Travel mode choice: affected by objective or subjective determinants?

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Abstract

The contribution presents theoretical considerations concerning the connections between life situation, lifestyle, choice of residential location and travel behaviour, as well as empirical results of structural equation models. The analyses are based on data resulting from a survey in seven study areas in the region of Cologne. The results indicate that lifestyles influence mode choice, although just slightly, even when life situation is controlled for. The influence of life situation on mode choice exceeds the influence of lifestyle. The influence which lifestyle and in parts also life situation have on mode choice is primarily mediated by specific location attitudes and location decisions that influence mode choice, likewise. Here objective spatial conditions as well as subjective location attitudes are important.

key words: lifestyle, linear structural equation modeling, residential location choice, residential self-selection, travel behaviour, travel mode choice

1 Introduction

Since the 1970s the interdependencies between population structure, urban form and travel developed as a research field in spatial sciences and transport sciences (see Boarnet & Crane 2001, Ewing & Cervero 2001, Timmermans et al. 2003, Hickman & Banister 2005). This was based on the understanding that travel might, to a considerable degree, be explained by urban form. This insight gradually found its way into the traditionally 'spaceless' science of transport planning, along with the development of integrated spatial and transport planning. The aim was, among other things, to attain a more sustainable transport demand by implementing land use and urban form concepts (Marshall 1999 and other contributions in the same issue, Schwanen, Dijst & Dieleman 2004). In the 1990s, however, a certain disillusion followed the 'urban form euphoria' of transportation research (Boarnet & Sarmiento 1998, Bagley & Mokhtarian 2002). The more precise the differences in population structure in different areas were being controlled, the more it became clear that simple spatial comparisons of travel behaviour might lead to wrong conclusions, and that behind the putative spatial causes of distance behaviour and mode use there are completely different mechanisms. Besides, the empirical content of the explanation models remained rather limited, despite their increasing complexity (see, as an example for many others, Kitamura, Mokhtarian & Laidet 1997).

Consequently, interdisciplinary transport research developed new and even more complex research agendas which consider subjective dimensions in addition to the objective dimensions of space and individual life situation. Firstly, the integration of attitudes in explanation models of travel behaviour has to be emphasised here (Bagley & Mokhtarian 2002, Golob 2003, Parkany, Gallagher & Viveiros 2004, Handy, Cao & Mokhtarian 2005). In Germany attitudes are mainly discussed under the premises lifestyles or 'mobility styles', a premise that is based on the increasing extent of freedom of action of mobile individuals. This approach argued for travel demand to be explained in 'cultural' terms of subjective attitudes, aims and preferences rather than in terms of demography and social structures (Scheiner & Kasper 2005).

Secondly, travel was now increasingly interpreted as related to residential mobility. It was assumed that spatial differences in travel demand were not so much related to differences in urban form but to selective immigration of certain population groups and their subjective location attitudes ('self-selection hypothesis', Handy, Cao & Mokhtarian 2005, Scheiner 2005, Schwanen & Mokhtarian 2005, Scheiner 2006b).

Studies on travel development usually stress the complex interdependencies between various causes of travel behaviour. In this context individual personal circumstances can be distinguished from external conditions. In particular, personal circumstances are usually described by socio-demographic variables on the individual level. External conditions are often studied with respect to urban form and transport system, although there are various other important determinants of travel behaviour, whose relevance is beyond doubt, for instance the economic and political context, technological innovations or ecological norms.

The investigation of complex interrelations is further complicated by intervening (mediating) variables that might help to explain travel behaviour on the one hand but which are themselves dependent on other explanatory variables on the other hand. Attitudes and lifestyles are examples for this; both have been focussed on as determinants of travel behaviour throughout the last decades. However, they themselves may depend on an individual's life situation, which also, and independently, influences travel behaviour. Thus, it appears that an individual's life situation has both direct and indirect effects on travel behaviour, the latter mediated by lifestyle and attitudes. With urban form, the situation is similar: Certain characteristics of urban form at an individual's place of residence might influence his or her travel behaviour. However, the decision for this place of residence might depend on the life situation and lifestyle of this particular individual (or his/her household). And this life situation and lifestyle might influence travel behaviour as well.

In this contribution the above mentioned interrelations are being studied simultaneously by means of structural equation modelling. In contrast to classical multivariate methods such as regression analysis or discriminant analysis, complex interdependencies including intervening variables can be estimated with this method. Travel behaviour is being studied here with respect to mode choice. Other aspects of travel demand are not considered in this article but can also be studied with the proposed model structures. At the same time various other interrelations are being studied, such as the relevance of lifestyle and life situation for choice of housing location.

In the following the basic concepts for the chosen approach are explicated stepwise and a model structure is developed (section 2). In section 3, the methodology of structural equation modelling and the empirical data is described. The results are presented in section 4. In section 5 some conclusions for further research are drawn.

2 Basic concepts

In the following the basic concepts and interrelations for the model structures presented in section 4 are being developed. They are based on five key elements: life situation, lifestyle, location attitudes, location choice/urban form, and travel behaviour.

The model structures are based on considerations which have been developed in the context of the two research projects 'StadtLeben' and 'Intermobil Region Dresden'[1]. The theoretical basis

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[1] "StadtLeben – Integrated approach to lifestyles, residential milieux, space and time for a sustainable concept of mobility and cities" (2001-2005). Project partners: RWTH Aachen, Institute for Urban and Transport Planning (coordination); FU Berlin, Institute of Geographical Sciences, Department of Urban Research; Ruhr-University of Bochum, Department of Cognition and Environmental Psychology; University of Dortmund, Department of Transport Planning (see http://www.isb.rwth-aachen.de/stadtleben/). – "Intermobil Region Dresden" (1999-2004) was a big cooperation project with a large number of partners. The authors were involved on behalf of the Büro für Integrierte Planung, Dortmund, in the project "spatial and behavioural conditions of a sustainable provision of

has been laid by Scheiner and Kasper (2005). The following summary focuses on its empirical operationalisation.

2.1 Lifestyle and life situation

Originating from market research, lifestyles developed into an intensively studied research field of the social sciences since the 1980s, particularly in Germany (Otte 2005). The theoretical background are the debates on modernisation (Giddens 1990) and individualisation (Beck 1992) that are, among other things, based on the diagnosis of a growing 'dis-embedding' of individual social relations from the spatio-temporal context, the decreasing relevance of traditional structures of social inequality, and the change from materialist to hedonist, 'post-materialist' values. The argument is that the 'old' vertical inequalities are now superimposed (complemented or substituted) by 'new' horizontal differences 'beyond class and status' (Beck 1992).

With regard to the different study approaches there are various definitions of lifestyles. According to Spellerberg (1996, p. 57) lifestyles are "group specific forms of organisation of daily life that are expressed symbolically in cultural taste and leisure activities". According to Müller (1992), four dimensions of lifestyles may be differentiated:

- expressive dimension (e.g., leisure preferences/behaviour, everyday aesthetics, consuming behaviour)
- interactive dimension (e.g., social contact, communication)
- evaluative dimension (e.g., norms, values, perceptions)
- cognitive dimension (e.g.,self-identification, affiliation).

Lifestyles always include an aspect of freedom of action and voluntarism ("stylism"). They mediate "between social situation and individual action, objective conditions of life and cultural life" (Spellerberg 1996, p. 53). Despite some voluntaristic approaches (mainly in Germany) which claim lifestyles to be independent from social structure (Beck 1992, Schulze 1995), the dominant interpretation regards lifestyles to be connected with life situations. This 'structural approach' was mainly developed by Bourdieu (1984). It is empirically supported by the continuous connection between educational and occupational achievements and social and ethnic origin, for instance (Lampard 1995, Kim & Tamborini 2006).

The following refers to the structural approach that conceptualises 'subjective' lifestyles as dependent on 'objective' life situations. The latter comprise structural differences that can be described by socio-economic and demographic variables such as income, education level, sex, age, nationality or cohort (Berger & Hradil 1990, p. 10). Without usually being explicitly referred to as life situation, such variables belong to the 'classical' determinants of travel demand. In transport science they are usually denominated as 'socio-demographics', though this is just a formal term that does not say anything about the reasons why the underlying variables should influence travel behaviour, whereas 'life situation' explicitly points to an individual's personal circumstances (e.g. social roles, social contact) relevant for his or her travel.

This does not mean that structural differences are *part* of lifestyles. 'Objective' and 'subjective' differences (life situation and lifestyle) should be analytically separated so that interdependencies between them can be investigated (Wieland 2004, p. 176). Otherwise, the additional value which lifestyles, compared to life situation, have for the explanation of spatial mobility cannot be tested.

2.2 Lifestyles, location attitudes and residential mobility

As lifestyles always include behavioural aspects (leisure behaviour, consuming behaviour, social networks…) the realisation of lifestyles specifically relates individuals to their spatial environment, for example, when activities take place in discos, pubs, sport facilities or other meeting points. As a consequence, lifestyle specific needs and preferences with respect to the neighbourhood are reflected by residential location choice. Self-realisation, adventure-oriented and hedonistic modern lifestyle groups, for instance, prefer urban neighbourhoods with a variety of cultural and

mobility", that was managed by the Technical University of Hamburg-Harburg, Department of Transport Systems and Logistics (see under http://www.vsl.tu-harburg.de/100). Both projects were funded by the German Federal Ministry of Education and Research (BMBF).

leisure opportunities, whereas more traditional or reclusive lifestyle groups live predominantly in rural areas (Schneider & Spellerberg 1999).

Besides location choice, the degree of residential mobility (frequency of migration, migration distances) also shows lifestyle specific differences (Schneider & Spellerberg 1999, p. 229ff). However, the lifecycle concept is probably superior to the lifestyle approach, as migration corresponds predominantly with lifecycle events (Dieleman & Mulder 2002).

The differentiation of location choice between various lifestyle and/or lifecycle groups is subject to the specific housing and location attitudes of these groups. Such attitudes might therefore be treated as intervening variables between life situation/lifestyle and location choice. In this paper, housing and location attitudes refer to the subjective importance which certain attributes of residence, location and neighbourhood have for an individual (Molin & Timmermans 2003, Scheiner 2006a). As attributes of the residence itself (the house or the flat) are not further investigated here, we will use the term 'location attitudes' from here on.

The bigger the leeway of a household willing to relocate on the housing market, the bigger is the practical relevance of location attitudes for this household. When the housing market is mainly controlled by the supply side (e.g. in growth regions), individual wishes on the demand side are hard to realise and of minor importance for the actual location decision. This depends mainly on individual financial and social resources.

2.3 Lifestyles and travel

The increase in travel distances and accessibility might also be interpreted with regard to individualisation and modernisation (Kesselring 2006). As symbols of flexible mobility, mass motorisation and cars are regarded as central conditions for the realisation of modern, individual lifestyles (Sheller & Urry 2003). Consequently, the lifestyle concept is increasingly used in transportation science and translated into 'mobility styles' that are mainly based on attitudes towards transport modes, corresponding to the evaluative and cognitive dimensions of lifestyles. In doing so, a differentiated understanding of travel demand is created in a subject oriented approach (Lanzendorf 2002). For instance, individuals for whom the car is an irreplaceable symbol of social status and individual freedom are distinguished from individuals who pragmatically use the car despite ecological concerns, or individuals with a rather car-critical attitude (Götz 2003).

The integration of lifestyles in travel research started in the early 1980s (Salomon & Ben-Akiva 1983). Then, the term lifestyle was rather focussed on aspects of life situation, including (besides leisure orientation) household type and employment. Today, attributes of 'mobility styles' which are related to travel modes or residential location type are also studied under the aspect 'attitude' (e.g. 'pro-drive alone', 'pro-high density', Bagley & Mokhtarian 2002; see also Golob 2003, Parkany, Gallagher & Viveiros 2004, Handy, Cao & Mokhtarian 2005). Firstly, these approaches aim at a more thorough explanation of travel behaviour and, secondly at the description of target groups for transportation planning concepts.

2.4 Residential mobility, urban form and travel

Choice of housing location and travel behaviour are not only two dependent variables for the investigation of lifestyles, but are connected with each other. On the one hand, choice of housing location might be regarded as a preliminary decision on travel behaviour that is centred at the location of residence. On the other hand, choice of housing location is influenced by life situation and lifestyle. Thus, choice of housing location as an intervening variable cannot be regarded as exogenous (Boarnet & Crane 2001, Waddell et al. 2001, Schwanen & Mokhtarian 2005, Scheiner 2006b). Life situation in particular refers to socio-structural conditions which cannot easily be altered by individuals and which precede location choice.

Concerning the effects of actual location decisions in particular, there is research into the interrelations between housing and travel by means of comparing travel demand of populations in different types of urban form. The results might be summarised with the key statement that the inhabitants of dense, compact cities with mixed land-use take comparatively short trips and use public transport (PT) or non-motorised travel modes (NMT) for a lot of their trips (Boarnet & Crane 2001, Ewing & Cervero 2001, Timmermans et al. 2003, Hickman & Banister 2005). In the first place this may be explained by the high density of activity opportunities in these urban structures, and secondly by the transport system serving these compact structures. However, the sum total of kilometres travelled in the whole region may not necessarily be affected, since the short trips of the city dwellers correspond with long distance trips of the incoming commuters (Holz-Rau & Kutter 1995).

It is yet unclear, in how far the observed spatial differences in travel behaviour are spatially determined or instead result from individual decisions about certain residential locations (self-selection hypothesis, Schwanen & Mokhtarian 2005, Scheiner 2006b). This question is currently investigated by comparisons between population groups characterised by specific forms of housing mobility or by specific location attitudes within a certain location type. These comparisons lead to a considerable differentiation of the above mentioned key statement about the effects urban form has on travel behaviour. Travel behaviour might be an effect of selective location decisions of individuals or households, who decide in favour of a certain location type that meets their needs and their behaviour (Boarnet & Crane 2001, Scheiner 2006b). One may call this a form of 'segregation of travel behaviour'. Urban form at the place of residence, however, undoubtedly also affects travel behaviour. This becomes evident by the finding that after relocating people adjust their travel behaviour according to the spatial structures at the new place of residence (Handy, Cao & Mokhtarian 2005, Scheiner 2005).

2.5 Study approach – model structures

Given the considerations above, model structures with various degrees of complexity can be derived. Within the basic structures numerous questions can be analysed, each of which can be specified in different ways. The models can be applied to all aspects of travel. Thus, the general term travel behaviour is used here. Empirically this contribution is limited to mode choice.

The approach used here claims that lifestyle influences spatial mobility. In accordance with many sociological studies it is further argued that lifestyles are dependent on social and demographic structures, in other words on life situations (Schneider & Spellerberg 1999). Lifestyle-oriented mobility research often treats typologies of lifestyle as independent variables and therefore as autonomously emerging styles. The question remains, how they are influenced structurally by non-lifestyle-specific resources or restrictions. It remains unclear what is 'behind' lifestyles. It appears of growing importance, as there is increasing doubt about the empirical evidence of the individualisation thesis and the lifestyle concept, this is even more important (Zerger 2000, Wieland 2004). From these considerations structures as shown in model 1 and 2 can be derived (Fig. 1).

With model 3 we seek to uncover the interdependencies between residential mobility and travel behaviour. In doing so, we assume unidirectional cause-impact relationships, as the effects of residential mobility as a long-term decision affecting travel behaviour gain priority over the reverse relationship[2]. The most important aspect of residential mobility in this context is location choice.

Moreover, we can assume that location decisions are affected by certain location attitudes. These attitudes are partly influenced by life situation, for instance by children in the household. But they might also be induced by the individual values and preferences captured by the lifestyle concept. We therefore incorporate location attitudes as further intervening variables between life situation and lifestyle on the one hand and location choice on the other hand (model 4). In doing so, model 4 includes life situation and location choice as objective explanatory variables for travel behaviour, whereas lifestyle and location attitudes serve as subjective explanatory variables.

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[2] The data suggest this direction of causality as well, as in the data set residential mobility precedes travel. Information on residential mobility is recorded retrospectively, whereas all travel information is recorded for the present. - The decision on the direction of causality also had to be made with respect to the relations between car availability and residential location as well as car availability and location attitudes (see model 5 below). Location attitudes and residential location choice might both influence car availability as well as the other way round (model 6). However, models allowing for bi-directional causality between either two of them turned out to be unidentifiable. Therefore we came to a decision in favour of the respective presumably stronger relationship. A series of models with reverse (unidirectional) relationships were tested for control reasons (see section 4.5).

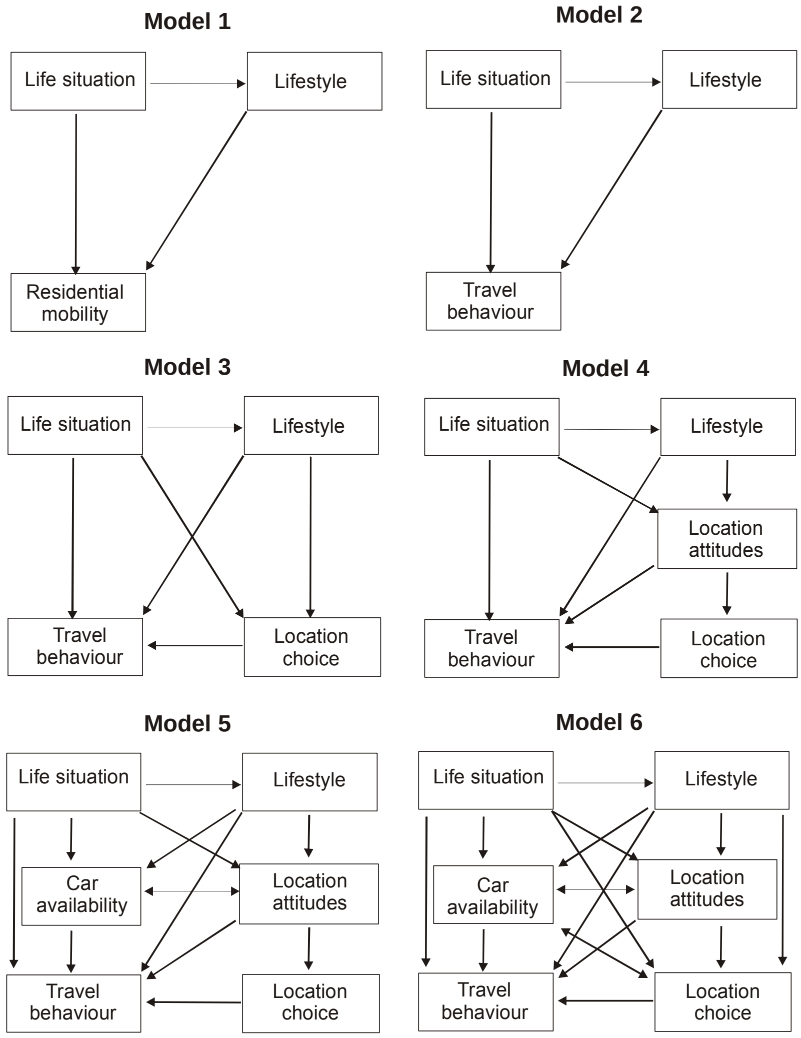

Fig. 1: Model structures to describe the interrelations between life situation, lifestyle, location requirements, location choice and travel behaviour

At this point another information is important. Location choice is reflected by the fact that individuals live in certain types of location. The actual location decision can therefore be described by attributes of the location. This means that the influence these attributes of the location have on travel behaviour can be interpreted in two distinct ways: as an effect of urban form, or as an effect of a certain location behaviour that reflects subjective location attitudes.

These two interpretations can indeed be separated in the model. Whenever attitudes are crucial, the location choice should definitely reflect them. Moreover, travel behaviour was likely to be strongly affected by location attitudes. Where urban form is crucial, travel behaviour should rather be influenced by (objective) location attributes than by (subjective) location attitudes. The length of the work trip, for example, probabilistically depends on the number of workplaces within a certain radius around the place of residence (an attribute of urban form). At the same time, it also depends on how important proximity to the workplace is for the individual (individual location attitude). Even in areas with few jobs, the work trip might be short, as long as the employee likes to have his or her workplace close by and is prepared to move closer, if necessary. Thus, an attribute of spatial structure (density of workplaces) is modified by an attribute of individual activity space.

In a further step, car availability is integrated (model 5) as it is - similar to location choice - an important pre-decision for travel behaviour. Car availability depends on the material resources of a person or household and might therefore be regarded as an intervening variable between life situation and travel behaviour. Potentially, car availability also depends on lifestyle. The spatio-temporal accessibility increased by the car results in the car influencing the individual's location attitudes as well (for instance: less importance of proximity to shopping centres for car-owning households). Therefore, the car might have indirect effects on travel behaviour. Conversely, the likelihood of car purchase might also be affected by location choice and even by location attitudes. In practice, one has to decide on the directions of causality and on whether or not to include bi-directional relationships on the basis of theoretical, conceptual or practical reasoning (see footnote 2).

In a last step (model 6), direct effects of life situation, lifestyle and car availability on location choice can be investigated, as it cannot be assumed that location choice is completely determined by individual location attitudes. Firstly, location attitudes, as any other model components, can only partially be included in the models in order to keep complexity under control. Secondly, location decisions are household decisions that do not necessarily reflect the location attitudes of every person in the household. Household structures are reflected in the life situation[3].

Before presenting the results of the model estimations, the methodology of structural equation modelling and the data used is briefly outlined.

3 Methodology

The interrelations discussed above can be studied by structural equation modelling. Recently, this method has increasingly been used in transportation research (Golob 2003). Structural equation models are frequently applied in mobility psychology, particularly in applications of the theory of planned behaviour (Ajzen 1991). In doing so, mode choice is explained by subjective norms, attitudes and perceived behavioural control (Bamberg, Rölle & Weber 2003). In other models more related to transport science, the availability of certain means of transport is treated as an intervening variable that explains mode choice and other aspects of travel behaviour (e.g. travel distances) and which is a part of the decision process concerning travel behaviour at the same time. This decision depends on socio-demographic factors of life situation (Simma & Axhausen 2001).

3.1 Methodology of structural equation modelling

Structural equation modelling can be described as a combination of factor analysis and a generalised form of regression analysis[4]. Even if this technique is used on the basis of micro data, it is a matter of aggregate analysis based on sample moments, i.e. means, variances and covariance/correlation matrices. In this paper, covariance matrices were used as is common in structural equation modelling. The raw data (in case of inquiries the data of individual respondents) is not mandatory. Compared to other multivariate techniques, structural equation models allow the investigation of multi-stage interrelations between variables. Unlike regression analysis or discriminant analysis, it is not limited to the analysis of explanatory (exogenous) variables on a single dependent (endogenous) variable. It can deal with several endogenous variables with interdependent relations among each other, and the inclusion of intervening variables that are exogenous and endogenous at the same time.

The procedure is to calculate the covariance matrix between the variables first. The parameters in the path diagram are then calculated in such a way that the empirical covariance matrix is reproduced as good as possible. The difference between empirical matrix and modelled matrix is tested for significance. The significance test assumes multivariate normal distribution of the observed variables, although in practice this assumption is often violated. But the effects of this violation have been shown to be negligible when large samples are used. The sensitivity

[3] Note that the empirical models presented in this paper do not allow for direct effects of life situation on location choice, as the 'fuller' models allowing for this interrelation were not identifiable (see footnote 9).

[4] Here, it is referred to the ‘regression analysis aspect’ (structural model) only. The ‘factor analysis aspect’ (measurement model) is based on the modelling of latent (unobserved) variables (Bollen 1989), whose values are estimated from observed variables within the model framework. In preparation of the analyses presented in this paper, a substantial number of estimations were undertaken that led to the basic decision to exclude latent variables from the models. The respective models had plausible coefficients, but very low goodness-of-fit values (likewise: Simma 2000 in similar studies). However, excluding latent variables from the models does not mean to limit the analysis to observed variables. The factor analyses were done separate from the modelling, and the factor scores were used as manifest variables in the models. As the factor analyses were explorative rather than confirmatory in nature, allowing loadings of any variable on any factor, there are no error correlations among the underlying observed variables or between observed variables and factors.

analyses described by Bagley and Mokhtarian (2002) indicate that "the findings from the model that met the assumption of multivariate normality were very similar to the results of the earlier model, on the larger sample, that did not meet the assumption" (ibid., p. 287). Therefore, the option of transforming variables with a skewed distribution (particularly the travel behaviour variables, e.g. by taking the natural log or square root) is rejected in favour of keeping the original values as they can be interpreted more easily.

The model fit can be regarded as good when the test is not significant. With large samples the problem is that the model test is 'too good' and even minor differences between model and data turn out to be significant. Therefore, there are a number of heuristic indices to assess the model fit. For these tested decision rules are available (Golob 2003, p. 9-11, Schermelleh-Engel, Moosbrugger & Müller 2003).

Subsequently, the significance of every single parameter is tested. This is done by setting the corresponding parameter to equal zero and re-estimating the model. Then the difference between the covariance matrix with the estimated parameter and the matrix with the fixed parameter is tested for significance. The parameters are usually estimated by the maximum likelihood approach.

For non-normal data, Browne (1984) developed an asymptotically distribution-free estimation procedure that can be applied to binary or ordinal-level variables. However, according to simulation studies, the maximum likelihood approach is robust against violations of distribution assumptions, at least for large samples (Golob 2003, p. 8). For non-normal continuous variables it is regarded to be better than the asymptotically distribution-free procedure (Schermelleh-Engel, Moosbrugger & Müller 2003, p. 27). In the following analyses, the asymptotically distribution-free procedure is used only for the model which includes (ordinal-level) car availability.

The analyses are undertaken with the programme AMOS 5.0 (Analysis of Moment Structures) that is available for SPSS with a user-friendly graphic surface.

3.2 Data and study areas

The analyses are based on data from a standardised household survey within the scope of the project StadtLeben (see footnote 1). The survey took place in ten study areas in the region of Cologne in 2002 and 2003. 2.691 inhabitants took part in extensive face-to-face interviews about their travel behaviour, housing mobility, life situation, lifestyle, location attitudes and residential satisfaction. The response rate varied between 23 percent and 37 percent, depending on the study area. The total response rate was 27 percent of those asked in all areas taken together.

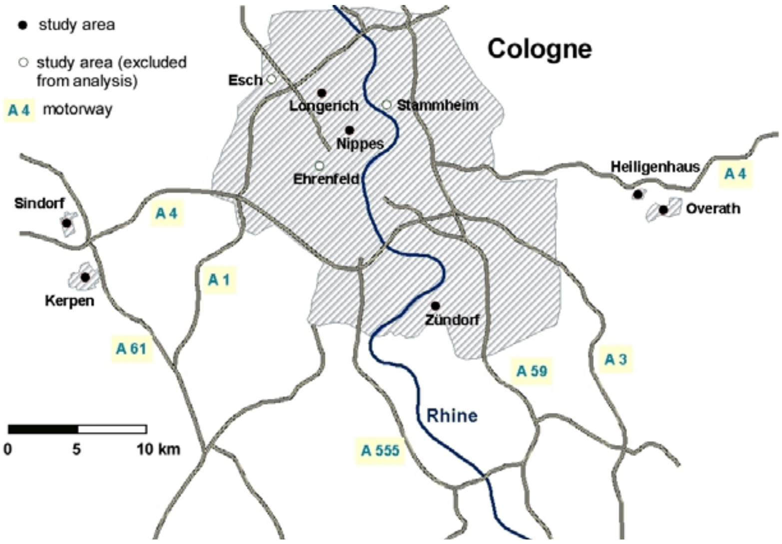

Fig. 2: Location of the study areas in the region of Cologne

Source: own concept of project group StadtLeben

The study areas represent five area types, and each one is represented by two areas (Fig. 2): high density inner-city quarters of the 19th century ('Wilhelminian style': Ehrenfeld, Nippes); medium density neighbourhoods from the 1960s ('modern functionalism') with flats in three- or four-story row houses (Stammheim, Longerich); former villages at the periphery of Cologne which have constantly been expanding since the 1950s with single-family row houses or (semi-) detached single occupancy houses (Esch, Zündorf); small town centres in the suburban periphery of Cologne (Kerpen-Stadt, Overath-Stadt); and suburban neighbourhoods with detached single occupancy houses (Kerpen-Sindorf, Overath-Heiligenhaus). The four suburban neighbourhoods are all about 30 km away from Cologne.

As the two areas belonging to one type are clearly different, the areas are very varied with regard to spatial location, transport infrastructure, central place facilities and socio-demographic structure. Nonetheless it has to be mentioned that there was no intention of choosing spatially or socially 'extreme' areas. There are no obvious high income areas, and only one distinct low income area (Stammheim). However, Stammheim, Ehrenfeld and Esch are excluded from the analysis because the location attitudes of the inhabitants of these areas could not be investigated due to reasons of the project flow. Therefore, the analysis is based on the seven remaining study areas only. Depending on the model, the resulting net samples have a value of about n=2.000.

Heiligenhaus represents the most peripheral neighbourhood. There are no retail or services worth mentioning, and PT is limited to an irregular bus service. However, one has to keep in mind that even this area is located within the outskirts of the city of Cologne. Thus, it is not particularly remote with regard to the total spatial variety of Germany.

The region of Cologne is a polycentric agglomeration with the clearly dominating centre of Cologne. The population trend is slightly positive, and the housing market is rather dominated by the supply side. The chances of different population groups defined by lifestyle or life situation to realise a specific location choice that meets their needs and wishes are limited. This is an important condition for the interpretation of the results.

To our knowledge, the data used is unique in so far that it allows to connect all necessary information for the suggested model structures on the individual level. However, the data shows some deficiencies:

1. The data are based on a cross-sectional survey with only a few retrospective elements. Cross-sectional data do not allow for the investigation of processes, such as the adjustment of lifestyles and location attitudes to the chosen location, or changes in travel distances after migration.
2. All data was collected with reference to the date of the survey. But the last relocation took place in the past. The location decision was made in the context of a certain life situation that might have been different from the life situation which represents the basis for the surveyed travel behaviour. Moreover, as mentioned above, it remains unclear whether lifestyles and individual location attitudes have changed since the last relocation.
3. The basis of the models is both individual behaviour (travel) as well as collective behaviour (household relocation). Possible interdependencies cannot be integrated into the models. For instance, location attitudes might in some cases not have had any impact on the actual location decisions, because the decisions were based on the partner's location needs. The calculated path coefficients should therefore be conservative estimates.

3.3 Specification of basic concepts

Because of the broadness of the basic concepts, a high variety of questions can be dealt with within the scope of the outlined model structures. For instance, travel behaviour might be examined under the aspects activity frequency, activity variety, travel distances or mode choice. Furthermore, the basic concepts can be specified with a low or high degree of complexity. Because of the many interdependencies, it is attempted to keep the degree of complexity of the respective model components as low as possible. The models are limited to observed variables and factor scores (see footnote 4). The following components are used:

Life situation is derived from a factor analysis based on the variables age, number of children in the household, education level, employment status, job position[5]. Out of these variables, two

[5] Other variables (sex, number of adult household members, nationality and income) were gradually excluded from the analysis, because the results were unsatisfactory. Firstly, some of the extracted factors appeared to be hardly interpretable. Secondly, the rates of variance explained by the factors was very low. The exclusion of sex

factors were extracted: social status and 'young family' (principal component method, varimax rotation, extraction criterion: eigenvalue > 1, variance explained by the factors 57 percent). In particular, three variables load on the status factor (loadings in parenthesis): education (0.688), employment status (0.616), and job position (0.740). The factor 'young family' mainly represents age (-0.793) and the number of children in the household (0.747).

In the data, *lifestyles* are presented by four domains: leisure preferences, values and life aims, aesthetic taste, and frequency of social contacts. These four domains can be summed up to nine scales (Schweer & Hunecke 2006):

- Leisure preferences: domestic/family-oriented preferences, out-of-home preferences,
- Values/life aims: traditional values, self-realisation values,
- Aesthetic taste: trivial culture, tension, high culture TV, high culture print media (reading),
- Frequency of social contacts (frequency of phone calls and face-to-face contact with friends, colleagues and neighbours).

Aesthetic taste has been excluded for its limited importance for travel behaviour. Extensive analyses with structural equation models with latent variables indicate that two lifestyle scales load particularly high on the latent variable lifestyle: out-of-home leisure preferences and self-realisation values. Therefore, these two scales are summarised by the factor 'out-of-home self-realisation' by means of factor analysis (principal component method, varimax rotation, variance explained by the factor 70 percent), which is integrated into the models as a basic dimension of lifestyle. The factor loadings of both variables are 0.836, respectively.

Individual *location attitudes* were operationalised by subjective importance ratings of neighbourhood and location attributes. These were surveyed by asking "how important are the following features of the neighbourhood for your personal decision in favour of a certain place of residence?" Subsequently, the attributes were given, for instance "accessibility of the city centre" or "proximity to PT". The five-point Likert-type answer scales ranged from 'not important' to 'very important' and were constructed in such a way that they come as close to an interval scale as possible (see Rohrmann 1978). In favour of the best possible adjustment to the respective endogenous variable of mode choice, the models used here are partly based on the original ordinal-level variables instead of factors.

Specifically, when examining the use of the private motorcar (including motorcycle) and of public transport, the importance of proximity to PT for a location decision is used ('importance of PT'). For NMT, the quality and quantity of local activity opportunities is more important than the quality of the local PT system. Thus, the importance of proximity to retail and services is used in the NMT model. For the study of vehicle kilometres travelled per week (VKT), one of five factors extracted by factor analysis out of the location attitudes is used (principal component method, varimax rotation, variance explained by the factor 64 percent, see Scheiner 2006a). VKT are largely depending on the centrality of the place of residence and the distance to the nearest centre. The most adequate factor represents the importance of accessibility of the next city centre. This factor is largely based on the items (loadings in parenthesis) 'accessibility of city centre' (0.644), 'accessibility of PT' (0.681), and 'accessibility of the workplace' (0.611)[6].

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seems justified as the determining power of sex for travel mode choice markedly declines over time, at least in Germany (Scheiner 2006c). This is due to the change in gender roles caused by increasing female labour participation and women's increased participation in higher education. In the same analyses, education appeared to be a much better indicator of social status than income. Therefore the exclusion of income seems acceptable as well. In the most important German travel behaviour survey (KONTIV), income data were not even collected before 2002.

[6] The other four factors can be summarised as follows (loadings in parenthesis): (1) neighbourhood and supply; based on the items security from crime (0.758), service supply (0.749), maintenance of green areas and squares (0.675), retail supply (0.698), neighbourhood (0.649), leisure supply for adults (0.544), noise and pollution (0.538); (2) children; based on the items playgrounds and leisure supply for children (0.890), leisure supply for teenagers (0.878), quality of schools and nursery schools (0.877); (3) residence; based on the items state of maintenance (0.866), equipment and furnishing (0.847), size and layout (0.819), costs (0.678); (4) car transport; based on the items access to motorways (0.792), supply with garages and parking spaces (0.699).

The *residential location type* is studied with regard to specific spatial attributes of the neighbourhood that are selected in accordance with the focus of the respective model. For instance, when location attitudes are studied in a certain model with respect to 'importance of PT', the actual location will be described by an indicator of PT supply. This indicator is based on a five-point scale describing the predominant functions of the different means of PT (micro-scale coverage of an area v. large-scale access)[7].

In the NMT models, the supply of opportunities within the neighbourhood is used as an indicator of urban form ('density of supply', sum of retail, service and leisure opportunities per km²)[8].

In the VKT model, urban form in the study areas was described by the indicator 'density and land-use mix'. A factor analysis was made including population density and supply density, i.e. a mixture of density and degree of land-use mix (explained variance 96 percent, loadings 0.978, respectively) that can be interpreted as a measure of urbanity.

Mode use was examined on the basis of the relative shares of car trips (including motorcycle), PT trips and NMT trips an individual reported to have taken, whereby the frequent activities method was applied. Activity frequency, usual travel mode, destination and travel distance were surveyed for selected activities including work, education, daily grocery shopping, weekly shopping, event shopping, administrative transactions at public authorities, private visits, sports, visits to restaurants or pubs, cultural events and sport events, disco and concert, walks, and excursions.

In addition to the share of a certain mode, weekly VKT are examined as an indicator of environmentally unfriendly travel behaviour.

Last, but not least, *car availability* is incorporated into the models as an ordinal level variable with four values: no car in the household; car in the household but not personally available for the interviewee, license and car in the household and temporarily available for the interviewee; license and car in the household and permanently available for the interviewee.

4 Results

4.1 Model fit

There are a number of heuristic indicators to assess the goodness-of-fit of structural equation models. For most of these indicators there are decision rules available and they have been tested in methodological studies. The indicators are based on different principles, for instance on discrepancies between theoretical and empirical covariance matrices, or on mean differences between expected and estimated values of various parameters. A number of these indicators for the estimated models, along with the corresponding decision rule, are given in Table 1.

According to most of the indicators, the model fit is generally close. The best models are the ones dealing with NMT and VKT. In these models the sample matrices do not differ significantly from the model matrices despite the large sample size. According to the Hoelter statistics, the sample size would have to exceed n=3.700 before one could reject the respective model. The model fits for car trips and PT trips are less close, however still acceptable. Only with respect to the indicator CMIN/DF, many of the models do not reach the required threshold value. In particular, this results from the models' small number of degrees of freedom. This is a consequence of the large number of parameters to be estimated. However, RMSEA turns out good due to our large sample size.

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[7] In German cities, the bus predominantly takes on the function of micro-scale coverage, while the S-Bahn (regional train system) takes on large-scale access within the region. The regional train does so as well, although the speed is even faster. The U-Bahn (underground) operates somewhere in between (medium-scale coverage and access). A five-point scale is derived out of this, where 1 means there is no public transport available in the area; 2 means the area is served by only one means of transport (i.e. either bus or S-Bahn or regional train or underground, and so on. 5 means that the area is served by all different means of transport, i.e. the area has a fully integrated system. The variable 'public transport supply' was constructed by the RWTH Aachen, Institut fur Stadtbauwesen und Stadtverkehr. Although being an ordinal-level variable, it may be interpreted as an interval-level variable, as it corresponds with the number of transport means operating in the respective area.

[8] The opportunities were mapped by the RWTH Aachen and the Ruhr Universität Bochum (Hunecke & Schweer 2004). Leisure opportunities as well as retail and services were mapped, including informal activity places, such as chance meeting points in public space. The number of workplaces is unfortunately not available on the micro-scale level.

	indicator of goodness-of-fit				
	CMIN/ DF	F0	RMSEA	PCLOSE Significance	Hoelter (p=0,05)
			decision rule		
	<2 good >5 n.a.	<0,05 good >0,1 n.a.	<0,05 good >0,1 n.a.	n.s. (> 0,05) good	≥ 200 good
Mode use					
share of public transport trips	5.600	0.005	0.041	0.735	1,252
share of car trips	5.422	0.005	0.041	0.757	1,293
share of non-motorised trips	1.590	0.001	0.015	0.996	4,406
share of public transport trips (persons with a car*)	5.506	0.005	0.041	0.747	1,273
share of public transport trips (persons without a car in the household)	5.457	0.005	0.041	0.752	1,284
vehicle kilometres travelled					
total sample	1.872	0.001	0.018	0.992	3,743
persons with a car*	1.876	0.001	0.018	0.992	3,735
total sample; model including car availability	9.371	0.013	0.065	0.115	558

Table 1: Indicators of goodness-of-fit of the models

n.a.: not acceptable
n.s.: not significant
* individuals with license and permanent or temporary car availability
CMIN/DF is the minimum of the discrepancy function between the sample covariance matrix and the model covariance matrix, divided by degrees of freedom (DF). The number of DF equals the difference between the number of sample moments and the number of parameters to be estimated. In correct models, the value of CMIN/DF approaches 1. Similarly, RMSEA measures discrepancy per degrees of freedom. However, it is inversely related to sample size. PCLOSE is the probability for testing the 'null hypothesis of close fit' which claims that the population RMSEA value is no greater than 0.05. F0 is the maximum of an interval ranging from zero to the difference between X2 and DF, divided by sample size. The Hoelter statistics specifies the required sample size (critical n) to reject the model at a certain significance level. The table gives decision rules for all indices.

The fit of the model including car availability, which is based on the asymptotically distribution-free estimation procedure is much less close compared to the other models. Therefore, the presentation of results generally focuses on the models without the factor car availability (model structure 4, see above). Only one model of the model structure 5 (including car availability) will be presented. However, separate models for individuals with and without access to a car are presented in order to control for car availability.

In contrast to the model fit as a whole, the explained variances of the various endogenous variables are generally low. Only lifestyle can be explained satisfactorily on the basis of life situation (R^2=0.23, see Fig. 3). Concerning location attitudes, variance explanation rates just ranged between R^2=0.01 to R^2=0.05, depending on the models. Concerning mode use, the variance explanation rates are on an acceptable level and range between R^2=0.07 and R^2=0.19. The low variance explanation rates suggest the existence of unconsidered variables that might influence the endogenous variables, e.g. transport prices and the housing market. However, low variance explanation rates are not uncommon for models of travel behaviour.

4.2 Mode use

Fig. 3 shows the postulated interrelations (model structure 4) for the share of PT trips[9]. As we are mainly interested in the strength of the examined interrelations, the figure shows the standardised

[9] This and the following models were also estimated in a 'fuller' version allowing for direct effects of life situation on location choice (represented by public transport supply in Fig. 3). In these models, however, the number of parameters to be estimated was too large. Therefore the models were not identifiable. The exclusion of these effects from the models seems justifiable, as various sensitivity analyses indicated very low coefficients between life situation and location choice, as compared to the ones between life situation and location attitudes.

direct effects (path coefficients) of a variable on another variable without regarding unstandardised coefficients and intercepts. The circles indicate non-observed error variables.

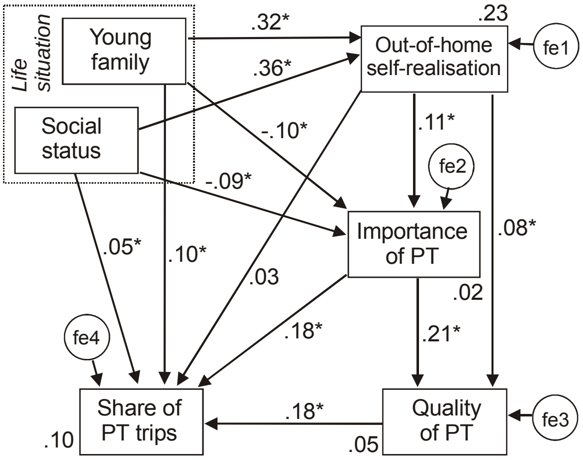

Fig. 3: Model of public transport trips

This and the following figures indicate the estimated standardised path coefficients and the proportion of explained variance of the endogenous variables. Significant coefficients (p=0.05) are marked with an asterisk.

The strongest interrelations can be observed between life situation and lifestyle, while all other interrelations are clearly weaker[10]. High social status as well as a high score in the dimension 'young family' correspond with more out-of-home self-realisation. Both of these dimensions of life situation have a negative effect on the importance of PT.

Out-of-home self-realisation is positively associated with the importance of PT, which is likewise clearly positively correlated with the actual location choice. This means that PT is more important for individuals with a strong tendency to seek out-of-home self-realisation than for others. Therefore they decide in favour of a residential location that meets this criterion. Often such individuals are young and highly educated (students, academics).

Furthermore, there are relatively strong interrelations between the subjective importance of PT and actual demand, as well as between the objective PT supply and demand. By contrast, the direct effects of life situation and lifestyle on PT use are comparatively weak. Although the total effect of lifestyle on PT use is somewhat fuelled by indirect effects (while the indirect effects of life situation seem insignificant), PT use appears to be more differentiated by urban form and location attitudes than by social and demographic attributes.

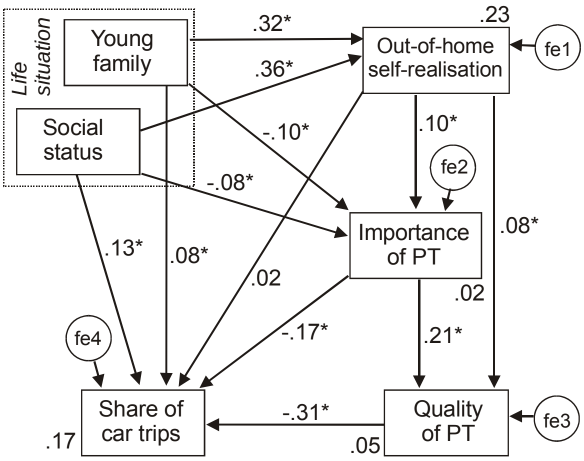

Fig. 4: Model of car trips (including motorcycle)

[10] The altogether low coefficients are common in structural equation models of travel behaviour (see e.g. Simma 2000) as well as in multiple regression models of travel behaviour.

In another model (Fig. 4), the share of car trips is examined in the same manner. This model represents a control analysis for the PT model, as it might be possible that good PT increases the share of PT trips at the expense of NMT, while the proportion of car trips among all trips of an individual is not being reduced[11].

However, the negative coefficient between PT supply and car use indicates that good PT supply corresponds with reduced share of car use, indeed. The result is robust when the absolute number of car trips is dealt with and not the fraction of car trips (without figure). Here, however, the path coefficient is weaker, indicating that the *proportionate* reduction of car trips induced by a good PT system is partly due to a higher number of trips, i.e. a higher activity level of the population living in such areas (see Holz-Rau 1997 for similar results in a case study of Berlin). In addition, it is worth mentioning that the positive influence of social status on car use is stronger than on PT use. Thus, high social status corresponds with a high share of PT trips but also with an even higher share of car trips.

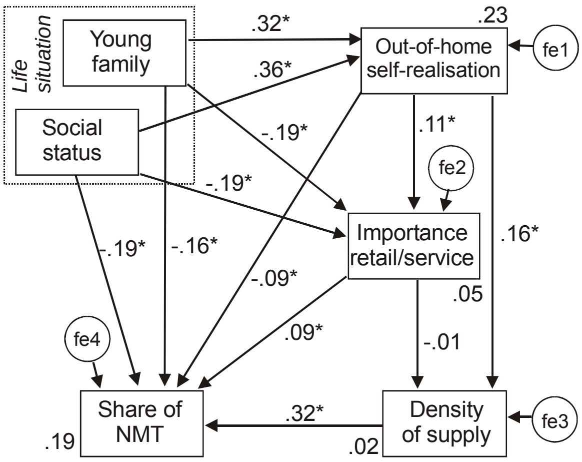

Fig. 5: Model of non-motorised trips

The third model (Fig. 5) shows the share of NMT. As mentioned above, supply density (sum of retail, services and leisure opportunities per km²) is used here as an indicator of urban form, because NMT is more dependent on local opportunities than on PT quality. Location attitudes are specified by the importance of proximity to retail and services.

In this model, the direct effect of out-of-home self-realisation on travel mode is negative and stronger than in the above models. This lifestyle orientation apparently corresponds with a lower proportion of NMT, although the indirect effects of lifestyle mediated by location attitudes and location choice mitigate its direct effect without reducing it to zero. It should also be noted that this is the only model with negative interrelations between life situation and travel mode. The dimensions 'status' and 'young family' are both positively associated with the car as well as with PT. By contrast, NMT is associated with individuals with low social status and the elderly. This indicates how important it is to go beyond the dichotomy of PT and the car and include NMT into the analysis. Interpreted in terms of social structures, there is a dichotomy between motorised and non-motorised transport rather than between public and individual transport.

4.3 Mode use: separate models for individuals with v. without access to a car

Extending the above analyses, models of travel mode are examined separately with regard to individuals with permanent or temporary access to a car, as well as to individuals without access to a car. Fig. 6 shows the results for PT use.

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[11] This suggestion is supported by the observation that the demand increase after the implementation of new PT supply is based on former car users only to a small degree, while the larger part is caused by shifts from established PT connections to the new one, or even from NMT to PT, and by the generation of additional trips (Hass-Klau et al. 2000).

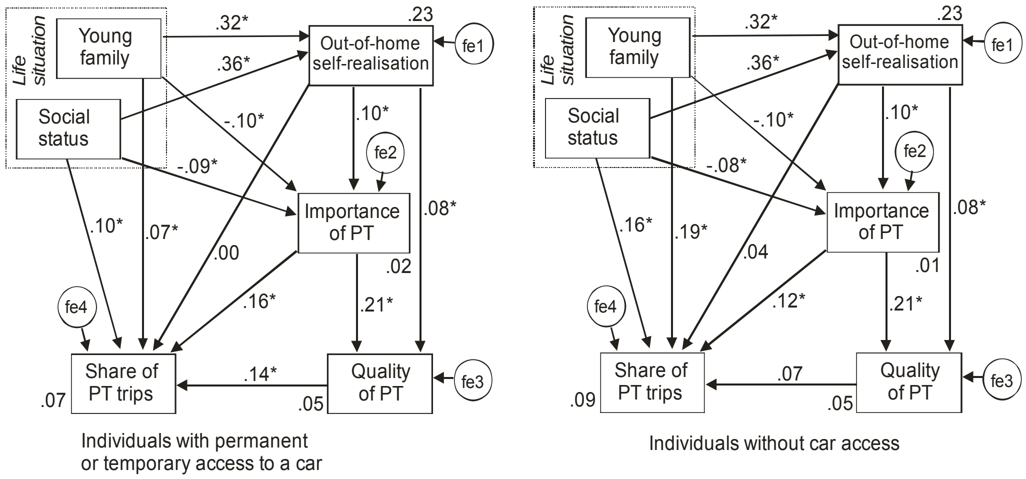

Fig. 6: Models of public transport trips, differentiated by car availability

The explained variance of PT use is slightly lower than for the model dealing with the total sample. This is particularly evident in the model for individuals with car access, indicating less differentiated mode use among car owners. Nevertheless, the subjective importance of PT as well as objective PT supply affects PT use by motorised individuals. Car availability as such does not appear to let PT become subjectively irrelevant in general. One may conclude that the subjective importance assigned to PT is not homogeneous even among car owners, and that even car owners react to objective PT supply[12].

Concerning individuals without a car, life situation is considerably more important for the share of PT trips than with respect to individuals with a car. Among the former, persons with high social status and young families basically are young employees who generally use PT at least for the work trips, but for other far-off activities as well. The elderly as well as individuals with low status undertake more micro-spatial activities within the neighbourhood with non-motorised modes (see the model of NMT above). This difference in activity spaces may serve as an interpretation of the strong differentiation of PT use among non-motorised individuals.

Moreover, it should be noted that the direct effects of the subjective importance of PT on travel mode are stronger than those of the objective PT supply. Taking indirect effects into account, the differences become even more pronounced. The prevalence of the 'subjective' side was less definite in the total sample model for PT, and even appeared to be the other way round for car trips and NMT. Among other factors, this was due to the unequal locations of residence of individuals with a car compared to those without a car in the total sample models. The unequal spatial distribution of these two groups is excluded by separating the models. As a consequence, subjective aspects are more accentuated.

4.4 Vehicle kilometres travelled

Decisions on travel modes, activity places and acceptable distances are not taken separately. Consequently, the question of sustainability in transport can only be answered by the combined consideration of travel mode and travel distances. Therefore, VKT per week is investigated as the dependent variable in the following. Spatially regarded, VKT largely depend on the centrality of the place of residence and the distance to the next centre. Therefore, 'density and land-use mix' is used as an urban form indicator. Location attitudes are specified correspondingly by the importance of accessibility of the next centre (Fig. 7).

VKT can satisfactorily be explained by the model. The most important personal characteristic is social status. Given that social status includes employment status, it should not surprise that it strongly influences travel distances as well as travel mode due to the frequent and relatively long work trips. High scores on the dimensions 'young family' and 'out-of-home self-realisation' correspond with more VKT as well, although the direct effect of out-of-home self-realisation is again mitigated by indirect effects.

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[12] Both is also true when the analysis is limited to individuals with *permanent* car availability (without figure).

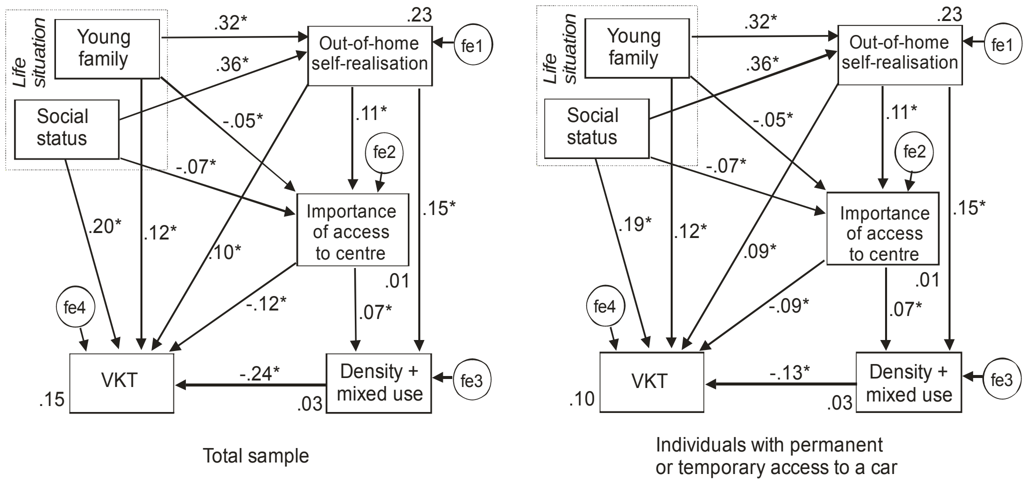

Fig. 7: Models of vehicle kilometres travelled, differentiated by car availability

The effect of urban form on VKT is remarkably strong. The higher the urbanity of the residential environment (higher density and more mixed land-use), the less VKT. Location attitudes also play an important, albeit less pronounced role. Individuals for whom accessibility of the next centre is subjectively important, travel less vehicle kilometres.

As might be expected, the connection between urban form and VKT is not as close for individuals with a car. This interaction between the urban form-transport connection and car availability seems plausible as car owners do not rely on opportunities within the neighbourhood as much as individuals without a car. Furthermore, they might own a car precisely because their demands are not fulfilled within the neighbourhood or because their life situations do not permit strong bonds with their neighbourhood (e.g. because of the workplace location, or because of family members living elsewhere). Therefore, car owners 'react' less to urban form of their neighbourhood. This statement, however, has to be put in quotes, because one cannot speak of a mere one-dimensional reaction of individuals to urban structure in form of shorter or longer travel distances. When access is inadequate, there are quite some more possibilities of reaction, e.g. relocation or reorganisation of daily life (weekly instead of daily shopping, trip chaining, avoiding activities…).

4.5 Integration of car availability into the models

VKT of an individual largely depend on car availability. It is standard knowledge in transport science that car availability is one of the dominating predictors of mode use. The role of car availability as an intervening variable between life situation and mode use has been investigated by Simma and Axhausen (2001) by means of structural equation models. Besides, car availability belongs to the most important predictors of private households' location decisions (Scheiner 2006b). Before concluding the article, VKT is therefore examined taking car availability into consideration. As mentioned above, the asymptotically distribution-free estimation procedure developed by Browne (1984) is applied.

Car availability turns out to be the most important determinant of VKT (Fig. 8). Individuals with (permanent or temporary) access to a car have an overall larger activity radius, compared to other individuals. The direct effect of car availability on VKT is much larger than the effects of life situation and lifestyle on car availability, and becomes even more pronounced when indirect effects are taken into account[13]. Thus, purchasing a car implies a strong pre-decision about travel behaviour. This can, to a certain extent, be applied to the whole population, although the model also indicates an unequal social distribution: lower car availability for persons with low social status, singles and the elderly (see above).

As the effect of social status on VKT also becomes stronger when indirect effects are considered, car availability and social status appear to be equally important determinants of VKT in terms of total effects.

[13] As the effect of social status on VKT also becomes stronger when indirect effects are considered, car availability and social status appear to be equally important determinants of VKT in terms of total effects.

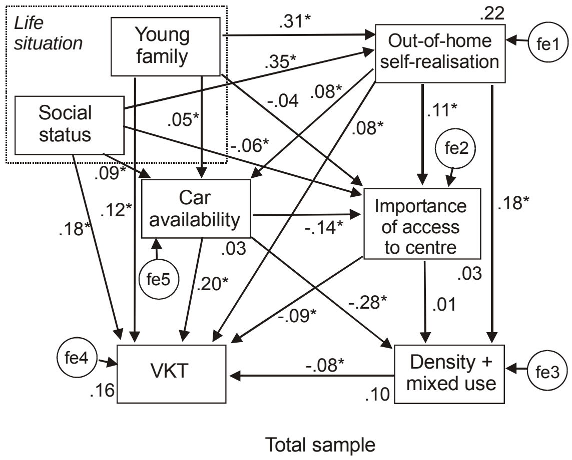

Fig. 8: Model of vehicle kilometres travelled including car availability as an endogenous variable

There is an even stronger effect of car availability on location choice. Individuals with a car are likely to live in places with low density and less mixed land-use. The well-known higher motorisation is not only a consequence, but also a condition of choice of such a location (Scheiner 2005). Therefore, the model explains location choice much better than the models without car availability. Then again, these location decisions affect VKT, but rather moderately.

Furthermore, access to the next centre is subjectively less important for individuals with a car. This attitude further supports longer travel distances even somewhat more than objective urban form.

As noted above, there is no unidirectional relationship between location choice and car availability. The same is true for location attitudes and car availability. Therefore, two models have been tested that allowed for bi-directional causality between (1) location attitudes and car availability, and (2) location choice and car availability. However, these models turned out to be unidentifiable. To shed more light on the question of causality, two further models were estimated in which the direction of causality between the said constructs went the other way. The results were almost identical to the model presented here in terms of model fit as well as with respect to the coefficients. From these results, it cannot be concluded as to whether there is a causal direction between location attitudes/choice and car availability fitting the data better than the other direction.

5 Conclusions

This paper examined the complex interrelations between life situation, lifestyle, residential location choice, urban form and travel mode by means of structural equation modelling. According to the overall results, travel mode is more affected by life situation than by lifestyle. However, lifestyle plays an important role by affecting location attitudes and location decisions that are in turn influencing travel mode. It also has to be kept in mind that the effects of life situation and lifestyle on location choice estimated in this paper are conservative estimates. Since the housing market in our study area is dominated by the supply side, the chances of certain lifestyle or life situation groups to realise a specific location choice that meets their needs and wishes appear to be rather limited.

For individuals with strong orientation towards out-of-home self-realisation, good access to PT, retail and services and urbanity in general is more important than for others. Consequently, they prefer to live in urban neighbourhoods with high density and mixed land-use. Corresponding with their preferred location types, they are more likely than others to use PT and NMT rather than the car, and they travel less vehicle kilometres.

Individuals with high social status and/or high scores of the dimension 'young family', as compared to the elderly and individuals without children in the household, are more likely than others to use the car and PT rather than NMT, and urbanity is less important for them. By contrast, it is far more important for the elderly and individuals with low social status to have PT and especially retail and services close to their place of residence.

The findings concerning the magnitudes of the effects of subjective location attitudes, compared to urban structure, are mixed. In some models, the effects of location attitudes turn out to be equally as strong or even stronger than the objective attributes of location. This result indicates remarkable effects of self-selection with regard to location choice, though objective spatial structure remains important.

Altogether one cannot give preference to 'objective' or 'subjective' determinants of travel mode use. Life situation seems to be more important than lifestyle; a finding that suggests the relevance of objective conditions. However, subjective location attitudes might be equally as, or even more important than objective location attributes. This underlines the importance of the recent debate in transport science on residential self-selection.

For further research, one should keep in mind that the suggested approach is applicable for the investigation of other important indicators of travel behaviour as well, for instance activity specific trip frequencies or trip distances. The definition of lifestyles that is partly based on leisure activities suggests considerable effects of lifestyle on leisure travel distances or leisure trip frequencies. Moreover, with dynamic models including lagged variables one could improve the existing knowledge about the 'true' interdependencies in time between life situation, lifestyle, urban form and travel. However, this requires panel data.

Last but not least it has to be critically pointed out that the variance in travel behaviour explained by the models does not considerably exceed traditional multiple regression analysis, despite the complexity of structural equation modelling. Keeping this in mind, further travel research in the context of societal and spatial development is needed.

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