Built environment, causality and travel

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Abstract

Within research into influences of the built environment on travel behaviour, the issue of causality has gained increased attention. Several attempts have been made in order to identify the true effects of built environment characteristics by controlling for attitudinal and lifestyle factors and by applying more sophisticated techniques of analysis. Most research still suffers from insufficient theorizing and empirical investigation of causal mechanisms. An implicit conception of causality in terms of correlation between subsequent events appears to be widespread. This paper argues that such a conception of causality is inadequate and can lead to model specification error. Instead, a conception of causality as *tendencies engendered by generative mechanisms* is proposed. Based on such an understanding, the paper discusses in what sense the built environment can be said to exert causal influences on travel behaviour. In order to integrate knowledge about causal influences at the level of the individual and at the city level, a combination of qualitative and quantitative research methods is recommended.

Keywords: Built environment, correlations, causality, travel behaviour, tendencies

1. Introduction

Better knowledge of how and why urban built environments influence travel is important in order to form sustainable strategies in urban land use planning. Interdisciplinary integration is necessary to improve this knowledge, since travel involves spatial, infrastructural, socioeconomic, cultural, as well as demographic factors of influence. However, different disciplines have different, and sometimes contradictory, meta-level conceptions of relationships between the spatial/physical and the social. This hampers interdisciplinary research and can give rise to distrust and scepticism between planning practitioners from different disciplines. Lack of adequate understanding of causal influences between built environment and travel also engenders diverging and contradictory knowledge claims about such relationships. Such contradictory knowledge claims sometimes legitimize ideologically motivated denial of causal mechanisms of great importance e.g. in terms of their environmental impacts.

The purpose of this paper is to provide a more solid fundament for claims about causal influences of the urban built environment and land use (hereafter the built environment for short) on travel behaviour by discussing the ontological[1] status of the built environment as a contributory cause of travel behaviour. In this context, the term of built environment applies to:

- The geographical distribution, fabric and design of the building stock
- The location of different functions (such as residences, workplaces, public institutions and service) relative to each other within the building stock
- The transport infrastructure system (road/street network, public transport infrastructure, and parking conditions)

Before offering an alternative, and in my view better, conceptualization of causality matching the multiple-cause situation land use and transport planners and researchers are facing when trying to investigate the ways in which the built environment influences travel, a critique of the predominant conception of causality within transportation research (below referred to as *correlationism*) will be presented[2] (Section 2). Arguments will be put forth that this understanding of causality offers no explanation of why built environment characteristics influence travel and provides little or no guidance for determining which variables to include or not include in a multivariate analytical model, nor which ones among those included to consider as endogenous or exogenous variables. The paper then moves on to presenting an alternative, dispositional notion of causality, where causality is conceptualized in terms of generative mechanisms normally operating in interplay with a number of other causal powers, some of which may enforce each other while others may counteract each other's influences (Section 3). The specific nature of the causal relationships between built environment characteristics and human actions will be elaborated on in Section 4, where the built environment is conceptualized as a particular sub-set of social structures. Arguments will be put forth that structures as well as agents have their own causal powers and properties and influence each other reciprocally, but with a time lag which implies that our actions on a given day take place under pre-existing structural conditions. Reflecting the need for integrating knowledge about causal influences at the level of the individual and causal influences at the city level, a combination of qualitative and quantitative research methods is recommended in the concluding section of the paper (Section 5).

2. Correlationism

Among researchers studying influences of urban built environments on travel behaviour as well as more broadly within what has been referred to as 'regional science', a neo-positivist paradigm has long been dominating, especially in the USA. Within this tradition, explicit reflection on the nature of causal influences is rare. Instead, the identification of correlations or invariances between observed phenomena is highlighted (Tonboe, 1993:292). I shall refer to this tradition as *correlationism*.

Nowadays, correlationist researchers into travel and the built environment rarely assume single-cause relationships. They typically conduct statistical analyses controlling for a host of demographic,

[1] Ontology is the philosophical study of the nature of being, becoming, existence, or reality, as well as the basic categories of being and their relations.

[2] Critiques of understandings of causality prevailing among planning academics are given in separate papers (Næss, 2015; Næss, forthcoming)

socioeconomic and even attitudinal variables. What researchers do when making multivariate analyses is basically to make a thought experiment to identify which correlation remains between each built environment variable in question and the relevant travel behaviour variable when all other investigated variables are presumed to be held constant. This still does not demonstrate that such a controlled correlation represents a causal influence.

A few authors discuss the causality issue explicitly (e.g. Handy et al., 2005; Mokhtarian and Cao, 2008; Cao et al., 2009). Reference is sometimes made to four types of evidence emphasized by Singleton and Straits (2005) as necessary for robust inferences about causality: statistical association, non-spuriousness, time precedence, and a causal mechanism. However, in most research studies on built environment and travel behaviour actually carried out, the focus is limited to the two first of these criteria. Some authors have called for longitudinal studies in order to obtain better evidence for the precedence of causes to effects (e.g. Krizek, 2003; Cao et al., 2009), but the number of such studies is so far still low. The fourth criterion, a causal mechanism, is to a surprisingly low degree made subject to empirical investigation. Explicit theoretical discussion on the plausibility or non-plausibility of causal influences of various built environment characteristics on relevant aspects of travel behaviour is also rare in the body of published material. Potential factors of influence rather seem to be included in the statistical analyses, based on previously found statistical associations, or in response to fashionable planning agendas such as 'new urbanism' or 'jobs-housing balance'.

The low attention given to the identification of causal mechanisms is in line with a tradition that can be traced back to the Scottish empiricist philosopher David Hume (1711-1776) and his conception of causality in terms of 'constant conjunctions'[3]. Within this tradition, conceptions of causal mechanisms are typically considered metaphysical and thus unscientific. Qualitative properties of the built environment as well as the humans whose actions are conditioned are put in the background. Theories explaining why correlations exist between built environment characteristics and travel behaviour are rarely exposed, let alone reflected on.

The strong focus within mainstream research on land use and transport on identifying correlations between built environment characteristics and travel behaviour, controlling for socioeconomic, demographic and attitudinal variables, does not necessarily mean that the researchers subscribe to a Humean conception of causality. Most researchers within the field probably do not reflect very deeply on this philosophical question. Rather, a research tradition has been formed where the attention is drawn towards measuring statistical relationships as exactly as possible. The one-sided emphasis on statistical analyses and correspondingly low research activity directed towards investigation into causal mechanisms and processes is, however, only logical if causality is understood in the Humean way. It is therefore fair to say that mainstream research into influences of land use on travel assumes, at least implicitly, a conception of causality as constant conjunctions between subsequent events.

The prevalence of (an implicit) correlationist understanding of causality among transportation researchers and in transportation research journals is evident, for example, in a review of 38 studies

[3] Hume held that human assumptions about causality resulted from constant conjunction of events, or customs based on expectations of subsequent events, rather than logic. His empiricist epistemological position rejects the possibility of knowledge about unobserved entities. Hume did not, however, consistently follow his original epistemological position, as he acknowledged that science had been effective in postulating successively deeper causal principles and mechanisms, such as gravity (Morgan, 2007).

addressing the so-called self-selection problem in studies of influences of built environment characteristics on travel behaviour (Cao et al., 2009). Among these 38 studies, only 2 applied methods aiming to identify the causal mechanisms that might have produced the observed statistical relationships. In a preceding review of methodologies for meeting the causality requisites of research aiming to identify the influences of built environment characteristics on travel by addressing the 'self-selection problem', Mokhtarian and Cao (2008) identified qualitative interviewing (referred to as 'direct questioning') as one out of nine possible methods. The 'direct questioning' method was, however, deemed the least relevant one, as it was considered more vulnerable than other methods to biases including memory, consistency, saliency and social desirability, as well as relying on small and non-representative samples. Similarly, in a recent comprehensive review of research designs for causal inference between the built environment and travel behaviour, xxx and xxx (2015) only include quantitative research designs, leaving out qualitative designs.[4]

Mainstream research on influences of built environment characteristics on travel usually pays considerable attention to refining the statistical methods of analysis, making sure that the mathematical requirements for unbiased parameter estimates are met to the greatest extent possible. Typically, measures are taken to counteract non-normality (e.g. sample selection methods), non-linearity (typically logarithmic or other transformation of the dependent or one or more of the independent variables), heteroskedasticity, autocorrelation, etc.; and various logistic methods are applied whenever the dependent variable is not at an interval or scalar level of measurement. Often, quite sophisticated methods are used to construct variables representing unobserved characteristics of the respondents (notably attitudes), based on a given set of observed characteristics.

Compared to the efforts spent on applying the statistical analyses in an as impeccable way as possible, the literature usually spends considerably less space on discussing which variables to include in the statistical models, their order in a causal chain, and whether or not two-way directions of influence exist between some of the variables. Bluntly, one might say that mainstream research on influences of the built environment on travel is much more preoccupied with *doing the things right* (making methodically correct statistical analyses) than with *doing the right things* (to include the relevant independent built environment variables and control variables while avoiding to include irrelevant control variables). *Model specification error* is, however, an equally serious, if not even more serious, source of biased estimates than any violation of the mathematical preconditions for unbiased statistical analyses (see, e.g., Lewis-Beck, 1980).

The correlationist approach does, however, not offer much help in avoiding specification error. In order to set up an appropriate multivariate model for statistical analyses, it is necessary to determine the directions of causality between the variables by defining endogenous and exogenous variables, and unidirectional and bidirectional relationships. These features of a model need inputs of a different kind than information about correlations.

There is thus an important contradiction in the correlationist position: If causality is nothing more than (statistically controlled) correlations, how then can the necessary control variables be identified among the myriad of circumstances likely to correlate in some way or other with travel behaviour?

[4] To the extent that the issue of causality is at all discussed in research within the correlationist tradition, the problem of *identifying* a causal mechanism sometimes seems to be mixed up with the problem of *estimating the strength* of such a mechanism (see, for example, Van Wee and Boarnet 2014; xxx and xxx 2015).

Obviously, scholars use theory and previous literature for this. But this does not bring us closer to understanding of causality unless the theories and literature in question propose explanations that go beyond mere correlations.

Absence of theoretical analysis of plausible causal mechanisms and/or lack of empirical investigation of such mechanisms, are probably important reasons why several studies have focused on built environment variables unlikely to exert much influence on the travel behaviour variables in question while omitting other, presumptively more important built environment characteristics. For example, several studies have included the street pattern of the neighbourhood as a variable in studies of factors influencing vehicle miles travelled while omitting the theoretically much more relevant distance from the dwelling to Central Business District or a similar regional accessibility variable (for overviews showing examples, see Boarnet & Crane, 2001; Cervero, 2003; Ewing & Cervero, 2010). In other cases, control variables have been introduced that are themselves likely to be considerably influenced by built environment characteristics. Using car ownership (or car availability) as a control variable is, for example, quite commonplace[5] (see, for example, Hjorthol, 1998; Schwanen et al., 2001; Krizek, 2003; Rajamani et al., 2007; Scheiner and Holz-Rau, 2007), although the need for owning a car (or purchasing an additional car to the household) is obviously not the same if you live close to downtown as if your residence is located in an outer suburb (Giuliano & Narayan, 2003; Næss, 2009; Zegras, 2010; van Acker and Witlox, 2010). Car ownership thus does not only enable people to settle in a suburb; the long distances to relevant destinations when living at such locations may also make people consider car ownership a necessity.

Theoretical reasoning and qualitative research on people's motivations for acquiring mobility resources like a private car or other motor vehicle might have disclosed such causal mechanisms and led the researchers to consider the relationships between residential location and motor vehicle ownership as bidirectional instead of unidirectional. The same applies to several attitudinal variables introduced over the last decade in order to control for residential self-selection based on preferences for certain kinds of transport lifestyles (Kitamura et al., 1997; Bagley and Mohktarian, 2002; Van Wee, 2009 and 2013). The implicit assumption when including such control variables (unless the statistical method treats them as endogenous variables allowing for bidirectional influences) is that transport attitudes influence residential location, but not the other way round. For critiques of this assumption, see Næss (2009, 2014a); for a further discussion see also Van Wee & Boarnet 2014, and Næss 2014b).

3. Causes as tendencies

Distinct from the conception of causality in terms of correlations, understanding causality in terms of tendencies and generative mechanisms (Bhaskar, 2008) appears to me to be much more appropriate and fruitful. Such an understanding of causality is usually associated with realist philosophical positions. Theories based on such conceptions are sometimes referred to as dispositional theories of causality (Mumford & Anjum, 2012). The conceptualization of causality presented in the following draws in particular on the philosophy of science position known as critical realism.

[5] This also applies to several of my own earlier studies. In most of these studies I did, however, also include indirect effects of built environment characteristics via car ownership.

Critical realism, as presented by, among others, Bhaskar (1993, 1998 and 2008), Sayer (1992), Archer (2000), and Danermark et al. (2001), offers a platform within philosophy of science which, more than many other such platform, appears to be relevant for research into the ways in which structural conditions (including built environment characteristics) influence human actions (including travel behaviour). According to critical realism, the world exists independently of our knowledge of it, and this knowledge is both fallible and theory-laden. On the one hand, critical realism conceives social phenomena such as actions, texts and institutions as concept-dependent. On the other hand, these mostly exist regardless of researcher's interpretations of them. Critical realism distinguishes between three different domains of reality: the empirical (consisting of what we experience directly or indirectly), the actual (where events occur whether or not we experience them) and the real (including both experiences, events and the causal powers producing the events) (Danermark et al., ibid.).

Moreover, according to critical realist ontology, reality consists of different levels (strata), where new properties and causal powers emerge at each level, compared to the level below. The causal powers of the lower levels still exist at the higher levels. For example, communication in the social domain depends not only on social phenomena, but also on laws of physics (e.g. transmission of sounds from speaker to listener, or of texts and images between computers differently located).

Different levels often correspond to the research fields of different disciplines. Moving from the most basic (lowest) to more complex (higher) levels, we can, for example, refer to phenomena dealt with within physics, chemistry, biology, psychology, and sociology as different levels of reality. Patterns of car travel among inhabitants of urban neighbourhoods depend, for example, on phenomena within physics and chemistry (e.g. the qualities of materials and fuels used for vehicle propulsion), biology (e.g. drivers' sight and physical ability to use steering wheel, accelerator and brakes), psychology (e.g. calm driving vs. road rage), social structures and institutions (e.g. affordability of cars, employment opportunities, traffic rules), built environment (e.g. infrastructure provision, proximity vs. distance), as well as cultures and discourses (e.g. a 'car culture' vs. high popularity of public transport and non-motorized modes). How we choose to subdivide the levels depends on the research topic, and the specific classification is a social construction. But the very phenomenon of emergence – that new causal powers emerge at higher levels, depending on lower levels but also working back on them – is a feature of the real world (Bhaskar, 2008). The extent to which the higher levels influence the lower varies with the levels dealt with as well as between different epochs. Human societies are, for example, emergent from psychological, biological, nature-geographical and basic physical conditions, but today they work back on the natural basis with considerably stronger power than in the Stone Age.

Both in daily life and in science the term 'cause' is used in very different senses. In some philosophical traditions, the notion of cause is used only about active impulses that trigger a given event to happen, whereas other circumstances enabling, modifying or preventing the effect of the triggering factor are termed as 'conditions' rather than causes. Critical realism does not make any such distinction. Causes are rather seen as 'tendencies' that may or may not be actualized. According to critical realist ontology, what happens in the world – in nature as well as in society – is a result of causal powers working via a number of mechanisms. Objects have properties enabling them to exercise certain forms of influences on other objects and/or make them liable to certain kinds of influences from other objects. Reality is understood to consist mostly of more or less open systems

where empirical regularities rarely occur spontaneously. In open systems, many different causal powers operate simultaneously. Some amplify each other, others counteract each other, and some are only activated under the influence of other causal powers. All this varies with the specific context (Bhaskar, 2008).

The general condition of context-dependent multi-causality still does not preclude the possibility of identifying causal mechanisms within the social world. According to critical realism, any human organization – from the family household to public administration, shopping centres and factories – are examples of partially closed systems. This limited and conditioned closure within some parts of society is obtained because humans are internally related to each other. Some such relations and regulations are more central than others and can give rise to regularities reflected within many fields of social life (Danermark et al., 2001; Karlsson, 2011).

In a critical realist view, acknowledgment of the importance of interpretive understanding does not prevent inclusion of causal explanations in explanations of 'purposeful action'. Moreover, according to critical realism, reasons may themselves be plausibly construed as causes (Bhaskar, 1998; Fairclough et al., 2002). Causal mechanisms can thus involve attitudes and knowledge resources of individuals, as well as intersubjective production of meaning.

The notion of causes as tendencies matches the multiple-cause situation a researcher is facing when trying to explain travel behaviour (Næss and Jensen 2002; Næss 2004). The built environment exerts influence on travel behaviour, but so do also a number of other circumstances. The patterns of travel behaviour in a given city are a result of people's resources, needs, wishes, and obligations, modified by the constraints and opportunities given by the structural conditions of society. Among the structural conditions, the spatial and physical urban structures of course make up only a few out of several categories (although of particular interest in land use and transport planning). Any cause of travel behaviour is only a *contributory* cause. Other causes may always add to or counteract the cause in question. For example, public transport improvements are, ceteris paribus, likely to increase the modal share of transit. But if at the same time road construction takes place making urban motoring faster and more convenient, the share of travellers opting for public transport may still decrease. This conception of causality also helps us understand why we can never expect to find the same kind of strong empirical regularities between causes and events in society as in some natural sciences.

The above conceptualization of relations between structural conditions and human behaviour implies a view on structure and agency[6] according to which causal power is attributed to structures as well as agents. Critical realist ontology insists that structure and agency both have their own properties and powers and can be separated analytically to investigate their distinct influences and interaction (Bhaskar, 1993; Archer 2000; Sayer, 1992; Danermark et al. 2001). Apart from our natural environment, the structures surrounding us are in various ways 'socially constructed'. The 'constructs' may be physical artefacts like buildings or roads, or more immaterial structures like property relations, economic conditions or prevailing belief systems and cultural traditions. Once created, the various types of structures hold emergent powers and properties different from and beyond the aggregate sum of agential powers by which they were created. At the same time, the structures are being reproduced, modified and changed by human actions. Such changes most often

[6] In the social sciences, agency is the capacity of an agent (a person or other entity) to act in the world.

occur gradually and slowly, but sometimes more dramatically and fast. The critical realist conception of relationships between social structures and agency is illustrated in Figure 1.

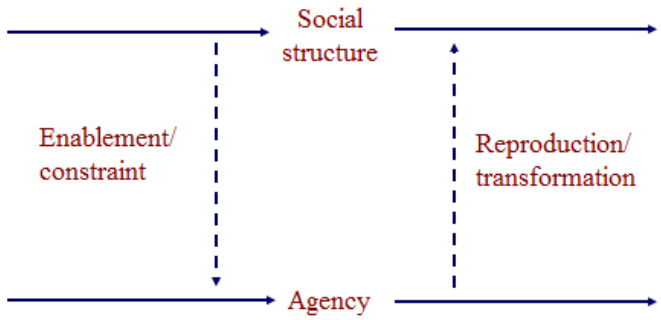

Figure 1: The transformational model of the connection between social structure and agency. Source: Bhaskar (1993).

The ways in which travel behaviour depends on built environment characteristics should not be conceived of as either voluntarism or determinism, but instead in terms of tendencies or dispositions, where the 'structural imperatives' imposed by the built environment are modified, amplified or counteracted by a number of other structural and individual circumstances. Moreover, the relationships between the built environment and the actions of individuals are not unidirectional but a matter of two-way influences. As already mentioned above and as elaborated more thoroughly on in Section 4, the built environment of a city influences a number of daily-life activities among its inhabitants, including travel. But the inhabitants obviously also influence the built environment. They do so as market agents by demanding, purchasing and using certain kinds of dwellings, vehicles and urban facilities, and they may collectively influence the way the urban built environment develops by electing politicians who promote a particular form of urban development. Some inhabitants may also take on a more powerful actor role in urban development, such as urban planner, property developer, etc.

4. The built environment as a causally efficacious structure

Any study of effects of the built environment on travel behaviour assumes – at least implicitly – that physical/spatial conditions have a potential to influence human actions. If the built environment did not exert any influences on people's well-being, the economy, the natural environment, etc., there would be no point in trying to influence how the built structures develop. But obviously several actors do try, and for good reasons. Buildings and physical infrastructure normally do not actively trigger things to happen, but they can in principle (usually in interplay with other causal powers) enable, augment, facilitate, constrain, stifle or prevent the occurrence of events and situations in such a way that the result differs from what would otherwise have been the case. They do not in this regard differ from humans, immaterial social structures, non-human nature or any other kinds of objects. Applying the critical realist conception of causes as tendencies (as distinct from constant conjunctions), built environment characteristics must thus clearly be considered causally efficacious for human actions and social phenomena, albeit not in a deterministic way.

However, although the built environment is perhaps the most obvious manifestation of socially constructed entities, it has to very little extent been theorized as a causally efficacious social

structure. Admittedly, there are traditions within sociology, geography, anthropology and not the least architecture and engineering that have implicitly assumed that built environments are capable of influencing people's actions, living conditions, well-being or aesthetic experience. The nature of these influences has, however, rarely been theorized. Such theorizing is arguably an important precondition for fruitful interdisciplinary integration among scholars and practitioners from different fields involved in urban and transportation research and professional practice.

In social theory, the concept of social structures is often understood to refer to overall economic systems, social hierarchies, legislation, social institutions as well as prevailing norms and discourses, each operating at different scales. Material structures are usually ignored although not explicitly excluded[7]. Even within critical realist ontology, the ontological status of the built environment has only to a little extent been theorized. The kinds of social structures referred to in critical realist literature are most often of a 'non-material' kind. A handful of critical realist authors have addressed the built environment as a meta-theoretical entity, but their focus has predominantly been on the built environment as the outcome of social structural causal mechanisms and agential power (e.g. Lawson, 2006; Wardner, 2014). The predominant non-inclusion of the built environment in conceptions of social structures might be a remnant of the traditional taboo in sociology against attributing causal influence on social life from the physical environment (Benton, 2001).

Distinct from the natural environment, the human-made urban fabric is undeniably socially constructed. It might therefore be reasonable to consider the urban built environment as a particular sub-set of social structures, with its own particular emergent powers and liabilities. As mentioned in the introduction, the term 'built environment' as used in this article does not only include the building stock and infrastructures as purely physical entities, but also the location of different functions and activities relative to each other within these physical entities. This, together with its key role in conditioning the activities, functions and patterned relations between different groups of a society, means that the built environment is much more than just 'material structures'. The built environment is an expression of and makes up conditions for the kinds of societies we have. Alternatively, labels such as 'socio-material structures' or 'socio-technical systems' could be applied to the built environment. But due to their social nature, these concepts could themselves be seen as parts of the broader concept of social structures.

Considering the built environment as a sub-set of social structure of course does not imply that its dependence on geographical factors such as topology, rivers, availability of construction land, building materials, water, energy, etc., are denied. In line with critical realist ontology, I consider social structures (immaterial as well as material) as dependent on (and emerging from) more basic levels of reality, including (and not the least) the natural environment. Material transactions with nature are essential for societies and human life (Bhaskar, 1993).

Some of the typical structure-agency relationships characterizing other types of social structures may, however, be different when the structure in question is the urban morphology and land use with all their material and spatial properties. Among other things, human-made material structures (such as roads and buildings) often have a high *permanence*, although they are gradually modified and changed by human actions (including those of urban planners). Buildings often have a lifetime of

[7] Some other authors, such as Østerberg (1968), explicitly distinguish between social structures and material structures.

many decades or even centuries, and the street network in the inner parts of many cities is still characterized by the street pattern established several hundred years ago. This arguably makes the overall spatial/material structures of cities more stable conditions for human daily-life activities than what may be the case for certain other social structures.

Moreover, whereas it is possible to 'disobey' non-material structures to a greater or lesser extent (for example, breaking the law or violating the code of conduct in an organization), material structures are in some ways more compelling and may make up more absolute constraints. You cannot drive through the walls of a building, and you run the risk of being killed if you walk between the metro rails. Many of the influences of the built environment on human behaviour and social life are still less absolute. In addition to making up some absolute constraints and enabling actions that would otherwise not at all be possible, the built environment facilitates, encourages and discourages, making some actions and adaptations attractive and easy while making others cumbersome and difficult.

Within human geography, the positions of possibilism and probabilism were developed in opposition to the (alleged) environmental determinism that had been a prevailing view toward the end of the 19th century. Possibilism was introduced in the early 20th century by the French historian Lucien Fevre and adopted by several human geographers. Possibilism acknowledges that the environment sets certain constraints on human activities, but contends that social conditions and the choices made by people are more influential (Fellman, 2000; Collins English Dictionary 2014). Possibilism is, however, not concerned about the different degrees to which a given set of environmental conditions may enable or constrain a particular kind of human activity. Some of the possible actions may be difficult and some others may be easy, but such differences are not catered for by a possible versus impossible dichotomy. In response to this shortcoming, the human geography position of probabilism was developed in the late 1950s and 1960s as a middle ground between environmental determinism and possibilism (Calhoun, 2002). Based on the nature of the environment, humans will, according to the probabilist view, be more likely to make certain decisions over other ones (Fellman, 2000).

The position of probabilism appears a reasonable approach to the study of influences of land use on travel behaviour. Apart from rendering certain actions impossible (such as driving across a river where there is no bridge), the built environment makes up a set of incentives facilitating some kinds of travel behavior and discouraging other types of travel behaviour, yet without making the latter impossible. And rather than a dichotomy between the facilitating and discouraging conditions, there is often a continuum. And the outcome is not only of the kind 'occurs or does not occur' (e.g. using or not using public transport as a travel mode), but is often a degree along a continuum (e.g. the daily travel distance). Within the range of possible actions, the built environment thus makes certain forms of behavioural adaptations more likely than other forms of adaptations, for example because differences in geographical proximity make some choices more time-consuming, costly or inconvenient than other ones. Probabilism does not, however, mean that the likelihood or unlikelihood necessarily lends itself easily to accurate measurement, let alone prediction. The nature of the relationships between built environment characteristics and travel behaviour should still be understood as probabilistic rather than merely possibilistic.

In Gibson's (1977) terms, urban built environments could be considered a kind of *affordances* offering opportunities or limitations for action that a subject might perceive. In the conception of Østerberg (1998), cities should be understood as a socio-material field of action, where the *facticity* of the material structures (cf. Sartre, 1948) creates constraints on the possibilities of the inhabitants to unfold their desires. The conception of the built environment as causally efficacious on human actions and social life put forth in this paper has some similarities with Gibson's and Østerberg's ways of theorizing. Rather than using their frameworks I have, however, situated my conceptualization of the causal status of the built environment within the critical realist ontology of the stratified world (cf. Section 3), which I consider as much more elaborate than those of Gibson and Østerberg.

The built environment can influence human actions, well-being and social life in several ways. The size, layout, technical equipment and design of dwellings is important to the residents' material standard of living; the distances between different urban functions and facilities can influence the needs for transportation as well as the possibilities people have for engaging in activities; the homogeneity or heterogeneity of local neighbourhoods in terms of dwelling sizes and standards can influence the level of social segregation or integration; the visual appearance of buildings can contribute to positive aesthetic experience; building styles and architectural forms can be imbued with symbolic meaning, convey a message about power and social order and have a disciplining effect, etc. Human actions, well-being and social life can also be influenced by several dimensions of the built environment: distances between different facilities ('relative space') as well as the material qualities of specific places such as the density, layout, shape and visual appearance of the buildings and streets of a geographically confined neighbourhood (local morphology). Moreover, the built environment exerts different influences at different scales: The distribution of urban settlements of different sizes at a national (or international) scale obviously has other types of social effects than the distribution of different types of neighbourhoods within a city or the characteristics of the built environment of an individual neighbourhood. For research into influences of urban built environment on travel behaviour, some of the above effects, dimensions and scales will be particularly important.

By determining the distances between locations where different activities may take place, and by facilitating various modes of travelling, the urban built environment makes up a set of conditions facilitating some kinds of travel behaviour (e.g. in terms of trip distances and travel modes) and discouraging other types of travel behaviour. For example, the overall density at city level influences how long distances there will be between potential origins and destinations within a city of a given size, while the density of local neighbourhoods along a public transport line influences the number of potential passengers within acceptable walking distance from the stops and thus the economic base for offering a high level of service. Neighbourhood design and local transport infrastructure can also indicate what travel modes are considered 'normal' or 'deviant' in an area. Apart from these and a number of other effects of built environment characteristics on travel, the causes of travel behaviour of course also include personal characteristics of the travellers, such as age, sex, income, professional status, as well as values, norms, lifestyles, responsibilities and acquaintances.

It should be noted that the spatial/physical characteristics of a city do not always relate to travel behaviour in a straightforward manner. The same built form feature can trigger mechanisms working in opposite directions. For example, while high urban density tends, in and for itself, to reduce traveling distances due to shorter average distances to facilities, this may be – at least partly –

counteracted if people utilize the greater accessibility thus provided by choosing among a larger number of facilities than in a less dense city of similar size. Proximity to trip destinations can also, while reducing traveling distances, induce higher trip frequencies since the inconvenience and costs of making additional trips (e.g. to shops or restaurants) will then be lower (Crane, 1996).

People's *transport rationales*, i.e. the backgrounds, motivations and justifications that agents draw on when they make transport-relevant decisions about their participation in activities, location of these activities, modes of transportation and the routes followed, make up important links in the chains of causal mechanisms by which built environment characteristics influence travel (Næss and Jensen, 2005; Næss, 2013).

Aggregate-level causal relationships between built environment and travel, for example between suburban residential development and increasing car traffic, are dependent on some regularity (only in the form of a tendency, not a deterministic conjunction) in the travellers' prioritization of different rationales for travel behaviour. Given the prevalence of a given set of transport rationales, city-scale causal relationships between urban form and aggregate-level travel behavioural patterns are thus emergent from individual-level causal relationships between residential location and travel. These aggregate-level relationships depend on the continual existence of some importance attached to rationales such as choice of the best facility, minimizing of friction of distance and limitation of physical efforts, giving rise to certain patterns of decisions resulting in certain patterns of travel behaviour under certain conditions (such as longer trips when distances to main concentrations of facilities are increased). For example, inhabitants in several modern cities have shown a tendency to emphasize (within some threshold distances) the possibility of choosing among facilities rather than proximity, meaning that the amount of travel is influenced to a higher extent by the location of the residence in relation to concentrations of facilities than the distance to the closest single facility within a category. Daily travelling 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 centres (Næss, 2005 and 2013).

In the terminology of Bhaskar (2008, pp. 231–234) we could say that the transport rationales according to which, for example, increased suburban residential development tends to increase car traffic make up an enduring condition of this socio-technical system. The various transport rationales manifest themselves in a pattern ensuring a stable aggregate correlation (i.e. in total for the many different tendencies represented by various transport rationales) between suburban residential location and long daily traveling distances, usually by car. The strength of these correlations will, however, vary across space and time, due to the different constellations of other causal mechanisms at work in each situation. This emergent system can in its turn react back on the rationales for travel behaviour on which it is (partially) based, among other things by undermining the population base for public transport and hence the level of, and perceived attractiveness of, the public transport services (Mogridge, 1997), and by contributing to the development of a cultural norm according to which the car is increasingly seen as the 'normal' means of transport (Næss and Strand, 2012).

The transport cultures found in different parts of Copenhagen Metropolitan Area may serve as an example of the latter. Among interviewees living in an outer suburb, car driving was largely considered the 'normal' kind of transport, whereas biking seemed to have a similar status among many of the residents of the three most centrally located interviewee areas (Næss, 2006). These

prevailing attitudes could hardly be understood detached from their urban structural contexts, i.e. the physical and location-based facilitation for different modes of travel. Such local 'transport cultures' will probably exert a certain conformity pressure towards a travel behaviour in accordance with what is 'normal' in each area (however probably not very strong – 'dissidents' hardly risk any sanctions).

5. Concluding remarks

Land use and transport planning has increasingly become an arena where experts with different disciplinary backgrounds promote different and sometimes competing perspectives, conceptualizations and methods. The research field has also seen contributions from a widening range of disciplines, although transport economics still appears to hold a dominant position. Considerable differences in the dominant professional discourses exist between transport planning and spatial planning (Sørensen, 2000) manifest in, among others, differing views on preferred research methods and methods for assessing and comparing alternative solutions. One of the issues where transport planners and spatial planners tend to 'speak in different languages', is their understanding of causality. Arguably, a more adequate conception of causality among transportation planners as well as among spatial planners is a prerequisite for better integration of transport and land use planning. For transportation planning and research, this implies a replacement of the dominating correlation-based notion of causality.

This paper advocates the view that that causality in the social world should be understood in terms of generative mechanisms; that the built environment exerts possibilistic as well as probabilistic influences on human actions such as travel; that both social structures and human agency have their own properties and causal powers; and that built environment characteristics could be considered as a particular sub-set of social structures characterized by having a relatively high permanence (although usually being constantly subject to incremental change).

The presently dominant quantitative-empiricist approach within studies of land use and travel runs the risk of concentrating the attention on other built environment characteristics than those exerting the strongest influence on travel behaviour (and failing to control for the latter), as well as a risk of omitting other relevant control variables and/or including irrelevant control variables in the statistical analyses. To the extent that the causality issue is addressed, a recommended solution has been to conduct longitudinal structural equations modelling with control groups (Cao et al., 2009). While such an approach would represent a clear improvement compared to current practice, it still has important practical as well as theoretical limitations. For one thing, there are considerable difficulties in retaining panels of respondents during a sufficiently long time. Moreover, statistical analyses, even with longitudinal research design, cannot themselves establish that causality exists.

In order to enhance interdisciplinary cooperation and integration, it is necessary to get rid of dogma and a priori assumptions that in practice deny the knowledge represented by other relevant disciplines. For research into influences of built environment on travel, the challenge is particularly to engage to a greater extent than presently with theories and methods from social sciences beyond the realm of microeconomics. Research on built environment and travel should aim at explaining the causal mechanisms and processes through which built environment characteristics of a city influence observed patterns of travel behaviour. This will enable researchers and planners to argue in a more

convincing way in discussions with representatives from other disciplines who might be less prone to persuasion by numbers.

In order to integrate knowledge about causal influences at the level of the individual and at the city level, a combination of qualitative and quantitative research methods is called for. Such combination involves breaking out of the 'cages' of, on the one hand, the quantitative regularity-seeking tradition and its typical disinterest in digging deeply into why the observed regularities exist, and, on the other hand, the interpretivist tradition with its focus on individuals and their motivations, leaving out what aggregate patterns and new emergent structures might result from the different individuals' adaptations to their contexts.

The traditional statistical approach plays an important role in illuminating how the combination of different built environment, social, cultural, economic, political etc. factors together result in some dominating aggregate-level relationships between built environment characteristics and travel, and how such patterns may vary with different city contexts. Although multivariate analyses cannot themselves establish that causality exists, they can be used in an exploratory way, revealing patterns and relationships that might be a result of causal influences. And they may be used as (part of) the evidence for theoretically founded causal relationships. Rather than being explanatory tools, multivariate regressions and other analytical statistics are evidentiary tools, enabling assessment of explanations.

However, in order to get insight into the detailed mechanisms by which the built environment can influence travel behaviour, qualitative studies are necessary (cf. Røe, 2000; Clifton and Handy, 2003; Næss, 2013). In particular, qualitative research is preferable in order to investigate people's transport rationales, i.e. the backgrounds, motivations and justifications that agents draw on when they make transport-relevant decisions about their participation in activities, location of these activities as well as modes of transportation. On the other hand, quantitative research is necessary in order to obtain knowledge about the form of combination and proportions of causal powers and mechanisms typical for the processes through which the built environment influences travel, and hence for the identification of aggregate-level relationships between, for example, residential location and travel behaviour.

Research designs combining qualitative and quantitative methods are therefore recommended. There is nothing wrong in itself with doing qualitative or quantitative research only, as long as insights from theories and research based on the approach not pursued by the researcher is also incorporated. Quantitative researchers should incorporate insights from qualitative research, and vice versa. However, because each research study of built environment influences on travel takes place in a specific spatiotemporal context, such incorporation of knowledge based on different research methods is likely to be most successful in studies combining quantitative and qualitative methods. The researcher will then also be able to draw on first-hand evidence from both kinds of sources.

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