CHAPTER 1

INTRODUCTION

1.1 Travel behaviour in the age of mobile technologies

A 2008 report from the magazine *The Economist*, entitled “Nomads at last”, referred to an alleged change in people’s lives and mobility styles following the advent of mobile technologies, i.e. mobile phones, laptop computers, PDAs (personal digital assistants) and hybrids (*The Economist*, April 2008). While acknowledging the buzz and the business interests underpinning the “mobile revolution” (Steinbock, 2005), we need to recognize that things are evolving very fast. Not only are devices unimaginable only a decade ago widely available today, but a new array of work-life arrangements are being put into practice by an expanding population of knowledge workers.

Such transformations are often backed by employers, especially major corporations and global players, focusing on improving efficiency and oriented more towards objectives than tasks. On the one hand, corporations restructure their organizations according to the principles of business process reengineering (Davenport and Short, 1990; Bresnahan et al., 2002); on the other, they increasingly allow their employees to telecommute, they equip them with laptops and Blackberries, and they introduce ubiquitous Wi-Fi connectivity and hot-desking (i.e. the temporary physical occupation of a work station or surface by a given employee).

Ongoing changes in people’s spatial behaviour are difficult to monitor using conventional statistics. We still do not know how to quantify their so-called “nomadism”, because of an inherent difficulty in defining and measuring it. We talk instead about telecommuting or mobile work. Hardly surprisingly, most scientific research on the implications of ICT (Information and Communication Technologies) on travelling habits has focused more on home and office computers than on the (mobile) technologies that accompany us while in transit (Kwan et al., 2007).

Leaving aside applications specifically designed to provide travel-related information (e.g. GPS, zoomable maps and real-time traffic information), mobile ICTs are designed to make travel a richer experience and an easier one to pursue. There nonetheless remains the fundamental question of how much people are willing to travel, under what
circumstances and for what reasons, given also that fixed (and mobile) internet connectivity enables us to accomplish an increasing number of activities without going anywhere.

In the developed world, the proportion of mobile workers in the total workforce is rapidly increasing, especially with the conversion of sedentary manufacturing jobs into less location-dependent knowledge work. It was recently estimated that 41% of the US workforce is mobile (i.e. people spending at least 20% of their working hours outside their main workplace, Yankee Group, 2006), and that approximately half of this figure concerns traditionally mobile workers (i.e. in a variety of occupations ranging from field sales/services to police officers), while the other half are knowledge professionals (i.e. from IT/creative/research workers to managers/consultants).

Shifting from an organizational to an urban perspective, we know that more than 50% of the world’s population was living in urban areas by the end of 2004 (UNPFA, 2004). The urban mobility of people and goods has been having an increasing impact on sustainable development, both as concerns the use of increasingly limited (built and environmental) spatial resources and in terms of pollution and quality of life (UITP, 2005). This mobility of people and goods within an urban perimeter reflects a city’s metabolism, in that we can see how efficiently the built space and transport infrastructures are used by looking at the population’s spatial distribution and at energy allocation.

Phenomena such as road congestion, urban sprawl, and inefficient office and residential building usage carry a high cost for the city as a system. They imply a loss of economic productivity, as well as wasting non-renewable resources such as fuel, building materials and electricity. This is particularly true of the current phase of industrialization and urbanization of emerging countries such as China and India.

All these phenomena are linked, one way or another, to mobility, i.e. to why and when people decide to move around the city, and what means of transport they use to do so. But while the need for a more environmentally savvy mobility is increasingly recognized by politicians and scientists (UITP, 2005), the relationship between the worldwide diffusion of digital mobile technologies like mobile phones and laptops, and their potential impact on people’s habits is still unclear.

The rapid diffusion of wireless Internet connectivity and the latest-generation mobile phones enable citizens and city-users to access information anywhere, any time of day, and this may induce them to reorganize their daily schedules and to use public, private and work spaces differently (Sheller, 2004). Such devices have modified the way we do
business, access services (e-commerce, e-banking), and dynamically manage our social networks, schedules and activities while away from home or out of office (Kwan et al., 2007). Thanks to urban Wi-Fi schemes, cities like Philadelphia and Singapore are moving towards a scenario of ubiquitous access to information and communication media everywhere in the city, indoors and out.

When access to information is ubiquitous, being in a given place at a given time becomes less important for numerous activities (i.e. to check e-mails) (Mitchell, 1999). At the Massachusetts Institute of Technology, for example, there is anecdotal evidence of the spatial behaviour and working habits of students on campus have changed since the introduction of ubiquitous Wi-Fi connectivity: for instance, places like the main cafes have evolved into multi-functional sites for individual and collaborative work using laptop computers (see Chapter 5).

The availability of PDAs and on-board computers may likewise enable some categories of mobile workers (such as police officers) to optimize their travel behaviour because they can be informed in real time. Being constantly reachable and potentially in a position to receive all kinds of information and establish whatever communication link may be needed can make individuals change their daily travelling routines.

The main purpose of this study was to measure the impacts of mobile digital technologies (e.g. laptop computers and mobile phones) on how professionals and other people move on a daily basis. Our interest in the impacts of mobile technologies on human travel behaviour stemmed from the realization that mobile phones and computers had been adopted extremely rapidly and on a massive scale all over the world.

It is still unclear whether the adoption of such technologies has a positive, neutral or negative impact in terms of a more environment-friendly mobility, assuming that all competing variables remain constant. The mobile technologies likely to make individuals change their travel behaviour can also be used to monitor this travel behaviour. In particular, data are collected on mobile phone activities at network level by telecoms, making it possible to map the aggregate behaviour of users and to reconstruct their main mobility patterns. Such approaches cannot replace traditional travel diaries when it comes to conducting an activity-related travel survey, but they do provide new opportunities for travel behaviour research (as discussed in Chapter 6 and section 7.6). In particular, they may partly overcome some of the acknowledged drawbacks of paper-based travel surveys (Schönefelder et al., 2002; Golob and Meurs, 1986; Hayslett and Wildemuth, 2004), i.e.:
• a limited pool of respondents;
• subjective measurement tool;
• item and unit non-response;
• errors and inaccuracies (especially regarding time, duration and distance);
• fatigue effects in longitudinal surveys.

Finally, before exploring the impact of mobile technologies on human travel behaviour, it is worth taking a look at the factors that prompt people to use them. Mobile technologies are more complex to use than fixed ones, since their adoption depends not only on a broad array of individual and organizational factors, but also on the different physical settings in which they can be used (as explored in Chapter 4).

**1.2 Research questions and case studies**

The research presented in this dissertation focuses on three main questions, which were defined after reviewing the scientific literature on the broad issue of the environmental sustainability of ICT (from a perspective of behavioural changes). The three questions that the research aimed to answer are:

1. What factors affect the acceptance or rejection of mobile technologies?
2. What is the overall impact of mobile technologies (and the ubiquitous connectivity they make possible) on human travel behaviour on a day-to-day basis and at local level?
3. How can new data generated by mobile technologies be used to measure human travel behaviour on the aggregate scale, beyond the capability of current methods?

The first two questions are closely related: to a certain extent, people might plausibly adopt a new technology - or a new technology might be introduced - in order to modify their behaviour in a given direction (among other possible reasons). All three questions need to be further explained, drawing from the case studies chosen in order to extract empirical data that enable us to answer them. Three case studies have been selected, regarding three different populations of mobile technology users:
1. Field police officers operating in the district of Groningen North (Netherlands), equipped with PDAs that they use anywhere to access information while on the move. This case study primarily addresses question 1 (acceptance), but also concerns question 2 (behavioural changes);
2. Students of the Massachusetts Institute of Technology (USA), equipped with laptops on a campus where wireless Internet connectivity is ubiquitous. This case study focuses on question 2 (behavioural changes);
3. All subscribers and roamers using their mobile phones in the Amsterdam Metropolitan Region via the KPN Mobile GSM network. This case study addresses question 3 (new measurements).

The three case studies differ in terms of the degree to which mobile technologies have been adopted and institutionalized. In the case of the Groningen police force, observations were carried out while the new PDA services were still in their infancy, when only a limited number of officers were testing them. At the MIT, ubiquitous Wi-Fi connectivity has been in place since 2003, so students and professors had already had time to equip themselves with laptops and adapt to the new situation by the time our data were collected in 2006 and 2007. In the case of Amsterdam, mobile phones have been used by virtually all residents and visitors for several years.
This difference gave us the chance to stress different research aspects in each case study: while in Groningen we gave priority to question 1 (the factors affecting acceptance), we focused on question 2 (behavioural changes) at the MIT and on question 3 (new measurements on the urban scale) in Amsterdam. Another reason for choosing these three case studies was that, in all three, human travel behaviour unfolded in a geographically contained environment (within the perimeters of the Groningen North district, the MIT campus, and Amsterdam Metropolitan Region) so it was easier to monitor and operationalize for our research purposes (as explained in Section 3.3).

Having chosen the case studies, we needed to establish which data to collect and how to do so. As a first step, we rephrased our research questions to make them fit the different research environments. In the study on police officers, we asked:

1. What makes police officers adopt or reject the new PDA applications?
2. Is usage of the new applications influencing the number and type of trips performed by officers to patrol the streets?
In the research on the MIT university students, we asked:

1. What makes students carry a laptop with them on a regular basis?
2. Is laptop use (and the ubiquitous connectivity they enable) having an impact on the number of trips made by students on a daily basis and the time spent in different campus locations?

In the case study on mobile phone users, we asked:

1. Is there any correlation between subscribers’ usage of mobile phones and how physically mobile they are?
2. What do aggregated and anonymized mobile phone usage data reveal on the human usage of different urban spaces used at different times of day and on different days of the week?
3. Can land uses be adopted to predict different mobile phone usage patterns?

1.3 Theoretical and methodological setting, relevance of the study

The theoretical and methodological setting for this research can be described as an econometric study on people’s activities and travelling habits to explore how different mobile information and communication technologies affect their daily behaviour.

Efforts to understand the essential reasons for travelling and for changing travelling behaviour are more typical of time use research conducted by the behavioural scientists, e.g. in the fields of anthropology, ethnology, sociology, psychology and geography (Kramer, 1998; Matuschek, 1999).

In the expanding transportation research community, a new corpus of scientific knowledge has taken shape in the last two decades, coming under the umbrella term of “ICT and travel” (Kwan et al., 2007). The main goal underpinning this development has been to assess the potential of telecommuting (i.e. working from home with the aid of ICT, see Chapter 2) for reducing daily traffic flows in urban areas. Research funds have been made available for this purpose and politicians have shown interest in the topic. Our investigation differs from others because it focuses on mobile rather than fixed
technologies, and because it considers technologies that have only recently entered the mass market (laptops, PDAs and mobile phones).

Our research took an empirical approach and was primarily quantitative. Due to the different types of data and sample sizes of the three case studies analyzed, the same issue was approached from different perspectives and using different methods. We used both descriptive and inferential statistics in two of the three case studies (i.e. MIT and Amsterdam). At the same time, in two of them (i.e. Groningen and MIT) the needed primary data have been generated. At MIT and in Amsterdam, novel tracking technologies were tested for collecting travel data, i.e. the very technologies that we hypothesized might have an impact on people’s travelling habits (PDAs, laptops and mobile phones) were used to observe any changes in their travels.

The findings and conclusions of this research may be useful to travelling behaviour researchers as well as in other fields, e.g. sociology (issues concerning technology and society); the organizational sciences (the economics of mobile work); architecture (occupancy and use of built space); urban planning (residential patterns of mobile workers).
1.4 Outline of the study

This dissertation contains seven chapters, three of which are dedicated to case studies.

Figure 1.1: Contents of the dissertation

In Chapter 2, we review the relevant literature on the use of mobile technologies and ICT vis-à-vis travelling habits. We include an analysis of the current socio-economic scenario, which is likely to affect the demand for travel. In the last section of the chapter, we approach the issue from the angle of mobile computing, emphasizing the market forces behind the adoption of mobile technologies.

Chapter 3 concerns the research methods applied. We elaborate on the main research paradigm (activity-based travel) within which our empirical data were collected. We explain why we chose our three case studies and how the main variables being investigated were operationalized, followed by a section where we list the main research tools used for data collection and analysis. We conclude the chapter by acknowledging the main elements of complementariness among the three case studies.

Chapters 4, 5 and 6 present our three case studies. Each of them includes, among others: an introductory section; sections on “research design” (including a sub-section on the main research constraints faced) and “discussion of findings”; a conclusive section which present the main lessons learned and our recommendations for future research.
Chapter 4 discusses our first case study, in which we assessed how local field police officers accepted and used new PDA applications implemented in the city of Groningen. After explaining the study design and the tools used for data collection, we present our findings, emphasizing the qualitative aspects emerging from face-to-face interviews. Finally, we provide a tentative explanation of our results, based on the evidence emerging from different datasets.

Chapter 5 is dedicated to the MIT case study, in which quantitative data were collected to assess how the availability of laptops affects the daily spatial behaviour of students attending the campus. After providing details on the study design and the tools used for data collection, we present the results of our descriptive statistical and regression analysis. Finally, we discuss our findings, elaborating on the causal relationship between the two main variables under investigation (availability of laptops and travel behaviour).

Chapter 6 describes an analysis of more than five months of data on mobile phone traffic over the KPN Mobile network in the Amsterdam Metropolitan Region. We determined the correlation over time between mobile communication (proxy: overall number of text messages, i.e. SMS, sent) and users’ travel behaviour (proxy: number of calls made and received while on the move). We also derived and commented on the spatio-temporal patterns of the network in different areas of Amsterdam, in terms of mobile phone use within their boundaries. Finally, we use regression analysis to quantify the relationship between mobile phone use and the land uses from which they originated.

The conclusive Chapter 7 gives a summary of our research work and its main findings, together with policy implications and possible directions for future research. There is also a tentative overarching explanatory framework, grounded on the drivers of travel behavior.