EUROPEAN PARLIAMENT

Science and Technology Options Assessment

S T O A

URBAN TRANSPORT

Barriers and success factors for innovation pathways to sustainable urban transport

Phase I I I

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URBAN TRANSPORT

Barriers and success factors for innovation pathways to sustainable urban transport

Phase III

Abstract

Looks at the socio-economic context in which innovative technologies and concepts are, or will be, implemented. It highlights the relevance of paradigms and visions and the importance of the attitudes and perceptions of the transport users for a successful transition to sustainable transport. The paradigm of sustainable transport is about to dominate transport planning in many urban areas, which can exert significant influence on the development of the technology-infrastructure combinations. But for a successful transition the transport users need to be taken into account more systematically. There is evidence that travel behaviour of some societal groups is about to change. E.g. a growing number of younger people show a more pragmatic attitude towards cars and car ownership than the generation before. Young people in urban areas seem to become more flexible in their mobility behaviour and more open to new forms of transport. Further this phase of the project deals with transport policies of the different political levels; policies are an important element in the transport system as they provide framework conditions under which other stakeholders act and orient themselves. The report also looks at barriers to implementation and on success factors on the way to a sustainable transport system. Typical barriers relate to financial constraints, institutional or legal shortcomings or a lack in public acceptability. An important success factor is, besides the formulation of a common vision, to try out new solutions in pilot projects.

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Executive Summary

It is well known that transport, on the one hand, is a basic pillar of economic growth and the quality of life in European countries. On the other hand, transport has negative impacts on the environment and human health. In addition, over the last decades the growth in motorised individual transport increasingly hampered the free flow of vehicles and thus the functioning of the system. The oil dependency of modern transport systems is projected to become a serious problem in the future. These challenges accumulate in urban areas where the density of population is high and the transport-related technology-infrastructure systems are extremely concentrated. Solutions are needed, innovative technologies and organisational innovations have not only to be developed but also need to be implemented on a larger scale to become effective.

Deliverable 2 of the project described technology options and mobility services which are, or might become, relevant for urban transport systems and, thus, will also become relevant for a transition to more sustainable urban transport. The report also looked at impacts, challenges, and visions related to these technologies and concepts. In doing so, it was putting the focus on the supply side of the transport system. A wide range of technical options were highlighted in this report. Some of them are already available, some are emerging, and others are of a more visionary character. It was argued that recently, with respect to innovations, major contributors to changes that are anticipated or already observable are developments in fields of:

- Alternative fuels and propulsion technologies
- Information and communication technologies (ICT)
- New concepts and business models (e.g. mobile-ticketing; bike- and car-sharing)

In Deliverable 2 of this project five factors were outlined that are seen to be relevant for changing the existing transport system. These factors are: technologies, business models, mobility patterns, transport policies, and paradigms. Under the umbrella of external framework conditions, such as the increasing scarcity of oil, the five factors mentioned are mutually dependent and complement one another. The term co-evolution is used to describe this mutual relationship. Two factors, technologies and business models, were already examined in Deliverable 2 of this project. Therefore the report at hand, which is Deliverable 3, discusses the relevance of paradigms and visions, the relevance of political framework conditions as well as the relevance of the mobility patterns, behaviour, and attitudes for sustainable innovations in urban transport.

It has been demonstrated in the history of transport planning that (policy) paradigms have decisive influence on design and development of technological and organisational innovations. For instance, transport policy of the 1960s and partly as well of the 1970s was characterised by the vision of optimising cities for private motorised transport. The impact of this paradigm is still visible in many European cities and regions, where large and busy arterial roads and inner-urban traffic junctions define the character and appearance of the city. In the meantime, this paradigm has been replaced by a paradigm of sustainable transport in many urban areas, resulting in the support of non-motorised and public transport as well as traffic restraints and a greater emphasis on the mutual relationship between land use and transport planning. It can be concluded that paradigms and visions matter and they change over time. The political realm is having influence on the development of paradigms and visions.

Paradigms and visions also influence – at least indirectly – people's behaviour which develops together with the technology-infrastructure systems. Such behavioural patterns are due to learning processes and routines which develop over longer times and are in general considered as being rather stable. Several studies as well as findings from innovation research illustrate that transport-related decisions are influenced by much more than "rational" economic reflections of the users of the transport system. These decisions are influenced by values and norms, by personal preferences, by more general perceptions and attitudes. Factors such as the image of a transport mode and self-recognition or self-expression can be relevant for the development of mobility patterns. A key lesson that should be used more offensive in policy practice is that environmentally-friendly modes of transport need a positive image that is in line with values and norms of its users. For example, cycling should rather be promoted as being fun, flexible, and handy than as being healthy and environmentally friendly. However, changing user behaviour which is based on norms and values surely is not an easy task; nevertheless, participation processes and early information about political decisions can help to increase acceptance.

There is evidence that travel behaviour is not that static as it seems, it rather changes over time. However, this surely depends on the group of people and the type of mode. In several countries, it can be observed that the travel behaviour of some societal groups is increasingly changing. A good example is Germany. Here the people older than 60 years are using the car more than the same group did about ten years ago[1], which is due to the growing number of people older than sixty but as well due to the fact that older people today are staying more active and mobile. It is mainly these people over 60 who are responsible for the slight growth in transport volumes in Germany. On the other hand, it can be observed that there is a growing group of young people in urban areas who have a more pragmatic relationship to car ownership and car usage compared to the same age group about ten years ago. For this people there are no emotional aspects or ideas of status symbol associated with cars.[2] In addition, these young people in urban areas seem to become rather flexible in their mobility behaviour. They are using the car significantly less compared to the group ten years ago.[3] It is assumed that the heavily increasing importance of information and communication technologies is a key driver for this development. Even if it is yet not clear if this group is changing its behaviour when entering a new phase of their life (e.g. getting children, first job, moving to another place), it seems to be disposed to use different modes of transport if it is "feasible and handy".

Transport policy is somehow the superstructure for change. It does not only set regulations and directives but also provides the framework conditions under which other stakeholders act and orient themselves. The responsibility for urban transport policies lies primarily with local, regional, and national authorities, although the European perspective is crucial as well. The EU should take the lead in promoting and supporting sustainable transport, therefore visions of how the transport system should look like need to be developed and communicated (for example guiding visions for different prototypes of urban areas).

[1] See KIT (2010).

[2] See FHDW (2010).

[3] See KIT (2010).

Moreover, the EU has capacities to advocate R&D activities that can support best practices and further encourage the development of innovations. A table of possible policy instruments in the annex gives an idea of the wide range of policy instruments being available for the different governmental levels. This table will be further developed in the final phases of the project.

There are several significant barriers to implementation. They can either be of financial nature, which can limit the overall expenditure on the strategy as a whole, on specific instruments, or on the flexibility of implementation. But those financial constraints might also stimulate decision-makers to try out new ways of organising transport. So-called institutional barriers occur when actions are difficult to co-ordinate between different organisations, levels of government, or policy sectors. To overcome this barrier an institutional framework is needed that encourages different departments to support and interact with each other towards the goal (or shared vision). Social and cultural barriers are strongly related to public acceptability (normative) and to public acceptance (empirical). A combination of measures that literally “pull” people towards cleaner modes by making them more attractive and those measures that push them to bear a greater proportion of the real costs of transport is needed. Moreover users need to be informed about the ideas and visions behind a political measure, in order to better understand the need for it. However, it is important to note that the way sustainable transport policy measures should be designed, communicated or implemented depends also on regional differences and features.

Furthermore, the support and development of so-called “niches” is outlined as a crucial political strategy in this report. Niches are defined as technologies or local practices that differ from the incumbent system (or regime). Examples are Bike-Sharing or also Car-Sharing Systems which were already described in Deliverable II of this project. In niches new actor constellations as well as new forms of organisation can be tried out and things can be modified in a way that they best match the users’ needs. With increasing pressure from external factors (e.g. rising oil prices) or when mature enough it might be possible that such niches are entering bigger markets and finally replace the “old” system.

This is an interim report and the conclusions have to be further developed in the final report of the project. This deliverable ends with a brief analytical framework that sets the basis for the interview meetings to be conducted in phase 4 of the project. The idea is to focus on the mobility behaviour of younger people in urban areas in different European countries. It is these urban youngsters which seem to be most flexible in their mobility behaviour. One important reason for that might be the fact that this is the first generation who fully grew up with internet and mobile phones; they grew up in a socio-technical environment that is definitely different to all that was before. Against this background, it will be interesting to learn more about younger people’s attitudes and perceptions towards sustainable mobility in urban areas.

Contents

General Information

Urban transport is related to a wide range of unsolved problems and challenges that need to be tackled in order to guarantee a high level of quality of life in European cities and to make the transport system an even more efficient pillar of the European economies. More information is needed, especially on the potential of future or emerging technological developments and organisational innovations. To aid understanding and ensure such potential is achieved it is important to get a better idea not only of technologies but also of the relationship between these technologies and concepts on the one hand and the different actors that are important for their successful development and implementation on the other hand. Against this background, this STOA project on urban transport considers technologies from an innovation-oriented angle. The overall aim is to highlight promising innovation pathways to a more sustainable urban transport system. Deliverable 2 of the project provided an inventory of both existing and future technology options in urban transport as well as an overview of the scientific knowledge concerning their impacts on health and/or environment.

The report at hand is Deliverable 3 of the project. On basis of DEL 2, it looks at the socio-economic context in which the technologies and concepts are, or will be, implemented. Its focus is on the factors and framework conditions influencing a successful implementation of promising innovative approaches in the transport system. In doing so, different components that are relevant for the system are distinguished: the report deals with paradigms and visions, with mobility patterns, user behaviour, attitudes and perceptions, with policy measures on the different administrative levels as well as with barriers and success factors for the implementation of promising approaches. The report concludes with a brief analytical framework that sets the basis for the interview meetings to be conducted in phase 4 of the project.

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1. Introduction

Transport is faced with various challenges, such as congestion, environmental and health damages, noise, reduced quality of life, emissions, accidents, and disruptions of communities. In DEL 2 of this project a broad range of technologies and concepts have been introduced which are supposed to have the potential to cope with these challenges and thus pave the way to a more sustainable urban transport system. Some of the innovations described are already established in urban areas (e.g. real time information, pedelecs, or car- and bike-sharing systems), others are being successfully tested in pilot projects (e.g. mobile ticketing), some are emerging but have not yet fully commercialised (e.g. electric cars) and there are also technologies which might only become relevant in a mid- to long-term perspective (e.g. freight tunnels in urban areas; personal rapid transport systems). It was illustrated that many of these technologies and concepts are influencing the current transport system. In respect to these developments, the main drivers of change could be highlighted as:

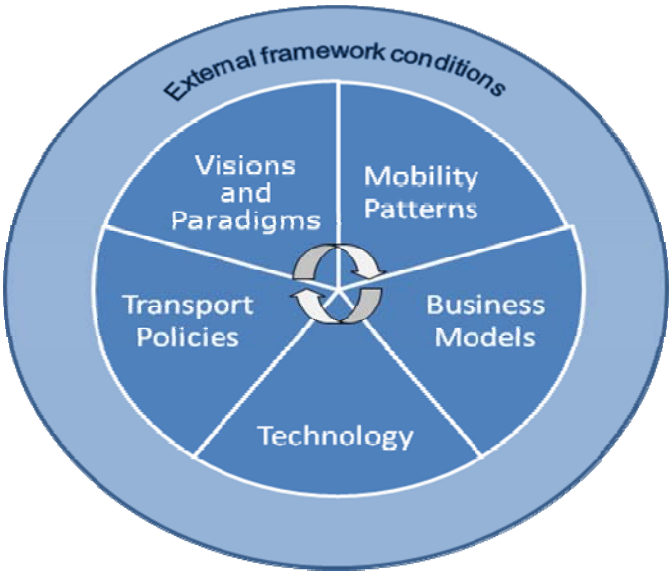
- Alternative fuels
- Information and communication technologies (ICT)
- New concepts and business models (e.g. mobile ticketing; bike and car sharing)

Along with these developments, DEL 2 has outlined that new actors are trying to enter the transport market. Besides traditional actors, such as automobile manufacturers, rail companies, or public transport companies, new actors are increasingly active and visible on the market. Among them are electricity companies (who are interested in electric vehicles), advertising companies (which have been significantly involved in setting up bike-sharing schemes), or online platforms (which are for instance important to organise car pooling). As a result, not just the vehicles themselves are changing, an increasing amount of multimodal transport options and organisational innovations could be identified as well. It was further anticipated that these developments could have a crucial influence on the demand side of the transport system. At the beginning of every activity in transport there is a decision taken by an individual about what to do, where to go, which mode to choose, and which route to take. The sum of these individual decisions is what can be observed in its cumulated form as number of trips, transport volumes and modal split. These choices and decisions determine in the end whether an urban transport system is more sustainable than another one. Of course, the final choice is restricted by the options the transport system offers. And therefore the supply side has a strong influence on the decisions taken by individuals and also on the emergence of an intention to travel. On the other hand, the supply side offers options which match existing needs and attitudes. In other words, transport demand and transport supply significantly influence each other.

Under the umbrella of external framework conditions, such as the increasing scarcity of oil, paradigms appear and change, transport policies are being adopted, mobility patterns rise and new technologies and business models are developed. Paradigms and transport policies somehow seem to be the superstructure for change, as they actively support and influence the development of technological and organisational innovations as well as indirectly influence user behaviour. Though, it is not easy to say which of the mentioned factors comes first to influence the others.

New technologies or changed mobility patterns might be likewise the first factor to influence the formulation of a new paradigm, which in turn has significant influence on transport policies. However, all factors described have a mutual relationship and are influencing each other (see figure Figure 1-1).

Figure 1-1: Co-evolution of mobility patterns, business models, technology, transport policies, and paradigms



Having this in mind, public authorities have the challenging task to provide an environment in which those components co-evolve in a more sustainable way than today. Decision-makers should therefore keep in mind all components described in figure 1-1. They should equally question the aspects of travel decisions, look at alternatives for travel and encourage greater efficiency in the transport sector. On the basis of this, three types of action can be clustered to achieve sustainable mobility:[4]

1) *Changing the specific carbon intensity of the different transport modes*
2) *Changing the modal split*
3) *Reducing the need to travel/decoupling transport growth from economic growth*

In this deliverable the focus will be on the question how the potential of technologies and concepts, which have been described in DEL 2, can be better used for a transition to a sustainable urban transport system. Therefore visions and paradigms as well as transport policies will be taken into consideration more deeply, since they have not yet been dealt with in detail in DEL 2 of the project. Thus chapter 2 will focus on existing and past paradigms in transport. Chapter 3 will give insights into existing knowledge about users' preferences, attitudes, and behaviour. Moreover, in chapter 4 strategies will be highlighted that can help to translate the above three types of action into political practice. In a conclusion potential barriers and success factors for innovation pathways will be outlined.

[4] See Schippl, J.; Leisner, I. (2009), as well as similarities to Banister, D. (2008)

Furthermore, this DEL 3 is supposed to set the basis for an empirical phase where the role of user perceptions and attitudes for a transition to sustainable urban transport systems is being analysed. An analytical framework for the design of the interview meetings is briefly described at the end of the document.

2. Visions and paradigms in transport policy

As it will be shown in this chapter, there is evidence that paradigms, visions, or "guiding principles" can exert significant influence on the development of socio-technological systems. They are a factor to be considered when it comes to the identification of pathways to sustainable urban transport systems and are of great importance for the technology-infrastructure combinations that are implemented in urban areas.

A paradigm[5] or guiding principle basically refers to how people think about problems and how they develop solutions to overcome these problems. Two essentially interrelated paradigms are important in the context of this project: policy paradigms and technology paradigms. However, a clear distinction cannot really be made since both have their origin in Kuhn's idea of a scientific paradigm, but they obviously have different points of reference. But still, there are definitely major similarities and they are mutually dependent on each other. Applied science and technology are significantly overlapping, and along this symbiosis institutional and social factors determine the direction of both.[6]

A policy paradigm, like Kuhn's idea of a scientific paradigm, is described by Hall (1994) as a framework of visions and standards that not only specify the goals of policy-making and the tools used to achieve these goals, but "also the very nature of the problems they are meant to be addressing".[7] In line with this, Dosi (1982) describes a technological paradigm as "model and a pattern of solution on *selected* principles [...] and on *selected* material technologies".[8] Dosi further states that technology embodies which pathways of technical change to pursue and which to neglect. The concept of a technological paradigm becomes obvious when looking at the need to transport passengers or goods. In order to comply with this need, specific technologies emerged that are provided for a specific kind of solution, while others are being neglected at the same time. A prominent example is the success of the internal combustion engine, while the electric drive has been the neglected alternative – at least for private motorisation and for a long time.

It has been demonstrated in the history of transport planning that (policy) paradigms have decisive influence on design and development of technological and organisational innovations. For example, in the 1960s and partly also in the 1970s, the leading paradigm for urban transport in many European countries was to create a city that was optimised for motorised individual transport, with wide roads and parking spaces. Public transport was considered as being old fashioned (see figure Figure 2-1). Many cities removed their tramway lines and extensive road construction schemes were planned and widely implemented.

[5] The term "scientific paradigm" has initially been coined by Thomas S. Kuhn (1962) to describe a set of practices that define the relevant problems as well as the specific knowledge related to their solutions; a scientific paradigm determines the field of enquiry, the problems, the procedures, and the tasks.

[6] See Dosi, G. (1982).

[7] Hall, P.A. (1993).

[8] Dosi, G. (1982).

Figure 2-1: Visions of a future transport system of 1959 and 1961

Source: Bürgle, K. (1959).

During that time "predict and provide" was the desired (and possible) policy logic in most European cities and regions. Transport policy followed a growth paradigm, both to encourage economic growth and to provide the road capacity to match the predicted increase in demand for travel.[9] Additionally this period was characterised by a "strong (and ever increasing) reliance on Technology to solve or alleviate problems in all aspects of the operation of the system from congestion to operation efficiency and safety".[10] Even though not all have become true, the impact of this paradigm is still visible in many European cities and regions. Specific policies of these decades (and especially between the 1960s and 1980s) were i.e. the strict separation of transport modes or the transformation of city centres into traffic junctions.[11] Road construction stimulated suburbanisation, both of individuals and of trade and industry. Suburbanisation in turn increased the demand for travel and strengthened car dependency, which lead to an ever increasing and continuous demand for road capacity. As a result of the growing awareness of environmental externalities associated with transport growth, the supply-oriented transport planning increasingly found itself under scrutiny. Various experts (e.g. Marvin and Guy, 1999; Goodwin, 1999) detected a "new realism" in transport planning, meaning the growing awareness to manage demand for travel rather than providing road capacity for traffic growth. And indeed, principles of sustainable mobility gradually obtained priority over the "predict and provide" approach of the years before. Related to urban transport policies the new approach basically consists of the following:[12]

- Improved provision of infrastructure for pedestrians, cyclists, and public transport
- Incremental use of traffic restraints
- Increased implementation of pricing policies

[9] See Banister, D. (2007).

[10] Giannopoulos, G.A. (2003).

[11] See Hatzfeld, U. (1996).

[12] See Vigar, G. (2001).

- Greater emphasis on relationship between land-use planning and demand for transport
- Little or no increase in road network capacity

Figure 2-2: Perspective of Malmös future transport system as an example for a sustainable transport vision

Source: Ljungberg, C. (2010).

In this sense the European Commission states in its White Paper on Transport (2001) that the answer to the ever increasing demand for transport "cannot be just to build new infrastructure and open up markets"[13] and declares sustainability of the transport system as priority and adds the user "at the heart of transport policy".[14] Decoupling economic growth from transport growth is a central target. Integration and modal shift are key concepts in the White Paper, whereas the 2006 mid-term review of the White Paper slightly shifts the focus by introducing the concept of co-modality. The underlying idea is that all modes must become more environmentally friendly, safe, and energy efficient.[15]

However, the existence of a paradigm or even a paradigm shift is never fully measurable, since the views of experts are likely to be controversial. Nevertheless there is an intense debate on whether a new paradigm is really emerging or whether sustainable development can be accommodated as a variant within the traditional paradigm.[16] Though, there surely is dynamic in the debate, as seen for example in the Commissions 2001 White Paper on Transport or the 2006 mid-term review of the Transport White Paper. Along the process of the emergence of a technology different forces come into play and act as selective devices. Among those are primarily new scientific insights and economic interests but also certain political drives and social factors. In this context, Geels (2004) developed the concept of socio-technical regimes to describe changes from one system to another.

[13] CEC (2001).

[14] See ibd.

[15] See CEC (2006).

[16] See Banister, D. (2007).

The concept of socio-technical regimes recognises that firms and engineers, scientists, users, societal groups, and policy makers are embedded within wider social and economic systems.[17] Some of the reasons why cleaner technologies are not being introduced to the market, even though benefits are evident, relates to dominant rules and practices of the incumbent regime.[18] According to Geels and Kemp (2007), the dominance of certain technologies is thus not only a matter of economics, but of routines, ways of thinking and doing (paradigms), because of formal regulations, institutional arrangements, and accompanying infrastructures. Because of these linkages, socio-technical systems are relatively stable (see chapter 6.1).[19] The key point is that system innovations – which a paradigm shift may bring about – occur through the interplay between dynamics at different levels, namely through co-evolution and interaction between technological change and socio-economic trends.[20] The use of existing and past technologies plays a significant role for the acceptance of new developments, as they are jointly responsible for today's preferences, tastes, and lifestyles.[21] The question is now how such a belief system can be replaced or modified? And what role do governments play in this field? According to Kuhn (1962), a paradigm shift occurs when one idea is overtaken by another, usually through the replacement over time of the generation of scientists (or politicians) who adhered to an old idea with another that cleaves to a new one. These shifts can be fostered by technological breakthroughs and by conceptual innovations. In this sense, one can speak of a (policy) paradigm shift if the fundamental goals that guide the policy, the instrument settings, and the instruments themselves, change.[22] One particularly interesting approach to increase the likelihood of a paradigm shift is transition management. It can be seen as an approach that provides a tool to help to understand the incumbent structure, culture, and practices of a societal (sub-)system. And hence might provide a tool to reflect policy goals and strategies. This strategy will be further highlighted in chapter 6.1.

[17] The socio-technical regime of car-based transport for example comprises of automobiles, fuel infrastructure, user mobility patterns, production system and industry structure, maintenance and distribution networks, regulations and policies, road infrastructure, culture, and the symbolic meaning of the car.

[18] See Geels, F. (2004).

[19] See Geels, F.; Kemp, R. (2007).

[20] See Geels, F. (2005).

[21] See Kemp, R. (1994).

[22] See Hall, P.A. (1993).

3. Behavioural aspects and mobility patterns

In this section we will have a closer look at the demand side of the transport system. In chapter 1 of this report three strategies for improving sustainability have already been briefly distinguished (and will be discussed in detail in chapter 4). The first strategy, changing the carbon intensity of transport modes, relates to the development of cleaner cars and other vehicles. However, if a cleaner car just substitutes an older one, this is usually not directly related to behavioural changes and will thus not necessarily induce changes in mobility patterns. The substitution of older cars with cleaner ones is rather a matter of buying decisions or motivations to purchase "green" products. Those buying decisions are related to the symbolic aspects linked to car ownership, which will be an issue later in this chapter (see chapter 3.2).

The other two strategies, changing modal split and reducing the need to travel, definitely require a change in mobility behaviour. The literature on user behaviour as well as the motivations for the trip generation and modal choice are manifold and cannot be discussed in their full scope here. In addition, there are differences between cultures, countries, and cities. In this chapter we will therefore try to briefly describe some key-aspects of transport behaviour. The relevance of these aspects for pathways to a more sustainable urban transport system will be of special interest and, at the same time, their relevance for barriers and success factors influencing these pathways.

Transport behaviour is getting visible in mobility patterns. So it is worth to take a brief look at some significant parameters of travel patterns in Europe. The share of total passenger travel undertaken in the EU-27 was steadily growing between 1995 and 2006. Some 6.4 trillion passenger kilometres, or an average of more than 13,000 km per person have been undertaken by the Europeans in 2006. This represents an increase of 1.7% per year since 1995.[23] During this period, the share of travel undertaken by public transport has been relatively stable with around 9-10%[24] since 1995. But also walking has a reasonable share of total trips in some European countries. Even though data is not available on a European basis, Bassett Jr. et al. (2008) provided some exemplary numbers. According to their study, numbers vary between 13% in Ireland and 35% in Spain. Nevertheless, the main mean of transport - the car - accounts for almost three quarters (73%) of the total performance.[25]

These numbers have to be changed if a modal shift or a reduction in transport volumes should be achieved. In the following, different studies and empirical findings are introduced, which give an idea of the attitudes and perceptions which are relevant for transport behaviour and thus for promising innovation strategies in urban transport.

[23] See CEC (2009a).

[24] These numbers vary depending on the country. According to Bassett Jr. et al. (2008), Germany, Finland, and Denmark for example have a mode share of public transport of 8%, the UK of 9%, Sweden 11%, Switzerland and Spain 12%, and Latvia has 32%.

[25] See CEC (2009a).

3.1. On behavioural changes

It is argued that transport behaviour is a matter of habitual behavioural patterns, meaning that, under ordinary circumstances, those patterns repeat themselves on a daily basis. Such behavioural patterns are due to learning processes and routines which develop over longer times and are difficult to break. According to Schlag and Schade (2007), behaviour is performed almost automatically and with a minimum of cognitive effort.[26] Schlag and Schade distinguish three relevant decision and behaviour levels that are of interest for behavioural change:

Table 3-1: Three levels of mobility behaviour

Decision level	**1. Level**	**2. Level**	**3. Level**
	Long-term decisions *(occur relatively rarely and are often well-thought)*	Medium-term decisions *(often habitual)*	Short-term decisions *(highly habitual)*
Behaviour level	• Choice of location (living, working, leisure) • Vehicle ownership • Type of vehicle	• Frequency of travel • Transport mode choice • Times of travel	• Style of driving • Speed

Source: Adopted from Schlag, B.; Schade, J. (2007).

These different decision levels are usually not separated from each other but are mutually influencing each other. The demand for travelling and the intention to travel corresponds to a variety of external factors, such as the spatial structure, the options that are available, or the quality of shopping facilities. Long-term decisions, e.g. about where to live (e.g. in the city centre or at the outskirts), will more likely affect decisions on the other two levels. According to Schlag and Schade, habitual travel patterns, as those usually happening at the second and third level, are not easy to change. Besides those external factors, socio-demographic factors (e.g. family structure, income, employment) and situational factors (e.g. family logistics, time pressure, weather) are said to determine decision on the choice of mode.[27] Furthermore, Bamberg et al. (2011) state that personal and social norms have a direct effect on pro-environmental behaviour.

In line with this, the transtheoretical model of behaviour change by Prochaska and Velicer (1997) was developed to describe the possibility for the desired behaviour change. The model proposes that changes in behaviour occur as a progress through a series of six stages: pre-contemplation, contemplation, preparation, action, maintenance, and relapse. The stages represent the cognitive and motivational difficulties individuals encounter when putting general goals of behaviour change into concrete action.

[26] See Schlag, B. and Schade, J. (2007).

[27] See Bamberg, S. et al. (2011).

In terms of sustainable transport this may mean that people initially need to be aware of the problem and the need to change their behaviour to further develop motivation to actually make a change. Activating social norms would be important in this stage, as well as raising awareness about individual responsibility. In the preparation stage, individuals start gaining the specific skills that are needed for a change; therefore the provision of information on alternative travel options is needed as well as social support. When successfully adopting the new behaviour in the action stage, the new activities have to be maintained and integrated into the lifestyle to prevent relapse. New technologies, services, laws, infrastructures, and incentives could prevent relapses into the old behaviour.[28]

And indeed, there are several studies that support the view about the effectiveness of influencing individual decision-making by changing people's perceptions and motivations. The idea is to use soft measures to raise people's awareness of the negative externalities and to highlight possibilities to change. Anable (2005) for example states that rational arguments are insufficient to explain why measures to restrict car use generate such strong emotions and negative reactions. Instead, psychological factors including perceptions, identity, social norms, and habits are increasingly being used to understand transport modal choice. In studies of consumer behaviour and marketing it is standard practice to distinguish homogeneous groups of consumers who can be targeted in the same manner because they have similar needs and preferences. In consequence, there is no sense in addressing the "average consumer" since different people have to be addressed in different ways.[29] Another approach of defining different groups of people with different habits and therewith diverse possibilities to address promotional efforts and innovative services is provided by Götz (2007). According to him, people will only change their travel behaviour if alternatives seem attractive enough and specific goals and orientations match with their reference group. One of the key aspects for decision-making is the information available. It was illustrated by many researchers that there is a strong relationship between not using public transport and a lack of knowledge on public transport. Brög et al. (2009) evaluated that information and motivation as well as incorrect perceptions of the alternatives to the car were significant barriers to modal shift and that highly customised information could reduce car-as-driver trips in a range of 5% to 15%. Beyond that, the evaluation showed that generated behaviour changes sustained over time. Similar conclusions can be found in Cairns et al. (2008), who come to the result that within ten years time large-scale programmes on "soft-measures" can have the potential to reduce national traffic levels by about 11%, with reductions up to 21% in peak-time urban traffic. However, Möser and Bamberg (2008) claim that there is only limited evidence that the observed reductions in car use can be causally attributed to soft transport measures such as information campaigns. In line with this, Schlag and Schade (2007) argue that these sorts of concepts fall too short to describe behaviour change in transport. According to them, there exists a gap between knowledge about negative externalities and transport behaviour. This gap can be seen as a major reason for the absence of voluntary behaviour change. Road users can directly experience the advantages of individual mobility, while a considerable part of the negative external costs is given to the public and is therefore not directly taken into account.

[28] See Bamberg, S. et al. (2011).

[29] See Anable, J. (2005).

As a result it can be said that a variety of different factors are relevant for rejecting or adopting an innovation. Also the willingness to change behaviour and the final adoption of those changes certainly depend on more than just rational decisions; and those vary depending on the group of people and the type of mode. The distinct background of European cities makes the situation even more complex. However, to address measures effectively, knowledge about who to actually concentrate on is needed. Often travel behaviour research is based on pre-defined parameters such as income, gender, car-ownership, or user frequency (e.g. high users vs. low users), drawing no conclusions from the above mentioned psychological factors.[30] Nevertheless, this data is required to assess such changes.

On the diffusion of innovations (Rogers, 2003)

As in other areas, innovations of the urban transport systems have to be adopted by the users to become effective. Users decide on the rejection or the adoption of an innovation and hence on the success of an innovation. In his book on the diffusion of innovations Rogers (2003), distinguishes between five criteria of innovations. These criteria influence individual decisions on adopting or rejecting an innovation, and thus explain the different rates of adoption:

1. Relative advantage: is the degree to which an idea is considered better than the idea it replaces. It is not only the objective advantage, such as economic factors, which is important but also prestige factors, convenience, or satisfaction.

2. Compatibility: is the degree to which an innovation is considered to match with existing norms and values. If compatible, the innovation will be adopted more rapidly than an incompatible innovation.

3. Complexity: is the degree to which an innovation is considered as difficult to understand and use. Ideas that are easy to understand are adopted more rapidly than innovations where new skills and understandings need to be learned by the adopters.

4. Trialability: is the degree to which an idea could be tried out prior to adaptation. An innovation that could be experimented with represents less uncertainty to the individual adopters

5. Observability: is the degree to which effects of a new idea are visible. The more visible results are, the more likely the idea will be adopted; additionally visibility can stimulate peer discussions.

According to Rogers (2003), an innovation is more likely to be adopted and disseminated at the community and population level if it fulfils all these criteria at once. He states that the adoption of an innovation is not an instantaneous act but a process which an individual passes through. At the beginning individuals gain knowledge about the innovation to further form an attitude towards it and then make a decision whether to adopt or reject it. Finally individuals implement the innovation and at last confirm their decision. This set of criteria indicates that individual choices are influenced by much more than “rational” economic calculation. Norms and values are of importance, and so are factors such as visibility or traceability which are not directly related to rational economic arguments.

[30] See Goodwin, P. et al. (2010).

3.2. The relevance of perceptions and attitudes

As indicated above, transport behaviour derives from several internal and external factors such as the need to travel or the opportunity to travel. Some empirically based reflections are presented in the following.

The box on Roger's criteria (see chapter 3.1) that are influencing the individual decisions on adopting innovations underpins that "rational" economic factors are only one aspect of transport-related choices. For many of these criteria, users' attitudes, perceptions, norms, and values are of importance, which can hardly be translated into economic yardsticks. Many studies acknowledge that perceptions and attitudes are of utmost importance for transport-related decisions such as the wish to travel, the choice of destinations, and the selection of mode, the route that was chosen as well as for the decision about which car to buy. The latter is highly relevant in the context of the discussion about the potentials of battery electric vehicles and other alternative fuels and propulsion technologies.

From the broad range of studies in this field it is only possible to mention a few here. In a study called "Symbolism in California's early market for hybrid electric vehicles" for example (Heffner et al., 2007) point out that it is widely acknowledged that automobiles symbolise more than only mobility; for many people they express an idea of self-identity. Through their car, people communicate what interests, beliefs, values, and social status they have, in other words, who they are. Labelling owners of a battery electric vehicle simply as environmentalists and technology enthusiasts would "oversimplify the factors involved in their buying decisions".[31] In this study different motivations for purchasing a Hybrid Electric Vehicle (HEV) were analysed. Intentions such as preserving the environment, opposing war, managing personal finances, or reducing support for oil producers as well as embracing new technologies were the superficial reasons. But the underlying – and maybe unconscious – motivations linked to these intentions are of different nature. By revealing these attitudes towards a product, HEVs become a product of distinction. They were chosen by the buyers to communicate that they are (for example) mature and sensible persons and that they have strong ethical principles, such as caring for others. Furthermore, the study emphasises that sending an effective message to car manufacturers was another strong argument for owners to buy a HEV.

Another survey to be mentioned here is a large-scale evidence review of more than 3000 studies focussing on attitudes to important aspects of transport policy (See Goodwin et al., 2010). One of the key findings of this review is that "just as transport and travel choices are rooted in the structure of activities undertaken by individuals and families, it follows sensibly that attitudes to transport must also be rooted in deeper values and aspirations of how people want to lead their lives"[32]. It is further concluded that economic motivations (costs, allocation of time, and participation in employment) are important, but so are influences such as stress, tranquillity, feelings of control and independence, social obligations, and desires for both excitement and calm. The study also points at the fact that there is a lack in evidence on how individual attitudes change over time. There is a strong need for longitudinal studies on individual perceptions and attitudes in relation to transport.

[31] Heffner, R. et al., (2007).

[32] Goodwin, R. et al. (2010).

Anable, J. et al. (2006) argue that there is only a weak link between knowledge and awareness of climate change on the one hand and travel behaviour at the individual level on the other. Transport policies can set out to change attitudes directly as a route to behaviour changes, or indirectly in aiming to change behaviour first without necessarily changing attitudes. There is a need to engage the public in issues of transport and climate change using deliberative methodologies to deviate from traditional 'top down' methods of information provision.

Another study to refer to deals with the travel behaviour of young people in the context of climate change (see Line, T. et al. (2010)). A series of discussion groups were undertaken with young people aged 11-18 who are living in suburbs around the City of Bristol. As a result it is stated that young peoples' behaviour intentions regarding transport are already well-developed by this age. The participants' travel behaviour intentions are dominated by a desire to drive. Key influences on this are values relating to identity, self-image, and social recognition (at the expense of their environmental values) as well as their affective attitudes towards transport modes. The participants' understanding of the link between transport and climate change is weak. Their values are related to their positive attitudes towards the car and driving; favouring this mode is rated higher than more environmentally friendly modes. The authors conclude that one answer to this may be "to promote cycling as a signal of success and being 'cool' rather than promoting the health and environmental benefits of this behaviour"[33]. Although young people express some support for transport policies aimed at reducing the impact of transport on the environment, they are generally defensive of their right to retain their use of the car. However, another interesting finding is that there is some acceptance of the idea of enforced travel behaviour change – away from the use of car towards more environmentally friendly modes. "This acceptance was in part due to their belief that such action would remove the influence of the 'social dilemma', where their own efforts to tackle climate change may be rendered worthless by the inaction of others"[34].

So values are important, image and self-recognition can have influence on the development of mobility patterns. In that sense and to come back to the diffusion of innovations, Urry (2010) states that innovations require "consumer communities" that highlight, advocate, develop, and declare these innovations as fashionable. He sees consumer fashion as the trigger for behaviour change. A sustainable transport system has to be better and signal to be more fun. In order to meet these requirements, innovations need to offer more than new technologies, they likewise need to offer new forms of organisation and business models that are well connected. Therefore policies are needed which provide framework conditions that are favouring such developments. In chapter 4 the focus will be on policy measure that can be used to stimulate a transition towards sustainable mobility.

[33] Line, T. et al. (2010).

[34] ibid. (2010).

3.3. Evidence for changes in mobility patterns

It was illustrated above that transport-related decisions are not only the result of stringent and conscious economical reflections; sometimes even unconscious attitudes, perceptions, and habits play a major role in the development of what is materialising as travel patterns. This illustrates that it is rather difficult to change these behavioural routines. On the other hand, there is evidence that transport patterns are not static, they are changing over time - but not necessarily towards more sustainability.

For several countries there is some evidence indicating that the travel behaviour of some societal groups is changing. We will briefly illustrate Germany as an example. Germany surely is a good showcase since the car plays a crucial role in the transport system as well as for the economic development of the country in general. Whereas for many years there was both a constant increase in the rate of car ownerships and in car transport volumes, there are now some indicators pointing at a possible change in these trends. Until today transport volumes are slightly growing in general, whereas public transport and cycling seem to gain in importance (see Infas and DLR, 2010). Two-thirds of all ways are undertaken for the purposes of shopping, private completions and this share is increasing. Commuting is losing importance, only one third of all ways are done for that purpose.

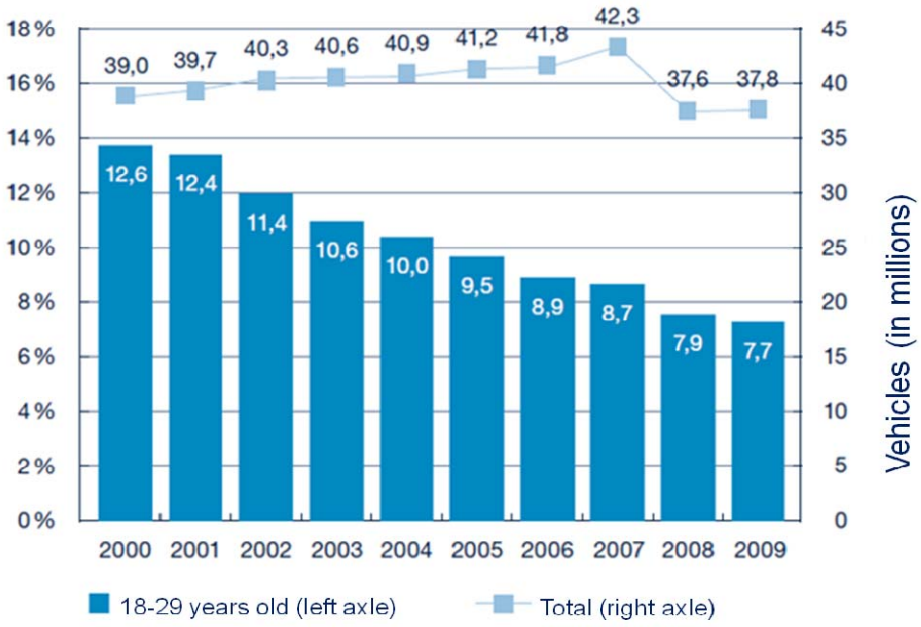
Interestingly, there are striking differences between different age groups. The people older than 60 years are using the car more than the same group did about ten years ago (KIT, 2010), which is due to the growing number of people older than sixty but also to the fact that older people today are staying more active and mobile. In particular the number of older women with driving licences is much higher than it was 10 or 20 years ago. It is mainly these people over 60 who are responsible for the growth in transport volumes in Germany.

The younger people, at the other hand, are using the car significantly less compared to the same age group ten years ago (KIT, 2010). For younger people, in particular for those living in urban areas, a decrease in both rate of car ownership (see chart Figure 3-1) and kilometres driven by car can be observed. Several empirical studies prove that there is a growing group of younger people with rather pragmatic attitudes towards car ownership and transport (FHDW, 2010). According to a (non-representative) survey, 22% of young people between 18 and 25 years stated that the car is nothing more to them than a mean to travel. 20% can imagine living without a car. However, for many young people the car is still something important. But other studies support the impression that the car is losing importance amongst younger people in urban areas (Fraunhofer IAO and PwC, 2010; Trendstudy Timescout). Young people in urban areas are the most flexible group in using different modes of transport.

It is assumed that the heavily increasing importance of information and communication technologies is a key driver for this development. Internet and mobile phones are getting more important for younger people. Social networks are more and more of virtual form. ICT is needed to get access to these networks. At the same time, the physical accessibility of friends and events might lose relevance. Another reason might be that access to public transport is getting much easier since all the required information is available all the time and at any place. It is easy to get used to public transport and to perceive it as something flexible, at least in urban areas with a dense public transport network.

Also “gadgets” such as smart phones, MP3 players, or laptops are becoming symbols affiliated with identity, self-image, or social recognition. Nevertheless, it is not clear if this group is changing behaviour when entering a new phase of their life (e.g. getting children, first job, moving to another place). However, this group seems to be disposed to use different modes of transport if it is “feasible and handy”.

Figure 3-1: Share of 18-29 years old of total vehicle ownership in Germany



Source: Fraunhofer IAO and PwC (2010).

Somewhat similar data are available for Nordic countries. Ruud and Nordbakke (2005) refer to a decrease in driving licence rates among young people between 18 and 24 years in Sweden and Norway. As possible explanations the authors mention urbanisation and the fact that more young people take higher education, resulting in the fact that many of the young Swedes get children late. Even if these people might start driving cars as soon as they get children, the observable lower degree in licence holding is seen as a good opportunity for public transport. It is further reported that for the young people time is the most important issue in daily transport. Young people are more “impulsive travellers” than older aged groups. Against the background that cars are usually associated with freedom, Ruud and Nordbakke (2005) suggest that future transport planning should try to communicate the freedom that public transport offer, e.g. freedom from responsibility, freedom to use travel time or that you do not always get back to the same spot etc.

Another interesting observation related to changes in travel patterns is that car sharing is becoming more and more popular in many European countries. As it was illustrated in DEL 2 of this project, the system is supposed to have a significant potential to change travel habits. Currently, 14 European countries have car sharing operations, with a total of nearly 385,000 customers and 12,000 vehicles.[35]

[35] See Bundesverband CarSharing e.V. (2008).

Whereas most car sharing organisations of the late 1980s and 1990s had a strong ecological motivation and were established as cooperatives, nowadays most car sharing organisations are corporate entities and operate more profit-oriented. The operators act much more professionally than two decades ago. It must be emphasised that information and communication technologies (ICT) have considerably supported and much improved both the organisation and the appearance of car sharing. ICT allows access to cars by smart cards instead of keys, 24 hour internet booking instead of telephone booking and on-board computers instead of manually filling out vehicle logbooks. Car Sharing fits in well with the flexible, not too much car-oriented travel behaviour of younger people in urban areas (see Deliverable 2 of this project).

4. Policy measures stimulating a transition

Even though it is not quite clear whether paradigm shift is the right term to outline the changes in policy priorities, it is certainly true that concerns about transport have grown over the last decades. Sustainable development has become the central objective of EU transport policy and the fundamental goal of most regions and nations in Europe. Albeit, reaching a modern transport system which is "sustainable from an economic and social as well as an environmental viewpoint"[36] is to some extent contradictory and action is needed to cope with these apparently conflicting targets. Policy-makers have the challenging function to balance the positive and negative impacts of transport, by involving different stakeholders, by enabling behaviour change, and by creating the right framework conditions. Among the various options to open society to a more sustainable lifestyle, technology is often seen as the most attractive, though it is by far not the only challenge to meet. Indeed, as illustrated in figure Figure 1-1, technology is one important element in reaching sustainable transport. However, technologies are needed that have not only the potential to contribute to emission and noise reductions but also bring about fundamental changes in dominant practices, rules, and shared assumptions. Rather than looking at isolated technologies alone, technologies need to be incorporated into a larger socio-technical system.[37] In that sense, Urry (2004) elaborates that automobility belongs to a certain system that includes cars, car-drivers and the car-industry, petroleum suppliers, consumer lifestyles, societal values, spatial planning, as well as urban and street design.[38] Technologies that simply lead to the optimisation of the existent system (e.g. end-of-pipe technologies) will be insufficient to achieve the goal of sustainable mobility. Other technologies certainly have the potential to lead to dynamics by leading to changed behavioural patterns. There are several interesting examples in DEL 2. Car sharing or bike sharing for examples are alternatives to the private car which combine the attractiveness of individual mobility (convenience and comfort) with advantages of public transport (low prices, area-wide services, general accessibility). These concepts are not completely new, but the use of ICT has made these options more convenient, efficient, and more competitive and finally helped to "individualise" public transport.

As described above, to picture a vision of the future is crucial for realising a transition towards more sustainable transport. Hence, governments have a leading role in that process since they can help to formulate that vision, in inspiring learning processes and encouraging other actors.[39] Reaching a sustainable mobility paradigm is more than implementing several but separated policy measures. It is about understanding the reasons behind effective implementation.[40] The system view emphasises the need for developing governance strategies that deal with the transport system as a whole. As already indicated in chapter 0, public authorities should, when having the aim to meet the requirements of an integrated approach, touch upon three fundamental types of action:

[36] See CEC (2001).

[37] See Kemp, R. (1994).

[38] See Urry, J. (2004).

[39] See Rotmans, J. et al (2001).

[40] See Banister, D. (2008).

1) *Changing the specific carbon intensity of the different transport modes:* increase system efficiency, including internal combustion engines as well as transport flows, alternative fuels, and propulsion technologies;

2) *Changing the modal split:* inducing a shift towards more environmentally-friendly modes of transport;

3) *Reducing the need to travel/decoupling transport growth from economic growth:* e.g. through avoidance of trips, shorter journeys, virtual accessibility (dematerialisation, teleconferencing).

Each type of action presents significant challenges in itself and each type deserves close attention. The goal of sustainable mobility is an immense task for political actors, as "it involves not only a change in technology, but also quite fundamental changes in production, organization and the way in which people live their lives".[41] However, there is a wide range of policy measures available to actually translate these types of action into political practice. Those instruments can be used to stimulate the uptake of the technical and organisational options to reduce the negative impact of the current transportation system, as highlighted in DEL 2. Policy instruments should be selected on "the basis of their effectiveness, efficiency or cost-effectiveness, fairness and acceptance"[42]. Particularly they should be combined into an integrated strategy that consists of a variety of policy measures that complement each other. The available instruments can be divided into the following five families of instruments:[43]

1) *Regulation and Control* (also known as "command & control" instruments): Instruments of this family are widely used in the transport sector in order to deal with environmental and other externalities, typically by laws and regulations to which transport users and suppliers must conform. The overall purpose of regulation is to reduce accidents and environmental damage, to protect and promote user interests, and to enhance the efficiency of markets. Tools of regulation involve:[44]

- Quantity entry controls (permits, allowances, or rights to limit the scale of emissions or pollutions, e.g. restricted access of freight vehicles to city centres);
- Quality entry controls (e.g. enforcement of technical standards, such as limits on emissions, noise, speed, or vehicle seize which has to be met by the transport firm before entering the market);
- Operational controls (e.g. inspection and maintenance);
- Direct government ownership (e.g. to directly regulate the scale of transport industries and the way they operate).

Regulatory measures are on the one hand relatively easy to implement, enforce, and understand, on the other hand they are inflexible and they do not provide incentives to go beyond the mandatory standard.[45]

[41] Kemp, R. (1994).

[42] Skinner, I. et al. (2010).

[43] Adapted from Skinner, I. et al. (2010).

[44] See OECD (1992).

[45] See Santos, G. et al. (2010).

2) *Economic instruments* are also widely used instruments in transport policy. Economic instruments involve many types of taxes and charges, as well as subsidies e.g. to efficient vehicles. The main motivation for the introduction of pricing instruments is to reflect the external costs of transport in the user prices of travel.[46] By increasing transport prices, economic instruments directly influence the cost of using transport and as such act as incentives (or disincentives) on behaviour. The revenues generated through economic instruments are used to redistribute (at least parts of it), to achieve more equity, or to correct market failures.[47] Even though economic instruments are more flexible than regulation policies, they may lead to equity problems such as social exclusion of the poor. Another difficulty that needs to be considered is that the implementation of economic instruments may be cost-intensive, though this depends on the type of measure (introducing a fuel tax for example is relatively easy to implement, whereas congestion charging may lead to higher costs).[48] Economic instruments should preferably be combined with other measures, such as regulation or land-use policy, in order to be effective.

3) *Infrastructure and spatial policy* are integrally linked to transport-related issues and vice versa. Spatial policy, such as mixed-use development or road layout, can be used to "build sustainable mobility into the patterns of urban form and layout"[49], which in turn may lead to modal shift or even the avoidance of travel. Infrastructure and spatial policy can be used to design cities in a way that they make walking and cycling more attractive, calm traffic flows, reduce noise emissions or induce a shift towards modes of public transport.[50] In doing so, these policy measures have a positive impact on the liveability and accessibility of cities.[51] The influence of transport on urban form becomes obvious when reflecting past policies (see chapter 2): the provision of highways has led to urban sprawl and facilitated car-dependent lifestyles. A potential barrier to implementation is that it only becomes effective in the long run. Banister and Hickman (2006) compare the timescale over which sustainable mobility might be realised with a turnover of the building stock, which is replaced by 1-2% per annum.[52] The responsibility for infrastructure and spatial policy is in most cases at a local or national level.

[46] See Proost, S. et al (2009).

[47] Santos, G. et al (2010a).

[48] See Rietveld, P. (2006).

[49] Banister, D. (2008).

[50] See OECD (1992).

[51] See Skinner, I. et al (2010).

[52] See Banister, D.; Hickman, R. (2006).

4) *Information to raise awareness* aims to change relevant values, attitudes, and perceptions. In principal it focuses on conviction for voluntary action, especially when price and regulatory measures do not seem to be adequate. Those measures are basically targeting three different aspects: (1) to increase the awareness of possible options to travel; (2) to raise awareness of the importance to take action, and (3) to overcome barriers associated with new technologies and/or modes of transport.[53] Brög (2002) emphasises that not only approaches are required that generally inform individuals about potential options, but also helps them to decide which option best matches any given circumstance, e.g. by personalised travel planning.[54] In Europe, measures of this family are often summarised under the term Mobility Management which is defined as "a concept to promote sustainable transport and manage the demand for car use by changing travelers' attitudes and behavior."[55] However, opinions about the effectiveness of such soft measures differ. Möser and Bamberg (2008) for example claim that there is no evidence that soft measures are an effective strategy for reducing car use.[56] Whereas Cairns et al. (2008) find that soft measures can reduce car traffic by 4 to 26%.[57] In any case, information policies need to be supported by a range of complementary instruments to ensure benefits.

5) *Research and development activities* are for example fleet test and demonstration programs or research and development (R&D). Both can help to stimulate the uptake of technologies or organisational reforms that have not yet experienced their breakthrough or that have not yet been tested in real environments (e.g. Electric Vehicles). Such instruments also send a clear signal to developers and operators as well as to the users in the way that decision-makers show clear commitment to the development of sustainable technologies or innovative ways of organising internal processes.[58]

There are tables of policy measures in the annex that give an idea of the wide range of policy measures being available for the different governmental levels. Even though the tables do not yet include all currently existing and known measures, they give an impression of what is possible. The tables are following the three types of action outlined above. The last column indicates whether the specific measure is to be implemented on local, national, or EU level. Some of the measures are relevant for more than one government level, some are only promising when implemented on the European level. The difficulty for instruments on the European level lies within the diversity of the member states. National governments need the autonomy to choose measures that suit their countries best. But at the same time the right framework condition on a European basis can help to enable and encourage member states to take action.

[53] See Skinner, I. et al (2010).

[54] See Brög, W. et al (2002).

[55] Maffii, S. et al (2009).

[56] See Möser, G.; Bamberg, S. (2008).

[57] See Cairns, S. et al (2008).

[58] See Skinner, I. et al (2010).

The role of the EU

Of course the responsibility for urban transport policies lies primarily with local, regional, and national authorities, even though the Green Paper 'Towards a new culture for urban mobility' states that "Europe has capacity for reflection proposal-making and mobilising for the formulation of policies that are decided and implemented locally."[59] In other words, Europe has the capacity to initiate and guide a paradigm shift in transport policy, which is to be carried out on a local level.

Having a global perspective, the EU should take the lead in promoting and supporting sustainable transport, meaning that they should serve as an example to other nations. Through White Papers the European Union has a guiding instrument to solve existing problems and to influence underlying policy objectives. A White Paper can help to set clear goals for reducing emissions and noise, modal shift, and promoting the possibilities to substitution of travel. Additionally directives and the Trans European Networks have a strong influence on the aims of infrastructure planning processes within the EU. It is the European Union's role to organise a debate on transport among all relevant stakeholders (e.g. social groups, users of transport, employers and employees, economic groups, urban transport organisations and industry, national, regional, and local authorities, stakeholder representatives as well as relevant associations).

The European Union is already active in promoting sustainable urban transport; in 2009 the Commission agreed to implement a strategy to promote sustainable urban mobility. The plan proposes 20 actions, main areas of contribution include:[60]

- Promoting the use of collective and non-motorised modes, especially through provision of platforms for mutual learning for local authorities and information and awareness-raising campaigns for users
- Promoting market penetration of lower and zero emission vehicles, especially through research and demonstration projects
- Stimulating the development of technology for urban mobility (e.g. ITS), especially through setting of common and harmonised standards that are interoperable and user-friendly as well as through offering financial support
- Fostering integrated intermodal freight and passenger transport policies, e.g. through support of local authorities in developing sustainable urban mobility plans
- Improving accessibility and travel information, especially through strengthening passenger rights and facilitating exchange of information
- Completing the market opening process by building up an appropriate EU legal framework, including simplifying and adopting new legislation

[59] CEC (2007b).

[60] See CEC (2009b); as well as CEC (2009c).

5. Barriers to implementation

Barriers impede a given policy measure from being implemented or limit its certain effectiveness. Such obstacles to transport policy implementation occur in various forms. Institutional and political structures as well as financial constraints and region-specific social and cultural factors may create implementation problems. Some transport policy instruments seem to prove difficult only for some regions to implement, some are generally difficult to realise. Barriers sometimes lead to policy measures being overlooked or forgotten, resulting in limited possibilities and strategies that are much less effective than they could be. Apparently there exists a gap between widely supported policy recommendations and their implementation. However, there are several barriers for policy measures to be implemented in the most ideal form. Based on the work of Banister (2005), in the following five main categories will be divided:

1) *Resource barriers* include financial as well as physical barriers. Financial barriers are budget restrictions which can limit the overall expenditure on the strategy as a whole, on specific instruments, and on the flexibility of implementation. According to Minken et al. (2003), road building and public transport infrastructure are the two main areas in European cities which are most often subject to financial constraints, while information provision is least affected. Physical barriers include e.g. geographic structures, topography, or space restrictions. Such barriers can mostly be overcome by technical and financial means.

2) *Institutional and policy barriers relate to problems due to (un-)coordinated* actions between different organizations, levels of government, or policy sectors. Since many public and private bodies are involved in transportation issues, it is likely that there are overlaps of responsibilities and at the same time a lack of interactions which sometimes make coordinated action difficult. An institutional framework is needed that encourages different departments to support each other and thus allows for holistic policy-making. Unstable administrative capacity and unqualified staff can exacerbate this barrier. Restrictions imposed by lobby groups can influence the effectiveness of instruments as well. Additionally controversies between commitments can be a barrier to a wide-scale implementation of sustainable transport measures, for instance if cities commit themselves to economic growth and at the same time to sustainable transport.

3) *Legal barriers* relate to the adjustment of laws and regulations in order to provide adequate framework conditions for sustainable urban transport. This includes rules and regulations for public transport provision and infrastructure, service obligations and private sector involvement, just like the adaptation of technical standards for vehicles and fuels. Also the adequate involvement of walking and cycling along with upcoming innovations, such as car sharing, need to be supported by the legal and regulatory framework. Of course, many of these can be beneficial; they might as well impose restraints on innovative solutions. According to Minken et al. (2003) land use, road building, and pricing are the policy areas that are most commonly subject to legal and institutional constraints in European cities, while information measures are generally substantially less constrained.

4) *Social and cultural barriers* relate to the public acceptability of measures. Some policy measures, especially those restricting car use, are often unpopular and policy-makers seem to reject them for that reason. Generally speaking, measures that are designed to encourage people to use sustainable modes of transport by making alternatives more attractive (so called “pull measures”) are more popular than those measures pushing people to bear a greater proportion of the real costs of their travel. A combination of both is needed since quite often users of the transport system do not behave in a way policy-makers assumed them to; people are often reluctant to voluntarily give up the freedom they have gained through the car (see chapter 3.1). However, behavioural responses are often disregarded by politicians, resulting in the dissemination of a number of measures that have no or only little effect on users' behaviour.[61] It can be a serious barrier if the population does not have sufficient knowledge and awareness of the need for policy measures; this can result in rejection and resistance.

5) *Side effects* occur relatively often; almost every measure implies consequences for other activities. It is possible that side effects have such serious consequences to other activities that implementation becomes too complicated. As an example, Banister (2005) adduces traffic calming, which does not only reduce the speed of cars but also may imply inconvenience to public transport.

Additionally there are barriers which have an effect on the overall political discourse.[62] Large changes need relatively long time to occur and there is uncertainty about future needs of the citizens. Today's preferences and values are not stable but will change over time. Nevertheless, this will not happen within relatively short political periods; the concept of transition management estimates a time horizon of at least one generation (25 years) for transitions in socio-technical systems. This short-term action can represent significant barriers for decision-makers at all levels.

But still, there exist pathways to sustainable urban transport. The task will not only be to avoid the above-mentioned barriers but to overcome them.[63] The following chapter will provide ways of dealing with these barriers by illustrating success factors of transport policy.

[61] See Salomon, I. and Mokhtarian, P. (1997).

[62] The following is based on Kemp, R. et al. (2007).

[63] See Minken, H. et al. (2003).

6. Success factors for innovation pathways

As seen in chapter 4 as well as to be seen in the tables in the annex, a wide range of policy instruments is available to pave the way for sustainable transport pathways. Albeit, many of these instruments seem to remain elusive for several European countries; in many regions the trend to suburbanisation of population and jobs continues while walking, cycling, and public transport shares decline and car ownership increases.[64] However, there is no golden rule for policy-makers for the correct procedure; the way sustainable transport policy measures should look like or in which way they should be implemented largely depends on regional differences and features. However, rather than looking at those regional requirements, the debate on sustainable mobility quite often seems to appear to pursue two main lines of argumentation. There is either a strong reliance on technology or a call for measures that lead to changed behaviour.[65] According to Elzen (2006), emissions for example are primarily seen as a technical obstacle while congestion is seen as a behavioural issue. As a consequence, reduction of emissions is above all seen as a problem of the vehicle industry that is in turn forced to develop cleaner cars while congestion is tackled by awareness campaigns, inviting people to travel less or to use alternative modes of transport. This split strongly determines the search for solutions.[66] It is rather useful to look at the transport system as a complex system in its environment; this certainly requires a more holistic perspective, including different strategies at different levels and the recognition of interrelations between the demand and supply side, already existing structures, and upcoming solutions. One prominent example for an integrated approach is transition management. This approach will be outlined in the following.

6.1. Integrated approaches: the example of transition management

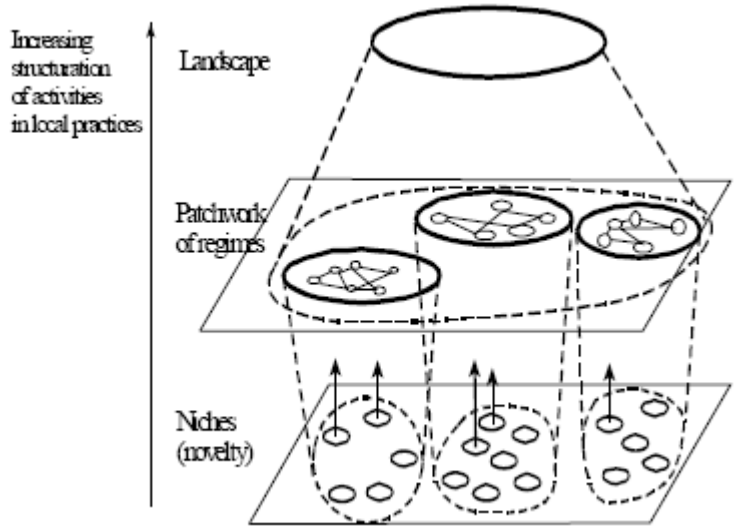
According to Geels (2004), changes take place in several different areas such as technology, economy, institutions, behaviour, and belief systems (paradigms). An important concept in this context is the multi-level perspective which has originally been developed by Rip and Kemp (1998) and refined by Geels (2004). He understands transition as “outcomes of multi-dimensional interactions” between three different levels: the micro level (or niches), the meso level (or regimes) and the macro level (socio-technical landscape).

[64] See European Conference of Ministers of Transport (ECMT) (2002).

[65] See Brand, R. (2008).

[66] See Elzen, B. (2006).

Figure 6-1: Multiple level perspective



Source: Geels, F. (2005).

The macro level relates to the slow changing exogenous environment which influences niche and regime dynamics. Overarching paradigms, macro economy, material infrastructure, environment, and demographics characterise this level. *The meso level* refers to socio-technical regimes (see above) like the dominant culture, practices, and rules that guide private action and public policy. *The micro level* relates to niches, such as individual or social actors, technologies, and local practices which differ from the incumbent regime. At the micro level novelties emerge in small markets, usually protected from mainstream markets.[67]

According to Rotmans (2010) those fundamental changes of structure, culture, and practices in societal sub-systems occur relatively rarely, usually it takes decades to change (1-2 generations). It is therefore characteristic when Bertolini et al. (2003) claim that transport policy is in "the midst of a paradigmatic transition".[68] They further emphasize that the new and overarching goal of transport planning is to achieve sustainable transport and therefore new tools and processes are being introduced and increasingly also applied.

To analyse transitions it is useful to look at the mechanisms and events that are likely to lead to a transition. While earlier studies of Geels (likewise figure 6-1) suggest a bottom-up pattern of transition where radical innovations emerge at the niche level, break through and finally depose the existing regime, more recent studies expect more encompassing pathways.[69] Those pathways are characterised by the main agents involved in the process and the type of action happening at different levels. And indeed, it is not likely that a bottom-up pattern of transition occurs in systems with large infrastructures, high sunk costs, and relatively high entry barriers which is certainly true for the road-based transport system. Therefore Geels and Schot (2007) have developed a typology of socio-technical transition pathways which distinguishes four ideal pathways for change. These pathways are:

[67] See Rotmans, J. et al (2001).

[68] Bertolini, L. et al (2008).

[69] See Geels, F.; Schot, J. (2007).

1. Transformation: This pathway is characterised by moderate landscape pressures, but without existence of sufficiently developed niches. The incumbent regime responses to these pressures by adjusting their development trajectories and by modestly changing their guiding principles and practices. Outsiders, such as social movements, are important because they draw attention to these pressures and translate them for regime insiders (which usually tend to neglect them). New regimes evolve from old regimes, resulting in a gradual change without disrupting the "basic architecture".

2. Reconfiguration: In this pathway niches are more developed. As soon as the existent regime faces landscape pressures, they adopt some of these innovations into the system as add-ons. The combination of new and old can bring about new behaviours and practices at different levels. The main interaction occurs between niche actors and regime actors. Unlike the transformation pathway this can lead to gradual changes in the basic architecture.

3. Technological substitution: Technological substitution comes about when strong landscape pressure creates "windows of opportunity" for niche innovations to break through to the meso level. Until then, niches have developed but remain stuck because of the stability of the regime. With increasing pressure, niches are increasingly entering bigger markets and eventually replace the incumbent regime. In this pathway niche actors are competing with regime actors.

4. De-alignment and re-alignment: This pathway is characterised by major landscape changes that lead to collapses, internal problems, and erodes in the existent regime. As a result, multiple niche regimes co-exist and compete for resources and support. Eventually one of these niches becomes dominant over the others and re-stabilises and restructures the system, leading to new actors, guiding principles, beliefs, and practices.

The increasing landscape pressures (such as the conceivable scarcity of oil, negative environmental and social externalities, or the dissatisfaction of many European citizens with the transport system in their surrounding[70], as well as the demographic trends in Europe) combined with the emergence of alternatives to the existing transport options as highlighted in DEL 2, is a considerable indicator that changes in the transport system are not only urgently needed but partly already occurring. Yet, it is still uncertain when exactly and in what form a transition will take place.[71] The political task will be to influence ongoing dynamics in terms of speed and direction. For now, options to change the current transport system are abundant, though they do lack wide diffusion. Since most people tend to think in terms of technologies they are familiar with, it is unlikely that they express a desire for innovations they do not even know of. Therefore the development of niches plays a crucial role to overcome the barrier of diffusion. According to Hoogma et al. (2002), such niches do not emerge spontaneously; they come about in the form of experiments, and pilot and demonstration projects. But still, innovations that require behavioural change do not directly catch the attention of masses, but usually start by attracting "early adopters".

[70] Nine out of ten EU citizens believe that the traffic situation in their area still should be improved (see CEC 2007a).

[71] See Loorbach, D. (2010).

6.2. Success factors

There is some evidence that the paradigm of sustainable transport is already about to materialise in European cities. However, it has been outlined that there are still several barriers to overcome (see chapter 5). The following section addresses success factors that can help to develop and implement technology options and organisational innovations which in turn can help to strengthen the upcoming, though still vulnerable, paradigm of sustainable transport.

Formulate a common vision on how transport futures should look like

As illustrated in chapter 2, the key to transformation of the existing transport system is the formulation of a vision and the specification of an objective. Of course, this can already be a barrier in itself since there is often ambivalence about certain goals.[72] Politicians, environmental groups, car drivers, or cyclists, all have a different perspective on what is "sustainable transport" and maybe come to different solutions. Car manufacturers for example may consider the electric drive the best solution to tackle existing problems while cycling associations claim that bicycle-oriented planning is much more expedient. But still, it might be possible to agree on key parameters for a future system and develop a national, or even EU-wide, policy framework for sustainable transport that supports and influences all other government levels.

Identify suitable measures to achieve that vision

Further an appropriate list of measures has to be identified which, in combination, are most likely suitable to achieve that objective. Usually professional judgement is used to determine this best combination and to specify the preferred strategy. And of course, when implementing measures to sustainable transport, the political feasibility as well as the overall desire for continued mobility and growth has to be taken into account, which makes it a rather challenging task. As a first criterion, several experts suggest a "working hierarchy" of modes for urban transport, according to their degree of sustainability. Typically non-motorized oriented planning (pedestrians and cyclists) comes first, followed by public transport and private motorized transport (see e.g. Banister, D. (2005); Marshall, S. (2001); as well as Rothengatter, W. (2010)).

Support the development of niches

Besides promotion of traditional modes of transport it is important to create space for new actors to develop and experiment with emerging alternatives. In line with the idea of transition management, those niches are crucial for innovation and can help to effectively create a new regime.[73] According to Rohracher (2003), the period from innovation to the early stage of diffusion "appears to be a phase where user involvement seems to have the greatest impact". Therefore it is important to provide a platform for interactive learning processes between early adopters, suppliers, and other intermediary actors to make sure that niches are emerging and that experience of users is included in a systematic way.

[72] See Kemp, R. et al. (2007).

[73] See Loorbach, D. (2010).

Integrate different actors and policy sectors

Shifting traditional transport policy to sustainable transport is a transformation process that includes multiple actors and a cross-sectoral approach. Therefore a more holistic perspective is needed that integrates different policy sectors and widens the public discourse.[74] In order to effectively implement sustainable transport measures, the support of all actors in the transport system is crucial, even though interests may be diverse and divergent. It should be a fundamental aim of politicians to stimulate new combinations of actor-cooperation. Those include social groups, users of transport, employers and employees, public transport, and land use-planning agencies and industry, national, regional, and local politicians, environmental authorities, private sector transport operators as well as real estate developers.[75] If actors and stakeholders are involved in the process in a clear and transparent way, all parties that are affected by an impact will more likely understand the consequences.[76]

Combine policy measures in a flexible way and communicate them properly

To better exploit the measures listed in the tables in the annex and to gain public support, the packaging of policies in a flexible and adjustable way is crucial. Packages should combine push and pull measures, comprised of regulatory and pricing instruments, spatial policy, information as well as research and development. Those packages should equally include actions aiming at substituting transport, stimulating modal shift as well as increasing efficiency. In order to be accepted, restrictive measures should be accompanied by well-communicated programmes which improve availability and attractiveness of the alternatives. Packaging of transport measures can also help to avoid unintended rebound effects (e.g. that someone makes use of freed-up road space, leading to zero relieve), and it can help to increase acceptance. Furthermore it is advisable to adopt controversial policies in stages since public support needs to be build up first. Positive outcomes, such as increased liveability or reduced noise, can help doing so. Therefore information is needed that conveys the positive effects of sustainable transport on the economy, equality, and health to individuals and businesses. Communication of the benefits is important, even if there are costs.

Encourage public participation

Policy measures will only become effective through the acceptance of the people that are affected by these policies. It is of utmost importance to involve the public already in the design of policy packages since acceptability is a prerequisite for sustainable transport and particularly important for demand management measures.

Improve data collection

It is important to understand behaviour and to explore under which circumstances cooperation and support can be obtained. In addition, it is important to explore the changeability of travel behaviour and the underlying reasons for that. Though, there is a lack in longitudinal data which would be required to assess such changes and give insights into urban travel trends and drivers.

[74] See Banister, D. (2008).

[75] See ECMT (2002).

[76] See Banister, D. (2008).

7. Conclusion

It is at the centre of this deliverable to illustrate that the development of pathways to a sustainable urban transport system needs to consider not only the technological and organisation innovations, but also paradigms or visions, transport policies as well as the attitudes and perceptions of the user. This is an interim report; the final report of this project will come up with more elaborate conclusions regarding the design of promising innovations strategies. However, based on this deliverable it is possible to draw the following conclusion:

- Paradigms, visions, or “guiding principles” can exert significant influence on the development of the technology-infrastructure combinations that are implemented in urban areas. For several decades the guiding principle of a car-friendly city dominated transport policy in many European cities. Corresponding planning decisions led to dense networks of roads, parking lots, information systems, etc.; the paradigm paved the way for the mobility patterns that we consider as “standard” today. In the meantime, the paradigm of sustainability is dominating transport planning as well as land use planning in many urban areas and at different governmental levels. It can be concluded that paradigms and visions matter for the development and adoption of innovations. Working with paradigms and visions clearly is a significant political task.
- Policy measures: from a European perspective it is crucial that different policies can be implemented on different levels. It is not easy to take direct influence on urban mobility patterns from the European level. However, as mentioned above visions can be developed (based on best practices). With R&D activities and pilot projects it is possible to foster the development of innovations that are supporting the physical implementation of such visions. At the same time, “hard” policies such as directives and regulations are used to both push innovations as well as to react on technological developments.
- A transition towards a more sustainable urban transport system is not imaginable without taking into consideration user habits and thus mobility behaviour. It was illustrated in DEL 2 that mobility patterns and innovation co-evolve. The developments in technology-infrastructure systems are the basis for modern mobility patterns; in turn the observed as well as the anticipated demand patterns are important triggers for technological innovations and new business models. However, changing user behaviour which is based on norms and values is surely not an easy task, although participation processes and early information about political decisions can help to increase acceptance – especially when explaining the importance of the measures and reinvesting in sustainable modes of transport. Furthermore, the users need to accept measures over longer periods of time. Another key lesson that should be used more offensive in policy praxis is that environmentally friendly models of transport need a positive image that is in line with values and norms of their users.

- Typical barriers either relate to financial constraints, institutional or legal shortcomings, or a lack in public acceptability. Difficult budgetary situations can limit the overall expenditure on the strategy, but can at the same time be used to explain to the public the need for road infrastructure cutbacks or innovative solutions that typically cost less. Therefore coordinated action among different organisations, levels of government, or policy sectors is needed. Since transport typically involves different public and private bodies, responsibilities are often shared by several institutions (e.g. land use and transport planning). Interaction is crucial when having the aim to bring about new ideas and innovations in transport. Another barrier relates to public acceptability of some measures, especially those restricting car use. Integrated approaches are decisive. A combination of measures that literally “pull” people towards cleaner modes, by making them more attractive and those measures that push them to bear a greater proportion of the real costs of transport is needed. It is important to inform users about the reasons behind a political measure in order to enable them to better understand the need for it.
- Important success factors are to try out new solutions in pilot projects. They can give important insights into technical and social processes and can help to organise innovations in a user-friendly way right from the beginning. Another crucial success factor is the formulation of a vision and the specification of objectives. Such a vision can have a significant effect on other decision-makers, such as local politicians, or also on engineers.
- The support and development of niches have been outlined as a crucial political strategy. Niches are defined as technologies or local practices that differ from the incumbent system (or regime). In niches new actor constellations as well as new forms of organisation can be tried out and things can be modified in a way that they best match the users’ needs. With increasing pressure or when mature enough it might be possible that such niches are entering bigger markets and finally replaces the “old” system. Car sharing could be one of these niches.

The deliverable ends with a discussion of success factors that will have to be further developed in the final report of this project “on innovation pathways to sustainable urban transport”.

8. Analytical framework for phase 4

The next phase of this project will have a closer look at the attitudes and perceptions of the citizens in European countries. Referring to findings and key questions of the previous deliverables, the following elements serve as an analytical framework for the interview meetings in phase 4 of the project:

- It was illustrated in DEL 2 that a wide range of innovations is available. ICT is an enabler for new business models and a driver for change in mobility behaviour. Both technological and organisational innovations supporting sustainable urban transport are available in principle but not fully implemented yet. The potential of these innovations is not fully exploited. The interview meetings to be conducted can make a contribution to the question how these potentials might be exploited more successfully.
- Following transition theory and innovation research it is argued in this deliverable that innovations need niches to be developed and tested. Against this background, the interview meetings should consider options for creating such niches in the discursive process.
- It is mentioned in chapter 4 that young people in urban areas seem to be more flexible in their mobility behaviour, more open for new forms of transport options. Given that there are no resources for covering a broader spectrum of societal groups, the citizens' interview will focus on the travel behaviour of younger people. They are the first generation that fully grew up in the age of Internet and mobile phones – in a socio-technical environment that is definitely different to all that was before. They are used to adopt new ICT solutions quickly. With this presupposition they might significantly contribute to the creation of the "niches" mentioned above.

Accordingly, the interview meetings could put the focus on

- the travel behaviour of younger people in urban areas
- their attitudes and perceptions towards individual mobility and the perceived importance of owning a car
- their attitudes towards new fuels and propulsion technologies (in particular electric cars)
- their interest in new business and marketing concepts such as mobile ticketing, online ticketing but also car sharing and bike sharing
- their preferences regarding different policy measures supporting sustainable urban transport
- their wishes and visions on sustainable urban transport futures and on the pathways leading to that futures.

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Annex I: Policy measures stimulating a transition

Table 9-1: Changing the specific carbon intensity of the different transport modes

Transport Policy	Potential contribution	Possible unintended effects	Local level	National level	EU-level	Best Practice
Regulation and Control						
Standards for emissions (as well as for noise and safety)	Can reduce energy consumption (or respectively noise emissions and increase safety); stimulation of improvements of in vehicle motor technology	It might distort the mix of large and small vehicles; and when reducing fuel consumption it might increase vehicle use		X	X	EU Directive 2003/17/EC
Fuel quality standards and alternative fuels	Can reduce energy consumption; stimulation of improvements of in vehicle motor technology	Reducing fuel consumption might increase vehicle use		X	X	
Eco-labelling of vehicles	Can reduce energy consumption; stimulation of improvements of in vehicle motor technology; increase awareness for externalities	Reducing fuel consumption might increase vehicle use; increase awareness for externalities		X	X	
Low-emission zones	Can reduce energy consumption (or respectively noise emissions and increase safety); stimulation of improvements of in vehicle motor technology			X	X	Low emission zone in London

Regulations on CO2 emissions from fuel	Can reduce the carbon intensity of transport fuels; stimulate technological improvements (e.g. of fuel efficient tyres and air conditioning)			X	X	Low Carbon Fuel Standard, introduced by the state of California in 2007
Obligation to catalytic converters	Can reduce the toxicity of emissions from internal combustion engines			X	X	EU Directive 91/441/EEC from June 1991
Environmental Zones	Can reduce energy consumption (or respectively noise emissions and increase safety); stimulation of improvements of in vehicle motor technology		X	X	X	
Economic Instruments						
Tax incentives for alternative fuels	Can discourage the use of the more environmental damaging fuels	May not be easy to find the efficient tax		X		
Fuel Tax	Can reduce vehicle use and promote cleaner or more efficient vehicles; can serve as price signals to drivers and manufacturers to invest in clean technology;	Drivers need to be aware of changes in behaviour that could reduce their tax payments		X		

Road pricing	Can reduce vehicle use and promote cleaner or more efficient vehicles; can serve as price signals to drivers and manufacturers to invest in clean technology;	Question of acceptability; possible implications for equity and economic vitality	X	X	X
Carbon tax	Can influence the choice of fuel type; can incentivise manufacturers to improve fuel efficiency, so as to reduce consumers' tax burdens	Possible implications for equity; may have an impact on competitiveness of the country where tax is implemented		X	
Emission taxes	Can correct emission externalities; can induce the optimal driving behaviour; can influence vehicle purchase and usage decisions	Monitoring of pollution generated is under current technology not feasible	X	X	X
Vehicle purchase tax	Can incentivise manufacturers to improve fuel efficiency, so as to reduce consumers' tax burdens	Possible implications for equity; if no tax is raised for 2nd-hand cars, measure may induce a longer usage rate of older and more polluting cars; do not directly target usage decisions		X	
Car-ownership tax (e.g. by vehicle age)	Can incentivise manufacturers to improve fuel efficiency, so as to reduce consumers' tax burdens	Possible implications for equity; do not directly target usage decisions		X	
Subsidies for the purchase of fuel efficient or alternative fuel vehicles	Can encourage the purchase of low, or zero emission vehicles	May also lead to an increase in the number of car-ownership		X	

Vehicle scrappage bonuses	Can remove inefficient, high-emission vehicles off the road	It might be economically and environmentally inefficient to destroy cars before their natural breakdown; may lead to an increase in CO2 emissions over the life-cycle of vehicles	X	
Tax deductions for part or all of the vehicle cost, or tax credits for the purchase of cleaner vehicles	Can encourage the purchase of low, or zero emission vehicles	The primary beneficiaries of tax deductions are those who earn taxable income and thus the relatively rich in the population	X	
***Feebate* schemes (combination of fees and rebates). Fees for fuel-inefficient vehicles and rebates for fuel-efficient vehicles**	Can encourage the purchase of low, or zero emission vehicles; can incentivise manufacturers to improve fuel efficiency; strengthens the life-time fuel saving linkage to the purchase decision	Targets only new vehicles; may lead to lower cost per km and thus longer distances	X	
Emission trading / Carbon allowances	Can help to control pollution; may provide economic incentives for achieving emission reductions			X
Infrastructure and spatial policy				
Providing intelligent transportation systems	Can improve road traffic safety and efficiency; possibility to gather real-time traffic data	Others can make use of the liberated road space	X	X

Providing charging infrastructure for Battery Electric Vehicles	Can accelerate the market take-up of electric vehicles			X	
Advanced traffic management systems	Can improve road traffic safety and efficiency; possibility to gather real-time traffic data	Others can make use of the liberated road space		X	X
Information to raise awareness					
Promoting fuel efficiency	Can reduce emissions and energy consumption	Other environmental and social impacts related to car-use	X	X	X
Promoting electric vehicles and alternative fuels	Can reduce emissions and energy consumption	Other environmental and social impacts related to car-use	X	X	X
Development of an internet-based guide on energy-efficient vehicles, including an overview of the market, legislation and support schemes	Can support the procurement of clean vehicles			X	X
Other instruments					
Enforcement and monitoring				X	X
Efficiency improvement of materials and energy				X	X

Providing Information Systems	Can induce a better use of road capacity and increase energy and environmental performance of the transport system	May make car use more attractive	X	X	
Implementing R&D programmes of specific and practical actions in the field of clean urban transport	Can strengthen the technological and scientific base; important for developing niches		X	X	CIVITAS
Support of stakeholders for promoting the market introduction of clean and energy-efficient transport	Can stimulate the market take-up of clean vehicles by ensuring a level of demand				

Table 9-2: Changing the modal split

Transport Policy	Potential contribution	Possible unintended effects	Local level	National level	EU-level	Best Practice
Regulation and Control						
Car- and cycle parking standards for new developments	Can reduce demand for transport			X	X	Parking policy in Switzerland
Restriction on vehicle ownership	Limits the number on vehicles on the streets					Vehicle Quota System in Singapore
Force developers to draw up a sustainable travel plan to receive planning permission	Can reduce car trips to and from that certain site		X	X	X	Switzerland
Economic Instruments						
Public transport subsidy	Can encourage people to use cars less; offers disadvantaged groups an affordable mode of transport	Providers of public transport may not have very strong incentives to minimise costs		X	X	

Congestion charging	Confronts the driver with true social cost of his journey; can reduce demand for travel; can increase speeds and total net benefits of travel; only the most valuable trips are being realised	Question of acceptability; possible implications for equity and economic vitality; there is no guarantee that only the most valuable trips are being realised	x	x		e.g. London; Stockholm
Road pricing	Can reduce demand for travel	Question of acceptability; possible implications for equity and economic vitality		X		
Fuel Tax	Can reduce vehicle use and promote the use of cleaner or more efficient vehicles; can encourage modal shift	Drivers need to be aware of changes in behaviour that could reduce their tax payments		X		
Tax on distance travelled	Can directly reduce distance travelled in private motorised transport; can reduce congestion	High incentive to cheat by rolling back old odometers		X		
Parking charges	Can reduce traffic levels; can regulate time-dependent driving and parking externalities	Can reduce the attractiveness of a given urban area; fail to differentiate according to trip length or emission levels; does not reduces through traffic; may	X			

		increase traffic (if charges vary with length of stay)		
Vehicle purchase tax	Can reduce the number of vehicles in circulation and a longer tenure; can influence the choice of car-ownership at the margin	Possible implications for equity; if no tax is raised for 2nd-hand cars, measure may induce a longer usage rate of older and more polluting cars; do not directly target usage decisions		X
Car-ownership tax (e.g. by vehicle age)	Can act as price signals to consumers purchase decisions and can encourage a shift to smaller cars; can influence the choice of car-ownership at the margin	Possible implications for equity; do not directly target usage decisions		X
Taxation of employer provided parking	Can reduce employers' subsidies to automobiles	Possible implications equity as it only targets a share of the population	X	X
Commuter allowances for environmental-friendly modes	Can reduce vehicle use and promote the use of cleaner or more efficient vehicles; can encourage modal shift			X

Infrastructure and spatial planning					
Improvement of public transport (e.g. offering demand responsive services, attractive intersections, advisory services)	Can improve image of public transport		X	X	
Schedule co-ordination	Ensures comfortable transfer		X		
Fare integration (e.g. same tariff for car-sharing, bike-sharing and public transport)	Can facilitate access to public transport		X		
Park&Ride; Bike&Ride	Can integrate private and public modes; can decrease the number of car journeys into the city-centre; can improve access to rail stations for inter-urban journeys	Not ideal for all users, purposes, distances, locations	X		
Parking capacity reduction	Can reduce traffic levels	May result in more trips of shorter duration; may result in congestion when more drivers are looking for parking lots; does not reduces through traffic			Copenhagen reduces the amount of parking spaces by 3% every year

Providing walking facilities (e.g. pedestrian zones, safe pedestrian crossings with short waiting times, footpath, benches)	Can reduce motorised travel, noise and energy use and thus reinforce attractiveness of the city; can increase health	Not ideal for all users, purposes, distances, locations, times of day	X	
Providing cycling facilities (parking facilities, cycle lanes, special traffic signals, signage)	Can reduce motorised travel, noise and energy use. May increase health.	Not ideal for all users, purposes, distances, locations, times of day	X	
Cycle-/ Public Transport integration	Can encourage intermodality; covers first-mile/ last-mile; can increase the appeal of a no-car journey		X	
Taxi services	Can encourage intermodality; can reduce demand for private motorized transport		X	
Priority for public transport and high occupancy vehicles	Accelerates public transport in comparison to car-use		X	x

Implementing bike-sharing schemes	Can encourage bike-use; covers first-mile/ last-mile	Not private car journeys, but walking trips can be substituted by bike-sharing	X	
Implementing car-sharing schemes	Can reduce demand for private motorised travel; encourage switch away from private car use	Not private car journeys, but cycling or public transport journeys can be substituted by car-sharing	X	x
Road capacity reduction, road closures	Can reduce demand for travel; encourage switch away from car use	May shift traffic problems elsewhere	X	
Mixed use development ("City of short distances")	Can reduce frequency and distances (e.g. journey to work)		X	
Compact cities	Can reduce travel distances; allows effective provision of public transport, walking and cycling	Individuals may still prefer car-use	X	
Traffic calming	Can reduce noise and energy-use and thus reinforce attractiveness of the city; accelerate alternative modes		X	

Restrictions of vehicle circulation (either closed to all traffic or only for private motorised transport)	Can reinforce attractiveness of the city and thus create a better environment for retailers in the city		X	X		Pedestrian Zones
Information to raise awareness						
Traveller (real-time) information	Can help users to organize their trips; offers high reliability		X	X		
Campaigns for environmentally friendly modes of transport	Can improve the image of bicycles and public transport as a mode of transport		X	X	X	
"Smart cards" for all available modes of transport (e.g. for public transport, bike-sharing and car-sharing)	Facilitates access to alternative modes and encourages intermodality		X	X		
Walk- and cycle-friendly developments	Design of buildings, spaces and routes can encourage walking and cycling		X	X	X	
Commute trip reduction programmes	Can influence demand for transport		X	X	X	

School travel planning	Can call attention of parents not to drive children to school by car	X			
Special event managing	Can call attention of attendees of events not to drive their by car	X			
Campus management	Can call attention of students not to drive to university by car	X			
Commuter financial incentives	Can influence demand for transport		X		
Campaigns for reducing private transport externalities	By being more aware of the externalities, people might change behaviour	X	X	X	
Personalised travel planning	Can help users to organize their trips; offers flexibility	X	X		
Support the organisation of campaigns to create a new culture of mobility (e.g. award schemes to encourage the adaptation of sustainable urban mobility plans)	By being more aware of the externalities, people might change behaviour		X	X	European Mobility Week

Other instruments						
Nomination of a transport planner responsible for an integrated transport policy	Integration in the sense of: (1) integrating different modes of transport, (2) making land-use and transport policy consistent, (3) integrating all social groups, (4) cooperation amongst all relevant institutions and policymakers		X	X		
Training courses for transport planners and local actors	Can be a forum for discussing standards and exchange of experience			X	X	Fahrradakademie [Bicycle-Academy] Germany
Integration of transport policy with other policies (e.g. health, land-use planning)			X	X	X	Transport, Health and Environment Pan-European Program, 2002
Earmarking revenues	Can establish a link between tax and use of a resource (e.g. road charges are spent on road projects)	Can increase the political acceptability of certain policies; hampers flexibility for the government; can allocate revenues inefficiently	X	X	X	

Strengthening passenger rights in public transport	Can increase quality and affordability of public transport; protects the rights of travellers with reduced mobility)			X	X	
Online platform or call centre for transport users to report about shortcomings	Can increase quality of transport systems and infrastructure in a user friendly way	If not rectified quickly, it might increase frustration	X			City of Karlsruhe (Germany)

Table 9-3: Reducing the need to travel

Transport Policy	Potential contribution	Possible unintended effects	Local level	National level	EU-level	Best Practice
Economic Instruments						
Fiscal incentives for relocation in designated areas	Can be an incentive to move into areas with good public transport			X		
Pay-as-you-drive vehicle insurance (PAYD)	Can reduce demand for travel	Monitoring of km travelled would be needed, which would come with high monitoring costs; PAYD would probably be chosen by those who already drive less		X		
Convert or return streets to a stronger focus on non-car traffic (street reclaiming)	Can reduce car traffic and increase pedestrian traffic		X			Shared Space in the Nether-lands and Switzerland
Development of car-free districts	Can reduce car traffic	A shift to other modes of transport or other districts where car traffic is possible	X	X		
Information to raise awareness						

Promotion of local destinations and local activity patterns	Can reduce long travel to recreation areas by call the attention on local recreation areas	Can attract people from elsewhere, which in turn travel long distances	X		
Campaigns for reducing private transport externalities	By being more aware of the externalities, people might change behaviour		X	X	X
Support the organisation of campaigns to create a new culture of mobility	By being more aware of the externalities, people might change behaviour			X	X
Other instruments					
Promotion of e-commerce	Can replace several individual trips with a single delivery round	People may move further away from shopping facilities and make longer non-shopping trips		X	X
Promotion of Teleworking	Can cut commuter trips	Employees may move further from their workplace; may still need non-work trips		X	X
Leading role of government institutions (e.g. in mobility management practices)	Governments have an important role as multipliers		X	X	X

Training courses for transport planners and local actors	Can be a forum for discussing standards and exchange of experience		X	X