Interdisciplinary Perspectives on Mobility

Your mobility is part of your personality, your identity, how you think, how you behave. European mobility patterns reflect common values and mind-sets.”

MIND-SETS Deliverable 2.1b

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Preface

Mind-sets: Interdisciplinary perspectives on mobility

The Mind-sets project
The MIND-SETS project “Mobility Innovations for a New Dawn in Sustainable (European) Transport Systems” is funded by the Directorate General for Research of the European Commission, under the Horizon 2020 Programme. Horizon 2020 is the financial instrument implementing the ‘Innovation Union’, a Europe 2020 flagship initiative aimed at securing Europe’s global competitiveness - the means to drive economic growth and create jobs.

The Mind-sets project is a completely new perspective on mobility. Mobility is the largest industry in the world and an industry experiencing rapid growth on all transport modes. There is an unceasing desire for mobility in European society. As such, mobility is a vibrant economic sector full of new ideas, concepts and services for keeping Europe moving. The key to success is economic growth while fully respecting the requirements to ensure ‘growth with sustainability’ and ‘growth with inclusion’. In this way, advances in mobility will proceed in harmony with European environmental and energy goals; and with the objectives to achieve greater social inclusion in European society and greater individual and social well-being.

In achieving these higher goals, it is important that those target groups responsible for the mobility means we all enjoy, understand which mobility innovations will be ‘game changing’ and grow economies; which ones will be accepted by different generations of the European public – and which ones could be rejected and why. This requires a full understanding of the underlying value of mobility in people’s lives; whether they are making local journeys, national or trans-European: Whether they are on foot, cycle, by public transport on land, sea, by air. In addition, physical and virtual mobility (via the internet) are now fully integrated and one cannot understand one without understanding the other. Mind-sets centrally addresses these issues in 3 basic objectives:

- How to better understand mobility (to better influence and change it)
- How to predict the likely future attitudes to, and patterns of, mobility
- What forms of mobility policies, products and services will best meet these future mobility needs

In developing the Mind-sets approach, the goal is to synthesise and coordinate current intelligence as building blocks for the new approach; and then to use the approach (through guidelines and a ‘Knowledge Centre’) to advise and support the key stakeholders in the wider European mobility industry.

One of the Commission’s important justifications for launching the Mind-sets project was that, while we have good knowledge of mobility patterns, we still lack the basic understanding of mobility and

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how travel patterns may be influenced and changed. An important element of Mind-sets is that it
takes a step back from current professional analysis of mobility and travel patterns, to more fully
understand how mobility is placed in the everyday lives of Europeans; using an approach which
embrace a wide range of intelligence from many disciplines.

This report and its sister reports
This deliverable (2.1B) forms one of three linked reports produced within the Mind-sets project under
its second workpackage. The objective of this report is to coordinate the understanding of mobility
from the viewpoint of several key disciplines – economics, psychology, sociology, geography and the
impact of new internet technologies. In turn, the work contained within each of these chapters of the
report draws on work from an even wider net of subject matter.
This report combines with a sister report (D2.1C) that addresses how we might develop a Mind-sets
approach from a core understanding of the drivers of different generations within European society.
Both of these reports are then synthesized in a ‘top report’ which outlines the basis for a new Mind-
sets approach to assessing mobility (Deliverable 2.1A).

Details of the 3 reports and their citations are as follows:

This report:
Deliverable D2.1B: Mind-sets: Interdisciplinary perspectives on mobility
UNAL, A. B. with BIOSCA, O., CALVET, M., CARREAS, B., FRANCKX, L., LARREA, E., MAYERES,
sets: Interdisciplinary perspectives on mobility Deliverable 2.1B of the Mind-sets project. European
Commission Directorate General for Research, Covent Garden, Brussels.

Sister reports:
Deliverable D2.1A: Mind-sets: A new vision on European mobility
PICKUP, L with BIOSCA, O, FRANCKX, L, KONINGS, H, MAYERES, I, PLAUT, P, SHACH PINSLY, D, UNAL,
Deliverable 2.1A of the Mind-sets project. European Commission Directorate General for Research,
Covent Garden, Brussels.

And
Deliverable D2.1C: Mind-sets: A generational perspective on mobility
2.1C of the Mind-sets project. European Commission Directorate General for Research, Covent
Garden, Brussels

One of the most striking features of the chapters that follow is the manner in which all disciplines
have moved from positions where achieving an understanding of their field depended on assessing
processes operating solely within that subject; to a position where understanding had to be achieved
through an explicit analysis of the woman/man relationship with their environment – and the
attachment to mobility that determines that relationship – from neo-classical economics to
behavioural economics, from environmental psychology to teleological behaviourism, from analysis
of ‘vertical’ social structures to social ‘mobilities’ and social networking. While each discipline comes
with its own language, Mind-sets has translated these academic barriers into a single explanation; accessible to a wider audience of mobility stakeholders; providing new insights into how mobility evolves, and how it shapes our personalities and our lives. It provides an approach which reveals that the standard variables we use to measure and model mobility patterns are becoming less relevant in the increasingly diverse European society – age and sex is becoming less relevant in contrast to defining common values and mind-sets within generations and social groups.

It is hoped that this report, and its two sister documents, will spark a new line of thought and debate among mobility specialists and, through the forthcoming Mind-Sets guidelines and Knowledge Centre, provide the intelligence and support that stakeholders need in developing new mobility products and services that will meet future mobility aspirations in Europe and drive sustainable economic growth to the benefit of all.

Professor Laurie Pickup
Mind-sets Technical Coordinator
October 2015
Chapter 1: The Economics Approach to Mobility

Mobility Mind-sets from the behavioural economics perspective

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1. Introduction

The recent Transport and Environment Reporting Mechanisms indicators of the EEA\(^1\) show an ongoing growth of passenger transport demand in the EU-13 countries, and a stabilization in the EU-15. The share of cars, which cause a lot of negative societal impacts in terms of the environment, congestion or accidents, is very high in the EU, and is growing in the EU-13. Air passenger transport has known a large growth in the past 15 years (with a drop-back during the recession), leading to larger environmental impacts. Recent projections for the EU expect transport to grow by 170% by 2050, compared to 1995. In the case of greenhouse emissions by transport, despite improvements in energy efficiency and fuel mix, emission reductions are projected to fall very short from the 2011 White Paper objective. The challenges are therefore large. While technical solutions such as emission reduction equipment or energy efficiency measures, play a role in mitigating the negative impacts of transport, understanding the fundamentals of transport demand is also crucial to attain a more sustainable transport system.

This chapter presents the contribution of economics to understanding travel demand choices. The sociological and psychological insights are discussed in Chapters 2 and 3.

In Section 2 we start with a very short history of transport demand modelling. The origins of travel demand modelling can be traced back to the 1950s in the United States, with as main objective to subject urban transport to systematic analysis. This practice rapidly spread to major urban centres around the world (Boyce and Williams, 2005). Since the 1970s, travel demand modelling has been dominated by neo-classical economic concepts. In Section 2.3 we discuss the traditional four-step models, which are the workhorse of the economic approach and subsequent refinements to this approach. Section 3 shifts the focus from models that are trip-based, to models that build on the activities that generate travel.

Over time the neo-classical approach to economics has been criticised. We review two main approaches that aim to model transport behaviour in a better way. Section 4 discusses Hybrid Choice Models. In this approach attitudes, beliefs and social norms are seen as important determinants of travel behaviour. It therefore aims to identify observable variables that affect these attitudes, beliefs and social norms. Alternatively, the behavioural economics approach, which is discussed in Section 5, argues that some of the axioms of neo-classical theory are wrong, and tries to replace them by more realistic ones. Section 5.5 dwells on some temporal dimensions of transport decisions.

Section 6 concludes with a discussion of the implications for transport policy and planning, with a focus on the recent insights from behavioural economics.

2. A very short history of travel demand modelling

The remarkable longevity of those models of the “traditional form,” (...) is due to their capacity to absorb innovations (...). There is also perceived to be a lack of a clear alternative for generating the required information. Assessment of the models is rightly seen as a relative not absolute activity, in relation to the next best alternative.

Boyce and Williams (2005, p. 40)

2.1. The foundations of the neo-classical economic approach

The cornerstones of the neo-classical approach to economics are usually said to be methodological individualism and rational choice.

\(^1\) [http://www.eea.europa.eu/themes/transport](http://www.eea.europa.eu/themes/transport)
Methodological individualism means that the modelling unit is the individual: economic theory predicts the choices of an individual, including his travel choices, given his/her preferences and any constraints he/she may face. Collective behaviour follows from the aggregation of the behaviour of individuals.

Neo-classical theory also postulates economic rationality. Loosely stated, economic rationality means that individuals are aware of all the potential combinations of goods and services that they can purchase, and that they are able to make logically consistent choices between these combinations. It is assumed that the preferences of individuals are given and stable, and are independent of contextual factors such as the preferences of others. The last point entails that people are neither altruistic nor jealous, and care only about the amount of goods they consume, not about their relative positions compared to other individuals.

2.2. Translation of the economic approach in transport demand modelling

In the context of transport planning, preferences are typically expressed over leisure time, various goods and services including transport goods and services, the time spent in transport, etc. Some transport models also include goods that can only be consumed if a transport activity is undertaken, such as touristic destinations. Individuals are assumed to aim for the bundle of goods and services that give the highest satisfaction, taking into account the following constraints:

- **budgetary constraints**: people cannot spend more than the sum of their wages and non-labour income – a complication in travel demand modelling is that their labour income may actually depend on their travel behaviour, such as commuting.
- **time constraints**: people’s activities (typically leisure, work and travel) are constrained by the time available.

The time constraints imply that people do not just consider the financial costs of transport, but also the opportunity cost of the time spent in transport. DeSerpa (1971) also introduced time allocation constraints, imposing minimum time requirements on activities (for example, because speed cannot be higher than a certain speed limit or than the speed level that is imposed by congestion).

The relevant concept is therefore the generalised cost of transport. This is a measure combining all the main attributes related to the disutility of a journey. Typical components are the financial costs including parking costs, the opportunity cost of time differentiated according to whether it is in-vehicle time, walking time or waiting time, and the discomfort of travel including safety (Ortuzar & Willumsen, 2011). As a result, people might sometimes prefer a longer route, entailing higher fuel costs, if they can travel faster via this route compared to the shorter route.

People are assumed to take into account all relevant information, including uncertainties, and to perfectly process this information in order to make optimal choices about the transport modes they use, the time of the day at which they travel, their destinations, the vehicles they purchase or their place of residence.

For empirical applications, discrete choice models (Train, 2009) are currently the standard; they are used as input in four-step models (Section 2.3) but also in models for vehicle choice or location choice.

2.3. The workhorse of the economic approach: the four-step model

From the outset of travel demand modelling, wherever data and resources allowed to do so, transport modellers have used the so-called four-step approach, where transport demand is modelled as resulting from four distinct steps:

- Trip generation: what is the total number of trips originating from and arriving in the different transport zones?
- Trip distribution: how many trips are undertaken for each zone pair?
- Modal split: which travel modes are used for the trips between each zone pair?
• Traffic assignment: how are the trips by each mode and zone pair assigned to the mode-specific networks?

Depending on the policy focus of the model, practitioners sometimes use simplified approaches. Some more strategic models do not include traffic assignment or use a limited level of geographic detail (see e.g., FPB (2012) or the TREMOVE model\(^2\)).

2.4. Transport modelling under attack

According to Timms (2008), since the 1970s, concerns have continually been expressed about the predictive accuracy of transport demand models. Timms (2008) identifies the following lines of defence that have been erected in favour of models:

- models have frequently been used to understand transport and mobility phenomena, as opposed to making predictions;
- the criticisms refer mostly to long term predictions, and so should not be used to criticise short term modelling;
- much of the model inaccuracy is a result of inaccuracy in exogenous (i.e. non-transport) modelling inputs;
- the lack of accuracy in forecasts could be attributed to the continuing practical use of four-step transport models, comprising sequential sub-models of trip generation, distribution, mode choice and assignment.

The inaccuracies in the forecasts of exogenous variables fall clearly outside the scope of the current chapter. One might also argue that, whatever the method used, the further one goes in the future, the more inaccurate the prediction will be. And, while the shortcomings of sequential four-step models are well understood, due to data constraints, they are often the only modelling approach than can be implemented in practical policy analysis.

A different concern that has been raised concerning four-step models is that they had been developed for the evaluation of large infrastructure projects, and that a finer representation and understanding of transport demand and supply was needed. For instance, increasing environmental concerns have led to the need to estimate flows and speed by time periods of the day (Boyce & Williams, 2005).

To a large extent, new developments in economic theory and methodology have provided answers to these concerns. First, the spectacular uptake of discrete choice theory in the 1970s has allowed to estimate demand at the individual level and to better take into account variability in individual behaviour. Second, the empirical basis of travel demand modelling improved with the application of stated preference techniques and their integration with revealed preference data (Boyce & Williams, 2005). Revealed preference data are data on the actual choices made by transport users. Stated preference data are obtained via various market research tools that are used to uncover how transport users value different product/service attributes. Stated preference techniques confront respondents with different hypothetical product/service scenarios, consisting of different attribute mixes. Respondents are asked to rank, rate or choose between the scenarios. The value of the different attributes is then inferred from the respondents’ choices. Stated and revealed preference data may be analysed separately, but their combined use enriches the explanatory power of models.

There has also been a shift in focus from models that are trip-based, to models that build on the activities that generate travel (see also Ortuzar & Willumsen, 2011). This has led to activity-based modelling, which we will discuss in Section 3.

As a matter of fact, the neo-classical approach to economics has itself increasingly come under fire in other applied domains than transportation alone. There is an important body of research

\(^2\) http://ec.europa.eu/environment/archives/air/models/tremove.htm
suggesting that preferences are not stable over time and are affected by the preferences of others, that people do not process all available information when they take decisions or that their decisions are affected by apparently irrelevant factors.

There are currently two main strands of thought on how to better incorporate (possibly less-than-perfectly-rational) behaviour in transport models.

One possibility is to maintain the essential assumptions of the neo-classical approach, but to **better integrate these behavioural aspects within a slightly modified version of the standard framework**. This is the position taken for instance by Timmermans (2010), who has argued that the typically assumed violations of the economic rationality axioms can for the most part also be captured by making appropriate operational decision in currently dominant utility-based theories.

For instance, one may argue that the limited capability to process information is an additional constraint people face when they have to take decisions, that sticking to habits is a way to deal with this constraint as long as circumstances do not change too much, and that this explains why people do not always choose the best possible bundle of goods and services. In a transport demand context, this may imply that, once people have chosen a certain route and transport mode for a given trip, they will stick to this choice, without constantly re-evaluating all available information every time they undertake this trip (although they will re-evaluate this information if significant changes in the key parameters are observed).

Similarly, if attitudes, beliefs and social norms are important determinants of travel behaviour, a researcher should aim to identify observable variables that affect these attitudes, beliefs and social norms (see the discussions in Gärling, 1998; McFadden, 1999; Avineri, 2012). This is the approach chosen in **Hybrid Choice Models**, which we will discuss in Section 4.

Another possibility is to accept that some of the axioms of neo-classical theory are just plainly wrong, and need to be replaced by more realistic ones. This is the **behavioural economics** school of thought, which we shall discuss extensively in Section 5.

As we shall see below, the distinction between the two approaches is not clear-cut. Both attempt to develop more realistic models of human behaviour, and to integrate insights from psychology and other social sciences.

Both are also still a long way from being integrated in mainstream transport modelling. For instance, in the introduction to the most recent edition of their widely used textbook on Modelling Transport, Ortúzar and Willumsen (2011) acknowledge that the vast majority of the models in their book are based on Random Utility Theory. Their discussion of the implications of Behavioural Economics is limited to the acknowledgement that the evidence in favour of Behavioural Economics punctures the underlying theory of traditional transport models, including Activity Based Models. Their main conclusion for the practice of transport modelling is that this “makes the application of judgement in the interpretation of model outputs even more important” (p.18). It is our intention to go beyond this in terms of recommendations.

### 3. From trips to activities

Four-step models are applied very frequently due to their simplicity in calculations and limited need in terms of computational requirements. However, this type of modelling contains a number of limitations (McNally, 2000):

- **Trip-based models** focus on individual trips, disregarding the basic principle that the demand for travel is not a demand as such, but derived from the demand for activity participation. Trips and activities are thus spatially and temporally related.
- **Four-step models** do not account for the behavioural foundation underlying travel behaviour, such as complex choice sets limited by personal and interpersonal constraints, household dynamics and interrelationships between travel and activity participation.
Activity-based models focus (1) on the relationship between all activities executed in the course of a day/week/month and not just on the connection between activities in one tour and (2) on the interaction between household members. Thus, an activity-based travel-demand model aims at predicting which activity is executed, where, when, for how long and which transport mode is used to get to the desired location (Arentze & Timmermans, 2005a).

Moreover, if implemented well, activity-based travel-demand models offer the opportunity of assessing the implications of non-transport policies or technological developments on travel, examining the impact of transport-related policies on non-travel issues and gaining a qualitative and quantitative insight of role of travel in people's lives (Jones, 1979). Furthermore, activity-based micro simulations provide numerous additional advantages, including predicting along a continuous time-axis instead of the traditional aggregated peak/off-peak estimations, the ability of realistically assessing the impact of travel-demand measures on individual activity-travel behaviour, and hence on travel-demand, the flexibility and versatility with respect to specific study objects and policy scenarios, the control on the accuracy by defining the desired level of spatial and temporal resolution and the comprehensibility as an evaluation tool (Kitamura, 1996).

A prominent requirement of dynamic activity-based travel demand models includes the ability to incorporate both short term and long term dynamics (Goodwin et.al., 1990). The former dynamics occur within a day, and refer to rescheduling due to the effect of preceding decisions or events on subsequent choices, and/or of later objectives on earlier decisions. An example is the occurrence of an unforeseen event in the course of the execution of an activity - either a negative or a positive delay - or unexpected travel times, resulting in a time-surplus or time-lack situation which triggers short-term adaptation (Arentze et.al., 2005; Goodwin et.al., 1990).

Long term dynamics cover the impact of experiences of previous actions on activity travel patterns over a longer time frame. While conducting activities, individuals build up expectations and beliefs based on the outcomes of their behaviour. New experiences cause these expectations and beliefs to be updated, and behaviour to change accordingly. This type of dynamics is subject to a high degree of inertia, implying a slow response rate. For instance, long term dynamics can cause household relocation or a change in the car availability of the household (Arentze & Timmermans, 2005b; Arentze et.al., 2005; Goodwin et.al., 1990).

Most implemented activity-based models cover high-resolution areas (e.g. on postal code level) and a large number of time periods or even minute-to-minute activity-travel schedules. Consequently, these models span a higher spatial and temporal resolution compared to four-step models which generally include aggregated traffic zones and only a limited number of time periods (peak vs. off-peak) (Rasouli and Timmermans, 2014).

However, even though activity-based models model individual activity-travel patterns, most activity-based models do not actual reflect actual individual choice behaviour. The underlying modelling techniques as discussed above do not cover the context-dependent mental decision-making process (Rasouli & Timmermans, 2014). Thus, regarding this aspect, implemented activity-based models resemble traditional four-step models.

Furthermore, the promise of synchronisation and coordination of activity-travel patterns between household members based on task and resource allocations, joint activities and joint travel, is only explicitly incorporated in a limited number of activity-based models, with the Albatross model as a prominent case (Rasouli & Timmermans, 2014).

All activity-based models implement a varying degree of interdependencies between the different choice facets of the activity-travel schedule: activity, location, transport mode and route. Due to the concept of simulating an iterative scheduling process for all household members, ALBATROSS for example guarantees modelling interdependencies to the largest extent possible (Rasouli & Timmermans, 2014). Other models focus less on capturing these interdependencies.
As a conclusion, we can state that large differences exist between activity-based models and the degree to which they address the shortcomings of traditional four-step models. The most comprehensive, fully operational model is undoubtedly ALBATROSS, which redeems most promises accompanying the arrival of activity-based models.

Yet, despite this fact that most activity-based models do not entirely comply with the initial requirements, these models do provide additional opportunities compared to four-step models due to their higher spatio-temporal resolution and individual-based approach. For example, the possibility of using the activity-travel schedules to estimate individual exposure to pollutants (Beckx et al., 2009a; Beckx et al., 2009b).

4. Hybrid choice models

The main motivation for the development of hybrid choice models is the finding that travel choices are not only affected by instrumental criteria (e.g., travel time, monetary costs, safety) but also by attitudes and social motives. Gifford and Checherita-Westphal (2008) have argued that “policies designed to alleviate congestion may be less effective than expected, because these qualitative factors are seldom measured and incorporated into demand models” (p.11).

**Hybrid choice models** (HCM) integrate discrete choice and latent variables models, “taking into account the impact of attitudes and perceptions on the decision process.” (Bolduc & Alvarez-Daziano, 2010, p. 2). Thus, unobserved psychological variables such as perceptions and attitudes are incorporated in the explanatory variables as latent variable.

“On the one hand, perception variables measure the cognitive individual capacity to represent and evaluate the attributes of different alternatives. Perceptions are relevant because the choice process depends on how attribute levels are perceived by the individual beliefs of a specific consumer. On the other hand, attitude variables measure the individual evaluation of importance assigned to the features of different alternatives.” (Bolduc & Alvarez-Daziano, 2010, p. 5).

Practically speaking, such models are estimated through a combination of observed choices (which serve as indicators for the alternatives’ utility) and observed indicators for the latent variables, mostly using surveys (Chorus, 2012a). Drawbacks of these model are higher data requirements, loss of parsimony in model parameters, and higher complexity (Chorus, 2012a).

5. Behavioral economics and mobility behaviour: research

5.1. Key concepts

Ever since the axioms of neoclassical economics were postulated, people have questioned their empirical validity.

A first fundamental line of criticism argued that humans have only a finite amount of attention and knowledge available, and cannot consider all possible alternatives and the corresponding outcomes when they have to take decisions. This criticism is attributed to Herbert Simon, who coined the term ‘bounded rationality’ in the 1950s. In Simon’s terminology, the model of the “rational” economic person should be replaced by a model of the “administrative” person (Gifford & Checherita-Westphal, 2008): the boundedly-rational person “satisfices” rather than optimizes. It should be noted that “bounded” rationality is thus not be confused with non-rational behaviour. “Satisficing” entails the following steps:

- The decision maker sets an aspiration level, which may change with experience (thus, if people find it difficult to reach their goals, their aspiration level will adapt).
- He/she then undertakes a sequential comparison of alternatives with the benchmark (rather than with all other alternatives, as assumed in neo-classical theory).
He/she selects an alternative as soon as he/she has found one that is satisfactory according to the aspiration level.

Moreover, the boundedly-rational person ignores those aspects of reality that appear irrelevant, and thus uses rules of thumb to economize on his/her cognitive resources.

However, the most influential contributions in this field have come from psychologist Daniel Kahneman, largely in joint work with Amos Tversky. The work of Kahneman, as summarized for a broad public in “Thinking, Fast and Slow” (Kahneman, 2011), has spawned a large literature, which is commonly known as behavioural economics. This emerging field acknowledges that neo-classical economics remains relevant for most decisions people take, but it also claims that there are some areas where behaviour deviates in a predictable and systematic way from the postulates of neo-classical economics.

In what follows, we will further elaborate on some key insights in behavioural economics, and how they have been applied in transport modelling.

We will consider the following topics. First, we will discuss heuristics: a heuristic technique is any approach to problem solving, learning, or discovery that employs a practical methodology not guaranteed to be optimal or perfect, but sufficient for the immediate goals\(^3\). More informally, “it is any “rule of thumb” or simple rule of behaviour by which a person solves a problem” (Cartwright, 2011, p. 27). Behavioural economists have identified a wide range of heuristics, some of which are directly relevant for transport behaviour.

Second, we will discuss human behaviour of choice under uncertainty. We shall see that, although there is a lot of evidence that people do not behave according to the standard economic axioms, it is not clear which alternative approach is the most appropriate, or how these alternatives can be applied in practical modelling.

In a third step, we will drop the assumption that people take their decision in isolation, and discuss how social factors affect mobility behaviour, for instance through peer pressure in mode choice, or as a motive for travel.

Fourth, we will discuss how people take decisions involving an explicit temporal dimension, such as assessing to what extent they take into account future fuel costs when buying a car.

5.2. Heuristics

Generalities

The fundamental premise of behavioural economics is that, because the world is complex, people use rules of thumb instead of explicitly optimizing each decision and incorporating all relevant information. As argued by Thaler and Sunstein (2008), these rules of thumb are sensible most of the time but sometimes can lead people astray.

We will now give an overview of some commonly used heuristics, and illustrate their relevance for transport modelling. A brief summary is provided in Errore. L'origine riferimento non è stata trovata.. A common theme across these different strategies is that, as Leong and Hensher (2012) have pointed out, the existence of heuristics implies that preferences for an alternative are influenced by the choice context itself, and cannot be assumed to be given.

Anchoring and priming

The anchoring effect occurs when someone’s “choice is influenced by some prior cue or anchor” (Cartwright 2011, p 38). In the context of transport modelling, the problem of anchoring is relevant because some values used in cost-benefit analysis (such as the value of time) are often obtained from Stated Preference surveys. In surveys about the value of travel time savings, the provision of an

initial valuation figure, for instance via an example of the choice sets prior to the survey questions, may lead to anchoring bias. In an analysis of the 1997 and 1997 Dutch value of travel time studies Van de Kaa (2010b) finds however only a marginal impact of anchoring bias, in spite of a very clear anchor value.

A related concept is priming: **people can be primed** into action by simple and apparently irrelevant cues. For instance, in surveys, when people are asked what they intend to do, merely asking the question increases the likelihood that they will act according to the answers (Thaler & Sunstein, 2008, p 70). Metcalfe & Dolan (2012) have suggested that **priming** could be used in transport to get **consumers in a certain mood** – by priming people with words and images about peak oil, potential fuel shortage in the (near) future and possibly climate change, they may chose for more fuel efficient cars when making a decision about what car to buy. This line of research suggests that priming can be used as a strategy to promote desired travel behaviour among people.

**Table 1: Commonly used heuristics relevant for understanding transport choices**

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anchoring</td>
<td>Choices are influenced by some prior cue or anchor</td>
</tr>
<tr>
<td>Priming</td>
<td>People are primed into action by simple and apparently irrelevant cues</td>
</tr>
<tr>
<td>Availability</td>
<td>People take decisions based on immediate examples that come to a one’s mind when evaluating a specific topic, concept, method or decision</td>
</tr>
<tr>
<td>Representativeness</td>
<td>In judging items, people compare them to a prototype or representative idea and tend to see them as typical or atypical according to how they match up with their model</td>
</tr>
<tr>
<td>Optimism and overconfidence</td>
<td>People show unrealistic optimism and overconfidence as regards their own potential and performance</td>
</tr>
<tr>
<td>The endowment effect</td>
<td>People value more highly goods that they have some ownership over</td>
</tr>
<tr>
<td>Status quo bias</td>
<td>People tend to stick the with current situation</td>
</tr>
<tr>
<td>Framing</td>
<td>Choices depend on the way in which problems are stated</td>
</tr>
<tr>
<td>Mental accounting</td>
<td>Any spending or income is put into distinct accounts for particular purposes and people are reluctant to move money between these accounts</td>
</tr>
</tbody>
</table>

**Availability**

This is a heuristic used when **people assess the likelihood of risks by asking themselves how readily examples come to mind**: they tend to be more concerned if they can easily think of relevant examples, which is in turn affected by the salience (e.g., think of aviation disasters versus car crashes) and the distance in time of these examples. This affects risk-related behaviour, such as the demand for insurance or the demand for public investments in safety measures (Thaler and Sunstein, 2008, p 25). It could also affect the perceived safety of specific transport modes of routes. For example, if a person has experienced unpleasant incidents many times on a particular route or
mode, that route or mode is seen as more dangerous, while statistically speaking, the risk might be overestimated since the assessment is only based on the available sample (Wretstrand, 2008).

Another application lies in the formulation of route descriptions. For instance, it has been argued (see Nothegger et al., 2004; Götze & Boye, 2013) that it is easier to follow route directions based on landmarks, i.e. prominent objects in the city environment, than on the geometry and place names provided by automatic devices. The most suitable landmarks would be those with the most salient features.

In addition, Metcalfe and Dolan (2012, p. 506) argue that that “the salient cost or experience of travelling and the end cost or experience may have a disproportionate impact on our transport behaviours. Changing the saliency of certain costs and/or experiences may be able to change transport-related behaviours.” For instance, highly publicised penalties due to speed controls may induce people to drive more safely.

Representativeness
This is a heuristic that can be described as follows: when asked to judge how likely it is that A belongs to category B, people answer by asking themselves how similar A is to their image or stereotype of B (i.e. how representative is A of B). For instance, because most people do not have an accurate idea of what random processes look like, when seeing the outcomes of such processes, they detect patterns that they think have meaning even if they are just due to chance (Thaler and Sunstein 2008). An example of the representativeness heuristic in the field of air travel behaviour is when the decision to fly with a particular carrier is assumed to be solely based on the most recent crashes without taking less recent events into account (see Squalli, 2010).

Optimism and overconfidence
There is ample evidence that people show unrealistic optimism and overconfidence as regards their own potential and performance. This affects individual risk taking, especially related to life and health risks. It also prevents people from taking preventive measures (Thaler and Sunstein, 2008). In the case of transport behaviour, research documents that people overestimate their driving skills and underestimate the risk of being involved in accidents (DeJoy 1987; Dalziel & Job, 1997; Harré & Sibley, 2007; Harré et al., 2005, Jiang et al., 2008). Moreover, there is no evidence that overconfidence decreases with experience (Sandroni & Squitani, 2004).

The endowment effect
The endowment effect (or loss aversion) refers to the observation that “people value more highly goods that they have some ownership over” (Cartwright, 2011, p 43). More informally, they dislike more losing something than gaining the same thing. This implies that the value assigned to an object is not given (which can be highly relevant for cost-benefit analysis). The endowment effect produces inertia and can prevent people from making changes that are in their own interest (Thaler & Sunstein, 2008).

This problem is relevant for a wide diversity of choice situations, such as car choice (Johnson et al., 2006); route choices (Hess et al., 2007; Hjorth & Fosgerau, 2008), choice of travel schedule (Ben-Elia & Ettema, 2011) or the use of tradable credit scheme to manage road mobility (Bao et al., 2014).

However, it is not clear to what extent the findings from these studies can be generalised to new settings or how the relevant reference point should be determined (see for instance Delle Site & Filippi, 2012) – we shall come back to the latter point when discussing choice under uncertainty.

Status quo bias
It has been observed that people tend to stick with the current situation. Several, not mutually exclusive, explanations have been given for this bias:
• A lack of attention, and the feeling that default options are endorsed (Thaler & Sunstein, 2008).
• If the cost of searching for and constructing new alternatives is too high and the expected gains associated with new alternatives too uncertain, people reuse past solutions to make their behaviour easier and less risky (Gärling & Axhausen, 2003).
• Habit triggers in general reactions such as a reduction in mental and cognitive efforts (Innocenti et al., 2013), and therefore people might be reluctant to change their old habits because habitual behaviour requires little processing effort (see Chapter 2).

Research has confirmed that inertia is strongly present in transport. Innocenti et al. (2013) also provide a series of other possible explanations for inertia in transport choices:

• Information provided by time tables is combined with personal experience, and, because of the representativeness heuristic (cf. supra), information is better processed when travellers lack long-term experience on travel time distribution.
• Due to limited working-memory capacity, people do not take into account all previous travel costs.

Innocenti et al. (2013) argue that such tendencies are particularly pronounced in mode choice, because the aforementioned factors are combined with other elements such as:

• The symbolic and affective value of cars (see also Steg, 2003): people seem to choose on the basis of an “affect pool” associating a positive tag to car use. This “affect heuristic” could be the result of repeated mental associations over time, which result in people generating intuitive responses that could previously have been the outcome of analytic thinking.
• People tend to underestimate the costs of cars because there is a time gap between car use and the payment of the costs (see also Section 5.5).

In a laboratory experiment, Innocenti et al. (2013) find that individuals show a marked preference for cars (even when against their economic interest), are inclined to confirm their first choice and exhibit travel mode stickiness. The study confirms that, in repeated travel mode choice, available information is not properly processed, cognitive efforts are generally low and rational calculation plays a limited role. Innocenti et al. conclude that economic incentives may be relatively ineffective in reducing the preference for cars, but that transportation policies should focus more on initiatives which increase individual awareness in making choices. However, they also point to the modest results obtained so far by “soft” policies based on the provision of information, which could rather be an argument in favour of “command and control” policies.

Other research has shown that status quo bias is also relevant for the choice of the service provider (e.g. in the commercial passenger rail market) after the travel mode has been chosen (see Paha et al., 2013).

The issue of rationality in route choice is more contentious. Innocenti et al. (2013) point out that, in route choice, expected travel time depends on the expectations of others’ route choices, which are in turn based on a combination of prior experience and public information. Several experimental studies conclude that travellers’ distribution is close to equilibrium. Moreover, real time additional information has been shown to enhance the optimality of choices, at least in an experimental congested network.

Empirical findings by Di et al. (2014) are consistent with several international studies based on field observations showing that a substantial share of people do not usually take the shortest route. The

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Authors propose a boundedly rational route switching model where people do not always select the shortest paths, but where the chosen routes are still within some threshold from the shortest ones. They refer to several experimental studies showing that commuters would not adjust their departure time unless the difference between preferred arrival time and actual arrival time exceeds a bound.

As far as policy is concerned, Garling and Axhausen (2003) argue that it is important to understand how habits are broken, in other words, how to ensure that choices become deliberate and rational again. Some research findings are:

- Aarts et al. (1997) show that accountability leads to higher efforts in judgments of travel mode use: subjects who have to explain their judgments in an experimental settings use more attributes of the available transport options and exhibit greater consistency in the processing of information.
- Fujii and Kitamura (2003) argue that a temporary structural change, such as offering car drivers a temporary free bus ticket, may be an important tool for inducing modal shift.
- In a field experiment, Garvill et al. (2003) observe a temporally extended decrease in car use if people are required to indicate the contextual conditions for each planned trip-chain, and indicate alternative travel modes if they plan to use the car.
- Chorus and Dellaert (2012) argue that the costless provision of multimodal travel information may slow down inertia emergence, but only to the extent that the information is considered reliable.

There is therefore a potential for inducing people to break their habits, provided that the policy design is of good quality.

**Framing**

Neoclassical economics assume that people process information rationally, i.e. are not affected by elements that do not affect the outcome of their choices. Framing means that choices depend, in part, on the way in which problems are stated (Thaler & Sunstein, 2008).

Avineri and Waygood (2013) consider whether framing can be used to enhance the evaluation of choice attributes (including of attributes that have social costs such as CO₂ emissions) and promote more sustainable choices. They conduct an experiment where the information is framed to focus the attention of the respondent either on the potential of a travel mode to provide environmental benefits (positive frame) or on its potential to reduce environmental loss (negative frame). They conclude that negative framing is more likely to influence travel-related choices. They suggest that valence framing information (this is, whether information in either a positive or a negative light) can be applied to diverse situation such as on-line journey planners, measures to voluntary change travel behavior, or CO₂ tax bands on cars.

Similarly, Arentze et al. (2012) find that the route choice of truck drivers/route planners is relatively sensitive to road pricing schemes but rather insensitive to environmental bonuses, which is consistent with the assumption in prospect theory (see Section 5.3) that people value losses more than gains.

A final example is the miles per gallon illusion: in the US, fuel efficiency is expressed as miles per gallon. Larrick and Soll (2008) find that people systematically misunderstand the concept of miles per gallon, and tend to undervalue small improvements on inefficient vehicles. If the standard is expressed as “gallons per mile” instead, consumers would understand better how much petrol they are using on a given car trip or in a given year.

**Mental accounting**

Formally, mental accounting is the process of coding, categorizing and evaluating choices and outcomes. In economics, this means that any spending or income is put into distinct accounts for particular purposes (Cartwright, 2011), and that people are reluctant to move money between these
accounts. Examples of such mental accounts are: an account for one’s mortgage, a different one for one’s savings, and still another one for holiday expenses.

Metcalfe and Dolan (2012) suggest that mental accounting could be important for analysing transport expenditure or the time spent travelling within a particular time period. They refer specifically to the findings by Schafer and Victor (2000) that, on average a person spends 1.1 h per day traveling and devotes a predictable fraction of income to travel, and that these time and money budgets are stable over space and time. If these relations would continue to hold in the future, further improvements to the transport system would not translate in a reduction of the total time spent in transport in the long run but in more travel over longer distances. However, after a comprehensive review of travel-time budget (TTB) studies in the literature for about the past four decades, Ahmed and Stopher (2014) conclude that the underlying cause of the regularity that is found at an aggregate level is still not known. However, they observe that almost all of the research discussed in their review is based on surveys measuring travel on one weekday for each respondent. Therefore, there is insufficient knowledge of possible variation of individual TTB over multiple occasions.

Using a stated choice experiment, Hess et al. (2012) conclude that the assumption of fungibility of money does not hold for the valuation of different categories of benefits from transport projects. In other words, the disutility from spending money depends on the area on which it is spent (e.g. travel time savings versus preventing statistical fatalities). From a policy point of view, Hess et al. conclude that these results advice against the use of benefit transfers from other monetary valuations in the appraisal of transport projects.

Competing theories
The differences between the heuristics discussed above are often very subtle, and one single phenomenon can often be explained by several competing theories.

One illustration of the complication this creates is provided by Hamilton et al. (2014) who use surveys in Stockholm, Helsinki and Lyon to explore what variables influence public attitudes towards congestion charges. Self-interest variables explain 20-50% of total explained variation in attitudes. However, what is remarkable is the high share of variation that is explained by “differences in respondents’ attitudes to environment, trust in public agencies, and views about the fairness of pricing policies in general” (p. 1). Moreover, the way in which congestion pricing is framed (cf. supra) in the local discourse appears to be a crucial element. The single most important factor is actual experience with congestion pricing, which leads to higher support. Hamilton et al. discuss several possible explanations for this “familiarity breeds acceptability” phenomenon, including:

- the positive effects of congestion charging turn out to be unexpectedly high and the amount spent on the congestion charges is lower than expected;
- once people are convinced that the introduction of the scheme is decided, they tend to accept the unavoidable; moreover, this could lead to a change in the reference point if people suffer from loss aversion and status quo bias;
- one completely different explanation refers to the substitution heuristic: this heuristic implies the necessity to understand the associations that are made between congestion pricing and its impacts in the specific context of a city: “If for example congestion pricing was suggested in a city where the public places a high value on economic development, and not so much attention to the natural environment, (…), one would need to foresee which characteristics of the congestion pricing policy will resonate with an economic development discourse, and then to anticipate whether this characteristic is interpreted as a support or an obstacle given the chosen frame of reference.”(Hamilton et al., 2014, p. 20).
5.3. Choice under uncertainty

A lot of travel-related choices (such as route and mode choices) are made under circumstances of uncertainty (for instance with respect to travel times). In the next paragraphs we summarise different theories that deal with this uncertainty and how they can be useful for travel-related choices.

Prospect Theory

Prospect Theory, as proposed by Kahneman & Tversky (1979)\(^5\), describes decision processes as consisting in two stages. In an editing phase, prospects would be organised and evaluated: people decide which outcomes they consider equivalent, set a reference point (generally, but not always, the status quo) and then consider lesser outcomes as losses and greater ones as gains. In the evaluation phase, probabilities are given subjective weights and the value of the prospect is evaluated. In prospect theory, gains and losses relative to the reference point are judged asymmetrically. Moreover, people tend to overweight small probability events, but underweight large probabilities. This stands in contrast with the standard economic model of Expected Utility Theory, where gains and losses are valued equally, and where subjective probabilities assigned to events comply with the axioms of probability theory.

According to Chorus (2012a), an enormous body of literature has confirmed these assumptions. Van de Kaa (2010a) adds the following distinguishing features of Prospect Theory compared to Expected Utility Theory:

- Context-dependent preferences: People’s preference orders are dependent on the context of the choice situation and the way choice options are presented and perceived.
- Change-oriented framing: People frame choice options in terms of the expected change in their assets rather than on their expected state.
- Diminishing sensitivity: the marginal value of both gains and losses generally decreases with their magnitude.

Despite the important differences between Prospect Theory and Expected Utility Theory, they also share some key assumptions (Van de Kaa, 2010a): subjects are considered as self-interested, non-satiable utility/value maximizers and their choice behaviour strategy is deterministic and static.

Next to Prospect Theory, there are two other closely related alternatives to Expected Utility Theory: rank dependent expected utility theory and cumulative Prospect theory. We will now first briefly discuss these variants, and then provide some examples of applications of the “Prospect Theory family of models” to travel behaviour. Finally, we will discuss some important controversies surrounding this approach.

Rank Dependent Expected Utility Theory

Rank Dependent Expected Utility (Quiggin, 1982)\(^6\) is another alternative to Expected Utility Theory, that attempts to explain anomalies in Expected Utility Theory by changing the assumptions on how probabilities are perceived. Notably, it is assumed that people overweight small probabilities and underweight large ones.

Cumulative Prospect Theory

This can be seen as a generalisation of Prospect Theory where, as in rank-dependent expected utility theory, weighting is applied to the cumulative probability distribution function, rather than the probabilities of individual outcomes. This entails that in Cumulative Prospect Theory, there is an overweighting of extreme events which occur with small probability, rather than the overweighting of all small probability events in Prospect Theory.

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\(^6\) This discussion follows Cartwright (2011, p 102-103).
Evaluation

Despite the numerous applications of the Prospect Theory family of models in transport, several questions remain open concerning their validity or generalizability. The following issues stand out:

- The predictions of models based on Prospect Theory are highly sensitive to the reference point, with respect to which losses and gains are determined. In transport applications, there are few natural reference points. Moreover, the endowment effect and the associated loss aversion also apply to expected and imagined endowments. Leong and Hensher (2012) discuss several approaches that have been considered in the literature, such as other transport alternatives that are currently available or relevant transport alternatives that have been encountered in the past (especially previously chosen ones). Some examples of reference points that have been proposed in transport applications are the mean travel time over the preferred route, but also its distribution over time and a notion of an acceptable bandwidth of arrival times and a preferred departure time (Van de Kaa, 2010a); the median or mean travel time experienced in the population of the target traveller group; the free flow travel time or the travel time experienced on a previous trip (Chorus, 2012a); in the case of vehicle choice, the current car owned by a person (Van Wee, 2010). In the case of multi-attribute goods (such as cars), it is an open question whether the individual will consider reference levels for each individual attribute, or rather for the general impression of the good (Van Wee, 2010).

- The relevant reference point may depend on the characteristics of the individual. For instance, the preferred departure time is affected by the reference time of arrival. This in turn depends on the flexibility one has in the starting time of the work day, and thus also by one’s place in the hierarchy or the type of work one performs (Van de Kaa, 2007). Moreover, the reference time of arrival may be very context specific (Van Wee, 2010).

- Timmermans (2010) also raises the question whether the application of the theory should not be restricted to decisions under risk that involve true significant, irreversible losses. In the context of departure time, for instance, the consequences of arriving late can be remedied by calling ahead, working more efficiently, etc.

- In Avineri’s (2011) view, the main implication of the reference point problem is that people’s perception and evaluation of travel choices is influenced by the way in which travel information is presented.

- Valuation depends on the relevant alternatives, but there is no direct way of knowing which alternatives are considered by the travellers. Researchers may end up considering “only those alternatives that they deem most relevant in the research setting” (Van de Kaa, 2010a, p. 308). However, it is also possible that respondents to surveys will reformulate the proposed alternatives in ways different from what was intended by the researcher (Van de Kaa, 2010a).

- Attempts to apply Prospect Theory to network equilibrium models are often based on parameter values that were obtained through experiments in general, non-transport contexts (Avineri, 2012). This approach can be explained to some extent by the large number of parameters that need to be estimated compared to Expected Utility Theory (Chorus, 2012a).

- Loss aversion has mainly been tested in static settings, and these ignore the effect of individual experience and learning in repeated decisions (Avineri 2012, Van de Kaa, 2007). We will come back to this point later.

- Loss aversion appears to apply mainly to goods that are not valued only because they can be traded. In experimental settings, loss aversion disappears after extensive instruction or when

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7 Timmermans argues that most travellers do not know these travel times, but need to rely on own experiences, unless this information has been disseminated through their social network.
it becomes a routine (Van de Kaa, 2007). Van de Kaa argues that this may explain why car drivers attach a much higher value to increases in toll expenses compared to running costs.

- Some empirical observations (such as the high cost attached to arriving late) can be explained just as well by Expected Utility Theory as by Prospect Theory, or even by other theories such as Regret Theory (cf. infra) (Van Wee, 2010). There is no obvious way to decide which theory outperforms the others. Timmermans (2010) argues that the literature on Prospect Theory has an inherent tendency to amplify anomalies and that it is not clear whether most potential for developing improved travel models lies in addressing these biases.

- The empirical evidence in favour of Prospect Theory is largely based on gambling experiments in which subjects are requested to choose one of two prospects. In real world transport settings, travellers have much more options open to them. More fundamentally, “in travel choices, uncertainty may arise from unfamiliarity with the choice alternatives and from uncertain events that are probabilistic in nature. Travelers are not always clear about existing alternatives, nor are they sure about the outcomes of some uncertain events in the transportation environment, mainly unforeseeable incidents, queues and congestion.” (Timmermans 2010, p. 377).

- In real world travel setting, travellers may have reason to believe that the travel information or recommendation (which is the only information at their disposal) is not credible because (i) it may be based on imperfect model predictions or historical data, (ii) it may not be real-time data, (iii) by the time they face the decision to make, the information may be old, and/or (iv) the information provider may have ulterior motives that may not necessarily be in the traveller’s personal interest (Timmermans, 2010).

- Timmermans argues that “departure time and route choice are just part of daily activity-travel scheduling processes and should be modeled accordingly” (Timmermans 2010, p. 380).

Regret theory
In regret theory (Loomes & Sugden, 1982), people anticipate and try to avoid post-decision regret, which would arise when ex-post a non-chosen alternative turns out to be better than the chosen one.

The model has direct behavioural implications (Chorus, 2012b). It implies for instance that alternatives with an average performance on all attributes are more popular than alternatives that score poorly on some criteria and strongly on others. Indeed, if an alternative already performs well (in comparison with other alternatives) on one attribute, further improvements to that attribute will bring relatively small improvements, while further deteriorations of attributes with below-average performance will bring large losses. In the field of route choice modelling, for instance, “the size of flows on risky routes and routes with a relatively high mean or worst-case travel time are likely to be overestimated when regret aversion is present but ignored” (Chorus, 2014, p. 302).

Chorus (2012b) argues that Random Regret Minimisation is an interesting alternative to Expected Utility Theory for route choice modelling, not only because of the empirical performance of the model, but also because of its relatively simple form compared to Prospect Theory. Moreover, compared to Prospect Theory, Random Regret Minimisation has the important advantage of avoiding the often arbitrary choice of reference points.

There are however also some drawbacks to the approach. For instance, adding new alternatives to the choice set may actually lead to an increase in expected regret, and thus to a decrease in welfare, which goes against fundamental premises of economic theory. Also, the need to evaluate each alternative in comparison with the other available alternatives constitutes an important constraint in empirical applications, especially in large networks. Moreover, Random Regret Minimisation also suffers from the drawback that parameter estimates are likely to be very person- and context specific.
Learning in the face of uncertainty

One of the more fundamental criticisms directed at the application of Prospect Theory is that it ignores that people experience the consequences or outcomes of their decisions, and can adapt their behaviour to influence the experienced outcome. Therefore, it is important to understand how travellers learn and adapt in an uncertain environment, for varying degrees of awareness, information levels and belief strengths (Timmermans, 2010; Avineri, 2012).

One example of such an approach can be found in Avineri and Prashker (2003). The authors use route-choice experiments to evaluate the effect of the feedback mechanisms on decision-making under uncertainty. The experimental results are compared to a model based on Cumulative Prospect Theory and to the following models based on learning approaches:

- **Fudenberg-Levine Model**: travelers’ route-choice behavior is described as an iterative process, in which, at each step, the traveler uses historical frequencies of different travel times and form a belief about the routes’ expected travel times. Then he/she chooses a route to optimize the expected (or random) utility, given his/her beliefs.

- **Reinforcement learning model**: in reinforcement models, a decision-maker is modelled as an adaptive learner who chooses between alternatives as a function of the rewards that were obtained for each alternative in the past. For instance, if the probability of adopting a certain strategy increases as this strategy is positively reinforced (i.e. leads to positive outcomes) and decreases when the outcome result is negative, then it said that the choices can be described by the Thorndike’s law of effect. According to the Reinforcement Learning model, each individual has an initial propensity to choose each of the available strategies (route-choices). The probability of selecting a certain strategy is a function of these propensities. Positive reinforcement increases the propensity of the selected strategy, while negative reinforcement reduces it. In this approach, the adjustment process is extremely sensitive to payoff (reward or penalty) variance.

The alternative, the Cumulative Prospect Theory Learning model (CPTL), is based on the Cumulative Prospect Theory assumptions. It is assumed that in each period route-choice decisions are based on the prospect value of all the measured travel times in previous time periods, given a reference point. The distribution of travel times is based on travel time frequencies, resulted by experience, instead of probabilities.

The experimental results, predicted by the different learning models, find that increases in payoff variance reduce the learning speed of agents. As a result, the higher the variance in observed payoffs, the lower the sensitivity to observed travel time differences.

Moreover, Avineri and Prashker (2003) find that in some cases, increasing travel time variability of a less attractive route could even increase its perceived attractiveness – this result completely differs from those predicted by Random Utility Theory and Cumulative Prospect Theory models. However, they acknowledge that their main objective was to demonstrate the possibility of developing a psychological framework as an alternative to the utility maximization approach, but that further methodological and experimental research is needed.

Conclusions

Based upon what we have discussed here, can we draw any clear conclusions on the relative performance of the different models?

Chorus (2012b) argues that the differences in model fit between Random Regret Minimisation and the linear-additive Random Utility Models are generally small yet statistically significant. However, the two model approaches can lead to substantial differences in elasticities and market share predictions, and thus also to very different behavioural insights and policy-implications.
de Moraes Ramosa et al. (2014) summarize the main advantages and drawbacks of each approach as follows:

- Compared to the satisfying heuristic rule, Expected Utility Theory, Prospect Theory and Regret Theory all use high accuracy-high effort decision mechanisms. Thus, none of these theories incorporate the possibility that people may wish to use simple decision rules.
- An important disadvantage of Prospect Theory is the lack of consensus about the relevant reference point in a travel behaviour context. Compared to alternative models, models based on Prospect Theory require the estimation of larger number of parameters.
- Expected Utility Theory models and Random Regret Minimisation models are easier to calculate and understand than Prospect Theory models.
- From a theoretical viewpoint, Prospect Theory models are better at capturing realistic behaviour than Expected Utility Theory and Random Regret Minimisation. In modal choice, the trade-offs between the attributes of the alternatives are usually very clear and explicit, and Random Regret Minimisation performs typically best. In more general applications, the principles of Expected Utility Theory appear to be in advantage.

de Moraes Ramosa et al. (2014) conclude that, merely due to its very tractable modelling framework, and despite observed violations of the axioms of Expected Utility Theory, the Expected Utility Theory model still provides the best framework to model and investigate travellers’ behaviour.

5.4. Social influence

Generalities

In the neoclassical model, peoples’ preferences are independent of those of others. In reality, “individuals are influenced by ‘significant others’, people in their social networks, and people who have geographical and social proximity (neighbours, work colleagues, class colleagues)” (Avineri, 2012, p. 518). There numerous ways through which interaction with others affects economic behaviour in general, and transport behaviour in particular (see also Chapter 2).

A first reason is that decisions are sometimes or partly made at the level of a group (e.g., household) instead of being made by a single traveller (Chorus, 2012a). Indeed, in the context of a household, the succession of trips reflect both the activities and the constraints faced by all household members. This is the subject of Activity Based Modelling, which was discussed in Section 3, on which we will not dwell further here.

Second, people tend to compare with others when taking decisions or evaluating their consequences. Abou-Zeid & Ben-Akiva (2011) distinguish the following three channels through which social comparison could affect behaviour (see also Thaler & Sunstein, 2008):

- **People obtain information from others**, and this affects both their level of awareness of options and the perception of the attributes of these options. The satisfaction and advice of others is used in the assessment of the attractiveness of different options. This will especially be the case in fields where they have little experience, and allows to save on cognitive resources.
- **People seek the approval of others** and adhere to group norms in order to reduce options (in other words, they exhibit herd behaviour, are influenced by peers, show conformity, etc.).
- **Downward comparison** (i.e. comparing oneself to others who are perceived as doing worse on an item of comparison) may make one feel happier, while upward comparison to others who are better off may make one feel less happy (Wills, 1981). This may in turn affect future choices.

All this raises several questions: How strong are social influences in shaping behaviour? Are these relevant from a policy point of view? How can we measure social influences? How do we need to incorporate them in our transport models? How do they affect our assessments of welfare?
The answer to the first question is that social influences are very strong in shaping behaviour. Psychological experiments show that even for very simple tasks, people tend to conform to other people’s judgement, even if these are complete strangers (Thaler & Sunstein, 2008).

According to Thaler & Sunstein (2008), conformism can have several negative consequences, such as:

- **Collective conservatism**: once a practice has become established, it is likely to be perpetuated even if there is no particular reason for it.
- **Pluralistic ignorance**: traditions persist because people think most other people like it.

Studies have found that that social interaction and social learning/imitation may have a considerable role in responses to ‘soft’ transport policy measures (e.g. travel awareness campaign, travel plan, car-sharing). According to Sunitiyoso et al. (2011a), in a group, actions of a group member receive higher influence than those of the wider population, since inside a group there exists a feeling of belonging and responsibility as a group member. They therefore conclude that ‘soft’ measures, such as travel awareness campaigns may be more useful if they have a local and personalised focus (e.g. targeting schools, companies or communities), instead of aiming at the whole population.

**Social influence and travel behaviour**

Dugundji and Gulyas (2008) discuss why reaching a critical mass through social influence can have a wider impact on the transport system:

“If a certain critical mass of households is willing to choose public transit in a particular region or at a particular park-and-ride location, it can become economically viable to provide a high level of public transit service to that region or from that park-and-ride location. Being able to guarantee a high level of service might then in turn attract additional households.” (p. 1029)

Several papers have investigated how the probability that an individual chooses a given option depends on the options chosen by his social peers. This research shows that ignoring social interactions may lead to highly misleading parameter estimates (see Dugundji & Walker (2005), Dugundji & Gulyas (2008) and Walker et al. (2011) for mode choice; see Páez et al. (2008) for residential location and Goetzke (2008) for positive network effects in transit use). Some of these papers also investigate under which conditions social influences can spread through the entire population - however, it should be noted that this strand of work does not consider any limitations on the supply side (e.g. the maximum number of trains that can ride over a given shared rail system) and therefore does consider whether the transport system could accommodate the resulting increases in demand.

Nevertheless, most mobility and travel surveys do not collect data on social networks. Social influences in transport are also at work in other fields, such as:

- Axsen and Kurani (2012) study car buyer perceptions of plug-in hybrid electric vehicles, and conclude that conformity and other mechanisms of social influence play a role in the assessment and adoption of vehicles.
- Fukuda and Shigeru (2007) provide an interesting example of conformity effects that induce undesirable results, i.e. illegal on-street bicycle parking.

One specific topic that has received a lot of attention is the impact of social influence on the decision to telecommute.

Páez and Scott (2007) for instance show that some marginal adopters of telecommuting are influenced heavily by the decisions of others in the first wave of adopters. Using semi-structured interviews, Wilton et al. (2011) also find that, in the context of a workplace, the information obtained from observing and/or talking with adopters and non-adopters has an important impact on the
decision to telecommute. Moreover, the actual impact of information-seeking and validation depends on the workplace culture. For instance, if a critical mass of telecommuters is reached, adoption may become easier if the experience is shared and accepted by co-workers. However, a high share of telecommuters can also backfire, as managers may react negatively if too many employees request telecommuting arrangements.

Scott et al. (2012) find a very strong positive influence of friends and neighbours with respect to this decision to telework. With respect to colleagues, they find that the greatest influence comes from teleworking colleagues who offer advice.

**Social learning and travel behaviour**

As discussed above, an important channel through which social influences take place is through social learning. Different social learning models exist which have completely different implications with respect to the potential emergence of new social norms, and the speed with which they will propagate through the population. This will be illustrated at the hand of a series of recent studies.

Sunitiyoso et al. (2011a) construct an experiment with a hypothetical company level travel incentive scheme, where the reward given to the company’s employees depends on the number of employees taking the bus. Their results confirm that giving participants access to social information about the behaviour of others may influence their behaviour. When individuals have access to social information, they are likely to maintain their behaviour when the target group also maintains their own behaviour (confirmation model) and they are likely to imitate the choice of the majority or the choice that is most frequently made (conformity model). However, the different learning processes can lead to completely different social outcomes. For instance, strong reliance on the conformity model of social learning may lead to a higher bus use, while strong reliance on confirmation model leads to a lower bus use. From a policy perspective, Sunitiyoso et al. emphasize the importance of ‘desirable’ examples, who could induce cooperation of a critical mass of people, which will in turn encourage more people to cooperate through the conformity mechanism (majority influence).

In a companion paper, Sunitiyoso et al. (2011b) set up a similar laboratory experiment, but with a different emphasis. In order to verify whether communication between participants would increase cooperation, they enabled communication between individuals through an anonymous ‘chat’ service. However, recognizing the evidence that face-to-face communication might be expected to have a greater influence on individuals’ behaviour than anonymous communication, they conclude that face-to-face communication should be also explored in the study of social interaction.

In a third laboratory experiment, Sunitiyoso et al. (2013) captured the role of social interaction and social learning in a hypothetical scenario of car-sharing in a university context. Again, they found that social interaction and social learning influenced individuals’ behaviour. Moreover, these results confirmed that providing **more social information makes people less cooperative** and more unstable in making choices: the provision of full information and the knowledge of what everyone else is doing, created a temptation to become an opportunist.

Of course, learning does not only pertain to the behaviour of others, but also to factual information, or to a combination of both. For instance, Bartle et al. (2011) have observed how a small group of commuter cyclists interact with one another through a map-based website, where they could share their routes and other cycling-related information. They find that, besides its functional role in diffusing practical travel information, the **information sharing process** can perform a social role as well: perceived in-group membership reinforces positive views of cycling as a commuter mode. Bartle et al. (2011) conclude that “both roles were thought to offer particular encouragement to those who were new to cycling or new to a particular workplace, suggesting that web-based information-sharing might be developed as a useful tool within contexts such as workplace travel plans.” (p.1).
Social interaction and the emergence of norms

How can social interactions related to transportation activities lead to the emergence of social norms? Mote & Whitestone (2011) explore the social practice of slugging, an informal system of carpooling in the Washington, D.C. area. Slugging emerged when Virginia introduced High Occupancy Vehicle (HOV) lanes in the early 1970s as a tool to encourage carpooling. As a result, a practice developed where single drivers picked up riders alongside the road (slugs) in order to meet the requirements for driving on the less congested HOV lanes. Mote & Whitestone see slugging as the spontaneous emergence of informal institutions with its own norms, etiquettes and practices. From a policy point of view, the case of slugging represents a typical case of the “law of unintended consequences”. Whilst the objective of the HOV policy was to encourage car-pooling, “it enabled a practice of slugging that emerged by chipping away from transit ridership. The perverse effect was to undermine two public policies at once.”(Dugundji et al., 2011, p. 244).

Social interaction as a travel motive

Carrasco et al. (2008) point to another important source of social influence: individuals’ travel behaviour is conditional upon their social network. In other words, social networks are a key cause of travel, rather than an attribute of travel.

Similarly, Axhausen (2008) argues that travel is necessary for building and maintaining one’s social capital. This travel is connected to the locational choices of the network’s members. As a result, the destination choice of an individual is the result of joint choices with other persons. Therefore, he argues that a person’s social network geography, his or her biography and network-based decision making should be added to the generalised costs of travel and the hedonic utility of a location. Once travel is seen in this light, it also recasts the importance of leisure travel as central to the social capital of a population.

Dugundji et al. (2011) say that, due to large scale migration and population aging, “one can expect an increase in travel that will not fall into the home-to-work category and that will be strongly influenced by social context such as leisure trips, as well as demand for alternative modes of mobility that will rely on broader social support.” (p.244). They see a self-reinforcing mechanism where the travel demand results from the need for social contact and this increase in travel demand itself leads to more opportunities for generating social interaction.

Social influence and welfare assessments

The existence of social influences is also relevant for the evaluation of transport projects and policies. Indeed, the metrics that are used in economic appraisals typically assume that an individual’s welfare does not depend on the goods and services owned by others, or by the welfare of others.

Abou-Zeid & Ben-Akiva (2011) consider the well-being effect of social comparisons. They postulate that social comparisons generate feelings of happiness or unhappiness, that this comparative happiness affects utility and consequently travel choices, such as destination, mode, time-of-travel, and route choice. They find that commute stress, commute enjoyment, comparative happiness arising from social comparisons, comparative happiness arising from intrapersonal comparisons, personality, and overall well-being determine commute satisfaction, which in turn affects work well-being.

5.5. The temporal dimension

A final point to consider is how people make trade-offs when benefits and costs occur at different points in time: when the benefits of some current costly actions occur in the future or vice versa.

Consider for instance vehicle choice. Dumortier et al. (2015) address user acceptance of technologies with a high initial purchase price and deferred financial benefits due to reduced energy consumption, such as hybrid or fully electric vehicles. Consumers may underestimate the fuel savings for a plug-in electric vehicle, or not engage at all in any comparative calculations. Dumortier
et al. suggest that consumers need more explicit assistance about how to weight fuel savings compared to purchase costs. They show that supplying explicit “total cost of ownership” could thus be a strategy to address user's misconception of long-term fuel cost savings.

A second issue with a temporal dimension is the valuation of travel time savings. Overmeyer et al. (2014) refer to several studies that found that, on a unit basis, small travel time savings are valued less than large ones. Several possible explanations have been put forward for this anomaly, such as: people cannot make effective use of small time savings and small time savings may be below the cognition threshold of travellers. The latter point however also raises the question whether the benefits of travel time reduction are lost when people do not recognize them (Mackie et al., 2001). Overmeyer et al. (2014) indicate a time threshold between two and three minutes, which implies that small travel time savings should indeed be valued at a lower unit value than larger ones. Moreover, their results suggest that the unit values of large time savings should be even higher than the values that are currently used.

6. Implications for policy and planning

In the previous sections, we have given an overview of the state-of-the-art of how behavioural economics is applied in transport research. Wherever there were immediate policy implications of the research findings, we also briefly discussed them. In this concluding section we summarize how the insights of behavioural economics can be used to improve transport policy and planning.

6.1. Policy relevance: generalities

From a positive to a normative approach: key questions

Three approaches are possible when confronted with the findings of behavioural economics Gifford and Checherita-Westphal (2008). The first approach is to ignore the problem or treat it marginally. Proponents of this approach continue to assume that rational behavior is the norm in people’s choice processes or ignore bounded rationality or non-rational behaviour in modelling. The second approach is to accept bounded Rationality as a norm and incorporate it into modeling. In this approach heuristics and satisficing can match or even outperform various rational inference procedures. Its proponents refute that classical rationality should be the normative standard. In a less extreme view, they consider that, even if the results of heuristics are less than optimal, they result from the necessities of real life conditions. The approach underlies the development of operational activity-based travel model systems (Waddell, 2001). The third approach is to remedy the problem. It retains rational behaviour as the normative standard, but acknowledges bounded rationality and non-rational behavior. In this view, the main policy implication is that policy-makers should implement measures that align individuals’ choice processes with their own best interest. This is essentially the approach known as “libertarian paternalism”.

Libertarian paternalism

The scientific insights from behavioural economics have largely been brought to the attention of policy makers through the work of Thaler and Sunstein. Throughout their book, the authors emphasize situations where, according to behavioural economics, people run the risk of acting against their own interest. The central policy innovation they propose is the concept of “libertarian paternalism” which they define as policies that:

- maintain or increase freedom of choice - the “libertarian” side.
- try to influence choices in ways that will make choosers better off, as judged by themselves – the “paternalistic” side

The central concepts are “choice architecture” (the organisation of the context in which people make decisions) and “nudges” (small features designed in the environment of choice making). There are several ways in which choice architecture will have an impact on behaviour through the biases described in the previous sections:
• Proposing a default option (which is often inevitable) will have a strong impact on the options people will actually choose.
• Systems can be designed to anticipate user errors (p 87-88).
• Systems can be designed to give immediate and meaningful feedback.
• “Mapping”: help people to improve their ability to map and to select options that make them better off.
• When choice sets get large, people cannot make trade-offs between the attributes of all the alternatives, and often resort to heuristics. In these case, choice architecture is even more likely to influence choices. Thaler and Sunstein refer specifically to “collaborative filtering” such as used by Netflix as a tool to facilitate choosing.

“Libertarian paternalism” is not without its critics. For instance, Fletcher (2008) argues that such policies can prevent consumers from learning from mistakes, discourage the emergency of market solutions for behavioural problems (such as markets for information) and can encourage even more inappropriate risk-taking. Moreover, the informational requirements to draft good policies are formidable and it is not certain that policy makers are well placed to control people who take decisions against their own interest (Armstrong, 2008). Armstrong even asks if there is much scope for “libertarian paternalism” in practice.

Hensher (2010), for his part, acknowledges that individuals adopt simplifying strategies in the face of the information they have to process, but argues that this is especially the case when the outcomes of their decisions have only a marginal impact on their well-being. He also emphasizes that any heuristics used are likely to be context-specific.

Avineri and Goodwin (2010) posit that one of the limitations of the ‘nudge’ strategy is that it is unlikely that they can lead to long-term behavioural changes. Indeed, while nudges can impact on unintentional/automatic behaviours, they do not lead directly to a real change in the individual’s knowledge, attitudes or values. Moreover, they point to the impossibility to control the overall context in which nudge initiatives are introduced, which can lead to the offsetting of behavioural changes by unintended effects.

6.2. Validity of conventional cost-benefit analysis
The neo-classical framework has not just been used to predict transport behaviour, but also to evaluate its impacts on social welfare. It provides a rigorous framework to evaluate costs and benefits of policies. The main challenge for cost-benefit analysis is that monetary values can only be used as an indicator for changes in welfare if they are the result of rational behaviour. Regarding Willingness-to-Pay (e.g., for travel time gains) and Willingness-to-Accept compensation (e.g., for travel time losses) economic theory postulates that they should be comparable, with the small difference between the two due to the so-called income effect.

However, one of the essential elements of Prospect Theory is precisely that, at the individual’s reference point, there is a large difference between Willingness-to-Pay and Willingness-to-Accept. This raises fundamental questions on how to undertake cost-benefit analysis. Of course, if Prospect Theory were used, as for instance suggested by Van Wee (2010) for the valuation of travel time savings, the question remains open what the relevant reference point is as there is no consensus on that issue (see Section 5.3). Moreover, the jury is still out on the question whether Prospect Theory is really superior to its alternatives, including Expected Utility Theory.

Actually, most heuristics raise questions regarding the validity of conventional cost-benefit analysis. For example, if people’s behaviour can be affected by irrelevant cues, by the way a choice problem is framed or by group norms (or, in general words, if their choices are context dependent), then it is difficult to argue that their behaviour reflects genuine preferences. Or, if people’s assessment of risks suffers from availability, representativeness or optimism bias, then the estimated benefits and costs of measures that affect the risk of certain events will be biased as well.
Some economists argue that the heuristics are mainly the result of the artificiality of laboratory experiments, and are not really relevant when people are confronted with choices in real life, where real money is at stake. If this is true, then there is no reason to deviate from existing practices. It is noteworthy that, in operational transport planning, modellers mostly stick to the conventional assumptions.

Alternatively, one could consider the use of completely different measurement rods. For instance, subjective well-being has been proposed by several authors as alternative to traditional welfare measurements for policy evaluation (Metcalfe and Dolan, 2012). Applications to transport contexts are discussed in Ettema et al. (2010), Roberts et al. (2011) and Jakobsson Bergstad et al. (2011). However, as White & Dolan (2009) point out, subjective well-being seems to suffer from limitations that are quite similar to those of traditional economic welfare assessments.

6.3. Implications for transport simulation and forecasting
The first generation of four-step models were based on a relatively simple equilibrium concept, using the twin assumptions of perfectly rational transport system users and prefect knowledge of all relevant characteristics of these users by the modeller.

In contrast, in the specification of bounded rationality, multiple equilibria emerge and transport models do no longer yield unique solutions (Mahmassani and Chang, 1987). Without criteria to determine which equilibrium is most likely to emerge under specific circumstances, these type of models can only support decisions on future policies and projects if some options clearly dominate the alternatives (or are clearly dominated by the alternatives).

This thorny issue is further exacerbated because there are other competing alternatives to the neoclassical approach. Prospect Theory and Regret Theory standing out from the crowd, but can yield completely different predictions. Moreover, while model predictions based on Prospect Theory can be highly sensitive to the specification of the reference point, there is no consensus on the relevant reference point in transportation-related choice problems. Finally, there is no clear evidence that any of the proposed approaches is always superior to the other.

The question of the relevance for transport practice remains open, though. To the best of our knowledge, all illustrations of the impact of alternative behavioural assumptions on network equilibrium are based on “toy” networks, with a very limited number of links. Transport networks that are used in actual transport planning contain at least the minimum several hundreds, and sometimes even over the hundred thousand links. It is difficult to imagine the practitioner to tinker with all the behavioural approaches we have discussed above, while there is no conclusive criterion that can be used to choose between them. Moreover, it is not clear either what the implications of different approaches would be in terms of computational requirements.

We are thus, again, confronted with a paradox. Expected Utility Theory is arguably the component of neo-classical economics that has been the subject of the most fundamental attacks from behavioural economics. However, as far as transport planning goes, we tend to agree with de Moraes Ramosa et al. (2014) that it currently still provides the best framework for travel demand simulation and forecasting. With more conclusive empirical evidence in favour of one of the alternatives, this may change.

6.4. Relation with traditional policy instruments
Most applications of the “nudging” approach proposed by Thaler and Sunstein (2008) are examples of situations where people do not act in their own interest. In contrast, most transport problems (congestion, air pollution, accidents) arise because private and public interests are not aligned – in economists’ jargon, because there are externalities. One may thus wonder what the relevance of this approach is for transport problems. The answer is threefold.

First, in some cases, externalities are exacerbated because people make choices against their own interest. For instance, there may be instances where people would be better off taking public
transport rather than a car, but still choose to take their car (for instance, due to “status quo bias”). In these cases, deviations from individual economic rationality push us even further away from the social optimum.

Second, behavioural biases such as the status quo bias may hinder the effectiveness of some policy instruments such as distance based road charging.

Third, the insights derived from the “nudging” approach can help to improve the effectiveness of market based instruments, regulation as well as so-called “soft” policy measures, which have become increasingly popular amongst policy makers over the past two decades (Dugundji et al., 2011; Avineri, 2012). The last term refers to instruments such as (sustainable) travel plans, promotion of car sharing, or leveraging social media or other forms of peer pressure. Taking into account that restrictive policies are likely to meet resistance or to be politically costly, Economides et al. (2012, p. 2589) see potential in measures that “encourage behavioural change towards the “right” direction, without restricting freedom of choice.” They propose behavioural economics as a model for policy measures beyond the traditional market-based instruments.

Examples of tools and insights from behavioural economics that could be useful in this context are:

- Increasing the salience of the cost of the variable costs of a car (for instance, through real time reporting of the value of fuel consumption, or by providing information on the life cycle costs of the car) could compensate some of the behavioural biases that induce people to favour cars over alternative transport models. Increased salience of variable costs could also improve the effectiveness of road charging.
- Route planners (especially those supplied by local authorities for recreational travel) could propose “sustainable” travel modes as the default option (while still leaving open the option of providing route advice for car trips) (Avineri, 2012) – we have seen above that defaults have a strong impact on the options people actually choose.
- People can be helped in the selection of alternatives, by expressing information in such a way that they can translate it directly in benefits and costs, such as expressing automobile fuel consumption in money terms rather than in energy or fuel consumed (“mapping”).
- If people wish to conform to the opinions and values of their peers, then the use of social networking (for instance in combination with car sharing, workplace and school travel plans) could encourage modal shift (Avineri, 2012). Moreover, people turn to their social networks to learn from their experiences when making travel decision, including strategic decisions such as telecommuting. As discussed above, collaborative filtering could be used as a tool to help people make decisions that involve difficult trade-offs.

It should be stressed that by no means behavioural economics entails that market based instruments, regulation and other forms of traditional policy intervention become obsolete. Rather, the insights from behavioural can help to improve the impact of such measures.

Behavioural economics could arguably also help in the development of new theoretical foundations for the design and evaluation of soft measures (Bamberg et al., 2011; Richter et al., 2010; Richter et al., 2011). The key message conveyed by Thaler and Sunstein is the following:

**The most important modification that must be made to a standard analysis of incentives is salience.**

It is quite interesting that they illustrate this central point with the lack of salience of the depreciation costs of cars in modal choice, as people usually only compare the operational costs of a car with the cost of using public transport.
6.5. The impact of new ICT technologies

The potential of ICT technologies to support travel decisions has grown enormously over the last few years (see Chapter 4). Several of the cognitive processes that underpin travel decisions have now, as it were, been delegated to ICT - multi-modal route planning is probably the most spectacular operational example until now. This raises the question whether the emergence of ICT will reduce the risk of cognitive biases in travel behaviour.

One might even argue that the emergence of mobile apps renders much of the existing research on cognitive biases obsolete, especially when dealing with habitual travel and bounded rationality (see for instance Gifford and Checherita, 2008). However, these new technologies also raise new research questions, and the potential for completely new approaches to travel research:

- One of the central insights of behavioural economics is that how people use information depends crucially on the way information is presented. This then raises the question how the information could best catch the users’ attention (Gifford and Checherita, 2008). We have also discussed above how choices are affected by defaults in the presentation of information or by valence framing (see Section 5.2).
- ICT can play a central role in social learning, in building virtual communities and in the development of tools such as collaborative filtering.

Modern ICT could also play a key role in helping behavioural economics to break out of the laboratory and to set up large scale, randomized field experiments in real life circumstances – from a methodological point of view, this could mean a revolution.
References


Avineri, E. and J.N. Prashker (2003), Sensitivity to uncertainty: The need for a paradigm shift, Transportation Research Record 1854, 90-98.


Dumortier, J., S. Siddiki, S. Carley, J. Cisney, R.M. Krause, B.W. Lane, J.A. Rupp, J.D. Graham (2015), Effects of providing total cost of ownership information on consumers’ intent to purchase a hybrid or plug-in electric vehicle, Transportation Research A 72, 71-86.


Gardner, B. (2009), Modelling motivation and habit in stable travel mode contexts, Transportation Research F 12(1), 68-76.


Garvill, J., A. Marell, and A. Nordlund (2003), Effects of increased awareness on choice of travel mode, Transportation 30, 63-79.

Gifford, J.L. and Checherita-Westphal, C.D. (2008), Boundedly- and Non-Rational Travel Behavior and Transportation Policy, mimeo, George Mason University, Arlington, Virginia, USA.


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Sandroni, A. and F. Squitani (2004), Survey on overconfidence insurance and self-assessment training programs, mimeo, Northwestern University and University College London.


Squalli, J. (2010), Mutual forbearance, the representativeness heuristic and airline safety, Transportation Research F 13, 143-152.

Srinivasan, K.K. and H.S. Mahmassani (2000), Modelling inertia and compliance mechanisms in route choice behaviour under real-time information, Transportation Research Record 1725, 45-53.


Chapter 2: A Psychological Approach to Mobility

Mobility mind-sets from an environmental sustainability perspective

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1. Introduction

Imagine that you want to travel from A to B. What would be your preferred travel mode? The answer to such a question may involve a series of decision-making, especially if you have to diverge from your habitual transport mode. Obviously, the distance from A to B would be an important factor affecting your decisions to take a particular transport mode. Longer distances would be effortful to travel on bike. Similarly, environmental and weather conditions might be other contextual predictors affecting decisions for mode choice. On a very hot day, one might be inclined to take a taxi to the city center, instead of using the metro-line. Hence, factors such as temperature, weather or distances which we can measure objectively play a role in determining our mobility behaviour. Interestingly though, how people perceive certain objective factors plays an even more important role in determining travel behaviour. For instance, the distance of 5km might be perceived to be a short distance to travel by bike for some people, while for some others it might be perceived as a very long distance to cover with any other mode than car.

In line with this, as we will explain further below psychological factors, such as one’s attitudes, values and norms play an important role in any simple decision, including those involving mobility (Noppers et al., 2014; De Groot et al., 2008; Verplanken et al., 1997). Psychological factors reflect how we perceive and evaluate the environment and decision contexts, and might predispose us to behave in certain ways and not the other. Then, what are the psychological predictors of our decisions when it comes to choices regarding mobility? What is the psychological function of going from A to B? And why does the transport mode we choose for travelling from A to B matter to us?

In the current chapter, we aim at discussing these questions, and elaborating on the existing literature on mobility decisions and behaviour by holding a psychological perspective. As mobility is a broad term, and covers many different lines of research even within the single filed of psychology, we will structure the chapter around environmentally sustainable mobility. We will first summarize the main literature on how to promote environmentally-friendly modes of transport and sustainable mobility in Europe. We will then discuss the psychological value of mobility for people, and how mobility inclusion can contribute to high quality of life among citizens in Europe.

2. How to promote sustainable mobility in Europe?

The European Union (EU) targets a 20 to 30% decrease in greenhouse gas emissions till 2020. Such a decrease is unattainable if we do not readily adopt a sustainable way of living in Europe relying on a smart and low-carbon urban organization. Research revealed transport related emissions, resulting from both mode choice (private car-use) and transport of goods within EU, as one of the top causes of CO₂ emissions (ECMT, 2007; see Figure 1). Mobility and transport account for the second largest contributor of acidifying emissions and emissions of ozone precursors in Europe (Eurostat, 2014, p. 159 and p.163). The heavy use of motorized vehicles not only leads to high environmental pollution, but also noise, which might impair urban quality of life and human well-being. In addition, heavy-use of motorized vehicles has been associated with road-traffic accidents, which is one of the main cause of deaths and injuries. Europe is still largely car-dependent, which contributes to the problems of air pollution and traffic-related noise and safety, especially in big cities. Decreasing car-dependency is a major challenge for many of the EU member states. Importantly, decreasing car-dependency requires increasing the adoption of environmentally-friendly modes of transport, which has been a major concern for environmental and traffic psychologists. Then, what are the psychological predictors of adopting sustainable modes of transport?
3. **Integrated Framework for Encouraging Pro-Environmental Behaviour**

Adopting a sustainable and environmentally-friendly way of living is not always easy, and this is even more so in the domain of mobility. Modes such as walking, bicycles or public-transport impact the environment less negatively than car, while however, it is not always easy or fun to travel by bike bicycle or public transport. For instance, when the weather conditions are poor, when one is living in a remote geographical region or if one has no direct access from A to B with public transport facilities, adopting sustainable modes might be perceived to be too costly. Then, how can we promote the adoption of sustainable modes despite the associated costliness of doing so?
Based on the Integrated Framework for Encouraging Pro-Environmental Behaviour (IFEP; Steg, Bolderdijk, Keizer, & Perlaviciute, 2014), adopting pro-environmental travel modes might rely on activating normative goals rather than goals that favour self-interest. Notably, environmental and travel behaviour is guided by three main goals: hedonic, gain and normative goals (see Goal Framing Theory; Lindenberg & Steg, 2007). When behaviour is steered by gain goals, individuals focus on whether the execution of a particular behaviour will enhance personal resources, such as finances, status or power. When hedonic goals are active, however, individuals become perceptive of whether the execution of behaviour would be effortful or pleasurable for them. Thus, when people are hedonically-oriented, the pro-environmental behaviour would be executed if it is fun, easy and not effortful. Interestingly, when normative goals are active, costliness of engaging in a particular behaviour loses its relative importance. Individuals whose behaviour are guided by normative goals focus more on whether they should engage in the (pro-environmental) behaviour for the sake of doing the right thing, such as using their bicycle while commuting to work instead of using their private vehicle because this would benefit others and the environmental, which is morally right.

Since the three goals guide attention on totally different aspects, they can motivate individuals to act differently in the very same situation (Lindenberg & Steg, 2007). Therefore, adopting sustainable modes of transport often depends on whether one can resolve the conflict between normative goals, and hedonic or gain goals (see Steg et al., 2014). For instance, walking or biking to the grocery shop instead of going by car is the right and normative thing to do (e.g., as this would reduce CO₂ emissions resulting from transport), but doing so may cost time and effort. Similarly, adopting a hybrid or an e-vehicle instead of a car with fuel-combustion engine is the right thing to do to decrease one’s impact on the environment. However, buying an e-vehicle costs financially more than a conventional vehicle, and may be less convenient (e.g., charging the battery takes time), and hence might be less appealing for many. How can we reduce this conflict between different goals? Or how can we motivate people to adopt sustainable and safe transport modes despite the prevalence of conflicting goals?

The IFEP (Steg et al., 2014) proposes two solutions in resolving the conflict between normative goals on the one hand, and on the other hand hedonic and gain goals: 1- reducing the conflict between hedonic and gain goals versus normative goals that affect pro-environmental behaviour, meaning that making the adoption of pro-environmental modes of transport more fun, easy and less costly; 2- strengthening normative goals so that the importance of hedonic and gain goals are pushed back, and people can genuinely opt for pro-environmental and sustainable modes.
of transport for the sake of doing the right thing (for the environment), even though this might involve some costs.

The first strategy has been used frequently by policy-makers in interventions aimed at promoting sustainable modes of transport, for instance, by implementing pricing policies or infrastructural changes (e.g. making it easier to bicycle by building dedicated cycle paths). Pricing policies generally aim at reducing the financial costs of using environmentally-friendly means of transport or increasing the financial costs of environmentally-harmful modes (Thogersen, 2009; Schuitema & Steg, 2008). In one particular study, Danish car-owners were given a voucher which allowed them to travel with public-transport for a full month for free (Thogersen, 2009). The idea was to break their car-habit, and to help them develop positive associations regarding the use of public transport, such as regarding the quality of service and the convenience of using public transport. Findings revealed a positive effect of the intervention on the frequency of using public transport. Notably, the price promotion led to an increase in the use of public transport, which was twice as much than the use of public transport before the intervention. Importantly, the positive influence of such a kick in breaking the old habits of using a car lingered for a period of five months after the intervention. This suggests that promoting the use of public transport by making it financially appealing to car-owners might lead to a long-term change in transport behavior, even after the financial incentive is removed (Thogersen, 2009). Importantly, a positive experience with public transport might help changing the misperceptions about the quality of public transport, and a financial incentive might be useful to make people be open to such an experience at the first place. As such, providing a monetary incentive for some time might indeed help reducing the conflict between normative versus hedonic and gain goals, and might lead people to continue with the desired behaviour afterwards.

Yet, other studies suggesting that providing incentives do not always work as intended, and might only be effective in the short-term. For example, in one study, drivers were given a discount on their insurance premium if they adopt an environmentally-friendly and safe driving style by driving according to the speed limit (Bolderdijk et al., 2011). Their driving behaviour was observed via GPS devices. It was found that drivers indeed reduced their speed, and engaged in less speeding violations as compared to another group of drivers who were not given a discount on their insurance. Interestingly though, when such financial incentive was removed, drivers had an increase in their speeding violations, and eventually, the difference between those who were provided with a financial incentive, and those who were not given a financial incentive vanished. This finding indicates that it might be very difficult to have long-term behavioural changes with short-lasting financial or hedonic incentives, especially when the targeted behavior had no desired consequences (such as those observed in relation to the changed misperceptions regarding the quality of public transport in the above mentioned study by Thogersen). Importantly, such incentives seem to overcrowd intrinsic motivation (see Frey & Oberholzer-Gee, 1997; Deci & Ryan, 1985), thereby strengthening the extrinsic motivation to act. When the financial or hedonic outcomes are out of the picture, individuals are likely to fall back to their habitual and non-normative behaviour. Long-term behaviour change in making people act safe and sustainable might be more feasible by making the normative goals active and prioritized. Then how can we make the normative goal active? And how can we make people to act normatively when it comes to decisions regarding mobility?
4. Values

According to the IFEP (Steg et al., 2014), normative goals would be strengthened if they are supported by people’s values, and if the context triggers doing the right thing thereby activating values that support normative goals (i.e., situational cues in an environment). Values can be broadly defined as one’s guidelines in life; that function as ‘guiding principles’ in life (see Schwartz, 1992). As such, values guide our thinking, decision-making, attitudes, motivations and behaviours (Feather, 1995; Steg, Perlaviciute, van der Werff, & Lurvink, 2014; Maio & Olson, 1994). It has been argued that values trigger different goals in people (Steg et al., 2014; Perlaviciute, 2014). For instance, values that emphasize a major concern for one’s gains and losses (i.e., self-enhancement values) would make hedonic and gain goals more salient in motivating behaviour. Values that emphasize a major concern for the environment or well-being of others (i.e., self-transcendence values), however, would make normative goals more salient in motivating behaviour. Among the latter, one particular type of value is found to be very relevant, and that is the biospheric values. More specifically, biospheric values represent a key concern for the nature and environment (see Steg et al. 2011). People who regard biospheric values as guiding principles in their life were found to act more sustainable, and environmentally-friendly, and this has found to be the case in relation to travel behaviour as well (Stern, 2000; De Groot & Steg, 2008; Jakovcevic & Steg, 2013).

Research investigated whether biospheric values lead to the adoption of more environmentally-friendly modes of transport, or the acceptance of transport services or policies that favour green mobility (Axsen & Kurani, 2012). One such policy is related to car-use reduction, as reduced car-use would have a positive impact on the environment due to reduced CO₂ emissions. As expected, it has been found that policies aimed at car-use reduction were rated to be more acceptable among people with strong biospheric values, and less accepted among people who value their finances, status or pleasure (i.e., strong egoistic and hedonic values; Jakovcevic & Steg, 2013; De Groot et al., 2008, De Groot et al., 2012). Importantly, such findings were found in many different countries in Europe, as well as in Argentina and Russia (Jakovcevic & Steg, 2013; Steg et al., 2011; Steg & De Groot, 2012), meaning that biospheric values are cross-culturally valid, and are essential in steering transport behaviour towards the direction of environmental sustainability in many countries and culture across the world. But how does biospheric values steer behaviour, and why are people likely to act upon their biospheric values?

5. The Value-Belief-Norm Theory

Values predict pro-environmental behaviour via a process of norm-activation, as detailed in the Value-Belief-Norm Theory (VBN; Stern, 2000; Schwartz, 1973; see Figure 2). More specifically, behaviour is directly predicted by personal norm, according to the VBN. Personal norm can be defined as one’s feelings of moral obligation to act in a certain way (Schwartz, 1973). For instance, if people feel morally obliged to act in an environmentally-friendly way, the person is expected to adopt a pro-environmental driving style, or drive less and show higher acceptance of car-use reduction policies. Personal norm is further predicted by whether one feels that his/her actions would help contributing to a green driving environment (i.e., ascription of responsibility), and whether one is aware of the possible negative consequences of own driving behaviour on the environment (i.e., awareness of consequences). When a person is aware of the consequences of his/her individual behaviour on the environment, and feels responsible about it, then the person would develop a strong personal norm regarding protecting the environment. According to the VBN, general environmental beliefs play a major role in affecting ascription of responsibility and awareness of consequences. These beliefs are in turn predicted by values. In other words, values lead us to think in a certain way, which either credits or discredits the importance of environmental issues, which
makes us be aware or unaware of environmental problems, and which influences the way we claim responsibility for contributing to the solution of those problems. As a result, we develop either a strong or weak personal norm aimed at the problem. Strong personal norm leads to the desired behaviour, while weak personal norm leads to the undesired behaviour.

![Value-Belief-Norm Theory by Stern (2000).](image)

Personal norm seems to be key in predicting behaviour. This suggests that interventions should aim at making the desired behaviour a personal norm. In the domain of sustainable mobility, this can be achieved by strengthening the biospheric values of individuals somehow, or facilitating that people can behave in line with their biospheric values. Notably, as previous studies indicate that biospheric values are regarded highly by individuals in different cultures (Jakovcevic & Steg, 2013; Steg et al., 2011), people might be motivated to act on those biospheric values, while however, they might not be able to do so all the time if the context does not allow them. For instance, if one's neighbourhood does not contain charging facilities for e-vehicles, no matter how much the person wants to adopt an e-vehicle, there will be no use of getting one in such neighbourhood. Similarly, if there are no public transport services available in a neighbourhood, it would be difficult for people to act on their biospheric values by taking a bus to work. Context, therefore, is an important determinant of individual behaviour, as the context can facilitate or inhibit people to act upon the values that they deem important in their lives.

An important contextual element that might support or weaken one’s personal norm is the social norm, which reflect informal rules about what is perceived to be appropriate or inappropriate (Bicchieri, 2006). Then, how does social norm affect mobility decisions?

### 6. Social Norms

Social norms play an important role in determining one’s mobility behaviour and decisions. There are two types of social norms: descriptive and injunctive (Cialdini et al., 1990; 1991). Descriptive norms are those type of norms which reflects people’s perceptions of what most people do in a certain environment. For instance, if a person thinks that the majority of the people in a neighbourhood uses public transport, then using the bus becomes a descriptive norm in that environment. The process behind the descriptive norm is that we tend to think that the majority should be right. That is, if the majority is doing a particular behaviour, that must be the right behaviour.

Descriptive norm can be very effective in making a desired behaviour the norm, by for instance, using it in information campaigns, and providing information to people about what the majority does when it comes to a particular behaviour (e.g. “The majority of people living in Amsterdam travels to work by bike”; see Cialdini et al., 1990). However, descriptive norm also bears the disadvantage that it might make the undesired behaviour the norm. For instance, irrespective of the information campaign that tells the majority goes to work by bicycle, when a person steps out, and sees that there are many people who commute to work by car, he/she might as well take it as a
descriptive norm, and decides to keep going to work by car. As such, descriptive norm is a powerful source of influence in both directions: it not only reinforces the desired behaviour but also the undesired behaviour (see Keizer, Lindenberg, & Steg, 2008). In that respect, information regarding the descriptive norm should be credible to be effective.

Injunctive norms, on the other hand reflect unwritten rules, which determines what a person should do in a given situation (Cialdini et al., 1990). People follow injunctive norms to gain social approval, or avoid social disapproval. Different than descriptive norms, injunctive norms do not only
tell what is the right thing to do at a certain moment, but they also signal that norm-violations would be associated with social sanctions (Cialdini et al., 1990). Hence, when an injunctive norm is violated, this would have social consequences for the individual, such as being judged by one’s immediate community. As such, injunctive norm is also a powerful source of influence on behaviours. The process behind injunctive norms seems to be related to conducting the socially accepted and approved behaviour, meaning that we find it important to gain social approval by others. But what happens when there is a mismatch between descriptive and injunctive norms? How would an individual behave when the speed-limit is 100km p/h, while all other drivers around are traveling above the speed limit?

In such situations where the (injunctive) norm is clearly violated, descriptive norm seems to be more predictive of behaviour (Keizer et al., 2008; Cialdini et al., 1990). Importantly, following from the example above, a situational cue, such as a speed limit sign of 100km, might make it more salient that other drivers are not obeying the rules, and hence, increasing the likelihood that one follows the descriptive norm of disregarding speed limits (Keizer, Lindenberg, & Steg, 2011). Situational cues (e.g. speed limit signs) are crucial in that respect in underlining whether other people (i.e., the majority of people) are following the norm or not; thereby increasing the chances of norm-abiding or norm-violating behaviour.

7. Old habits die hard

Above, we have discussed different psychological aspects, such as values and norms, and their effects on transport behaviour. The study of such psychological processes generally relies on the assumption that people think thoroughly before they act. However, this is not always the case as many decisions are made without much reflection, particularly if repeated frequently. Hence, yet another major predictor of one’s mobility decisions is related to habits. More specifically, habits are those behaviours that we carry out frequently and without thinking (Verplanken & Orbell, 2003). For instance, if a person is used to commuting between work and home by car, car-use becomes habitual for the person when thinking of ways to commute work, and probably even for other trips made. As a result changing behaviour towards alternative and more sustainable ways of commuting modes might be difficult.

Previous research indeed found that habits serve as one of the biggest barriers to safe and sustainable transport (Verplanken, Aart, & Van Knippenberg, 1997; Verplanken & Wood, 2006). More specifically, when asked to decide which mode to use in situations described in hypothetical scenarios, people with a strong habit of car-use were found to seek less information regarding alternative ways of transport, and they needed less travel-related information (such as on whether conditions) to decide whether they would pick a car or not (Verplanken et al., 1997). In addition, people with a strong car-habit were found to look for information that is congruent with their past behavior. That is, they looked for information on traveling by car rather than on other modes of transport. These findings suggest that habit strength leads to a biased way of thinking or even a shallow way of processing new information regarding alternative modes of transport, for instance. As a consequence, the habitual behavior of car-use remains unchanged.

It appears that people reconsider changing habitual behaviours only when they experience drastic or natural changes in their lives. For instance, there has been evidence suggesting that habits can be countered especially for those individuals who are in a transition in their lives, such as moving to a new neighbourhood or changing offices (Verplanken & Wood, 2006; Walker et al.,
2014). Such natural changes in one’s life seem to provide the best opportunity to inform people about alternative ways of commuting, and getting them acquainted with more sustainable modes of transport. That is because habits are strongest in the context that they had been initially developed. Context serves as a cue, eliciting automatic behavior. When such contextual cues are not present in the environment (which is provided in the example of moving to a new neighbourhood), then habit strength is weakened, leaving room for behaviour change towards the desired direction.

The reason for habits to be such strong predictors of behaviour is because changing habits requires reconsideration of alternatives, and therefore a deeper information processing to come up with a new planning. Changing habits can be cognitively effortful because one has to diverge from his/her automatic pattern of thinking and acting. As outlined previously in the section on behavioural economics (see Chapter 1), we are usually reluctant to engage in such effortful thinking. Habits prevent us from even considering to reconsider alternatives. If we can make people somehow motivated to reconsider alternatives, then different choices might follow and help break old habit.

8. **Costliness of behaviour and behaviour-change**

Perceived costs and benefits of engaging or not engaging in a behaviour might affect our willingness to perform the behaviour (Dunlap & Scarce, 1991; M. Keizer, 2014). In this respect, people consider many different types of costs, not only financial costs. For example, behaviour can be costly in terms of effort and time as well (Steg & Vlek, 2009). As stated in the low-cost hypothesis (Diekman & Preisendörfer, 2003), one’s attitudes or beliefs regarding using sustainable modes, for instance, would predict the actual adoption of such modes only if the costs associated with using them are low. In line with this, in one study M. Keizer and colleagues (2014) investigated the factors that make people cease driving and adopt more sustainable modes of transport. It was found that people were more willing to adopt sustainable modes for short-distance than long distance trips (see Figure 3). The finding suggests that switching from car to a more sustainable mode is perceived to be easier and more convenient for short-distance trips. For long-distance trips, leaving the comfort of one’s private vehicle seems to be rather costly, and people do not seem to find it very attractive to travel by public transport when distances are somewhat bigger (Anable & Gatersleben, 2005).

We should note that in psychological research, absolute costs and benefits are not the main determinants of behaviour, but rather the perceived costs and benefits. Similarly, not the real effort of changing behaviour but the perceived effort is more predictive of mobility decisions. Several psychological factors might affect the perceived costs and effort associated with sustainable transport modes. In countries where the adoption of sustainable modes such as the bicycle are also sometimes habitual, such as in the Netherlands, distances do not appear as big barriers to adopt a bicycle for work-related commuting (Martens, 2004). This indicates that socio-cultural factors play an important role in defining what is costly and acceptable or not for people in an environment, and how people perceive the very same objective barriers differently.
What these findings suggest is that the perceived behavioural costs might decrease the likelihood of engaging in sustainable travel behaviour. Interestingly though, research identified that engaging in costly or effortful transport behaviours might also be associated with gaining status among some people (Noppers et al., 2014), which is an aspect that might lead to the adoption of costly (or effortful) pro-environmental transport modes, such as electric vehicles.

9. Status

We had indicated earlier that car-use reduction was hardly acceptable among people with strong egoistic or hedonic values and goals (Steg et al., 2011; Jacovcevic & Steg, 2013). Among the latter, car-use reduction might be associated with reduced convenience, increased effort, and impaired status. Indeed, preferred mode of transport is a status signal for some social groups, and this is more so when it comes to car ownership, as private vehicles do not only possess an utilitarian function but also a self-expressive function (Dittmar, 1992; Fitzmaurice, 2005; Steg, 2005).

In one particular study, Steg (2005) asked participants to indicate whether instrumental (e.g. driving makes life easy), affective (e.g. driving is fun) or symbolic (e.g. driving gives status and prestige) motives are more important for people in their decision to drive a car. Results revealed that non-instrumental aspects such as symbolic and affective characteristics associated with car-use were the main motives for people to drive a car. This finding also indicates why it is difficult to convince people to switch to other transport modes with similar instrumental qualities. People are less willing to give up on driving because they seem to enjoy it and they seem to associate it with prestige and high-status. Can we then also make environmentally-friendly alternatives attractive to people?

In a recent study, researchers replicated the study of Steg (2005) by applying it to the purchase of electric vehicles, which is an environmentally-friendly alternative to the car (Noppers et al., 2014). The findings revealed a similar pattern. Participants indicated that instrumental aspects are more important to them in their decision to buy an electric vehicle, while purchase intentions were particularly predicted by the evaluation of the symbolic and environmental aspects of the electric vehicle. The purchase of an electric vehicle was clearly linked with gaining status, as early adoption of innovations is associated with high-status among people (Egbue & Long, 2012). Hence,
people might indeed prefer certain transport modes, including relatively environmentally-friendly modes, if they are associated with high-status and prestige (Noppers et al., 2015). In other words, mobility choices might have a signaling function that is used to convey one’s status. Given the rise in new technologies, trends and innovations in the domain of mobility (such as automated vehicles or transport apps), the signaling function of the adoption of green mobility innovations seems to be very relevant to promote sustainable options.

10. The psychological function of mobility: Mobility as a catalyzer of quality of life and well-being

Above, we discussed some of the psychological theories and mechanisms that allow for explaining ways to promote sustainable and environmentally friendly transport modes among people. However, regardless of the transport mode choices that people have, mobility has key psychological functions for individuals.

Notably, research revealed that personal well-being depends heavily on the fulfillment of three key psychological needs: autonomy, competence and relatedness (see Self-Determination Theory; Ryan & Deci, 2000). Autonomy can be broadly defined as having the independence to act and explore the environment freely. Competence refers to whether one is capable of accomplishing goals, and feels in control of things. Finally, relatedness refers to whether one has a social support mechanism around, and whether one is connected to the outside world with social ties. It has been argued that the three key psychological needs should all be satisfied and should not be in conflict with each other in order to achieve physical and psychological well-being (Ryan et al., 1995). The three psychological needs also reinforce each other. For instance, feelings of competence usually is reinforced by feelings of autonomy. Similarly, when relatedness is high, then one might feel more competent in achieving his/her goals because one would feel valued and supported. Notably, when these needs are somehow not fulfilled or satisfied, individuals might experience a negative emotional state and diminished well-being. Hence, for a well-functioning society, it is important to facilitate the fulfillment of these needs one way or another. Interestingly, mobility plays a crucial role in that sense, as the ease or difficulty of fulfilling these key needs might heavily depend on mobility.

Figure 4. Adopted from the Self-Determination Theory (Deci & Ryan, 2000)
More specifically, mobility can promote autonomy because being mobile stimulates feelings of independence and freedom. Mobility promotes relatedness because it allows us to be a part of social life, and it prevents us from being isolated and alienated from others. Finally, mobility promotes competence because the fulfillment of daily goals, and even the simplest ones such as doing the groceries, depends on being mobile. In other words, mobility helps the individual to gain control over daily actions. So, when mobility services, products and policies help individuals to somehow fulfill these key psychological needs, we might expect a high quality of life and psychological well-being among those who have can freely move around. When, however, mobility services and policies fail to support these basic needs, we expect to observe a lowered quality of life among citizens. As such, it is utmost importance to improve mobility inclusion in Europe for everyone, and especially for those with certain disadvantages.

Achieving mobility inclusion for certain disadvantaged groups, however, is not an easy task and requires a clear mindset and determination at the level of policy-making. Let us zoom in the case of elderly people, for instance. In less than 20 years, the number of elderly people is expected to double, especially in developed parts of the world, such as in Western Europe and the US (Rosenbloom, 2001). Compared to the current generation of the elderly, the coming generations of this group are predicted to have higher income (Tacken, 1998), and will be more likely to own a car and hold a driving license. As such, the proportion of elderly drivers in the general driver population is expected to increase in the coming years. On the one hand, mobility is an important factor for happiness and well-being among the elderly, because it corresponds to feelings of freedom, independence and to a higher number of out-of-home activities that promote social contact with others (Marattoli et al., 2000). On the other hand, due to possible cognitive and physical deficits that might come along with aging, elderly drivers might be at a higher risk in terms of road traffic accidents (Brouwer & Ponds, 1994). Hence, promoting individual mobility of elderly might increase their well-being. However, the well-being of elderly citizens may also be seriously threatened when they continue to drive their own vehicles for instance, because of the risks of increased accident involvement resulting in physical injuries. How can we ensure both psychological and physical well-being among the elderly if both ceasing and continuing to drive involve risks? What kind of alternative modes should be promoted among the elderly, so that they stay connected to the outside world, yet without the risk of injuring themselves? What kind of city-planning or spatial solutions would account for high mobility inclusion among this group?

Similar questions can be posed for other groups such as people with physical or cognitive handicaps, but also for people who are living in remote areas or who are fighting against poverty. A mobility mind-set that takes into account the three key psychological needs (i.e., autonomy, competence, relatedness; Deci & Ryan, 2000) would help develop policies that serve a higher happiness, well-being and quality of life among European citizens.

11. Conclusions

In the current chapter, we had an environmental psychology focus in discussing the literature on sustainable mobility in Europe. Notably, we aimed at summarizing the key psychological literature on adopting environmentally-friendly modes of transport, and acceptability of sustainable mobility policies, such as policies on car-use reduction. We further aimed at describing the importance of individual (e.g., values, personal norms, habits) and contextual factors (e.g., social norm, presence of situational cues) in affecting people’s decisions for sustainable modes of transport. In addition, we described the basic psychological needs, the fulfilment of which would be important for individual well-being. We aimed at discussing how mobility is related to the fulfilment of those needs, and why it is important to achieve mobility inclusion in Europe for all citizens.
We have three main conclusions from the environmental and traffic psychology perspective on mobility, which can also serve as mind-sets for future. First, given the high CO₂ emissions resulting from transport, policies should still aim at facilitating green and sustainable transport in Europe. Importantly, irrespective of culture, people seem to endorse biospheric values; that are values representing a key concern for the planet. Policies and interventions should help people act on their biospheric values, for instance, by making it feasible for people to employ green modes in European cities. Second, mobility policies should aim at facilitating feelings of autonomy, competence and relatedness as key psychological needs serving personal well-being. In other words, a future mobility mind-set should strive to achieve mobility inclusion for everyone, and especially for those with mobility restrictions.
References
Dittmar, H. (1992). The social psychology of material possessions: to have is to be. St Martin’s Press, Harvester Wheatsheaf.


Chapter 3: The Sociological Approach to Mobility

Mobility Mind-sets: the social dimension

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VECTOS
1. Introduction

In this chapter, we develop the social dimension of our mobility mind-sets. This will develop the idea that, as social animals, the basis of our mobile lives lies in the balance we develop between our conflicting fundamental desires for autonomy and control, and the desire to find attachment through bonding in social groups (Ryan & Deci, 2000; see Chapter 2) – and that, in this balancing act, our mobile lives have important mental, physical and virtual impacts. Additionally we explore the proposition that the value sets which we express in our mobility have strong norms relating to the current European social model, the legacy of previous social models and norms reflecting the diversity of European culture. These generate different mobility mind-sets across Europe, but mind-sets which have a single explanatory DNA running through them.

The chapter will therefore start by exploring the significance of the underlying social model that is driving mobility in Europe. I then explore the impact of continuing change in European social structures and the rapid change in patterns of social networks and social interaction. Probing deeper into our mobility mind-sets, the essential mobility component emerges within social processes that define individual, group and national identities, social norms and habits and mobility-related decisions. The chapter then underlines the distributional impacts of mobility inside the current social model: the benefits of the greater mobility freedoms enjoyed, the mobility component in physical and mental well-being, and patterns of mobility influenced social exclusion in Europe’s cities and regions. I conclude with a look to future social development in Europe and the important role that mobility futures will play in that.

Much of the conventional thought on mobility focuses on the actions of individuals. To assess the role of mobility in society, it is worth making a digression into what we mean by ‘society’ and ‘mobility’. The direction of thinking on mobility mind-sets has purposely coordinated intelligence across many related disciplines; including sociology. This coordination has enabled a new broader perspective on mobility to emerge, increasing our understanding of the way in which social and mobile lives are entwined.

“You cannot live for yourselves. A thousand fibres connect you with your fellow-men; and along those fibres, as long as sympathetic threads, run your actions as causes, and return to you as effects”.

Reverend Henry Melville, 1856
(Quoted in Pinker, 2014)

2. Individual decisions or social decisions – cross-disciplinary thinking

As we have seen in previous chapters, economists of the neo-classical school see social decisions, as the mere accumulation of individual decisions- there is no ‘social’ dynamic. The environment is seen as an ‘externality’ and all people’s perceptions and attitudes are presumed equal. The application of the scientific model allows for people’s behavior to be represented as a series of decisions whereby trade-offs are made according to the utility people can maximize. Traditional psycho-analysts start from a similar basis: that people’s behavior is controlled from within, through processes in the brain and an individual’s cognitive abilities; independent of external influences.

However, a more recent wave of cross-disciplinary thought has emerged, re-emphasising that people have a fundamental relationship with their environment that affects their physical and mental lives. This of course has always been something central to anthropology. The man-environment relationship has also been strong in human geography since Freidreich Ratzel in the mid-nineteenth
century (indeed the early discipline was most commonly termed geography and anthropology). What started as a straightforward relationship between man, woman and their ‘natural’ environments, developed, within the ‘built’ environment of the city landscape – the interrelationships between city architecture, social spaces and the developing urban social society.

During the course of the last century, firstly in psychology and more recently in economics (with much professional debate), we see psychology developing a new strand from cognitive psychology to teleological behaviorism (Rachlin, 1994): Neo-classical economics developing into behavioral economics (Kahneman, 2011). While many in these disciplines believe that most decisions made in life can be adequately modeled by classical utility models or conditions explained solely by reference to mental processes alone; a broader consensus agrees that human behavior is essentially understood with reference to the physical and social environment surrounding people; from where they get their stimuli and express their behavior.

Sociology also has its roots in anthropology and the study of man as a social animal. To the sociologist, social and individual desires are represented as the influences of social ‘Structure’ and ‘Agency’ (i.e. the decisions made by individuals). There have been three primary strands to sociological development (Collins, 1994). Firstly, society could be seen to operate as a functional organism, comprising norms and institutions which drive the overall social body forward (for example in the work of Emile Durkheim). Secondly, theorists such as Karl Marx stress the internal social conflicts that can naturally arise among different norms and institutions within the society, engaged in a ‘struggle’ over valued resources. Thirdly, sociologists such as Max Weber argued that society is nothing more than the shared reality that people construct as they interact with one another.

However, much in the same fashion to economics and psychology, sociology developed very much inward looking at the internal structures within society relating to ‘class’ and power relations between people and groups in society, kinship and cultural structures etc. To the sociologist, mobility refers to a process of ‘vertical mobility’ whereby people move up and down the social ladder. Social geographers have provided the essential link, providing the understanding of the interaction between social and spatial processes (for example, Harvey, 1973), but only within the last 10 years has there been the development, from within mainstream sociology, of a school to reinterpret traditional conceptions of mobility into ‘mobile lives’ (Urry, 2007, Elliott and Urry, 2012).

We need to fully understand where thinking in transport and mobility planning has developed from these wider disciplinary roots: and the role of social factors in that development. In traditional transport planning, human behavior was formulated using a combination of neo-classical economics and analogies with Newtonian physics – the classical 4-stage ‘gravity’ model. The influence of the scientific approach is absolute. Subsequent refinements to the behavioural elements of the model have sought to include elements of individual choices influenced by social dynamics (attitudes, perceptions, habits), but the underlying logic remains the same: Only from the recent ‘Mobilities’ work do we see a new way to re-conceptualise movement patterns from a sociologists standpoint (Urry, 2007).

Early observations on the Mind-sets approach are the manner in which it turns current thinking on mobility ‘upside down’. Mobile behavior in society has focused around the aggregation of individual trips. In some cases, work has focused on the ‘chains’ of trips an individual can undertake; for example in a single day or over one week.. The development of this approach to assess the activities that generate the trips has provided a closer link to lifestyle; travel being the derived demand. While some of this work has assessed the interaction of activity needs within households, the focus on measuring activities reports only the end of the behavioural decision process, so wider social dynamics is not addressed. This concentration on the prediction of individual trips ignored important areas of the role of mobility in society. The emphasis on the scientific model has produced important research on the observed patterns and trends in mobility. However, this work relies on a substantial level of cause and effect interpretation from statistically valid relationships to understand the
processes by which mobility decisions are being made - the common misconception is that ‘to measure’ is ‘to know’.

3. The current social model in Europe

When we start to develop a Mind-sets approach to understanding mobility, it is important to be aware of the social model in which we live. The last 30 years have seen a radical change in the social model across Europe. For example, Margaret Thatcher in 1987 proclaimed that ‘There is no such thing as society’

There are two primary forces driving modes of thinking in general; but also in mobility policy and planning – the scientific model and neo-liberalism. In both models, society appears on the fringes. In the scientific model, which has dominated our thought in all disciplines since the mid-1950s; social norms and forces are treated as externalities; largely because they are difficult to measure. It is easier to measure individuals and then aggregate them to some form of social statement. This approach has been common within the transport planning profession.

Then there is neo-liberalism. All societies have developed throughout history, based on a balance of four dimensions – politics, religion, the economy and the arts – healthy societies develop a ‘healthy’ balance of these elements (Verhaeghe, 2012). Imbalances in these elements in the 20th century led to forms of totalitarian social systems with strong central control (for example in Fascism and Communism). What we are witnessing now is a reaction to these systems with Neo Liberalism. While this new regime on the surface emphasizes a ‘healthy’ respect for individual freedoms relative to the state, the model is also problematic in placing the free market at the centre of social development; through the promotion of individual well-being in a competitive society (Achterhuis, 2010). The traditional responsibilities and obligations that people felt towards the community (going back as far as the ancient Greeks) have now switched to the individual (the ‘selfish gene’ (Dawkins, 1976)) and social obligations are now only those undertaken by the state.

From the late 1990’s, and accelerating since the millennium, the dilemma has become how to satisfy the demands of a new social system, where individual success and identity in society is driven by competition, the market and the ‘growth at all costs’ agenda; against the alternative agenda that seeks greater well mental being, environmental sustainability and an inclusive society. Are these two
dimensions mutually exclusive? Certainly this dilemma is a central thread in EC transport policy thinking (EC White Paper on Transport, 2011).

Paul Verhaeghe, the eminent psycho-analyst states (2011) “To sum up, never before have we in the West had it so good, and never have we felt so bad”. Additionally, it is clear that market based societies operate on the ‘trickle down benefits’ principle, which over time exacerbates the differences between the ‘haves’ and the ‘have nots’ – social conflict theory. In this context, mobility has been no exception. The situation has been further exacerbated by the economic crisis since 2008; which was itself caused through applying the excesses of neo-liberalism. Reinforced on this market-based model for social development are the accelerated changes on society brought about by the internet revolution – providing fast, personalized, customized and automated services; generating a new baseline for social development, providing new channels for personal expression and individuality. So citizens have become consumers and internet contacts have generated ‘friends’. A major issue with Neo-liberalism is that people on different rungs of the class ladder and in the countries of west and East Europe have started at different levels. One strong feature of this has been the resilience of the highest social groups and the immobility of the lowest.

4. Mobility dimensions

The Mind-sets approach attempts to coordinate the intelligence gathered from the broad range of disciplines into a new holistic way of viewing mobility; but not being tied to any specific disciplinary straightjacket. All disciplines are on the table. In the sorting process – society is of fundamental importance.

The strength and importance of mobility has been understated in the past due to its restricted definition purely as the ability of individuals to travel from A to B. This myopic view of mobility clouds the important ways in which mobility contributes to physical and mental well-being, to personality and to social identity. Let us therefore extend the scope to a ‘Mind-sets’ conception of mobility.

Mobility is a fundamental freedom – it is one of the most fundamental freedoms we have; whether we choose to use it or not. As a result, mobility plays an important role in defining social status and power relationships between individuals, communities and countries. It defines the ability people have to move about in time and space to satisfy their activity needs; and thus plays an important role in influencing their life chances. It influences the possibility and course of personal relationships and social interaction. It dominates conversation; as people reflect on the wider experiences they have had from increased mobility and of the travel experience itself. It is usual when two people meet for the first time that some comments are made to establish the relative mobility level (and thus expected respect) of each person. It is an important defining element in a person’s self-esteem and self-achievement through the course of their lives; and an important factor defining their projected
personality to others. In summary, mobility is a central feature, not only of our revealed behavior, but of our identity; both as we feel it and how others see it. It also explains why measures from whatever source, to restrict mobility freedoms meet with the strongest opposition. One representation of the composite elements of a mobility mind-set is shown in the Figure 1 below:

Mobility is about freedom. Accessibility is about meeting needs. The two factors are frequently mixed and misinterpreted. In highly mobile dependent societies such as in Europe, mobility has a large influence on access. However, it is perfectly possible to have highly mobile people living, for the most part, local accessible lives. Also to have people with low mobility suffering the disadvantages of the need to access distant activities with limited means. In this way, mobility can have diverse impacts within society. People’s identities, and the growing gap between those who have high mobility, and those who have little, are becoming threatened by the power of the mobility explosion: leading to defensive actions in the form of xenophobic types of behaviour and increasing community tension in the neighbourhoods of many European cities (see Section 9).

While mobility freedoms bring to individuals greater feelings of control and social advantage, it is important to underline that, as stated above, mobility does not have to be fully expressed; particularly in accessible environments – there is a difference between mobility potential and mobility use. In this context, it is important to remember that most societies do not support the unlimited expression of freedoms; but the practice of moderation and self-control – relegating freedom to the background. This feature underpins most of current mobility policy. Psycho-analysts have found that levels of ‘excessive freedom’ can be identified where freedom leads to boredom, in its most positive form; and to disorders and addiction in its worst form. Sigmund Freud underlined the importance of social norms in placing ‘an innate internal break on pleasure’ (Freud, 1920).

**Figure 1: The dimensions of a mobility mind-set**

*Mobility is increasingly becoming a fundamental aspect defining the character and lifestyles of Europeans, changing the diversity of European culture.*
5. Mobility, social structures and social networks

The increasing pace of social change is breaking down traditional family and social structures, weakening kinship and dependency structures and changing social roles, for example between the genders (rising divorce rates and multi-parent family structures being two of the most predominant changes). Traditional explanatory variables of behaviour patterns are becoming less and less relevant. In turn, accelerating social change is increasing the complexity of social spaces and how people perceive the physical/virtual world they live in: increasing the cognitive load required for living. People now exist and move around within a myriad of different peer groups, each of which can exert social pressure or a particular norm for behaviour; and can also provide reward and enhanced well-being. We have moved from the traditional to the urban to the virtual village for kinship and dependency.

Within modern society, it is not sufficient to understand mobility purely through expressed mobility, in terms of patterns of trips or web-sites surfed. The perception of the freedom that your mobility is giving you is of fundamental importance to the manner and competence with which you interact with others – it can either provide positive self-esteem and mental well-being, or it can provide negative self-imagery and assist mental decline. Multiplied over whole communities, mobility freedoms provide a critical pivotal element between community development and community breakdown – between inclusion and exclusion.

This process is not uniform and mobility freedoms are expressing themselves differently across Europe. In Eastern and South Eastern countries, there is a two way migration for economic reasons from the regions to the major cities, and to other member states. In addition to a greater choice of jobs and educational opportunities, there is prestige and status attached to city living. The overnight adjustments from a society based on Communism to a Neo-liberal society have remained problematic: infrastructure decline, exclusion, widening gaps in income and well-being and the difficulty for people to adapt to a competitive mind-set to achieve potential economic growth and individual achievement. In Western Europe and Scandinavia, the opposite is true. As the birthplace of Neo-liberalism, mind-sets are relatively more adapted to individualism and having a competitive edge. Migration is from the regions (rural areas and small towns) to the major metropolises, de-concentration of the biggest cities into large regional hinterlands (re-colonisation of the countryside by the middle classes), and lifestyle and tourism migration to other member states; primarily in the Mediterranean. While the migratory patterns from Eastern Europe are primarily among lower skilled workers; the migration from Western Europe reflects society’s achievers. These trends are indicative of the way in which traditional social networks are rapidly changing across Europe. Social networks, for a majority of Europeans are now international, increasing the demand on all long distance modes of travel.

In addition to the significant impacts of the reduction of traditional family and kinship structures in society, the impact of internet communication has been transformational. We can now identify 3 interlocking worlds in which people exist – the physical, the mental and the virtual. It is possible to see people travelling and texting, while listening to music or the radio on headphones. Although the activity

The ‘hill people’ and the ‘valley people’ of the physical environment - in the highlands of Papua New Guinea* are now extended to the artificiality of the built environment - the ‘village people’ of Brooklyn; and the now emerging virtual environment - ‘internet villages’. *(Documented in Diamond (2013))

The modern complexity of people’s activity spaces (regular and occasional) in physical and virtual space and of their much wider awareness spaces makes the conceptualization of people’s mental maps almost impossible in the modern age.
is taking place while walking down the street, the individual prefers the virtual world to the physical. This behaviour has quickly become ‘social’.

A more detailed explanation of the interactions between physical and virtual networks and their impact on travel is discussed elsewhere in this report (see Chapter 4). That work underlines 3 potential interactions between social networks, mobility and internet-based communication (ICT):

- ICT is used to maintain an existing social network and therefore travel is generated
- ICT influences the volume of social interaction, which then generates travel
- ICT use has complementary impacts on both social interaction and travel

The combined impact of these 3 processes is generating wider social networks across society. Indeed, for every type of travel purpose, there is now a virtual equivalent that we can choose instead.

The fusion of physical and virtual worlds is generating new forms of mobility. In the social mobility arena, the new ‘sharing society’ is a good example, and here I distinguish between the so-called ‘accessible society’ (shared common services such as car or bike sharing, or public transport) and the ‘sharing society’ in which I share my mobility. In traditional close knit communities which still exist across many parts of Europe, sharing is part of daily life. I will give a lift to that person because they are one of us, they are known; or at least someone will know them.

Urry (2007) makes a good point in this respect “Sharing seems natural among immediate family; with the increase in social media, people have connections all over the world. Are the boundaries between “family” and “friend” blurring to the younger generation?”. Therefore they feel more comfortable sharing with a wider network because they still feel like they are sharing with “their community”.

The confidence inspired in close knit rural communities is less common today in urban social networks than in past decades. However, it is being rejuvenated through new types of trust that people place within new internet communities. Particularly popular among the new digital generations, the old concept of sharing is revived. Lift giving and receiving through smart phones is one example.

The act of sharing releases Oxytocin, the bonding hormone, into the body and increases feelings of well-being. This hormone also provides a stimulus to protect the bond formed against other surrounding bonds. Sharing, so psycho-analysts will tell us, has socially desirable though perverse

“*In the modern world, the building and maintenance of social networks involves physical travel but also technology-mediated contact. As virtual interaction continues to expand, more emphasis is now being made on the need to retain face to face contact. Social networks are no longer place to place but person to person*.  
(Urry, 2007)
consequences. A carpooling scheme may work in a close knit physical or virtual village; but not for a broader population. However, the solution to this may exist within the potential of IT mobility services to substitute for the perception of social bonding.

6. Mobility and identity in society

Identity and personality – A person’s identity is defined by the peer groups in society with whom they interact: you do not define your own identity – the ‘image’ people have of you. You can therefore have multiple identities in mutually exclusive communities – through face to face contact but these days more frequently through ‘groups of friends’ within social media channels. Despite this, you can influence your identity through projecting a personality to your peer groups. This is most commonly done through face to face and online communication; and through the possessions and the style of behaviour you display to them: your projected lifestyle.

Mobility has played a major role projecting personality and defining identity. In this way, the decisions to purchase and use this or that mobility product or service primarily involve as much decisions that relate to social forces, as they do to any objective reasoning on the mobility advantages of car A over car B, bicycle over bus, or a ticket with a ‘main carrier’ over a so called ‘low cost’ airline. Mobility possessions such as cars, the latest bikes, skateboards, yachts, private drones or private jets have the additional benefits that they express personal freedoms and are able to be driven, sailed or flown around more or less at will – a mobile display to project how you would like people to see you. For example, your car is the one status possession you can display, parked outside your house. Except in the coldest climates, who parks their car in the garage anymore (having a garage is in some countries, status giving in itself). Of course the projected personality is not the real personality. The ‘sentence under the sentence’, as psychiatrists say, is quite different in most people; an issue we return to in later sections.

Mobility behaviour therefore displays possessions that express advantageous freedoms to others in society, competing for status in the street. In the past 50 years, the projected mobility image was dominated by the power, potential speed, and the pseudo-sexual connotations of the car. Dominant was the post-war freedom of car ownership and use in Western Europe, a mind-set which predominated for half a century, as car ownership moved from elitism to saturation, from household cars to individual cars.

Since the 1980’s, cars could also project a family image, sensible, utilitarian. These two images were given rather crude gender social stereotypes. In this environment, it was also necessary to be new and fashionable: for example, from the 1980s, company cars initially had images of high status, elitism, your status in your community, graded on the basis of the quality of the car allocated to you. Once company cars became commonplace, the trend reversed – ‘oh I only have a company car’ – ‘we got rid of them; my car is mine’. However, in many social peer groups across Europe, peer group pressure expects a certain level of mobility from you; resulting in your group acceptance or your marginalization. In recent times the dominant role of the car in projecting mobility image is broadening to other modes of travel; promoting a broader range of mobility images and personalities in diverse peer groups. For example in IT use on public transport, privately rented jets, state of the art cycles, yachts, Segways etc.

The CREATE project (Jones, 2015) is essentially tracking mind-sets across Europe over time, in relation to traffic congestion. Stage 1 cities are identified where the mind-set is for image enhancing, socially acceptable car-based freedoms, with consequent traffic and congestion growth. Stage 2 cities represent those where, to the professional and the politician, ‘enough is enough’ and ways are
explored to reduce the use of cars in urban areas. This change in the professional mind-set may not be matched by a social consensus. This consensus remains influenced by the image and functionality of the car born in Stage 1. Stage 3 cities have succeeded in reducing car use, with sustainable mobility policies and a mind-set more balanced between alternative modes of urban mobility. While this latter stage encompasses the larger cities in Western Europe, the Eastern European cities remain in Stage 1. The challenge is how to influence individual and professional mind-sets in the stage 1 cities to produce a quick migration to stage 3. This is explored in the next section.

Public transport or cycling, in countries where the aspiration for car ownership is strong, is seen as ‘poor person’s mobility’. However, in the new digital world, public transport and cycling are the perfect environments for self-expression through appearance, and for displaying your connectedness with the new society through smart phone and tablet/lap-top use – at the bus stop, cycle rental point, in the airport, on the train and so on. Of course this excursion into the importance of projecting image hides the huge intrinsic value that smart phone and tablet devices bring to extend the time for socializing, for leisure and for working – whether sedentary or mobile.

Mobility can be used in conversation to lay down relative status (and power); and therefore to command respect from people and peer groups. People meeting for the first time pass ‘mobility-based’ signals to each other to establish relative status. While in the past, one’s occupation may have been the first signal to pass on, in the modern world, these signals are more likely to emphasize mobility freedoms, mobility status and strong IT connectivity.

The exchange of mobility experiences is also a primary subject of dialogue. Of course, this should not be surprising, given the increasing volume of mobility for leisure and business travel, in addition to the commuting experience; but it serves to re-emphasize that mobility means more to a person than actual movement. This is essential intelligence to those planning and designing mobility products, services. It is something that psychologists in the car manufacturing sector have been working with for years but needs to take the foreground with all stakeholders in the wider mobility economy.

Psycho-analysts define 2 basic drives within any one individual; the drive for self-expression and the drive to bond with a group (sometimes termed extrinsic and intrinsic values). In individuals, each drive strives for dominance – they are mutually exclusive factors. In societies where social and kinship structures are weaker, individuals migrate in their behaviour to individual expression. In closer knit social structures, behaviour drives toward greater bonding. People’s social ‘drives’ in society are being played out through their mobility. Importantly, mobility is also an important way we judge our social performance, get our self-esteem and reflect on life’s achievements:

In modern neo-liberal society, mobility is associated with speed, flexibility, efficiency, accomplishment, and achievement, having the competitive edge: it expresses all of the elements that are driving modern society. Low mobility is associated with failure, suspicion, ‘loafing around’ and idleness. Mobility competition is not confined to car owner against car owner. The city cyclist eagerly
overtaking the traffic (with additional internal competition to beat their best commuting time on their cycling app.), people passing lines of commuters on escalators, unhappy with losing, not so much the few seconds they gain from their aerobics, but the loss of control in the crowd. The same is true of the arriving plane or train and the rush to grab bags and regain the control of time sacrificed on route.

**Mobility is competition and its power is freedom and control.**

In the modern world, enjoying life to the full involves consumption and products – the right car or bike, holiday in the right place, the right laptop etc. Stronger social pressures for competitiveness and social skills mean that these forces are harder to escape

Expensive mobility possessions, providing status and power could be being replaced by the status and power achieved through purchasing the latest new lap-top or smart phone, ‘applications’, or through the content and power of your Facebook page – perhaps a far safer environment to express your competitive edge.

7. **Social conformity and mobility choices**

So as we can see, the mobility decision-making process; whether it be a decision to change and purchase a particular type of mobility, the purchasing decision moment itself for product X or Y, the decision to use or rent mobility; and finally the mobility experience, all involve strong social influences and have little to do with the functional value of the mobility. In the neo-classical model people’s preferences are independent of others but this is not the case in reality. Some decisions are made at the level of the group (for example, as seen in studies of activity based scheduling between household members). People also compare with others, or with society in general, when obtaining information, taking decisions or when evaluating the consequences of decisions.

Mobility innovators need to be sensitive to social dynamics in developing products and services. For example, innovating into smaller groups can produce more success than innovating into an overall population; as the feelings of belonging and responsibility within the group are stronger. In this context we can return to the example of mobility sharing. In the UK, Liftshare have over half a million registered car poolers. Rather than take the step to develop a population wide ‘open’ service, they
have chosen to develop common awareness-raising tools, but applied within ‘closed social networks’ in workplaces – and with considerable success.

Research shows that conformity to group behaviours is very strong; and the social pressure to conform to the views of one’s immediate peers is strong. These social norms have strong impacts on how choices are made. For example, collective conservatism can develop, even if the rationale for it becomes outdated: in addition, traditions persist because people think others like it. In this context we need to distinguish between fashion, tradition and habit. Fashionable mobility is on the competitive edge – buy an electric car, an electric ‘plugboat’, use Uber etc. Tradition is well explained by the persistence of the post-war attachment to cars for 60 years; despite growing congestion. Habit in mobility is a very strong force in resisting change, even where the argument for behavioural change is compelling.

Social, as opposed to individual, values and norms generate a critical mass of choices; which then acts as its own dynamic. Models of mobility choices that ignore this dynamic will produce misleading forecasts. Elsewhere in this book, environmental psychologists, Linda Steg and Berfu Unal discuss two types of social norms, descriptive and injunctive:

“Descriptive norms – describe what most people do in a certain environment: thinking that the majority must be right (called the social proof heuristic). It can have both desired and undesired effects – encouraging conformity to the social norm, or strengthening the reaction to it.

Injunctive norms – these only promote the desired behaviour. They inform people what they should do, and what might happen if they do not conform.” (Unal and Steg, 2015, in this report)

In situations where the (morally correct) injunctive norm is violated, then the descriptive norm appears to be the most accurate predictor of behaviour – norm abiding or norm violating. In the case of norm violations, situational cues are important to reinforce the norm (for example speed warning signs).

Our mental lives are entwined with social lives and ‘social norms’. These are strong influences in the formation of our beliefs, values, perceptions and attitudes. This combined force can have both positive and negative outcomes for individual and social well-being (see Section 8).

Conformity breeds habit. Habitual mobility decisions require less cognitive effort and have been shown to have strong resistance to change policies. In the treatment of ‘anti-social’ habits (addictions), psychiatrists and psychologists now believe there are strategies to combat habit.

In this context, mobility behaviours are among the most challenging and complex social (rather than anti-social) habits to change; and will perhaps prove the hardest test for the new intelligence.

Transport planners have pursued a number of progress traps in the attempt to get large changes in mobility behaviour: The most

Conforming behaviour that says, ‘well if that’s what people do, it must be right’. In contrast, other social norms that say ‘this is what you should do’ and ‘this is what will happen if you do not’. (see Chapter 2)

In the past decade, our understanding of the neurology and psychology of habits, and the way patterns work within our lives, societies and organisations has expanded in ways we could not of imagined 50 years ago. We now know why habits emerge, how they change and the science behind their mechanics. We know how to break them into parts and rebuild them into our specification. Transforming a habit is not necessarily easy or quick, but it is possible – and now we understand how.

Duhigg (2012)
recent one being Personalised Travel Planning. Rather similar in logic to neo-classical economics, the vast numbers of mobility decision makers are held constant; isolating (from a very large screening sample) the usually small minority that has indicated the ‘realistic’ possibility to change. The stimulus to change is provided by travel information and a visit from a transport-planning officer to indicate ‘what are the best options for them’. Changes (usually short term) in the behaviour a small proportion of this latter group are then mis-reported against the initial large screening sample of the population. In the absence of other methods, and as justification to the considerable costs incurred, much is at stake to prove this method works. Recent projects within the European Commission’s Intelligent Energy Programme (SWITCH, PTP Cycle, CHUMS) are applying PTP to specific groups of people (people at ‘life change moments’ making short car journeys, potential cyclists, and potential car poolers). In all cases, the application and results are, not surprisingly, disappointing. Deeper insights are needed.

More promising progress has been made in the area of social awareness-raising campaigns on mobility issues; though the direct impact on changing mobility behaviour is often difficult to measure, unless the campaign supports a specific new innovation to increase market share – or by stimulating change through participatory actions such as gaming and fun activities (for example the Beat the Street exercise with school children).

The advertising industry will claim that, for over 10 years, it has understood the basis on which people change behaviour and possibly break habits. Raising awareness only of the characteristics of the (mobility) product and service to target groups in society will have a muted impact. Factual points are just side issues they argue. What is important is to sell values – values that appeal to the drives of different generations and values that appeal to basic emotions that evoke family, maternal love, fidelity, security, status, triumph, performance etc. In the current social model favoring the ego, the impetus for change is the positive impact on the individual’s well-being – that is, change which conforms to current social values, but where the individual is the primary beneficiary. In contrast, in many cases some emotions and beliefs are so engrained in individuals, cultural and social mores that change options cannot be contemplated at all (what the psychologist terms ‘cognitive dissonance’).

It is here that the wider context of mobility mind-sets is significant. Change is not driven by knowledge and insight; but through emotionally perceived values, socially conditioned – knowledge is not enough. Messages to change mobility behaviour will only be effective if they latch on to deep rooted emotions. Such emotions are barely conscious and deep rooted but highly influential. Through social interaction, kinship networks and other social bonding; these deep rooted emotions can also reflect the emotions of peer groups and of whole cultures. “Longer term changes in (mobility) behaviour and in life in general will not come about through rational knowledge but through emotionally charged values; not through the cerebral cortex but through ‘gut feelings’” (Verhaeghe, 2012).

8. Mobility and social well-being

How does your mobility in society build a better life? Psychiatrists define three layers in mental well-being – psychological, social and mental. The psychological layer is visible through physical and mental behaviour patterns. In contrast, the social layer is more difficult to see. It could be seen through the prevalence of one type of behaviour in excess to the social norm. The third medical layer corresponds to the ‘illness model’ (see below). The social layer, from a mobility point of view, can be seen in the definition of the social norm for mobility - what is accepted mobility behaviour and what is considered deviant. Different driving styles in different countries, with consequent enforcement cultures may be one example.
Psycho-analysts define 5 dimensions of mental well-being; heavily related to social position and interaction:

- The quality of our social relationships,
- The extent to which we control our lives,
- Our social status,
- The fears and cares we experience, and, as a result
- Health and life expectancy.

Mobility freedoms are an essential element of our locus of control, our social status and of the relationships we form in our kinship and peer groups. These have impacts on our overall levels of perceived competence and security/insecurity in society. The World Health Organisation (2002) has identified clear relationships between active mobility, health and life expectancy.

These factors re-state the need to find balance between the two conflicting individual desires to bond with others and to have autonomy. A well-functioning society balances the individual with the communal. Social pressures in this context can breed defiance. On the other hand, loneliness and fear of abandonment are probably the greatest illnesses in our modern, ageing society; where increasing age brings on lower mobility and dependency on others.

Individuals and their disorders are products of society. All societies induce both illness and well-being. In turn, every community shapes and defines what is considered normal (and by default, what is abnormal). The definitions of social deviation have consequences for how stressed and detached people can feel in their environment relative to others. In the current social order, society lambasts those who are seen to be deviant more than benefitting those that meet social norms – the economic model of society is heightening feelings of social disparity. The current health norm in society is success that is financially and materially visible. The mobile and virtual environments are the perfect channels for expression in this respect. Cortisol (the stress enzyme) measures highly in very mobile societies.

People’s brains respond differently to stress depending on whether they have grown up in urban or rural societies. Our brains respond in their development to the environment in which they grow up. People who have been raised in urban communities, in this respect, are more susceptible to mental disorders than those raised in rural regions. If societies can differ greatly in the way they organise their social relationships and perceive norms and values, they can also produce very differing identities. They also define deviations differently. Every community defines and shapes its own normality; and, at the same time, defines its abnormality. So the issue is not whether society makes people ill or well, but how it defines the line of social deviations – and the impacts this has.

The psycho-analyst, Paul Verhaeghe, concludes that the diagnosis of mental well-being is based, not on biological causation, but on social norms. Therefore, the focus on the problems individuals face misses the social causation. For example agoraphobia among adults is increasing rapidly. The general fear of others (crowds) was the third most common psychiatric disorder after depression and alcoholism – most prevalent in mobile environments.

The vast majority of mental disorders are not illnesses as such. They are manifestations of an individual’s social problems. Being labelled with a disorder underlines a failure to comply with a social norm. (Verhaeghe, 2012)

Modern social lifestyles are producing mentally and physically unhealthy, immobile people. Obesity and sedentary behaviour are rapidly increasing the incidence of cardiac problems; indeed it would seem that the impact of sedentary behaviour on cardiac illness is greater than that of obesity itself.
Additionally, self-respect in society is reduced, negative social imagery with consequent mental health issues. While the cause of the problem lies in a range of factors from poor diet, lack of physical exercise, an over enthusiasm to sit in front of the TV or (more commonly today) a computer; the solution lies in the mobility environment. There are many initiatives to encourage ‘active travel’ as it has come to be known (PASTA, 2015). Active travel can also lead to a pronounced improvement in mental health and thought processes (Gros, 2014). Additionally, the World health Organisation has shown that regular active travel can maintain a healthy body into older age and prolong life expectancy (WHO, 2002).

9. Mobility deprivation and social change

The continuing mobility revolution, by its very nature, will have distributional impacts. Most people in society suffer some form of mobility disadvantage (either permanent or transitory) as they pass through the life cycle. This will be due to dependency (among the very young and old), frailty (as a result of age or physical disability), gender role, low income, faith or ethnicity or sensory and mental impairment. These factors are not limited to mobility but affect the whole lifestyles of people afflicted with these conditions. Mobility disadvantage is most acute when these factors combine in any one individual, family or community. Where mobility disadvantages become compound in particular neighbourhoods, then it can give rise to social breakdown (The very definition of the word ‘mob’ (Urry, 2007)).

Despite the current focus on the mobility issues surrounding the lives of the millennial generation, it is important not to forget that the primary demographic change is population ageing; and therefore an increase in frailty, dependency and disability. As the previous section has documented, the primary mental disorders are loneliness and detachment; plus depression, agoraphobia and addiction. While many older people are ‘blooming’ in new healthier lifestyles, promoted through greater mobility, the very old require mobility support to retain the important social connectivity they need. Customised mobility solutions exist for these groups of mobility impaired persons – paratransit solutions (Pickup, 2014). The ageing baby boomers, currently experiencing a healthy mobile lifestyle, will get older and the demand for society’s support with their mobility will be necessary, as family support networks decline. The point of giving up the car, of using slippers as the main footwear, we know to be points of mental change in older persons. Ironically, the very types of ‘demand responsive’ mobility designed for the disabled and elderly over the last 50 years, will go mainstream, as younger generations call for customized, automated and seamless mobility choices.

In previous work on the mobility component of poverty (Pickup, 1988), journeys defined as ‘shopping’ and ‘personal business’, to older people are important for social and bonding reasons; and not the category specified. Another common purpose not in the coding list but of essential importance to older people was the regular visit to the cemetery to pay respects to departed loved ones – often in inaccessible locations on very large sites. John Urry (2007) also picks up this point about what he calls the ‘invisible patterns of mobility demand among retired persons: “Elderly users describe their journeys as ‘just’ for shopping, research identified many other ‘needs’ that people had; visit a spouse in a care home, visit friends, go to a café, attend a community centre, art classes, to get to work or to go to the pub – this range of what it is that the otherwise ‘excluded’ are trying to access may only be revealed through new infrastructures that ‘realise’ such latent demand”.

The self-perception of low mobility feeds social tension and threatens breakdown: clinical psychologists underline that powerlessness and helplessness are among the most toxic emotions. Inequality leads to a loss of respect, including self-respect – in psychological terms this is the worst that can happen to anybody. In recent years, depression has doubled and people see it as a personal failure in the new social order. Responsibility has increased as has the level of guilt in failure, which, if multiplied across a community can be toxic.
Whether we judge that the mobility freedoms used by individuals to attain power and status in social peer groups is ethically desirable; it is nevertheless a strong force in society. It is particularly strong force where the people perceive themselves as losers in the process, not winners.

The explosive growth in mobility has only served to exacerbate the difference in life chances between ‘low’ and ‘highly’ mobile groups.

The negative feelings for the relative minority with low mobility are essentially stronger than the impact of further enhanced mobility enjoyed by the very highly mobile (the ‘boredom on pleasure’ syndrome identified by Freud). For low mobile groups, restricted mobility freedom at the social scale may be felt in the development of low community self-esteem. This leads both to negative forms of social reinforcement within the excluded community, manifest in increasing xenophobia; and an increase in antisocial reaction in the form of radicalized behaviour (mental social disorder) – particularly where the community can build mobility discontent into a wider sense of exclusion; for example the exclusion felt by different ethnic or faith groups, women, the poor, the dependent and the disabled.

There is a strong spatial element to mobility social exclusion, particularly prevalent (though not exclusively) in peripheral neighbourhoods or regions, where the impact of low mobility combines with low accessibility to create social tension. The book, The Spirit Level’ (Wilkinson and Pickett, 2010) analyses countries with more equal and unequal societies (measures by income differentials) across a whole diversity of social and epidemiological factors. The powerful results demonstrate clearly that the more equal the society, the less the incidence of these factors. In this context, mobility is no exception.

Guy Diaz grew up on the wrong side of the Peripherique, the eight-lane ring road that surrounds the City of Lights like a traffic-filled moat. Inside the “Periph,” as its known here, is the Paris of postcards. Outside, “it’s another country,” Guy, 18, said. “We don’t look the same. We have our own language.” The only thing you need to understand,” Guy told me, “is that there are only three ways out of the ghetto for people like us: sports, music or fashion.” The burning of cars was a way to bring attention to the plight of the people who lived there, I was told over and over. It’s not enough to come and watch cars or buildings burning. You should try to understand why people decide to do all that,” Darren Foster, freelance journalist.

The widening and marginalization of the gap in Europe between the ‘mobility have’s’ and the ‘mobility have not’s’ is a cause for concern and an issue that has to be tackled at its roots to combat social tension and promote inclusion in the broader society without unnecessary ‘Ghettoisation’ and radicalization.

Mobility and the power symbols it demonstrates between the social classes are both the simmering symbols of social tension in excluded communities, and the immediate targets in the event of social disorder. This has been a worrying trend in the peripheral suburbs of the largest European cities – in Paris in 2005 and in London in 2011.
Not all of the analysis is negative. We can conclude in a more positive light from the above discussion is that mobility is a powerful force for social change. For example, recent work in Egypt by author (Pickup et al., 2015) addresses the appalling frequency with women are routinely sexually harassed in the travelling environment; an expression of the wider problem of women’s position and lack of employment and education opportunities in Egyptian society as a whole. The national railway company, as part of a large investment plan, are implementing a full gender mainstreaming programme, combining a mix of physical, ITS, enforcement and education measures to improve women’s safety and security in the station and train environments.

This example in Egypt is a good indicator of what mobility policy can achieve through the appropriate cocktail of investments.

10. Conclusions

Social forces in mobility futures

This chapter has focused on the interplay between mobility and society. It has underlined that social forces play the major role in determining mobility patterns and the way people mould their identities and form values. The social dynamic is strongly entwined with people’s mobile lives – in thinking and in action – physical and virtual – physical and mental.

Society has moved from an emphasis on social support to one of individual responsibility. This has served to widen the gap in society between the mobility rich and poor. Mobility has an important impact on the primary mental and physical problems facing society – loneliness, fear of abandonment, agoraphobia, obesity, sedentary behaviour etc. Expanded to whole communities, mobility deprivation exacerbates social tensions and continues to provoke social disorder.

Conversely, we can see that mobility initiatives can work to achieve positive social change and improved health conditions. New trends in active mobility, personalised mobility services to meet the specific needs of minority groups, the new mobility sharing culture will all have positive impacts on social development; harnessing the benefits of information technology.

In the current enthusiasm to investigate those mobility innovations popular with the new digital generations, the importance of an ageing society can easily be forgotten. While the ‘older’ generation are more mobile than ever (‘Babybloomers’), the ‘oldest’ generation requires social support for their mobility needs. Ironically the characteristic features of personalised, customised mobility developed for this group over the last 50 years are now the same mobility features popular with the digital generations.

Social change has been rapid in recent decades, with new family and kinship networks, changing roles of individuals within society. The pace of technological innovation is faster and faster. A mobility rich population, unwilling to forego the mobility freedoms with age and with young digital generations

Adama replied: “We’re sitting between two worlds (second generation immigrants not accepted in society). We’re stuck.” It’s been 30 years that we’ve been caged into the suburbs,” said Senhadji Djouad, a 19-year-old medical student. “It was bound to happen one day or another.” You wouldn’t believe the conditions that we live in,” he continued. “We have rats. The pipes are old. It stinks. And remember, you’re only 20 minutes from the Champs-Elysees. The only thing that separates us is the ring road.”

Darren Foster, freelance journalist.
with different value sets which demand new types of mobility – a new world where transport modes become attachments to smart phones; and the whole locus of mobility control and seamless movement transfers to the user. The Mind-sets project investigates the value sets of the generations in the context of future mobility and lifestyles at the end of this report (Konings and Van Dist).

Social futures and mobile futures will be inseparable; mixing physical and virtual environments in the new age of competition and (personal and social) success in the free market. Mobility freedoms are socially desirable provided, they are well managed, show moderation and self-control, respect the principle of sustainability and are available to all – for future society in Europe, this is the challenge.
References


Chapter 4: A Virtual-Spatial Approach to Mobility

Emerging technologies: Mobility, travel and urban form

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1. Introduction

The aim of this chapter is to introduce the inter-relationships between virtual mobility and physical mobility as mediated by new technologies and perceptions of space and alternative travel options. For this end we will review concepts, theoretical and empirical studies focusing on new and emerging technologies and how they affect travel demand. We will consider mental maps and their role in activity spaces and virtual spaces as they influence people's mobility horizons.

The past decade has witnessed rapid communication developments which had major social impacts. The use of the new Information and Communication Technologies accelerated the shift from social groups that were defined through a specific location (e.g. residential neighbourhood or work place) to individually based social networks. This shift, coined by Wellman (2002) the "Networked Individualism", is a stage in which mobile, high-speed telecoms allow for personalized networks and "person-to-person" social ties. These new social networks are associated with several changes, when comparing to the past 50 years, such as (Ling, 2004, Sheller and Urry, 2006):

- Wider spatial distribution of social networks members than in the past
- Typical social networks are less coherent, i.e., fewer people share multiple affiliations today than in the past
- The memberships overlap less in spatial terms, i.e., vis-à-vis their residential locations and activity spaces
- People have a larger set of active contacts today than in the past
- The contacts are spread across more social networks than in the past.

At the same time, rapid transport network systems enable long-distance mobilities and multilocality to develop. These mobility practices depend on residential biographies, social and familial anchorages and appear to concern more and more people. The appearance of virtual social networks, such as Facebook, on the one hand and the changes of working patterns (home/hub based, shorter working week days) on the other hand have resulted in intertwining of leisure activities with other daily routines. All of the above have an impact upon travel behaviour and mobility within the urban space.

Travel behavior has traditionally dealt with the physical movement of persons outside their reference location (usually home) to perform diverse activities. However, following the developments in telecommunication technologies, the literature on travel behavior in the last decades reflects a wider definition, conforming to a new notion of ‘mobility’ which includes not only the physical mobility of persons but also the physical movement of objects, and the imaginative and virtual travel of persons using various telecommunication means (Urry, 2000).

Travel has been acknowledged, therefore, as a particular form of mobility. In the context of the activity-based approach now dominating research on travel, it is perceived as one of a variety of mechanisms used to perform daily life activities. McNally & Rindt (2008) referred to travel as the “physical mechanism to access an activity site for the purpose of participating in some activity”. As activities have become the acceptable context for the analysis of choice processes related to travel, decision making refers, first and foremost, to the choice of the desirable mechanism to perform an activity. This perspective points to the hierarchical structure of choice, associated with the differentiation between short- and long-term decisions and the integration of travel within a wider social and behavioral context. Telecommunication technologies represent, therefore, alternative mechanisms to physical travel. Within the scope of the traveler’s short- and long-term decision processes, the mechanisms of telecommunication and transportation are assumed to interact with each other.
2. Transport and ICT relationships: Substitution and Complementarity

2.1. The Substitution vs. Complementarity Debate

The rapid developments in information technology and data processing have inspired a growing interest in the interactions between telecommunications and transportation. Both act as subsystems or modes of a communication system. Indeed, many of the forms of transportation terminology have been applied to communication, e.g., the ‘information highway,’ telecommuting, telesprawl, etc.

At the end of the 20th century there was considerable discussion of the relationship between transportation and communications technologies (Hjorthol, 2002, Mokhtarian, 1990, Niles, 1995). The Internet has become an integral part of daily life for many in modern industrialized societies. As Internet use changes our perceptions of accessibility, by weakening the traditionally strong links between activity, distance, place and time, questions regarding the impacts of Internet use for accessibility and thus activity participation and travel have been raised (Mok and Wellman 2007). The rapid growth in telecommunications technologies and the expansion of the communications service industry have direct implications for the use of transportation and therefore indirect implications for urban and regional structure.

Many, including transportation planners and researchers, have suggested that such communications activities will replace transportation of people and goods. Substitution of communications technology for travel was the common hypothesis (Niles 1988).

In addition to substitution, other potential first-order impacts of ICT use on travel were suggested: complementarity (the generation of additional travel), modification (the change in travel patterns), and neutrality (Salomon, 1986). Conceptual and empirical research has focused on assessing the impact of three major ICT applications that were suggested as travel substitutes (Salomon 1998): Telecommuting (e.g., De Graaf & Rietveld, 2007; Mokhtarian, 1991; Pendyala et al., 1991; Salomon, 1998), teleshopping (e.g., Farag et al., 2007; Weltevreden & Rotem-mindali, 2009; Rotem-mindali & Salomon, 2007) and teleconferencing (Benninson, 1988; Mokhtarian, 1988). A popular media scenario described how the people of the next century will work from home in ‘tele-offices,’ linked by computer and telecommunications, where they ‘telecommute’ and do their ‘teleshopping,’ etc. Teleconferencing, teleworking, e- health and e- learning were researched while trying to discover how they affect travel behavior. But research show that the news of the (partial) demise of transportation, similar to that of Mark Twain, were premature. A complementarity relationship has emerged where increasing importance of telecommunications contacts may in fact mean that transportation needs and services will grow in importance as well. People who use telecommunication services have more contacts and they do travel more and for more distant destinations to convert those contacts into face-to-face socializing (Niles, 1995).

In summarizing three decades of research on telecommunication-transportation relationships it is clear that the expectations of reducing travel through the use of virtual mechanisms were not met (Mokhtarian, 2009; Plaut 1997). Although some direct substitution effects have been discovered (e.g., Balepur et al., 1998; Henderson & Mokhtarian, 1996; Pedyala et al., 1991), Aggregate travel has increased (Mokhtarian, 2009). Among some of the explanations to this paradox are low adoption rates (Salomon, 1998) and the offset of direct travel decreases by the indirect stimulation of travel by ICT use (Mokhtarian, 2009). It has also been acknowledged that research on these effects faces major limits such as the abundance of possible cross effects and the extremely dynamic context of technology change and adoption (Aguillera et al., 2012).
The emergence and rapid adoption of mobile telecommunication technologies has further challenged research in that field. Mobile communications are associated with the disconnection of activities from specific locations, leading to increasing flexibility in the timing and location of activities (Couclelis, 2004; Dal Fiore et al., 2014; Kwan, 2007; Lenz & Nobis, 2007; Schwanen & Kwan, 2008). Patterns of mobility have become less structured and thus less predicted. This shift has introduced increasing complexity in the travel-related decision processes and practices, and the recent literature has been “recalculating its route” to meet the challenge and promote new research agendas.

2.2 The efficiency effect

The ‘complementarity’ between transportation and communication technologies actually encompasses two distinct phenomena. The first is enhancement, which refers to a situation in which the use of telecommunications technologies causes additional travel that would not have occurred in the absence of the augmented use of communications. For example, the observation that telecommunications cause a broader geographic dispersal of social and economic relationships, which can produce travel stimulation (Niles, 1995). The second refers to any situation in which one of the two services contributes to the efficiency of the other. For example, it may be possible to increase the efficiency of transportation systems through more intensive use of telecommunications (Giannopoulos and Gillespie 1993).

The use of telecommunications technology itself contributes to the efficiency and logistics of the transport system and its operations, both public and private. Expressions such as ‘just in time’ and ‘total quality control’ or references to the five ‘Olympic zeroes’ - no stock, no time lag, no fault, no breakdown, no paper - point to a new form of logistics based on tighter flow management and the desire to enhance productivity and meet the challenges of the competitive economy. For example, there is evidence that introduction of new information management technology produced a sharp upturn in railroad productivity in the U.S.A. in the early 1990s.’ This includes adoption of data sharing among railroads and an electronic data interchange network. Conservation of resources may be achieved through reducing delays or improving the level of service through timely coordination of pickups. Improvements in load factors, routing and backhaul planning made possible through telecommunications increase the efficiency of transport systems. In the freight transport system the decision to travel is determined by the need to move a physical item from one location to another. Warehousing is also influenced by telecommunications technologies which make the transport system more flexible and responsive. There has occurred a transformation in the nature of warehouse operations, shifting toward a smaller number of larger depots serving large areas. ‘No stock’ and ‘just-in-time’ production and personalized tailored-made products require smaller, but more frequent, deliveries.

2.3 Interacting with the transport system in real-time

New ICT developments have enhanced our ability to manage and interact with the transport system in real-time. On one hand considerable investment has been made over recent decades in the development of sophisticated ‘advanced traveler information systems’, delivering formal, top-down information through media such as online journey planners. The use of ‘formal’ travel information pertaining to costs, routes, journey times, or real-time transport disruptions, and its impact on travel behaviour (for example, choice of mode, route or departure time). On the other hand the emergence of smart-phones led to technological developments in the form of diffusion of bottom-up user-generated information. Many innovative new mobility services have been developed just in the last few years such as: Waze, Uber, Moovit, GetTaxi, Where-is-Bus and others. All are combinations of cellphones with GPS technology. The results are: more complex travel demand patterns, strong links between lifestyles and personal travel in the context of continuing social and technological change and lifestyle as a generator of “Mobility Mind-Sets” and transport services tailored to personal needs.
3. Social Networks and Travel Behavior mediated by ICT

The focus on behavioral aspects of travel is reflected, among others, in the increasing interest in the social dimension of individuals as an important influence on travel patterns. In the context of the activity-based approach the demand for travel is driven, to some extent, from the generation of social activities. The growing relative share of leisure and social have motivated the investigation of this dimension. However, it has been acknowledged that the social environment also has influence over other segments of travel (Paez & Scott, 2007).

The social dimension has been frequently incorporated in the literature by the notion of the social network. The social network is a structural representation of social relationships, where each node is a person, group or organization, and the links between the nodes represent interactions or flows of resources. To incorporate this dimension, travel behavior research relies on network analysis methods which deal with the mapping and measurement of networks. In the social sciences, network research is mainly concerned with the outcomes of network actors as consequence of network properties or their position in the network (Borgatti et al., 2009). In the context of travel research, network properties and persons' positions within the network may account for variations in travel behavior and choices. Axhausen (2003) suggests, therefore, that in contrast to sociologists that focus on the topological structures of social networks, research on travel behavior should also be concerned with the networks' spatial dimension. Some attempts have been recently made in this direction (e.g. Carrasco et al., 2008; Larsen et al., 2006; Van den Berg, 2012).

The incorporation of social networks in the study of travel behavior has become extremely relevant in the context of emerging communication technologies (Carrasco & Miller, 2006). The building and maintenance of social networks involves physical travel but also technology-mediated contact (Larsen et al., 2006). Virtual interaction continuously expands and may directly substitute travel to some extent. Yet, face-to-face contact is still acknowledged as central to social life (Urry, 2003). The fast adoption of mobile communication technologies has led to fundamental changes in the spatial structure of connectivity and social networks, shifting it from place-to-place connectivity to person-to-person connectivity (Carrasco et al., 2008; Kwan, 2007). The consequent rise of social media as networking spaces, information resources, and their potential impact on face-to-face contact may change the impact of the social dimension on travel behavior.

- The building and maintenance of social capital (in the sense of human interaction in daily life) involves physical travel but also technology-mediated contact (Axhausen, 2008). Although virtual interaction continuously expands and substitutes to some extent physical interaction, face-to-face contact is still central to social life (Urry, 2003).
The relationship of ICTs and travel behavior appears to be much more complex than simple substitution, as ICTs can also change patterns of physical mobility and can also promote social interaction.

4. The Impact of Social Networks on Travel Behaviour

The formation and maintenance of social networks involves the continuous building of social capital. Arentze & Timmermans (2008) emphasize social and information needs as components of the utility associated with social interaction. Their theory postulates that social links lead to information exchange and the adaptation of preferences and behaviors, including activity travel patterns. These two basic elements of social networks, of engaging in social interaction and activities, and exchanging information and knowledge, also characterize two lines of research on social networks and travel behavior as identified by Van den Berg (2012); one deals with the way people’s social networks influence their travel decisions through the exchange of information and opinions, and the other deals with direct effects of social networks which are related to the desire of individuals to interact with members of their network and engage in social activity.

These two lines of research represent mechanisms through which social networks may influence travel behavior. Similarly, Axhausen (2006) mentions two basic elements representing the social context of the traveler: “The geography of activity space” (which is determined, among others, by the spatial locations of social network members and the performance of joint activities) and other “non-geographical elements of knowledge”. These elements are conceptually contradicting each other; on the one hand social networks function as resources in the context of travel decisions, by leveraging the person’s knowledge and abilities. On the other hand, the joint activities with other network members requires the scheduling and coordination with others, thus imposing constraints on the individual’s travel decision process.

Axhausen (2003) puts the interaction between social networks and activity-travel patterns within the context of urban spatial evolution. Urban decentralization and dispersion, enabled by transport technologies, have contributed to the spread of social networks which have become less embedded in the local context and practices of daily lives. The spatial spread of social networks has been supported by emerging telecommunication technologies. These processes may have affected various dimensions of social networks:

1. The **quality of contacts** may have changed due to increased spatial separation such that the distribution of contact densities should be formed of fewer strong ties and more superficial ties.
2. The number of active contacts may have increased because telecommunication technologies assist in maintaining remote relationships and also increase the amount of free time available for social interaction. Moreover, the decreasing costs of telecommunications allow more contact time. (This also follows from the conceptual analysis in Carrasco et al., 2008)

3. As the spatial locations of people are less important in establishing social contacts, people can be more selective and more satisfied from their social network.

The main conclusion from this description of trends is that the increase in leisure travel could be attributed to the trends in the spatial spread of social networks. This conclusion relates to the line of research focusing on social networks as generators of social travel. However, the description of these trends has also implications regarding the effect of social networks on travel through the exchange of information. The rise in the amount of contacts in conjunction with the apparently decreasing strength of ties due to spatial separation may have affected the flow of information through social networks. According to the strength of weak ties theory, developed by Granovetter (1973), weaker ties are more likely to be sources of novel information.

The increased selectivity of contacts may result, according to the theoretical framework presented by Arentze and Timmermans (2008), in more similarity with other social network members, leading to the increased adoption of attitudes, perceptions and behaviors among network members. Increased selectivity may also be manifested in the choice of contacts according to the potential of acquiring new knowledge.

The influence of the social network on activity travel patterns is a continuous dynamic process as the social network of a person is not a static structure. The dynamic nature of social networks follows life cycle changes (Sharmeem et al., 2014), changes in social and information needs and the changing potentials of satisfying them through the current network affect. These may affect the utility associated with each social link, leading to dissolution and reinforcements of links with the passage of time (Arrentze & Timmeremans, 2008).

As a part of their research Sharmeem et al. (2010) develop a conceptual framework to integrating dynamic social networks into activity-travel behaviour. As it is illustrated in Fig.1 the researchers hypothesize that with changing socio-demographics and with life-cycle events, social network changes, having an impact on activity-travel behaviour, both direct (frequency, duration, use of ICT) and indirect (exchange of information).
The concept includes three parallel, interdependent phenomena: events, social networks and activity-travel behaviour. Changes in one may result in change in the other two. E.g.: Getting married could mean that the spouse’s social network is at least partially included, which leads to a change in social network and eventually travel behaviour. Another example in the graph is joining the gym and thus extending one’s social network etc.

5. The Impact Mechanisms of ICT on social networks and travel behavior

ICT use is expected to significantly affect the formation and maintenance of social networks through various mechanisms, some of which are relevant to travel behavior. The possible effects on travel behavior are hereby classified to three types:

1) Travel behavior is changed through the use of ICTs in the maintenance of social networks (direct effect of ICTs).
   This type of effects is related to the role of ICTs in facilitating communication and exchange of resources.

   a. ICTs provide new modes of space-time coordination [Larsen et al., 2008; Line et al., 2011; Kwan, 2007 cites: Ling and Yittri, 2002; Katz, 2003; Ling, 2004] and the
relaxation of space-time constraints (Schwanen & Kwan, 2008). These include the flexibility of schedules, multi-tasking, and the fragmentation of activities.

b. The use of ICTs in social networks enhances the transferring of knowledge and information (Arentze & Timmermans, 2008; Axhausen, 2006).

2) Travel behavior is changed through the effect of ICTs on social interaction (indirect effect of ICTs).

This type of effects is related to the role of ICTS in promoting social interaction and consequent social travel

a. ICTs expand social networks in terms of size and geographic span (Axhausen, 2003; Schwanen & Kwan, 2008). This implies more social contacts and long-distance social interaction and travel (Larsen et al., 2007).

b. ICTs promote the generation of social activities (Carrasco & Miller, 2006)
c. Time saved due to mobile ICTs usage enables more social travel (Kwan, 2007). On the opposite side, the time people spend using ICT may reduce the time available for activities demanding physical travel [Kwan, 2002 (cited in Kwan 2007)].

3) Travel behavior is changed through the effect of ICT use on the relationship between social interaction and physical mobility (indirect effect of ICTs).

This influence follows the literature dealing with the interaction among communication modes, but with relation to the social sphere rather than work and maintenance activities

a. The use of ICT in social networks may substitute/enhance the need of face to face interaction. Tillema et al. (2010) found a correlation between ICT use and face-to-face contact, suggesting a complementarity effect between ICT use and travel in the context of social networks and social activity travel. The results of van den Berg et al.,
(2012) also indicate a complementary relationship between contact frequencies by different modes.

In the following sections we will focus on the urban aspect of mobility. We will consider mental maps and their role in activity spaces and virtual spaces as they influence people’s mobility horizons.

6. Current Technological Trends, Mental Maps, and Mobility Horizons

The emerging development of new technologies has major influence on the way we understand and read the urban environment, which is being developed by mapping the urban space. Maps become the main interface for accessing data over the Internet. Urban digital maps are being developed using several methods, including using basic streets digital maps, mental maps and cognitive maps (Ron, 2008). For understanding how these maps are conceptually developed and how they influence our mind-sets and our, mobility we would like to introduce the concept of mental-maps.

A mental map is: “a person’s perception of the world is known as a mental map. A mental map is an individual’s own internal map of their known world. A mental map can be defined as an internal representation of a place based on memory” (Rana, 2008. pp.288). A mental map is a person's point-of-view of the perception of their area of interaction, or a visualization of an area based on their known sense of direction (http://www.urbandictionary.com/). Wagner, 2010, p. 245, noted that in addition to mental mapping: "... cognitive maps contain information on the ‘qualitative characteristics’ of the represented object”. The research relating to mental maps is one of the first studies that connected urban settings with human action. Kevin Lynch is the most prominent contributor to this field of study in his book “The Image of the City” (Lynch, 1960). Lynch asked people to sketch maps from their own perspective of an urban area from their memory, pointing out five main elements of the city including: nodes, edges, districts, paths and landmarks. Lynch determined that “Most often our perception of the city is not sustained, but rather partial, fragmentary, mixed with other concerns. Nearly every sense is in operation, and the image is the composite of them all.” (Lynch, 1960, p 2.).

Mental maps have influence on several aspects of our spatial choices and decision making, mainly on: way-finding and orientation (Kitchin, 1994). Wayfinding combines all of the ways that people orient themselves in physical space and navigate from place to place (Lidwell, et. al, 2010). Weisman (2001) identified three major environmental factors that affect wayfinding: 1) differentiation – between different parts of an environment such as: size, shape, architectural style; 2) visual access – people see different views from different viewpoints ; and 3) layout complexity - a space broken up into different parts, makes it more complex. The way that different parts are organized makes the variances between diverse environments. Travelers are aware of their location relatively to their destination, and to other places or objects. Orientation in maps refers mainly to directions. Lahav & Mioduser (2000) argued that for developing efficient orientation and mobility skills in space, there is a need for mental mapping of the space, and mapping the possible paths for navigating in these spaces. This information is mainly gathered through the visual channel.

The following Figure 2 shows an example of two different ways for presenting perception of mental maps.
Mental and cognitive maps have important role in current development of urban space for three main reasons: 1) knowledge derived from a cognitive map could be used by designers to improve a system's interface; 2) improving database design and efficiency by using cognitive map information regarding the way we store and think about geographical data, and 3) education - cognitive map information could be used to improve urban environment education (Kitchin 1994).

The new digital street maps, or grid maps, as are being used today, are becoming the main reference for the way we see and understand the world, reach a destination, and share different types of information to enrich our knowledge on the urban environment (Caquard, 2013), hence the use of maps has become an essential tool to the way we move in the built environment. Landry (2006) observed that “A map is an image that represents graphically the position of an element in the real world. But many ‘real’ elements of the world are invisible” (Landry, 2006, p. 46. in Jagdish, D. Re-Mapping the City). Mental maps have also influence on a person's awareness and knowledge of the urban space, the impressions about the character, function, dynamics, and structural morphology, and the beliefs that people have about environments (Moore & Golledge, 1976, p. xii). For a better perception of our surrounding there is a need for spatial identification with our environment. This awareness of the perception is very close to the feeling of a ‘sense of place’. We don’t perceive the spatial world through our senses alone, there are many strategies we use in order to make the spatial world more understandable such as: maps of urban space and spatial identification with our surroundings as feeling of a ‘sense of place’ and and memory (Willis, 2007).

A close notion to a mental map is the “mind map” (Buzan, & Buzan, 2010). A mind map is a way to organize information in a more visual way. Such mind maps are usually organized around one single concept (usually an image), main ideas related to this concept are directly associated with this image, and secondary ideas branch out from these ideas (see figure 3).
7. The Role of New technologies in representation of the City

Computing research is currently much more focused on urbanism than it was in the past. This led to design research that develops a conceptual framework for new media urbanism (McCullough, 2007). The rapid development of new technologies leads to a change in the way we read and understand the physical environment. New technologies enable us to create a new layer of the urban environment, a layer of information that can be overlaid on the city map. This new layer, which is using dynamic and intelligent information, helps the users move towards a more meaningful and informative representations of the city (Jagdish, D. Re-Mapping the City). Following this digital stage, several tools for visualizing and analyzing urban environment have been developed, including GIS (Geographic Information Systems). GISs systems mainly process data regarding urban environments and cognitive maps mainly process and expose the way we think, store, produce and utilize such data. Other forms of spatial expressions include: alternative approaches for mapping the city and alternative mapping strategies, collaborative mapping (Sant, 2004); mapping both vernacular knowledge and fiction knowledge, and online mapping services such as Google maps (Caquard, 2013); distinction between story maps and grid maps as an analytical framework and location modeling (McCullough, 2007). These lead to the use of database driven maps that can be applied in order to understand a place within a system of relations determined by their relevance to the queries, rather than only by their geographic location (Sant, 2004).

A related concept of Digital Skin was developed by Juan Freire of MediaLab-Prado (Brunet, 2010) a marine biologist, who draws an analogy between the ocean teeming with life and the city that grows and developed constantly. He describes the digital skin as the active layer of city life and explains: “Although many collaborative mapping projects undermine their own base maps by layering them with collectively defined concepts of space; including participants emotions, itineraries and memories, these annotations are inextricably linked to the predefined foundations of the map they overlay” (Sant, 2004, Riga: The Center for New Media Culture RICX, pp. 153-156). The problem is that most of this concept is based upon the 20th century streets map, that Sant (2006) describes as “…an expression of a singular notion of urban space…one that favors the street over the route… the formal over the subjective” (http://leoalmanac.org/journal/vol_14/lea_v14_n03-04/asant.asp). The Digital Skin can be combined by many different layers, each layer having different information, properties and entities that represents different aspects of the city. Each layer was developed by collaborative collecting data from various aspects of the urban environment, done by users using...
mobile devices, or other mapping devices (Jagdish, D. Re-Mapping the City). This concept is reflected in GIS technology and analysis.

Currently there is a shift of our traditional points of urban reference and view due to this gathered information that affects our notions of the physical space (Sant, 2004). One example is the mobile devices that allow people to create and share localized experiences in different urban areas that result in the creation of multiple layers of information that could highlight information about the city that was unknown before (Jagdish, D. Re-Mapping the City). One of the interesting examples is a WAZE map (see Figure 4) that adds a dynamic and interactive layer that assist in navigating in diverse known/unknown environments, follow users recommendation regarding the best short way of getting to a chosen location or directing the drivers into a non-congestion rout.

Figure 4: A diverse perception of mental maps (from: http://www.technologyguide.com/news/google-set-to-purchase-waze-traffic-app-for-over-1-billion/waze-screenshot/)

8. Concepts for New Mapping

Traditionally the general grid map is seen as a way of putting together geographical imagination alternatives, as any other authoritative and functionalistic map (Phillips, 1997 in Caquard, 2013), or as several researchers argue, a cartography envisions mapping as a conceptual framework to improve our understating of the narrative development of a story (Moretti 1999; Bulson 2007). The new technological trends contribute greatly to the development of new concepts for mapping systems that mainly serve as a basis for theory and research development, in several directions such as: concepts based on story maps, emotionally based maps, environmental analysis based maps, and location based maps.

Figure 5: The literary road trips map created by Kreitner and Melendez. (from: http://www.atlasobscura.com/articles/the-obsessively-detailed-map-of-american-literatures-most-epic-road-trips)
Robert MacFarlane (2007) introduced the concept of “story maps” for describing diverse forms of spatial expressions that embody both our personal experiences of the environment and contribute to creating a deep understanding of urban places. One example for a “story map” is the literary road trips map created by Richard Kreitner and Steven Melendez, (2015). They have developed an interactive map of literary road trips, adding quotes and notes about specific places from the books they followed. The map includes every place-name reference from 12 books about cross-country travel, stories beginning with Mark Twain’s book “Roughing It” (1872) and up to Cheryl Strayed’s book “Wild” (2012). They mapped each authors’ routes on top of one another. The purpose of this map is to enable people who would like to follow the books’ trip by their own car, making all the pertinent stops along the way. An alternative way is to follow the road trips virtually. (see Figure 5).

Another mapping concept is the “emotionally based mapping”. It includes the development of emotionally charged maps and geo-visualizations for better understanding places and to mobilize ways of actions (Aitken and Crane 2006; Kwan 2008; Dodge et al. 2009; Nold 2009; all in Caquard, 2013). It includes mapping of personal feelings and emotions over different issues (Coulis 2010). This practice of mapping emotions was developed as a way to politically engage different communities and individuals in their processes of reclaiming back some control over their neighborhoods and place of living (Nold 2009). The environmental quality based map represents measurements of urban environmental qualities and show the results over geo-mapping systems, for example: walkability, (Lee, and Moudon, 2006); urban vulnerability and security (Shach-Pinsly and Ganor, 2014) visibility (Batty, 2001).

The emerging technology development enables the “location based maps”. The location based map have become essential research focus in knowledge representation for pervasive computing. For example: service ecologies, that use location based maps had become a prominent research concern, both in urban design and in web design (McCullough, 2007); and location based maps and interactive maps for tourists (Zipf, 2002); Mobile network operators can easily use customer information based on end users’ location and tailor services based on personal preferences.

9. Activity space

One of the issues that connect ICT; social networks; travel; technological trends; urban form and mental maps are the activity spaces. An activity space is that part of the environment that a traveler uses for his/her activities (Schönfelder, & Axhausen, 2003). Or as Lynch (1960) described it, it can also be thought of as an approximation of the mental map of the traveler (Schönfelder, & Axhausen, 2003). Harding, et. al., (2014) noted that activity spaces, as a travel-behavior indicator, differ in the way they represent the spaces where households interact in the cities, to where there is a potential for interaction. Many researchers argued that activity spaces are a representation of the area covered by an individual or household during the course of their habitual travel. (Buliung and Kanaroglou, 2006; Dijst, 1999; Fan and Khattak, 2008; Kamruzzaman and Hine, 2012; Manaugh and El-Geneidy, 2012; Schönfelder and Axhausen, 2003 in Harding, et. al., 2014).

The mental map emphasizes the spatial knowledge about activity opportunities and their relative positions and connections in the environment, while the activity repertoire looks at the type, quality and costs of different activities or activity types at different locations. In a wider sense, the mental map comprises both those locations in which a traveler has a personal experience (activity space), as well as those in which the traveler has second hand experiences through family, friends, books, films or other media (the knowledge space) (see e.g. Horton and Reynolds, 1971; Dürr 1979 or Goldenberg, Libai and Muller, 2001 in Schönfelder, & Axhausen, 2003).
The study of activity in a context has become a central focus of interaction design (see figure 6). It had also formed a recent paradigm shift in its own right (McCullough, 2007).

Figure 6: From: (McCullough, 2007).

Scheiner, et al., (2006) added that activity spaces contribute to present theoretical considerations on the interconnections between life situation, lifestyle, and choice of location, as well as empirical results on the basis of path analyses. This indicates that lifestyles influence activity spaces even when the life situation is controlled, but, the impact of life situation on activity spaces is higher than the impact of lifestyle.

Recently, there is a new growing interest in understand the non-work travel behavior of individuals and households, and expanding this interest by using an additional dimension of mobility: the activity spaces (Harding, et. al., 2014). A question resulted from this idea is: what is the size of a person's activity space? Schönfelder & Axhausen, (2003) argue that the main driver of the size of the activity space is the overall number of unique locations visited by the respondents and to a lesser extent, their socio-demographic characteristics. They pointed out that the size of the area is an indicator for the dispersion of visited locations and may be used to compare the dispersion between travelers or of one respondent on different days of the week.

During the 1970's two important developments emerged from this growing interest, influencing what later was developed into the Activity – Based travel approach: Chapin theories on human behavior, and Hägerstrand (1970) time-space geography theory. Chapin (1974) places human behavior as driven by needs, satisfied through activities. Two groups are defined: Subsistence needs (food, shelter, sleep, etc.) and socio-cultural needs. As suggested by Fox (1995, p.107): “individuals are first motivated to act, they then make a choice, and finally they act”. Hägerstrand developed at the same time his “time-geographic approach”, which contradicts Chapin. Rather than needs, at the core are three groups of constrains which affect an individual activities:

A. Capability constrains: These are limitations based on fulfilling physical needs (such as sleep, eat, etc) and time per each activity, influenced by mode of transport.

B. Coupling constraints: These limitations are based upon joint activities and their implications (such as joint schedule, locations available for the joint activity, etc)
C. Authority constraints: These are based upon accessibility, and who authorizes to permit it (for example shopping center opening hours, or entry to a private domain.

As seen at the diagram (Figure 7), activities 1, 2 and 3 are assumed to follow a regular time-table; 1 is attached to some fixed installation and 4 represent a telephone call, a coupling which needs no transportation by the person but takes away time from other activities.

![Figure 7: The web of individual paths in a space/time representation (Hägerstrand 1970)](image)

**Measuring Activity Spaces**

The early literature in transport and geography on activity spaces was based on cross-sectional data for groups of respondents (Kutter, 1973; Zahavi, 1979; Beckmann, Golob and Zahavi, 1983a,b; Holzapfel, 1980; Scheiner, 2001, Dijst, 1999, in Schönfelder & Axhausen, 2003). Currently, due to technology advancement, there is a major shift in the way that data is collected and analyzed by adding the technology of mobile phone data (Järvi, et. al., 2014); geocoding and GIS data and measurements (Schönfelder & Axhausen, 2003), ICT (Sclater, & Lally, 2014), Virtual world technology (Sclater, & Lally, 2014), and additional technology based tools.

Harding, et. al., (2014) obtained that when measuring the activity spaces of people or households, there is an assessment of spread or dispersion. They noted that the measures can be generated using diverse GIS tools and geometries, such as road-network buffers, minimum convex polygons (MCP), or standard deviational ellipses (SDE). Schönfelder & Axhausen, (2003) emphases three measures for an activity space size: 1) A two-dimensional confidence ellipse (interval) around a suitably chosen center point; 2. The activity space, measures by using information about the locations; 3) based on the idea of minimum spanning tree (network), the length of the minimum
distance routes between the locations visited, or the area covered by a buffer around those routes. Regarding the size of the activity space, it can be measured as: a) the number of cells were the density exceeds a certain threshold (i.e. > 0); and b) reduced by areas usually not open for regular activities.

McCray & Mora, (2011) measured data through observation, discussions, socioeconomic surveys, activity records, safe/unsafe area mapping, and perception-of-violence surveys. The analysis of the activitie spaces uses variety of tools: for example, McCray & Mora, (2011) used a repeated measures mixed regression model, rearranged data in SAS using PROC MIXED to create a stacked data set; GIS tools, ArcGIS, Data from the National Health and Nutrition Examination Survey; questioner asking for each activity entry about: activity location; modal use; accompanying individual (i.e., alone, friends, family, etc.); and when the activity typically takes place. Haybatollahi, et. al., (2015) measures consisted of the number of apartment buildings; the total amount of floor space (m2) of all apartment buildings; the number of single-family or detached houses; and the total amount of floor space (m2) of all single-family or detached houses. They also used density measures based on municipal dataset on building locations and characteristics.

10. Virtual spaces

New technologies create Virtual spaces. This term is generally used to refer to two particular ideas (Wonders, 2010): (1) a reproduction of real space (or fantastic space) within a digital environment, for example, Second Life (https://instagram.com/) or games etc; (2) an abstract space that exists in our mind, deliberately defined as a space and consists of virtual “thinking” processes that take place in a realm world that is difficult to materialize or describe objectively (https://martaco.wordpress.com/2010/06/13/484/). There are additional definitions for example: virtual space is a term that indicates an environment where people can interact. A virtual space can be a 3D virtual world like World of Warcraft (http://eu.battle.net/wow/en/), or an Internet forum (Minocha and Reeves, 2010). Sköld, (2011) noted that the notion of virtual space is used as an umbrella term for similar concepts such as virtual learning environment (VLE), virtual world (VW), collaborative virtual environment (CVE), multi–user virtual environment (MUVE) and game space. Virtual space is also conceptualized as a cultural artifact whose production, consumption, and modes of usage are intimately connected to the cultural sphere (Williams, 2007). It can also be connected to mental maps.

Several researchers examine virtual spaces in relation to mental maps and urban environments. For example, Apostol, et. al., (2013) introduced the practice of flanerie, characterized by Baudelaire as a "gentleman stroller of city streets" (Shields, 1994), in the physical and virtual space as a method to produce representative images of contemporary social life.

In this era individuals and organizations live in ‘multiple spaces’ incorporating the physical, electronic, and virtual worlds, which are creating numerous new socioeconomic opportunities and challenges. From a social perspective, the new virtual worlds represent the frontier of social media and social computing, therefore, we need to understand their implications for policy and for our society as a whole (Li & Bourlakis, 2010). For example, research on eBay presents eBay as a space where consumers' imaginations are stimulated.

11. Understanding the cultural dimensions of social media spaces.

McCullough (2007) noted that places are not only passive containers, but are indeed the very expression of cultures. Arora, (2012) broaden this notion and suggested a framework that captures the cultural dimensions of new media spaces based on five typologies: 1) utilitarian-driven 2)
aesthetic-driven, 3) context-driven, 4) play-driven, and 5) value-driven. This framework transfers mapping of diverse actors and networks from the real world to the virtual space to capture and organize diverse cultural aspects. This framework allows exploring online spaces transformed into physical place, serving as spatial metaphors, for unraveling social relations, histories, and attitudes. The following Figure 8 summarizes this framework.

<table>
<thead>
<tr>
<th>TYPES OF SPACE</th>
<th>PLACE AS METAPHOR</th>
<th>VIRTUAL SPACE ISSUES/FOCUS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Utilitarian-driven</td>
<td>highways</td>
<td>information infrastructures, digital divide, online traffic, virtual communities, shared space, convergence</td>
</tr>
<tr>
<td>2 Aesthetic-driven</td>
<td>homes</td>
<td>customization, personalization, ownership, taste, private versus public space</td>
</tr>
<tr>
<td>3 Context-driven</td>
<td>parks</td>
<td>cyberleisure, social network sites, situated activity online; gendering online space; online pluralism</td>
</tr>
<tr>
<td>4 Play-driven</td>
<td>playgrounds</td>
<td>engagement, interactivity, corporate blogging, work-play, hard play, gaming</td>
</tr>
<tr>
<td>5 Value-driven</td>
<td>museums</td>
<td>emotion, affective spaces, nationalism and online tourism, digital flaneur and browsing, politics of information</td>
</tr>
</tbody>
</table>

Figure 8: Arora, (2012) framework that reveals dominant cultural dimensions of Web 2.0 spaces laying on five typologies. (from: Arora, 2012).

If we take the context-driven space for example, for understanding the transformation of the digital realm as an extension of the real world, we can say that spaces can be grouped according to their location and embedded practice (Lave and Wenger, 1991). Following this notion, urban park spaces can be oriented towards public leisure while school spaces are designed by educational activities. We can also say that the presence of parks is found in every city, were they evoke specific kinds of practices; however, parks in Manhattan differ from parks in Egypt or New Zealand in their usage, perceptions, and layout design. Open spaces in urban areas can get marked as gendered or elite, depending on the kind of demographics consistently fill-in that space. Arora, (2012) concluded that “this framework argues for an organization of these online borders through the aid of how physical structures are constrained and contained...this framework attempts to broad terms and yet ground our conceptualization, by addressing larger networks and online structures and yet grounds it through its specific architectures, cultures, histories, human action and relation within these virtual spheres.”

Brewer and Dourish (2008) also dealt with cultural aspects and the connection to virtual spaces. They argued that when we think about mobility in the environment in social or cultural terms,
different set of topics and issues come into view, such as: pilgrimage and religious practice, migration and cultural identity, globalization and economic differences, and daily commutes and the suburbanization of cities. They pointed out that mobile information technologies are tools that serve to structure the spaces through the way they, and the people who operate them, move. They illustrated how three concerns with mobility and space: 

**legibility, literacy, and legitimacy**, open up new routes for designing, exploring and analyzing the urban environment.

### 12. Conclusions

In this chapter we lay out the building blocks for developing the MIND-Sets concept relating to emerging technologies their impact on mobility, travel behaviour and the user’s mental map. We reviewed concepts, theoretical and empirical studies for understanding the inter-relationships between virtual mobility and physical mobility as mediated by new technologies and perceptions of space and alternative travel options. Mental maps appear to have a central role in activity spaces and virtual spaces as they influence people’s mobility horizons. The following scheme summarizes the concepts and inter-relationships among the various components of the MIND-Sets approach.
References


Jagdish, D. Re-Mapping the City


Mokhtarian, P. (2009). If telecommunication is such a good substitute for travel, why does congestion continue to get worse?. Transportation Letters, 1(1), 1-17.


https://instagram.com/
https://martaco.wordpress.com/2010/06/13/484/
http://eu.battle.net/wow/en/
http://www.slideshare.net/lschmidt1170/mental-maps
http://www.virtuesforlife.com/10-ways-to-spark-creative-thinking/
Chapter 5: A Geographical Approach to Mobility

Mobility mind-sets mapped across Europe

Authors: Berta Carreras
         Oriol Biosca
         Marta Calvet
         Andreu Ulled
         Efrain Larrea

MCRIT
1. Aim of this contribution

The current chapter is aimed at comparing mobility patterns in different parts of Europe: in different geographic areas of Europe and in different types of areas within them.

In this chapter we explore how spatial dynamics influence long-distance mobility patterns across Europe. The work will build upon existing literature, analysis of available data on travel patterns (Eurostat, EU wide transport models etc.), and by a number of case-studies in more detail.

The review will attempt at exploring the contemporary meanings of “distance” and “place”, and elaborating the result as “Mobility mind-sets mapped out across Europe”.

Preliminary indications to refine and update transport models at European scale will be provided in the latest stage of the task.

2. Methodological approach

General review of the spatial dimension of European mobility mind-sets

The review gets started by identifying a number of relevant mobility mega-trends, existing or upcoming:

- Social developments leading to mobility flows: labour migrations (east to west and south to north), retirement migrations (north to south), tourism mobility (internal and external tourism), cross-border commuting, long-distance commuting.

- Social values linked to mobility: e.g. use of green modes, use of diverse sharing formulae, car ownership decrease, mobility decoupling from economy.

This review is undertaken based on the identification of major trends in the literature, and their territorial differentiation using maps and charts.

Analysis of European borders: new meanings for the word “distance”

State-of-the Art transport models consider “distance” between places as “impedance functions” measured as "generalised cost functions”. Because of the cultural fragmentation of Europe, some European models introduce somehow “cultural” or “political” factors in the generalised cost functions, often as an additional parameter used in the calibration process. This approach however is not a complete answer to mobility because not all international relations are affected equally by the presence of a border.

The analysis of “cultural distances” carried out not just at European level but at global scale may bring new useful insights for European transport models.

Work is initiated with a review of literature on cross-border mobility (e.g. ESPON Metroborder, Interconnect FP7, Origami FP7, TEN-CONNECT....) to identify main patterns described by other studies and to assess orders of magnitude estimated up to date in relation to the size of cross-border mobility in different locations: between internal borders, in external borders, in intra-regional borders, in different areas of Europe.

Secondly, a collection of maps representing “cultural proximities” in Europe is elaborated integrating multiple sources, and covering all relevant factors:

- Geographical (e.g. landscape, mountains...)
- Political (e.g. related to former political borders...)
- Historical (e.g. related to the rest of the world, the colonisation period...)
- Religious
- Linguistic
Thirdly, an analysis of international travel behaviour is performed based on quantitative data available. Two main databases are exploited at European level:

- Intra-European travel at regional level, between European NUTS3 including a number of neighbouring countries (TRANS-TOOL transport model OD matrixes)
- Intra- and extra-European air travel from and to European airports (EUROSTAT)

Outcomes of this data analysis are then contrasted with the findings in the literature, and the main patterns encountered are contextualised in relation to different cultural maps. Based on this, it is then attempted to find patterns and to derive considerations of the implications of such patterns for transport planning, transport modelling and transport policy assessment in Europe.

**Data sources**

All literature references used for the elaboration of this report are included in the section “References”.

**TRANS-TOOL model travel database**

Data based on TRANS-TOOLS, the European official transport model. In particular, data is obtained from INTERCONNECT FP7 study (based on TRANS-TOOLS 2005) and ETIS+ study (based on TRANS-TOOLS 2010).

Data includes travel demand by trip purpose between all European NUTS3 regions, including a number of neighbouring countries. It includes average travel cost and travel time based on shortest-cost assignment algorithms.

It considers 1,443 origins and destinations at NUTS3 level from 42 countries (EU28 countries + EFTA countries + Albania, Belarus, Bosnia-Herzegovina, Makedonija, Moldavia, Montenegro, Russia, Serbia, Turkey, Ukraine, United Kingdom). It considers 2,082,249 OD relations in total.

Originated trips at NUTS3 level are provided in thousands. Returns are not included and need to be considered additionally.

The Graph was developed by INTERCONNECT FP7 study in 2010 based on the union of single separated uni-modal TRANS-TOOLS v2005 graphs. It contains 35,000 nodes and 62,000 links structured according to a complex network topology able to handle transport services.

**EUROSTAT Air Travel database**

Data is obtained from EUROSTAT dataset "Detailed air passenger transport by reporting country and routes". Data availability is form 1993 to 2014. The version used in MIND-SETS is the March-April 2015 update.

The database provides numbers of passengers travelling between airports from 31 European countries and a number of selected representative destinations outside Europe.

All in all, 394 airports are considered as origins (all within the EU28 + Norway, Iceland and Turkey), and 853 airport destinations (62% Europe, 13% Asia, 10% Africa, 9% Latin America and 7% North America).

### 3. General mobility Mind-Sets across Europe

**General magnitudes of European Mobility**

In 2012, there were 6.391 billion passenger km (pkm). Most trips were supported by the road mode (82.4%), of which 74% corresponded to private cars and 8% to buses and coaches. The rail had a modal share of just 8.0%, but increasing (7.8% in 1997), whereas the air mode was the mode to increase more reaching a 9% share (from 7% in 1997). The air mode has grown a +2.6% yearly increase over the last 15 years (in pkm), but road only 0.7% and rail 1.2%. Ferry represents below 1%.
On average, European citizens travelled 11.8km per day\(^8\), with differences across Europe. In general, distance travelled daily was related both to personal income (i.e. wealthier countries tended to travel more) and to core-periphery differences (in general, peripheral countries travelled more, or their trips were longer, e.g. to reach all other areas of the EU). Trip distance data corresponds to 2005.

\(^8\) Data exploitation of INTERCONNECT FP7. INTERCONNECT (2011) was based on TRANS-TOOLS 2005 OD matrixes generated during the TEN-CONNECT II project (2011)
Local trips dominate to long distance trips, both in number of trips and in paxkm

Road trips represent slightly more than 82% of all trips in Europe (in pax-km) (EC 2014). Road trips beyond >3 hours represent only 12% of total trips between NUTS3 according to TEN-CONNECT (EC 2007) based on TRANS-TOOLS database. In fact, close to 70% of all trips in Europe take less than 2 hours to complete.

The INTERCONNECT FP7 study estimated that 91% of all trips in Europe take place within NUTS3 regions (intra-NUTS3). These trips are responsible for 71% of total pax-km travelled in Europe. Logically, trips between different NUTS3 regions are typically longer than trips inscribed within NUTS3.
Long distance transport increases over time

With personal and professional networks growing exponentially, the needs for personal mobility will continue to increase in the future. Virtual mobility will only be able to compensate for a part of such increases: ICTs are already impacting on mobility both by substituting trips (e.g. because of email, teleconferencing) and by inducing new trips (e.g. due to enlarged relations supported by ICT). The net impact is difficult to assess isolated from other social, economic and technologic drivers but on a long-time perspective may increase personal and business mobility patterns. Long-term series show that innovations in telecommunications (i.e. Telegram, Telephone) have had no alteration on mobility increases in the past.

Figure 4- Average length of commuting trips originated in European NUTS3 regions. Source: INTERCONNECT 2011, based on TRANS-TOOLS TRIP OD matrixes 2005

Figure 5- Linked growth of transport and telecommunications 1800-2000. Source: “Anthropological invariants in travel behaviour”, C. Marchetti, 1994
**Mobility decoupling from economy? Urban mobility towards stabilisation**

In past decades, the aggregate demand for passenger travel has developed roughly in line with per capita GDP and population growth but there are signs according to OECD ITF report (ITF, Discussion Paper 2013 - 09) that this close connection could be weakening in advanced economies, especially in relation to passenger mobility. In particular, car travel volumes in some countries stopped growing or have declined despite continued growth in GDP. Some explanatory factors come from cohort effects, like population ageing, but others like the role played by information and communication technologies are more uncertain. Decoupling is certainly more intense in urban areas than for long-distance transport, partially motivated by new lifestyles of younger generations and partially due to intense urban policies aimed at reducing traffic in city centres (pricing, taxation, parking policy).

**Source:** Eurostat, tables 2.2.2 and 2.3.2

**Notes:**

(1): passenger cars, powered two-wheelers, buses & coaches, tram & metro, railways, intra-EU air, intra-EU sea

(2): road, rail, inland waterways, oil pipelines, intra-EU air, intra-EU sea

GDP: at constant year 2000 prices and exchange rates

**Figure 6- GDP Growth, Passenger-km and Tonne-km Evolution 1995-2012 (Index 1995=100) in Europe. Source: Transport Pocketbook 2014**
Figure 7 - GDP growth and passenger-km evolution linked to fuel prices, 1970-2010 (index 2000=100) in selected economies. Source: OECD International Transport Forum Discussion Paper 2013 - 09
East-west migrations with EU enlargements

A study by the DG Employment in 2011 (Holland et al., 2011) concluded that since the 2004 enlargement, about 1.8% of the EU8 population had moved to the EU-15, raising the host country population by 0.3%. Of this, approximately 75% could be attributed to the enlargement process itself. Since 2007, about 4.1% of the EU-2 population moved to the EU-15, raising the host country population by a further 0.3%. Of this, just over 50% could be attributed to the enlargement process itself.

According to the same study, there is clear evidence that the pattern of transitional restrictions in place at the beginning of the 2004 enlargement diverted mobile workers away from traditional destinations – namely Germany – and towards the more easily accessed labour markets in the UK and Ireland. Final transitional restrictions on the free mobility of labour from the EU-8 to the EU-15 were lifted on 1 May 2011. As of June 2011, workers from the EU-2 still faced some restrictions on access to labour markets in Belgium, Germany, Ireland, France, Italy, Luxembourg, the Netherlands, Austria, the UK and Malta. As the existence of support networks for new migrants is one of the most important factors affecting the location decision, any distortion in the distribution of EU-8 citizens across the EU-15 that has resulted from the transitional restrictions is likely to prove permanent.

Figure 8- Migrations from Eastern European countries to Western European countries 1997-2009.
Source: EC DG for Employment, Social Affairs and Inclusion, 2011

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9 Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Slovakia, and Slovenia
10 EU Member States until 1995 enlargement: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden, United Kingdom
11 Romania and Bulgaria
Cumulated migrants from Eastern Europe to Western Europe between 1997-2009

<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>Germany</td>
<td>8.056.003</td>
<td>9,84%</td>
<td>81.902.307</td>
</tr>
<tr>
<td>Spain</td>
<td>5.683.197</td>
<td>12,26%</td>
<td>46.362.946</td>
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<tr>
<td>Italy</td>
<td>4.913.029</td>
<td>8,31%</td>
<td>59.095.365</td>
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<tr>
<td>UK</td>
<td>4.324.533</td>
<td>6,94%</td>
<td>62.276.270</td>
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<tr>
<td>Austria</td>
<td>1.266.386</td>
<td>15,18%</td>
<td>8.343.323</td>
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<tr>
<td>France</td>
<td>931.134</td>
<td>1,44%</td>
<td>64.702.921</td>
</tr>
<tr>
<td>Greece</td>
<td>694.586</td>
<td>6,21%</td>
<td>11.187.085</td>
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<tr>
<td>Belgium</td>
<td>507.045</td>
<td>4,70%</td>
<td>10.796.493</td>
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<tr>
<td>Sweden</td>
<td>452.707</td>
<td>4,87%</td>
<td>9.298.515</td>
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<tr>
<td>Netherlands</td>
<td>368.795</td>
<td>2,23%</td>
<td>16.530.388</td>
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<tr>
<td>Ireland</td>
<td>334.606</td>
<td>7,38%</td>
<td>4.535.375</td>
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<tr>
<td>Finland</td>
<td>244.562</td>
<td>4,58%</td>
<td>5.338.871</td>
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<tr>
<td>Denmark</td>
<td>219.379</td>
<td>3,97%</td>
<td>5.523.095</td>
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<tr>
<td>Portugal</td>
<td>202.661</td>
<td>1,92%</td>
<td>10.568.247</td>
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<tr>
<td>Luxemburg</td>
<td>46.512</td>
<td>9,34%</td>
<td>497.783</td>
</tr>
</tbody>
</table>

Figure 9: Weight of Eastern Migrants 1997-2009 in Western European Countries’ Population in 2009.
Source: EC DG for Employment, Social Affairs and Inclusion, 2011
South-North migrations driven by the 2008-2015 crisis

The economic crisis has affected mobility patterns by redirecting flows away from the periphery, but the crisis has shown the limits of labour mobility potential within the Europe, largely due to the negligible mobility of nationals from large countries hit by the crisis. Spain has significantly produced more emigrants than other Mediterranean countries like Portugal, Greece or Italy, up to 0.5 million in 2013 (even these were partly compensated by some 0.25 million immigrants, resulting in a more moderate migratory balance). These migrations correspond to immigrated population in the times of economic boom now returning to their home countries (circa 85%), and to a much lower extent young population seeking for a carrier abroad (circa 13%). Numbers of national citizens emigrating to other European countries are limited compared to east-west migrations in the 2000, indicating that population mobility in Europe is still relatively low. Whereas 30 million eastern Europeans moved to another European country between 1997 and 2008, only around 1 million have emigrated from Mediterranean countries to other European countries between 2009 and 2013. According to a recent CEPS paper, in order to improve mobility in the longer term, a number of unresolved issues should still be addressed, namely an easier recognition of labour skills across Europe (university degrees, professional training...) and new impetus to the ‘mother tongue + two foreign languages’ objective of the EC.

![Evolution of the External Migration of Greece, Spain, Italy and Portugal (2008-2013) in Cumulated Emigrants. Source: Eurostat 2015](image1.png)

(* ) Spanish emigrants correspond in 85% to immigrants arrived in the 2000 returning to their origin country

North-south migrations linked to residential tourism and retirement

Retirement migration to southern Europe is, to a large extent, the result of mass tourism and involves a range of economic, sociocultural, and demographic considerations (Barke and France 1996; King, Warnes and Williams 1998; Rodríguez, Fernández-Mayoralas and Rojo 1998). In spite of the magnitude of tourist flows and the resulting cultural and economic influences in contemporary society, both tourism and tourists are often accompanied by ambivalence, disparagement, and even hostility according to literature (Gustafson, P., 2002).

Still, elderly in Europe are expected to amount 20% in 2020 and almost 30% in 2060 (people aged >64) (Eurostat 2015). Between 2000 and 2050, the proportion of the world's population over 60 years is expected to double according to UNWHO, from about 11% to 22%. Evidence suggests that many of the current generation of older people are keen and frequent travellers (Frye 2015, OECD), having both purchasing power and leisure time (Eurostat 2012). For transport, this means that increasing focus need to be devoted to comfort, convenience and ease of travel, both from and to transport and the convenience with which they can move around the resort or city at their destination.

Figure below quantifies the amount of old migrants in the Spanish Mediterranean coast. In 2009, there were almost 0.5 million permanent residents older than 55 years from other EU15+Norway+Switzerland countries living in the 4 Mediterranean regions, and in the Balearic and Canary islands. This niche of older European immigrants represented a 1.6% of the total overall population in these regions, and in some regions, the share is higher, e.g. Valencia 3.2%; Baleares 2.9%; Canarias 2.5%.

<p>| Table 2. Población extranjera mayor de 55 años: distribución geográfica, 2009 |
|----------------------------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|</p>
<table>
<thead>
<tr>
<th></th>
<th>Andalucía</th>
<th>Baleares</th>
<th>Canarias</th>
<th>Cataluña</th>
<th>C. Valencia</th>
<th>Murcia</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>110.566</td>
<td>37.638</td>
<td>62.513</td>
<td>71.589</td>
<td>181.746</td>
<td>23.153</td>
<td>487.307</td>
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<td>Europa</td>
<td>95.380</td>
<td>31.937</td>
<td>53.087</td>
<td>38.401</td>
<td>166.893</td>
<td>19.008</td>
<td>404.706</td>
</tr>
<tr>
<td>UE</td>
<td>91.098</td>
<td>30.875</td>
<td>50.370</td>
<td>33.765</td>
<td>153.192</td>
<td>17.992</td>
<td>377.292</td>
</tr>
<tr>
<td>Reino Unido</td>
<td>49.941</td>
<td>8.265</td>
<td>15.898</td>
<td>5.164</td>
<td>81.634</td>
<td>12.811</td>
<td>173.713</td>
</tr>
<tr>
<td>Francia</td>
<td>3.550</td>
<td>2.530</td>
<td>1.779</td>
<td>6.612</td>
<td>6.928</td>
<td>671</td>
<td>22.070</td>
</tr>
<tr>
<td>Italia</td>
<td>3.177</td>
<td>2.250</td>
<td>5.004</td>
<td>5.373</td>
<td>3.968</td>
<td>309</td>
<td>20.171</td>
</tr>
<tr>
<td>Bélgica</td>
<td>2.720</td>
<td>604</td>
<td>1.759</td>
<td>1.492</td>
<td>6.364</td>
<td>316</td>
<td>13.255</td>
</tr>
<tr>
<td>Noruega</td>
<td>1.652</td>
<td>109</td>
<td>1.399</td>
<td>77</td>
<td>5.993</td>
<td>264</td>
<td>9.494</td>
</tr>
<tr>
<td>Suiza</td>
<td>684</td>
<td>724</td>
<td>1.033</td>
<td>1.592</td>
<td>4.969</td>
<td>130</td>
<td>9.332</td>
</tr>
<tr>
<td>Finlanda</td>
<td>3.506</td>
<td>113</td>
<td>716</td>
<td>89</td>
<td>1.380</td>
<td>105</td>
<td>5.909</td>
</tr>
<tr>
<td>Dinamarca</td>
<td>3.967</td>
<td>257</td>
<td>410</td>
<td>220</td>
<td>902</td>
<td>93</td>
<td>5.519</td>
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<tr>
<td>Portugal</td>
<td>1.784</td>
<td>204</td>
<td>583</td>
<td>1.104</td>
<td>747</td>
<td>212</td>
<td>4.634</td>
</tr>
<tr>
<td>Irlanda</td>
<td>1.364</td>
<td>140</td>
<td>541</td>
<td>183</td>
<td>2.137</td>
<td>160</td>
<td>4.545</td>
</tr>
<tr>
<td>Austria</td>
<td>381</td>
<td>404</td>
<td>1.206</td>
<td>220</td>
<td>648</td>
<td>55</td>
<td>2.914</td>
</tr>
<tr>
<td>Grecia</td>
<td>58</td>
<td>25</td>
<td>55</td>
<td>91</td>
<td>66</td>
<td>8</td>
<td>302</td>
</tr>
<tr>
<td>Luxemburgo</td>
<td>63</td>
<td>27</td>
<td>50</td>
<td>58</td>
<td>70</td>
<td>15</td>
<td>283</td>
</tr>
<tr>
<td>UE15 + Noruega y Suiza</td>
<td>90.486</td>
<td>30.346</td>
<td>51.981</td>
<td>30.436</td>
<td>165.942</td>
<td>17.539</td>
<td>376.730</td>
</tr>
<tr>
<td>%</td>
<td>24</td>
<td>8.1</td>
<td>13.8</td>
<td>8.1</td>
<td>41.4</td>
<td>4.7</td>
<td>100</td>
</tr>
</tbody>
</table>


Figure 13: Foreign population older than 55 years old: geographical distribution, 2009. Source: Instituto Nacional de Estadística; Padrón Municipal de Habitantes, 2009

North-South tourism on the rise

Tourism is a big business worldwide, with 1 billion international tourist arrivals per year forecasted to rise to 1.5 billion per year by 2020 according to UNWTO. The OECD estimates that tourism directly contributes in OECD countries, on average, around 5% of GDP, 6% of employment, and 21% of exports of services. When considering the total impact of tourism, including direct, indirect and
induced impacts, tourism represents around 9% of GDP and employment (OECD 2014). Leading tourism countries in Europe are France with 84.7 million visitors in 2013 (global leader), Spain with 60.7 million, Italy 47.7 million, Turkey 37.7 million, and Germany and the UK with 31 million each. The numbers of growing tourists are a challenge both for transport networks (especially airports) and for social accommodation of larger volumes of tourist in a number of concentrated top tourist destinations.

<table>
<thead>
<tr>
<th></th>
<th>2013</th>
<th>13/12 %</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 France</td>
<td>84.7</td>
<td>2.0%</td>
</tr>
<tr>
<td>2 United States</td>
<td>69.8</td>
<td>4.7%</td>
</tr>
<tr>
<td>3 Spain</td>
<td>60.7</td>
<td>5.6%</td>
</tr>
<tr>
<td>4 China</td>
<td>55.7</td>
<td>-3.5%</td>
</tr>
<tr>
<td>5 Italy</td>
<td>47.7</td>
<td>2.9%</td>
</tr>
<tr>
<td>6 Turkey</td>
<td>37.8</td>
<td>5.9%</td>
</tr>
<tr>
<td>7 Germany</td>
<td>31.5</td>
<td>3.7%</td>
</tr>
<tr>
<td>8 United Kingdom</td>
<td>31.2</td>
<td>6.4%</td>
</tr>
<tr>
<td>9 Russia</td>
<td>28.4</td>
<td>10.2%</td>
</tr>
<tr>
<td>10 Thailand</td>
<td>26.5</td>
<td>18.8%</td>
</tr>
</tbody>
</table>

Source: UNWTO.

FIGURE 14- TOP 10 GLOBAL TOURIST DESTINATIONS IN 2013. SOURCE: OECD-ITF DISCUSSION PAPER 2015 – 15

Tourism habits differ across Europe. Figure below suggests that whereas largest southern European countries use generally domestic tourism (e.g. 90% Greece, 88% Spain, 83% France, 82% Poland, 77% Portugal, 75% Italy), Northern European countries have a larger trend towards international intra-European tourism: 61% in Belgium, 57% in Ireland, 50% in Denmark, 47% in the Netherlands, 43% in Germany, 43% in Germany, 42% in the UK.

Besides from traditional “sun” tourism, there is an increasingly large number of northern Europeans that are moving south in search of what they perceive as a better quality of life. The typical representation of this form of migration suggests that it is consumption-led, tourism-related and leisure-based; it is to be located within late modern, global, elitist, borderless and highly mobile social practices. (Torkington 2012).


Source: Eurostat, Statistics in focus (in the following ‘SIF’) 18/2004, How Europeans go on holiday, p. 2 (and own compilation). n.a. EE, NL, MC, CY.
Decreasing car ownership
After rising almost continuously since the end of WWII, the motorisation rate in Western-European countries has started a decline since the 2000, with a start before the crisis suggesting economics is not the only cause. This is becoming increasingly important in largest European cities. Between 2005 and 2014, the number of cars per 1,000 head of population has declined in Paris by 9%, in London by 8%, and in Munich (home of BMW and Audi) by 16%. As public transport increasingly offers performing internet connection people begin considering it more attractive than stragglings in car congestion as they commute from and to work. Car ownership becomes less attractive, especially for younger generations. Still, clear differences seem to pop in different areas of Europe, besides the urban and rural dimension. Car ownership decreased in Europe before the crisis mostly in more economically performing regions, while continued to increase in lagging economies in the South and East of Europe.

![Figure 16- Changes in car ownership 2000-2007 (car / 1000inh) – Pre-crisis period. Source: Eurostat 2015](image)

Increased preference for rail and soft modes
Rail modal share is generally greater in central Europe that in other areas. Map below shows rail modal share at regional level based on trips between different NUTS3 regions\(^{12}\), depicting high levels of ridership in Switzerland, Austria, Hungary, the Netherlands and Belgium, as well as some areas of Germany and France, and some larger metropolitan regions across Europe. Eurostat statistics at national level based on tripkm (taking also into account urban mobility supported by metro and tramway) corroborate this picture, with Switzerland having 18.1% rail share, Austria 15.5%, Hungary

\(^{12}\) Exploitation of TRANS-TOOLS v2 data corresponding to 2005, from projects TEN-CONNECT II (EC 2009) and INTERCONNET FP7 (EC 2011)
13.0%, Netherlands 11.2%, but also Czech Republic with 17.3% and Romania with 11.7%. At the other edge of the spectrum, peripheral countries, especially smaller ones, or countries with geographical constraints (islands and mountains) show significantly lower rail modal shares: Greece 2.1%, Ireland 3.1%, Portugal 5.2%, Finland 5.8%, Spain 7.1%.

**FIGURE 17** - Rail modal share in trips originated in European NUTS3 regions (% trips in rail). Source: TEN-CONNECT II (2009) based on TRANS-TOOLS TRIP OD matrixes with base year 2005

**FIGURE 18** - Modal shares in European countries in 2012 (% tripkm). Source: Transport Pocketbook 2014
Use of shared mobility solutions: Car sharing
Economics is becoming less about ownership and more about access, younger generations becoming less interested purchasing and more in renting and sharing (CSIRO 2012). Consumption identified with environmentally sensitive goals is also on the rise. As “Green” becomes a business and a consumption good, corporations, not governments, are driving the push toward sustainability (Bakas 2006). Users of car-sharing are increasing annually in Europe. In 2006 there were 0.36 millions of users whereas 8 years later, on 2014, in Europe there were 4.95 millions of car-sharing users (STATISTA). Germany had by far the highest number of vehicles owned by car sharing companies, followed by France and the United Kingdom. In the Netherlands there were 2,300 car sharing vehicles in 2014.
Use of shared mobility solutions: Bike sharing

Bike ridership has experienced sharp growth over the last 10 years, with municipalities across Europe promoting bicycle as a way to enhance mobility, alleviate congestion, reduce air pollution, boost health, support local businesses, and attract more young people. There are currently more than 500 cities in 50 countries hosting bike-sharing programs. In Europe, prominent cases include Copenhagen (now targeting to increase the % of commuting trips on bike from 36% to 50%), Lyon (who's system in 2005 resulted on 44% increase in bicycle ridership according to local authorities), Paris with a similar impact, London, Barcelona, among many others. In 2012, Spain leaded the world with 132 separate bike-share programs, Italy had 104, and France, 37. Bike sharing experiences have lead to the extension of the concept towards car sharing systems across a substantial number of cities.
4. Analysis of European borders: new meanings for the word “distance”

Limited cross-border mobility in Europe

It is frequent perception that cross-border mobility is set to increase with Schengen agreements. D.Ralph (2014) reminds how the 2006 study by the influent UK based think tank Centre for Future Studies (CFS 2006) -Social Demographics in 2016- anticipated the number of cross-border ‘Euro-commuters’ by 2016 would rise to millions taking advantage of the removal of mobility and labour market barriers between European countries.

Labour mobility, though, is low in the EU despite public perceptions, particularly within the euro area. The TEN-CONNECT study (EC 2009) concluded based on 2005 data of TRANS-TOOLS model\(^\text{13}\) that international traffic in Europe represented less than 10% of all passengerkm in Europe, and that cross-border traffic (between regions located on both sides of the same national border) represented less than 0,1%. The 2010 transport data from ETISplus project (used for calibration of TRANS-TOOLS v3) provides a similar order of magnitude for international travel in Europe but assessed cross-border mobility up to 1,1%. The EC’s (2011) report Mobility in Europe (based on analysis of 2010

\(^{13}\) TRANS-TOOLS is the official DG Move and JRC transport forecast model. It is an EU-wide 4-step generation, distribution, mode choice and assignment transport model, calibrated with EU statistical data. Currently available TRANS-TOOLS is v2.5 and runs on a 2005 calibration. TRANS-TOOLS v3 is under development and will run on a 2010 calibration based on ETISplus OD mobility data.
European Labour Force Survey) found that 0.7% commuted across European state borders for work, but with several hot focus which much higher activity (9% of Lorraine in France commuted to Luxemburg or Germany; or 8% of Alsace commuted to Switzerland).

As they have become more numerous over time, cross-border workers have made visible the complex construction of transnational norms by the EU that seek to reduce the legal barriers and inequal treatments that are a natural outgrowth of heterogeneous national institutional frameworks. Although EU-wide intervention grants special status to this category of workers and limits the risks of discriminatory treatment in terms of access to social benefits, attempts made by some member-states to renationalise these benefits reveal the fragility of EU guarantees. (Batal,L., Delteil,V., 2012).
Low border permeability also affects economic activities. Despite European single market for goods being a reality for 20 years, in case of services there is no real and effective single market yet. Services represent the 75% of aggregate GDP of EU27, around 9 trillion euro in 2011; however less than 0.7 trillions are traded through the EU borders, namely 7.4%. (Santagostino, A., 2012).

The EC Mobility in Europe report argued that between 2004 and 2007 (along with the 2 waves of EU enlargements) the numbers of commuters moving between new EU12 states and older EU15 states increased, resulting in 40% increase in Euro-commuting figures, from 0.5% in 2004 to 0.7% in 2007 and to almost 0.8% in 2010.

**Holiday and business trips dominate European international travel**

Trips for holidays have top shares of international travel with 20.9% of all paxkm (1.6% corresponding to cross-border and 19.3% to long-distance); whereas business trips have 13.3% international travel measured in paxkm. On the other hand, international commuter trips represent less than 2% and for private purposes (e.g. visiting relatives, friends...) represent close to 5%.
Figure 25- National, international and cross-border travel in Europe 2010 by trip purposes (based on PAX*km). Source: ETISPLUS data

Air traffic still dominated by domestic air routes

Air transport is dominated in Europe by domestic relationships, compared to international intra-European transport, for equivalent trip lengths and equivalent population of origin and destination city pairs. For instance, despite Lyon in France and Bilbao in the Basque Country being similar in size (1.32 million inh. in Lyon for 0.97 million in Bilbao) and both being located 600km far from Barcelona, air passenger flows between Barcelona and Lyon are just 60% as large as air flows between Barcelona and Bilbao (294,000 to 507,000 trips in 2013). This phenomenon is constant in the analysis of many different European city pairs. For example, air trips from Paris, for the range of 400 to 1000km, are circa 50% busier for domestic destinations than for European ones.

This is obviously not a surprise. The flow difference between these 2 city pairs is the result of political, language (and cultural to some extent) borders and its magnitude can be attributed to the “cost of European borders” or “cost of European integration gaps”.

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This project has received funding from the European Union’s Horizon 2020 research and innovation Programme under grant agreement No 640401.
Limited border permeability at local level is greater in central Europe

Border areas obviously tend to have higher shares of international trips than inland regions but not all border areas have as much international travel as others. In general, border permeability is higher in those regions that share the same language across the border (e.g. Germany with Austria, Switzerland, Luxemburg,...Galicia in Spain with Portugal) or that share a same cultural or political heritage (e.g. many areas in central and eastern Europe).

The figure below depicts formalised cross-border regions in Europe (Perkmann,M, 2003). Out from almost 75 cross-border regions existing in 2003, more than 40% used the German language; German speaking cross-border regions were also much more active than others in Europe, representing 60% of high intensity cooperation cross-border regions..
border regions in Europe, even compared to other German neighbours further in the east like the Czech Republic and Poland.

In fact, international cross-border mobility in Europe is significantly higher in Central Europe than in Northern Europe and the Mediterranean. Capitals and largest metropolises obviously get greater shares of international mobility as well.

**Figure 28:** Share of commuting trips originated in NUTS3 regions and bound to foreign countries (measured in % trips). Source: Exploitation of TEN-CONNECT II data (2011) based on TT2005

**Figure 29:** Share of cross-border commuting trips across Europe. Source: Exploitation of TEN-CONNECT II data (2011) based on TT2005
Language, cultural and historical heritage behind most cross-border mobility highlights

The next three figures portray patterns of international mobility which outstand being substantially more intense than others. The case of Latvia shows that historical and political heritage matters a lot in mobility patterns, with important mobility relations between major Latvian cities (e.g. Kaunas) even outside the EU with Belarus, Ukraine and Russia. The case of Porto shows that common language and cultural backgrounds increase the magnitude of cross-border relations, in this case with the Spanish region of Galicia (but not with other neighbouring regions in Spain like Castile). The case of Malmö and the region of Scania in Sweden shows how institutional and infrastructure promotion can increase the magnitude of cross-border relations, in this case with Copenhagen in Denmark.
Many sociologic elements may represent underlying factors for increased or decreased relationship of regions across borders. Just a few of them are presented below in a synthesis of “cultural maps” of Europe.

**Language borders** do not fit political borders in Europe, even despite the “nation state” having taken root. Maps of language borders are the result of all historical movements of populations and do no represent any administrative country borders. French is spoken across France, but also in Belgium and Switzerland. Austrians speak German but after the fall of the Austro-Hungarian multi-national and multi-lingual empire and after the “independence” of many of its nation states, left linguistic minorities all over the continent. All these historical facts promote areas of high intensity cooperation and mobility across borders.

Europe is a home for many **religions** though the traditional religions are Judaism, Christianity, and Islam, whereas Christianity is dominated in all Europe. The three major groups of Christianity are orthodox in eastern countries, Catholics in western countries, and protestant in the centre and north.
Different religious trends have shaped diverse political alliances along history, cultural affinities and differences across the continent, and consequently, areas of more intense relationship than others.

**Figure 33 - Religions of Europe, beyond political borders. Source: Eupedia.com**

The genetic history of Europe is complicated because European populations have a complicated demographic history, including many successive periods of population growth and decline, and many internal migratory movements. The history must be inferred from the patterns of genetic diversity across continents and time. The Genetic Map of Europe shows that we’re all not that different after all, and puts into light the artificiality of political borders.

**Figure 34 - Genetic map of Europe, beyond political borders. Source: Eupedia.com**

Europe has always been full of stereotypes. It is to some extent fun and fascinating to see how the different preconceptions differ from one country to another. French are said to be snob, Brits well mannered, and Germans hardworkers... All these stereotypes and misconceptions don’t learn us
much on our European neighbours, as they most of the time tend to be false, but they learn us more on the perceptions and the way we tend to see the others. Stereotypes show actually that Europeans need to develop an image of their neighbours.

The case of cross-border mobility in Germany

Germany is a paradigmatic case, showing a strong diversity of patterns all across its borders. On the western regions there are relatively high levels of mobility between Germany and countries like France, Switzerland or in the Benelux countries. Regions in the western and southern borders of Germany maintain historical bondages with their neighbouring regions (e.g. with Alsace and Lorraine in France), and share in many occasions the German language. It hosts some of the most active cross-border regions in Europe in terms of commuting traffic (ESPON METROBORDER, 2010), namely the Luxembourg region (Germany-Belgium-Lux-France), Basel-Moulouse, Aachen-Liège-Maastritch, Saarbrücken, and Strasbourg. They also concentrate the largest amount of formalised cross-border cooperation areas (inscribed in the Association of European Border Regions - AEBB), more specifically 15 out of 22 regions.
On the other hand, cross-border mobility relations in the eastern border are almost inexistent (commuters, personal mobility, purchases...), with countries like Poland or Czech Republic, despite
former relations of Eastern Germany with neighbours at the times of the iron curtain. The analysis of trips originated in Polish cities close to the border like Wroclau shows very low flows towards Germany or the Czech Republic (according to TRANS-TOOLS data 2005), similarly to trips originated in Prague or trips originated in Berlin. Borders show up as strong barriers.

**RELEVANT EXAMPLES OF INTENSE CROSS-BORDER PERMEABILITY IN THE WESTERN AND SOUTHERN BORDERS OF GERMANY**

**EXAMPLES OF LOW BORDER PERMEABILITY IN THE EASTERN BORDERS OF GERMANY**

**FIGURE 38- DESTINATION OF TRIPS IN GERMAN AND FOREIGN CITIES LOCATED CLOSE TO GERMAN BORDERS. SOURCE: EXPLOITATION OF TEN-CONNECT II DATA (2011) BASED ON TT2005**
Increasing permeability for extra-EU borders

Growth of global has risen at global level along with liberalisation of rules resulting from GATT and WTO trade rounds over the last quarter of the 20th century. Global trade multiplied by more than 10 times between 1960 and 2005, significantly more than World’s output since the early 1970s (UNCTAD, 2011). Along with this general pattern, the global aerial transport growth has appeared resilient to the 2008-2015 economic shock, and despite the crisis, total RPKs have grown between 2001 and 2011 a remarkable 53%. The air sector still expects an average yearly growth of traffics close to 5% between now and up to 2030, according to both Boeing and Airbus estimates. The growth of Megacities in the World would also motivate that 90% of the long-haul air passengers in 2030 travel between a reduced number of global metropolises.

An increased polarisation of the European territories is expected under prevailing globalization, given that accessibility to intercontinental transport hubs will be determinant for the competitiveness of European regional economies. Major airports and ports in the continent will continue to expand their capacity to achieve even higher economies of scale. Today, just 4 airports concentrate 70% of all extra-EU intercontinental passengers (London Heathrow, Paris Charles-de-Gaulle, Amsterdam Schiphol and Frankfurt am Main); 4 European ports concentrate 60% of the total EU container throughput (Rotterdam, Hamburg, Antwerp and Bremen).
The European economies are becoming, after the crisis, increasingly more interdependent from the rest of the world economies, and extra-EU FDI, trade, or tourism may grow more than between European countries. Trade of EU Member States has already been growing faster with the rest of the World than within Europe since the beginning of the crisis. FDI in 2008 was in many countries almost twice as large outside the EU than in other European countries. With the introduction of the euro, trade imbalances among euro area members widened considerably, even after allowing for permanent asymmetries in trade competitiveness within pairs of countries or in the overall trade competitiveness of individual countries. Intra-euro area imbalances also seem to have become more persistent with the introduction of the euro (Berger, Nitsch, IMF 2010).

![Graphs showing trade in M€ of Companies located in Germany, France, Spain, and UK](image)

**Figure 41 - Intra and Extra-EU imports and exports for Germany, France, the UK and Spain. 1999-2012 evolution. Source: ESPON ET2050 from Eurostat, 2013**

In terms of mobility, the evolution of intra and extra EU trade implies that a number of extra-EU air flows are also growing much faster than intra European flows. Largest intra-European flows correspond in general to domestic relationships (in green in the figure below) like Barcelona-Madrid (5,5Mpx/year), Paris-Lyon (4Mpx/year), Milano-Rome (2,5Mpx/pas). The first international city pair relation is London-Paris (both air+HSR considered), with over 10Mpx/year; but to next 2 are outside the EU. Out for the 10 first international relations, 6 are of European cities with cities outside the continent. There are approximately as many air passengers from London to Amsterdam, than from London to Hong-Kong.

The figure below shows main passenger flows (air+hsr) between major European city pairs, and with other global cities, being greatly dominated by domestic relationships, and without a clear distinction between intra-EU and extra-EU international relationships, at least for busiest corridors. High-speed
rail passenger flows have been estimated based on individual operator data and a number of specialised studies, given that opposite to the air sector, there is little amount of harmonised statistics available.

![Graph showing main passenger flows between European and non-European city pairs.](image)

**Figure 42 – Main passenger flows between European and non-European city pairs (including aviation and HSR flows). Source: Eurostat (air transport) and operator data for HSR services.**

At the largest European metropolises, extra-EU flight matter as much as or even more than intra-EU flights. For instance, after the London-Paris relationship, the 2nd largest flow between London and any foreign city outside the UK is with New York, with almost 3M pax/year and the 3rd largest flow is London-Dubai (2M pax). Only London-Dublin and London-Frankfurt come next. The airport of London is considered an airport specialised in Asia and Oceania and in North America trips. Proportionally (to distance), Asiatic and American traffic are larger than EU traffic from London. This difference can be attributed to the “cost of EU integration gaps”.
Similar effects can be perceived in other European hubs like Paris, Madrid. Paris has a much higher weight of African passenger flows, whereas Madrid serves mostly as a European getaway with Latin America. In both cases, these relationships represent (proportionally to distance) higher volumes of passengers than international intra-EU relationships.
In fact, in their way out of the crisis, European economies are moving to increase their trade with world emerging economies. Companies located in different European countries and economic sectors are taking advantage of the growth of emerging markets differently, based on pre-existing social, economic and cultural links. The European economies may become, after the crisis, increasingly more interdependent from the rest of the world economies than on the internal European market. European foreign policy may become even more difficult, since global national interest may easily diverge.

**Figure 45** - Air trips from Madrid to Main Domestic, European and Intercontinental destinations. Passengers to flight distance relationship. Source: Exploitation of Eurostat data 2015

**Figure 46** – Cumulated FDI stock of European countries in world macroregions, in M€ (2008). Source: Eurostat 2013
5. Conclusions

In first part of this report analysed 12 mobility mega-trends and mind-changers at European level, with focus on their spatial distribution (e.g. how they differ from one area to another in Europe). It explored how spatial dynamics influence mobility patterns across Europe, building upon existing literature and exploitation of available data on travel patterns (Eurostat, EU wide transport models...). In particular, it identified the following:

- **General magnitudes of European mobility**: In 2012, there were 6.391 billion passengerkm (pkm). Most trips were supported by the road mode (82.4%). On average, European citizens travelled 11.8km per day, with wealthier countries and periphery countries travelling more on a general basis.

- **Local trips dominate to long distance trips**: Road trips beyond >3 hours represent only 12% of total trips between NUTS3 in Europe, and close to 70% of all trips in Europe take less than 2 hours to complete.

- **Long distance transport increases over time.** ICTs are already impacting on mobility both by substituting trips (e.g. because of email, teleconferencing) and by inducing new trips (e.g. due to enlarged relations supported by ICT). The net impact is difficult to assess isolated from other social, economic and technologic drivers but on a long-time perspective may increase personal and business mobility patterns.

- **Mobility decoupling from economy? Urban mobility towards stabilization.** The aggregate demand for passenger travel developed roughly in line with per capita GDP and population growth in the past, but there are signs that this trend could be weakening in advanced economies, especially in relation to passenger mobility in urban areas. Mobility policy is proving more efficient in urban areas than otherwise (road pricing, vehicle taxation, parking regulation).
• **East-west migrations with EU enlargements.** Between 2004 and 2011, after enlargement of the EU to Eastern European countries, about 1.8% of the population in new Member States moved to western European countries, raising the host country population by 0.3%. Transitional restrictions in place diverted workers away from traditional destinations like Germany towards more easily accessed labour markets in the UK, Ireland and the Mediterranean.

• **South-North migrations due to the 2008-2015 crisis.** Whereas 30 million eastern Europeans moved to another European country between 1997 and 2008, only around 1 million have emigrated from Mediterranean countries to other European countries during the crisis between 2009 and 2013, showing the limits of labour mobility potential within the Europe, caused still by cultural, language and bureaucratic barriers.

• **North-south migrations linked to residential tourism and retirement.** Elderly in Europe are expected to amount 20% in 2020 and almost 30% in 2060. They are keen and frequent travellers according to evidence, having both purchasing power and leisure time. In 2009, there were almost 0.5 million foreign residents >55 years living in the Spanish Mediterranean coastal and island regions, from other EU15+Norway+Switzerland countries. This niche of older European immigrants represented a 1.6% of the total overall population in these regions.

• **North-South tourism on the rise.** Leading tourism countries in Europe are France with 84.7 million visitors in 2013 (global leader), Spain with 60.7 million, Italy 47.7 million, Turkey 37.7 million, and Germany and the UK with 31 million each. The numbers of growing tourists are a challenge both for transport networks (especially airports) and for social accommodation of larger volumes of tourists in cities. Northern European countries have a larger trend towards international tourism within the EU, whereas Mediterranean countries take vacations locally to a much higher extent.

• **Decreasing car ownership.** After rising almost continuously since the end of WWII, the motorisation rate in Western-European countries has started a decline since the 2000, specially in cities, with a start before the crisis suggesting economics is not the only cause.

• **Increased preference for rail and soft modes.** Rail modal share is generally greater in central Europe that in other areas, Switzerland having 18% rail share, Czech Republic 17%, Austria 15% and Hungary 13% according to Eurostat. At the other edge of the spectrum, peripheral countries, especially smaller ones or countries with geographical constraints show significantly lower rail modal shares: Greece 2%, Ireland 3%, Portugal 5%, Finland 6%, Spain 7%.

• **Use of shared mobility solutions: Car sharing.** Economics is becoming less about ownership and more about access, younger generations becoming less interested purchasing and more in renting and sharing. In 2014 there are in Europe close to 5 millions car-sharing users, Germany being by far the highest scoring country, followed by France and the United Kingdom.

• **Use of shared mobility solutions: Bike sharing.** There are currently more than 500 cities in 50 countries hosting bike-sharing programs. Prominent cases in Europe include Paris, London, Barcelona, with more than 6000 bikes each on use.
The second part of this report attempted at exploring the contemporary meanings of “distance” and “place” by studying the “cost of EU integration Gaps” or the “cost of European borders”. The report came to the following conclusions:

- **International mobility between European countries is still very limited**: less than 5% of all trips, less of 10% of all trip-km. Cross-border mobility between neighboring regions at 2 sides of a political border is even more limited, below 1% of trips. Low border permeability also affects economic activities, despite European single market for goods being in place already for 20 years. Services represent the 75% of aggregate GDP of the EU, around 9 trillion euro in 2011, but less than 0,7 trillions are traded across EU borders, only 7,4% of all services' trade.

- **International travel in Europe is still dominated by holidays** (21% of all holidays pax·km are international) and business (13,3% of pax·km are international). Visiting friends and relatives abroad (personal mobility) does only represent 5%, and international commuter trips do not represent more than 2%.

- **Air transport is dominated in Europe by domestic connections.** For equivalent trip lengths, domestic flight are likely to have up 50% more demand than international flights within the Union (despite Lyon and Bilbao having similar demographics and both being located 600km far from Barcelona, air passenger flows between Barcelona and Lyon are just 60% as large as air flows between Barcelona and Bilbao). This effect is caused by the “cost of European borders” or “cost of European integration gaps”.

- **Daily cross-border mobility is greater in central Europe. Language, cultural and historical heritage behind most cross-border mobility highlights.** Approximately 40% of formalised cross-border regions in Europe in 2003 were German speaking, and they were generally more active than others in Europe. The hot spots of cross-border mobility in Europe (indicating the quantity of labour mobility working in a neighbouring region in another European country) mainly concentrate around German borders with the Benelux, France, Switzerland and Austria, and in other central European countries like Czech Republic or Slovakia. Largest cross-border success stories take place in Luxemburg, Basel, Aachen-Liège-Maastricht, Sarbrüken, Strasbourg, Geneva, Lille, Copenhaguen-Malmö, Vienna-Bratislava.

- **Increasing permeability for extra-EU borders.** Extra-EU passenger flows between city pairs are growing faster in many cases than flows between European cities in different countries. Largest intra-European flows still correspond to domestic relationships like Barcelona-Madrid, Paris-Lyon or Milano-Rome, and out of the 10th busiest international city pair relations, 6 of them are between European cities and cities outside the continent (mostly between London and American or Asian cities). Proportionally (to distance), Asiatic and American traffics are larger in London than EU traffics, African traffics are larger in Paris, and Latin American traffics are larger in Madrid.

- **Transport model logics at EU level are to be reformulated.** State-of-the-Art transport models consider “distance” between places as “impedance functions” measured as ”generalised cost functions”. Generalised cost functions are estimated in economic terms by a function that integrates: “door-to-door travel times” and “value of time by travellers”, travel fees or operational costs, externalities. Because of the cultural fragmentation of Europe, models need to increasingly focus on generation of traffics at global level, i.e. flows between European and global largest metropolises and become complemented by diffusion models at the level of Member States, rather than extrapolating models at regional level on a continental scale. European models transport models need to introduce “cultural” or
“political” factors in their generalized cost functions to better take into account the “cost of EU integration gaps”.


References

Association of European Border Regions in the area of Germany (AEBB) 2015.


ETISplus transport database (base year 2010), linked to TRANS-TOOLS 3. http://www.etisplus.eu/

EC DG for Employment, Social Affairs and Inclusion, 2011.

EEA based on European Metropolitan Transport Authorities (EMTA), 2014, - Modal shares in a number of European metropolises including soft modes (walk, bike) in 2009 and 2012 (% tripkm).

ESPON METROBORDER (2010). Largest European cross-border regions according to the magnitude of international commuting trips.

EUPEDIA (www.eupedia.com)


Eurostat (2013). Intra and Extra-EU imports and exports for Germany, France, the UK and Spain. 1999-2012 evolution, Statistics in Focus, EURSTAT 2013

Eurostat (2014) European economies are specialised in different World regions when it comes to FDI, Statistics in Focus, Eurostat 2014

Eurostat (2015):

- Evolution of the external migration of Greece, Spain, Italy and Portugal (2008-2013) in cumulated emigrants, Statistics in Focus, Eurostat 2015
- Air trips from PARIS to main Domestic and European destinations, Statistics in Focus, Eurostat 2015
- Air traffic in Europe by type: domestic, intra-european and intercontinental, 2013, Statistics in Focus, Eurostat 2015
- Intercontinental air traffics in Europe by world destination region 2013, Statistics in Focus, Eurostat 2015

EUROSTAT and operator data for HSR services, Main passenger flows between European and non-European city pairs (including aviation and HSR flows)

EU Transport in figures; Statistical Pocketbook 2014, European Commission


INTERCONNECT FP7 2011 based on TT2005 data.

INTERCONNECT 2011, based on TRANS-TOOLS trip OD matrixes 2005.


http://www.cesaremarchetti.org/archive/scan/MARCHETTI-052.pdf


OECD-ITF, Discussion Paper 2013 – 09


Santagostino, A. (2012). Permeability (Goods) and Impermeability (Services) in EU Internal Market: a Liberal Perspective, Eurolimes (13)

TEN-CONNECT II transport database (base year 2005), linked to TRANS-TOOLS 2.


