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Working Paper 1: Sustainable Travel Behaviour

Abstract

This working paper reveals and describes the characteristics and parameters of "sustainable travel" as a basis for the project "Promotion Sustainable Travel". Firstly, it deals with factors for the origins of travel and outlines constraints for travel behaviour. Different projects and articles, revealing the habitual character of individual mobility decisions are displayed to highlight possible difficulties for measures aiming at behavioural changes. In the next sec, the paper explains definitions and basic principles of sustainable development and links them to the transport sector. General approaches to develop indicators and basic conditions for a sustainable transport system are shown to represent the complexity and possible variety of aspects of sustainable mobility.

The subsequent section highlights some recent publications from the huge amount of relevant research to demonstrate possible approaches for a classification of sustainable travel behaviour. Based on these articles, the characteristics of sustainable traveller groups are identified. Regarding the forthcoming research project, the paper concludes that on the one hand some simplifications of sustainability aspects could help to improve manageability of evaluation tools and understandability of results. On the other hand, a complex acquisition of all aspects of individual travel behaviour seems to be necessary to develop recommendations for policy and planning measures towards more sustainable travel behaviour.

Introduction

Travel is an integral component of every day life. It allows people to meet their needs and provides access to other persons, locations and services. However, transport related impacts are still amongst the most crucial threats for humans and the environment (e. g. EEA 2007, European Commission 2003). Therefore, policy-makers, planners and researchers are aiming at measures that permanently shift people's travel behaviour towards more sustainable mobility. To reach this goal, a fundamental understanding of individual travel behaviour and its driving forces and influencing factors is necessary (e. g. McFadden 2007). Against this background, the working paper highlights the fundamentals of individual travel decisions and links sustainability with mobility. It shows characteristics

and relevant factors for sustainable travel and lists some of the recent approaches describing and categorising sustainable mobility.

Travel Behaviour

A fundamental condition for human existence is the satisfaction of individual needs, ranging from basic needs like eating and sleeping up to the need for self-fulfilment (Maslow 1943). Transport itself is a result of needs that can't be met in situ (Gerike 2007, Becker et al. 1999). To meet these needs, people or goods must cover distances. It depends on interactions among individual factors (attitudes, opportunities) and accessibility of places of activities (distribution in space, infrastructure), if and how these movements happen. Hägerstrand (1970) was one of the first researchers to explain these interactions in a spatial-temporal context. To describe the duality of constraints and possibilities, he distinguishes between three types of constraints: a) individual temporal or *coupling constraints* from given appointments and resultant available times; b) spatial or *capability constraints* from accessibility of locations within the available time; and c) additional spatial or *authority constraints* from admission restrictions like private property or – together with temporal constraints – opening hours.

By adding individual socio-demographic characteristics, Geurs and van Wee (2004) classify these accessibility attributes into four different groups: a land use component (locations and characteristics of opportunities and of demand), a transport component (location and characteristics of infrastructure for passenger and freight travel), a temporal component (opening hours of shops, available time for activities), and a individual component (income, gender, educational level, mobility resources like vehicle ownership etc.). Individual mobility decisions are made within this context, eventually leading to physical movement and therefore becoming measurable. Lanzendorf and Scheiner (2004) extend this model by including social and psychological aspects. They define a framework of structural (spatial and urban structure, transport system, temporal structures, economic factors, political and planning factors) and individual social and psychological attributes (demographic and socio-economic factors, social situation, lifestyles and mobility styles, attitudes and norms, availability and ownership of means of transport) as basic conditions for the genesis of travel.

A deeper understanding of psychological factors for travel decisions is a necessary basis for successful measures aiming at the influence of individual mobility behaviour. For many years, transportation research has relied on approaches using the model of a "homo economicus",[1] implying that the main criterion for individual decisions is the maximisation

[1] This concept is mainly used in many economic theories; according to Persky (1995) the term was first introduced by John S. Mill in the middle of the 19th century.

of benefits. An application to travel behaviour is often made by using the "Rational Choice" theory (e. g. Simon 1955). As an example, Gorr (1997) sees the attractiveness of a means of transport – defined by travel time, travel costs and quality – as the main factor for travel behaviour decisions (see also Heggie 1978, Mahmassani and Jou 2000, etc.; for an overview of different traveller decision models see Sirakaya and Woodside 2005). One of the main criticisms of the "Rational Choice" theory questions the rationality of human choices and argues that because of different limiting factors like incomplete information or influence from passion (Frank 1990) people are only able to make subjective decisions. Another point of critique deals with the mainly individual approach of the theory, hindering the identification of influencing social laws (Sen 1982, for a more general criticism see Green and Shapiro 1994). Both aspects are important for researches focusing on the investigation and description of individual travel decisions.

In recent years, another psychological approach has become more popular among travel behaviour researchers – the "Theory of Planned Behaviour" (Ajzen 1991). Like the "Rational choice" theory, it focuses on a maximisation of satisfaction of needs as a basis for decisions. Additionally, this concept is widened by including social norms and rules and accounting for subjective perception. Hence, the "Theory of Planned Behaviour" allows a more detailed view on travel behaviour and mobility decisions, and many researchers use this approach to get insights in the nature and structure of travel choices (e. g. Hunecke et al. 2007, Anable 2005, Bamberg and Schmidt 1998). Based on this theoretical approach, the mostly habitual character of individual travel behaviour can be explained and considered (e. g. Gärling and Axhausen 2003). Møller (2002) gives a detailed overview over the role of habits for travel behaviour and mode choice. Verplanken and Aarts (1999) describe habits as "*learned sequences of acts that have become automatic responses to specific cues, and are functional in obtaining certain goals or end-states*". This automation is the main reason for the common resistance of individual travel behaviour to influencing measures, especially under stable contextual conditions (Verplanken et al. 1997, Ouellette and Wood 1998).

On the one hand, a habitual behaviour is very functional for the individual, because it reduces the necessary mental activity and eases complicated behavioural processes in stressful situations (Verplanken and Aarts 1999) and allows parallel acts (Ouellette and Wood 1998). On the other hand, other persons do not necessarily benefit from an individual's habits (Verplanken and Aarts 1999). A habitual behaviour is established when a deliberate decision is made and frequently repeated in a stable, supporting context, and when this decision always leads to a satisfying result (Møller 2002). In regard to travel behaviour research, the term "state dependence" (e. g. Dargay et al. 2006) implies a consideration of habits. It describes the dependency of recent travel behaviour on previously practised behaviour and, hence, takes into account learning effects from successful action.

Concerning measures to change travel behaviour, the process of establishing habits is more or less unfavourable. It intensifies the individual's focus on one chosen means of transport and reduces the perception of travel alternatives (Verplanken et al. 1997, Fujii et al. 2001). Additionally, habits force a biased estimation of other means of transport, resulting in an increase of perceived costs. E. g., Kenyon and Lyons (2003) show that car drivers normally overestimate costs and travel times for public transport use. Both facts – selective and biased perception of alternative means of transport – have to be considered for attempts to change individual travel behaviour in general, and particularly for measures to influence travel behaviour towards a more sustainable mobility.

Sustainability and Mobility

Responding to worldwide growing environmental problems and a massively increasing use of resources in the second half of the 20th century (Høyer 1999), the United Nations convened the World Commission on Environment and Development in 1983 (UN 1983). The final report of this commission – also named "Brundtland-Commission" after its chair Gro Harlem Brundtland – became the initial document for a global campaign to achieve a more sustainable development (WCED 1987). Most of the successive research projects, measures and action used and use the report's definition of sustainable development:

"Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs." (WCED 1987)

While the actual concept of sustainability implies environmental, economic and social issues, it is often mainly associated with environmental problems. The original term "sustainability" dates back to Hanns Carl von Carlowitz, a German forestry expert (Gerike 2007). In his handbook for a successful and long-term forest management (von Carlowitz 1713) he recommends a "sustainable forest management" and suggests to extract only as much wood over a certain period from a forest as would grow again in this forest within the same period. This aspect – the use of resources over a long-term period – is still one of the main issues of sustainability. By using the Brundtland Commission's definition, economist Herman Daly (1990) developed three main principles for a sustainable development:

a) Rates of renewable resources must not exceed their rates of regeneration.
b) Rates of use of non-renewable resources must not exceed the rates at which renewable substitutes are developed.
c) Rates of pollution emission must not exceed the assimilative capacity of the environment.

Because of its critical role for environmental problems and the consumption of resources and energy, the transport sector is one of the most important areas for measures towards a more sustainable development (for an overview see Høyer 1999). One of the first publi-

cations introducing the term "sustainable mobility" was the according "Green Paper" of the Commission of the European Communities (1992). It doesn't directly refer to the concept of sustainable development, but highlights the need for changes in the transport system to reduce negative effects on man and environment. By integrating aspects of the social and natural environment, Zeitler (1995) sees a necessity for mankind to "exercise maximum possible concerns towards other forms of existence". Regarding to consequences for the transport sector, he concludes two main simple principles: Firstly, the largest possible reduction in transport activities; and secondly, a development of the most considerate modes of transport. One of the most considerable events on the way to a sustainable mobility was the Vancouver Conference in 1997 (OECD 1997). By adapting the existing sustainability definitions, the conference developed nine criteria for a sustainable transport system. The nine "Vancouver Principles" are:

- Access
- Intra- and inter-generational equity
- Individual and community responsibility
- Protection of health and safety
- Education and public participation
- Integrated planning
- Conservation of land and other resources
- Prevention of pollution
- Economic well-being

Source: OECD 1997

Arguing that current trends in transport are not sustainable, Greene and Wegener (1997) see social and equity problems rising from an uneven distribution of causers and sufferers of negative transport related consequences across different socioeconomic groups and across different world regions. They conclude that the most developed countries must lead a movement towards a more sustainable transport system, and suggest three promising areas for research and measures for sustainable transport: implementation of technology, pricing and financing, and integrated transport and land use planning.

By now, the principles and concepts of sustainable transport in general have been implemented in many different research projects, articles and policy papers, addressing politicians and planners on global, regional and local level. Though, the main goal is a transformation of these universal and relatively vague guidelines into manageable and measurable tools. One of the most comprehensive research projects within this field was Swit-

zerland's "National Research Programme 41". There, scientists developed a set of criteria for an evaluation of transport systems, concerning different aspects of sustainable mobility (Ernst Basler + Partner Ltd. 1998a). Accounting for aspects from all three dimensions of sustainability – ecological, economic and social issues –, the evaluation tool consists of 13 criteria and 21 indicators. The most important of these indicators are emissions of greenhouse gases, noise and air pollution, size of unfragmented areas, coverage of all social costs, prices of transport services, access to regional centres by public transport, and participation of the public in decision-making.

More recent research tries to establish a theoretical framework for political and planning measures. E. g., Gerike (2007) develops a set of three task fields as basis for concrete applications towards a sustainable transport system. An allocative task field reduces market distortions (like external costs, see also Litman 2006) and uses market mechanisms to identify and satisfy needs. The aim of the social task field is the provision of a basic transportation supply to guarantee the fulfilment of basic needs. At last, the resource task field rules the distribution of natural resources among generations and regions and uses carrying capacities as limits. These three task fields establish a development corridor for sustainable mobility measures. For instance, acting within this corridor means for transport planners to concentrate on a basic transportation supply that guarantees the satisfaction of basic needs for all people instead of trying to satisfy all mobility needs, especially with the background of still increasing distances for the same travel purposes. For a comprehensive sustainability evaluation of transport and related measures, Litman (2008) suggests the use of indicators from seven different areas: the planning process (evaluation of quality of analysis), options and incentives (travel options and incentives to use efficient means of transport), travel behaviour (e. g. vehicle travel, modal split), physical impacts (e. g. pollution, crash rates, land consumption), human and environmental impacts (e. g. illnesses, environmental degradation), economic effects (e. g. monetized estimates of economic costs) and performance targets (degree of achievement of stated targets). These areas result in a large number of useable social, economic and environmental indicators like annual person kilometres and trips, per capita crash and fatality rates, or per capita energy consumption.

Whilst this recent complex research and the resulting conclusions provide excellent frameworks to evaluate and design policy and planning measures on a larger scale, they could also be applicable to existing travel behaviour on a local level. A more comprehensive assessment of daily mobility can be achieved, if the criteria used are focused on suggested sustainable transport indicators. Simultaneously, a more complex evaluation would be more difficult to handle and to understand. Two major reasons are several uncertainties regarding the future development of different sustainability factors and their values, and difficulties with the development of summarised indicators (Ernst Basler + Partner Ltd. 1998a). Existing sustainable transport theories are also basically process oriented. Therefore, additional benefits from an overall comprehensive evaluation system could be

less important than an easy and understandable standard of evaluation, providing a better manageable and presentable project.

Sustainable Travel

The ECMT (2004) published an across the scientific community widely accepted definition for sustainable transport. According to this definition, a sustainable transport system is one that a) allows the basic access needs of individuals and societies to be met safely and in a manner consistent with human and ecosystem health, and with equity within and between generations; b) is affordable, operates efficiently, offers choice of transport mode, and supports a vibrant economy; and c) limits emissions and waste within the planet's ability to absorb them, minimizes consumption of non-renewable resources, limits consumption of renewable resources to the sustainable yield level, reuses and recycles its components, and minimizes the use of land and the production of noise. There is also a general agreement that the current situation and trends in transport are not sustainable (e. g. European Commission 2003, Greene and Wegener 1997). Undoubtedly, changes in the transport sector are strongly necessary to reverse present trends and force changes towards a more sustainable development.

While the concept of sustainability deals with economic, ecological and social issues, research and measures from the sustainable transport sector are often focused on environmental issues (e. g. EEA 2007, OECD 2000a, Geurs and van Wee 2000). On the one hand, this could be caused by the immediate and ascertainable nature of ecological threats and their current and future impact on human well-being, combined with the common presence in media. On the other hand, environmental effects are better measurable and assessable than social and complex economic effects (OECD 2000b, Steg and Gifford 2005). Furthermore, effects from the three areas often go hand in hand and depend on each other. E. g., a popular economic criterion for sustainable transport is a corrected price for the efficiency of transport under consideration of additional costs like insufficient coverage of operation costs, congestion costs and external costs (Ernst Basler + Partner Ltd. 1998b). Because large parts of external costs of transport are, for instance, due to emissions and accidents (Maibach et al. 2004), it also covers environmental and social issues. A general summary of the cited projects and publications delivers some common criteria for all three dimensions of sustainability. Besides the above mentioned corrected price of transport services, social costs (or percentage of covered operational costs) and economic welfare are often used as economic indicators. Sustainability on the social field is frequently measured by accessibility, for instance percentage of people with acceptable access to the next regional centre by public transport or accessibility of facilities to meet basic needs, or security aspects (e. g. rates of traffic casualties). Common ecological indicators are the amount of emissions (e. g. CO_2, particulate matter, other air pollution), land consumption, the use of resources and noise emissions.

A comparison of the different indicators shows that existing simplifications regarding sustainable travel behaviour (e. g. limitation to environmental effects, see below) seem to be legitimate. Dependent on travel purpose, most research projects compare share and intensity of the generally considered least sustainable means of transport with used alternative transport modes. For (almost) daily travel like commuting, shopping or leisure trips, these analyses often distinguish between car use on the one hand and public transport or bicycle use and walking on the other. For less frequent long distance trips like tourist travel, the distinction is often between air travel and other transport modes; an additional aspect is the consideration of the particular travel distances. While these evaluation systems mainly consider environmental effects, social and economic indicators are also covered to a certain amount. Regarding external costs, air travel and car use are the most unfavourable means of transport (Maibach et al. 2004), but in regard to covered costs or effects on economic welfare as other economic indicators this conclusion cannot be drawn directly. In terms of social criteria, an efficient public transport system is generally considered to provide access for all users (Ernst Basler + Partner Ltd. 1998a); other indicators can't easily be linked to specific modes of transport. In general, and under consideration of the above mentioned uncertainties, the existing simplifications seem to be acceptable for the adaptation of process oriented and complex indicator systems to a sustainability evaluation of today's travel behaviour.

Many different travel behaviour research projects are drawing on ownership and use of a car to distinguish between sustainable and non-sustainable mobility. E. g., Steg and Gifford (2005) focus on car use to evaluate the relationship between sustainable development and quality of life, highlighting the role of individual acceptance of sustainability measures on the transport sector. Concentrating on sustainable tourism in rural areas, Dickinson and Dickinson (2006) compare different strategies and projects to reduce car use and increase the use of alternative modes of transport (public transport, cycling, walking). With this background, they discuss a social representations perspective to take into account the "social reality" and social processes that underlie people's travel decisions. Focusing on rates of motor vehicle ownership and use, Zegras (2005) explores the role of the built environment for sustainable urban mobility. Donegan et al. (2007) calculate a more comprehensive "household sustainability index" to show differences in sustainable travel behaviour regarding residential location and length of occupancy. By utilising expert interviews, they develop a set of evaluation attributes, consisting of five household travel behaviour components: mode of transport used for activities, location of activities, frequency of activity trips, proximity of public transport, and number of private vehicles / licence-holders.

Anable (2005) introduces a more psychological approach, tracing back to the "Theory of Planned Behaviour" (see above). Comparable to existing lifestyle approaches, she utilises a set of 17 factors related to attitudes towards car use, attitudes towards the use of alternative modes, attitudes towards the environment, and "green behaviour". These factors

are the basis for a cluster analysis, resulting in six different groups of survey respondents: four car owning (malcontented motorists, complacent car addicts, die hard drivers, aspiring environmentalists) and two non-car owning groups (car-less crusaders, reluctant riders). Current travel behaviour patterns are used to show characteristics and describe differences between clusters (see below). A comparable approach is used by Götz et al. (2003). Within the project "City:mobil", they evaluate mobility orientations, resulting in five different mobility styles: traditional domestics, reckless car fans, status-oriented automobilists, traditional nature lovers, and ecologically resolute. Travel behaviour patterns associated to these groups show noticeable differences, for instance for car use rates. By reversing these approaches, Hunecke et al. (2007) calculate a general indicator for the ecological impact of individual travel behaviour and develop a regression model, including socio-demographic, psychological and infrastructural variables. They limit the evaluation of sustainability or environmental effects to the amount of annual emissions. This simplification allows an inclusion of all different personal travel patterns in one factor, but represents only a small amount of all dimensions of sustainability. Additionally, they examine determinants of travel mode choice and travel distances as the two most important behavioural determinants of individually caused greenhouse gas emissions.

Travel patterns as well as infrastructural, socio-economic, demographic and psychological factors are the main variables to characterise individuals and groups with more sustainable mobility behaviour. Necessarily, in many projects these factors at least partly overlap with indicators to identify persons with sustainable travel behaviour. Within this context, an often discussed topic is the influence of the built environment on travel behaviour (e. g. Williams 2005). While there is a wide acceptance that the city is the most sustainable urban structure and that compact urban forms provide shorter trips and the use of alternative modes of transport (Banister 2008), it is questioned if there are stronger predictors for travel behaviour than infrastructural parameters. For places in Northern Ireland, Donegan et al. (2007) show a significant influence of length of occupancy (established residents show a more sustainable behaviour than newcomers) and settlement location (compact urban settlements allow a more sustainable behaviour than rural locations) on a household's sustainability index, covering different travel behaviour aspects.

Krizek's (2030) project results support these findings. By using an analysis of the Puget Sound Transportation Panel, he shows that an increasing accessibility, measured by density, land use mix and street pattern, reduces vehicle miles travelled (vmt) and overall distances covered. Simultaneously, the number of trips increases, but the sustainability relevant decrease in vmt prevails. Schwanen et al. (2005) qualify the role of the built environment for travel behaviour and show a varying significance of urban form for different household types and different travel purposes. They assume additional relevant factors for travel behaviour like socio-economic condition, car availability, or lifestyle. Hunecke et al. (2007) conclude from their study a more significant influence of socio-demographic and psychological variables on the ecological effects of mobility behaviour, with a minor

relevance of infrastructural aspects. In their regression model, predicting the ecological impact of mobility behaviour, the most significant factors were psychological variables (perceived behavioural control, perceived mobility necessities) and socio-demographic variables (full-time employment, part-time employment, age, living apart together relationship); living in an inner city, car availability and number of cars per household showed also some significant impact.

Psychological variables are the basis for Anable's (2005) travel behaviour groups (see above). Socio-demographic characteristics of the different groups show less differences between the four car-owning groups. Only the educational level of "aspiring environmentalists" is significantly higher than those of the other car owner groups. In contrast, members of the two non-car owning groups are older, have fewer children and are more often retired than car owning participants. Anable draws the conclusion that with equal vehicle availability personal characteristics are not an important determinant of attitudes or differences in behaviour. But the different attitudes and values of the groups lead to expected differences in mobility behaviour and intention to change travel mode. In particular, this means a high car dependency and low intentions to use alternative transport modes for "die hard drivers" and "complacent car addicts", while "malcontented motorists" have a rather high intention to change to alternative travel modes. Significant differences in travel behaviour can also be documented for five mobility style groups in Freiburg (Germany), introduced by Götz et al. (2003, see above): "Reckless car fans" show the highest amount of car use, covering 56 % of all trips by car. Instead, the lowest car use rate, only covering 10 % of all trips, can be found for "ecologically resolute".

Conclusion

A literature review of some relevant projects and articles delivers a variety of indicator sets for an evaluation of sustainable mobility. Each approach tries to take into account all three dimensions of sustainability – ecological, economic and social issues. Because the indicator sets are aiming at an evaluation of future trends of mobility and transport measures, they are generally very complex, including some difficult to manage criteria. Nevertheless, these approaches can also be used as a basis for comparisons and evaluations of sustainability aspects in current individual travel behaviour.

Recent travel behaviour projects have often been focused on environmental aspects of sustainability. In most cases, this simplification seems to be acceptable. It increases understandability of evaluation tools and reduces uncertainties regarding values and future development of used indicators, while some uncomplicated definitions of sustainable transport will still be met (e. g. Zeitler 1995, see above). A comparable approach would also avoid often experienced and criticised difficulties with a summarised value for different indicators. Additionally, with some exceptions the use of environmentally unsustainable travel modes often goes hand in hand with negative effects on the other two fields of

sustainability. All in all, concentrating on some aspects of sustainable mobility seems to reduce complications and vulnerability of the analyses and increases the manageability and perceivability of the project results.

The direct measurement of environmental effects of individual travel is the most common approach, but indicators for sustainable mobility behaviour can also be found on the field of psychological and behavioural aspects. While the classification of travel behaviour groups often refers to car ownership and intensity of car use or – especially for tourist and business trips – air travel, the design of psychological categories takes into account perception, values and attitudes towards different modes of transport. A combined approach, joining psychological, lifestyle and travel behaviour attributes, is the application of mobility styles. This could be a promising concept for a comparative investigation of individual mobility. A complex evaluation of current travel behaviour in terms of sustainability should also consider impact from socio-economic, demographic and infrastructural aspects as these are additional parameters of travel genesis. As far as possible, characteristics of different purposes of travel (e. g. causes like underlying needs, mode of transport, frequency and distance of trips, direct environmental effects, etc.) should be observed and compared. The outcome could provide new findings regarding relations between different types of individual sustainable travel and could be the basis for a hierarchical evaluation of necessary shifts in individual travel behaviour.

Finally, recommendations for measures towards sustainable mobility must take into account the habitual nature of travel behaviour decisions and the biased individual perception of travel alternatives. Consequences of potential measures must be considered completely, e. g. if specific policies would reduce unsustainable travel on one hand, but could on the other hand also result in generated travel for other purposes. Under consideration of findings regarding a relatively stable individual time budget of approximately one hour a day (e. g. Schafer and Victor 2000), simple shifts and changes without a resulting reduction of travel become possible. Therefore, a complex behavioral approach, covering all dimensions of individual travel, seems to be a promising research tool towards a more sustainable mobility.

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