.437*
local centre	*0.276**	*0.129**	*0.523**	-	*-0.330**	-	*-0.168**	-	*-0.494**
location relative to	0.383*	0.199*	0.439*	-0.045*	-0.454*	-0.044*	-0.232*	-0.021*	-0.516*
regional centre	*0.376**	*0.228**	*0.488**	-	*-0.526**	-	*-0.218**	-	*-0.573**
local accessibility	-0.247*	-0.131**	-0.323*	0.048*	0.331*	0.223*	0.006	0.023*	0.184*
	*-0.257**	*-0.177**	*-0.410**	-	*0.436**	*0.192**	-	-	*0.255**
regional	-0.148*	-0.107*	-0.297*	0.000*	0.222*	0.152*	-0.001**	0.000*	-0.002*
accessibility	*-0.192**	*-0.138**	*-0.370**	-	*0.292**	*0.197**	-	-	-

Note: direct effects shown in italics, - = direct effect estimated but found insignificant and therefore constrained to zero, * significant at α = 0.01, ** significant at α = 0.05

Table 7 – Standardized direct and total effects on modal choice for different leisure trips *continued*

	Car use			Public transport			Cycling and walking		
	AL N = 633 (53.7% no, 46.3% yes)	**FV** N = 903 (25.2% no, 74.8% yes)	**FS** N = 577 (46.8% no, 53.2% yes)	**AL** N = 633 (90.4% no, 9.6% yes)	**FV** N = 903 (87.4% no, 12.6% yes)	**FS** N = 577 (62.0% no, 38.0% yes)	**AL** N = 633 (37.3% no, 62.7% yes)	**FV** N = 903 (68.5% no, 31.5% yes)	**FS** N = 577 (56.0% no, 44.0% yes)
Built environment									
density	-0.229*	_-0.219*_	-0.457*	0.036*	0.448*	0.035*	0.129*	0.017*	0.421*
	_-0.289*_	_-0.313*_	_-0.635*_	-	_0.656*_	-	_0.155*_	-	_0.605*_
Residential attitudes									
car alternatives	0.060*	0.042*	0.114*	0.000*	-0.088*	-0.058*	0.000**	0.000*	0.001*
	-	-	-	-	-	-	-	-	-
open space and quietness	0.145*	0.137*	0.285*	-0.023*	-0.279*	-0.022*	-0.082*	-0.011*	-0.263*
	-	-	-	-	-	-	-	-	-
safety and neatness	-	-	-	-	-	-	-	-	-
accessibility	-0.025*	-0.031*	-0.052*	0.006*	0.061*	0.007*	0.013**	0.003*	0.046*
	-	-	-	-	-	-	-	-	-
social contact	-	-	-	-	-	-	-	-	-
Travel attitudes									
frustrated traveller	0.011*	-	-	-	-	-	-	-	-
	-								
pro-environment	-0.223*	-0.095*	-0.220*	0.114*	0.201*	0.148*	0.161*	0.090*	0.128*
	-	-	-	-	-	-	-	-	-
frequent car user	0.015*	0.002*	0.006*	-0.005*	-0.005*	-0.006*	-0.016*	-0.009*	-0.001**
	-	-	-	-	-	-	-	-	-

Note: direct effects shown in italics, - = direct effect estimated but found insignificant and therefore constrained to zero, * significant at α = 0.01, ** significant at α = 0.05

Table 7 – Standardized direct and total effects on modal choice for different leisure trips *continued*

	Car use			**Public transport**			**Cycling and walking**		
	AL N = 633 (53.7% no, 46.3% yes)	**FV** N = 903 (25.2% no, 74.8% yes)	**FS** N = 577 (46.8% no, 53.2% yes)	**AL** N = 633 (90.4% no, 9.6% yes)	**FV** N = 903 (87.4% no, 12.6% yes)	**FS** N = 577 (62.0% no, 38.0% yes)	**AL** N = 633 (37.3% no, 62.7% yes)	**FV** N = 903 (68.5% no, 31.5% yes)	**FS** N = 577 (56.0% no, 44.0% yes)
Travel mode attitudes									
car = comfortable	0.105* -	0.036* -	0.083* -	-0.078* -	-0.073* -	-0.097* -	-0.266* _-0.209*_	-0.152* _-0.116*_	_-0.022**_ -
car = negative effects	-	-	-	-	-	-	-	-	-
public transport = comfortable	-	-	-	-	-	-	-	-	-
public transport = positive effects	-	-	-	-	-	-	-	-	-
public transport = time-saving	-	-	-	-	-	-	-	-	-
bike/on foot = comfortable	-	-	-	-	-	-	-	-	-
bike/on foot = positive effects	-0.138* _-0.137*_	-	-	-	-	-	-	-	-
Car availability	0.624* _0.606*_	0.259* _0.253*_	0.598* _0.567*_	-0.489* _-0.488*_	-0.499* _-0.499*_	-0.555* _-0.555*_	-0.308* _-0.295*_	-0.266* _-0.264*_	-0.164* _-0.160*_
R^2	***62.2%***	***22.3%***	***80.5%***	***23.8%***	***62.3%***	***49.6%***	***29.6%***	***18.3%***	***49.7%***

Note: direct effects shown in italics, - = direct effect estimated but found insignificant and therefore constrained to zero, * significant at α = 0.01, ** significant at α = 0.05

Table 8 – Standardized direct and total effects on travel (mode) attitudes

	Travel attitudes			**Car attitudes**		**Public transport attitudes**			**Cycling and walking attitudes**	
	Frustrated traveller	Pro-environment	Frequent car user	Comfortable	Negative effects	Comfortable	Positive effects	Time-saving	Comfortable	Positive effects
Car use for AL	-0.001*		0.003*	0.115*		-0.002*	-0.002*	-0.001*	-0.002*	-0.001*
	-	-	-	_0.114*_	-	-	-	-	-	-
Car use for FV	-0.005*	-0.158*	0.135*	0.245*	-0.025*	-0.006*	-0.028*	-0.003*	-0.013*	-0.041*
	-	_-0.154*_	_0.121*_	_0.187*_	-	-	-	-	-	-
Car use for FS	-0.005*	-0.183*	0.011*	0.242*	-0.021*	-0.006*	-0.031*	-0.003*	-0.006*	-0.038*
	-	_-0.173*_	-	_0.178*_	-	-	-	-	-	-
Public transport for AL										
	-	-	-	-	-	-	-	-	-	-
Public transport for FV										
	-	-	-	-	-	-	-	-	-	-
Public transport for FS						0.174*				
	-	-	-	-	-	-	-	-	-	-
Cycling/walking for AL	0.003*	0.207*	-0.172*	-0.069*	0.037*	0.004*	0.033*	0.002*	0.014*	0.050*
	-	_0.200*_	_-0.158*_	-	-	-	-	-	-	-
Cycling/walking for FV										
	-	-	-	-	-	-	-	-	-	-
Cycling/walking for FS	0.003*	0.196*	-0.137*	-0.067*	0.022*	0.004*	0.031*	0.002*	0.011*	0.174*
	-	_0.191*_	_-0.127*_	-	-	-	-	-	-	_0.123*_

direct effects shown in italics, - = direct effect estimated but found insignificant
* significant at α = 0.01, ** significant at α = 0.05

5. CONCLUSIONS

This paper aimed at contributing to the research on the link between the built environment and travel behaviour by evaluating the objective and subjective influences on modal choice for leisure trips. Moreover, our analysis also accounts for complex interrelations due to issues such as residential and travel-related self-selection. The dataset we used, stemming from an 2007 Internet survey on personal attitudes, preferences and lifestyles, allowed us to include subjective influences on each level of the hypothesized model. Doing so, our analysis results are controlled for the influence of subjective personal characteristics (i.e., lifestyles), subjective attitudes toward the built environment (i.e., residential attitudes), and subjective attitudes toward mobility and travel (i.e., general travel attitudes and specific travel mode attitudes). Our findings suggest that modal choice is more a question of car use versus use of car alternatives (public transport, walking/cycling) rather than the assessment of individual (car, walking/cycling) versus public transport or motorized (car, public transport) versus non-motorized (walking/cycling) transport.

Based on our results, it is hard to say which one is more important: objective variables or subjective variables. For example, car use and public transport use are considerably influenced by stage of life. However, a traditional family lifestyle is strongly associated with car use for active leisure activities and, thus, the influence of lifestyles cannot always be ignored. Another example is the assessment of the influence of objective and subjective spatial characteristics. At first sight, the built environment seems to influence modal choices to a larger extent than residential attitudes. However, residential attitudes have an important influence on selecting the spatial characteristics of the built environment in the first place (i.e. the residential location decision), supporting the need to account for residential self-selection in assessing the impacts of the built environment on modal choice. A last example refers to objective and subjective travel aspects. Car availability seems to be a major influence on modal choice, but our results indicate that travel attitudes and travel mode attitudes should be accounted for as well. This refers to a second type of self-selection with respect to travel. We suppose it is more accurate to say that modal choice can be explained properly only by a mix of objective and subjective variables.

The explained variance values of some models are quite high, especially for the models explaining car use for active leisure activities and fun shopping. Other models indicate that improvement is still possible. For further research, one should keep in mind that our analysis focuses on the individual and his or her modal choice for leisure trips. We did not take into account the interactions among individuals. This might become important, especially for leisure trips since leisure activities are often jointly performed with other individuals. Consequently, it seems appropriate to analyze the individual's travel behaviour within a broader (social) context.

Based on our findings some policy implications might be formulated as well. The results suggest that objective spatial characteristics remain important in the discussion on the link between the built environment and daily modal choices. Spatial planning can contribute to a more sustainable mobility by means of (i) densifying, (ii) fostering residential developments close to town and city centres, and (iii) providing facilities at neighbourhood-level. However, our results also point out that these suggested spatial planning policies might only be successful for a specific group of respondents. Non-traditional lifestyles and people with a positive attitude toward having access would possibly prefer to reside in such urban neighbourhoods. The suggested spatial planning policies seem likely to be unsuccessful for active and family-oriented lifestyles groups and people with a positive attitude toward open space and quietness, who prefer a suburban or rural neighbourhood. These neighbourhoods are generally associated with more car use and less use of car alternatives. However, there still exist some possibilities to reduce car use, especially by means of transport planning. Our results suggest that car use is influenced by a positive attitude toward cars. Transport planning policies should focus on improving the image of travelling by public transport or cycling and walking. This can be done by underlining their positive effects for the environment and, especially for cycling and walking, their relaxing (and physical health) effects. After all, these two aspects were found to be associated with a positive attitude toward public transport use and cycling and walking. Consequently, an integration of spatial planning and transport planning seems useful. Moreover, policy should not only focus on designing and developing objective plans (e.g., a more sustainable lay-out of residential neighbourhoods), but should also be aware of their subjective implications (e.g., image building of travel modes).

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