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## Knowledge-based land use and transport planning?

### Consistency and gap between ‘state-of-the-art’ knowledge and knowledge claims in planning documents in three Scandinavian city regions

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#### Abstract

The central concern of this paper is the relationship between research-driven ‘state-of-the-art’ knowledge, and knowledge claims made in practice, in planning for sustainability. The paper approaches this topic from a critical realist perspective, which is used to provide criteria for positing ‘state-of-the-art’ knowledge validity, and assessing the quality of situated knowledge claims in planning practice. In this way the paper contributes to debates about an ontological turn in planning knowledge. By reviewing key planning documents in three Scandinavian city regions, the paper shows that the knowledge claims about travel behavioral impacts of proposed land use and transport infrastructure presented in the documents are to varying extent in accordance with ‘state-of-the-art’ academic knowledge on these topics. Some long-standing ‘planning myths’ are encountered in the investigated planning documents. In one of the cities, residential and workplace location close to suburban public transport stops is highlighted as a traffic-reducing measure rather than proximity to inner-city concentrations of jobs and other facilities, and density is discussed at a neighborhood scale rather than at a city scale. In all three cities, planning documents depict road capacity increases as having no traffic-generating effect. These latter claims are used in support of more decentralized land use pattern and considerable road development.

Since the likelihood of achieving sustainability goals relies heavily on whether the measures chosen are productive or counter-productive, knowledge obviously matters. A stronger focus on how well-suited proposed strategies for spatial development are to produce their purported outcomes should be welcomed in planning research and practice.

#### 1. Introduction

Sustainable development has been on the international agenda since the United Nations’ World Commission on Environment and Development published its report ‘Our Common Future’ a quarter of a century ago (WCED, 1987). The transportation sector is one of the most problematic fields in terms of environmental sustainability, internationally as well as in the Nordic countries. Sustainable mobility<sup>1</sup> (OECD/ECMT, 1994; Høyer, 1999; Banister, 2008) has therefore become an important concern in urban planning and development. Not the least in the Nordic countries, the role of land use planning in facilitating lower needs for transportation and less dependency on the private car has been emphasized by national planning

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<sup>1</sup> According to Banister (2008, p. 75), the sustainable mobility approach requires actions to reduce the need to travel (less trips), to encourage modal shift, to reduce trip lengths and to encourage greater efficiency in the transport system.

authorities (e.g., Ministry of the Environment (NO), 1993 and 2011; Ministry of the Environment (DK), 2007) as well as by many municipalities. In many municipal plans, it is stated that more sustainable mobility can be obtained by locating new development close to public transit stops, providing a better local balance between dwellings, jobs and service functions, and improving the public transport network, and to a varying degree, these ideas are incorporated in legally binding land use plans and infrastructure funding. But how well-founded in academic research are statements like those mentioned above about the merits of various measures in land use and transport planning? Here we are interested in how such statements, or claims, made in situated planning practice, relate to research-driven 'state-of-the-art' knowledge in land use and transport infrastructure planning aiming at sustainable mobility. In doing this, we problematize both the notion of 'state of the art' knowledge within a planning field, and the mobilization of knowledge in practice. The paper addresses this question by investigating the extent to which statements in the planning documents<sup>2</sup> of three medium-sized Scandinavian city regions (Aarhus, Trondheim and Helsingborg) about transport impacts of land use and transport infrastructure development are consistent with 'state-of-the-art' academic knowledge about such impacts. Although all three cities have expressed goals of reducing greenhouse gas emissions and strengthening the role of modes of transport other than the private car, such goals may in practical planning have to be traded off against other, competing goals. Nevertheless, a premise of this paper is that if goals of sustainable mobility are to result in land use and infrastructure development contributing to at least some progress toward such goals, then land use and transport planning needs to be informed by 'state-of-the-art' knowledge about the likely transport consequences of different kinds of land use and infrastructure development.

A further issue is that what counts as state of the art knowledge in planning for sustainable mobility is itself contested, and various knowledge claims rise to dominant status though this may be a transient state of affairs. For example, among proponents of the so-called 'new urbanism' land use principles, an exaggerated belief in the potential for reducing the amount of intra-metropolitan car travel through local neighborhood<sup>3</sup> density, design and mixed land use has sometimes been seen (Boarnet & Sarmiento, 1997). Similarly, among transport planners, the traffic-inducing effect of road construction allowing higher traveling speeds by car has been criticized as often being neglected (Kenworthy, 1990; Tennøy, 2003; Andersen, 2013). An important purpose of the present paper is to investigate whether such conceptions are still prevailing in recent planning documents of three Scandinavian cities.

Land use and transport infrastructure investments are usually under public control via legal measures and public funding. The land use development that has taken place in investigated Scandinavian urban areas has to a high extent been found to be in accordance with municipal land use plans (Saglie & Sandberg, 1997; Næss et al., 1998; Næss et al., 2011a and b). Although the contents of the legally binding elements of land use and transport infrastructure plans may be influenced by several actors, the assumptions of the professional planners about cause-effect relationships on relevant topics usually influences the solutions proposed in the plans. The topic of this paper is not whether the actually planned land use and infrastructure is likely to contribute to sustainable mobility; such a perspective has been addressed in other papers (see e.g. Tennøy, 2012 for an overview). The extent to which the assumptions expressed in the plans are in line with 'state-of-the-art' knowledge will, however – if the plans are implemented – influence whether or not the envisaged spatial strategies will be successful. These assumptions also serve to legitimate the chosen

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<sup>2</sup> We use the term 'planning documents' in a way including the spatial plans themselves (maps + text) as well as publicly available background documents used by the administration and politicians during the treatment and adoption of the plans.

<sup>3</sup> The term 'local neighborhood' is not very precise, and its operationalization varies between studies. In line with the way that neighborhood units were conceptualized by Perry (1929/1998), several studies have measured local-area densities and supply of service facilities within half a mile around the dwelling, and for some purposes within one mile. When discussing the local scale in the present paper, we refer to a scale similar to how it has been conceived in these studies.

solutions to stakeholder groups concerned about the topics in question. This paper can therefore complement previous research concerning planning and knowledge claims.

## 2. Research design

The overall approach of the paper is to compare the statements expressed in selected planning documents for each city region about influences of land use and transport infrastructure provision on travel behavior with academic ('state-of-the-art') knowledge about these relationships, in order to identify consistencies as well as gaps between the academic knowledge and the knowledge claims expressed in the planning documents.

As a foundation for the analysis, an evaluative position will be established in the next section of the paper (section 3). In section 4, the knowledge claims in the cities' planning documents about how the planned land use and transport infrastructure development are likely to affect travel behavior will be compared with state-of-the-art academic knowledge, and their plausibility will be assessed. Thereupon, the plausibility of these knowledge claims will be assessed (section 4), based on 'state-of-the-art' theoretical knowledge. Our discussion of theoretical knowledge on travel behavioral impacts of land use and transport infrastructure and the cities' knowledge claims on these issues will concentrate on the influences of land use and road infrastructure development. Obviously, also other aspects of urban spatial development are of importance. However, due to space constraints, we have chosen to focus mainly on the former aspects of urban development. The paper concludes with some considerations on implications for planning practice and an outlook on further theory development.

Our choice of case cities is partly pragmatic reflecting practical and project-administrative criteria (they needed to be in line with the design of the overall research project of which this study is a part), but within these frames we have tried to find theoretically good cases. The selected cities and city regions are all medium-size for their countries (population of the continuous urbanized areas varying from around 100,000 to approximately 250,000). They are all currently experiencing considerable population growth. They all belong to a rather homogenous socioeconomic and cultural context (Scandinavia). Aarhus, Trondheim and the Skåne region to which Helsingborg belongs all have a reputation for being forerunners in terms of public transport-enhancing innovations, Congestion problems as well as limitation of CO<sub>2</sub> emissions are issues high on the planning agenda. On the other hand, the national urban planning discourses during recent decades have differed somewhat, where the 'compact city' has had a stronger position as an ideal for urban development in Norway than in Denmark (Hoftun, 2002; Næss et al., 2011a), with Sweden positioned somewhere in-between.

The paper draws on empirical data from all three case city regions, in particular recent plans for public transport improvement, municipal and/or regional master land use plans, road infrastructure plans and available impact assessments of these plans. In the Aarhus case, we have investigated the 2009 Municipal Plan; a preceding Environmental Assessment of a draft version of this plan; an EIA report on a proposed light rail scheme in the Aarhus area; a recent (2011) proposal for a so-called Plan Strategy for the municipality of Aarhus; and finally an 'analytic foundation' of the forthcoming Regional Development Plan for the region of Mid Jutland, of which Aarhus is a part. In the Helsingborg case, the investigated planning documents include the 2010 Master Plan and the stakeholder comments made during the hearing process; a separate Impact Assessment of this plan; a Traffic Plan for Helsingborg; and two documents (a traffic analysis and an Environmental Impact Assessment) concerning a planned urban transformation of a previous harbor and industrial area close to the city center of Helsingborg. In the Trondheim case, we have examined the 2007 Municipal Plan (including several thematic background reports); a Plan Program for the land use part of the next Municipal Plan (2012); a separate Working Paper prepared by the municipal Chief Officer to

the municipal Climate Committee<sup>4</sup>; the municipality's 'Environmental Package for Transport' (including statements from political parties on a draft version), as well as an Environmental Impact Assessment of a new major road scheme in the southern part of the municipality.

We consider knowledge claims in the chosen plans and policy documents to be representative of how the influences of land use and transport infrastructure development are depicted by the responsible planning authorities in each case area. 'Background' documents like working papers and environmental impact reports have been included in order to bring in more specific information about the assumptions about transport impacts of the formal land use and transportation infrastructure plans, as the formal plans usually do not go into details about these effects. We find the statements in the investigated background documents about impacts of land use to be generally consistent with those in the formal plans, whereas there are certain discrepancies as regards the impacts of transport infrastructure provision.

### Conceptualization of 'state-of-the-art' and 'knowledge claims'

The notion of 'state-of-the-art' knowledge indicates that some knowledge claims about the subject matters in question are considered to be more credible than other such knowledge claims (although all knowledge claims are fallible). Noting tensions with alternative approaches that may be more mainstream in planning knowledge debates, this paper is based on a critical realist perspective combining ontological realism, epistemological relativism and judgmental rationalism (Bhaskar, 2008). *Ontological realism* is a position insisting that the world exists independently of our knowledge about it. This applies to nature (notwithstanding the fact that is influenced and transformed by human actions) as well as the social world (which is not constructed by social scientists, but has been created by actors throughout history and is reproduced or transformed, often unconsciously, through the social actions and interactions of all agents in society). Social science can influence the development of society, but if so, this happens with a time lag in relation to the research activity. At the same time, our knowledge of the world is both fallible and theory-dependent (although not theory-determined). Our knowledge claims are fallible – theories can always be surpassed by new theories. Like poststructuralists, critical realists are also aware that social scientists are themselves part of society. The researchers' interpretation of the world may be influenced by their social positions and the discourses in which they engage, and power relations can influence what counts as valid knowledge. For these reasons, *epistemological relativism* is unavoidable. This does not, however, mean that any knowledge claim is equally valid. Through researcher education and scientific norms of validity within the research communities, researchers are socialized into trying to limit interest-based, ideological or other power-based influence on the research results as much as possible. Researchers also usually spend more time and efforts on penetrating a problem complex than do most other participants in societal debates (e.g. journalists and politicians). Academic criteria of validity form a basis for *judgmental rationalism*, making it possible to distinguish between knowledge claims of a high and low credibility. (Bhaskar, *ibid.*)

#### *The 'ontological turn'*

Following the 'communicative turn' (Healey, 1992/1996), planning scholars have since the 1980s been preoccupied with planning processes rather than the outcomes of spatial planning. Arguably, this has to do with an increasing influence of poststructuralist ideas according to which truth is relativized to discourses on the surface of reality, rendering it *á priori* impossible to say anything about what exists outside these discourses (Bhaskar, 1998 and 2008; Buch-Hansen & Nielsen, 2005). Within the discourse on urban planning and sustainability, the strong social constructionism associated with the above-mentioned ideas would typically limit the scope to the cultural processes through which certain phenomena come to be

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<sup>4</sup> This Working Paper was prepared in the Environmental Package for Transport by the municipal administration in response to a number of questions raised by the members of the Climate Committee (a body consisting of politicians from different parties) about the likely impacts of various proposed land use and transport policy measures.

perceived as environmental problems, and neglecting the underlying structural mechanisms creating these phenomena as well as their impacts on the physical environment.

The detachment of planning theories from the actual subject areas has, however, increasingly been criticized (Huxley & Yiftachel, 2000; Næss, 2001; see also Fainstein & Fainstein, 1996). In the case of sustainable development such a separation appears to be particularly inappropriate, as the recommendable procedures will most likely depend on the goals and policy issues dealt with. Communicative planning theorists have been branded ‘the mandarins of neoliberalism’ (Bengs, 2005), and the implications in a distribution-ethical perspective of the radical contextualizing leading to a privileging of ‘local knowledge’ over ‘expert knowledge’ has been questioned (Purcell, 2006). Although most critics do not reject the relevance of process-oriented planning theories to issues such as stakeholder involvement, citizen empowerment and the influence of power relations on what comes to count as valid knowledge in public debates and decision-making, they generally consider that poststructuralist scholars tend to over-emphasize the implications of power-knowledge relationships and the situatedness of knowledge.

In the planning literature, a call for re-vindication of ontology and for the recognition of the possibility of anticipating likely impacts of alternative spatial solutions has gained increased momentum during recent years (Turner, 1995; Neumann, 1998; Næss & Saglie, 2000; Talen & Ellis, 2002; Næss, 2004; Purcell, 2008; Høyer & Næss, 2008; Næss, 2012). This resonates with what has been referred to as an emergent ‘ontological turn’ across the social sciences. Though the notion of a ‘turn’ is not fully accepted, contributions across many disciplines refer to the existence, or the beginning, or at least the presence of claims, surrounding such a turn. These include STS (van Heur et al, forthcoming), philosophy (Society for Phenomenology and Existential Philosophy, 2012), anthropology (Paleček and Risjord, 2013), economics (Lewis, 2003, Pratten, ed, forthcoming), and geography (Escobar, 2007). Exploration of an ontological emphasis in planning offers fresh perspectives on longstanding debates about planning knowledge, some of which are explored in this paper.

### *Validity*

According to Ormondroyd (2004), the quality and validity of a text can broadly be categorized as either relating to formal information about its source or to its actual content. Text published by authors possessing high academic positions within a field and who have published widely in academic journals or books on the subject in question could generally be considered to have a higher credibility than texts created by less renowned authors. The author’s institutional affiliation and the type of publisher also matter, as the goals or values of the institution or employer might influence the views and findings emphasized in the text. In line with this, a text produced by a university researcher and published in a scientific journal would normally be considered more credible than a text produced and published by a think-tank supporting particular views and interests. As regards aspects related to the actual content of the text, primary material dealing directly with the data could generally be regarded as more trustworthy than secondary (or tertiary, quaternary etc.) material based upon other research in the field. Needless to say, peer-reviewed material could generally be expected to have been subject to higher extent of quality control than material that has not been peer reviewed, and it is therefore normally considered more credible. Most basically, though, an evaluation of credibility must address the validity of data and reasoning, with an assessment of the premises, assumptions and conclusions. (Ormondroyd, *ibid.*)

### *Identifying the ‘state-of-the-art’*

Several authors have summarized main findings from individual studies of associations between urban structural characteristics and sustainability-relevant aspects of travel behavior such as traveling distances and travel modes (e.g. Stead & Marshall, 2001; Noland & Lem, 2002; Cao et al., 2009; Ewing & Cervero, 2001

and 2010; Lefèvre, 2010; Litman, 2011). Such summarizing has sometimes been carried out as so-called meta-analyses, where the quantified effects of urban structural variables on travel behavior variables in different studies have been used as input data for statistical analyses of the average strengths of these relationships across the individual studies (Ewing & Cervero, 2010). However, generalizing from such meta-analyses remains a challenge, due to differences in, among other things, the scale of analysis, types of built environment measures used, areal scales of measurement, types of travel behavior data used, analytical approaches and control variables, and in the ultimate outcome variables measured (trip frequencies, mode choices, distances traveled, etc.) (Zegras, 2010; Ewing & Cervero, *ibid.*). Furthermore, it is often not clear whether or not the effect of a particular urban structural characteristic in a study included in the meta-analysis (for example the degree of mixed land use) has been controlled for other relevant urban structural variables (for example the distance from the dwelling to the city center). There is also an overall American dominance among the meta-analyses carried out within this field.

Reflecting the Nordic geographical context of our three case cities, the paper in particular draws on a recent review of 30 Nordic studies carried out since 1982 on the influence of urban structural conditions on travel (Næss, 2012b). Several of these studies arguably belong to the international ‘state-of-the-art’ research within this field. Instead of the quantitative meta-analysis approach, ‘state-of-the-art’ knowledge about influences of urban structure on transport was identified through qualitative and critical assessments of the methods, data sources and theoretical underpinnings of the research results. In situations where there are divergent conclusions, emphasis has in the present paper been laid on criteria such as theoretical plausibility; consistency with qualitative research on rationales for transport behavior; control for other relevant factors of influence; non-inclusion of irrelevant control variables; and the type of publication in which the knowledge claim has been put forth.

### **3. Impacts of urban land use and infrastructure on travel: ‘State-of-the-art’ knowledge and claims in planning documents**

There is quite overwhelming evidence that urban spatial structures matter to travel behavior (see, e.g., Newman & Kenworthy, 1999; Ewing & Cervero, 2010; Næss, 2012). The mechanisms through which these influences operate appear to be present in a wide international context, indicating a high degree of generality. Notably, the tendency of inhabitants in modern cities to emphasize (within some threshold distances) the possibility of choosing among facilities rather than proximity means that the amount of travel is influenced to a higher extent by the location of the residence in relation to concentrations of facilities, rather than the distance to the closest single facility within a category. Daily traveling distances therefore tend to be more influenced by the distance from the dwelling to the city’s main concentration of facilities (usually the inner city) than by its distance to local centers (Røe, 2001; Nielsen, 2002; Næss, 2005, 2011 and 2012). According to ‘state-of-the-art’ knowledge on relationships between urban spatial structures and travel in a Nordic context, urban planners aiming to reduce car dependency and urban motoring should seek to avoid urban sprawl, increase the proportions of the population living and working in the inner and central areas of the city, and ensure a sufficiently high density in new developmental areas to facilitate a good provision of local service and a good public transport provision.

Below, we will highlight four interrelated dimensions along which the cities express different interpretations that may to varying extent be in line with ‘state-of-the-art’ knowledge about influences of urban land use on travel and transport: density, residential location, workplace location, neighborhood diversity and design, and road capacity increase.

#### **3.1. Density**

*‘State-of-the-art’ knowledge*

The influence of the density of the city as a whole on energy use for transport, as well as the level of service of the public transport system has been documented in several studies in the Nordic countries (Næss, 1993; Næss, Larsen & Røe, 1994; Næss, Sandberg & Røe, 1996) well as internationally (e.g. Keyes, 1976; Newman & Kenworthy, 1989 & 1999; Kenworthy, 2003; Lefèvre, 2010). Density at a local neighborhood scale has generally been found to be of a lower direct importance to travel behavior, at least in a Nordic context, but still exerts some influence (e.g. Næss, Røe & Larsen, 1995; Næss & Sandberg, 1996; Næss, 2006; Engebretsen et al., 2010).

### *Knowledge claims in the cities' planning documents*

In all three case cities, the plans express a general understanding of dense urban development as preferable to urban sprawl, seen from the perspective of minimizing car traffic and greenhouse gas emissions from transport. For example, the Municipal Plan of Helsingborg (2010, p. 37) states that the city will 'exploit the advantages of being a compact city and promote sustainable mobility'. In a working paper about the proposed land use in the Municipal Plan prepared by the Chief Officer of Trondheim, 'a strong emphasis on densification' is underlined as a basic condition for reaching the city's goal of reduced greenhouse gas emissions (Municipality of Trondheim, 2008c, p. 9). The Municipal Plan of Aarhus (2009, p. 20) similarly states that 'higher density contributes to limit the total amount of transport and supports the possibilities for public, pedestrian and bike transport'.

There are still important differences between the cities in how this is being interpreted at a more specified level. Whereas Trondheim and Helsingborg emphasize density for the city as a whole, with densification within the existing urbanized area as the associated policy measure, Aarhus places most attention to the density of proposed new 'greenfield' developmental areas disconnected from the main city. Among the planning documents of Trondheim, a working paper prepared by the Chief Officer for the municipality's Climate Committee (Municipality of Trondheim, 2008c) is the document in which knowledge claims about influences of urban structure on travel behavior are expressed most explicitly, e.g. as follows: 'Peripheral development results in a higher dependency on motorized transport. Densification is a measure to deal with growth in a transport-efficient way.' (p. 6). Densification is also mentioned in Trondheim's 'Environmental Package for Transport' the as a key measure to reach objectives of reduced CO<sub>2</sub> emissions, limiting car traffic and improving the conditions for public and non-motorized traffic (Municipality of Trondheim, 2008b, p. 1). In Helsingborg, the Municipal Plan mentions a compact city as a condition for reaching national environmental goals and a sustainable urban development (Municipality of Helsingborg, 2010a, p. 37), and densification is described as a measure to improve public transport and enable air-quality-favorable travel (p. 14). These points are elaborated in the separate Impact Assessment of the plan (Municipality of Helsingborg, 2010b, p. 19): 'With a more dense and compressed city, accessibility to destinations can be improved. Important service facilities are available within walking or biking distance, resulting in further reduced car dependency and increased levels of physical exercise.' While a reasonable interpretation of the statements on density in Helsingborg as well as in Trondheim is that they refer to density and densification within the city as a whole (i.e. within the continuous urbanized area of the municipality's largest urban settlement), the following statement in the Municipal Plan of Aarhus (2009, p. 14) refers to density at a much smaller geographical scale: '... a number of planning initiatives ... are to contribute to make Aarhus CO<sub>2</sub> neutral in 2030. For example, the establishment of new residential areas is related to the goal of reducing CO<sub>2</sub> emissions: the new urban district at Lisbjerg will be an example of a compact and integrated district with effective public transport and district heating supply – all of which are decisive physical conditions for reducing CO<sub>2</sub> emissions.' The district referred to, Lisbjerg, is located approximately 8 km away from the city center of Aarhus, disconnected from the existing urbanized area. The other proposed new urban districts are located even more peripherally (10-15 km from the city center). Admittedly, Aarhus' municipal plan also points at densification of districts within the existing city as a contribution to minimizing the needs for transport. But the main emphasis in the plan's discussion of the impact of density on travel is on the density of the new satellite settlements.

### 3.2 Residential location

#### *'State-of-the-art' knowledge*

As regards residential location within an intra-metropolitan context, the characteristic found to exert the strongest influence on travel behavior is the location of the dwelling relative to the main city center. Studies in a number of cities in the Nordic countries and elsewhere have shown that inner-city dwellers tend to travel shorter overall weekly intra-metropolitan distances and carry out a lower proportion of their travel by car than their outer-area counterparts do (e.g. Næss, Røe & Larsen, 1995; Martamo, 1995; Hartoft-Nielsen, 2001a; Røe, 2001; Tillberg, 2001; Nielsen, 2002; Næss & Jensen, 2004; Engebretsen, 2005; Næss, 2005, 2006a,b, 2009). In particular, inner-city dwellers tend to travel more by non-motorized modes. Travel by public transport differs less between suburbanites and residents of central areas; although the latter are usually blessed with the highest level of public transport service, proximity to trip destinations often makes motorized travel unnecessary. Among suburbanites, there is still a tendency of higher use of public transport among those who live in areas with a high level of public transport accessibility (Næss, Røe & Larsen, *ibid.*; Næss, Mogridge & Sandberg, 2001; Hartoft-Nielsen, 2001a). Some influence of proximity to local centers or local service facilities on travel behavior has also been found in some studies, but in the Nordic countries this influence has generally been found to be considerably weaker than that of distance to the main city center (e.g. Næss, Røe & Larsen, 1995; Nielsen, 2002; Næss, 2011 and 2012).

#### *Knowledge claims in the cities' planning documents*

Compared to the strong emphasis placed on density in the texts of all the three cities' municipal plans, residential location is to a much lesser degree a topic of explicit discussion. Statements about the transport-minimizing effect of densification can of course be interpreted to logically imply an acknowledgement of the higher needs for transportation when living at peripheral locations, since new greenfield developmental areas will most often be located further away from the city center than areas where densification takes place. However, neither the Trondheim nor the Helsingborg municipal plan includes any explicit statement about the different transport impacts of densification close to the city center compared to densification of suburbs close to the urban fringe. In the municipal plan of Aarhus (2009, p. 225-226), the distance to the city center is mentioned as a transport-relevant feature in the chapter discussing the general impacts of the proposed land use. The location of many trip destinations in the inner city and the resulting longer average traveling distances among residents of peripheral parts of the municipality is mentioned in a separate document assessing the environmental impacts of the municipal plan. This report includes a graph borrowed from an empirical study of residential location and travel in Aarhus (Hartoft-Nielsen, 2001a), showing how the average daily amount of transport tends to increase the further away from downtown Aarhus residential areas are located. It is also admitted that the proposed land use will increase the average distance between dwellings and the city center, compared to the existing situation as well as to an alternative proposal for future land use based on concentric urban expansion instead of new satellite towns. However, according to the EIA report,

'the consequences of the longer travel distances in the main alternative are planned to be avoided by employing two measures: Partly through local supply, and partly by transferring transportation to modes other than the private car. One of the urban developmental principles is 'to develop diverse, exciting and lively townships with a varied supply of dwellings, workplaces, stores, service, cultural facilities, green areas...' in such a way that the new townships to a higher extent will be self-sufficient areas that can meet the daily needs. An implication of this is that travel distances will be reduced, since the destinations of different trips, e.g. journeys to work and shopping trips, will to a higher extent be local rather than located in a different part of the municipality.' (Municipality of Aarhus/COWI, 2008, pp. 40-41.)

The likelihood that local suburban jobs will reduce commuting distances will be discussed in the paragraph below on workplace location. Whereas it is recognized in Aarhus' planning documents (particularly the environmental assessment of the municipal plan) that residential location exerts an important influence on travel behavior, the interpretation of this seems in a way to be sliding from some general statements in the EIA report emphasizing the influence of the location of dwellings relative to the main city center, to statements where the location of the proposed new residential areas is mainly discussed in terms of their proximity to lower-order centers and proposed light rail stations. To the extent that residential location is mentioned explicitly in the planning documents of Helsingborg and Trondheim, this is also referring mainly to the location relative to public transport opportunities.

### 3.3. Workplace location

#### *'State-of-the-art' knowledge*

For workplaces, a number of Nordic studies have found lower proportions of car commuting and higher shares of travel by public transit, bicycle or by foot to workplaces located in the inner-city than to suburban jobsites (Monsen, 1983; Hanssen, 1993; Martamo, 1995; Næss & Sandberg, 1996; Hartoft-Nielsen, 2001b; Strømmen, 2001; Næss, 2007). In particular, a strong center-periphery gradient has been found for office workplaces. Contrary to the quite widespread belief that employees at suburban workplaces would on average enjoy shorter commuting distances than those of centrally located jobsites (e.g. Gordon & Richardson, 1989; Giuliano & Small, 1993; Crane & Chatman, 2003; Guth et al., 2009), there is little evidence in the Nordic countries of any such overall tendency. For office workplaces, average commuting trips instead appear to increase slightly the more peripherally the jobs are located (Hartoft-Nielsen, 2001b; Strømmen, 2001). While office workplaces are often highly specialized (requiring high education within a particular discipline and maybe experience within a quite narrow sub-field of professional practice), less specialized workplaces (e.g. within retail, primary education, kindergartens and health care) are more able to recruit employees locally, resulting in somewhat shorter trips to such suburban workplaces (Næss, 2007).

#### *Knowledge claims in the cities' planning documents*

There are some interesting differences in the ways in which the municipal plans of the three cities conceive of the transportation impacts of workplace location. In Aarhus as well as in Helsingborg, the planning documents stress the favorability of locating workplaces close to public transport nodes and stops in order to strengthen alternatives to the private car. In the planning documents of Trondheim, the location of workplaces not only relative to public transport opportunities, but also in relation to the overall center structure of the city is mentioned as crucial. Clearly inspired by the Dutch ABC principle (Verroen et al., 1990), the Trondheim municipal plan (2008a, p. 2) states that labor- or visitor-intensive workplaces should be located centrally with good public transport accessibility. The planning documents also emphasize the importance of the availability of parking opportunities at the workplace and state that the proportion of car commuting will generally be high at workplaces where free parking is provided by the employer. According to the research literature on the influences of urban form on travel behavior (cf. section 2 above), proximity of the workplace to the main city center is normally much more influential to the modal split among commuters than proximity to public transport nodes in the suburbs. In the city center, car commuting is discouraged not only through high accessibility by public transport, but also through narrow and often congested streets as well as scarce and/or expensive parking. In Helsingborg and Aarhus, only the 'carrot' effect of high public transport accessibility is mentioned. In the Trondheim planning documents, this 'carrot' as well as the 'sticks' represented by the worse conditions for driving in the city center are emphasized. These differences in terms of references to different aspects of the influence of workplace location on travel are reflected in the land use proposals of the municipal plans of Trondheim and Aarhus. In Trondheim, the plan states that 60% of the growth in labor-intensive jobs is to take place within the 'public transport arc'

(i.e. the main public transport corridor through Trondheim's inner city), whereas in Aarhus only a modest proportion of the capacity for new workplaces<sup>5</sup> is located in the inner city. In Helsingborg, the municipal plan points at the areas around the central public transport terminal as well as around two suburban regional public transport nodes as the preferred locations for labor-intensive workplace location.

### 3.4 Neighborhood diversity and design

#### *'State-of-the-art' knowledge*

Whereas much of the research in USA and parts of Europe has focused on the influences of local neighborhood characteristics on travel, the Nordic research shows, as can be seen above, effects on travel behavior mainly from urban form characteristics at a higher geographical scale. In many of the studies in the United States showing effects of neighborhood-scale variables like local-area diversity of land uses or the layout of the local street network, the locations of the investigated neighborhoods relative to the metropolitan center structure have not been taken into consideration in the analyses (Boarnet & Crane, 2001; Cao et al., 2009). For example, in Ewing and Cervero's (2010) meta-analysis, street intersection density and street connectivity were found to be nearly as influential as distance to the city center or employment concentrations on traveling distance by car. However, based on the transport rationales identified in qualitative research (see above), local-area street design (grid-pattern vs. curvilinear cul-de-sac streets) could hardly be expected to exert any strong influence on overall traveling distances by car. Instead, the location of the residence relative to main concentrations of facilities (in particular employment) is likely to exert far stronger influence on traveling distances in general and car travel in particular. In empirical studies in the Nordic countries where both city-scale and neighborhood-scale characteristics have been taken into consideration, the effects of the latter have generally been found to be small, compared to the former (Næss, 2011 and 2012b).

#### *Knowledge claims in the cities' planning documents*

The municipal plan of Aarhus expresses a strong faith in the possibility of reducing the need for transport and increasing the shares of environmentally friendly travel modes through mixed land use. For example, it is stated that 'the development of new townships shall aim at creating local communities that are, to some extent, self-sufficient with certain functions, such as stores for daily necessities, and local workplaces. This can reduce the need for transport and influence on the modal split, and hence reduce the environmental loads' (Municipality of Aarhus 2009, p. 40). While provision of local opportunities for daily-life shopping will normally be instrumental in reducing the amount of motorized travel, local job opportunities in new suburban townships is likely to create considerable crisscross traffic between different suburbs as well as trips from the inner parts of the city to the suburban workplaces. Even though higher local jobs-housing balance may reduce commuting distances among the residents of the areas where new jobs have been established, such employment growth may result in longer commutes for those employees who are not local residents, especially if the workplaces in question are specialized and recruit employees from a wide catchment area. This likely effect is not mentioned in the Aarhus planning documents and seems to have been ignored when drawing the conclusions about the merits of suburban job provision. In Helsingborg, combined development of housing and jobs is mentioned first and foremost as a feature of the planned development around the three main regional public transport nodes. In such high-density, central or semi-central areas, the likelihood of obtaining the assumed high shares of commuters by other modes than the private car does not seem unrealistic. Distinct from the two other cities, Trondheim emphasizes neither mixed-use nor jobs-housing balance in its planning documents, and no knowledge claims are thus made about the alleged transport benefits of such land use principles.

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<sup>5</sup> A capacity of 35.000 workplaces in urban transformation areas, compared to a capacity of 120.000 new jobs in greenfield development areas (Municipality of Aarhus 2009, p. 17).

### 3.5 Road capacity increase

Although travel behavior is influenced not only by instrumental, but also by symbolic and affective motivations (Steg et al., 2001), hardly anyone disregards instrumental reasons completely. Assuming that people will aim at reducing travel time, improve travel comfort or reduce direct expenses related to travelling, we may also assume that the relative and absolute quality of the transport systems matter for people's travel behavior. Improvements in transport infrastructure are thus likely to induce travel in terms of trip frequencies and trip lengths. Changes in travel mode will also often occur, depending on the kind of infrastructure that is improved. Whereas public transport improvement can attract previous car drivers as well as bicyclists and pedestrians as new passengers, road improvements facilitating higher travel speed can make users of the latter modes shift to car travel, especially under congested urban conditions.

Below, we will focus on the impact of road capacity increases, since this is the issue where considerable deviations can be found between 'state-of-the-art' knowledge and the knowledge claims in the cities' planning document. The knowledge claims in the planning documents about the impacts of public transport improvements and parking provision, respectively, are generally fairly well in accordance with 'state-of-the-art' on these issues. Due to space constraints, we will not go into these topics in the following.

#### *'State-of-the-art' knowledge*

International research during several decades has demonstrated theoretically and empirically that road capacity increases in congested urban areas makes the car a more attractive travel mode and may also facilitate the substitution of short trips (within walking/biking distance) with longer trips. As a result, the modal split changes toward more car traffic, congestion builds up anew, and much of, if not all the time savings due to better traffic flow immediately after opening of the new roads are in a few years lost because of traffic growth (Downs, 1962; Thomson, 1977; Mogridge, 1997; Noland & Lem, 2002; Cairns et al., 2002; Litman, 2011).

Historically, the phenomenon of induced traffic has been understood theoretically for at least one-and-a-half centuries (Schram & Hjort 1840) and demonstrated empirically in several studies over the last eight decades (Christiani & Nielsen et al. 1936; Schmidt & Campbell 1956), induced traffic has traditionally been ignored in standard traffic models. Until the 1990s, the above-mentioned influences of transport infrastructure development were also to some extent contested among transport researchers. However, along with growing empirical documentation, and especially since the publishing of an extensive report on the issue by the British Government's Standing Advisory Committee on Trunk Road Assessment (SACTRA, 1994), academic studies denying the traffic-generating impact of road capacity increases in congested transport corridors are rarely found. Some studies of induced traffic have also been carried out in the Nordic countries (Engebretsen, 1996; Næss, Mogridge & Sandberg, 2001; Næss & Møller, 2004; Twitchett, 2013), demonstrating the importance of the travel time ratio between car and public transport (and also non-motorized modes) to the proportions of travelers preferring each different mode. In cities with congestion on the road network, the inhabitants' choices of mode of transportation are influenced by the relative speeds of car and public transport, measured from door-to-door, as well as by the availability of parking facilities. Road extensions in order to reduce congestion will usually release a latent demand for space on the roads and thus cause a higher proportion of the commuters to choose the car mode, whereas faster and better public transport may have the opposite effect.

#### *Knowledge claims in the cities' planning documents*

The impacts of road capacity increase on travel behavior and traffic growth are downplayed in the planning documents of all three cities. Although none of the cities' planning documents explicitly reject that increased

road capacity in urban regions tends to induce traffic growth beyond what would have occurred in the absence of such capacity increase, these influences are not mentioned in any of the municipal plans and only implicitly hinted at in a few of the background documents. The message that shines through when reading the municipal plans is that the amount of transport and the modal split between car, public transport and non-motorized modes are influenced by land use, the provision of public transport and (in one of the cities) the availability of free parking, whereas road construction does not play any role worth mentioning.

In Aarhus, the Environmental Assessment of the municipal plan admits that the planned development of transport infrastructure within the municipality and the surrounding region, combined with the growth in employment and residences, will result in increasing traffic. In the environmental assessment, this is not included as an impact, since it is partly considered to be due to 'background' traffic growth. The EIA report still admits that this growth is supported by Aarhus' planning, since the planned infrastructure development facilitates increased commuting by car (Municipality of Aarhus/COWI, 2008, p. 43). In the municipal plan itself this is, however, barely mentioned. Instead, road capacity increase is depicted as a necessary response to traffic growth caused by the general societal development. Similarly, in Helsingborg's Traffic Plan, it is stated that the combined effect of widening one of the main roads from two lanes into an 'urban motorway' of four lanes, the construction of a new harbor access road, and allowing car traffic in a street presently used only by public and non-motorized traffic will be a traffic increase only from 100,500 to 101,000 cars, i.e. by 0.5 per cent (Municipality of Helsingborg, 2007, p. 36). Somewhat contradictory to this, the Traffic plan also admits that car traffic tends to increase if the network for car traffic is extended. This qualitative and isolated statement is, however, not reflected in the quantitative figures. In the Trondheim case, the only available assessment of the impact of road capacity increases is an EIA of a planned improvement of the main highway in the southern part of the municipality (Norwegian National Public Roads Administration, 2008). According to this assessment, the establishment of a new four-lane motorway instead of the existing two-lane road will lead to only marginal changes in the total traffic volume, compared to the 'do-nothing' alternative, with traffic increases on 8 stretches and reductions on 7 stretches (*ibid.*, p. 26). It is also stated that the new motorway will improve speeds not only for car traffic but also for buses and hence not affect the modal split to any extent worth mentioning (*ibid.*, p. 63). This claim disregards the fact that buses will have to drive off and on the motorway in order to pick up and let off passengers at stops, which are typically located in urban settlements and not along the motorway. The speed improvement will therefore be more modest for buses than for car traffic. This fact is actually pointed at in another of the planning documents of Trondheim (Municipality of Trondheim 2008c, p. 6). The Municipal council of Trondheim appears to be aware of the tendency of increase road capacity to increase car traffic, indicated by the following statement in the Environmental Package for Transport:

'New roads will together lead to a considerably increased capacity of the road network in Trondheim. The Municipal Council intends to implement measures to ensure that this capacity increase does not result in a corresponding increase in car traffic and its related pollution.' (Municipality of Trondheim, 2008, p. 3.)

The quote illustrates that as long as you have knowledge, you can use that knowledge even when you do not plan in accordance with the immediate policy implications of this knowledge (seen in relation to planning goals), for example by identifying needs for compensatory measures.

As can be seen, there seems to be differing assumptions between the local authorities in Trondheim and the Norwegian national road authority over the extent to which road capacity increases induce a growth in car traffic, where the statements of the municipal politicians and planners in Trondheim are more in line with state-of-the art knowledge (cf. section 2) than their counterparts in the national road administration.

### **3.6. Summarizing on 'state-of-the-art' knowledge and knowledge claims in planning documents**

Several of the influences of urban structural characteristics on sustainability parameters mentioned in the preceding ‘state-of-the-art’ paragraphs have been subject to controversies in public debates. Defending their position against criticism of unsustainable traveling patterns, advocates of low-density and decentralized urban developmental patterns (including supporters of alternative urban sustainability ideals such as ‘the green city’ or ‘the polycentric city’) have often raised doubt about the relationships between urban form and travel emphasized by compact city proponents (see, e.g., Breheny, 1992; Williams et al., 2000; Bruegmann, 2005). It is also not uncommon to encounter debaters denying that road capacity increase in urban areas induces more car traffic. Such counter-claims must, however, be evaluated on their own scientific credibility. Often, they are based on transport modeling simulations where the results merely reflect the assumptions fed into the models. In other cases, skeptics have drawn general conclusions based on investigations of relationships between other urban structural characteristics (such as neighborhood-scale density) or other aspects of travel behavior (e.g. travel time instead of traveling distances or modal split) than those which, from theoretical considerations, could be expected to be the most important ones. To our knowledge, none of the research studies concluding about small or no influence of urban structure on travel have investigated causality by means of qualitative methods or discussed the existence or non-existence of causal mechanisms between urban structure and travel from a theoretical point of view. Quite often, the counter-claims are raised by representatives of conservative think-tanks fearing that the research showing adverse environmental effects of sprawl and urban highway development could be used to change the status quo in urban development (Owens & Cowell, 2002; see also Jacques et al., 2008 for a wider account). Within academic scholarly work addressing the Nordic/Scandinavian context, there is rather overwhelming agreement that the urban land use and infrastructural characteristics identified above in this section do influence travel behavior and greenhouse gas emissions from transportation (although the magnitude of the effects will necessarily vary, depending on the city context). Most of the relationships are theoretically well understood, the causal mechanisms by which land use and infrastructure affect individuals’ travel behavior have been identified empirically in a Nordic context through qualitative research, and the aggregate-level effects have been shown in several quantitative studies controlling for demographic, socioeconomic and in many cases also attitudinal variables. We therefore consider the validity of these conclusions about the impacts of urban land use and transport infrastructure provision on travel behavior to be generally high. Based on the preceding review, Table 1 summarizes ‘state-of-the-art’ knowledge about urban structural characteristics considered to be favorable and unfavorable to sustainable mobility.

(Table 1 approx. here)

Table 2 offers an overview of the extent to which the knowledge claims presented in the planning documents of the city regions on travel behavioral impacts of land use and transport infrastructure could be assessed (based on theory-informed, qualitative judgment) to be in line with state-of-the-art knowledge.

(Table 2 approx. here)

The greatest deviations from ‘state-of-the-art’ knowledge can be found in the way the cities present the effects of road capacity increases. For workplace locations, the consistency of the knowledge claims in the planning documents with state-of-the-art knowledge varies considerably between the cities, with one city (Trondheim) presenting the travel impacts in high accordance with ‘state-of-the-art knowledge’ whereas in the claims of another city (Aarhus) such knowledge is used in an incomplete and for some aspects distorted way.

The greatest deviations from ‘state-of-the-art knowledge’ can be found in the way the cities present the effects of road capacity increases. The main way in which knowledge claims inconsistent with state-of-the-art knowledge about the effects of road capacity increase are presented in the cities’ planning documents is by ignoring the traffic-generating effect of building wider roads in transport corridors where congestion

occurs. By presenting the future traffic volume as being equally large with and without increased road capacity, these documents convey the message that the construction of new and wider urban highways is not in conflict with goals of reducing car traffic and its related emissions. In the case of Trondheim this claim is, however, contested, where the municipality's own planners and politicians appear to be aware of the tendency of road capacity increase to induce more car traffic whereas this effect is ignored in the EIA document produced by the national road administration. When it comes to workplaces, the main misinterpretation of state-of-the-art knowledge is to consider only the effect of proximity to public transport nodes while ignoring the deterrent effects against car commuting caused by narrow streets, frequent street crossings and scarcity of parking typical for inner-city locations. In the case of Aarhus, this interpretation, together with an unrealistic belief in reduced travel distances due to mixed land use in suburban settlements, results in a presentation of workplace location close to the planned suburban stops of the city's projected light rail line as favorable seen from the perspective of reducing car commuting.

The issues of density and residential location are also represented by the cities in ways more or less consistent with 'state-of-the-art' knowledge. In two of the cities, the discussion of the relationship between density and transport refers to density at the scale of the whole city, whereas in one city (Aarhus) density is discussed only at a neighborhood scale. While the latter usually has some effects on the length of non-work trips and on the modal split, the density of the city as a whole is usually more important to the overall amount of transport and the dependency of cars. In dense cities, residences will, other things equal, on average be located closer to the central parts of the city than in less densely developed cities. They will therefore also tend to be located closer to the concentration of jobs and other facilities usually found in the inner and central areas. This aspect of residential location is ignored in the Aarhus planning documents, where the discussion of residential location refers mainly to proximity to stops on the projected light rail line.

#### 4. Concluding remarks

In each of the three case city regions, policy goals of reducing greenhouse gas emissions and limiting the growth in car traffic have been formulated. According to the municipal plan for Aarhus, a central goal is for Aarhus to become CO<sub>2</sub> neutral by the year 2030 (Municipality of Aarhus, 2009, p. 12). The Municipal plan of Trondheim (2008) states that the Trondheim region is to become a role model for competitive and sustainable land use and transport solutions, among other things by reducing the transport-related CO<sub>2</sub> emissions by 20% compared to the 2008 level, a.o. by locating residences and workplaces in such a way that the need for transport is reduced (*ibid.*, p. 16). In Helsingborg, the Municipal plan mentions 'Reducing the environmental load and dealing with climate change' and 'Dealing with increased needs for travel and transport' as two of the five main challenges.

Needless to say, the achievement of such goals depends on whether or not the land use and infrastructure planning measures chosen by the cities will actually contribute to reducing the amounts of car traffic and the associated greenhouse gas emissions. And the choice of measures efficient to achieving that end depends on knowledge about the likely impacts of different strategies for urban land use and transport infrastructure development. The use of valid knowledge about such consequences is necessary in order to systematically and consciously make plans that contribute to reduction rather than growth in traffic volumes and related environmental impacts.

Our review of key planning documents in the three medium-sized Scandinavian city regions shows that the knowledge claims about travel behavioral impacts of proposed land use and transport infrastructure presented in the documents are to varying extent in accordance with 'state-of-the-art' academic knowledge on these topics. In line with this knowledge, the cities' planning documents present dense urban development and public transport improvement as favorable to goals of reducing urban motoring. The importance of workplace and residential location is also highlighted. Some of the old planning assumptions referred to in the introduction of this paper are, however, encountered also in the investigated planning documents, which

were produced only a few years ago. In some of the plans, proximity to public transport stops is emphasized rather than proximity to inner-city concentrations of jobs and other facilities, and density is discussed at a neighborhood scale rather than at a city scale. These interpretations support spatial developmental patterns associated with ‘new (sub)urbanism’ but are not addressing the aspects of density and locations of jobs and housing that are, according to the academic knowledge, of highest importance to travel behavior. The planning documents also often ignore the traffic-generating effect of increased road capacity. While the competition between car and public transport is recognized in the impact assessments of public transport improvement, forecasts of changes in traffic volumes due to road constructions tend to ignore that a field of competition exists between car traffic and other travel modes.

Our case study based investigation of course does not provide any basis for statistical generalizations. We do, however, believe that the discrepancies between knowledge claims in planning documents and ‘state-of-the-art’ knowledge may correspond with practice in other European and in wider international contexts. At least in countries where the availability of mobility resources is high enough to enable people to choose jobs and services beyond their local neighborhoods and where congestion exists on urban highways, developing new ‘self-sufficient’ suburbs are likely to generate more motorized travel, and urban road construction is likely to induce more car traffic. In spite of this, impact assessments for new highways in metropolitan areas often ignore their traffic-generating effects (Litman, 2011), and proponents of ‘new urbanism’ often exaggerate the effects on travel behavior from building new suburbs with a somewhat higher density and a higher degree of land use mix (Architecture Week, 2008). The ‘planning myths’ encountered in the case cities can be retrieved in current discourses among land use and transport planners, for example on websites about ‘smart growth’, ‘transit-oriented development’ and ‘new urbanism’ (e.g. CNU, 2013), in policy documents e.g. about ‘polycentricity’ (Davoudi, 2003; Jensen & Richardson, 2004), and not least in transport modeling practice (Nielsen & Fosgerau 2005; MOTOS, 2007; Andersen, 2013).

The findings of inconsistencies between knowledge claims in planning documents and state-of-the-art knowledge could indicate that this is part of the explanation why greenhouse gas emissions from road traffic continue to increase. More research is, however, needed to uncover the consequences of such claims to the actually planned land use and infrastructure development, as well as the causes of the above deviations between knowledge claims and ‘state-of-the-art’ knowledge: Are they resulting from ignorance, cognitive dissonance and/or strategic misrepresentation (Festinger, 1956; Flyvbjerg, 2007)? The direction of causality between the knowledge claims in the planning documents and the proposed land use and infrastructure is not necessarily straightforward. The question still remains whether proposals for sprawling and car-accommodating developmental patterns despite sustainability goals are the results of cause-effect assumptions inconsistent with state-of-the-art knowledge or the opposite is the case: that knowledge is filtered and distorted in order to fit better with already preferred land use and infrastructure solutions.

Since the likelihood of achieving sustainability goals relies heavily on whether the measures chosen are productive or counter-productive, judged against this end, knowledge obviously matters. Knowledge about the impacts of different policies is also necessary to understand what is at stake in conflicts between different interest groups about spatial urban development. Insofar as the ‘ontological turn’ can lead to a reinvigorated research interest in the outcomes of spatial planning without disregarding the insights brought by process-oriented planning research, it should therefore be welcomed. Such a balanced focus on outcome as well as process should, however, perhaps not be labeled a ‘turn’, since this term bears connotations of turning one’s back completely to the ideas held by the dominating ‘pre-turn’ discourse.

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Table 1: Selected urban structural characteristics favorable/unfavorable to sustainable mobility (according to ‘state-of-the-art’ knowledge applied to the context of the Nordic countries).

<i>Urban structural dimension</i>	<i>Characteristics favorable/unfavorable to sustainable mobility</i>
Density	<ul style="list-style-type: none"> <li>• High density favorable for the city as a whole (low amount of urban area per capita).</li> <li>• Less effect, although some, of neighborhood-scale density</li> </ul>
Residential location	<ul style="list-style-type: none"> <li>• Proximity to major concentration of jobs and services favorable, i.e. close to the main city center.</li> <li>• Less effect, although some, of proximity to local centers</li> </ul>
Workplace location	<ul style="list-style-type: none"> <li>• Central location favorable for workplaces with many jobs or visitors per area unit</li> <li>• Local services (primary schools, grocery shops etc.) should be interspersed with housing</li> <li>• Freight-generating and land-consuming enterprises should be located in suburbs close to main roads, with rail side-track</li> </ul>
Mixed land use	<ul style="list-style-type: none"> <li>• Mix of jobs, dwellings and services favorable in inner-city areas</li> <li>• Mix of suburban dwellings with local service favorable – but not with specialized jobs</li> </ul>
Public transport improvement	<ul style="list-style-type: none"> <li>• Favorable, especially when road space for cars is reallocated to streetcar lines or bus lanes</li> </ul>
Road capacity increase	<ul style="list-style-type: none"> <li>• Unfavorable - capacity should be reduced to fit with desired sustainable traffic volumes.</li> <li>• New roads to lead traffic away from neighborhoods should not be wider than the original ones, and existing roads should be closed to balance the added new capacity</li> </ul>
Parking policies	<ul style="list-style-type: none"> <li>• Limited and tolled parking favorable, especially in inner-city areas but also in main suburban centers</li> </ul>

Table 2: Consistency of knowledge claims on travel impacts of land use and transport infrastructure with ‘state-of-the-art’ knowledge. H = Helsingborg, T = Trondheim, Aa = Aarhus. A parenthesis indicates that the impact of the urban structural dimension in question is dealt with only very superficially in the planning documents of the city.

<i>Urban structural dimension</i>	<i>Consistent</i>	<i>Partially consistent</i>	<i>Rather inconsistent</i>
Density	T, H	Aa	
Residential location	(T, H)	Aa	
Workplace location	T	H	Aa
Neighborhood diversity and design	H	Aa	
Road capacity increase		T	H, Aa