Introducing the lifestyle concept in travel behaviour research

Van Acker, V. & Witlox, F.

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Veronique Van Acker
Ghent University, Department of Geography
veronique.vanacker@ugent.be

Frank Witlox
Ghent University, Department of Geography
frank.witlox@ugent.be

Abstract

This paper considers the complex relationships between different lifestyles, the built environment, stage in life, car availability and travel behaviour by means of structural equation modelling. The analyses are based on 2007 data from an Internet survey in Flanders, Belgium. The sample is overrepresented by highly-educated respondents, but different travel patterns can still be found within this homogenous group. This is (partly) due to lifestyles. While controlling for residential self-selection and mediating variables such as car availability, the results indicate that lifestyles significantly influence modal choice for shopping trips, social visits and leisure trips. The built environment also has the expected effect on modal choice: car use is lower among respondents living in neighbourhoods closely located to a local or regional centre, with high density and good local accessibility. The influence of lifestyle on modal choice is, however, not always that strong compared to the influence of other variables. Especially modal choice for shopping trips is more influenced by the built environment than by lifestyles.

KEYWORDS: lifestyle, built environment, travel behaviour, structural equation modelling, Flanders

1 Introduction

Although sometimes people travel just 'for fun' (e.g., Mokhtarian, 2001; Mokhtarian and Salomon, 2001), they mainly travel in order to access desired activities in other locations. Hence, travel is generally considered as a derived demand. After all, activities such as living, working, shopping and recreating are in most cases spatially separated. Therefore, it seems commonsensical that the travel behaviour of individuals and households will alter by changing the location of these activities and the design characteristics of these locations. This suggests a strong relationship between the built environment and travel behaviour. Many studies try to model and measure this relationship while controlling for socio-economic and socio-demographic differences among individuals and households. However, different travel patterns can still be found within similar neighbourhoods or within similar socio-economic homogenous population groups. This is (partly) due to personal lifestyles. The impact of lifestyle has certainly increased. During the last decennia, prosperity increased, resulting in more available possibilities to choose from. Moreover, the social burden to behave uniformly disappeared because of increasing individualization and decreasing social control. These processes resulted in that people lead different personal lifestyles (Ferge, 1972; Bootsma et al., 1993). Consequently, taking lifestyles into account in addition to the traditionally used variables in travel modelling provides interesting insights in explaining the connection between the built environment and travel behaviour.

Despite its frequent colloquial use, a distinct lifestyle theory is hard to find. Lifestyle is elaborated pragmatically, rather than theoretically. Especially marketing studies (e.g., Mitchell, 1983) use the concept of lifestyle in order to retrieve market sectors. These studies generally cluster analyze numerous data. Each cluster is then referred to as another lifestyle. Because a sound theoretical basis is lacking and results are data-dependent, each study "finds" new lifestyles. This pragmatic approach is criticized by Sobel (1983) among others. Nevertheless, some theoretical contributions to the lifestyle concept are made by Weber (1972), Bourdieu (1984) and Ganzeboom (1988). They agree on the communicative character of lifestyles: the individual elucidate his or her social position through specific patterns of behaviour. However, lifestyles include more than observable patterns of behaviour. According to Ganzeboom (1988), lifestyles also refer to opinions and motivations, including beliefs, interests and attitudes. This may confound our understanding of the lifestyle concept. For that reason, Munters (1992) distinguished lifestyles from lifestyle expressions. He considered lifestyles as the individual's opinions and motivations, or orientations. Mainly work orientation, leisure orientation and household/family orientation define lifestyles (Salomon and Ben-Akiva, 1983; Bootsma et al., 1993). Consequently, lifestyles are internal to the individual and, thus, are unobservable. A lifestyle, then, manifests itself in observable patterns of behaviour, or lifestyle expressions. In this way, observable patterns of behaviour (i.e., lifestyle expressions) are explained by underlying opinions and orientations (i.e., lifestyles). Current travel behaviour surveys can be used to analyze travel behaviour as the derivate of activity behaviour, but these surveys generally lack information on lifestyles. Therefore, we conducted an Internet survey between May 2007 and October 2007 which primarily aimed at how different lifestyles interact with travel behaviour, the results of which are described in this paper.

The paper is structured as follows. Section 2 reviews the literature on the relationship between lifestyles, the built environment and travel behaviour. Section 3 discusses the methodology, the Internet survey and some basic concepts in the empirical data. Results are presented in Section 4 and, finally, our major conclusions are drawn in Section 5.

2 Literature review

Many studies focus on the relation between the built environment and travel behaviour. As a consequence, an enormous variety of variables have been taken into consideration. By summarizing some of the relevant literature, this section discusses several major research questions which are at central stage in the debate on the relation between the built environment and travel behaviour (for more comprehensive reviews, see, e.g., Stead and Marshall, 2001; van Wee, 2002; Handy, 2005; Van Acker and Witlox, 2005).

2.1 The built environment and travel behaviour: basic conceptual model

While controlling for socio-economic and socio-demographic factors such as gender, household income and car ownership, empirical studies use various factors to characterize the built environment. Frequently used factors are, among others, density, diversity, design and accessibility.

The effects of density on travel demand have long been acknowledged (e.g., Levinson and Wynn, 1963) and remain well-studied and understood. Higher spatial densities are associated with lower car ownership and more public transport use, less car use, and more walking and cycling. After all, in high-density areas public transport is organized more efficiently (more routes, higher frequency of services) and car users face higher levels of road congestion. Also, travel distance and time are negatively associated with increasing spatial density (Cervero and Kockelman, 1997; Kitamura et al., 1997; Stead, 2001; Dargay and Hanly, 2004; Schwanen et al., 2004).

A second issue is diversity. Several indicators have been developed to measure diversity: among others, a jobs/housing ratio (Ewing et al., 1994; Boarnet and Sarmiento, 1998), an entropy index to quantify the degree of balance across various land use types (Frank and Pivo, 1994; Kockelman, 1997) or a (dis)similarity index to indicate the degree to which different land uses lie within a person's surrounding (Kockelman, 1997). The effects of more diversity on car ownership and (car) travel behaviour are comparable to the effects of higher densities.

A third dimension is spatial design. Design can be characterized by a general classification of neighbourhoods with a standard suburban neighbourhood and a neo-traditional neighbourhood as extremes (McNally and Kulkarni, 1997; Gorham, 2002). Standard suburban neighbourhoods are characterized by low densities, limited diversity, and a car-orientated design. As a consequence, these neighbourhoods are associated with more cars per capita and more car use. Spatial design however also relates to site design, and dwelling and street characteristics. Neighbourhoods characterized by small block sizes, a complete sidewalk system, the absence of cul-de-sacs and limited residential parking tend to encourage walking and cycling (Cervero and Kockleman, 1997; Hess et al., 1999; Stead, 2001). Meurs and Haaijer (2001) noted that, although characteristics of the dwelling, street, and neighbourhood may influence modal choice, this is only true for shopping and social or recreational purposes. Working trips are less likely to be influenced by spatial design characteristics.

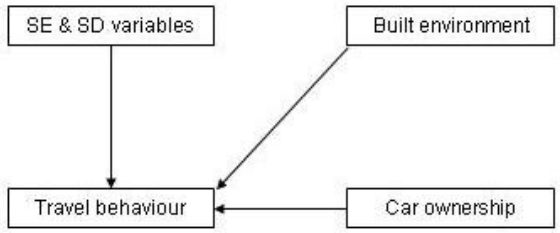
Accessibility is a fourth important characteristic of the built environment which is generally referred to as the ability "to reach activities or locations by means of a (combination of) travel mode(s)" (Geurs and van Wee, 2004). Most studies pointed out that accessibility is negatively associated with car ownership (e.g., Kockelman, 1997; Simma and Axhausen, 2003; Chen et al., 2008; Gao et al., 2008). Rajamani et al. (2003) found that higher accessibility by a given mode is likely to result in higher

usage of that mode. For example, households living in neighbourhoods that are easily accessible by public transport tend to make more trips by public transport (Kitamura et al., 1997). Similarly, individuals that have several facilities and services such as a shops, banks, schools and doctors within walking distance of their residence undertake more walk trips and less car trips (Simma and Axhausen, 2003). However, some confounding results exist related to the influence of accessibility by car on car use. Some studies (e.g., Rajamani et al., 2003) found that better accessibility by car results in more car use, whereas other studies state the opposite (e.g., Kockelman, 1997; Gao et al., 2008).

In sum, there seems to be a lot of literature confirming the relationship between the built environment and travel behaviour. Kockelman (1997) stressed that, after demographic characteristics were controlled for, the built environment has an important influence on travel behaviour. Similar conclusions have been made by, e.g., Dargay and Hanly (2004) and Zhang (2004). Meurs and Haaijer (2001) refined these findings. According to their analyses the built environment has a significant influence on non-work travel, whereas work travel is largely or almost entirely determined by personal characteristics. Dieleman et al. (2002) found an equal influence of the built environment and personal characteristics. On the other hand, several other studies point out that the built environment has only a moderate effect on travel behaviour (e.g., Cervero and Kockelman, 1997; Stead, 2001; Simma and Axhausen, 2003; Schwanen et al., 2004).

Figure 1 symbolizes the use of a regression analysis in order to explain travel behaviour by various spatial variables, socio-economic (SE) and socio-demographic (SD) variables and car ownership. This is a commonly used approach to study the relationship between the built environment and travel behaviour. However, some of these independent variables might influence each other as well. For example, car ownership can be considered as a mediating variable and results should be controlled for the effect of residential self-selection.

Figure 1: Basic conceptual model



2.2 The built environment and travel behaviour: necessary extensions

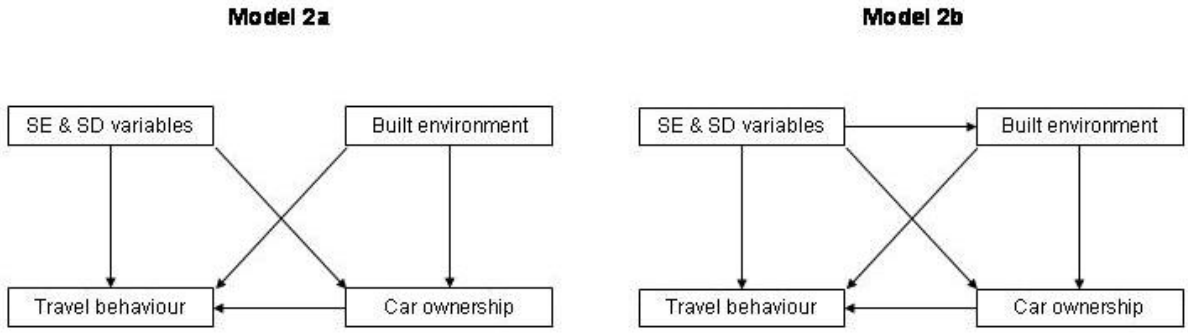
Figure 2 illustrates some necessary extensions of the basic conceptual model. Several studies use car ownership as an independent variable in order to explain travel behaviour. Car use seems higher among households owning several cars than among household without a car (Dieleman et al., 2002). Moreover, owning a car enables people to travel longer distances compared to people that must rely on slower modes such as public transport, walking and biking (Bagley and Mokhtarian, 2002; Schwanen et al., 2002; Krizek, 2003;). On the other hand, car ownership in itself is influenced by other socio-economic variables, especially income. Car ownership is generally higher among high-income groups (Kockelman, 1997; Dargay and Hanly, 2004; Soltani, 2005; Whelan, 2007).

Recently, some studies combine both approaches and consider car ownership as a variable that mediates the relationship between travel behaviour on one hand, and spatial, socio-economic and

socio-demographic variables on the other hand (Schimek, 1996; Simma and Axhausen, 2003; Cao et al., 2007; Scheiner and Holz-Rau, 2007). This is illustrated by Model 2a in Figure 2. Van Acker and Witlox (2009) pointed out that ignoring car ownership as a mediating variable results in a misspecification of the effects of the built environment. Spatial characteristics such as accessibility and distance to public transportation are mainly associated with car ownership. The effect of these characteristics on car use will therefore be overestimated if car ownership is not considered as a mediating variable. An underestimation of the effect of the built environment is also possible. Spatial characteristics such as density, diversity and distance to the CBD are more associated with car use than car ownership.

There is also a fundamental question of causation in any of the previously mentioned studies (Kockelman, 1997; Handy et al., 2005). Based on these studies, it seems that in certain circumstances the built environment may have a statistically significant influence on travel behaviour. However, statistical results can mask underlying linkages that are more important and of which the built environment characteristics are only a proxy. For example, most recently, there is a growing body of literature on the relationship between the built environment and personal characteristics (e.g., Bagley and Mokhtarian, 2002; Cao et al., 2006; Bhat and Guo, 2007; Pinjari et al., 2007). This research question refers to the issue of residential self-selection: people tend to self-select themselves into different residential neighbourhoods. In other words, people choose their residential neighbourhood according to their personal characteristics (e.g., income), attitudes and preferences. For example, people's residential location decision is based on their travel preferences, so that they are able to travel according to these preferences. Consequently, the relationship between the built environment and travel behaviour is more a matter of personal characteristics, attitudes and preferences. Moreover, this suggests that the influence of the built environment can not be exogenously determined from these personal characteristics. This is confirmed by Bagley and Mokhtarian (2002) and Cao et al. (2006): i.e. after controlling for residential self-selection, the built environment was found to have little effect on travel behaviour. However, Bhat and Guo (2007) and Pinjari et al. (2007) state the opposite. Model 2b in Figure 2 considers this issue.

Figure 2: Necessary extensions of the basic conceptual model



2.3 Introducing the lifestyle concept

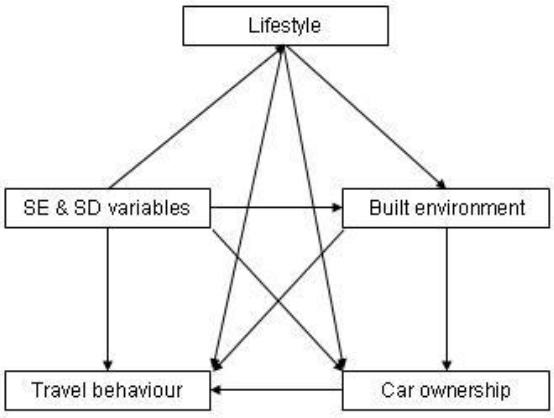
Although studies control their results for socio-economic and socio-demographic differences among respondents, van Wee (2002) and Mokhtarian and Cao (2008) note that different travel patterns still exists within socio-economic homogenous population groups. It remains possible that individuals with similar socio-economic and socio-demographic background travel in different ways. This is due to

among others personal lifestyles. Therefore, recently some studies focus on the influence of lifestyles on travel behaviour. This is illustrated by Figure 3.

We already mentioned that lifestyles refer to the individual's opinions and orientations toward general themes such as family, work and leisure. Bagley and Mokhtarian (2002) discussed the influence of lifestyles on travel demand. They used data from a 1993 survey carried out in five neighbourhoods in San Francisco. This survey included among others a list of more than 100 types of activities and interests. Respondents had to mark on what types of subjects they had read last month, how they spend their last weekend and what type of leisure activities they had done within the last year. These answers were factor analyzed into eleven lifestyle factors such as culture lover, hobbyist and family-oriented. A more adventurous lifestyle appeared to be associated with longer travel distances by car. Collantes and Mokharian (2007) used data from a similar 1998 survey in the same research area as Bagley and Mokhtarian (2002). This survey included among others 18 statements on work, family, money, status and time use. These statements were also factor analyzed into four lifestyle factors: frustrated, status seeker, workaholic and family-oriented. Individuals with a family-oriented lifestyle as well as individuals with a frustrated lifestyle indicated to frequently use their car for short-distance trips. A family-oriented lifestyle was also found to be associated with less long-distance leisure trips. Furthermore, they found that workaholics travel significantly less short-distance as well as long-distance trips for leisure purposes. Previously mentioned studies confirm the influence of lifestyles on travel behaviour. Scheiner (2006) and Scheiner and Holz-Rau (2007) refined these conclusions. They stated that travel behaviour is indeed influenced by lifestyles, but socio-economic characteristics of the respondents are more important.

Some empirical studies (e.g., Salomon and Ben-Akiva, 1983; Cooper et al., 2001; Hildebrand, 2003) analyze what they would call lifestyles, but in fact they combine various objective socio-economic and socio-demographic characteristics of the individual and the household. Consequently, these studies refer to stage of life or household composition rather than to lifestyles. Although a lifestyle is partly influenced by stage of life or household composition, lifestyle has a different meaning. Socio-economic and socio-demographic variables must, therefore, be separated from lifestyles. Consequently, Figure3 also distinguishes socio-economic and socio-demographic variables from lifestyles. This is the model we will take as a starting point of our analyses.

Figure 3: Introducing the lifestyle concept



3 Methodology and data

The brief literature review highlights the complex relationship between the built environment, travel behaviour and lifestyles. Various variables must be accounted for and, moreover, these variables can influence each other as well. A variable can be the outcome variable (or dependent variable) in one set of relationships and at the same time a predictor (or independent variable) in another equation. Structural equation modelling is a suitable methodological technique that is able to handle such complex relationships.

3.1 Structural equation modelling

Structural equation modelling is a research technique dating from the 1970s. Most applications have been in psychology, sociology, the biological sciences, educational research, political science and marketing research. It is only recently that a structural equation model (SEM) has been applied to understand the relationship between the built environment and (car) travel behaviour (e.g., Bagley and Mokhtarian, 2002; Chung et al., 2004; Cao et al., 2007; Van Acker et al., 2007).

Structural equation modelling can be considered as a combination of factor analysis and regression analysis. The factor analysis aspect in a SEM refers to the modelling of indirectly observed (or latent) variables of which the values are based on underlying manifest variables (or indicators) which are believed to represent the latent variable. The measurement model, therefore, defines the relationships between a latent variable and its indicators. However, since all variables in our data source are directly observed (manifest variables), our analysis is solely based on the regression analysis aspect of SEM. Therefore, our results are based on the estimation of a series of simultaneously estimated structural (i.e. regression) equations. Because a variable can be an independent variable in one equation but a dependent variable in another equation, we differentiate between 'endogenous' variables and 'exogenous' variables. Exogenous variables are not caused by any other variable in the model. Instead, exogenous variables influence other variables. Endogenous variables are influenced by exogenous variables, either directly or indirectly through other endogenous variables (Byrne, 2001; Kline, 2005; Raykov and Marcoulides, 2000). The relationships between exogenous and endogenous variables are represented by the structural model and are defined by the matrices (Hayduk, 1987; Oud and Folmer, 2008):

$$\boldsymbol{\eta} = \mathbf{B}\,\boldsymbol{\eta} + \boldsymbol{\Gamma}\,\boldsymbol{\xi} + \boldsymbol{\zeta} \qquad [1]$$

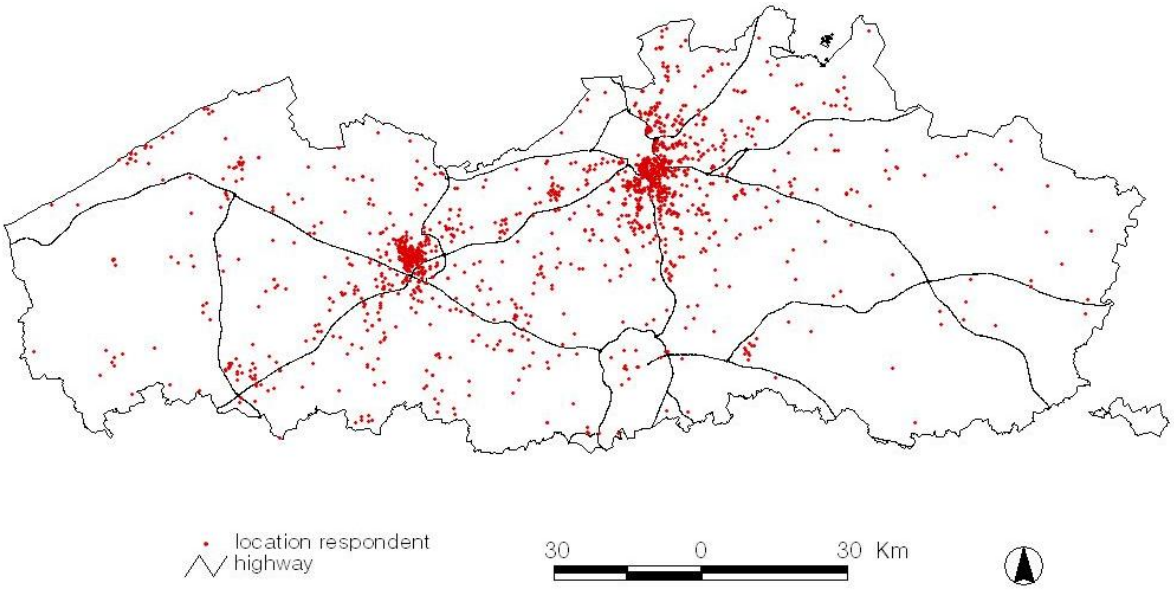
with $\boldsymbol{\eta}$ = L x 1 matrix of endogenous variables
$\boldsymbol{\xi}$ = K x 1 matrix of exogenous variables
$\mathbf{B}$ = L x L matrix of coefficients of the endogenous variables
$\boldsymbol{\Gamma}$ = K x K matrix of coefficients of the exogenous variables
$\boldsymbol{\zeta}$ = L x 1 matrix of residuals of the endogenous variables

The estimation of a SEM is (usually) based on matching the observed covariances among $\boldsymbol{\eta}$ and $\boldsymbol{\xi}$ with the model-based covariances. In this paper, we used the software package M-plus 4.21 because of its ability to model categorical endogenous variables.

3.2 Internet survey

Current travel behaviour surveys generally lack information on lifestyles. Therefore, we conducted an Internet survey on lifestyle and mobility between May 2007 and October 2007. In accordance to the definition of lifestyle, this survey included questions on leisure orientation and the assessment of the work-family balance. Initially, this survey was announced among students and staff members of the University of Antwerp and the Faculty of Sciences at Ghent University. Since this results in an overrepresentation of highly-educated respondents concentrated in the cities of Antwerp and Ghent (Flanders, Belgium), a second announcement was published in regional information magazines of several villages in the larger urban region of Ghent (Destelbergen, Gent, Lochristi, Merelbeke and Oosterzele). In total, 2.363 persons completed the survey of which 1.878 were retained after data-cleaning for further analyses. Figure 4 illustrates the residential location of these respondents. Despite our efforts to obtain a well-balance sample, highly-educated respondents are overrepresented in the sample: 66% has a degree of higher education or university education. Within this homogenous group of highly-educated respondents, one expects to find similar recurrent travel patterns.

Figure 4: Location of respondents in Flanders



3.3 Empirical data: key variables

Variables used in the analysis refer to the various model components of the model depicted in Figure 3. This section discusses how we measured these key variables.

3.3.1 The built environment

Using information of various land use and transportation databases, we calculated several spatial characteristics of the built environment of the respondent's residence. These characteristics include density measures (population density, job density, built-up density), diversity measures (jobs-housing balance, land use mix) and accessibility measures (potential accessibility by car on several time scales ranging from 5 minutes to 60 minutes). Design aspects could not be included in the analysis due to a lack of suitable data. The calculation of these spatial variables is discussed in detail in previous research (Van Acker and Witlox, 2009a, b). However, density, diversity and accessibility are often

related to each other. For example, city centres are generally characterized by high densities, high diversity as well as several opportunities accessible within a short time span. Density, diversity and accessible actually measure the same phenomenon so that they can be combined into one measure. In order to reveal the structure among these spatial variables, we performed a factor analysis (principal axis factoring, promax rotation) which revealed five factors: (i) location in relation to local centre, (ii) location in relation to a regional centre, (iii) local accessibility, (iv) regional accessibility, and (v) density. Surprisingly, diversity measures did not obtain a high loading on any of these five factors (see Appendix 1).

3.3.2 Socio-economic and socio-demographic variables

Out of various socio-economic and socio-demographic variables we extracted three factors related to stage in life (principal axis factoring, promax rotation). A first factor refers to students living at home and is determined by five variables (loadings in parentheses): presence of children in the household (0.946), number of older children in the household (0.938), household position as a child (0.739), highly educated (-0.390) and full-time employment (-0.320). A second factor is determined by six variables: age (0.558), household income (0.446), full-time employment (0.444), household position as a child (-0.321), highly educated (0.273), presence of children in the household (0.242). This indicates an older family with employed adults. A third factor refers to a young family and is characterized by the number of young children in the household (0.937), the presence of children in the household (0.361), and the number of older children in the household (-0.271). Other socio-economic and socio-demographic variables such as gender were excluded from the analysis because the results of the factor analysis were unsatisfactory. However, gender will be included in the structural equation models as a separate variable.

3.3.3 Car availability

Our Internet survey provided information on not only car ownership and possession of a driving license, two traditionally used variables in travel behaviour research, but also on the possession of a public transport pass and the temporarily availability of a car. Since all four variables might be related to each other, we performed a factor analysis (principal axis factoring, 31.36% explained variance) in order to construct one general factor related to car availability. This factor is characterized by: permanent car availability (0.940), possession of a driving license (0.385), number of cars in the household (0.381), possession of a public transport pass (-0.278).

3.3.4 Lifestyles

Lifestyles are derived from a second-order factor analysis (principal axis factoring, promax rotation) based on 135 variables on leisure orientation. Other variables on the assessment of the work-family balance were excluded from the analysis since the results were unsatisfactory (no distinct factors could be obtained). First, we determined those factors related to the various dimensions of leisure orientation: (i) holidays, (ii) literary interests, and (iii) leisure activities. Table 1 summarizes these first-order factors (for more information on factor loadings, see Appendix 2). Since similar aspects occur (e.g., family-oriented, culture lover), a second factor analysis was performed on the factors from the first analysis. This resulted in the final lifestyle factors (see Table 2).

Tabel 1: Factors regarding holidays, literature, leisure and work-family balance

Holidays (hol)	Literature (lit)	Leisure (leis)
hol 1: low-budget, active and adventurous	lit 1: pro-housing, cocooning	leis 1: traditional family activities
hol 2: frequent traveller with second place	lit 2: fantasy world, fiction	leis 2: sports
hol 3: self-organized, family-oriented	lit 3: style and trends	leis 3: social nest-builder, social cocooning
hol 4: all-in-one	lit 4: culture and current events	leis 4: socially engaged
hol 5: culture lover	lit 5: non-emotional, non-fiction	leis 5: culture lover
hol 6: close to home and unadventurous		leis 6: party people
		leis 7: creative

Table 2: Final lifestyle factors

	LOADING
Factor 1: culture lover	
leis 4: socially engaged	0.843
lit 4: culture and current events	0.444
hol 5: culture lover	0.423
lit 5: non-emotional readers	-0.305
Factor 2: friends and trends	
leis 6: party people	0.937
lit 3: style and trends	0.262
leis 1: traditional family activities	-0.246
Factor 3: active family, outside oriented	
leis 2: sports	0.741
lit 1: pro-housing, cocooning	0.628
hol 3: self-organized, family-oriented	0.253
Factor 4: low budget and active/creative	
leis 7: creative	0.922
lit 5: non-emotional, non-fiction	0.289
hol 1: low-budget, active and adventurous	0.246
Factor 5: traditional family, home oriented	
leis 1: traditional family activities	0.607
lit 3: style and trends	0.598
hol 4: all-in-one	0.444
hol 2: frequent traveller with second place	-0.200

3.3.5 Travel behaviour

Travel behaviour (in this analysis: modal choice) is the final outcome variable in our structural equation models. In our Internet survey we asked respondents what kind of leisure trips they performed on a monthly basis and which travel mode they generally use for this. In what follows, we present the results of nine structural equation models. For each travel purpose (shopping trips, social visits, and leisure trips), we performed three analyses of modal choice (one for bike/on foot, one for car use and one for public transportation). In each of these models, modal choice is a binary variable.

4 Results

Prior to discussing the modelling results, we consider several model specification issues. Our final outcome variable modal choice is categorical and this imposes some limitations to the analysis. The maximum likelihood (ML) method is a generally used estimating procedure, but it assumes a multivariate normal distribution of all continuous endogenous variables in the model (Kline, 2005, p. 112). Our models do not fulfil this assumption and, therefore, we use the alternative mean- and variance-adjusted weighted least square parameter estimator (WLSMV). WLSMV is a robust estimator that does not require extensive computations and enormously larger sample sizes (Muthén, 1983; Satorra, 1992; Yu and Bentler, 2000).

Models in Figures 1 to 3 are hierarchically nested into each other so that we can determine which of the four models best fits our data by performing a χ^2 difference test. For each of the nine structural equation models, we found that the model depicted in Figure 3 is an improvement over all three other models. While controlling for the mediating nature of car availability and residential self-selection, including lifestyles in travel behaviour research adds explanatory power to the models. Tables 3 to 5 report the results of the estimation of the model in Figure 3 for shopping trips, social visits and leisure trips.

All structural equation models are also controlled for the effect of outliers. Outliers were determined by calculating 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. These outlier scores were plotted against the scores for modal choice. Next, we removed five outliers at a time and observed the changes in modal fit and individual parameter estimates. The model fit did not change considerably in none of the nine structural equation models. However, some individual parameter estimates became insignificant. Nevertheless, we retained all outliers since those outliers have interesting characteristics for our analysis. Those outliers generally refer to respondents with a pronounced lifestyles or to respondents living in an interesting neighbourhood (especially highly accessible neighbourhoods at a short time span and neighbourhoods distant from a regional city centre).

We also have to note that only those variables with a significant direct influence on modal choice are retained in our structural equation models. Insignificant direct influences were constrained to be zero. For example, regional accessibility turned out to be insignificant in all structural equation models and is excluded from our analyses. Nevertheless, some insignificant total effects are still reported in Tables 3 to 5. This is because of the interaction among variables. For example, we assume that stage in life not only has a direct effect on modal choice, but also an indirect effect caused by the interaction between stage in life, residential location, car availability and modal choice. This indirect effect might be insignificant resulting in an insignificant total effect which is the sum of the direct and indirect effect. Tables 3 to 5 report unstandardized as well as standardized coefficients. The direction (positive or negative) and the significance of the modelled relationships are represented by the unstandardized coefficient, whereas the standardized coefficients illustrate the strength of these relationships. Tables 3 to 5 also mention several modal fit indices. Cut-off values indicating good modal fit are: χ^2 with p-value > 0.05, RMSEA < 0.05, WRMR < 1.000, CFI > 0.90 and TLI > 0.90 (Hu and Bentler, 1999; Yu, 1999; Byrne, 2001; Kline, 2005). All nine structural equation models have a good model fit.

4.1 Modal choice for shopping trips

Table 3: Total effects on modal choice for shopping trips

	Car 38.7% explained variance	**Bicycle / On foot** 38.2% explained variance	**Public transportation** 29.5% explained variance
Lifestyles			
culture lover	-0.0268* (-0.241)	0.094* (0.086)	0.022* (0.019)
friends & trends	0.006 (0.006)	-0.124* (-0.129)	-0.015* (-0.016)
active family	0.218* (0.196)	-0.076* (-0.069)	-0.017* (-0.015)
low budget & active	-0.019* (-0.017)	0.110* (0.104)	0.014* (0.013)
traditional family	-0.014* (-0.011)	0.018* (0.014)	0.203* (0.160)
Built environment			
location to local centre	0.267* (0.323)	-0.363* (-0.445)	-0.016* (-0.020)
location to regional centre	0.267* (0.321)	-0.493* (-0.599)	-0.031* (-0.036)
density	-0.280* (-0.347)	0.445* (0.557)	0.031* (0.038)
local accessibility	-0.029* (-0.041)	0.189* (0.267)	0.107* (0.148)
Stage in life			
student living at home	-0.024 (-0.025)	-0.144** (-0.155)	0.347* (0.361)
older family, working	0.141* (0.138)	0.020 (0.020)	-0.330* (-0.318)
young family	0.100* (0.095)	-0.033* (-0.032)	-0.216* (-0.203)
Gender (female)	-0.347* (0.158)	-0.026 (-0.012)	0.492* (0.221)
Car availability	0.382* (0.344)	-0.094* (-0.092)	-0.288* (-0.255)
Modal fit:			
Chi^2	Chi^2 = 53.246, df = 41, p = 0.0952	Chi^2 = 53.295, df = 42, p = 0.1136	Chi^2 = 54.115, df = 42, p = 0.0996
CFI	0.979	0.980	0.979
TLI	0.975	0.977	0.976
RMSEA	0.022	0.021	0.022
WRMR	0.935	0.930	0.935

* = significant at $\alpha = 0.05$, ** = significant at $\alpha = 0.10$
standardized effects mentioned between parentheses

We already mentioned that a χ^2 difference test confirmed the importance of lifestyles in travel behaviour research. Table 3 reports how these lifestyles are associated with modal choice for shopping trips. These shopping trips do not include shopping for daily groceries, but rather "shopping-for-fun". According to our data, car use is higher among respondents with a friends and trends-lifestyle or an active family-lifestyle. Both lifestyle categories include a more active lifestyle: friends and trends is more orientated towards performing social activities (e.g., going out with friends, visiting family), whereas active family is involved in sports. The other lifestyles (culture-lover, low budget and active, traditional family) are associated with more cycling and walking, and public transportation. For some lifestyles this seems obvious. For example, cycling and walking, and the usage of public transportation fit well within a low budget lifestyle.

The built environment has the expected effect: car use is higher for respondents living in distantly located, less dense and less accessible neighbourhoods. The opposite holds for cycling and walking, and public transportation. Stage in life is also significantly associated with modal choice for shopping trips. Young families as well as older families tend to use the car for shopping. Students living at home seem to travel more often by public transportation than any other travel mode. This is also true for females. As expected, high car availability is positively associated with car use and negatively associated with other travel modes.

Based on the standardized total effects (reported between parentheses in Table 3), we can determine the strength of the previously discussed relationships. Although lifestyles have a significant influence on modal choice for shopping trips, this is rather a weak relationship compared to other variables. Car use, and especially cycling and walking, are influenced to a large extent by the built environment. This is however not the case for public transportation. The usage of public transportation is mainly influenced by stage in life, gender and car availability.

4.2 Modal choice for social visits

Table 4: Total effects on modal choice for social visits

	Car 33.1% explained variance	**Bicycle / On foot** 10.2% explained variance	**Public transportation** 42.6% explained variance
Lifestyles			
culture lover	-0.071* (-0.066)	0.014* (0.013)	0.084* (0.078)
friends & trends	0.029* (0.029)	-0.116* (-0.114)	0.066 (0.065)
active family	0.139* (0.128)	-0.004* (-0.004)	-0.163* (-0.150)
low budget & active	-0.033* (-0.031)	0.152* (0.143)	0.027* (0.026)
traditional family	0.146* (0.121)	0.001* (0.001)	0.022* (0.018)
Built environment			
location to local centre	0.038* (0.044)	-0.011* (-0.013)	-0.032* (-0.037)
location to regional centre	0.070* (0.085)	-0.020* (-0.024)	-0.163* (-0.196)
density	-0.179* (0.223)	0.020* (0.025)	0.274* (0.343)
local accessibility	-0.050* (-0.073)	0.014* (0.021)	0.042* (0.061)
Stage in life			
student living at home	-0.102* (-0.107)	0.217* (0.229)	-0.128* (-0.136)
older family, working	0.216* (0.212)	-0.079* (-0.077)	-0.241* (-0.236)
young family	0.229* (0.245)	-0.033* (-0.036)	-0.111* (-0.119)
Gender (female)	0.081* (0.040)	-0.087* (-0.042)	0.013 (0.006)
Car availability	0.664* (0.499)	-0.187* (-0.174)	-0.554** (-0.488)
Modal fit:			
Chi^2	Chi^2 = 43.749, df = 47, p = 0.6080	Chi^2 = 46.400, df = 49, p = 0.5791	Chi^2 = 44.902, df = 46, p = 0.5182
CFI	1.000	1.000	1.000
TLI	1.004	1.003	1.001
RMSEA	0.000	0.000	0.000
WRMR	0.799	0.814	0.811

* = significant at $\alpha = 0.05$, ** = significant at $\alpha = 0.10$
standardized effects mentioned between parentheses

Table 4 summarizes the modelling results for modal choice for social visits. In this analysis, social visits include visiting other family members. The effect of lifestyles on cycling and walking for social visits is similar to shopping trips: the usage of active travel modes is associated with a culture lover-lifestyle, a low budget and active-lifestyle, and a traditional family-lifestyle. For other modal choices, the effect of lifestyles is somewhat different compared to shopping trips. Additional lifestyles are positively associated with car use and the usage of public transportation for social visits: car use is also associated with a traditional family-lifestyle and usage of public transportation with a friends and trends-orientated lifestyle.

The built environment has a similar effect on modal choice for social visits compared to shopping trips: neighbourhoods close to a local or regional centre, with high density and high local accessibility are associated with more cycling and walking, and more public transportation. Modal choice for social visits is also significantly influenced by stage in life. Students living at home tend to travel by bike or

on foot, whereas car use is positively associated with young and older families. All stage in life-categories are negatively associated with public transportation. Whereas females tend to use only public transportation for shopping trips, they seem to use the car as well for social visits. Similar to shopping trips, high car availability appears to result in more car use, and less public transportation and less cycling and walking.

The standardized coefficients reveal that the built environment does not have a strong effect on modal choice for social visits (contrary to the previous model of modal choice for shopping trips). Only density has a considerable effect, and specifically on car use and usage of public transportation (not on cycling and walking). Other variables are of greater interest. For example, car use and public transportation are mainly determined by car availability. Once again, the effect of lifestyles on modal choice is rather weak. However, cycling and walking is to a certain extent influenced by some lifestyles. The extent of a friends and trends-lifestyle ($\beta = -0.114$) and a low budget and active-lifestyle ($\beta = 0.143$) is similar to the one of car availability ($\beta = -0.174$).

4.3 Modal choice for leisure trips

Table 5: Total effects on modal choice for leisure trips

	Car 23.4% explained variance	**Bicycle / On foot** 16.5% explained variance	**Public transportation** 12.7% explained variance
Lifestyles			
culture lover	-0.208* (-0.192)	0.137* (0.126)	0.202* (0.186)
friends & trends	0.146* (0.148)	-0.005 (-0.005)	-0.187* (-0.189)
active family	0.017* (0.014)	-0.016* (-0.013)	0.087 (0.070)
low budget & active	-0.019* (-0.018)	0.110* (0.108)	0.009* (0.009)
traditional family	0.214* (0.175)	-0.117** (-0.096)	0.015** (0.012)
Built environment			
location to local centre	0.022* (0.025)	-0.098* (-0.114)	-0.011* (-0.013)
location to regional centre	0.113* (0.133)	-0.154* (-0.180)	-0.020* (-0.024)
density	-0.117* (-0.144)	0.120* (0.148)	0.127* (0.157)
local accessibility	-0.029* (-0.041)	0.015* (0.022)	0.109* (0.153)
Stage in life			
student living at home	0.040 (0.044)	-0.017 (-0.018)	0.099 (0.107)
older family, working	0.189* (0.186)	-0.181* (-0.178)	-0.232* (-0.228)
young family	0.118* (0.111)	-0.039* (-0.036)	-0.178* (-0.167)
Gender (female)	0.032 (0.016)	-0.069 (-0.034)	0.102* (0.051)
Car availability	0.380* (0.336)	-0.203* (-0.193)	-0.192* (-0.173)
Modal fit			
Chi^2	$Chi^2 = 39.750$, df = 50, p = 0.8501	$Chi^2 = 37.698$, df = 50, p = 0.8980	$Chi^2 = 37.566$, df = 50, p = 0.9026
CFI	1.000	1.000	1.000
TLI	1.017	1.020	1.021
RMSEA	0.000	0.000	0.000
WRMR	0.728	0.709	0.709

* = significant at $\alpha = 0.05$, ** = significant at $\alpha = 0.10$
standardized effects mentioned between parentheses

We categorized all trips for purposes to actively participate in sports or cultural activities as leisure trips. Table 5 presents the total effects on modal choice for these leisure trips. Active lifestyles and family-orientated lifestyles seem to result in more car use for leisure trips. Comparable to modal choice for social visits, car use for leisure trips is positively influenced by a friends and trends-lifestyle, an active family-lifestyle and a traditional family-lifestyle. Culture lovers and respondents

with a low budget but active lifestyle tend to use public transportation or to cycle or walk for leisure trips. Public transportation is also associated with a traditional family-lifestyle.

The effect of the built environment on modal choice for leisure trips is similar to the previous models. Residing in traditional neighbourhoods characterized by a short distance to a local or regional centre, high densities and many accessible opportunities within a small time span favours the use of alternative travel modes to car use. Stage in life obtains somewhat different results than in previous models. Whereas older and young families tend to prefer their car for leisure trips instead of cycling and walking or public transport, students living at home are not significantly related to any of these travel modes. Gender has only a significant effect on public transport usage: females seem to use public transportation for leisure trips more often than men. Finally, car availability has a similar effect on modal choice for leisure trips than for shopping trips and social visits. If cars are available to a respondent, car use is likely to be higher, and public transportation usage as well as walking and cycling tends to be lower.

Based on the standardized coefficient, we find that car availability determines modal choice for leisure trips to a large extent, especially for car use. The effect of lifestyle has similar strength as other variables. For example, public transportation is influenced by a mix of lifestyles, spatial variables, stage in life-variables and car availability: older working family (-0.228), a friends and trends-lifestyle (-0.189), a culture lover-lifestyle (0.186), car availability (-0.173), young family (-0.167), density (0.157) and local accessibility (0.153).

5 Conclusions

This paper presented the results of nine structural equation models which represent the complex relationships between lifestyles, the built environment, stage in life, car availability and travel behaviour. Models were estimated based on data from an Internet survey on lifestyles and travel behaviour. Most respondents were highly educated, but different travel patterns still occurred within this homogenous group. Our results point out that differences in modal choice for shopping trips, social visits and leisure trips are due to personal lifestyles and the built environment.

Car use is mainly associated with an active lifestyle: the car is a flexible transport mode that enables respondents to easily combine and participate in many activities such as going out with friends (ref. friends and trends-lifestyle) or different sports and family activities (ref. active family-lifestyle). Public transportation and cycling and walking are more associated with a non-traditional lifestyle (e.g., culture lover-lifestyle) or a low budget lifestyle (e.g., low budget and active-lifestyle). Lifestyles can also be associated with the use of various travel modes. For example, a traditional family-lifestyle is not related with either car use or not. Instead respondents with a traditional family-lifestyle cycle and walk, use public transportation as well as their car. Thus important differences exist within socio-economic and socio-demographic homogenous groups. Therefore, transportation planning and policy should not focus on travel patterns by, e.g., gender, age and income groups.

On the other hand, the built environment still has an important influence on travel behaviour even when lifestyles are accounted for. Short distances between residences and local or regional centres, high densities and good local accessibility are associated with less car use and more cycling and walking as well as more public transportation usage. In order to encourage the use of car alternatives

spatial planning policies should focus on (i) residential developments connected to city centres and town centres, (ii) condensing, and (iii) the provision of opportunities close to the residence.

The suggested models can be applied to other travel behaviour aspects such as travel distance and trip chaining. Furthermore, the explained variance of modal choice in our models ranges from 10.2% to 42.6%. This indicates that our models could benefit from the inclusion of additional information, for example subjective aspects such as attitudes towards the built environment and travel modes. These specific attitudes are not included in the lifestyle concept which only includes attitudes toward general themes such as leisure orientation. Moreover, all components of the model illustrated in Figure 3 are concurrently and continually considered since our data is cross-sectional. However, lifestyles, stage in life and residential location can evolve over time. A longitudinal approach seems interesting in order to study the dynamics between all these components, but this requires data from a panel survey or a retrospective survey. Several venues thus exist for further research into the connection between lifestyles, the built environment and travel behaviour.

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Appendix 1: Factor loadings on factors related to the built environment

STATEMENT	LOADING
Factor 1: location in relation to local railway station and smaller cities	
Distance to station level regional, 1, 2, 3, 4	1.061
Distance to station level regional, 1, 2, 3, 4, 5	0.995
Distance to station level regional, 1, 2, 3	0.768
Distance to station level regional, 1, 2	0.443
Distance to city level 1, 2, 3, 4, 5	0.350
Factor 2: (urban) regional accessibility	
Potential accessibility 60 minutes	1.023
Potential accessibility 45 minutes	0.969
Distance to city level 1	-0.918
Potential accessibility 30 minutes	0.553
Distance to station level regional	-0.440
Distance to station level regional, 1	-0.314
Factor 3: density	
Population density	0.953
Built up index	0.718
Job density	0.532
Land use mix	-0.407
Potential accessibility 5 minutes	0.356
Factor 4: location in relation to regional railway station and regional cities	
Distance to city level 1, 2, 3	0.929
Distance to city level 1, 2, 3, 4	0.797
Distance to city level 1, 2	0.705
Distance to station level regional, 1	0.622
Distance to city level 1, 2, 3, 4, 5	0.515
Distance to station level regional, 1, 2	0.361
Distance to station level regional	0.356
Factor 5: local accessibility	
Potential accessibility 10 minutes	0.994
Potential accessibility 15 minutes	0.860
Potential accessibility 5 minutes	0.625
Potential accessibility 30 minutes	0.464

Appendix 2: Factor loadings on factors related to holidays, literature and leisure activities

STATEMENT ON HOLIDAYS	LOADING
Factor 1: Low budget, active/adventurous	
What type of accommodation? camping	0.742
What type of accommodation? hotel	-0.531
Who organizes the holiday? myself	0.486
What aspects are important? inexpensive, low-budget	0.425
How do you travel? by train	0.275
What aspects are important? luxury	-0.246
What aspects are important? nature	0.248
What aspects are important? adventure	0.221
Factor 2: frequent traveler, second home	
How many holidays lasted one week or longer?	0.818
How many times did you spend a holiday the last year?	0.766
What type of accommodation? second home	0.256
Factor 3: family-oriented or self-organized, independent traveler	
How do you travel? by car	0.686
What type of accommodation? rental house	0.389
How do you travel? by airplane	-0.290
How do you travel? by train	-0.277
What aspects are important? inexpensive, low-budget	-0.264
What aspects are important? nature	0.243
Factor 4: all-in-one	
What aspects are important? sunny	0.582
What aspects are important? relaxation	0.408
What aspects are important? good food	0.329
What aspects are important? sport accommodation	0.307
What aspects are important? luxury	0.273
What type of accommodation? resort, holiday village	0.229
Factor 5: culture lover	
What aspects are important? culture	0.437
What type of accommodation? local people	0.387
How do you travel? by airplane	0.341
What aspects are important? nature	0.328
What type of accommodation? hotel	0.240
What aspects are important? unfamiliar places/adventure	0.211
Factor 6: close to home and unadventurous	
What aspects are important? familiar places	0.340
What aspects are important? close to home	0.324
What aspects are important? no language problems	0.251
What aspects are important? unfamiliar places/adventure	-0.226
What aspects are important? inexpensive, low-budget	0.200

STATEMENT ON LITERARY INTEREST	LOADING
Factor 1: pro-housing, cocooning	
On what subjects do you read a book or magazine? Housing/decoration	0.581
On what subjects do you read a book or magazine? Gardening	0.558
On what subjects do you read a book or magazine? Do-it-yourself	0.481
On what subjects do you read a book or magazine? Cooking	0.380
On what subjects do you read a book or magazine? Health	0.338
On what subjects do you read a book or magazine? Environment, nature	0.286
On what subjects do you read a book or magazine? Pets	0.259
Factor 2: fantasy world, fiction	
On what subjects do you read a book or magazine? Thriller, adventure	0.549
On what subjects do you read a book or magazine? Fantasy, SF	0.427
On what subjects do you read a book or magazine? Horror	0.421
On what subjects do you read a book or magazine? Detective, crime story	0.400
On what subjects do you read a book or magazine? Humor, comedy	0.387
On what subjects do you read a book or magazine? Comic book, cartoon	0.356
Factor 3: style & trends ("women's magazines")	
On what subjects do you read a book or magazine? Women's magazine	0.582
On what subjects do you read a book or magazine? Fashion	0.528
On what subjects do you read a book or magazine? Entertainment, showbiz	0.365
On what subjects do you read a book or magazine? Science	-0.318
On what subjects do you read a book or magazine? Environment, nature	-0.294
On what subjects do you read a book or magazine? Humor, comedy	0.233
Factor 4: culture and current events	
On what subjects do you read a book or magazine? History	0.612
On what subjects do you read a book or magazine? Art, architecture	0.522
On what subjects do you read a book or magazine? Politics, news magazine	0.375
On what subjects do you read a book or magazine? Religion, spirituality	0.337
On what subjects do you read a book or magazine? Novel	0.232
Factor 5: non-emotional /non-fiction ("men's magazines")	
On what subjects do you read a book or magazine? Novel	-0.391
On what subjects do you read a book or magazine? Computer, ICT	0.331
On what subjects do you read a book or magazine? Sports	0.325
On what subjects do you read a book or magazine? Detective, crime story	-0.300
On what subjects do you read a book or magazine? Thriller, adventure	-0.288
On what subjects do you read a book or magazine? Humor, comedy	0.271
On what subjects do you read a book or magazine? Men's magazine	0.242
On what subjects do you read a book or magazine? Finances, business, trade	0.242

STATEMENT ON LEISURE ACTIVITIES	LOADING
Factor 1: traditional family activities	
What are your hobbies? Doing chores, do-it-yourself	0.670
What are your hobbies? Gardening	0.598
What leisure activities do you do? Gardening	0.560
What leisure activities do you do? Doing chores, do-it-yourself	0.555
What cultural activities do you often attend? Flee market	0.323
What leisure activities do you do? Constructing and repairing furniture	0.272
What sports do you often practice? Walking	0.260
What sports do you often practice? Cycling	0.253
What cultural activities do you often attend? Parade	0.239
What cultural activities do you often attend? Commodity exchange	0.214
Factor 2: sports	
What leisure activities do you do? Practicing sports	0.853
What are your hobbies? Practicing sports	0.846
What sports do you often practice? Jogging, running	0.391
What sports do you often practice? Soccer	0.271
What sports do you often practice? Badminton, (table) tennis, squash	0.271
Factor 3: social nest-builder, social cocooning	
What leisure activities do you do? Going to the movies, cinema	0.537
What leisure activities do you do? Staying at home and relaxing	0.506
What leisure activities do you do? Shopping	0.467
What leisure activities do you do? Watching TV, movies, DVD	0.464
What cultural activities do you often attend? Going to the movies, cinema	0.441
What leisure activities do you do? Going out for diner, to restaurant	0.362
What leisure activities do you do? Gardening	-0.342
What leisure activities do you do? Listening to the radio, to music	0.342
What leisure activities do you do? Visiting family and friends	0.298
What are your hobbies? Gardening	-0.283
What leisure activities do you do? Inviting family and friends	0.241
What leisure activities do you do? Cooking	0.216
Factor 4: socially engaged	
What leisure activities do you do? Volunteering, club/social life (e.g., scouting)	0.903
What are your hobbies? Volunteering, club/social life (e.g., scouting)	0.888
Are you member of a club? Yes	0.240
Factor 5: culture lover	
What cultural activities do you often attend? Museum, exhibition	0.526
What cultural activities do you often attend? Opera, musical	0.509
What cultural activities do you often attend? Concert	0.411
What are your hobbies? Reading	0.385
What cultural activities do you often attend? Library	0.350
What cultural activities do you often attend? Ballet, dance performance	0.285
What sports do you often practice? Walking	0.278
What are your hobbies? Playing theater	0.258
Factor 6: party people	
What leisure activities do you do? A night out in a disco or at a party	0.896
What cultural activities do you often attend? Party	0.617
What cultural activities do you often attend? Disco, club	0.569
Factor 7: creative	
What are your hobbies? Computer, web design	0.376
What are your hobbies? Playing music	0.356
What leisure activities do you do? Shopping	-0.258
What cultural activities do you often attend? Concert	0.251
What leisure activities do you do? Going out for diner, to restaurant	-0.250
What are your hobbies? Photography	0.244
What leisure activities do you do? Listening to the radio, to music	0.239
What leisure activities do you do? Cultural and creative activities (e.g., singing, …)	0.235
What leisure activities do you do? Cooking	-0.203