

# Causality, not just correlation:

## Residential location, transport rationales and travel behavior across metropolitan contexts

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### Abstract

The literature on relationships between the built environment and travel is extensive, but the vast majority of such studies relies solely on statistical analyses of travel survey data, with limited possibilities for establishing causality. This article presents insights from in-depth qualitative research, offering stronger evidence of causal influences than in mainstream studies on the built environment and travel. Analyzing 33 qualitative interviews, the paper explains causal mechanisms underlying observed differences between inner-city and suburban residents' travel behavior in the Norwegian metropolitan areas of Oslo and Stavanger and in several earlier studies. We argue that built environment characteristics influence travel through their interplay with inhabitants' rationales for location of activities and travel mode choice. The interviewees' main rationales for activity locations, choosing the best facility and minimizing the friction of distance, are often traded off against each other. Inner-city residents can still be selective about the quality of the facility without needing to travel a long distance, since many potential facilities are often available within short distance from the dwelling. For suburbanites, choosing the best facility more often requires acceptance of longer travel distances. This is still context-dependent, depending on the center structure of the city. The interviewees' rationales for travel mode choice are, together with time-geographical constraints, an important part of the explanation why suburbanites tend to travel much more frequently by car than inner-city residents do. Those who need to overcome long distances to reach daily destinations need fast means of transportation, and therefore consider themselves more car-dependent. The similarity of the transport rationales found in this study with rationales identified in other studies in different city contexts suggests a high degree of generality in the basic mechanisms through which urban form influences travel behavior.

### 1. Introduction

Several studies of relationships between urban land use and travel have quantified correlations between daily-life travel and the location of the dwelling. There are strong theoretical reasons for believing that residential location influences travel behavior. Yet, doubt has repeatedly been raised about such relationships, sometimes underpinned by model simulations (Ehenique et al., 2012) but in recent decades more often founded on arguments about travel-based residential self-selection (Bagley & Mokhtarian, 2002; Van Wee, 2013). In much of the literature, such attitudes and car ownership are included as control variables. This means that some of the correlation between residential location and

travel is subtracted from the otherwise estimated effects of residential location on travel. Moreover, many studies of built environment and travel over past decades focus on the neighborhood scale without considering the location of the investigated neighborhoods within the wider urban structure (Cervero, 2003; Cao et al., 2009). Because the vast majority of studies of residential location and travel have relied solely on statistical analyses, usually with little theoretical reflection, their choices of what urban structural and control variables to include are often based on shaky assumptions (Næss, 2015a).

Within transportation research, the nature of causal influences is rarely discussed. In order to demonstrate that built environment characteristics are (contributory) *causes* of differences in travel behavior, it is important to show *why* the urban structural situation influences travel behavior. Qualitative research is necessary to this end (Røe, 2000; Clifton & Handy, 2003).

In line with Handy's (2017) recommendation to conduct more qualitative research rather than producing yet more quantitative cross-sectional studies, this paper offers insight from qualitative interview research into the links between built environment characteristics and travel. This contributes to a more nuanced understanding of the complex and particular causal relationships influencing travel behavior, which quantitative research can only address to a limited extent.

One way to illuminate causal influences of urban structures on travel is to investigate *transport rationales*. Such rationales involve the backgrounds, motivations and justifications that individuals draw on when making transport-relevant decisions about their participation in activities, location of these activities, modes of transportation and routes followed (Næss & Jensen, 2005, p. 165). Another helpful approach is a *time-geographical perspective*, which is a framework for understanding human activity patterns related to travel and locations in space (Hägerstrand, 1970).

The travel pattern we want to explain is the tendency of suburbanites to travel longer distances and carry out higher proportions of their travel by car than their inner-city counterparts, among whom walking and biking make up higher shares of the distance traveled. Such patterns have been found in numerous metropolitan areas around the world, including Paris (Mogridge, 1985; Fouchier, 1998), London (Mogridge, *ibid.*), New York and Melbourne (Newman & Kenworthy, 1989), San Francisco (Schipper et al., 1994), Austin, Texas (Zhou & Kockelman, 2008), Athens (Milakis et al., 2008), Santiago de Chile (Zegras, 2010), Copenhagen (Næss, 2005), Oslo (Næss et al., 1995; Næss et al., 2017a), Stavanger (Næss et al., 2017a) and several other Nordic cities (Næss, 2012).

Internationally, relatively few studies on land use and travel have included qualitative interviews (Røe, 2001; Tillberg, 2001; Nielsen, 2002; Næss & Jensen, 2004 and 2005; Næss, 2005, 2013 and 2015b; Scheiner, 2005; Stanbridge et al., 2005; Schwanen, 2006, 2008a and 2008b; Guell et al., 2012; Venter et al., 2014; Ferrer et al., 2015; Hess et al., 2017; Næss, 2018). These studies were situated in different urban contexts, from large metropolitan areas to small towns. One common finding among those studies that have investigated people's choices of activity locations is that people do not necessarily use the closest ones among available facilities. Daily travel distances instead tended to depend more on the distance from the dwelling to the city's main concentration of facilities than its distance to local centers.

This study uses qualitative data from a mixed-methods study in the Norwegian metropolitan areas Oslo and Stavanger (Næss et al., 2017a). Analyzing 33 qualitative interviews, we explain causal mechanism underlying important findings from a questionnaire survey included in the same research project (Næss et al., 2017a, b). In the predominantly monocentric Oslo region, suburbanites living beyond 22 km from

the city center travel on average six times as long distances by car for commuting and intra-metropolitan non-work purposes as their counterparts living below 6 km from the city center do (Figure 1, left). In the smaller and polycentric Stavanger region too, suburbanites travel more by car than inner-city dwellers do, but the pattern is less clear-cut than in Oslo, especially for commuting (Figure 1, right).

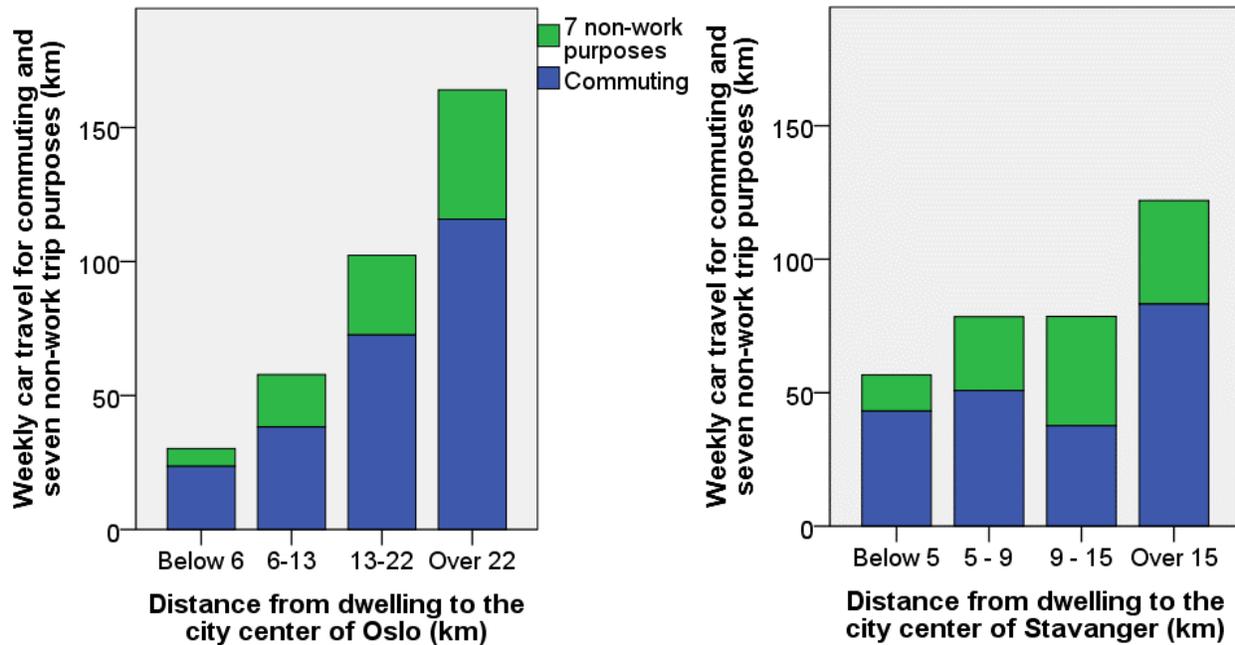


Figure 1: Weekly travel distances by car for commuting and seven non-work purposes among workforce participants living at different distances from the city centers of Oslo (left, N = 1061) and Stavanger (right, N = 718). Source: Næss et al., 2017a, p. 32.

Apart from residential distance to the main city center, some aspects of travel behavior are also associated with local-area densities and the distance from the dwelling to second-order centers. In the Stavanger region, commuting is associated more with residential location relative to a second-order employment center developed since the 1970s (Forus) than by its distance from the historical city center (Næss et al., 2017a).

*Why do we find such differences across residential locations in travel behavior? In this paper, we show that the observed patterns are not merely correlations, but the results of underlying causal mechanisms. We do this by identifying how residents' transport rationales interact with spatial conditions in shaping travel routines. We also discuss the role of time-geographical constraints as links in causal mechanisms by which residential location influences travel.*

The paper is structured as follows: Section 2 presents the theoretical background for the interpretation of the data. Next, we describe the case metropolitan areas (section 3) and the research methods (section 4). Then the interviewees' transport rationales are presented (section 5), followed by a discussion of how these rationales affect relationships between built environment and travel (section 6). Section 7 rounds up the paper with some concluding remarks.

## 2. Theoretical background

### 2.1. Urban structures as causes of travel behavior

Any study on influences of built environment characteristics on travel (and strategies for promoting sustainable mobility through land use planning) assumes – at least implicitly – that there is some kind of causality between spatial/physical conditions and human actions. However, within transportation research, causal mechanisms and processes are rarely investigated. The emphasis is instead on identifying correlations between observed phenomena, following a tradition from the empiricist philosopher David Hume (1711–76). This conception of causality does not explain *why* built environment characteristics influence travel.

This paper understands causality in terms of *causal powers* that nearly always operate in situations also influenced by many other causal powers. These other causal powers may counteract, amplify, activate or prevent the activation of the causal power we try to investigate. Ontologically and epistemologically, our study is inspired by the position of critical realism (Bhaskar, 2016; Archer, 2000; Danermark et al., 2001). Causal mechanisms can include the physical and mental capabilities of human agents, social structures, the natural environment, as well as discourses shaping people's beliefs, attitudes and practices. Critical realism understands outcomes as the results of the combined mechanisms at work in the specific situation, where the activation of causal mechanisms depends on the context-dependent combination of causal powers as well as objects' receptivity to influences. This understanding fits well with the complex multiple-cause situation a researcher is facing when trying to explain travel behavior.

Urban structures, together with other societal conditions and the natural environment, make up a set of circumstances enabling or facilitating some actions while hindering or discouraging other actions (Bhaskar, 2016; Archer, 2000; Næss, 2015a and 2016a). The spatial distribution of dwellings, workplaces, schools, stores, restaurants, cinemas and other facilities sets conditions for the inhabitants' need for travel in order to reach various activity locations. People have different resources, needs, wishes and commitments, reflecting their position in relation to various social structures, networks and discourses. They also have different values, attitudes, abilities and predilections in life. Individuals' transport rationales emanate largely from such individual characteristics, which also influence some of the time-geographical constraints that individuals are facing.

### 2.2. Transport rationales

Transport rationales (cf. the introductory section) may be based on different rationalities (Habermas, 1991; Tuan, 1977) and include instrumental, safety-based, comfort-based, esthetic as well as affective dimensions. The concept has some overlap with the notion of 'mobility views' coined by Beckmann (2001:123).

Relatively few studies have applied the transport rationale concept as a framework for identifying, through qualitative interviews, the considerations influencing people's travel within a city or metropolitan area (Næss & Jensen, 2005; Næss, 2005 and 2013; Næss et al., 2017a). The residents' individual resources, motives and social environments influence their transport rationales. Combined with the accessibility of various facilities, these rationales influence frequencies of activity participation, the locations people choose for their various activities, and their ways of traveling to the relevant destinations. The above-mentioned studies of transport rationales took place in diverse national contexts and in differently sized urban regions. Although the importance of different built environment

characteristics on travel varies within and between urban areas, the transport rationales identified in qualitative studies so far show a high degree of commonality.

### 2.3. Time-geographical constraints

The opportunities available for individuals to conduct planned activities are limited by constraints resulting from earlier decisions, social obligations, organizational structures, the location and availability of resources, and from the distances between places (Ellegård, 1999). The time-geographical framework (Hägerstrand, 1970) is useful for describing and analyzing relations between activities, locations and the movements of individuals.

Hägerstrand (1970) described three types of interrelated restrictions that people face when carrying out daily-life activities: capability constraints, coupling constraints and authority/steering constraints.

*Capability constraints* are limitations to individuals' activities due to their biological properties (e.g. need for sleep) and the capability of the tools they have at their disposal (e.g. means of transport). A person's radius of action during a given period depends on, among others, the speeds by which she can travel, and thus on her available modes of transport. However, a person's spatial reach is also determined by the time available for traveling. (Economic expenses and inconvenience of travel come in addition).

*Coupling constraints* are regulations requiring persons, instruments, materials and signs to be coupled into co-operating groups. The necessity of being present at a workplace is a classic example (ibid: 21-22).

*Authority/steering constraints* include spatial restrictions on who is entitled to move through or stay in different places, and temporal restrictions such as the length of working hours and opening hours of stores or kindergartens. Authority/steering constraints also include, among others, the network and time schedule of bus lines (ibid: 25-27). Together, the different constraints imply a considerable limitation on people's use of time and the spatial dispersal of their activities.

During the nearly fifty years since the framework was introduced, time geography has been developed further by Hägerstrand himself as well as numerous other researchers, applied to several research agendas within the field of human activities and travel possibilities in space and time (Neutens et al., 2010; Schwanen, 2008b; Sui, 2012; McQuoid & Dijst, 2012). We consider time-geography highly relevant for research aiming to investigate causal relationships between the built environment and travel, since it can illuminate reasons behind people's movements by examining the contexts in everyday life in which individuals need to change places in order to carry out their planned activities (Ellegård & Svedin, 2012).

## 3. Case metropolitan areas

The data of this study were collected in two Norwegian urban regions: the Oslo and the Stavanger metropolitan area. The continuous urban area of Oslo has about one million inhabitants, while the continuous urban area of Stavanger/Sandnes has about 215 000 inhabitants. The urban area of Oslo has higher population density (37 persons/ha) than the Stavanger/Sandnes urban area (29 persons/ha). Stavanger also has a more weakly developed transport infrastructure - especially when it comes to transit.

Oslo metropolitan area is rather monocentric with one dominant downtown area where many jobs are concentrated. Stavanger metropolitan area is much more polycentric, comprising two old cities (Stavanger and Sandnes) now grown into one continuous conurbation. Importantly, a large business park was established fifty years ago at Forus, roughly midway between the two cities, and has gradually become the region's largest concentration of jobs.

## 4. Methods and interviewees

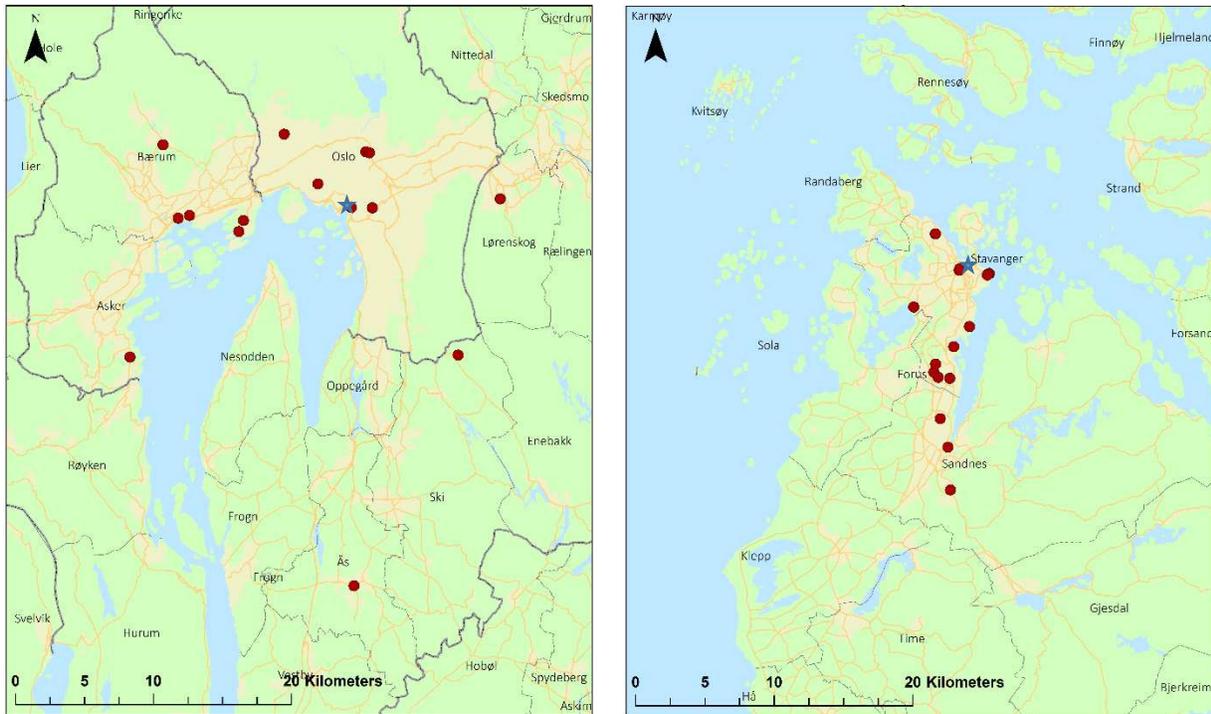
The empirical base of this paper is the qualitative part of a study comprising both qualitative and quantitative methods<sup>1</sup>. The qualitative part included 33 in-depth interviews evenly distributed between the Oslo and Stavanger regions.

We selected interviewees among the more than 900 questionnaire respondents who had volunteered for this task, aiming to include roughly the same number from each of three geographical zones (inner city, close to a second order center and non-central) in each metropolitan area. Another selection criterion was to obtain diversity in terms of socio-demographic aspects, such as age, household patterns, income and education. We also tried to include interviewees whose travel behavior patterns were typical as well as some who were atypical of their residential locations, based on their questionnaire responses. Although we attempted to include interviewees with different socioeconomic characteristics, persons with high income and particularly long academic education are overrepresented among the interviewees, compared to the populations in the two city regions. Appendix A provides an overview of key residential, demographic and socioeconomic characteristics of the interviewees.

The interviews (lasting 60 to 90 minutes) were semi-structured addressing several pre-identified topics. Each interview was conducted in an open manner, where the interviewees were first given the opportunity to speak freely for some minutes about their thoughts regarding residential location, activity participation and travel. The interview guide is shown in Appendix B.

The interviews were conducted in the summer of 2015, all except four<sup>2</sup> in the home of the interviewee, all audio-recorded and fully transcribed. The main purpose of our qualitative interviewing was *explanatory* (Næss, 2018), aiming to deepen the understanding that quantitative research has already suggested. However, we also tried to be open for new, previously overlooked issues, thus including an explorative element. An *interpretation scheme*, developed in our earlier studies (Næss, 2005, 2013, 2015b; Næss & Jensen, 2004) was refined and developed further in the present study<sup>3</sup> (Appendix C). Besides the narratives of each interviewee, our interpretations were also informed by the interviewees' and the general respondents' questionnaire answers.

Figure 2 shows the approximate location of the interviewees' dwellings in Oslo and Stavanger.



## Legend

- Residential address of interviewees
- Municipal border
- County border
- Road
- Urbanized area
- Forest, farmland and barren areas

Figure 2: Location of the dwellings of the interviewees in the metropolitan areas of Oslo (left) and Stavanger (right). Blue asterisks indicate main city centers of each metropolitan area. Maps by Anja Fleten Nielsen, Institute of Transport Economics.

## 5. Interviewees' transport rationales

In this section, we present two groups of rationales identified from the qualitative interviews; a) rationales for choosing locations of activities, b) rationales for choosing modes of transportation. Although interrelated, we identify the two groups of rationales as distinct from each other<sup>4</sup>. The rationales were normally not stated explicitly by the interviewees. Rather, they were inferred from the interviewees' narratives about job locations, acceptable home-work distance if they were to find a new job, location choices for other out-of-home activities, and statements about hypothetical changes in activity pattern and/or travel behavior if they were to live in a different part of the metropolitan area.

## 5.1. Rationales for choosing location of activities

### 5.1.1. Rationales identified in the interviews

Based on the interviews, we identified five rationales for activity location<sup>5</sup>:

- Choosing the best facility (all interviews)
- Minimizing the friction of distance (all interviews)
- Limiting other travel-related expenses (a few interviews)
- Maintaining social contacts (nearly half of the interviews)
- Variety-seeking (several interviews).

The two first are the main rationales and were encountered in all interviews. These rationales are traded off against each other and tend to pull the locations of interviewees' activities in opposite directions. Whereas the rationale of minimizing friction of distance tends to make interviewees choose activity locations at short distance from home (or from other places they are anyway visiting), the 'best facility' rationale tends to make them travel beyond the closest possible opportunities in search for facilities more suitable for the interviewee.

#### *Choosing the best facility*

The best facility rationale refers mainly to the facility where the purpose of the activity can best be met. However, this varies between facility categories (workplace, shop, kindergarten, outdoor recreation area, etc.). For workplaces, specific quality aspects are mentioned only among a few interviewees. The aspects mentioned are that the job should meet the interviewee's professional interests and educational qualifications, as illustrated by a resident of one of Oslo's outer western suburbs:

"Ideally, I would like to work here, down at Rud [a local center], in Sandvika or Bekkestua [two second-order centers], or at Østerås [a local center]. This would have been excellent. But you see, wishes and dreams don't always come true when it comes to available jobs. The thing is that there is a greater supply [of jobs matching his qualifications] in Oslo's inner area, and maybe also some at Fornebu [a previous airport now being redeveloped]." (ID16030<sup>6</sup>)

None of the interviewees mentioned salary or working conditions, although our questionnaire data show that especially the salary level is important when choosing between differently located work opportunities. For outdoor recreation, experiencing nature and having opportunities for mental relaxation/restoration are important, besides the practical possibilities for performing particular activities (dog-walking, hiking, cross-country skiing, alpine skiing, jogging, diving and mushroom picking were mentioned). Outdoor recreation is therefore located to different area types, depending on the desired kind of experience. For special commodity shopping, parking conditions and the atmosphere of stores were also mentioned.

The 'best facility' rationale refers partly also to features of the immediate surroundings of the facility: 'atmosphere' (Stefansdottir, 2017), adjacent green areas and esthetic quality. Apart from residential location, interviewees refer to 'atmospheric' qualities only when talking about leisure facilities, and at no occasions as a criterion influencing their choice of workplace.

#### *Minimizing the friction of distance*

The rationale of minimizing the friction of distance (Lloyd & Dicken, 1977) refers to travel time, costs

and inconvenience/effort of trip-making, which are all related to, but not necessarily identical to minimizing distances measured in kilometers. Among the interviewees, the rationale of minimizing friction of distance is underpinned by the following sub-rationales: time-saving, avoiding too much physical efforts, comfort/convenience, and frustration aversion. The interviewees mostly do not experience that travel time differs much from distance for regular travel purposes. For non-motorized travel, the friction refers to travel time and physical efforts, which are usually related to the distance in kilometers (although deviations may occur in hilly areas). For drivers, congestion or different speed limits may sometimes make the friction of distance lowest along a route different from the shortest one. For transit passengers, the friction of distance depends on frequency of departures, direct routes versus routes requiring transfers, waiting time and walking distance to and from stops. These elements are often more important than the Euclidian distance from the dwelling to the facility in question.

#### *Limiting travel-related expenses*

The rationale of limiting travel-related expenses refers to toll, parking fees and costs related to traveling. Such elements are mentioned only in a few interviews. Talking about their weekly main grocery shopping, a retired resident of one of Oslo's western suburbs said:

“You see, it is quite expensive to drive to downtown Oslo, having to pay toll cordon fee as well as for parking ... then it is convenient to go to CC Vest [a suburban shopping mall] or you can go to Skøyen [a second-order center] which is also just outside the cordon.” (ID13896)

#### *Maintaining social contacts*

For some activity types, a rationale of maintaining social contacts exerts strong influence on choice of locations. This applies particularly to visits to restaurants, cafes and pubs., visits to cinema, informal team sports, and common outdoor recreation/exercise activities. For choices of restaurants etc., the social contacts maintenance rationale implies that the best facility is one preferred collectively by a group of visitors rather than what any separate interviewee judges as the best. Often, this collective preference is based on accessibility. The best facility is then the one that minimizes the friction of distance for the group as a whole, as illustrated by the following quote:

“[Mainly] how easy it is for both to access the place. Largely inside Ring 1” [the ring road around the very central part of Oslo's downtown area]. (ID11404)

#### *Variety-seeking*

When several options are available within acceptable distance and more than one is of acceptable quality, interviewees sometimes alternate between options just for the sake of variation. If the choice of location is open each time (for example when purchasing daily necessities or hiking in natural areas), the rationale of variety-seeking can add to the 'best facility' rationale in expanding the distance within which facilities are chosen. The rationale of variety-seeking is indicated in some interviews, mainly in connection with outdoor recreation but also for choices of shopping location.

#### *5.1.2. Prioritization between rationales for choice of activity location*

The interviewees' prioritization between the two main categories of rationales (distance minimizing vs. best facility) varies between activity types, resulting in wide acceptable travel distances to the locations of activities where the 'best facility' is considered most important and much shorter acceptable travel distances to activities for which distance minimizing has stronger weight.

The activity categories for which the rationale of choosing the best facility is most pronounced are work,

higher-level school/education, long-duration outdoor recreation, and attending cultural events. For workplaces, the interviewees choose the best job they can get within wide limits for acceptable commuting time<sup>7</sup>. Among employed interviewees, the workplace is the daily-life facility category where the longest travel distances are accepted.

Although quite long commuting distances are generally accepted, interviewees in some cases manage to find a job close to their home. This applies particularly to those who live close to large concentrations of employment opportunities. Moreover, two interviewees have zero commuting distance since they have their office at home, but it is not clear from the interviews whether distance minimizing was an important reason for their choices to become home-office-based freelance workers.

Differences in the emphasis on 'best facility' versus 'distance minimizing' are not only present between different activity types. People's mobility resources obviously matter, as do lifestyles and attitudes. Not having a car can make a person place more importance to distance minimizing than to choosing the best facility. Some interviewees have adopted a high-mobility lifestyle making them prone to accept rather long travel distances to find the best facility. Such high-mobility lifestyles are related to these interviewees' status as high-income households. However, high income does not automatically generate high-mobile lifestyles, as illustrated by another interviewee, who despite being an affluent suburbanite did not make particularly long leisure trips.

The relative priority attached to 'best facility' versus 'distance minimizing' also shows some gendered patterns, especially in the family of one interviewee where a traditional division of roles seems to prevail. The husband and her two sons traveled long distances to reach their jobs, and the husband claimed that he could have traveled anywhere by car to get a relevant job if necessary. Distinct from that, the wife said she had to limit her commuting distance (although she emphasized the importance of having a job matching her education), since she wanted/needed to spend time on domestic work and take care of the other family members.

### 5.1.3. Nested chain of activity location choices

Several interviews show examples of a *nested* process of locational choices, where the place of residence is first chosen, based on one set of dominant rationales. Locations for other facilities are thereupon chosen, based on prioritizations between rationales that may differ from the former. In a few cases, this nested process also involves a job choice prior to and/or after the choice of residence.

For example, ID51899 first got job at Fornebu (a western suburb of Oslo) based on a 'best facility' rationale (fitting his expertise) and then chose residence based mainly on a distance-minimizing rationale, where the new dwelling was close to his workplace as well as several service facilities and leisure opportunities. An important reason for the family's wish to live close to the workplace of at least one parent was to be able to pick up children quickly at short notice from the kindergarten if necessary (e.g. if the child got sick). Caretaking responsibility thus amplified the influence of the distance-minimizing rationale on their choice of residence. Given their new residential location, the family also chooses service and leisure facilities based on the distance-minimizing rationale.

Another example is the Stavanger interviewee ID53940 and his family, who first decided to move from Trondheim to a city closer to where their parents lived, based on a rationale of social contact combined with caretaking tasks (grandparents take care of their grandchildren, and ID53940 and his wife take care of their elderly parents). Choosing a workplace not too far from the parents was clearly based on a 'best facility' criterion, probably with the strongest emphasis on the wife's job since her job qualifications

were the most specialized ones. Given their new job locations in Stavanger, they then chose a residential location based on proximity (biking distance) to their workplaces and other potential weekday destinations. With this residential location, their choice of non-work facilities (except weekend outdoor activities) is based mainly on a distance minimizing rationale.

## 5.2. Rationales for choosing travel modes

Individuals' travel mode choices are based on multiple interrelated considerations. These considerations, including both physical and social factors, differ between individuals and between geographical contexts. In most cases, interviewees considered a mix of and balanced several rationales against each other. However, the travel mode choice rationales do not as often as the rationales for activity locations pull in opposite directions.

The rationales for choosing travel modes<sup>8</sup> apply to different phases of travel: preconditions, the process and experience of traveling, and possible consequences (e.g. in terms of time consumption or health benefits). The precondition considerations refer to either individual conditions, such as physical ability (cf. the time-geographical concept of capacity constraints), or external factors such as the built environment.

Some rationales were highlighted more frequently than others and are here called main rationales (see list below). The secondary rationales are less important in the overall picture, appearing typically in combination with the main rationales. However, although they appear less frequently, they may in particular cases be highly important, even overriding the 'main' rationales.

### Main rationales

- Convenience and comfort, including (all interviewees):
  - Avoiding physical efforts,
  - Mobility simplicity
- Frustration aversion (most interviewees)
- Time-saving (most interviewees)

### Secondary rationales

- Wish for physical exercise (several interviewees)
- Long-term habits (few interviewees)
  
- Limiting travel expenses (few interviewees)
- Safety (very few interviewees and only indirectly)
- Social contact and caretaking (few interviewees)
- Esthetics (very few interviewees)
- Environmental concerns (very few interviewees)

### 5.2.1 Main rationales

#### *Convenience and comfort*

This rationale applies to considerations regarding the process of travel. It is both the most emphasized rationale and the most faceted one. It appears in many forms, such as when interviewees mention overcoming long distances, avoiding physical efforts, such as carrying heavy items, and avoiding harsh weather. Smooth travel, good connections, overall efficiency and simplicity are also dimension of convenience.

The convenience rationale seems to occur independently of residential location and geographical contexts. Rather, convenience is always important to the interviewees and has strong bearing on their travel mode choice. The rationale can motivate choosing motorized as well as non-motorized travel. In many cases, interviews indicate that it may be more convenient to walk, bike or use transit rather than drive a private car, as illustrated by a Stavanger resident living close to a secondary center:

“Yes, but, well, such short trips, well they are so short that, during the rush, it is almost faster to bike those two kilometers. And regarding the car, it is no advance for these short trips, when the motor does not even get warm, even polluting, and in addition on has to pass this beloved road toll line.” (ID33352)

The convenience rationale also comprises a wish for mobility simplicity. For inner Oslo interviewees, mobility simplicity often implies choosing transit in combination with walking. The transit functionality (as a combination of good access and service) of the inner city is so convenient that other transport modes are often not considered. In polycentric Stavanger, where interviewees generally did not talk positively about the transit system, simplicity was rather associated with walking (inner-city interviewees), or with driving a private car.

#### *Frustration aversion*

In both cities, frustration is mainly mentioned in connection with motorized transport, while biking and walking do not seem to be experienced as frustrating. In Stavanger, frustration due to waiting times, unreliability and costs seems to be an important reason for people to choose travel modes other than transit. A Stavanger interviewee who had moved some years earlier from an inner-city apartment to a suburban single-family house stated:

“It is a long way uphill to the bus stop. ... The first year I lived here, I tried to live without a car ... so then I tried to take the bus. .... I reported [to the traffic planner of the transit company] each time the bus just passed without stopping, or did not show up, or was much delayed.. I was so angry, I was seriously mad with the transit company. Then, finally, I bought a car.” (ID35894)

Typically, frustration in relation to car travel is linked to congestion (waiting time) and demanding traffic situations (busy traffic in inner cities). It seems though that this frustration causes only central Oslo inhabitants to abstain completely from car use.

#### *Time-saving*

This rationale refers to consequences of travel mode choice in terms of time consumption. Although important, it almost never comes up in isolation, but interlinked with other rationales such as convenience. Emphasis on smooth travel, without stress, congestion, waiting times and interruptions reflects an interplay of the convenience and the time-saving rationales. For example, one interviewee in Stavanger laments on low transit frequency, time schedule and need to change lines.

Time-saving seems to play a less important role in inner Oslo than in other parts of Oslo. The reason is most likely that distances are often so short that time consumption will anyway be moderate, regardless of travel mode. One might though argue that a time-saving rationale is at play when deciding not to use a car for inner city travel, because driving there is rather troublesome and may take a considerable amount of time.

For suburban interviewees, time-saving plays an important role. Most of these interviewees have to overcome long distances to reach their diverse activities. They therefore need fast means of transportation. Transit access and frequency are also more limited in the suburbs than at central locations. Even for suburbanites living close to a transit stop, transit is often perceived as too time-consuming, as illustrated by this Stavanger interviewee:

“In my view, the [local] transit provision is very good ... buses go all the way. And the departures are relatively frequent. What is cumbersome is that it takes too long time. 35 minutes in total from leaving home [before arriving at the workplace] ... [more than three times as long as by car] ... On the way home ... the bus that I needed to take never showed up. ... So I had to take the next one. ... which is indeed stuck in congestion! .. It took an hour, all included.” (ID52803)

Suburban interviewees thus consider themselves to depend more on the car to manage their daily life within a certain timeframe (as also shown in the quantitative part of the study). Nevertheless, many suburban interviewees (especially those in the second order centers) expressed a dislike for driving.

Overall, time-saving seems to play a more important role the further the dwelling is located from the main or closest secondary center, where one has better access to a variety of facilities. The other way round: the closer interviewees live to the center (especially in the case of Oslo), the less important is the time-saving rationale for their daily travel. In Stavanger, the time-saving rationale seems to lead interviewees to choose the car when active transport modes, like biking and walking, become too cumbersome because of long travel distances.

### 5.2.2 Secondary rationales

#### *Physical exercise*

This rationale refers to a consideration of the consequences travel may have for health. It is not emphasized much by Oslo interviewees, regardless of how far from the center they live. The wish for physical exercise and a certain health awareness concerning travel are stronger among Stavanger interviewees. This may reflect that opportunities for recreational walks of some duration in forests and other natural areas are poorer in Stavanger than in Oslo.

#### *Long-term habits*

This rationale refers to the preconditions of travel. It relates to personal long-term habits, typically developed since childhood. It could be characterized as an unconscious lifestyle, such as following travel mode choice patterns without seriously considering possible alternatives. The different spatial configurations of Oslo and Stavanger do not seem to have an influence on the occurrence of this rationale.

When present, this seems to be a particularly strong rationale overriding most other rationales. Arguably, it is of a particular nature insofar as people experience it as determinant, a factual condition that one cannot really change. Interviewees' stories indicating this rationale typically link it with personal identity traits, such as one interviewee using the car because he is a 'car man', or a woman not

using a car because she grew up in a family that never had a car.

#### *Limiting travel expenses*

This rationale relates to monetary expenses resulting from choosing a certain travel mode, such as road tolls, parking costs, transit fares, etc. It can therefore be a consideration of the consequences of travel. The travel expenses rationale comes up frequently as a general consideration, but is not highlighted enough to override other mode choice rationales.

In Oslo, it is linked to how expensive it is to drive a car, regarding road tolls and high parking costs in the inner city. This rationale was not addressed by the Stavanger interviewees.

#### *Safety*

This rationale refers to the possible consequences of travel mode choice. It was barely mentioned in the interviews, regardless of geographical context. However, this does not mean that safety is not important to the interviewees. Rather, this rationale seems to be taken so much for granted that it goes without saying.

#### *Social contact and caretaking*

This rationale applies to the process of travel and refers to choosing a transport mode based on a motivation to travel in company, for pleasure or caretaking reasons. In most cases, interviewees highlighted caretaking as the main element of this rationale (picking up children and transporting partners).

#### *Esthetics*

This rationale is about the process of traveling, making a mode choice influenced by the wish to have a positive esthetical travel experience, or to avoid a negative one. Nobody explicitly stated esthetics as a rationale, but there are indications that an esthetical perspective – in the sense that it has a recreational value – is important to some people, mainly linked to the experience of walking, be it in built environment or nature. Esthetics may play a more important role regarding route choice than travel mode choice, although these two are interrelated.

#### *Environmental concerns*

This rationale involves consideration of environmental consequences of travel modes. Only a few interviewees from non-central Oslo explicitly mention this as one of their reasons for trying not to use a car.

## 6. Consequences of the rationales to relationships between residential location and travel

### 6.1 Influences of activity location rationales on relationships between residential location and travel distances

In this section, we discuss implications of rationales for workplace location and location of non-work activities to the relationships between residential location and travel distances. Table 1 summarizes the contributions of various rationales for activity location to the tendencies of shorter travel distances when living close to the main city center and lower-order centers, respectively<sup>9</sup>.

Table 1: Rationales for activity location encountered among Oslo and Stavanger interviewees, and the contribution of these rationales to relationships between residential location and intra-metropolitan travel distances.

<i>Rationales</i>	<i>Influence on activity location</i>	<i>Contribution to the tendency of shorter intra-metropolitan travel distances when living close to the main city center</i>	<i>Contribution to the tendency of shorter intra-metropolitan travel distances when living close to lower-order centers</i>
Minimizing the friction of distance (all interviews)	Tends to make the interviewees limit their choices of facilities for a given type of activity to those facilities which are accessible within a certain geographical radius, and to choose the closest facility meeting his/her quality criteria. Threshold distances are usually widest for workplaces and shortest for daily necessity shopping.	<b>Supports this tendency somewhat</b> , both because the facilities in the central districts of the cities are the closest opportunities for inner-city residents, and because of the shortage of facilities in the periphery.	<b>Supports this tendency substantially</b> by increasing the likelihood of choosing local facilities rather than more distant ones. In Stavanger, this rationale contributes strongly to shorter <i>commuting</i> distances among local residents near the suburban employment center Forus.
Choosing the best facility (all interviews)	Tends to make the interviewees consider a large number of facilities within each facility category as potential locations of their activities, regardless of the distance from the dwelling to these facilities (as long as some quite wide threshold distance is not exceeded).	<b>Supports this tendency substantially</b> by increasing the likelihood of traveling to the large concentration of facilities in the inner parts of the metropolitan area. In Oslo also because of downtown's role as an approximate point of gravity for all peripheral destinations.	<b>Counteracts this tendency somewhat</b> by increasing the likelihood of choosing distant facilities rather than local ones. In Stavanger, this rationale at the same time strongly supports a tendency of shorter <i>commuting</i> distances the closer to the suburban employment center Forus the dwelling is located
Maintaining social contacts (nearly half of the interviews)	Tends to make interviewees choose facilities not only based on their own preferences, but on the common preferences (in terms of accessibility, quality criteria etc.) of a group of friends.	<b>Supports this tendency</b> because of downtown's density of facilities and its higher accessibility by public transport. In Oslo also because of downtown's role as an approximate point of gravity for the housing stock	<b>Supports this tendency</b> insofar as the groups of friends who decide to meet at restaurants etc. live in the same local district. In Stavanger, this rationale also supports a tendency of shorter leisure trip distances the closer to the second-order center Sandnes the dwelling is located
Limiting travel-related expenses other than transit fares and fuel costs (a few Oslo interviews)	Tends to make car driving interviewees abstain from choosing facilities where they have to pass toll cordons or pay expensive parking fees	<b>Supports this tendency slightly</b> since it can make inner-city Oslo residents more reluctant to choosing destinations outside the toll cordon. But it can also discourage suburban residents from choosing inner-city destinations.	<b>Supports this tendency</b> by increasing suburban residents' propensity for choosing local destinations where parking is free or cheap and without needing to pass toll cordons
Variety-seeking (several interviews)	Combined with rationales of choosing the best facility, variety-seeking tends to make interviewees sometimes choose more distant facilities than the closest one matching the interviewee's quality criteria.	<b>Hardly any effect</b> , since it does not plausibly influence much on the distances traveled by residents living in different parts of each metropolitan area	<b>Hardly any effect</b> , since it does not plausibly influence much on the distances traveled by residents living in different parts of each metropolitan area

### 6.1.1 Workplace location

Within each metropolitan area, the spatial distribution of dwellings and jobs with different qualification requirements results in shortage of suitable jobs close to home for those who live in the peripheral parts, but not for those living close to the main employment centers. What is considered a *suitable* job depends on the emphasis placed on the 'best facility' rationale compared to distance minimizing. However, even for those attaching high importance to the latter rationale, the likelihood of finding a local job will be lower in the suburbs due to the lower job densities characterizing these areas. Combined with the 'coupling constraint' (Hägerstrand, 1970) of being present at the workplace, this necessitates that a high proportion of residents of the metropolitan peripheries make long commutes, while the proportions who need to make long commutes are much smaller among those living close to the main employment centers.

The rationale of *minimizing the friction of distance* contributes strongly to a tendency of shorter commuting distances when living close to local centers, since it increases the likelihood of choosing local jobs, if available, rather than more distant ones. However, this rationale also contributes somewhat to the tendency of shorter commuting distances when living close to the main metropolitan employment centers (inner Oslo, Forus and central Stavanger). This is because the jobs in these centers are the closest opportunities for residents of adjacent neighborhoods.

The rationale of *limiting travel expenses* can make interviewees abstain from choosing jobs where they have to pass toll cordons when commuting or pay expensive parking fees at the workplace. In Oslo, a wish to avoid toll cordons can increase suburban residents' propensity for choosing local jobs and thus make commuting distances more dependent on the location of the dwelling relative to local centers. However, this rationale can also make inner-city Oslo residents more reluctant to choosing jobs outside the toll cordon. The rationale of limiting travel expenses therefore plausibly contributes to a slight strengthening of tendencies of shorter commuting distances when living close to the main city center as well as to a local center.

The rationale of *choosing the best facility* contributes strongly to the tendency of shorter commuting distances when living close to the main city center, since it increases the likelihood of traveling to the large job concentrations found in inner Oslo, Forus and central Stavanger. On the other hand, this rationale counteracts to some extent the tendency of shorter commuting distances when living close to lower-order centers, since it increases the likelihood of choosing distant job opportunities rather than those existing locally.

The different rationales for choices of workplace location can largely be fulfilled simultaneously for inner city interviewees in Oslo and to some extent also in Stavanger. In the latter metropolitan area, workplaces are concentrated more to the Forus business park than to inner Stavanger, so the advantage for central-city residents over suburbanites in the possibility of finding employment close to home is lower in Stavanger than in Oslo. Since many different job opportunities are often available within short distance from the dwelling, inner-city residents in Oslo can be quite selective about the quality of the job (in terms of salary, job content, working conditions, etc.) without needing to commute long distances. In Stavanger metropolitan area, the same applies to workers living close to either the Forus area or central Stavanger.

### 6.1.2 Location of non-work activities

For similar reasons as for workplace location, the rationale of *minimizing the friction of distance* supports the tendency of shorter travel distances when living close to lower-order centers, and to some extent also of proximity to the main city center. This rationale is particularly prominent for activities such as daily necessities shopping and physical exercise on weekdays. The rationale of *limiting other travel-related expenses* (notably road tolls and parking fees) works in ways similar to the rationale of minimizing the friction of distance. On the other hand, because the range of opportunities for more specialized and culturally differentiated non-work activities is usually greater in the inner city than in lower-order centers, the rationale of *choosing the best facility* strongly supports the tendency of shorter travel distances when living close to the main city center. It may, however, lead to some weakening of the influence of residential proximity to lower-order centers.

Inner-city residents can reach several sophisticated as well as mainstream cultural events within a moderate distance from the dwelling. In Oslo metropolitan area, some suburban residents too have specialized and/or non-specialized cultural facilities close to where they live, but for most suburbanites, few such opportunities exist within moderate distance from home. Suburbanites' trips to cultural facilities thus tend to be longer than those their inner-city counterparts make. This is amplified by the prevalent tendency among interviewees of choosing facilities matching their cultural taste and interests rather than the closest cultural arena. Neighbors of a suburban cultural facility therefore also tend to visit other cultural facilities located in the inner city or in other suburbs. In Stavanger metropolitan area, the main concentrations of cultural facilities (theaters, cinemas, concert arenas, museums, art exhibitions, etc.) are located in Stavanger's downtown area and, to a lesser degree, the central part of Sandnes. Given the emphasis attached to the 'best facility' rationale for this activity group, culture-interested residents tend to go to events matching their specific cultural taste even if this involves more travel. Culture-interested suburbanites as well as downtown Sandnes residents therefore tend to make longer trips to cultural events than their counterparts living close to the city center of Stavanger.

For special commodity stores and restaurants/cafes, the situation and resulting mechanisms leading to geographical differences in travel distances are quite similar to those concerning cultural facilities. For grocery stores, the mechanisms are different. Although different rationales dominate when choosing between discount stores and stores offering wider assortment, both categories are usually available in most local centers. Most interviewees therefore usually differentiate between stores of a given assortment category within a quite narrow threshold distance.

Because areas suitable for recreational walks, jogging, etc. exist close to most residential neighborhoods in each metropolitan area, the distances traveled to such areas tend to vary less between different parts of the urban region. However, a larger number of facilities for indoor exercise exists in the inner and central parts of the metropolitan areas. Inner-city dwellers therefore tend to travel shorter overall distances to exercise opportunities, despite greater proximity for suburbanites to areas for long-duration outdoor activities.

The rationale of *maintaining social contacts* guides the location of common activities such as going to restaurants, cafes or bars and common outdoor recreation trips. The central part of the metropolitan area is usually easier accessible for a group of people than suburban locations (unless all group members live in the same suburb). The high concentration of facilities in the downtown area also makes it more likely for a group of friends to find a facility they like there than in more peripheral parts of the urban

region. Therefore, facilities close to the city center are more likely to be chosen when a group of friends or colleagues go out together. Especially when visiting restaurants, cafes and bars, the rationale of maintaining social contacts tends to produce shorter travel distances among inner-city dwellers than among suburbanites. For other types of common social activities, such as common outdoor recreation activities, facilities are less centralized. For such undertakings, the social contacts rationale is less likely to produce great center-periphery differences in travel distances.

The *variety-seeking* rationale appears mainly for outdoor recreation, but in a few cases for shopping as well. This rationale tends to increase the distances traveled to relevant non-work facilities, but it does not plausibly influence much on the differences between residents living in different parts of each metropolitan area in travel distances.

## 6.2 Influences of travel mode choice rationales on relationships between residential location and modes of transportation

The *convenience and comfort* rationale seems to occur independently of residential location, but its impacts on travel mode choices differ geographically. Suburban interviewees often perceive car travel as the most convenient, whereas inner-city dwellers often find it more convenient to walk, cycle or use transit. In this way, the convenience and comfort rationale amplifies tendencies of higher shares of non-motorized travel among inner-city residents and, less pronouncedly, among those living close to a lower-order center. However, the convenience and comfort rationale can also make some residents of central neighborhoods choose car instead of walking, biking or going by transit, for example on rainy days. This can to some extent counteract the above-mentioned impacts of residential location on travel mode choices.

The *frustration aversion* rationale contributes to higher shares of car travel among suburbanites than among inner-city dwellers. For central city interviewees, particularly in Oslo, frustration associated with travel typically arises from driving and parking under congested conditions. The frustration aversion rationale thus contributes to prevent inner-city residents from traveling by car for local trips. A similar, but weaker effect exists for residential proximity to lower-order centers, where congestion is usually less severe. For interviewees living close to a lower-order center or at non-central locations, travel by transit sometimes is a cause of frustration, motivating these residents to travel by car rather than transit.

The *time-saving* rationale often motivates suburban interviewees to travel by car. If a person lives far from the workplace and other regular trip destinations and has to walk, cycle or go by transit, these trips will consume a high proportion of the time budget. The time allocated to necessary travel may then replace other, desired activities. By acquiring a car (or a second car), some of the 'capacity constraints' (Hägerstrand, 1970) are relieved and higher travel speed is obtained. This mechanism applies, of course, not only to car acquisition, but also to suburban car owners' choice to use their car rather than alternative travel modes if the latter are slower.

The time-saving rationale thus has a clear connection with the time-geographical constraints to which a person is exposed. Most people need to come home each night for sleep, and many also for family obligations. In addition, most workforce participants are subject to the 'coupling constraint' (Hägerstrand 1970, cf. section 2) of having to be present at the workplace each weekday. Some also have to bring and pick up children at kindergarten on their way to and from work. The time slot in the morning between the opening of the kindergarten and the start of the working hours is often short.

Similar shortage of time often occurs in the afternoon between the end of the workday and the closing time of the kindergarten, or maybe more importantly, the perceived appropriate picking-up time (Schwanen, 2008a). The timetable for transit and walking distances to and from stops may render it too time-consuming for a suburbanite to move between mandatory locations unless traveling by car. Moreover, if the same suburbanite wants to participate in organized leisure activities in the afternoon it may often become difficult to reach these activities on time by other transport modes than a car. For inner-city dwellers, the above time constraints are usually more relaxed since the relevant facilities are closer to the dwelling. Walking distances to transit stops are normally also shorter and frequencies of departure higher.

For inner-city interviewees, trip distances are often so short that time consumption will be moderate regardless of transport mode. However, a time-saving rationale is arguably still at play when deciding not to use a car for inner city travel, since driving in congested traffic, searching for a parking place and possibly needing to walk long distances from and to parking may take considerable time.

Among the secondary rationales, emphasis on *physical exercise* has similar, but opposite effects as the limiting physical efforts component of the convenience rationale. It can therefore contribute to support as well as counteract the tendencies of less frequent car travel among centrally residing interviewees. The same applies to the *environmental concerns* rationale, which can make some inner-city residents who would otherwise find walking or biking a bit too time-consuming or uncomfortable still choose these modes for environmental reasons. On the other hand, this rationale can also activate a potential for commuting by bike among physically fit suburbanites who would else prefer motorized travel modes.

*Long-lasting habits* tend to weaken the influence on travel modes of residential proximity to the main city center as well as to lower-order centers, since such habits can make residents stick to old ways of traveling more or less regardless of the urban-structural situation of the dwelling. The rationales of *safety* and *caretaking/social contact* have similar effects. By promoting car travel (often perceived as more safe, more convenient when escorting children or physically impaired persons and offering better conditions for private conversations than on a bus or metro) regardless of residential location, the safety and social contact/caretaking rationales reduce the differences between inner-city dwellers and suburbanites in travel mode choice.

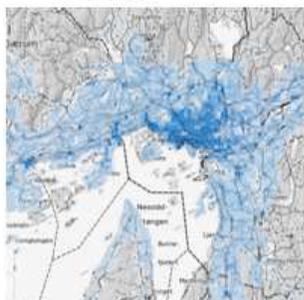
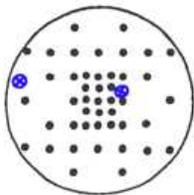
The *esthetics* rationale relates mainly to the experience of the surrounding built environments or vegetation as a pedestrian or cyclist. Some interviewees emphasize the esthetic value of experiencing vegetation along the route, which may be more common in the suburbs. Others appreciate the esthetic qualities and atmosphere of the historical urban core. This rationale can thus release an additional potential for non-motorized travel among inner-city dwellers as well as suburbanites.

Finally, the rationale of *limiting travel expenses* can, in some cases, make residents who are not much in need for car travel sell their car, or one of the cars if the household owns more than one. Since the conditions enabling this typically exist more often in the inner city than in the suburbs (cf. Cao et al., 2018a), the travel expenses rationale strengthens the tendency of lower shares of car travel among inner-city residents. Concerns of limiting travel expenses can also motivate some additional inner-city dwellers to use non-motorized modes, similar to the effects of the physical exercise and environmental rationales. On the other hand, the travel expenses rationale can make some suburbanites who would otherwise pay toll fees for driving to inner city facilities choose transit instead.

### 6.3. Interactions between built environment characteristics, time-geographical constraints and transport rationales – an example

It would be quite complicated to illustrate an interviewee's time-space prism over the week or her movements between spatio-temporally more or less fixed, semi-fixed and flexible activities in a diagram or on a map, let alone to show how such patterns differ between groups of interviewees living in different parts of a metropolitan area. Instead, we have tried to summarize how the interaction between built environment characteristics, time-geographical constraints and transport rationales tends to produce different typical traveling distances and travel modes among suburbanites than among inner-city dwellers (Figure 3). A resident of a dense, inner-city area in Oslo (depicted by the blue symbol close to the center of the circle in the upper left part of the figure) has numerous facilities within a short distance from the dwelling. In contrast, a resident of a low-density suburb (depicted by the blue symbol near the periphery of the circle) has only a few facilities close to home. Several time-geographical constraints imply that both have a tight schedule of daily-life tasks requiring them to avoid spending too much time on traveling. They also have limited capacity for making physically exhausting travel by non-motorized modes. This engenders a rationale for both residents of minimizing the friction of distance in terms of time consumption and physical effort. At the same time, they both have rather specialized job skills and leisure interests, which forms the basis for a rationale of choosing the best facility. The inner-city resident can fulfil both these rationales by finding a job and leisure facilities within walking and biking distance from home. The suburban resident has to travel far beyond her local neighborhood to find a satisfactory job and relevant leisure facilities. Because of the long distances and the poorer transit provision at her residence, she needs to go by car to reach her mandatory destinations within the tight time slots available. (The example is an idealized illustration based on the interviews but not depicting any particular interviewee.)

#### Built environment characteristics, e.g.



#### Time-geographical restrictions, e.g.

- Coupling constraints
  - Need to be present at the workplace
  - Need to pick up child in kindergarten
- Capacity constraints
  - Need to be at home in the evening and night for family obligations and sleep
  - Do not have physical fitness for bike commuting at distances exceeding 5 km

#### Steering constraints

- Working hours, kindergarten opening hours
- Transit lines and timetables

#### Rationales for location of activities, e.g. employment

- Limitation of the friction of distance, in terms of
  - Time consumption
  - Monetary expenses
  - Physical effort
- Choosing the best facility, in terms of
  - Job content
  - Salary
  - Work conditions
  - Colleagues

Figure 3: Interactions between built environment characteristics, time-geographical restrictions and transport rationales.

## 7. Concluding remarks

The transport rationales identified in the qualitative interviews have contributed to deeper understanding of *why* residents living close to the main center travel shorter per day and use cars less than those living in the outer parts of the urban regions do. The rationales have also helped understanding why the variations in travel behavior with residential location differ between the monocentric Oslo and the polycentric Stavanger metropolitan area. While the rationales show much similarity to those found in earlier studies, the present study has corroborated and nuanced existing insight in new contexts (monocentric as well as polycentric city regions). The study also has a stronger and more nuanced methodological grounding. This substantiates the few efforts that have been made earlier to identify causal relationships behind transport behavior through qualitative research.

The study's main limitations are, first, that interviewees' accounts are both limited and corrigible due to the existence of unacknowledged conditions, unintended consequences, tacit skills and unconscious motivations (Bhaskar, 1998), and we cannot rule out recall-bias. Second, different possible interpretations exist about what an interview material is about, and any meaning pulled out of interviews is in principle contestable (Alvesson, 2011:5). Moreover, the interpretations, as well as the conduction of the interviews (e.g. when posing probing follow-up questions) is theory-laden. However, we still maintain that the interviews provide a better base for drawing conclusions about our research topic than what would have been the case in the absence of interviewing. This is especially so because the qualitative interviews were not conducted as the only research method, but in combination with a questionnaire survey forming the base for cross-sectional as well as quasi-longitudinal analyses. A possible improvement for future research could be to carry out qualitative before-and-after interviews among movers, instead of just asking retrospective questions.

The study counters claims that the influences of compact development characteristics on driving are small (Stevens, 2017). It also shows why urban form features at the city or metropolitan scale are generally more important to travel distances and modes than neighborhood-scale built environment characteristics.

Citizens' choices of where in the city region they will work and where they will carry out non-work activities are affected by transport rationales and time-geographical limitations. We have identified five rationales for such activity location choices among the interviewees: choosing the best facility, minimizing the friction of distance, limiting other travel-related expenses, maintaining social contacts, and variety seeking. The two first mentioned seem to be the most influential. Inner-city residents can be quite selective about the quality of the facility without needing to travel a long distance, since many potential facilities are often available within a short distance from the dwelling. For suburbanites, choosing the best facility more often requires that they need to accept longer travel distances.

We identified three main rationales for choices of travel modes: convenience and comfort, frustration aversion and time saving. Overall, these rationales contribute to strengthen tendencies of lower shares of car travel and higher shares of non-motorized (and partly transit) travel among inner-city dwellers than among suburbanites. The three rationales' contributions to travel mode effects of living close to lower-order centers are less pronounced. In addition, seven other rationales play some role when choosing travel mode: physical exercise, long-term habits, travel-related expenses, safety, social contacts, esthetics and environmental concerns.

Some of the rationales can also explain why car travel plays a more important role for intra-metropolitan travel in the smaller Stavanger than in the bigger Oslo metropolitan area. Due to higher overall congestion level on the roads, better transit provision, lower and more expensive parking opportunities and toll fees, rationales of time-saving, comfort/convenience and limiting of travel expenses make up greater incentives against car driving in Oslo than in Stavanger.

Interestingly, contrary to claims in much of the American literature on built environment and travel (e.g. Ewing & Cervero, 2010), none of the interviewees indicated that the local street pattern was important to their travel – this feature of the built environment was barely mentioned at all. Our material demonstrates how causal mechanisms lead to different travel behavior among suburbanites than among inner-city dwellers, regardless of residential self-selection. The interview material showed the importance of residential preference criteria other than travel attitudes when households decide where to live. For example, several interviewees who did prefer to go by transit or non-motorized modes, if possible, still opted for a suburban dwelling because this conformed with their lifecycle stage and other attitudes that they also held. Some were also unable for economic reasons to buy a dwelling as close to the city center as they had otherwise wanted.<sup>10</sup>

The main rationales for location of activities and travel mode choices found in Oslo and Stavanger and the relative importance attached to different rationales are very similar to findings from earlier studies in the metropolitan areas of Copenhagen (Denmark), Hangzhou (China) and Oporto (Portugal) (Næss & Jensen, 2005; Næss, 2005, 2013 and 2015b). Different wordings are sometimes used in these studies about basically the same rationales, reflecting slight nuances in the narratives from which the rationales were inferred. The rationales are also consistent with findings in other qualitative studies not using the concept of transport rationales. For example, Røe (2001) found that inner-city living offered high-mobile and spatially flexible Oslo residents high accessibility to services near the dwelling as well as elsewhere in the metropolitan area, while suburbanites belonging to the same mobility lifestyle group needed to travel long distances to meet their preferences. Individuals with a low-mobility lifestyle could also choose between a wide range and number of facilities if they lived centrally, but experienced several spatial constraints and less freedom of choice if they lived in a suburb, particularly if transit accessibility was poor. In the Danish city of Aalborg, Nielsen (2002) found that the interviewees usually chose the location of their jobs, leisure activities and to some extent social contacts within the entire urban area, not restricted to the local neighborhood.

The similarity of transport rationales across such differing contexts as demonstrated above suggests a high degree of generality in the basic mechanisms through which urban form influences travel behavior. At the same time, the different spatial contexts of different cities imply that the nature and strength of the influences of various built environment characteristics on travel behavior will necessarily differ with the particular city context, as also observed when comparing the findings in Oslo with those in Stavanger.

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## Appendix A: Demographic, socioeconomic and residential characteristics of the interviewees

ID number	Type of residential location	Housing type	Age	Gender	Number of adult household members	Number of children below 7 years	Number of children 7-17 years	Education level	Workforce participation	Personal income (1000 NOK)	Household income (1000 NOK)	Number of cars in the household
Oslo (17 interviewees):												
10078	Inner city	Apartment	50	Female	1	0	0	High school	Employed	400 to 499	400 to 499	0
10749	Inner city	Row house	36	Female	2	2	0	Uni ≥ 4 years	Employed	700 to 799	Over 1200	0
11404	Inner city	Apartment	38	Male	2	2	0	Uni ≥ 4 years	Employed	500 to 599	600 to 799	1
12137	Inner city	Apartment	63	Female	2	0	0	High school	Employed	300 to 399	400 to 599	1
13896	Non-central	Single fam	75	Male	2	0	2	Uni ≥ 4 years	Neither	600 to 699	1000 to 1199	2
15965	Second-order center	Single fam	54	Female	2	0	0	High school	Employed	300 to 399	800 to 999	1
16030	Non-central	Single fam	41	Male	2	3	0	Uni ≥ 4 years	Employed	700 to 799	Over 1200	2
17095	Second-order center	Single fam	51	Male	2	0	2	Uni ≤ 3 years	Employed	700 to 799	Over 1200	2
17239	Non-central	Duplex	60	Male	2	0	0	Skilled worker/craftsman	Un-employed	400 to 499	800 to 999	2
17833	Non-central	Single fam	53	Female	1	0	0	High school	Employed	200 to 299	200 to 299	0
20398	Non-central	Single fam	19	Female	3	0	1	High school	Pupil	Not stated	Not stated	2
50136	Inner city	Apartment	71	Female	2	0	0	Uni ≤ 3 years	Retired	300 to 399	800 to 999	1
50711	Inner city	Apartment	32	Female	2	1	0	Uni ≤ 3 years	On birth leave	600 to 699	800 to 999	0
51437	Non-central	Apartment	40	Male	2	1	1	Uni ≥ 4 years	Employed	over 800	Over 1200	1
51899	Non-central	Apartment	47	Male	2	2	0	Uni ≥ 4 years	Employed	over 800	Over 1200	2
52271	Second-order center	Apartment	37	Female	1	0	0	Uni ≥ 4 years	Employed	600 to 699	600 to 699	1
52375	Non-central	Apartment	26	Female	1	0	0	High school	Employed	300 to 399	300 to 399	0
Stavanger (16 interviewees):												
32356	Non-central	Single fam	42	Female	4	0	2	Skilled worker/crafts-woman	Employed	100 to 199	Over 1200	4
33352	Second-order center	Duplex	48	Male	2	2	1	Uni ≥ 4 years	Employed	over 800	1000 to 1199	1
35196	Non-central	Apartment	76	Male	1	0	0	Skilled worker/craftsman	Retired	200 to 299	200 to 299	2

35894	Non-central	Single fam	46	Female	3	0	1	Uni ≤ 3 years	Employed	600 to 699	Over 1200	3
37424	Inner city	Apartment	74	Male	1	0	0	Uni ≥ 4 years	Retired	600 to 699	600 to 699	1
39693	Non-central	Apartment	50	Female	3	0	0	Not stated	Employed	Not stated	Over 1200	2
40363	Second-order center	Single fam	46	Female	1	0	2	Uni ≥ 4 years	Employed	600 to 699	1000 to 1199	1
40880	Second-order center	Apartment	60	Male	1	0	0	Uni ≤ 3 years	Employed	700 to 799	700 to 799	1
41053	Second-order center	Single fam	35	Female	2	1	0	Uni ≥ 4 years	Unemployed	Not stated	600 to 799	1
52703	Second-order center	Apartment	71	Female	2	0	0	High school	Retired	100 to 199	600 to 799	2
52803	Non-central	Apartment	60	Male	2	0	0	Uni ≥ 4 years	Employed	over 800	Over 1200	2
53787	Inner city	Apartment	66	Male	2	0	0	Uni ≥ 4 years	Employed	over 800	Over 1200	2
53816	Inner city	Apartment	28	Male	2	1	0	High school	Employed	400 to 499	600 to 799	2
53892	Inner city	Row house	37	Female	2	1	0	Uni ≥ 4 years	Employed	600 to 699	Over 1200	1
53940	Inner city	Row house	38	Male	2	2	0	Uni ≥ 4 years	Employed	600 to 699	Over 1200	2
54466	Non-central	Apartment	61	Female	1	0	0	Uni ≤ 3 years	Employed	500 to 599	500 to 599	1

## Appendix B: Interview guide

Topics to be addressed in qualitative interviews as part of the research project “Where and how should we build our homes? – Residential location, activity participation and travel behavior”

We are conducting a study of choices about where to live and about daily travel and activities of residents from different kinds of neighborhoods. It is funded by the Norwegian Research Council and is carried out by Norwegian University of Life Sciences in cooperation with Institute of Transport Economics and the University of Minnesota. You are one of the survey respondents who volunteered to participate in a qualitative interview as part of this project.

It is desirable to have the interviews take place in the home of the interviewee, although other locations can be chosen if they are more convenient. Each interview is expected to last from 1½ to 2 hours. The sequence of topics will be adapted to the situation of each specific interview and may not necessarily follow the order displayed in this guide. A map of the metropolitan area will be placed on the table so that interviewer(s) and interviewee(s) can point to places on the map and identify locations. The interviews will be audio-recorded and transcribed in their entirety (yet without including coughs, stuttering, repeated words, etc.). The transcript will be treated confidential.

- General thoughts on the importance of residential location to activity participation and travel
- Opinions about the dwelling and the residential area
- Regular activities and travel – workforce participation, studying, escorting, etc.
- Weekend activities and travel
- Leisure activities
- Physical exercise
- Shopping
- Urban ‘atmosphere’
- Transport opportunities and constraints
- Holiday trips
- Activities and travel if living in a different urban context
- Health
- Rounding off

## Appendix C: Research sub-questions included in the interpretation scheme<sup>1</sup>

1. In which intra-metropolitan "bounded" activities does the interviewee participate on weekdays and, if relevant, in the weekend?
2. In which intra-metropolitan "partially bounded" activities does the interviewee participate on weekdays and, if relevant, in the weekend?
3. In which intra-metropolitan "non-bounded" activities does the interviewee participate on weekdays and, if relevant, in the weekend?
4. In which extra-metropolitan activities does the interviewee participate?
5. How important has the distance from the dwelling been for the interviewee's choices of workplace/place of education, kindergarten/crèche, shops and leisure facilities?
6. Which daily-life activities does the interviewee travel out of the local area to reach?
7. Which more sporadic intra-metropolitan activities does the interviewee travel out of the local area to reach?
8. Which daily-life activities does the interviewee carry out within the local area?
9. Which, if any, of the intra-metropolitan "bounded trips" have destinations within a short distance from the dwelling?
10. Which, if any, of the intra-metropolitan "bounded trips" have destinations within a long distance from the dwelling? (occupational journeys not included)
11. Which, if any, of the intra-metropolitan "partially bounded trips" have destinations at a short distance from the dwelling?
12. Which, if any, of the intra-metropolitan "partially bounded trips" have destinations at a long distance from the dwelling?
13. Which, if any, of the intra-metropolitan "non-bounded trips" have destinations within a short distance from the dwelling?
14. Which, if any, of the intra-metropolitan "non-bounded trips" have destinations at a long distance from the dwelling?
15. Do any of the acquaintances of the interviewee live in the local area?
16. Is there much contact and common activities among the neighbors in the residential area?
17. Which means of transport are used for the different travel purposes in everyday life?
18. Do the travel modes of the interviewee deviate for ideological or attitudinal reasons from what is usual in their local neighborhood and in the metropolitan area as a whole?
19. Which, if any, activities does the interviewee carry out in the downtown area?
20. Does the interviewee consider that the downtown area has any particular "atmosphere" making it attractive beyond its mere concentration of facilities? Does the interviewee consider other parts of the metropolitan area to have any such "atmospheric" qualities?
21. Does the interviewee emphasize accessibility/reduced needs for transport as an important feature of the residential area and/or reason for living in this residential area?

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<sup>1</sup> In cases where the information given in the interview provided a basis for it, the questions were answered taking the whole household of the interviewee into consideration and not only the individual interviewee.

22. Does the urban structural situation of the dwelling put any constraints on the interviewee's outdoor life/use of recreational areas?
23. Does the urban structural situation of the dwelling put any constraints on the interviewee's participation in physical exercise? Does the interviewee consider that there are any features of the dwelling and its neighborhood that are unfavorable from a health perspective?
24. Has the interviewee taken up any new activities or dropped previous activities as a result of having moved from one residential location to another?
25. Has the interviewee changed her/his travel behavior as a result of having moved from one residential location to another?
26. Has the interviewee changed her/his car ownership (or ownership of other motor vehicles) as a result of having moved from one residential location to another?
27. Does the interviewee consider that he/she would have had a different activity pattern and travel behavior if living in a different part of the metropolitan area? If so: what would have been different?
28. Does the layout of the road network and/or the availability of bike paths in the local neighborhood and/or along relevant corridors influence the interviewee's choices of travel modes and/or activity locations?
29. Which considerations influence the interviewee's choices of travel routes when traveling within the metropolitan area?
30. Does the quality of public transport connections (walking distances, frequency of departures, necessity of changing between different lines, etc.) have any influence on the interviewee's choices of travel modes and/or trip destinations?
31. Which considerations influence the interviewee's choices of travel modes when traveling within the metropolitan area?
32. Would the interviewee (if presently having a car available for use) have to change her/his activity pattern significantly if she/he had no longer access to a private car?
33. Are there indications of "compensatory" leisure travel?
34. Does the interviewee for cultural or lifestyle reasons prefer to visit certain districts within the metropolitan area frequently (or avoid certain areas)? In case, which areas?
35. Are there any other places within the metropolitan area (i.e. other than the existing place of residence) where the interviewee would like to live, or places where she/he would not at all like to live?)
36. Is the interviewee interested in and/or involved in the spatial planning and development of Oslo (alternatively Stavanger) Metropolitan Area?
37. Are there any indications of residential self-selection based on travel behavior attitudes?
38. Other important issues raised in the interview not covered by the above questions?
39. Which overall life-forms, lifestyles and rationales are influencing the interviewee's participation in out-of-home activities?
40. On which rationales does the interviewee base her/his choices of activity locations?
41. On which rationales does the interviewee base her/his choices of travel modes?
42. On which rationales does the interviewee base her/his choices of routes followed?
43. Which among competing rationales seem to be the strongest ones for the interviewee's choices of activity locations?

44. Which among competing rationales seem to be the strongest ones for the interviewee's choices of travel modes?
45. Which among competing rationales seem to be the strongest ones for the interviewee's choices of routes followed?

## Notes

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<sup>1</sup> The survey-based quantitative part included cross-sectional and quasi-longitudinal analyses based on retrospective questions, employing various statistical methods (among others, ordinary linear regression, binary logistic regression and Poisson regression) and controlling for demographic, socioeconomic and residential preference variables. See Næss et al., 2017a and b for more information about the quantitative methods of the study.

<sup>2</sup> The remaining four interviews took place either at the interviewee's workplace, at a café, or via Skype.

<sup>3</sup> Compared to our earlier studies, the interpretation scheme addressed self-selection more explicitly as an interpretation theme. Possible health impacts of living in the residential neighborhood were also included as a theme. The descriptive parts were nuanced more, for example in the distinctions between bounded, non-bounded and partially bounded activities, and between intra-metropolitan and extra-metropolitan activities. The parts about rationales were also separating more clearly between rationales for activity location, travel mode choice and route choice.

<sup>4</sup> While we are not able to state in general terms what comes first (rationales for transport or rationales for activity), we highlight that they are not the same thing, and particularly that rationales for activity location cannot be reduced to derivatives of available travel options or preferences for particular travel modes. For example, our interviews as well as our quasi-longitudinal and cross-sectional quantitative data show that car ownership is influenced by residential location (Cao et al., 2018a), indicating that the distance from the dwelling to chosen destinations influences the perceived need for car travel. In general, location of activities far away from home tend to make interviewees choose motorized travel, whereas non-motorized travel is more often chosen for facilities closer to the place of origin, and nearly always for very short distances. This is also evident from the quantitative material (see, for example, Næss et al., 2017a:28).

<sup>5</sup> Detailed information exists in Næss (2016b), available on request.

<sup>6</sup> ID numbers refer to the interviewees' ID numbers as respondents of the questionnaire survey.

<sup>7</sup> This is also reflected in the quantitative part of our material. For example, a majority of the Oslo respondents would rather prefer to spend 45 min instead of 30 min on their journey to work if they could then increase their salary by 10% (Næss et al., 2017a, pp. 18-19.)

<sup>8</sup> Detailed information exists in Peters (2016), available on request.

<sup>9</sup> Due to space constraints, we do not present any corresponding table regarding rationales for travel mode choice.

<sup>10</sup> In the interviews, we asked questions about reasons for choice of residence, and the issue of residential self-selection was one of the items addressed in the interpretation scheme. A recently published article in this journal draws partly on this material, although its main focus is on the quantitative part of the study (Wolday et al., 2018). We are currently preparing another paper on residential self-selection, based mainly on the qualitative material.