

The changing role and importance of the built environment for daily travel in Sweden

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ABSTRACT

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Geography, in terms of the built environment and location patterns, was traditionally, and still is, emphasized by many scholars, policymakers, and planners as greatly influencing people's daily travel behaviour. However, taking recent decades of rapidly increasing mobility capabilities (physical as well as virtual) into account, and the related increase in individual choice opportunities, others argue that the importance of geographic factors has gradually dissolved. Starting from this discussion, the overall aim of this thesis is to examine the current role and relative significance of the built environment for the geographical extension of individuals' daily travel in Sweden. The thesis is based on three empirical studies in which particular attention is paid to detailing the impact of geographic factors on various daily travel activities (paper I); exploring possible changes over time in the importance of the built environment for home–work distances (paper II); and the potential relaxing of the relationships between locational structures and travel behaviour when people regularly use ICTs and telework (paper III). All three papers apply multivariate quantitative approaches to a unique combination of detailed, high spatially resolved micro-data, including the national travel surveys and register data of the total population.

An overall conclusion of the thesis is that the proximity of various aspects of the built environment to home still plays an important role in how far people in Sweden travel daily. However, the analyses, informed by theory emphasizing everyday spatiotemporal constraints, reveal that these relationships have become relaxed in several important respects. First, the specific time–spatial constraints associated with different daily activities that motivate trips and travel are key and also differentiating factors. When considering trips taken during holidays and for everyday leisure purposes, the built environment is less important for the observed daily travelled distance. Whereas service trips to a greater extent is associated with the built environment surrounding home, and work trips even more. Second, important changes occur over time, here examined in the case of work trips. Workers living in the same neighbourhood increasingly travel divergent distances between home and work. This suggests a continued decrease in the influence of the built environment on work related travel. Third, in terms of time–spatial relaxation, a rapid increase of telework lately is an important case. The built environment influences teleworkers' daily travel to a lesser extent than it does regular workers' daily travel since telework allows for the freer scheduling of daily activities in time and space. Conclusively, the results confirm the importance of considering spatiotemporal constraints related to daily activities when exploring the role of the built environment and its importance for daily travel. More generally, the thesis also remind us that the importance of the built environment changes as an integral part of larger societal transformations connected with development of mobility technologies and profound socio-economic and demographic changes.

Keywords: built environment, travel, distance, daily, commuting, telework, residential location, Sweden, activities, mobility, spatiotemporal constraints

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Paper I: Elldér, E. 2014. “Residential Location and Daily Travel Distances: The Influence of Trip Purpose”. *Journal of Transport Geography* 34, 121–130.

Paper II: Elldér, E. 2014. “Commuting Choices and Residential Built Environments in Sweden, 1990–2010: A Multilevel Analysis”. *Urban Geography* 35(5), 715–734.

Paper III: Elldér, E. 2015. “Does Telework Weaken Urban Structure–Travel Relationships?”. Accepted for publication in *Journal of Transport and Land Use*.

1 Introduction

1.1 Background

This thesis concerns how land use in terms of the built environment influences people's daily travel – a “hot topic” in current debates on how to manage mobility through spatial planning strategies, for example, limiting urban sprawl by building denser cities. It also contributes to a long-standing issue in geographical theorizing and research concerning the relationships between location patterns, individual capabilities, and human spatial interaction. The specific concern of my thesis is the geographical extension of people's daily travel activities, and how these relate to the various built environments of people's homes, locally as well as regionally. I make a case for this by drawing attention to some of the drastic changes that increasing mobility has generated over the last century.

In Sweden, average daily travel has increased from a few kilometres a day in the early 20th century to about 45 kilometres one hundred years later (Frändberg and Vilhelmson, 2011). A series of innovations in transport technology has increased the geographical reach of people's daily activity spaces twenty-fold. All developed countries have experienced similar trends, and developing countries are largely following the same path (Banister, 2012). This development continues to have profound geographical consequences, including suburbanization, increased labour market ranges, and the spatial extension of leisure activities. While individual reach and freedom of choice have increased greatly, high levels of mobility also bring many drawbacks and costs: car dependence and urban sprawl, congestion and pollution, path dependencies, and lock-in situations. The currently most prominent example of a negative impact is greenhouse gas (GHG) emissions from transport, which are increasing at a faster rate than emissions from any other sector and have more than doubled globally since 1970 (Sims et al., 2014). Eighty per cent of this increase comes from road vehicles. In 2010, transport accounted for 27% of total energy use globally and is expected to make up an even larger share in the future. In the absence of effective policy interventions, transport-related GHG emissions are expected to more than double by 2050 (Sims et al., 2014). In Sweden, transport-related emissions continue to grow despite the

rapidly increasing energy efficiency of new cars (Johansson, 2011). This calls for careful attention to reducing traffic to more sustainable levels and to the potential of various planning measures to do so.

From a geographer's perspective, the contested effects of increased mobility evoke the concern of the relationships between the locations of human activities and the needs for daily travel – and to what extent these could be influenced by urban and regional planning. For example, in the newly released *Fifth Assessment Report – Mitigation of Climate Change*, the Intergovernmental Panel on Climate Change (IPCC) emphasizes improved land use and transport planning as major mitigation strategies (Seto et al., 2014; Sims et al., 2014). The IPCC proceeds from the argument that the built environments of cities and regions establish path dependencies that have long-term effects on travel. Infrastructure and spatial planning efforts therefore play a key mitigation role in providing templates for future low-carbon travel behaviour. The IPCC draws heavily on a vast, longstanding, and still growing academic literature that interrogates the associations between transport demand and the built environment (e.g., Boarnet, 2011; Ewing and Cervero, 2001, 2010; Newman and Kenworthy, 1999; Næss, 2012; Salon et al., 2012). This literature provides one starting point for this thesis. Strong links have been found in a wide range of geographical contexts; for example, people living in densely built environments close to a mix of daily amenities and served by good public transport and cycling connections generally travel shorter distances and less by car every day than do people living in suburban and sparsely populated areas. Based on these results, many influential scholars (e.g., Newman and Kenworthy, 1999) and policymakers (e.g., the IPCC) imply that there is more or less a straightforward causal connection between denser location patterns – i.e. increased proximity – and reduced travel.

This view is, however, challenged by another important theoretical concern in human geography and related academic fields, namely, whether travel and destination choices are becoming less constrained by location and proximity over time (see, e.g., Giuliano, 1995; Kwan and Weber, 2003; Miller, 2007). Geographers have long since highlighted the problems of using geographic location patterns as the single determinant of human spatial behaviour (e.g., Cox and Colledge, 1969; Olsson, 1965). More nuanced views have been established that stress the importance of taking the analytical point of departure in individuals, their needs and capacities to perform activities at

various locations, and the role of everyday spatiotemporal constraints in doing so (see, e.g., Hägerstrand, 1970; Jones et al., 1983). Accordingly, when access to rapid mobility resources, such as cars, increases, people's opportunities to more freely choose where to perform daily activities also widen and become more flexible, and travel and location patterns follow suit. Simply stated, people might no longer be as dependent on the built environment and what is in geographic proximity, and can perform everyday activities in a number of different places in the same day.

In addition, not only have changing capacities for physical travel between locations possibly weakened built environment–travel relationships, but the virtual mobility enabled by information and communication technologies (ICTs) could also have similar implications. ICTs have the potential to further relax the spatiotemporal constraints of daily life and make traditional temporal and spatial patterns of activity participation less dependent on geographical location and proximity (see, e.g., Dal Fiore et al., 2014; Kwan, Dijst and Schwanen, 2007; Lenz and Nobis, 2007; Lyons, 2009; Van Wee, Geurs and Chorus, 2013).

These discussions generate many important questions deserving further exploration, some of them highlighted in this study. Theoretical and methodological developments focusing on individual needs and wants have produced a series of somewhat mixed and contradictory results as regards the importance of the built environment in daily travel (Ewing, Deanna and Li, 1996; Handy, 1996; Kitamura, Mokhtarian and Laidet, 1997; van de Coevering and Schwanen, 2006; Van Wee, 2013). Some of these studies even find travel to be relatively independent of what they define as the built environment while also accounting for various individual aspects, such as car access and use, household situation, and socioeconomic characteristics. In addition, from a dynamic perspective, a key question is the extent to which the influence of location patterns is actually decreasing over time when it comes to daily travel, bearing in mind the possible effect of improved research that better capture individual explanations. In the background lurks the worry that the “individual-based turn” and approaches – i.e., the search for explanations at an individual level in transport research – have somewhat neglected the challenge of properly defining and measuring geographical contexts and built environments. For example, as increasing mobility has allowed daily travel to destinations farther from the local neighbourhood, recent research has emphasized the

importance of regional built environment structures (Boarnet, 2011; Næss, 2011). Dealing satisfactorily with these issues of dynamics and scale, however, makes specific demands of data and methods. This includes a persistent need to properly describe the individual (e.g., as regards socio-demographics), her actual daily travel (e.g., as regards distances, modes, and purposes), and other potential modes of access (e.g., via ICTs). In a society where the ability to move physically as well as virtually is increasing, the factors underlying the geographical extent of our daily activities are changing and multifaceted. This includes social issues (e.g., changing intergroup mobility divides; see Frändberg and Vilhelmson, 2014; Östh and Lindgren, 2012; Solá, 2013) and virtual access and labour market changes (e.g., recent rapid increases in telework; see Green, 2004; Vilhelmson and Thulin, 2015).

Several considerations need further investigation in order to settle to what extent, and in what dimensions, for whom, and at what levels, the spatial opportunities manifested in the built environment are actually playing a role and changing in importance. This improved knowledge is relevant for evaluating the efficient and effective use of the spatial policy instruments in which, for example, the IPCC and many urban and regional authorities set great store. My thesis contributes to these discussions by scrutinizing the importance of built environments for people's daily travel for various purposes, considering whether its role is changing over time and whether ICTs play a role in this process. The constituent empirical studies of the thesis contribute by using and combining rich sources of geocoded micro-level data capturing people's daily travel and ICT use, the spatial opportunities provided by transport systems, and the location patterns of the built environment in Sweden.

1.2 Aim

Due to increased access to faster means of transport and ICTs, people's travel and activity patterns can be expected to become increasingly heterogeneous, flexible, and less dependent on proximity and the location of activities. In this study, I explore whether this relaxation is occurring. Specific attention is paid to detailing the impact of the built environment on different travel purposes, exploring possible changes over time, and, finally, the potential role of ICT use in relaxing spatial constraints. I believe that these issues are central not only to

many theoretical discussions in geography but also to many key challenges facing planners and policymakers now and in the future, particularly in relation to the mitigation of transport-related GHG emissions.

The overall aim of this thesis is to *examine the role and relative significance of the built environment for the geographical extension of individuals' daily travel in Sweden*. This aim is pursued through three empirical studies in which the specific research questions are:

- Does the built environment affect daily distance travelled differently when individuals travel for different purposes? (Paper I)
- Is there a trend whereby the built environment is of decreasing importance when it comes to home–work distance? (Paper II)
- Does the built environment influence daily travel behaviour differently when people regularly use ICTs and telework? (Paper III)

1.3 Outline of the thesis

The heart of this thesis is the three papers in the appendices, referred to in the text by their roman numerals. The papers are theoretically framed and their results are discussed and concluded in the five chapters of this thesis summary. This introductory chapter continues by broadly defining some of the central concepts and setting the scene in the geography of Swedish daily mobility trends. The theoretical framework of the thesis and a discussion of issues explored in the papers are presented in the second chapter. The methods and data are presented in the third chapter. The fourth chapter presents a summary of each paper. Finally, the thesis summary is rounded off with a concluding discussion on the joint theoretical and practical contributions and recommendations derived from the empirical studies.

1.4 Central concepts and delimitations

Two groups of key concepts that play a central role in the thesis can be derived from the aim and research questions. These concern (i) *people's daily travel and mobility* and (ii) *the built environment*. It is important that the reader be attentive to how these concepts are broadly defined before reading the rest of the text

since they take on different meanings in academic literature and in everyday life. Basically, these meanings concern the dimensions and scale levels at which mobility and space are observed.

The terms *travel* and *mobility* are used mainly to broadly describe *people's actual movements between locations and activities in geographical space*. People's movements between places can be studied within different time periods and at different levels of spatial scale, ranging from long-distance infrequent international travel, on the one extreme, to short-distance movements. Against that range, this thesis is concerned mainly with *daily movements, including everyday travel to work, services, and leisure*. These daily movements are mainly local and regional, not that there are no important interactions with other temporal mobility scales. Trips and travel can be measured in three interrelated dimensions – i.e., travel time, distance, and frequency – that are more or less relevant to the problem studied. This study focuses on the geographical dimension of daily travel, mainly in terms of travel distances. Travel distance is, however, closely related to and a foundation for other aspects of daily mobility, such as speed, mode choice, and time pressure (Banister, 2011). These and other delimitations and operationalizations are discussed in the theoretical framework following this introductory chapter. How daily travel is further operationalized empirically is elaborated on in chapter 3, which presents the data and methods used in the constituent papers of the thesis.

The *built environment* broadly designates the location patterns of potential destinations that in various ways might affect people's daily travel, i.e., the locations of various facilities (e.g., stores, workplaces, and schools) people potentially use to perform certain daily activities in relation to where they live. The literature on built environment–travel relationships is vast and various concepts describing the built environment are in use, including land use, urban structure, urban form, accessibility, density, and proximity. One important point to bear in mind is that the meanings of the concepts differ if approached from a theoretical or an empirical angle. From an empirical point of view, the meanings appear straightforward and much a question of what built-environment features are being measured. For example, Seto et al. (2014) defines the four main metrics of the built environment as density, land use mix, connectivity, and accessibility. To be measurable, these metrics are operationalized in often crude and simplistic ways, for example, density in terms of population per neighbourhood and land use mix in terms of the ratio

of jobs to residents. In this dissertation, and in the Swedish case, access to unique micro-level register data for the total populations of individuals and firms, geo-referenced at a high spatial resolution, makes it possible to design and test a wide range of metrics. This process is further described and discussed in chapter 3. From a theoretical perspective, questions such as why and under what conditions various features of the built environment can be expected to be important to people's daily travel are emphasized. The theoretical framework presented in chapter 2 elaborates on these aspects and inform the empirical operationalization and analysis presented later.

1.5 The Swedish case and context

Empirically, this dissertation analyses travel/built environment-related patterns, processes, and developments in Sweden. Historically, the interlinked trends of built environment, infrastructure, and travel in Sweden have been similar to those of many other countries of the global north (Banister, 2012; Frändberg and Vilhelmson, 2014; Metz, 2010; Millard-Ball and Schipper, 2010; Vilhelmson, 2007). The beginning of mass motoring in the early 1950s generated exponential growth in daily travel that continued for several decades and allowed many people to move from cities to their rural hinterlands in the 1970s, resulting in increased urban sprawl. The average daily distance travelled in Sweden increased from about 1 kilometre in the early 19th century to about 10 kilometres in the 1950s; from there, it increased rapidly, finally peaking a few years into the 21st century at around 45 kilometres (Frändberg and Vilhelmson, 2011). From 1978 to 2006, the average distances travelled for work, leisure, and shopping increased the most (>50%), while school, child care, social, and health care trip lengths increased only slightly (10–20%). Sweden is now witnessing small reductions in total daily travel distances, the stagnation of car use, and densification in the largest cities (Frändberg and Vilhelmson, 2014). The car is the dominant mode of transport (accounting for 59% of all daily trips in 2006). Car use has peaked in recent years, but continues to increase for some cohorts and trip purposes. For example, the average distance commuted to work by car increased by 27% for men and 31% for women between 1995 and 2011 (Elldér, 2014a). Sweden does not distinguish itself from the rest of Europe in its modal split of passenger transport and its motorization rates are similar to that of the rest of Europe

(Eurostat, 2014); in 2006 there were 464 cars per 1000 inhabitants in Sweden compared with the average of 455 in EU 27.

In the case of ICT and virtual mobility use and access, there have been drastic changes in recent decades (Vilhelmson and Thulin, 2008): for example, between 1990 and 2000, Swedes spent 80% more time on ICT use, and only 30% had home Internet access in 1998, versus over 70% in 2005. Telework has also increased rapidly in recent years: 17% of Swedish workers reported teleworking regularly in 2011, versus only 10% in 2005–2006 (Vilhelmson and Thulin, 2015).

Furthermore, the geography of the built environment and the population differ from those of many other countries. In 2013, 9.6 million people lived in Sweden at an average population density of 23.7 inhabitants per square kilometre. In the European Union, only Finland has a lower population density than Sweden (Eurostat, 2014). The geography of the Swedish population, however, is highly diverse and includes metropolitan cities, small towns, and very sparsely populated areas. The population is concentrated mainly in the southern and coastal areas, as shown in Figure 1. In 2010, 85.1% of Swedes lived in built-up areas¹ and 35.6% lived in the three largest urban regions of Stockholm, Gothenburg, and Malmö (SCB, 2010). Urbanization is slowly continuing into the 21st century, but at a faster rate in Sweden's largest urban regions. Furthermore, partly due to its geographically dispersed population structure, Sweden has more transport infrastructure per capita than do many other countries; there are, for example, 1.2 kilometres of railway and 0.2 kilometres of motorway per 1000 inhabitants in Sweden versus 0.6 kilometres of railway and 0.15 kilometres of motorway in the EU (Eurostat, 2014).

In summary, Sweden is a country with a highly heterogeneous built environment, and – like many other countries of the global north – is characterized by high degrees of physical and virtual mobility. Although recent years have seen a slight decrease in daily travel distances, travel among certain groups and for specific purposes continues to increase, and ICT use continues to climb. The papers delve deeper into these developments because they are

¹ The Swedish official definition of a built-up area (termed 'locality' by Statistics Sweden) is any area with at least 200 inhabitants that also meet the criterion that houses are not farther than 200 metres apart.

central to the discussion of changes in the relationships between the built environment and daily travel.

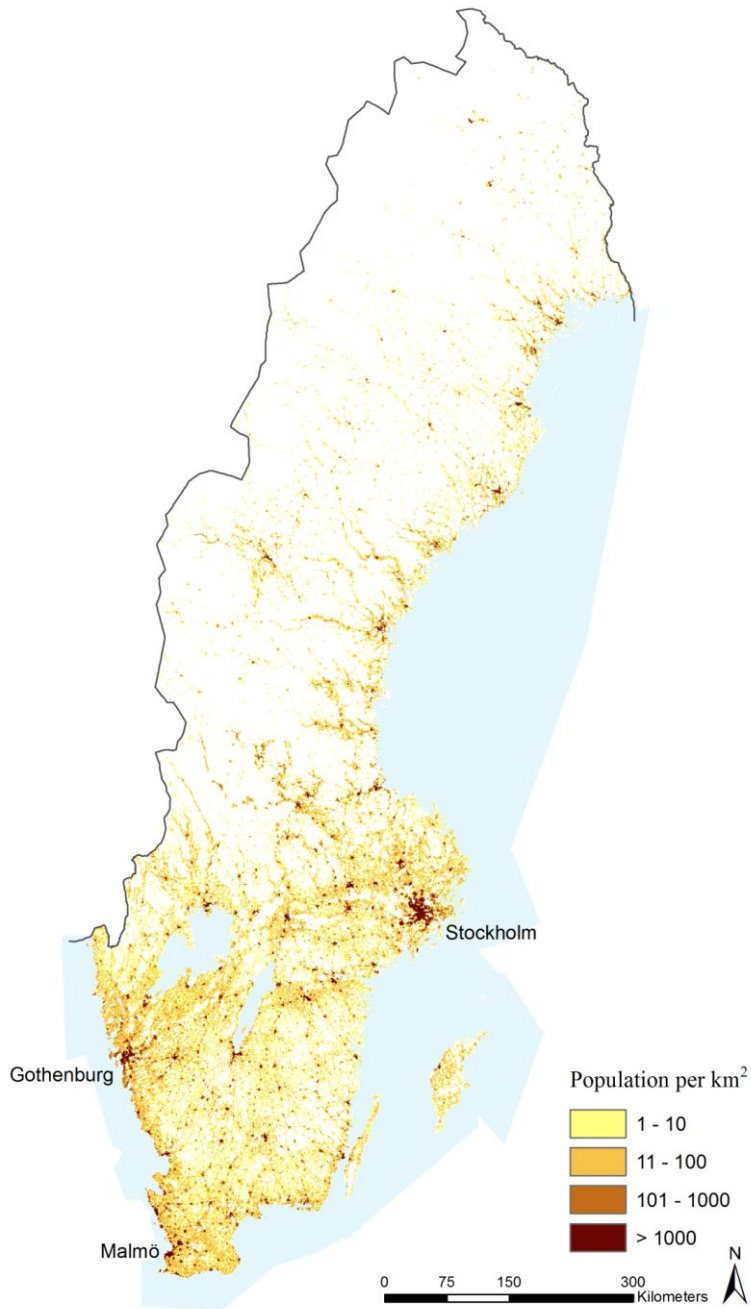


Figure 1. Population distribution in Sweden, 2008 (source: GILDA).

2 Theoretical framework

2.1 Introduction

The theoretical understanding of daily travel has changed profoundly in the last fifty years. In general, the research has shifted from a technical focus on infrastructure development, network characteristics, and sheer flows of vehicles, to a social-science orientation emphasizing human travel behaviour and the role of transport in society and policymaking. If the mid-20th-century focus was estimating aggregated transport flows in networks and between zones in order to “predict and provide” for infrastructure construction, travel is now more often approached as a behavioural or activity-based phenomenon in the context of people’s use of time and space. In geography, this was associated with a change of focus in several important ways: viewing travel as an outcome of individual decision processes rather than derived directly from locational patterns; disaggregating the level of analysis from aggregated flows of traffic to individual (and household) trip making; and deriving travel from individual needs to perform various activities distributed in time and space rather than analysing trips isolated from their socio-spatial context. It is also in individual capabilities, needs, and wishes that I take my theoretical starting point, adopting a time-geographical activity-based approach, as outlined in section 2.2. This approach considers people’s everyday life as a sequence of activities, such as working, eating, exercising and sleeping, and notes that travel stems from a need to schedule these activities in different places. Central to this approach are the constraints to which this process is subject, for example, the geographical accessibility of locations. As my thesis sets out to investigate how and to what extent people’s daily travel is related to and determined by the spatial opportunities provided by the built environment, I delve into these spatial constraints in section 2.3. Finally, section 2.4 elaborates on certain processes of socioeconomic and mobility change that may have important implications for built environment–travel relationships, and therefore are explored empirically in the papers.

2.2 An activity-based approach

2.2.1 Choice in the context of constraints

My main theoretical point of departure is in the human activity approach (Axhausen and Gärling, 1992; Fox, 1995; Jones et al., 1983; Vilhelmson, 2007). This approach emerged from mounting criticism of “positivistic” theories of spatial interaction, network analysis, and gravity models (and associated traditional trip-based forecasting methodology, four-step-planning models, etc.) central to transport research and planning at the time (and often still in use in practical planning). Heavily inspired by Hägerstrand (1970) and Lenntorp (1976) – and the famous claim to pay attention to “people in regional science” – Jones et al. (1983) developed the “human activity approach” to better understand daily travel. Unlike the standard transport models of the time, which mainly constituted statistical descriptions of trends and provided no behavioural content, Jones et al. built on a growing contemporary literature of human activity studies, especially a branch that studied activity patterns.

Building on Chapin’s (1974, as cited by Jones et al., 1983) work, human activity patterns can be said to derive from individuals’ various physical and physiological needs. The needs and wants of everyday life are translated into a set of activities that are spontaneous, planned, or routinely scheduled into a pattern (or a sequence of activities) in time and space each day. Some of people’s basic daily activities, such as sleeping and cooking, are normally performed at home. Many activities, however, demand specialized facilities outside the dwelling in order to be carried out. To shop for groceries, we often need to visit the grocery store, to attend a medical appointment we need to go to the hospital, and so on. Daily travel behaviour can therefore be seen as the result of a process whereby people match the demand for activities against the supply of facilities (in both time and space) in preferred sequences. Travelling is therefore understood as a demand derived from the need to perform activities at geographically separated facilities. However, drawing on Hägerstrand’s (1970) time-geographic approach, Jones et al. (1983, p. 266) also emphasized that the process of meeting this demand is subject to several space-time constraints levied by “physiological, economic and cultural factors” and, as is central here, “the nature of space itself”. Hägerstrand (1970) initially identified three main types of constraints: *capability constraints* refer to the

capabilities individuals have to perform activities, including allocating time for biological needs and the mobility resources possessed; *coupling constraints* require that individuals and objects come together in time (at certain points in time, in a specific sequence, and for certain periods) and space (at certain physical locations) for activities to be performed; and *authority constraints* regulate access to facilities at particular times, for example, during working hours.

By synthesizing these two contrasting approaches – i.e., choice and constraint thinking – into a basis for understanding daily activity patterns and travel behaviour, Jones et al. added a behavioural aspect to time-geography (cf. Vilhelmson, 2007), summarizing it as “choice in the context of constraints” (Jones et al., 1983, p. 266). The core idea of “choice in the context of constraints” also sums up the general theoretical impetus for the empirical investigations reported in the appended papers. The implications of various spatial constraints constituted by the location of facilities and inherent in the built environment for the shaping of daily travel constitute the focus of all three papers.

In sum, in this thesis, daily travel is theoretically understood as *a demand derived from people’s needs and wishes to perform daily activities that are geographically dispersed; various types of constraints are crucial for understanding the spatial outcome (e.g., in terms of daily travel distance) of this process.* A fundamental question, then, is the extent to which travel relates to, or is determined by, the location patterns of the built environment. The answer is not as obvious as it may appear at first glance, and the human activity approach clearly emphasizes that other factors contribute. It is therefore appropriate to conduct a deeper review of the central constraints of daily activities, spatial ones in particular.

2.2.2 The spatiotemporal constraints of daily activities

The needed and wanted activities of daily life per se are not only an important starting point for understanding the origin of travel, as their associated (and varying) spatiotemporal fixity levels can be expected to have further key consequences. First, an individual’s daily activity pattern – seen through a time-geographical lens – results from solving an allocation problem in which both time and space are limited resources (Hägerstrand, 1970; Jones et al., 1983). Within time–spatial boundaries, people have to make trade-offs between activities. The fact that activities are derived from various types of need – and

are more or less fixed at certain locations – has been an important feature from the very start of activity-based approaches.

Efforts to classify needs and the daily use of time for various mobility-related activities are central in this context. A basic categorization of activity types in relation to need is typically made by roughly differentiating between mandatory and discretionary activities. Chapin (1974, as cited by Jones et al., 1983), for example, early on identified two main activity groups: activities that satisfy subsistence needs (including sleeping, eating, and working) and activities that fulfil culturally, socially, and individually defined needs. For better or worse, such basic categorizations still underlie much activity-based analysis of travel behaviour (Doherty, 2006). Ås (1978) provides a general framework for placing activities in priority order based on freedom of choice and constraints, as follows: 1. necessary time, 2. contracted time, 3. committed time, and 4. free time. Note, however, that Ås does not attend to the location of activities and time use – i.e., to the extent to which activities are fixed or flexible in space (cf. Vilhelmson, 1999). However, the framework can be used as a basis for further theoretical elaboration concerning spatial constraints on travel as follows (cf. paper I).

People satisfy their basic biological needs during *necessary time*, which includes activities such as sleeping, eating, and personal hygiene. These activities are generally characterized by little flexibility and are often spatially tied to the home (Ellegård and Vilhelmson, 2004). The second group of activities are performed during *contracted time*, which mainly refers to paid work and participating in education. These activities are often associated with relatively little individual choice once they are decided upon (i.e., once a “contract” is signed). The time–spatial premises (e.g., working hours and location) are largely not individually determined. Activities performed during *committed time* are predominantly linked to household work such as grocery shopping. These are activities that also have to be carried out on a regular basis, but could be expected to be associated with more individual flexibility concerning when or where to perform them than are activities performed during contracted time. People have greater abilities both to postpone such activities and to decide where to perform them. Most committed activities, however, must be performed during a limited amount of time, many during a regular week, for example. The time people then have left can be considered *free time*, which can be used for various leisure activities. Activities executed

during this time can theoretically also be expected to be the most flexible in time and space.

Furthermore, the linkages between daily time use, prioritization of daily activities, and spatiotemporal constraints are important when it comes to analysing the geographical extension of daily travel for various purposes (i.e., activities). For example, mandatory activities such as sleeping and working are often defined as fixed in time and space and are used as a basis when modelling how other activities are distributed in time and space (Schwanen and Dijst, 2003). Cullen and Godson (1975) early on demonstrated that these activities and the places where they are performed are used as anchors around which other activities are ordered. In later studies, work has been treated as an activity that often tends to bind other activities in time and space (Schwanen, Kwan and Ren, 2008). A person who is employed and must perform wage labour eight hours a day at a specific location has limited opportunities to engage in leisure activities far from their home and work locations. If this person also has many obligations during committed time, his or her spatial opportunities for daily activities are still further constrained.

Note, however, that conditions in society have changed since the early conceptualizations of time-geography and activity-based approaches, possibly influencing the need for activities, together with their prioritization and associated spatiotemporal fixity for many people. For example, such conditions include an increasingly knowledge-intensive and “flexible” labour market (Green, 2004) and the associated rapid development and spread of ICT use (Mokhtarian and Tal, 2013). These developments have also laid the groundwork for criticism of the traditional categorizations of activities discussed above and established a need to re-examine the original time-geographic constraints as regards capability, coupling, and authority (e.g., Kwan and Schwanen, 2008). Some scholars have questioned the traditional activity categorizations and sought more salient attributes of activities (see, e.g., Akar, Clifton and Doherty, 2012; Doherty, 2006). Using data from an in-depth week-long activity scheduling survey, Doherty (2006) found significant variations in spatiotemporal attributes between and within the traditional categorizations. Another emerging literature studies the fragmentation of activities in time and space enabled by ICT (see, e.g., Alexander et al., 2011; Couclelis, 2000; Lenz and Nobis, 2007). The fragmentation hypothesis posits that ICT weakens the relationships between activities, space, and time by

enabling many activities to be fragmented into smaller components distributed in time and space.

These processes and their theoretical implications for the spatial constraints of various activities and for the role of the built environment in shaping everyday travel for various purposes are further discussed in section 2.4.

2.2.3 The role of individual needs, wishes, and capabilities

Though activities performed during necessary time, especially sleep, are very fixed and must be executed by all individuals every day, the scheduling of most daily activities in time and space is subject to individual needs, wishes, and capabilities. There are important inter-individual variations both in what activities are performed daily and in their associated spatiotemporal constraints. In the activity-based approach, scheduling constraints at the individual and household levels are therefore central to understanding travel behaviour (Axhausen and Gärling, 1992; Fox, 1995; Jones et al., 1983). Jones et al. (1983) paid considerable attention to the links and interactions among household members, individual lifecycle stages, and daily trip patterns. The other members of the household to which a person belongs contribute significantly to shaping individual activity patterns. Individuals have to share the available mobility resources within the household in terms of, for example, car access or available time outside paid and unpaid labour. Many individuals must consider other household members' needs and constraints when planning their own and joint activities. For example, if there are children in the household, their needs must also be met and integrated into the scheduling of the parents' activities.

Much empirical work has shed light on the importance of these factors. A common approach is to investigate how socio-demographic factors relate to travel. Important factors found in most contexts include gender, household composition and life course stage, income, education, car access, and daily pursuits (in the Swedish context, see, e.g., Elldér, Solá and Larsson, 2012; Frändberg and Vilhelmson, 2011; Öhman and Lindgren, 2003; Östh, 2007; Sandow, 2011). All these factors mediate the capabilities that enable and constrain daily activity spaces. Gaining access to a car, for example, greatly widens the opportunities for individuals to choose where to perform activities

(Vilhelmson, 2007). Likewise, a higher salary can be invested in mobility resources, giving opportunities for extended activity spaces (Swärdh, 2009). Gender also has important implications for many reasons, including the unequal division of unpaid work in the home limiting the capabilities for many women to participate in certain activities (Solá, 2013; Solá and Vilhelmson, 2012). These factors are also closely related to the duties included among the daily pursuits in which individuals are engaged (e.g., wage labour, education, and household work), duties that are highly decisive for daily activity participation and thus travel. Berg et al. (2014), for example, illustrated how the transition to retirement fundamentally changes experienced time–spatial constraints and mobility.

The present study further gauges the relative significance of the built environment for daily travel in relation to individuals' capabilities, needs, and wishes – mainly operationalized as the socio-demographic factors mentioned. These factors are closely related to other intervening factors highlighted in recent literature as influential in shaping daily travel, for example, various socio-cultural factors and related individual interests, attitudes, and desires (see, e.g., Næss, 2013). As discussed below, personal desires and wishes can challenge the importance of the built environment, for example, when distant destinations are favoured over nearby ones. Similarly, also influencing individual interests as well as preferred activities and destinations, social networks and their influence on travel have recently been stressed (see, e.g., Dugundji et al., 2012; Tilahun and Levinson, 2011). Furthermore, personal and socio-demographic factors are modified by the structural conditions of society (cf. Næss, 2006), as there is a range of socially conditioned activities in which many people must participate (e.g., wage labour and education). In addition, lifestyles and attitudes are structurally influenced: individuals are situated in a range of social contexts and networks that bring people together and enable information sharing, affecting what activities are needed and wanted, and what travel choices are made. Altogether, various factors operating at different scales influence people's capabilities, needs, and wishes for activity participation and travel.

So far, I have built a theoretical understanding of the geographical extension of daily travel as a consequence of our need and want to perform activities that are separated in space. I have also emphasized that activities are associated with various time–spatial constraints. These constraints vary

depending on the individual needs that activities fulfil, on how these daily activities are scheduled in time and space, and on individual capabilities, needs, and wishes. Such individual factors have received much attention in the literature in recent decades as people (i.e., “actors” or “decision makers”) have moved to the centre of transport studies, concurrent with a paradigm shift (e.g., the behavioural turn, the time-geographic turn, and activity-based thinking) in social science in general and in human geography in particular. Arguably, the roles of geographical context and space have been downplayed somewhat, at least concerning the potential relaxation of their role over time and concerning the impacts of ICTs. Accordingly, the shift has resulted in controversies concerning our understanding of the role of the built environment in shaping daily travel patterns. These controversies and the general role of spatial constraints and opportunities in daily activity participation – the group of constraints in focus here – are discussed in the next section.

2.3 The role of the built environment in daily travel

2.3.1 Facility constraints

In initial conceptualizations of the human activity approach, Jones et al. (1983) identified “facility constraints” manifested by and related to the built environment. Many of the needed and wanted activities of daily life require specialized facilities adapted to the activities to be performed. In other words, facilities such as schools, workplaces, public offices, shops, and parks shape people’s activity possibilities as people visit them to perform daily activities. Usually, several spatiotemporal constraints are encountered when matching facilities and activities. Some facilities are only available during specific hours and at a limited number of locations. Therefore, when individuals seek to satisfy their personal demand for daily activities, there is a need (to various extents) to match this demand with the supply of facilities. The fact that this supply (manifested in the built environment) is unequally distributed in space is a central departure point of this thesis and constitutes the basis of each of its constituent papers. The main research questions share a concern with the role of the built environment in people’s daily travel in various dimensions: when travelling for various purposes (activities) (*paper I*); how this influential role

changes over time (*paper II*) and when certain activities (in this case, teleworking) are performed in virtual instead of physical space (*paper III*). The answers to these questions are not only of theoretical interest in understanding the mobility dependencies of society; they also help us ponder the effectiveness of spatial planning and policy measures intended to promote sustainable travel (e.g., reduce distance travelled via energy-consuming modes of travel) by changing the built environment (e.g., densifying cities and applying urban planning principles based on compact cities, containment, and proximity).

This raises the question of how properly to observe and measure the built environment and its supply of opportunities for human activity. A wide range of operationalizations is presented in the literature. Various characteristics – for example, proximity to destinations (including agglomerations in city centres, jobs, and various service facilities), density (e.g., population or jobs per hectare), and land use mixes (e.g., job-to-worker ratios and entropy measures) – can all be seen as proxies and measures of the varying spatial supply of facilities mediating the geographical extension of daily travel. I will elaborate further on this in the next section.

When it comes to theoretical explanations of spatial behaviour and organization, the friction of distance and geographical proximity have traditionally been central factors in geography (Couclelis, 1996; Miller, 2007). As physical relocation costs resources (e.g., time, energy, and money), actors are more likely to use geographically easily accessible facilities. As Couclelis (1996) highlights, this is manifested in the widely cited Tobler's (1970, p. 236) "first law of Geography", i.e., "everything is related to everything else, but near things are more related than distant things", and in many classical theories addressing, for example, the size and geographical distribution of cities (Christaller, 1933) and household localization (Alonso, 1964). The same line of reasoning can be applied to daily travel in relation to the proximity to and geographical accessibility of various facilities in relation to where people live (Næss, 2006). Some people live in city centres with a high concentration of activity possibilities, such as workplaces, stores, and various recreational facilities, while others live peripherally, far from urban areas and agglomerations of the facilities needed for daily activity participation. These spatial constraints are often emphasized as highly influential on daily travel (Ewing and Cervero, 2010; Newman and Kenworthy, 1999), while others note that the friction of distance is increasingly being challenged by the spread of

rapid means of transport that relax the capability constraints on individuals' daily reach (e.g., Kwan and Weber, 2003).

Before further elaborating on these relationships and discussions, it is important to point out that the spatial variation in the use of facilities is closely related to the individual needs and wants of daily life and the prioritization of various activities. There are qualitative differences, and proximity is often challenged by taste and preferences (Haugen, 2012; Næss, 2006, 2013). The nearest grocery store might, for example, not be well-enough stocked to supply the ingredients for a certain preferred dish. Other facilities are essentially equally suited for the purpose of a certain activity; for example, all mailboxes are equally suited for posting a letter. However, even for such facilities, proximity to home is not always the most influential factor, as activities may be performed at nearby facilities linked to other activities (e.g., shopping for groceries on the way home from work) (McGuckin, Zmud and Nakamoto, 2005; Næss, 2006). The coupling constraints arising from coordinating an individual's sequencing of activities in time and space, that is, matching daily needs with the supply of facilities, are important in this context. Following the basic time-geographical postulate, it is necessary that individuals and facilities be coordinated in the same place for a certain time. The grocery store, for example, not only must be located near the workplace, but also must have opening hours that coincide with the individual's working hours. Such links between activities, individual constraints, and spatial constraints exemplify how these are not mutually exclusive, but closely interrelated factors. Accordingly, the next section will discuss previously measured relationships between the spatial supply of facilities manifested in the built environment and daily travel.

2.3.2 Relationships between the built environment and daily travel

The relationships between the built environment and travel demand have grown to become one of the most researched subjects in the urban planning literature (Ewing and Cervero, 2010). Boarnet (2011) describes the background to the “explosion” of built environment–travel studies in the mid 1990s in terms similar to those of the activity-based approaches. The rise and increasing problems of congestion and emissions moved transport planning beyond the traditional “predict and provide” approach to a more behavioural focus on how to break habits, curb demand, and promote shifts from car-based to

transit-based mobility. Many scholars and policymakers then realized that the geographical locations of trip origins (e.g., housing) and destinations (e.g., jobs) could also be used to influence travel by using spatial planning as a tool to, for example, place them closer together.

Research into daily travel and the built environment is typically empirically focused (Boarnet, 2011; Ewing and Cervero, 2010). Many of the studies are based on travel diaries and use statistical methods to test potential relationships between various measures of the built environment and travel behaviour. A general trend within this literature in recent decades has been an increasing level of detail as regards spatial context and related characteristics, while early studies often compared travel and built environment measures aggregated to the city level (e.g., Newman and Kenworthy, 1999) or neighbourhood level (e.g., Cervero, 1989). As regards spatial resolution, the development of GIS and of computer power have allowed for more micro-level analysis, which permits detailed measures of the built environment at specific locations (e.g., travel time by different modes from home to the closest grocery store) and of individual travel behaviour. More recent studies are also micro-level in that they typically control for various individual variables (cf. section 2.2.3). The crucial behavioural dimension – travel – is commonly measured in terms of trip rates, travel distance and time, and mode choice.

The extensive literature on built environment–travel relationships includes several reviews² and even reviews of reviews.³ I will therefore provide only a concise overview, and then focus on certain aspects relevant to the research questions posed here. Overall conclusions often highlighted in the literature are that people living in *denser* inner-city areas with *diversified* land use travel shorter distances and use more sustainable transportation modes (e.g., public transport, cycling, and walking) than do others. Note, however, that many scholars question such simplified generalizations, which will be further elaborated on in the following sections. Each constituent paper of my thesis also provides a detailed overview of the literature directly relating to its theme.

In an influential paper, Cervero and Kockelman (1997) summarize the main features of the built environment associated with daily travel as the “Ds

² See, e.g., Boarnet (2011) and Ewing and Cervero (2001, 2010); see Næss (2012) for a review of studies performed in a Nordic context.

³ See, e.g., Gebel, Bauman and Petticrew (2007).

of the built environment” – now commonly cited in built environment–travel studies – namely, density, diversity, and design. These features of the built environment could all be seen as proxies for the varying spatial supply of facilities constituting constraints on the geographical extension of daily activity participation, as discussed above. *Density* typically measures the number of land uses (e.g., population and jobs) within each area of analysis or the number of land uses relative to the geographical size of the area (e.g., inhabitants per square kilometre). Density is, to date, the most studied variable, being relatively easy to determine. *Diversity* typically measures the mix of land use within the area of analysis. A classical and simple measure is the job-housing balance (Cervero, 1989), which captures the spatial mix of jobs and housing within each area. Entropy measures of diversity taking into account many different land uses have recently become more common (Boarnet, 2011). *Design* often refers to the characteristics and design of the street network (Marshall and Banister, 2000). Examples of characteristics are street density, cul-de-sac occurrence, proportions of four-way intersections, presence of separated bicycle lanes, etc.

Complementing these three Ds, more recent studies often use more detailed proxies of the built environment by directly taking account of the actual travel opportunities provided by transport systems. For example, as a more detailed proxy of built-environment features, another D has been added, namely, *destination accessibility* (Ewing and Cervero, 2001, 2010). Destination accessibility takes into account the ease (often by various transport modes) with which various desired activities can be reached from certain locations.

One concern is that many of these features are statistically often highly correlated with each other; for example, densely populated areas often also allow for more mixed land use and better destination accessibility. It could therefore be difficult to evaluate whether or to what extent certain features of the built environment exert a causal influence on daily travel. There is, for example, recent discussion in the literature of local versus regional built environment–travel relationships (Boarnet, 2011; Næss, 2011). Local neighbourhood-scale variables assessing, for example, density or diversity within a census tract have been found to be less important than regional variables. Such regional variables as the distance to the closest city centre are to some extent proxies for a range of other built-environment features (e.g., a range of destinations, including jobs, education, and services, often clustered in

city centres). In the case of travel distance, a key aspect is the importance of longer trips. Longer trips, outside the neighbourhood, constitute large shares of the total distance travelled during a day, making regional-level variables more important. Likewise, in light of increasing mobility, some authors speak in terms of the regionalization of activities when daily activity spaces extend from the local to the regional (Haugen and Vilhelmson, 2013), having consequences for the relationships between the built environment and daily travel. Haugen and Vilhelmson (2013), for example, found that while better local-level spatial access is associated with shorter travel distances, a larger supply of service amenities on a regional level leads to longer travel distances. These issues of scale and causality place high demands on methods and data. The traditional quasi-experimental design of neighbourhood comparison studies (Saelens, Sallis and Frank, 2003) might miss such important dynamics. Data capturing the built environment therefore need to extend geographically far outside the residential neighbourhoods of the sampled individuals. The analysis techniques must simultaneously be able to take into account various scales, including the individual, neighbourhood, and regional scales. These issues have important implications for the empirical approach of this thesis and are further discussed in chapter 3 outlining methods and data.

The results of qualitative studies confirm the importance of regional built-environment features in various contexts, for example in Hangzhou Metropolitan Area, China (Næss, 2013) and Copenhagen, Denmark (Næss, 2006). Næss notes a strong tendency for interviewees to emphasize, rather than the proximity of the closest facility, the importance of having the opportunity to choose from a range of facilities. Daily travel demand could therefore be expected to be more influenced by how the residence is located relative to concentrations of facilities (e.g., city centres), in line with the arguments presented above. Another key conclusion from Næss's studies is the significance of various individual factors, as introduced in section 2.2.3, emphasizing the relevance of activity-based approaches. Travelling for activities in free time can be expected to result mostly from personal interests and preferences. Such discussions of the relative importance of the built environment and individual characteristics and other controversies in the literature are discussed in the following sections.

2.3.3 Controversies

Many scholars highlight the contradictory results and controversies within the literature on built environment–travel relationships (see, e.g., Ewing, Deanna and Li, 1996; Hamidi et al., 2015; Kitamura, Mokhtarian and Laidet, 1997; Pontes de Aquino and Timmermans, 2010; Stead, 2001; Van Acker and Witlox, 2011; van de Coevering and Schwanen, 2006; Van Wee, 2013). A key aspect of these debates is the theoretical and methodological advances and discussions in the research field as discussed above; in simplified (and static) theoretical terms, these concern whether the approach assumes that geography explains the process (i.e., location patterns shape individual travel-activity decisions and choices) or that individual processes explain spatial behaviour and outcomes. In an empirical sense, this is most evident in the increasing inclusion of various individual factors in the analysis. When controlling for various individual characteristics, similar built environmental proxies were found to have no or contradictory effects on travel (Ewing, Deanna and Li, 1996). Giuliano and Small (1993, p. 1485), for example, argued that “evidence is accumulating that in modern cities the effects of commuting cost are swamped by variations in household characteristics, preferences and locational amenities”. Handy (1996) concluded early on that more advanced research methods analysing travel behaviour at the individual micro-level generally find smaller built environment effects. To date, many studies in various ways explore the relative importance of locational and individual characteristics for daily travel. These studies reach divergent conclusions, some finding a strong built environment effect (e.g., Shuttleworth and Gould, 2010), other find little or no such effect (e.g., Bagley and Mokhtarian, 2002; Kitamura et al., 1997; Weber and Kwan, 2003).

Van Wee (2013) lists several reasons why the results differ, including research methods, geographical scale and scope, time horizon, factors included, and indirect effects. Underlying many of these differences, there are often various theoretical, methodological, and contextual explanations. A most obvious explanation is often found in how travel behaviour is operationalized. For example, Meurs and Haaijer (2001), when studying various trip purposes defined by the number of trips during a week, found that travelling to work was almost exclusively explained by individual factors. This comes as no surprise, as the number of work trips can be expected to be a function mainly of employment type and daily pursuit, while travel distance and time are not.

The geographical scope can also be expected to have consequences. For example, large metropolitan areas give people many choices as to where to perform activities and might relax built environment–travel relationships compared with more sparsely populated areas. However, some authors go further and argue that contemporary spatial behaviour is becoming more complex due to technological and socioeconomic developments, a behaviour that is increasingly disentangled from the built environment (Kwan and Weber, 2003; Miller, 2007). These discussions raise many important questions to which I will return in the next section.

The idea of a simple and “direct causality” between the built environment and travel is further challenged from other theoretical perspectives. For example, based on economic utility theory, some scholars view the features of the built environment mainly as factors that influence the cost of travel by determining travel times (Boarnet and Crane, 2001, as cited by Boarnet, 2011; van Wee, 2011). This view is part of a long tradition, notably among urban economists, in which individuals are seen as homogeneous rational actors weighing travel costs, wages, land rent, etc., to reach various spatial outcomes (e.g., Alonso, 1964; Brueckner, 2000). Such perspectives, however, are increasingly challenged by the complexities underlying contemporary spatial behaviour derived from the need to perform activities, as outlined throughout this thesis (cf. Giuliano, 1989; Kwan and Weber, 2003; Mokhtarian, 2005). In this context, it is appropriate to comment on the criticism of the view of travel as a derived demand (Mokhtarian, 2005; Mokhtarian and Salomon, 2001). Ory and Mokhtarian (2005), for example, highlight several occasions when travel is an end in itself, including for physical exercise, variety-seeking, adventure seeking, and escape. This view obviously challenges a narrow economic–rational approach treating travel as a disutility to be minimized and also casts some doubts on activity-based approaches. However, I see no direct contradictions between the theoretical understanding constructed here and a focus on choice in the context of constraints and the perception that travel is sometimes wholly or partly an end in itself. In fact, as further discussed in the next section, this constitutes an important aspect of my hypotheses. When more trips are not made in connection with activities during contracted time (paper I), and when mobility technologies evolve and become more available (papers II and III), the individual meaning of travel as a

(leisure) activity in itself might be more important than, for example, the location patterns of the built environment.

Also challenging the direct causality is the discussion of to what extent people weigh future travel abilities, needs, and preferences when they choose their residential location, i.e., the residential self-selection hypothesis (Mokhtarian and Cao, 2008). The self-selection hypothesis taken to its theoretical extreme claims that the built environment has no effect on daily travel because individuals freely choose their place of residence according to their travel needs. However, this hypothesis is questioned due to, for example, the fact that even though people largely weigh future travel needs when changing residential location, the underlying location patterns of the built environment still have an effect by allowing households to make that choice (Næss, 2009, 2014). Cao, Mokhtarian and Handy's (2009) review of 38 self-selection studies also found no studies that did not establish a significant travel–built environment relationship after controlling for self-selection. A rich set of socio-demographic variables appears to account for most self-selection (Bhat and Guo, 2007; Brownstone and Golob, 2009, as cited by Guerra, 2014).

In summary, a main lesson from the extensive literature on the relationship between the built environment and travel is the importance of placing studies in theoretical and geographical context, and pay attention to individual constraints and opportunities. Daily travel is fundamentally a human behaviour and is in that sense very complex and multifaceted. The determinants work on several scales – individual, household, local, regional, societal, etc. – and therefore need to be understood within these various contexts. As touched upon in the following section, some of the “controversies” might unravel if seen through an activity-based lens focusing on spatiotemporal constraints. Given the activities that individuals want and need in their everyday life and given the various time–spatial constraints and opportunities to which these activities are connected, the built environment can be expected to have a range of meanings and roles. In view of the complexity underlying contemporary society, various processes and factors could be expected to contribute to major differences in the geographical extension of daily activities for individuals living in similar built environments. It is therefore a key task for geographers to explore these processes and factors, and specifically ask for whom, when, where, and how the location patterns of the built environment influence people's everyday geographies.

However, before embarking on such an empirical endeavour, it is important to take a step back, and relate the built environment's potential role in and importance for personal travel to a broader, long-term view of socio-spatial change associated with processes of time–space convergence. In the next section, I therefore cite such conceptualizations to justify closer analysis of the specific relationships between the built environment and daily travel explored in the papers.

2.4 The changing role and importance of the built environment

The well-established concept of time–space convergence denotes the fundamental process of how transport and communication technology affect people's use of geographical space. The concept was introduced in the 1960s by Janelle (1969),⁴ who demonstrated that the diffusion of transport innovations brought places closer together in time and thus also in relative and perceived space; i.e., when the time required to move between locations decreases, the significance of geographical distance subsides. Typical of geographical research at the time, Janelle developed a quantitative model illustrating how increasing time–space convergence led to major changes in the location of supply, in this case food stores in the western United States. The concept of time–space convergence and its implications are now widely acknowledged theoretically and empirically (Dodgshon, 1999; Harvey, 1989; Knowles, 2006). The concept has become even more prominent because of the rapid development of ICT and its potential impact on spatial processes and behaviour (Kwan, 2002) – ultimately expressed in terms of the “death of distance”. The convergence discussion is central to my thesis focusing on everyday life and the role of the built environment in shaping people's daily activity patterns. The rapid time–space convergence occurring in Sweden in the 20th century was discussed in section 1.5 and is indicated by the access to and use of physical space-bridging technologies that have caused the actual daily distance moved to increase dramatically.

⁴ The concept of time–space convergence is closely related to the concepts of “time–space compression” (Harvey, 1989) and “time–space distanciation” (Giddens, 1984) that were introduced later but describes generally similar processes.

Time–space convergence is not only associated with increased activity spaces, but also constitutes a process that increases the complexity of the relationships between individuals, built environments, and travel, all in all indicating weakening built environment–travel relationships (Brotchie, 1984; Giuliano, 1995; Kwan and Weber, 2003; Miller, 2007; Mokhtarian and Tal, 2013). Spatial constraints generally relax when individuals gain more control over where to perform daily activities, making travel patterns more heterogeneous and varied. This relaxation of constraints has also had repercussions for location decisions (e.g., where to locate shopping centres, housing, and workplaces), producing more dispersed location patterns and regional structures (cf. Brotchie, 1984) commonly referred to in terms of urban sprawl and regional enlargement. In theory, time–space convergence presents a radical contrast to the simplified theoretical hypothesis underlying some of the literature on built environment–travel relationships, and to many of its planning implications. This hypothesis is based partly on the idea that individuals who share spatial constraints and opportunities (e.g., living in the same neighbourhood and sharing identical built environments) largely share similar daily activity spaces and patterns. However, apart from that, there seldom exists such direct mono causality (cf. section 2.3.3): increasing opportunities to overcome geographical distances probably increase the importance of capabilities and constraints directly linked to individuals (and their households), as the capacity to travel rapidly increases individual variation in travel in terms of destination and distance. This raises concerns regarding the traditional approach, which views individuals as more or less homogenous actors who largely shape similar daily activity patterns according to the nearby general opportunities that the built environment offers (cf. Miller, 2007).

From the perspective of this thesis, it is important to stress that few empirical studies of daily travel and the built environment test the hypothesis that spatial factors are declining in importance over time, i.e., time–space convergence in ongoing, an issue also important in relation to discussions of peak travel (Frändberg and Vilhelmson, 2011, 2014; Metz, 2010). Some studies are exceptions, having presented varying results, but without finding evidence of major changes over time in recent decades (e.g., Grunfelder and Nielsen, 2012; Guerra, 2014; Susilo and Maat, 2007; Zegras and Hannan, 2012). *Paper II* contributes directly to this discussion by examining whether the relative

significance of residential location and the built environment has decreased in Sweden in recent decades when it comes to commuting distances.

Another important aspect of time–space convergence concerns the rapid development of ICTs. ICTs augment the space-transcending capabilities of individuals and relax the coupling constraints of human interaction. Research into the links between ICT and the demand for daily travel has a fairly long tradition (Andreev, Salomon and Pliskin, 2010; Mokhtarian, 1990; Mokhtarian and Tal, 2013; Salomon, 1986). This literature has traditionally been interested in whether ICT substitutes, generates, or/and complements travel, where substitution would clearly reinforce convergence in terms of “distanciation” and complexity. More recently, the possible effects of the modification and fragmentation of daily activities, time use, and mobility have been examined (Lenz and Nobis, 2007). A general conclusion from this literature is that ICT access and use increase the complexity underlying daily travel choices (Dal Fiore et al., 2014; Mokhtarian and Tal, 2013). However, there is little empirical scrutiny of how ICT influences built environment–travel relationships (see paper III for a detailed review). The potential of ICTs to ease various spatial constraints is often theoretically emphasized, for example, by possibly replacing traditionally location-based activities (e.g., work and banking) with virtual ones, and by creating opportunities for individuals to choose more freely where to perform daily activities (Van Wee, Geurs and Chorus, 2013). These discussions of the lessening of spatial constraints due to virtual mobility provide a key justification for *paper III’s* focus on one prominent ICT-based activity, telework. The ability of a person to telework (often enabled by using ICTs) might relax daily spatiotemporal constraints and erode the strong relationships between the built environment and daily travel behaviour on workdays – an important issue to explore given the strong focus on commuting trips in traditional distance- and location-based models used for predicting and planning transport.

Processes of time–space convergence also relate to several other broad social changes that potentially further complicate and erode relationships between the built environment and daily mobility. Many of these changes are linked to the rapid labour market changes of recent decades, changes characterized by, for example, increased flexibilization and uncertainty, less manual and more knowledge-intensive employment, increasing double-career households, a smaller proportion of the total population gainfully employed,

and a larger proportion of the population in higher education and retirement (Borggren, 2011; Green, 2004; Green, Hogarth and Shackleton, 1999; Östh and Lindgren, 2012; Standing, 2011; Van Ham, 2002; Weber and Kwan, 2003). Important topics in the context of these processes concern how people choose between daily activities and travel purposes, what daily activities are actually being carried out, and how the time–spatial constraints associated with certain everyday activities have changed (cf. section 2.2.2). For example, fewer people are permanently employed with distinct time–spatial boundaries, instead being engaged in flexible working practices and non-manual jobs (Green, Hogarth and Shackleton, 1999). This increases commuting tolerance and opportunities to plan where and when work is performed (e.g., by teleworking), relaxing work-related spatiotemporal constraints for some workers.⁵ In turn, this may also change the priority order of everyday activities. For example, certain activities conducted during committed time (e.g., picking up and dropping off children at school) could become more constrained in time and space than contracted-time activities. Furthermore, as larger proportions of the population retire, while others are engaged in higher education, larger shares of these groups' daily activities will be associated with committed and free time, possibly accompanied by greater spatiotemporal autonomy (especially in free time). For these reasons, it is important to study whether the relative importance of the built environment and individual choice to travelling behaviour in contemporary society is conditional upon trip purpose (i.e., activity) – a main justification for *paper I*.

In summary, the described developments raise many important questions. When opportunities to travel (physically as well as virtually) increase, the importance of the (local) localization patterns of the built environment for daily mobility can be hypothesized to decrease, while individual-related factors might play an increasingly prominent role. This hypothesis needs to be examined empirically in various respects. Is it valid for all travel purposes? Is the built environment really decreasing in importance over time? What is the role of ICTs in this context? Answering these questions requires a theoretical understanding of the determinants of travel, of the importance time, scale, and

⁵ This “flexibilization” also has many downsides for individual workers (Standing, 2011). Under precarious working conditions, for example, it is more difficult to make longer-term mobility decisions about, for example, residential relocations, and people can be forced to endure long commuting distances.

the varying spatiotemporal constraints of daily activities, of individuals' needs and wants in daily life, and, not least, of how to properly operationalize the built environment. These factors were all important when designing the empirical studies, as described in more detail in the following chapter.

3 Data and methods

3.1 Point of departure

When outlining the theoretical framework, I argued that engaging with built environment–travel relationships in contemporary society makes specific demands in terms of the data needed and methods to be used. Besides focal information concerning individuals’ daily travel behaviour, it is also crucial to characterize their capabilities, obligations, as well as daily activities that involve travel. Furthermore, there is a need for detailed information on spatial context, i.e., the facilities inherent in the built environment on different spatial scales, and on the physical opportunities to reach these. Conducting geographic research within the Swedish context therefore has its advantages, because of good access to detailed, high spatially resolved micro-data covering the total population and spanning comparatively long periods of time. My thesis seeks to benefit from this comparative advantage and advances the research field by applying a multivariate quantitative approach (e.g., multi-level statistical models) to a unique combination of such rich data sources. In other words, it is the quantification of actual behaviour, distances, built environments, background factors, etc., that is in focus. This is associated with a number of ontological possibilities and limitations (Næss, 2004; Sayer, 1992). For example, the thesis does not extend to personal attitudes, meanings, and desires, excluding individual perceptions and valuations of geographical proximity in various respects.

This chapter provides a general overview of data and methodological considerations, while further details can be found in the constituent papers of the thesis. The sources of data are presented in the next section. This is followed by an account of the empirical approach, including empirical operationalizations of key concepts, statistical methods, and a discussion of important limitations.

3.2 Data

3.2.1 Complementary data sources

Three basic complementary data sources are used (in different combinations)

in the thesis' papers. These data enable a joint description and analysis of how individual daily travel activities, given varying individual mobility capabilities, are associated with spatial opportunity structures, i.e., the underlying built environment patterns of transport infrastructure, housing, workplaces, services, and other facilities. Information about spatial opportunities at the local and regional levels, as well as certain information about individual mobility capabilities, are retrieved from the Geographical Individual Longitudinal Database for Analysis (GILDA). GILDA comprises geocoded micro-data on every individual and organization in Sweden. Information concerning actual travel activities is retrieved from the Swedish National Travel Survey – RES. RES includes survey data on all everyday trips of large randomized samples of the Swedish population. Furthermore, a GIS-based accessibility tool adds information about potential access to opportunities facilitated by transport networks. GILDA is used in all three papers to define various characteristics of the built environment, and in paper II also to define certain individual-level variables. RES is the main source of data used in papers I and III to define both individual characteristics and travel behavioural variables. The highest possible geographical resolution of residential neighbourhoods is then used to integrate information from RES and GILDA. In addition, paper III takes into account actual opportunities to reach destinations provided by the public transport and car-road networks. The rest of section 3.2 further describes these data, followed by an account in section 3.3 of how the data are used in the empirical analysis (see also Table 1).

3.2.2 GILDA

The GILDA database is administrated by the Human Geography unit at the University of Gothenburg, Sweden. It comprises official register data provided by Statistics Sweden from the database Longitudinell Integrationsdatabas för Sjukförsäkrings- och Arbetsmarknadsstudier (LISA) (SCB, 2011). Annually updated data, starting from 1990, from educational, income, employment, health insurance, and population registers are integrated in this database. It holds data on every individual, sixteen years or older, registered in Sweden as of the 31st of December each year. A wide range of variables regarding demographics, education, employment and unemployment, income, and social security are included. Gainfully employed individuals are linked to their

workplaces, which are characterized by several variables, for example, industry sector and number of employees. From a geographical perspective, a key focus in my thesis is the inclusion of geographical coordinates for the places of residence and work of each individual (with a 100-metre resolution). This information is fundamental to the research designs applied in the papers, as it allows the definition of variables that describe the spatial characteristics and locational patterns of the built environment (see section 3.3.1).

3.2.3 National travel survey

RES comprises data on the everyday travel of the Swedish population aged 6–84 years and is conducted by Transport Analysis, a governmental transport policy agency. Paper I is based on RES 2005-06 (SIKA, 2007) and paper III on RES 2011 (Trafikanalys, 2012). The initial sample of RES 2005-06 included 40,928 individuals and the response rate was 68%. RES 2011 initially included 39,596 individuals and the response rate was 43%. The survey is carried out by phone interviews referring to prepared individual travel diaries. Every individual is randomly assigned a survey day during the studied period and the diary is sent by mail a few days beforehand. Information about two main types of trips are included in RES: all trips taken on the survey day and any trips longer than 100 kilometres taken during the month before the survey day. Since the focus here is on daily travel, only trips taken on the survey day are used. Furthermore, the respondents are also asked questions about various background conditions (e.g., income, household situation, and car access) that may affect their travelling behaviour.

All relocations outside the respondent's dwelling are surveyed, including short walks. These are defined and arranged in a hierarchy of main trips, partial trips, and trip elements. A trip is defined as a main trip if it starts and ends at a facility defined as a main trip location. A main trip location is the respondent's main dwelling, holiday house, workplace, school, or temporary overnight abode. The main trip consists of one or more partial trips, which emerge when the respondent performs an errand outside of a main trip location. The partial trip is divided into trip elements when the respondent changes travel mode. Furthermore, each main trip, partial trip, and trip element is characterized by a range of variables. For example, respondents are asked to

report the main purpose of main and part trips, while for trip elements they are asked to state, for example, travel mode, distance, and time.

3.2.4 Accessibility calculations

For paper III, which is delimited to the greater Gothenburg area, GILDA was complemented with a GIS-based accessibility tool⁶ for the purpose of more precisely capturing the potential given by transport systems to reach built environment facilities (e.g., workplaces and stores). This tool computes travel times by car and public transport between 500×500 -metre cells using a detailed “door-to-door” approach. Because of this comparatively high geographical resolution, it was impossible to run such an analysis nationwide. The tool uses several input data sources. The computing of car travel times is relatively straightforward. First, the centre point of each cell is linked with a straight line to its closest road segment. The road network is compiled from the official Swedish road database (NVDB) provided by the Swedish Transport Administration. Second, travel time is computed by means of simple shortest-path analyses based on the speed limit and length of the road links. Travel times by public transport are drawn mainly from the timetable database of the regional public transport authority (Västtrafik). Based on this data, an origin–destination matrix of travel times between all public transport stops within the study area was compiled. The selected travel times describe the fastest connections when arriving at each stop within a timeframe set to 7–8.30 am on a regular weekday. Finally, the estimated times it takes to walk via the road network to the closest public transport stop from the starting and destination cells are also added to the travel times. These combinations of data make it possible to define detailed built-environment variables by measuring travel times by car and public transportation between the residential location of the respondents in RES and key destinations defined using GILDA. One such variable is how many jobs can be reached within a certain travel time by car or public transport from the respondent’s home location.

⁶ This tool was initially developed by Dr. Svante Berglund, KTH Royal Institute of Technology, for Skåne, Sweden. I developed it further as part of a research project about accessibility planning for Västra Götaland, Sweden. For further description of the tool and its underlying data, see Larsson et al. (2011) or Larsson and Elldér (2014) in English.

Table 1. Basic information regarding the data and methods used in the papers.

	Paper I	Paper II	Paper III
Aim	Examine whether residential location relative to individual attributes affects daily distance travelled when individuals travel for various purposes.	Analyse how home-work distance varied among workers and across residential areas in Sweden, 1990–2010.	Examine how urban structure relates to the daily travel behaviour of teleworkers compared with workers who do not telework.
Data source	RES and GILDA	GILDA	RES, GILDA, and accessibility instrument
Method	Multilevel modelling	Multilevel modelling	Pearson correlations and OLS regressions
Study area	Sweden	Sweden	Gothenburg, Sweden
Time period	2005/2006	1990, 1995, 2000, 2005, and 2010	2011
Number of observations	12,370	140,531–171,859 depending on the year studied	2500
Definition of travel	Total daily distance travelled for all purposes, including work, services, and leisure, on both weekdays and weekends	Euclidian home-work distance	Total daily travel distance and time on workdays

3.3 Methods

3.3.1 Empirical considerations

This section presents and discusses overall empirical considerations such as concept definitions and the treatment and merging of data. More detailed considerations regarding, for example, variable definitions and data selection procedures are described in each paper.

Travel-activity locations of origin

In measuring travel behaviour, I take operational departure in people's residential location. This plays a central role in shaping the regularity of daily activity patterns as most daily trips start from and return to people's homes (Ellegård and Vilhelmson, 2004). The home is also the only place that can reasonably be considered of relatively equal importance across various population groups and activities. This increases the possibility of making comparisons between the three studies. Besides, the residential location is of practical importance as it serves as a data merging key in the empirical designs. For ethical reasons, it is impossible to identify and match information on the same person in RES and GILDA. However, geo-referenced information makes it possible to build detailed spatial variables using GILDA and to link these to the actual travel behaviour of individuals defined by RES.

However, locations other than the home might also be important anchoring points for the organization of a person's daily travel activities in specific cases, and have when possible been considered in the research. Arguably, this is particularly relevant to workplaces, as work often acts as an anchor around which other activities are scheduled (Saxena and Mokhtarian, 1997; Schwanen, Kwan and Ren, 2008). As GILDA provides detailed information on the workplace location, this was explored when building the statistical models for paper II. The results suggest that the workplace location also constitutes a source of variation in commuting distance, but that the residential location is much more important. Other daily activity nodes, especially children's schools and day-care centres, could sometimes be expected to play a part but are not covered in the data sources.

The issue of spatial resolution

Once the location on which to base the empirical analyses has been chosen, new challenges are encountered. A first operational dilemma, also highlighted by previous research, concerns the definition and spatial delimitation of residential areas (Horner and Murray, 2002; Kwan and Weber, 2008). In many studies, this is a main limitation because data are often based on various administrative areas that are more or less suitable in terms of both travel behaviour and the built environment. Built environment–travel relationships have traditionally largely been studied at an aggregate level, sometimes that of whole cities (e.g., Newman and Kenworthy, 1999) and often at the neighbourhood level (Saelens, Sallis and Frank, 2003). The many pitfalls associated with using different area definitions and aggregations – i.e., the spatial resolution – have long been highlighted (Openshaw, 1984; Robinson, 1950). When data are grouped into spatial units, important individual variation might be missed, and different area definitions can also create different results. The highest spatial resolution in RES is delimited to Small Area Market Statistics (SAMS) areas and is therefore used as a basis for capturing the built environment in all papers (the second highest spatial resolution is that of municipalities, which are considerably less detailed). SAMS areas are statistical areas defined by Statistics Sweden for the purpose of representing residential neighbourhoods (Amcoff, 2012; SCB, 2005); there are about 9200 SAMS in Sweden, with an average of around 1000 people living in each. Like most area definitions, the validity of SAMS is open to question. In the geographical literature, most prominently as regards neighbourhood effects, SAMS are sometimes pointed out as highly problematic since the number of individuals included in each area varies between zero and tens of thousands (Amcoff, 2012). The most important aspect as regards area definitions in my thesis, however, is that these are homogeneous in terms of the built-environment features theoretically expected to influence daily travel distances. Geographically, the SAMS are quite detailed within cities, but can be very large in the sparsest-populated parts of Sweden. This makes it more problematic to portray the built environment within and near SAMS far away from urban agglomerations and to define exact geographical points for defining variables. One measure taken to minimize potential biases has been to use the geographical potential of GILDA and define a demographic centre of gravity based on all inhabitants registered in each SAMS. Furthermore, when fitting

models for paper II, the high spatial resolution of GILDA was also used to evaluate different area definitions, and both administrative areas (i.e., municipalities, postcode areas, parishes, and SAMS areas) as well as 1- and 5-kilometre cells were used. If much larger areas are not used (e.g., municipalities, which give smaller built environment effects), the overall results are similar.

Spatial characteristics of the built environment

A wide range of variables that capture various aspects of the built environment on different scales – local (e.g., within residential areas, i.e., SAMS) as well as regional – defined from GILDA has been evaluated. A typical local built environment variable is the population density within SAMS. The more regional variables can, for example, describe the distance from the population centre of each SAMS to its closest city centre. Papers I and II use Euclidian distances, but paper III uses accessibility calculations to account for the opportunities provided by cars or public transport. It is thus possible to compare the results of variables describing the proximity to similar facilities but with different distance constructs (Paper III), and to evaluate potential biases in more crudely defined variables (Papers I and II). A great many variables that capture different aspects of the built environment are defined initially for each paper, for example, the shortest distance to various facilities (e.g., grocery stores and day-care centres), density measures (e.g., population, jobs, and streets), and regional location (e.g., distance to closest city or suburban centre). The papers further describe the selection and exact definitions of the built-environment variables used. Paper III also includes a more detailed list and evaluation of different variables.

Measuring trips

The main dependent variable in all three papers is travel distance. Distance is chosen as it underlies other travel dimensions such as speed, time, and frequency (cf. section 1.4). Focusing on distance (in contrast to time and speed) also more explicitly addresses sustainable mobility, including environmental impact (e.g., energy use and GHG emissions), social differentiation (e.g., equal access), and wellbeing and health (e.g., physical activity) (Banister, 2008, 2011). However, though measuring travel distances may appear straightforward it can be problematic. Various methods can be used, including self-reporting, Euclidian distances (calculated from trip origins

and destinations), GPS tracking, and vehicle miles travelled, each having various benefits and drawbacks (see e.g., Bricka and Bhat, 2006; Sparks, Bania and Leete, 2011; Wolf, Oliveira and Thompson, 2003). The use and comparison of multiple data sources, in which distances are measured differently, again provides opportunities to assess potential biases. In papers I and III, based on RES, the respondents report the distances travelled in a survey. The dependent variable in paper I is defined as the total daily distance travelled for different purposes, including work, service, and leisure on both weekdays and weekends. Paper III uses the total distance travelled on the survey day for all purposes. In both papers, every trip (via all transport modes) is included. Trips are observed regardless of how long (or short) they are, but do not include travel abroad. For paper II, there is no information available on the actual travel distance. The geographical information in GILDA is instead used to calculate Euclidean distances between home and work. To reduce possible biases (e.g., weekly commuters residing in temporary housing on weekdays), workers registered as living more than 200 kilometres from work are excluded.

To sum up, an overall intention has been to take advantage of the particular qualities of different data sources to strengthen the validity and reliability of the empirical operationalizations and analyses. The geographic dimension has been central here, not only in practically integrating the data, but also to increase comparability between studies. The rich datasets provide good opportunities to operationalize and analyse the relationships between the built environment and travel. The next section briefly discusses the analytical techniques used.

3.3.2 Statistical methods

The complexity of the relationships between the built environment and daily travel, combined with the high resolution of the data, places specific demands on the statistical analysis techniques. In light of the many previous studies that have found strong effects of various individual factors, an initial basic requirement is that the approach should allow for multivariate analysis in which such potential covariates are controlled for. Both GILDA and RES contain a number of variables describing individual and household-related characteristics previously found important. Each paper includes a set of such

variables comprising, for example, car access, income, education, and family situation. This is to ensure that the variation in travel behaviour potentially explained by the built environment is not due to, for example, certain groups of people being clustered in similar geographical contexts. Both GILDA and RES generally provide good opportunities for this, the main difference being that GILDA does not include any information about driving licensing or car access. As expected, in the empirical analysis in papers I and III based on RES, these variables proved important. Part of this variation is probably captured by other socioeconomic variables available in GILDA, for example, income and life course.

Two main multivariate statistical analysis techniques are used: multilevel linear modelling using MLwiN software (papers I and II) and ordinary least squares (OLS) regression modelling using SPSS software (paper III). Multi-level models are an umbrella term for various statistical models that all address the hierarchical or clustered structure present in most behavioural data (Goldstein, 2011). There are natural hierarchies in many datasets, especially those that involve spatial information. For example, people living within the same residential neighbourhood tend to be more like each other than are people randomly chosen from the rest of the population (e.g., the self-selection hypothesis discussed in section 2.3.3). This data clustering is ignored in standard regression models, which assume independence between observations. Multilevel models recognize that such hierarchical data levels exist by allowing effects to work at each defined data level. Several facets of the importance of such scale issues have been discussed. The determinants of daily travel distances could theoretically be expected to work at various scales. Individuals are situated in and share different contexts, such as residential neighbourhoods, regions, workplaces, and households, that need to be considered analytically. In addition, the effects of various characteristics of the built environment have also been found to differ across scales. Multilevel models are specifically designed to address these matters. The hierarchical structure of the models also provides additional analytical opportunities that have been important in answering the research questions in papers I and II. By dividing the analysis into different hierarchical levels (i.e., individuals clustered in residential areas), for example, it is possible to derive the similarity of the distances travelled by individuals living in the same neighbourhood.

3.4 Limitations

This section highlights some key limitations as regards data and methods. First, the analysis is mainly limited to measuring the impact of the built environment on the distance that individuals travel daily. Although distance is fundamental in many respects, people's daily travel-activity patterns are obviously multifaceted, incorporating other important dimensions for which the built environment can be expected to differ in role and importance from that of the distance context. Travel time is one example, and has to some extent been taken into consideration by being included as the dependent variable in paper III. In this case, the built environment proved to be less significant for daily travel time than it was for distance, but displayed similar inter-group differences. However, the relationships between different travel dimensions (e.g., distance, time, and speed) might vary depending on trip purpose. The distance to work, for example, can be expected to be covered in a shorter time (i.e., at higher speed) than leisure trips, which are often slower. This is only partly captured in travel distance. In relation to this, it may also be noted that the empirical models focus on estimating changes in the mean of the dependent variable travel distance. Like many other variables that describe spatial interaction, travel distance is highly positively skewed and, again, the distribution can differ among various travel activities. Taking discretionary travel as an example, some trips might be short distance (e.g., walks in the neighbourhood) while others are considerably longer (e.g., road trips on the weekend). Consequently, models of the mean might miss explanations of parts of the distribution. Fitting models with other assumptions, such as quantile regressions based on the median, might change some of the inferences. This particularly applies when large outliers, i.e., very long distances, are present in the analysis. However, since the focus is on daily travel (and different delimitations have been applied to this end), few outliers are present in the various datasets. If less frequent long-distance travel had been included, the risk of biases would have been higher.

Furthermore, the population of the empirical studies does not include children 16 years old or younger or people older than 84 years. The daily travel patterns of these excluded groups are likely to differ than from those included in the analysis of the thesis. Finally, it is important to acknowledge that the cross-sectional nature of the empirical designs makes it difficult to definitely infer the direct causal effects of the built environment (Cao, Moktharian and

Handy, 2009; van de Coevering, Maat and van Wee, 2015). In particular, the scheduling of daily travel is in various ways interrelated with longer-term mobility decisions and habits, such as the decision to buy a car or move one's place of residence. Experimental designs and longitudinal approaches could allow more robust conclusions regarding causal relationships and effects; however, such conclusions would still be difficult to reach considering the complexity of factors contributing to individual travel behaviour and that daily travel occurs within relatively "open systems" (Næss, 2004, 2015). As elaborated on in the theoretical framework description (e.g., section 2.2), the built environment does not in itself create travel, but is one of many contributory factors. To discover the incentives and mechanisms underlying the measured relationships between the built environment and daily travel, qualitative methods are also needed. Note finally that each paper further discusses its specific limitations. Related recommendations for future studies are given in section 5.2.

4 Paper summaries

Paper I

This paper takes its point of departure in the often cited controversies regarding the extent to which proximity and the built environment relative to individual choice explain daily travel demand. It contributes by investigating whether the relative importance of these factors to travel distance changes when different travel purposes are considered. Trip purpose is examined from an activity-based perspective focusing on the varying spatiotemporal constraints of daily activities. For this purpose, multilevel statistical models are applied combining two rich sources of geocoded micro-level data: Swedish National Travel Survey data from 2005–2006 captures individual travel behaviour while Swedish register data capture the built environment. Separate models are fitted to examine the extent to which everyday travel distances for various purposes vary among individuals who share residential locations. Three main categories of trip purposes are modelled: trips to activities performed during contracted time (work trips), committed time (e.g., service trips to the grocery store and for health care), and free time (e.g., various leisure trips).

The results indicate that the influence of residential location and the built environment on daily distance travelled is conditional on trip purpose in a nationwide Swedish context. Statistically significant proportions of the variation in daily distance travelled to work and, to a lesser extent, on service errands are dependent on proximity to various features of the built environment. Daily distances travelled for leisure activities vary greatly among people living in the same neighbourhood, however, and in this context, variables capturing the built environment were found to have no significant effects. These results confirm the importance of considering the time–spatial constraints of activities when examining the relationships between location, individual characteristics, and travel behaviour. Also, from a policy perspective, these results suggest that measures intended to alter the built environment to reduce the volume of travel will be most effective in addressing work trips, while trips taken during free time will likely be little affected. In addition, the multilevel models applied reveal several important interactions between variation in travel distances across residential locations and individual characteristics of which researchers should be aware, especially when examining service trips.

Paper II

Some scholars emphasize that everyday travel behaviour is becoming less location based and increasingly dependent on individual choice, mainly due to increasing mobility capabilities. Few studies, however, apply a dynamic approach and attempt to quantify how or in what direction the relative significance of built environment factors for everyday travelling has developed in recent decades. Doing so calls for further empirical examination using appropriate data and statistical models. The empirical analysis presented in this paper focuses on work travel: as it is generally more closely related to the built environment than are other types of travel (cf. paper I), it is often emphasized in traditional distance- and location-based models and policies used in predicting and planning transportation. Trends in the relative significance of residential location for home–work distance in Sweden, 1990–2010, are explored. The analysis has two aims: first, to evaluate to what extent workers who live in the same residential area travelled similar home–work distances during the studied period and, second, to evaluate whether there has been any change in the effect of individual and spatial characteristics on the home–work distance. The paper uses official register data from GILDA covering the home and work locations of the total Swedish working population.

Two results from the analysis that are important in relation to previous research can be highlighted. First, the explained variance in commuting distance attributed to the individual level is low compared with that found elsewhere. Most previous studies were based on single metropolitan areas that are comparatively geographically homogeneous and generally include better choice opportunities as regards possible job locations. The nationwide Swedish case, however, includes a wide variety of built environments ranging from large urban agglomerations to very sparsely populated areas. The most important result, however, concerns changes over time. The results indicate growing variation in home–work distance for workers living in the same residential neighbourhoods, indicating that the significance of residential location for home–work distance decreased throughout the studied period. This leads to a conclusion that relationships between daily travel and the built environment could indeed change over a few years. This possibility calls for studies exploring whether changes are occurring in other dimensions as well, for example, as regards additional travel activities or in other geographical contexts.

Paper III

The third paper studies work-related travel in detail, considering how it relates to the built environment by focusing on a key ICT-based activity, i.e., telework, that has increased rapidly in recent years in Sweden. It is often argued that, due to its space-transcending abilities, ICT use reduces the importance of proximity as an organizing principle of travel. However, as telework has so far not been that widespread, most previous studies use small samples, unrepresentative of entire workforces. More precisely, this paper investigates whether the built environment influences daily travel behaviour differently when people telework in urban contexts. Regression models are applied to address whether and to what extent travel is associated with various measures of the built environment and key destination accessibility relative to the home location in Gothenburg, Sweden. The analysis treats groups of workers defined by teleworking practices. Micro-level data from the Swedish National Travel Survey, 2011, capture individual travel behaviour, and Swedish register data on the location of all firms and individuals combined with a GIS-based tool measuring travel times by car or public transport capture the built environment.

The results indicate that telework weakens the relationship between the built environment and daily travel in various dimensions. First, workers are differentiated in terms of those who did and did not report teleworking regularly. The total daily travel distance and time are significantly related to the built environment for both groups, but the built-environment variables explain considerably more of the variation in travel for non-teleworkers. Second, only regular teleworkers were analysed, and differentiated based on whether or not they teleworked on the survey day. For those respondents, the built-environment variables explain little of the variation in travel time and distance, and retain few significant effects when fitting the models. These results lead to the conclusion that telework allows various mobility strategies that together foster more spatially heterogeneous daily travel behaviour, more dependent on personal attributes than on the home location relative to various built-environment features. Planners and policymakers should monitor whether the number of teleworkers continues increasing. If so, traditional distance- and location-based models and policies for predicting and planning transport may prove less accurate and effective than currently assumed.

5 Concluding discussion

5.1 Main conclusions

Geography, in terms of the built environment and location patterns, was traditionally, and still is, emphasized by many scholars, policymakers, and planners as greatly influencing people's daily travel behaviour. However, taking recent decades of rapidly increasing mobility capabilities (physical as well as virtual) into account, and the related increase in individual choice opportunities, others argue that the importance of geographic factors has gradually dissolved. Starting from this discussion (and controversy), the overall aim of this thesis is to examine the current role and relative significance of the built environment for the geographical extension of individuals' daily travel in Sweden. Particular attention is paid to detailing the impact of geographic factors on various daily travel activities, including the potential relaxing of the relationships between locational structures and travel behaviour enabled by space-transcending ICT use, and to detecting actual changes over time. This final chapter proceeds from these concerns and outlines the main findings from my three empirical studies and relates them to an overall framework and understanding of the issues at hand. The main conclusions are first summarized in this section, which is followed by discussions of implications for further research (section 5.2) and of practical lessons (section 5.3).

An overall conclusion of my thesis is that *the proximity of various aspects of the built environment to home still plays an important role* in how far people in Sweden travel daily. However, my analyses, informed by theory emphasizing everyday spatiotemporal constraints and using rich sources of geocoded micro-data, reveal that these relationships have become relaxed in several important respects. First, the specific time–spatial constraints associated with different *daily activities that motivate trips and travel* are *key* and also *differentiating factors when it comes to this relaxation*. When considering trips taken during holidays and for everyday leisure purposes, the built environment is less important for the observed daily travelled distance. Activities carried out during daily free time are related mainly to the individual's own capabilities and wants rather than to his or her physical environment. This means that, compared with the firmly established routines and space–time fixities of work-related travel, school trips, etc., personal preferences and interests as regards daily *free time* are translated

into activity patterns less dependent on the built environment surrounding the place of residence. Apparently, individuals can schedule these activities more freely in time and space. Other travel activities are, however, more dependent on proximity and the local environment. It has been demonstrated that the distance Swedes cover to perform activities in relation to *committed time* (e.g., various service errands) is more associated with proximity and the built environment surrounding the home. Commuting to work, being the prime activity in relation to *contracted time* use, still overall displays the strongest relationship with various land use measures compared with other trip purposes.

Important urban and regional changes over time are, however, observed as regards work trips. The study indicates that *the influence of the built environment on work-related travel has weakened in recent decades*. This means that workers living in the same neighbourhood increasingly travel divergent distances between home and work and presumably also to more dispersed job locations. This suggests a continued decrease in the influence of distance on labour market choices and, hence, on commuting destination; this change coincides with a general increase in commuting, urban sprawl, and “regional enlargement” occurring in contemporary Sweden. This supports the hypothesis that increased personal mobility capabilities reduce the importance of the built environment for daily travel distances. At the same time, it is important to recognize that several interrelated processes at work potentially also influence the spatial constraints on travel. Complexity makes it difficult to entirely disentangle the exact roles of key contributing factors, as elaborated on in the next section.

Other key spatiotemporal constraints traditionally associated with work and daily commuting are also being relaxed and new opportunities have opened up. The development of virtual mobility opportunities and other labour market changes (e.g., the growth in non-manual employment) have resulted in the increased decoupling of work-related activities from regular workplace locations – at least for some groups. The rapid recent increase in telework is evidently an important case of this. My study demonstrates that *the built environment influences teleworkers’ daily travel to a lesser extent* than it does regular workers’ daily travel. Telework allows for the freer scheduling of daily activities, and is used to make travel less dependent on location structures and relatively more based on individual needs and wishes.

Furthermore, increasing mobility capabilities are presumably also a key factor when it comes to what aspects of the built environment are most prominent in explaining variation in daily travel distances. This study demonstrates that the *regional built-environment variables are generally more important than are the characteristics of local neighbourhoods in explaining the daily travel distance*. When they have the opportunity, many people extend their daily activity spaces, which makes regional location structures more important. This observation remains robust when running models on the different sets of data. “The proximity of home to larger agglomerations of destinations in city centres” is a key determinant in all cases in which built-environment variables have significant effects. This testifies to the importance of longer trips outside the neighbourhood, as such trips often make up most of the daily distance travelled. It also indicates that the relaxation of spatial constraints works up to a certain range, beyond which distance again becomes truly crucial from the perspective of many daily activities.

Taken together, the empirical results of my study confirm the importance of considering spatiotemporal constraints related to daily activities when exploring the role of the built environment and its importance for daily travel. Some travel purposes (e.g., commuting to a regular workplace) leave less room for free individual spatial scheduling and therefore are more closely related to the built environment. While other travelling (e.g., for leisure purposes, broadly defined) is open for a range of mobility strategies conditional on individual needs and wants, and to a relatively smaller extent on distance to locations and opportunities. In this context, the results also remind us that the importance of the built environment changes as an integral part of larger societal transformations connected with processes of both time–spatial convergence and profound socioeconomic change. For example, regular work has traditionally been an important anchor, spatially and temporally, around which people’s daily activity patterns have been planned and formed. This situation has changed for some workers as labour markets have become more “flexible”, for example, by enabling telework. Nevertheless, considering the weaker influence of the built environment on non-work travel activities, an ongoing decrease in the proportion of the population engaged in (permanent) work is likely to play a more important role overall. These concerns and the findings summarized in this section have important implications for future research and practice, as discussed in the two remaining sections.

5.2 Implications for future research

Many authors have drawn attention to controversies and discrepancies in results concerning the built environment's role in shaping daily travel, and some have argued that geography is of little importance (e.g., Bagley and Moktharian, 2002; Snellen, Borgers and Timmermans, 2002), while others strongly emphasize the role of urban structure and location (e.g., Newman and Kenworthy, 1999; Seto et al., 2014)⁷. My results conclusively contend that any of these positions risks conveying too simplistic a view of the situation (also with implications for policy and planning; see next section). From a research perspective, this points to the importance of situating *empirically grounded built environment–travel studies* within a *basic activity-based understanding of daily travel and associated spatiotemporal constraints*. In this context, the study conclusively leads to several suggestions for future research, most prominently as regards the scope and scale of future studies.

A first suggestion concerns the increased importance of considering regional structures when seeking to explain daily travel. If only the built-environment features of the local neighbourhood are taken into account, important locational drivers (e.g., regional points of supply and agglomerations) will be overlooked. Studies ignoring this fact may find no or very weak built-environment effects for the wrong reasons. This underscores the importance of situating built environment–travel studies within contextual knowledge of the area of study as regards *access on the local and regional scales and associated spatial constraints*. The relationships between location patterns and travel distances are likely to differ across regions and countries (cf. Cervero, 2013). Results from my study indicate that built-environment variables still contribute greatly to explained variance in commuting distance – more than the results of many similar studies in other geographical contexts. This is partly contingent on scale, that is, because a nationwide Swedish case is used that includes a large variety of geographical contexts ranging from very sparsely populated areas to large metropolitan areas, resulting in more apparent spatial differences. Paradoxically, the direct link between the built environment and travel could be expected to be of lesser magnitude if studies were delimited to larger urban agglomerations with good overall accessibility to daily activities

⁷ See also section 2.3.3

(where individuals have more choice opportunities). An interesting topic for future research would therefore be to design comparative studies evaluating such dynamics. For the purpose of further scrutiny of the joint influence of various scales of the built environment – both across and within urban agglomerations – on travel, multilevel models similar to those applied here are important tools (cf. the concluding sections of papers I and II).

A challenging task for future research concerns *the relative importance of individual and spatial factors in supplementing dimensions as regards capabilities, needs, and wants*. Overall, the activity-based conceptualization will continue to provide a basic appraisal. Many people still follow relatively similar life courses that entail more or less mandatory activities fairly fixed in time and space, activities such as work and care for children. The built environment obviously plays a decisive role in shaping the total daily trip length in these cases. However, for some travel activities in contemporary society, the importance of geographic context and proximity to the home location is diminishing in relative terms (i.e., in relation to individual capabilities, needs, and preferences). Leisure travel and travel during teleworking days are examples of such more flexible options highlighted here. In these cases, various individual experiences, desires, and practices are expected to be central determinants. In addition, though all physical mobility is place bound and corporeal by definition, the theoretical understanding of travel as a demand derived directly from the need to perform geographically separated activities needs to be nuanced in many cases. The demand is “less derived” when individuals have increasing opportunities to engage in substitute virtual activities that are not fixed to certain locations and times. A thorough understanding of these processes cannot rest solely on the quantitative research designs that currently dominate this area of research (cf. Næss, 2015).

Another aspect as regards the relative importance of the built environment and individual choice calling for further study is how and to what extent the spatiotemporal constraints associated with certain activities change over time, concerning work in particular. The role of work is evidently shifting and in some cases becoming less fixed. This is crucial, because home–work relationships (and associated locations) are often regarded as having a key organizing impact on other parts of the daily activity pattern. When workplaces are used as a basis for understanding travel activities and how location patterns impact travel, it is essential to account for individual workers’ spatiotemporal

constraints in various ways (e.g., regarding telework opportunities). However, other (non-work) activities are also changing rapidly and merit further study as regards their dependence on proximity and built-environment location patterns. For example, education and service activities can increasingly be accessed virtually. In my study, a rather crudely defined group of committed time activities was examined. The time–spatial constraints associated with these activities may vary greatly (Doherty, 2006). Some of these activities (e.g., taking care of children) are usually very fixed in time and space, and proximity to appropriate facilities (e.g., day-care centres) is crucial, while many other activities conducted during committed time are subject to increasing individual choice opportunities (e.g., buying groceries via the Internet). Likewise, the role and significance of location also differ among what are labelled free-time activities. An important subject in this case, not explored here, concerns the role of non-built environments, including the physical geographies of nature and vegetation giving outdoor recreation possibilities.

Additional important interrelationships between individual capabilities, daily activities, and the built environment merit further study and theorizing (on empirical grounds). In particular, there proved to be interactions between individual and spatial scales as regards travel undertaken to carry out activities in relation to committed time. In this case “access to a car” plays a key role giving significantly more options for when and where these activities can be performed. This is, however, not the case when it comes to commuting, as many people do not have similar choice opportunities for work activities. In this context, my study also raises important questions regarding how the effect of individual mobility capabilities varies in different built environments. A reasonable hypothesis is, for example, that the effect of car access is stronger in sparser location structures with accordingly fewer choice opportunities. Similar reasoning can also be applied in many other dimensions, opening up important avenues for future research, for example, how different stages in the life course (e.g., parenthood) and associated spatiotemporal constraints affect the importance and roles of the built environment when people schedule various travel activities. This further connects to a research focus on processes of social differentiation and exclusion in relation to local and regional access; for example, for what activities and population groups is local versus regional access important.

Furthermore, my study points to the need for continued *empirical exploration of changes over time* in the effects of the built environment. This is an under-researched topic in the current literature that is only partly covered in my thesis as regards work trips. The analysis should be enlarged to encompass other travel activities, segments of the population, and geographical delimitations. Repeated cross-sectional data over periods of time, as used here, are important for the purpose of identifying change, but other approaches are also needed to disentangle possible underlying causal factors. Besides longitudinal approaches, quasi-experimental before-and-after studies could be used to compare the daily travel of “treatment groups” with that of control groups to isolate various effects of individual capabilities, spatiotemporal fixity of activities, and changes to the built environment (e.g., residents in neighbourhoods subject to densification strategies).

All in all, my thesis clearly testifies to the importance of a *theoretical understanding of the spatiotemporal constraints* of individuals studied in terms of *space bridging, accessible temporal capabilities, and daily activities needed and wanted*. The activity-based approach is therefore an important theoretical and empirical departure when studying the travel choices and mobility dependencies of daily life – not least when exploring under what circumstances and to what extent built structures are likely to influence daily travel in the future. Needless to say, this will continue to merit study in the future. Like most phenomena involving human behaviour, the underlying factors continuously change in time and space. When it comes to built environment–travel relationships, a range of possibly related processes has been set in motion. These include ongoing urbanization (e.g., larger urban agglomerations, increasing choice opportunities, and increased segregation), urban structure adaptations to high mobility levels (e.g., urban sprawl and lock-in effects), further labour market-related developments (e.g., policies of regional enlargement, flexibilization, insecurity, and increasing commuting tolerance), and the development of ICT practices (e.g., virtual substitution of more activities and telework practices).

5.3 A practical view

From a policy and planning perspective, my study demonstrates the importance of viewing cities and regions as relational spaces. The built environment of the region and the proximity to regional agglomerations greatly

impact daily travel distances. This highlights the importance of focusing on the location and concentration of city centres within regions in urban and regional planning. From this perspective, typical “new-urbanism” ideas, often with a strong focus on the local neighbourhood, might be less effective than expected (cf. Næss, 2011). Furthermore, policymakers and planners should heed the increasing complexity of travel and destination choices, a complexity that makes it problematic to use spatial planning and urban restructuring measures with the sole aim of reducing people’s travel distances and associated general costs (e.g., congestion and pollution). Urban planning principles based on compact cities and the containment of urban areas are probably necessary, yet are not sufficient conditions given the interaction of a complex web of factors. Trips that concern free-time activities, where individuals have considerable spatiotemporal flexibility, are very difficult to address by means of changes in the built environment alone. In addition, commuting, which has traditionally been the target of location-based policies and prediction models, have become increasingly difficult to influence. This confirms the need to combine different measures when planning for sustainable mobility and cities. Much daily travel in Sweden today may be more responsive to instruments directly targeting the individual level of travel decision making, such as fuel taxes, congestion charges, and awareness campaigns. However, as discussed throughout my thesis, this situation could change if individuals’ capabilities to travel quickly should decline, affected, for example, by rising fuel prices.

Still, the built environment constitutes one of the foundations of sustainable mobility. To make individually targeted measures acceptable and effectual, alternatives enabling changes in daily travel, for example, densification strategies, are essential. Without increased proximity, it is infeasible for many people to reduce their car use and accustom themselves to more sustainable options, such as improved public transportation and cycling. This also raises questions of mobility divides and social welfare issues that policymakers should take into account. Mobility resources, like many other societal resources, are quite unevenly distributed. Car access is a crucial factor in this context. The opportunities for daily activity participation that the local built environment offers can play an important role not only in fostering ecological sustainability but also in creating improved social justice in cities.

6 Sammanfattning (summary in Swedish)

Avhandlingen studerar den byggda miljöns betydelse för människors vardagsresande. Inom urban och regional planering knyts numera ofta stora förhoppningar till att den geografiska närhet som täta och funktionsintegrerade bebyggelsemönster kan erbjuda skall bidra till ett mer hållbart vardagsresande. Samtidigt medverkar människors växande möjligheter att överbrygga geografiska avstånd, genom ökande bilinnehav, förbättrad kollektivtrafik etc., till att minska betydelsen av närhet och den byggda miljöns utformning. Den tilltagande rumsliga flexibiliteten återspeglas bland annat i den exponentiella ökningen av individers dagliga reslängd som skedde under 1900-talet, och i de senaste decenniernas snabba utveckling i användning av informations och kommunikationsteknologi (IKT) för att överbrygga avstånd.

Avhandlingen syftar därför till att undersöka den byggda miljöns roll och relativa betydelse för den geografiska utsträckningen av individers vardagsresande i dagens Sverige. Detta genomförs i tre empiriska forskningsartiklar där särskild uppmärksamhet riktas mot tre viktiga aspekter: att undersöka skillnader i den byggda miljöns betydelse för olika resesyften (*paper I*); att utforska hur den byggda miljöns betydelse förändras över tid när det gäller en viktig relation i vardagen, nämligen för arbetsresor (*paper II*); och slutligen att undersöka den potentiellt ökade rumsliga flexibilitet och vad den innebär för resandet när individer använder IKT regelbundet och distansarbetar (*paper III*).

Artiklarna utgår från ett teoretiskt ramverk som betonar samspelet mellan individens resurser, roller och omgivning som betydelsefulla när de vardagliga aktivitets- och resmönstren formas med hänsyn till olika tidsrumsliga restriktioner. I artiklarna analyseras sedan med multivariata kvantitativa metoder unika kombinationer av innehållsrika geokodade mikrodata inbegripet nationella resvaneundersökningar och registerdata gällande hela befolkningen och samtliga arbetsplatser i Sverige. Detta möjliggör en integrerad beskrivning och analys av hur individers dagliga reseaktiviteter, givet olika resurser och restriktioner (t.ex. bilinnehav, familjeförhållanden), samvarierar med den byggda miljöns lokaliseringar av transportinfrastruktur, bostäder, arbetsplatser, service och andra viktiga samhällsfunktioner.

Avhandlingens övergripande slutsats är att den geografiska närheten till olika samhällsfunktioner och verksamheter viktiga i vardagslivet i relation till

bostaden fortfarande spelar en viktig roll för hur långt individer i Sverige reser dagligen. Dock visar analyserna att betydelsen av närhet luckras upp i flera viktiga avseenden. Tidsrumsliga restriktioner förknippade med de aktiviteter som motiverar resor i vardagen är viktiga och differentierande faktorer. När endast helg- och fritidsresor beaktas är den byggda miljön av relativt liten betydelse när det kommer till daglig reslängd. Personliga preferenser avseende aktiviteter formar då dagliga aktivitetsmönster relativt oberoende av närhet. Andra aktiviteter är däremot mer beroende av närhet och den byggda miljöns lokaliseringmönster och täthet. Hur långt individer färdas för att nå service och utföra hushållsrelaterade aktiviteter samvarierar i viss utsträckning med den byggda miljön som omger bostaden. Arbetsresor uppvisar det starkaste sambandet jämfört med andra resesyften.

Dock observeras viktiga urbana och regionala förändringar över tid gällande arbetsresor. Avhandlingen visar att den byggda miljöns påverkan på arbetsresor har försvagats i Sverige under de senaste decennierna. Det innebär t ex att förvärvsarbetande som bor i samma område (dvs med samma omgivningsförhållanden) uppvisar alltmer divergerande avstånd mellan hemmet och arbetet. Detta indikerar en avtagande betydelse av avstånd för geografiska val på arbetsmarknaden; en förändring som också sammanfaller med en generell ökning av pendling och sk regionförstoring i dagens Sverige. Detta stödjer hypotesen att ökade individuella mobilitetsresurser minskar betydelsen av den byggda miljöns lokaliseringmönster för vardagsresandet.

Men även andra tidsrumsliga restriktioner kopplade till arbete och daglig pendling luckras upp. Utvecklingen av virtuella mobilitetsmöjligheter och en generell flexibilisering av arbetsförhållanden i stort bör ha resulterat i en större individuell frikoppling från arbetsplatsen. Distansarbetets snabba utbredning under de senaste åren är en central indikator. Avhandlingens resultat tyder på att distansarbete ytterligare försvagar sambandet mellan den byggda miljön och dagliga resor i olika dimensioner. Variationen i distansarbetares dagliga restid och reseavstånd förklaras i mycket liten utsträckning av den geografiska tillgängligheten till arbetsplatser och andra viktiga samhällsfunktioner i relation till bostaden. Distansarbete möjliggör ett bredare spektrum av dagliga mobilitetsstrategier (t ex att arbeta hemifrån och avstå från resor alternativt resa mer på fritiden) eftersom det dagliga aktivitetsmönstret då inte är knutet till en specifik arbetsplats.

Vidare visar avhandlingen att regionala lokaliseringsmönster generellt är viktigare än egenskaper i det lokala bostadsområdet för att förklara dagliga reseavstånd. När möjligheten ges utvidgar många sina dagliga aktivitetsutrymmen bortom närområdet, vilket gör regionala lokaliseringsstrukturer viktigare. En särskilt viktig faktor är bostadens läge i förhållande till den regionala huvudortens centrum, där en mer nära lokalisering generellt ger mindre resande. Detta vittnar om vikten av längre resor utanför grannskapet då sådana resor ofta utgör en majoritet av den dagliga reslängden.

Avhandlingens resultat påminner om att den byggda miljöns betydelse för individers rörlighetshandlingar förändras som en integrerad del av större samhällsomvandlingar: både gällande transport- och kommunikationsteknikens utveckling och djupgående socioekonomiska förändringar. Till exempel har fast arbete traditionellt varit en viktig nod i tid och rum kring vilka individers dagliga aktivitetsmönster har formats. Men denna situation förändras för vissa förvärvsarbetare när arbetsmarknaden blir mer flexibel i tid och rum, till exempel genom distansarbete och olika former av mobilt arbete. Med tanke på det betydligt svagare inflytande som den byggda miljön har på fritidsresandet, kommer sannolikt också en fortsatt minskning av andelen av befolkningen som deltar i fast arbete att spela en viktig roll totalt sett.

Slutligen vittnar avhandling om vikten av att beakta individers tidsrumsliga restriktioner i vardagen vad gäller deltagande i aktiviteter och tillgång till rumsöverbryggande resurser och tid. Detta är centralt för att förstå resval och mobilitetsberoenden i vardagen, inte minst när det gäller att fastställa under vilka omständigheter och i vilken utsträckning den byggda miljön påverkar vardagsresandet i framtiden.

7 References

- Akar, G., Clifton, K. J., & Doherty S. T. 2012. Redefining activity types: Who participates in which leisure activity? *Transportation Research Part A: Policy and Practice*, 46(8), 1194–1204.
- Alexander, B., Hubers, C., Schwanen, T., Dijst, M., & Ettema, D. 2011. Anything, anywhere, anytime? Developing indicators to assess the spatial and temporal fragmentation of activities. *Environment and Planning B: Planning and Design*, 38(4), 678–705.
- Alonso, W. 1964. *Location and Land Use: Toward a General Theory of Land Rent*. Cambridge: Harvard University Press.
- Amcoff, J. 2012. Hur bra fungerar SAMS-områdena i studier av grannskapseffekter? En studie av SAMS-områdenas homogenitet [How well do SAMS work in studies of neighbourhood effects?]. *Socialvetenskaplig tidskrift*, 19(2), 93–115.
- Andreev, P., Salomon, I., & Pliskin, N. 2010. Review: State of teleactivities. *Transportation Research Part C: Emerging Technologies*, 18(1), 3–20.
- Ås, D. 1978. Studies of Time-Use: Problems and Prospects. *Acta Sociologica*, 21(2), 125–141.
- Axhausen, K. W., & Gärling, T. 1992. Activity-based approaches to travel analysis: conceptual frameworks, models, and research problems. *Transport Reviews*, 12(4), 323–341.
- Bagley, M., & Mokhtarian, P. L. 2002. The impact of residential neighborhood type on travel behavior: A structural equations modeling approach. *The Annals of Regional Science*, 36(2), 279–297.
- Banister, D. 2008. The sustainable mobility paradigm. *Transport Policy*, 15(2), 73–80.
- Banister, D. 2011. The trilogy of distance, speed and time. *Journal of Transport Geography*, 19(4), 950–959.
- Banister, D. 2012. Viewpoint: Assessing the reality—Transport and land use planning to achieve sustainability. *Journal of Transport and Land Use*, 5(3), 1–14.
- Berg, J., Levin, J., Abramsson, M., & Hagberg, J-E. 2014. Mobility in the transition to retirement – the intertwining of transportation and everyday projects. *Journal of Transport Geography*, 38, 48–54.

- Bhat, C. R., & Guo, J. Y. 2007. A comprehensive analysis of built environment characteristics on household residential choice and auto ownership levels. *Transportation Research Part B: Methodological*, 41(5), 506–526.
- Boarnet, M. G. 2011. A Broader Context for Land Use and Travel Behavior, and a Research Agenda. *Journal of the American Planning Association*, 77(3), 197–213.
- Boarnet, M. G., & Crane, R. 2001. *Travel by design: The influence of urban form on travel*. New York: Oxford University Press.
- Borggren, J. 2011. *Kreativa individers bostadsområden och arbetsställen: bebyggelsestrukturer i Göteborg* [Creative individuals' residential areas and places of work. In light of economic transformation and changes in urban structure in Gothenburg] (PhD thesis). Gothenburg: Departments of Geography, University of Gothenburg.
- Bricka, S., & Bhat, C. R. 2006. Comparative Analysis of Global Positioning System-Based and Travel Survey-Based Data. *Transportation Research Record: Journal of the Transportation Research Board*, 1972, 9–20.
- Brotchie, J. F. 1984. Technological change and urban form. *Environment and Planning A*, 16(5), 583–596.
- Brownstone, D., & Golob, T. F. 2009. The impact of residential density on vehicle usage and energy consumption. *Journal of Urban Economics*, 65(1), 91–98.
- Brueckner, J. K. 2000. Urban Sprawl: Diagnosis and Remedies. *International Regional Science Review*, 23(2), 160–171.
- Cao, X., Mokhtarian, P. L., & Handy, S. L. 2009. Examining the Impacts of Residential Self-Selection on Travel Behaviour: A Focus on Empirical Findings. *Transport Reviews*, 29(3), 359–395.
- Cervero, R. 1989. Jobs-Housing Balancing and Regional Mobility. *Journal of the American Planning Association*, 55(2), 136–150.
- Cervero, R. 2013. Linking urban transport and land use in developing countries. *Journal of Transport and Land Use*, 6(1), 7–24.
- Cervero, R., & Kockelman, K. 1997. Travel demand and the 3Ds: Density, diversity, and design. *Transportation Research Part D: Transport and Environment*, 2(3), 199–219.
- Chapin, F.S. 1974. *Human Activity Patterns in the City: Things People Do in Time and Space*. New York: Wiley.

- Christaller, W. 1933. *Die Zentralen Orte in Süddeutschland*. Jena: Gustav Fischer.
- Couclelis, H. 1996. The death of distance. *Environment and Planning B: Planning and Design*, 23(4), 387–389.
- Couclelis, H. 2000. From sustainable transportation to sustainable accessibility: can we avoid a new tragedy of the commons? In *Information, Place and Cyberspace: Issues in Accessibility*, eds. Janelle, D. G. & Hodge, D. C. Berlin: Springer.
- Cox, K. R., & Golledge, R. G. (eds). 1969. *Behavioral Problems in Geography: A Symposium*. Evanston: Northwestern University Press.
- Cullen, I., & Godson, V. 1975. Urban networks: The structure of activity patterns. *Progress in Planning*, 4(1), 1–96.
- Dal Fiore, F., Mokhtarian, P. L., Salomon, I., & Singer, M. E. 2014. “Nomads at last”? A set of perspectives on how mobile technology may affect travel. *Journal of Transport Geography*, 41, 97–106.
- Dodgshon, R. A. 1999. Human geography at the end of time? Some thoughts on the notion of time - space compression. *Environment and Planning D: Society and Space*, 17(5), 607–620.
- Doherty, S. T. 2006. Should we abandon activity type analysis? Redefining activities by their salient attributes. *Transportation*, 33(6), 517–536.
- Dugundji, E., Scott, D. M., Carrasco, J. A., & Paez, A. 2012. Urban mobility and social-spatial contact—introduction. *Environment and Planning A*, 44(5), 1011–1015.
- Elldér, E. 2014a. Commuting choices and residential built environments in Sweden, 1990–2010: a multilevel analysis. *Urban Geography*, 35(5), 715–734.
- Elldér, E. 2014b. Residential location and daily travel distances: the influence of trip purpose. *Journal of Transport Geography*, 34, 121–130.
- Elldér, E. 2015. Does telework weaken urban structure-travel relationships?. *Journal of Transport and Land Use*. Manuscript accepted for publication.
- Elldér, E., Solá A. G., & Larsson, A. 2012. Featured graphic: Spatial inequality and workplace accessibility: the case of a major hospital in Göteborg, Sweden. *Environment and Planning A*, 44(10), 2295–2297.
- Ellegård, K., & Vilhelmson, B. 2004. Home as a Pocket of Local Order: Everyday Activities and The Friction of Distance. *Geografiska Annaler: Series B, Human Geography*, 86(4), 281–296.

- Eurostat. 2014. *Eurostat statistics* [web page], accessed November 25, 2014. <http://epp.eurostat.ec.europa.eu/portal/page/portal/statistics/themes>
- Ewing, R., & Cervero, R. 2001. Travel and the built environment : a synthesis. *Transportation research record: Journal of the Transportation Research Board*, 1780, 87–114.
- Ewing, R., & Cervero, R. 2010. Travel and the Built Environment. *Journal of the American Planning Association*, 76(3), 265–294.
- Ewing, R., Deanna, M., & Li, S-C. 1996. Land use impacts on trip generation rates. *Transportation Research Record: Journal of the Transportation Research Board*, 1518, 1–6.
- Fox, M. 1995. Transport planning and the human activity approach. *Journal of Transport Geography*, 3(2), 105–116.
- Frändberg, L., & Vilhelmson, B. 2011. More or less travel: personal mobility trends in the Swedish population focusing gender and cohort. *Journal of Transport Geography*, 19(6), 1235–1244.
- Frändberg, L., & Vilhelmson, B. 2014. Spatial, generational and gendered trends and trend-breaks in mobility. In *Handbook of sustainable travel*, eds. Gärling, T., Ettema, D., & Friman, M. Dordrecht: Springer.
- Gebel, K., Bauman, A. E., & Pettecree, M. 2007. The Physical Environment and Physical Activity: A Critical Appraisal of Review Articles. *American Journal of Preventive Medicine*, 32(5), 361–369.
- Giddens, A. 1984. *The constitution of society. Outline of the Theory of Structuration*. Polity press: Cambridge.
- Giuliano, G. 1989. Research policy and review 27. New directions for understanding transportation and land use. *Environment and Planning A*, 21(2), 145–159.
- Giuliano, G. 1995. The weakening transportation-land use connection. *ACCESS Magazine*, 6, 3-11.
- Giuliano, G., & Small, K. A. 1993. Is the Journey to Work Explained by Urban Structure? *Urban Studies*, 30(9), 1485–1500.
- Goldstein, H. 2011. *Multilevel statistical models*. Hoboken: Wiley.
- Green, A. E. 2004. Is Relocation Redundant? Observations on the Changing Nature and Impacts of Employment-related Geographical Mobility in the UK. *Regional Studies*, 38(6), 629–641.
- Green, A. E., Hogarth, T., & Shackleton, R. E. 1999. Longer distance commuting as a substitute for migration in Britain: a review of trends,

- issues and implications. *International Journal of Population Geography*, 5(1), 49–67.
- Grunfelder, J., & Nielsen, T. S. 2012. Commuting behaviour and urban form: a longitudinal study of a polycentric urban region in Denmark. *Geografisk Tidsskrift-Danish Journal of Geography*, 112(1), 2–14.
- Guerra, E. 2014. The Built Environment and Car Use in Mexico City: Is the Relationship Changing over Time?. *Journal of Planning Education and Research*, 34(4), 394–408.
- Hägerstrand, T. 1970. What about people in Regional Science?. *Papers in Regional Science*, 24(1), 7–24.
- Hamidi, S., Ewing, R., Preuss, I., & Dodds, A. 2015. Measuring Sprawl and Its Impacts: An Update. *Journal of Planning Education and Research* 35(1): 35–50.
- Handy, S. 1996. Methodologies for exploring the link between urban form and travel behavior. *Transportation Research Part D: Transport and Environment*, 1(2), 151–165.
- Harvey, D. 1989. *The condition of postmodernity*. Oxford: Blackwell.
- Haugen, K. 2012. *The accessibility paradox. Everyday geographies of proximity, distance and mobility* (Phd thesis). Umeå: Department of Geography and Economic History, Umeå University.
- Haugen, K., & Vilhelmson, B. 2013. The divergent role of spatial access: The changing supply and location of service amenities and service travel distance in Sweden. *Transportation Research Part A: Policy and Practice*, 49, 10–20.
- Horner, M. W., & Murray, A. T. 2002. Excess Commuting and the Modifiable Areal Unit Problem. *Urban Studies*, 39(1), 131–139.
- Janelle, D. G. 1969. Spatial reorganization: a model and concept. *Annals of the Association of American Geographers*, 59(2), 348–364.
- Johansson, H. 2011. *Ökade utsläpp från vägtrafiken trots rekordartad energieffektivisering av nya bilar* [Increased emissions from road transport despite record high energy efficiency of new cars]. Borlänge: Trafikverket.
- Jones, P. M., Dix, M. C., Clarke, M. I., & Heggie, I.G. 1983. *Understanding travel behaviour*. Aldershot: Gower.

- Kitamura, R., Mokhtarian, P. L., & Laidet, L. 1997. A micro-analysis of land use and travel in five neighborhoods in the San Francisco Bay Area. *Transportation*, 24(2), 125–158.
- Knowles, R. D. 2006. Transport shaping space: differential collapse in time–space. *Journal of Transport Geography*, 14(6), 407–425.
- Kwan, M-P. 2002. Time, Information Technologies, and the Geographies of Everyday Life. *Urban Geography*, 23(5), 471–482.
- Kwan, M-P., Dijst, M., & Schwanen, T. 2007. The interaction between ICT and human activity-travel behavior. *Transportation Research Part A: Policy and Practice*, 41(2), 121–124.
- Kwan, M-P., & Schwanen, T. 2008. The Internet, mobile phone and space-time constraints. *Geoforum*, 39(3), 1362–1377.
- Kwan, M-P., & Weber, J. 2003. Individual accessibility revisited: Implications for geographical analysis in the twenty-first century. *Geographical Analysis*, 35(4), 341–353.
- Kwan, M-P., & Weber, J. 2008. Scale and accessibility: Implications for the analysis of land use–travel interaction. *Applied Geography*, 28(2), 110–123.
- Larsson, A., Elldér, E., Ernstson, U., & Fransson, U. 2011. *Analysverktyg för tillgänglighetsberäkning med bil och kollektivtrafik i Västra Götaland. Slutrapport* [Analysis tool for calculation of accessibility by car and public transport in Västra Götaland. Final report]. Gothenburg: Department of Human and Economic Geography, University of Gothenburg.
- Larsson, A., & Elldér, E. 2014. Accessibility Tool for Road and Public Transport Travel Time Analysis in Västra Götaland. In *COST Action TU 1002: Collecting accessibility instruments and improving their usability for planning practices*, <http://www.accessibilityplanning.eu/wp-content/uploads/2013/10/Accessibility-Tool-for-Road-and-Public-Transport-Travel-Time-Analysis-in-V%C3%A4stra-G%C3%B6taland.pdf>.
- Lenntorp, B. 1976. *Paths in space-time environments : a time-geographic study of movement possibilities of individuals*. Lund: Department of Geography, Lund University.
- Lenz, B., & Nobis, C. 2007. The changing allocation of activities in space and time by the use of ICT—“Fragmentation” as a new concept and

- empirical results. *Transportation Research Part A: Policy and Practice*, 41(2), 190–204.
- Lyons, G. 2009. The reshaping of activities and mobility through new technologies. *Journal of Transport Geography*, 17(2), 81–82.
- Marshall, S., & Banister, D. 2000. Travel reduction strategies: intentions and outcomes. *Transportation Research Part A: Policy and Practice*, 34(5), 321–338.
- McGuckin, N., Zmud, J. P., & Nakamoto, Y. 2005. Trip-Chaining Trends in the United States: Understanding Travel Behavior for Policy Making. *Transportation Research Record: Journal of the Transportation Research Board*, 1917, 199–204.
- Metz, D. 2010. Saturation of Demand for Daily Travel. *Transport Reviews*, 30(5), 659–674.
- Meurs, H., & Haaijer, R. 2001. Spatial structure and mobility. *Transportation Research Part D: Transport and Environment*, 6(6), 429–446.
- Millard-Ball, A., & Schipper, L. 2010. Are We Reaching Peak Travel? Trends in Passenger Transport in Eight Industrialized Countries. *Transport Reviews*, 31(3), 357–378.
- Miller, H. 2007. Place-Based versus People-Based Geographic Information Science. *Geography Compass*, 1(3), 503–535.
- Mokhtarian, P. L. 1990. A typology of relationships between telecommunications and transportation. *Transportation Research Part A: General*, 24(3), 231–242.
- Mokhtarian, P. L. 2005. Travel as a desired end, not just a means. *Transportation Research Part A: Policy and Practice*, 39(2–3), 93–96.
- Mokhtarian, P. L., & Cao, X. 2008. Examining the impacts of residential self-selection on travel behavior: A focus on methodologies. *Transportation Research Part B: Methodological*, 42(3), 204–228.
- Mokhtarian, P. L., & Salomon, I. 2001. How derived is the demand for travel? Some conceptual and measurement considerations. *Transportation Research Part A: Policy and Practice*, 35(8), 695–719.
- Mokhtarian, P. L., & Tal, G. 2013. Impacts of ICT on travel behavior: a tapestry of relationships. In *The SAGE Handbook of Transport Studies*, eds. Rodrigue, J.-P., Notteboom, T., & Shaw S-L. London: SAGE.
- Næss, P. 2004. Prediction, Regressions and Critical Realism. *Journal of Critical Realism*, 3(1), 133–164.

- Næss, P. 2006. *Urban Structure Matters: Residential Location, Car Dependence and Travel Behaviour*. London: Routledge.
- Næss, P. 2009. Residential Self-Selection and Appropriate Control Variables in Land Use: Travel Studies. *Transport Reviews*, 29(3), 293–324.
- Næss, P. 2011. ‘New urbanism’ or metropolitan-level centralization? A comparison of the influences of metropolitan-level and neighborhood-level urban form characteristics on travel behavior. *Journal of Transport and Land Use*, 4(1), 25–44.
- Næss, P. 2012. Urban form and travel behavior: experience from a Nordic context. *Journal of Transport and Land Use*, 5(2), 21–45.
- Næss, P. 2013. Residential location, transport rationales and daily-life travel behaviour: The case of Hangzhou Metropolitan Area, China. *Progress in Planning*, 79, 1–50.
- Næss, P. 2014. Tempest in a teapot: The exaggerated problem of transport-related residential self-selection as a source of error in empirical studies. *Journal of transport and land use*, 7(3), 57–79.
- Næss, P. 2015. Built Environment, Causality and Travel. *Transport reviews*, <http://dx.doi.org/10.1080/01441647.2015.1017751>.
- Newman, P., & Kenworthy, J. R. 1999. *Sustainability and Cities: overcoming automobile dependence*. Washington: Island Press.
- Öhman, M., & Lindgren, U. 2003. Who is the long-distance commuter? Patterns and driving forces in Sweden. *CyberGEO: European Journal of Geography*, article 243.
- Olsson, G. 1965. *Distance and human interaction : A review and bibliography*. Philadelphia: Regional Science Research Institute.
- Openshaw, S. 1984. *The Modifiable Areal Unit Problem*. Norwich: Geo Books.
- Ory, D. T., & Mokhtarian P. L. 2005. When is getting there half the fun? Modeling the liking for travel. *Transportation Research Part A: Policy and Practice*, 39(2–3), 97–123.
- Östh, J. 2007. Homogeneous regions and heterogeneous populations - creating and analysing labor market regions for subgroups in Sweden. In *Home job and space. Mapping and modeling the labor market* (Phd thesis). Uppsala: Department of Social and Economic Geography, Uppsala University.
- Östh, J., & Lindgren, U. 2012. Do changes in gdp influence commuting distances? A study of swedish commuting patterns between 1990 and 2006. *Tijdschrift voor Economische en Sociale Geografie*, 103(4), 443–456.

- Pontes de Aquino, A., & Timmermans, H. 2010. The Built Environment as a Décor of Unfolding Housing Careers and Activity Travel Patterns: Reflection and Research Agenda. Paper presented at *The 12th World Conference on Transport Research*, Lisbon, Portugal.
- Robinson, W. S. 1950. Ecological Correlations and the Behavior of Individuals. *American Sociological Review*, 15(3), 351–357.
- Saelens, B. E., Sallis, J. F., & Frank, L. D. 2003. Environmental correlates of walking and cycling: Findings from the transportation, urban design, and planning literatures. *Annals of Behavioral Medicine*, 25(2), 80–91.
- Salomon, I. 1986. Telecommunications and travel relationships: a review. *Transportation Research Part A: General*, 20(3), 223–238.
- Salon, D., Boarnet, M. G., Handy, S., Spears, S., & Tal, G. 2012. How do local actions affect VMT? A critical review of the empirical evidence. *Transportation Research Part D: Transport and Environment*, 17(7), 495–508.
- Sandow, E. 2011. *On the road. Social aspects of commuting long distances to work* (Phd thesis). Umeå: Department of Social and Economic Geography, Umeå University.
- Saxena, S., & Moktharian, P. L. 1997. The Impact of Telecommuting on the Activity Spaces of Participants. *Geographical Analysis*, 29(2): 124–144.
- Sayer, A. 1992. *Method in social science: a realist approach*. London: Routledge.
- SCB. 2005. *Geografen i statistiken : regionala indelningar i Sverige* [Geography in statistics : regional divisions in Sweden]. Stockholm: Statistiska centralbyrån.
- SCB. 2010. *Tätorter 2010* [Built up areas 2010]. Stockholm: Statistiska centralbyrån.
- SCB. 2011. *Longitudinell integrationsdatabas för sjukförsäkrings- och arbetsmarknadsstudier (LISA) 1990-2009* [Integrated database for labour market research]. Stockholm: Statistiska centralbyrån.
- Schwanen, T., & Dijst, M. 2003. Time windows in workers' activity patterns: Empirical evidence from the Netherlands. *Transportation*, 30(3), 261–283.
- Schwanen, T., Kwan, M-P., & Ren, F. 2008. How fixed is fixed? Gendered rigidity of space–time constraints and geographies of everyday activities. *Geoforum*, 39(6): 2109–2121.
- Seto K. C., Dhakal, S., Bigio, A., Blanco, H., Delgado, G. C., Dewar, D., Huang, L., Inaba, A., Kansal, A., Lwasa, S., McMahon, J. E., Müller, D.

- B., Murakami, J., Nagendra, H., & Ramaswami, A. 2014. Human Settlements, Infrastructure and Spatial Planning. In *Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, eds. Edenhofer, O., Pichs-Madruga, R., Sokona, Y., Farahani, E., Kadner, S., Seyboth, K., Adler, A., Baum, I., Brunner, S., Eickemeier, P., Kriemann, B., Savolainen, J., Schlömer, S., von Stechow, C., Zwickel, T., & Minx, J.C. Cambridge: Cambridge University Press.
- Shuttleworth, I., & Gould, M. 2010. Distance between home and work: a multilevel analysis of individual workers, neighbourhoods, and employment sites in Northern Ireland. *Environment and Planning A*, 42(5), 1221–1238.
- SIKA. 2007. *RES 2005-2006: Den nationella resvaneundersökningen* [RES 2005–2006: the national travel survey]. Stockholm: Statistiska centralbyrån.
- Sims R., Schaeffer, R., Creutzig, F., Cruz-Núñez, X., D’Agosto, M., Dimitriu, D., Figueroa Meza, M. J., Fulton, L., Kobayashi, S., Lah, O., McKinnon, A., Newman, P., Ouyang, M., Schauer, J. J., Sperling, D., & Tiwari, G. 2014. Transport. In *Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, eds. Edenhofer, O., Pichs-Madruga, R., Sokona, Y., Farahani, E., Kadner, S., Seyboth, K., Adler, A., Baum, I., Brunner, S., Eickemeier, P., Kriemann, B., Savolainen, J., Schlömer, S., von Stechow, C., Zwickel, T., & Minx, J.C. Cambridge: Cambridge University Press.
- Snellen, D., Borgers, A., & Timmermans, H. 2002. Urban form, road network type, and mode choice for frequently conducted activities: a multilevel analysis using quasi-experimental design data. *Environment and Planning A*, 34(7), 1207–1220.
- Solá, A. G. 2013. *På väg mot jämställda arbetsresor: vardagens mobilitet i förändring och förhandling* [Towards gender equality? Women’s and men’s commuting under transformation and negotiation] (PhD thesis). Gothenburg: Departments of Geography, University of Gothenburg.
- Solá, A. G., & Vilhelmson, B. 2012. Convergence or divergence? Changing gender differences in commuting in two Swedish urban regions. *Cybergeo: European Journal of Geography*, article 591.

- Sparks, A. L., Bania, N., & Leete, L. 2011. Comparative Approaches to Measuring Food Access in Urban Areas: The Case of Portland, Oregon. *Urban Studies*, 48(8), 1715–1737.
- Standing, G. 2011. *The precariat: the new dangerous class*. London: Bloomsbury Academic.
- Stead, D. 2001. Relationships between land use, socioeconomic factors, and travel patterns in Britain. *Environment and Planning B: Planning and Design*, 28(4), 499–528.
- Susilo, Y. O., & Maat, K. 2007. The influence of built environment to the trends in commuting journeys in the Netherlands. *Transportation*, 34(5), 589–609.
- Swärth, J-E. 2009. *Commuting time choice and the value of travel time* (Phd thesis). Örebro: Örebro University.
- Tilahun, N., & Levinson, D. 2011. Work and home location: Possible role of social networks. *Transportation Research Part A: Policy and Practice*, 45(4), 323–331.
- Tobler, W. R. 1970. A Computer Movie Simulating Urban Growth in the Detroit Region. *Economic Geography*, 46, 234–240.
- Trafikanalys. 2012. *Metodrapport RVU Sverige 2011* [Method report RVU Sweden 2011]. Stockholm: Trafikanalys.
- Van Acker, V., & Witlox, F. 2011. Commuting trips within tours: how is commuting related to land use?. *Transportation*, 38(3), 465–486.
- Van de Coevering, P., Maat, K., & van Wee, B. 2015. Multi-period Research Designs for Identifying Causal Effects of Built Environment Characteristics on Travel Behaviour. *Transport Reviews*, <http://dx.doi.org/10.1080/01441647.2015.1025455>.
- Van de Coevering, P., & Schwanen, T. 2006. Re-evaluating the impact of urban form on travel patterns in Europe and North-America. *Transport Policy*, 13(3), 229–239.
- Van Ham, M. 2002. *Job access, workplace mobility, and occupational achievement* (Phd thesis). Delft: Eburon.
- Van Wee, B. 2011. Evaluating the impact of land use on travel behaviour: the environment versus accessibility. *Journal of Transport Geography*, 19(6), 1530–1533.

- Van Wee, B. 2013. Land use and transport. In *The transport system and transport policy*, eds. Van Wee, B., Annema, J. A., & Banister, B. Cheltenham: Edward Elgar.
- Van Wee, B., Geurs, K. T., & Chorus, C. 2013. Information, communication, travel behavior and accessibility. *Journal of Transport and Land Use*, 6(3), 1–16.
- Vilhelmson, B. 1999. Daily mobility and the use of time for different activities. The case of Sweden. *GeoJournal*, 48(3), 177–185.
- Vilhelmson, B. 2007. The use of the car: Mobility dependencies of urban everyday life. In *Threats from car traffic to the quality of urban life : problems, causes, and solutions*, eds. Gärling, T., & Steg, L. Amsterdam: Elsevier.
- Vilhelmson, B., & Thulin, E. 2008. Virtual mobility, time use and the place of the home. *Tijdschrift voor economische en sociale geografie*, 99(5), 602–618.
- Vilhelmson, B., & Thulin, E. 2015. Who and where are the flexible workers? Exploring the current diffusion of telework in Sweden. *Submitted manuscript*.
- Weber, J., & Kwan, M-P. 2003. Evaluating the effects of geographic contexts on individual accessibility: a multilevel approach. *Urban Geography*, 24(8), 647–671.
- Wolf, J., Oliveira, M. S., & Thompson, M. 2003. Impact of Underreporting on VMT and Travel Time Estimates: Preliminary Findings from the California Statewide Household Travel Survey GPS Study. *Transportation Research Record: Journal of the Transportation Research Board*, 1854, 189–198.
- Zegras, P. C., & Hannan, V. A. 2012. Dynamics of Automobile Ownership Under Rapid Growth. *Transportation Research Record: Journal of the Transportation Research Board*, 2323(2), 80–89.

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