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Correlation, causality or what? Findings and controversies on the relation between urban form and mobility styles

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Abstract

The relation between transport and land use is a widely debated issue; beside some theoretical assumptions, many researches tried to find evidences for it, especially in terms of causality. Most of the scientific literature about the influence of urban structure on mobility can be found within the debate over compact city and urban sprawl. Two main goals can be identified for these studies (the first being by some means functional to the second): a deep understanding of the relation between the two fields and the detection of a “good” urban structure.

Moreover, this relation is analyzed in order to devise and support integrated land use and transport strategies meant to counter de-territorialization processes and to get to a more balanced modal share.

Research efforts, those of the last decade in particular, are then focused on finding causal relations between land use and transport, in order to support - or in some cases to undermine - integrated policies (e.g. Transit Oriented Development in the USA or the ABC policy in the Netherlands).

Despite the amount and variety of studies devoted to this topic, this relation is still far from being understood and empirically proven, turning out to be a very complex and disputed issue.

Analyzing the literature about the relation between transport and land use, the paper will identify the main emerging problematic issues and controversies. Not denying the importance of causal relations between urban structure and mobility styles, the question that will be addressed, and that underlies the analysis, is whether the evidence for this relation should be considered as a staging post for devising policies to counter de-territorialization processes and unsustainable lifestyles or not.

Urban structure and mobility styles: more than a relation

As many authors outlined and the common sense suggests, land use and transport are two sides of the same coin. With few exceptions, people travel in order to reach places where they can carry out their activities. The research interest over the relation between transport and land use seems to be more than obvious, so that the great amount of studies on that topic does not give rise to astonishment, especially when considering that, as Clifton *et al.* suggest: “There is perhaps no topic more central to the study of urbanism than urban form” (Clifton *et al.*, 2008; p. 17).

If on the one side talking about land use and mobility may seem redundant, this kind of feeling of redundancy and yet the great and growing interest of the scientific community reveal the complexity of this relation.

Does the spatial structure of cities influence mobility styles?

This is the first question that should be addressed when dealing with this issue. Many scholars tried to provide answers for this question and a great and growing attention has been paid to the issue since the second half of the last century, attested by a great amount of both qualitative and quantitative studies.

Without coming back to the origins of the attention to the relation between transport and the urban structure, we can consider the 1950s as the starting point of a systematic scientific interest in this issue, with the seminal work of Robert Mitchell and Chester Rapkin “Urban Traffic: a function of land use” (Mitchell & Rapkin, 1953) and that of the other pioneers of these studies, such as Colin Buchanan, John Tetlow and Anthony Goss (Buchanan 1963, Tetlow & Goss, 1965).

Jonathan Levine suggests an interesting interpretation of the evolution of the objectives to which the studies on this topic have been addressed during these decades (Levine, 2006). During the 1960s, he writes, the attention was focused on the quality of life in communities, while the energy crises of the 1970s determined a shift of the attention to fuel savings and the individuation of development patterns that can counter auto-oriented ones. The 1980s are then devoted to the issue of congestion, trying to identify land-use configurations that can mitigate it. Levine sees the 1990s as a kind of synthesis of all the issues previously tackled, following the principles of smart growth and New Urbanism movements in urban design and planning. Finally, the turn of the century saw a growing attention in public health, looking for the relationship between urban form and people’s physical activity, such as walking and cycling.

Considering the evolution of the literature on the relation between the spatial structure of cities and the inhabitants’ travel behaviour, a gradual softening of positions can be identified, so that unambiguous positions are disappearing. After a first period of general acknowledgment of the influence of urban structure on mobility (and of mobility on urban structure as well), some authors tried to demonstrate the groundlessness of this relation. If the work of the pioneers of these studies, and of those that tackled this issue in the immediately following years, can be easily placed into the “yes, they are linked” category, during the next decades the opposite position emerged. Both the clusters of studies belonging to the “yes” and to the “not” side revealed the great difficulty of proving or denying this relation, being the two phenomena – urbanization and mobility - affected by too many factors.

Those scholars that believed in the “yes” answer to the “if” question have then devoted their attention to the “how” issue, trying to find evidences for the way in which urban structure affect, or is affected by, mobility styles.

The most recent studies have been devoted to the detection of causal links between urban structure and mobility (Handy, 2005; Naess, 2005). This is a tricky field, and the disagreement within the scientific community over the subsistence of the causal relations is the most evident confirmation of this complexity.

The interlink between urban structure and mobility is anyway a common wisdom, both among planners and the general public. Considering transportation as a derived demand, depending on the need for carrying out activities that are spatially separated, is an axiom for transportation planners, so that models and policies are based upon this assumption. Few exceptions can be identified: as an example, some authors outlined that some markets segments may view movement as an end itself, with people consuming transportation for the pleasure of movement (Mokhtarian *et al.*, 2002).

Being deeply and diffusely studied, the relation between urban structure and mobility has been subject to many efforts of classification. Nevertheless, the complexity of this issue, its interpretability and the great amount of scientific literature on it make its classification a hard task. Using the words of Randall Crane, who wrote one of the most comprehensive and well-known literature review,

“In organizing a summary of any literature it would be useful to propose a typology, but there is no one best rationale for doing so in this instance. Studies of the influence of urban form on travel can be usefully organized in any number of ways [...]” (Crane, 1999; p. 3).

Many literature reviews have been compiled on this topic, some of them being comprehensive and reliable. Considering the existence of such broad and consistent works, this paper only gives a brief overview of scientific positions over the relation between urban form and mobility in order to focus on the critical aspects that emerge from literature. In order to set and implement urban and transport policies, these critical aspects, chiefly the difficulty with proving causal links between the two sectors can be considered in two ways: as nodes to be solved or as something to deal with that cannot be solved. The second way seems to be the most practicable, since following the first one would mean give this causal relation such an importance to make it at the same time the cornerstone of integrated policies and their most doubtful element. To build a theory or a policy on a weak cornerstone does not seem to be the best solution.

For the purposes of this paper and as its briefness requires, it will be useful to organize literature according to the nature of the analysis, e.g. the methods and tools that has been used. According to this criterion, literature can be subdivided into two main categories: theoretical studies and analytical studies. These two chief categories can be further split into subcategories, as it will be explained in the following pages. Theoretical and analytical studies are obviously interlinked, as some theories are built on previous quantitative findings and at the same time analytical studies may be built on some theoretical assumptions. Therefore the subdivision into these two groups is not categorical, rather it attempts to turn the emphasis from the single methodological areas that have studied this topic (e.g. transport, urban planning, economics, sociology...) to a more comprehensive overview. For a better understanding of the relation between land use and transport both theory and observation have to be considered and intertwined, since, as Levinson and Krizek point out:

“theories destroy data and data destroy theories [...] a simple, clear theory, model or worldview is worth thousands of observations” and, on the other hand, “solid, well-founded, and replicable observations that contradict theories [...] destroy those theories as valid world-views” (Levinson and Krizek, 2008; p. 10).

Theoretical studies

As mentioned above, the first wave of theories about the relation between urban form and mobility dates back to the 1950s, Mitchell and Rapkin’s (Mitchell & Rapkin, 1954) study marking a crucial turning point into the transport and mobility field of studies. Many studies followed during the very next years, confirming the wave of interest that Mitchell and Rapkin’s study produced among the scientific community. As the title suggests, the core thesis of “Urban Traffic: a Function of Land Use” is that a direct and well-defined relation exists between land use and transport. This quite elementary assertion, that simply outlines the link between the location of activities and people’s movements in order to reach them, revealed itself much more tricky than how it seems, arising a growing interest and scientific endeavour during the next decades. Especially in the Anglo-Saxon field, many authors, the most renowned of them being Colin Buchanan, John W. Dyckman, John Tetlow and Anthony Goss (Buchanan, 1963; Tetlow & Goss, 1965; Dyckman, 1968), followed this path, developing their own theories or trying to find evidences for this relation.

Before this wave of studies traffic has been merely considered as the vehicular flow/street capacity ratio, so that any traffic problem was supposed to be solved by providing additional capacity or through the adequacy of the single road section. Mitchell and Rapkin work opened a new perspective on traffic, involving the physical, social and economic urban features into traffic analysis and transportation planning.

The majority of studies that followed belong to the transportation field, with few exceptions, like Tetlow and Goss book “Homes, Towns and Traffic” (Tetlow & Goss, 1965), that tackle the issue of urban transportation by the land use point of view (that of architects and urban planners), also providing suggestions on how homes, cities and transport should be organized in order to improve urban conditions. Unfortunately this is an exception that has not been followed by many other, so that architects and urban planners has played a very marginal role in the land use/transport debate.

A schematic representation of land use-transport interaction, that became a commonplace in the American planning literature after the 1950s, is that of the “land use-transport feedback cycle”, that can be summarized as follows (Wegener & Furst 1999):

- the pattern of *land uses* determines the location of human *activities* (living, working, shopping, education,...);
- the distribution of activities implies interactions or trips through the *transport system*;
- the structure of the *transport system* provides opportunities for spatial interactions, that can be measured as the level of *accessibility*;
- the level of *accessibility* co-determines location decisions, influencing the *land use* pattern.

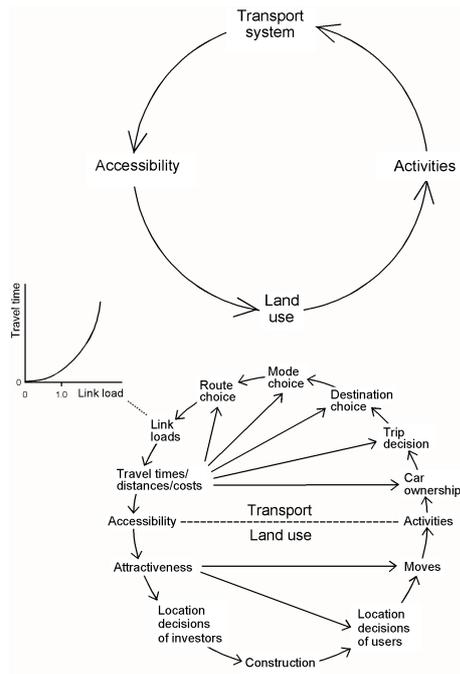


Fig. 1: Land use- transport feedback cycle. Source: Wegener & Furst 1999.

As arguable, the relation between the land use patterns and mobility styles is much more complex than this, so that the outcomes of several urban plans that came during that era according to these theoretical assumptions have been really different from the expected ones. Nevertheless, as it will briefly shown in the following section, empirical studies haven't been able to cast much more light on the nature of this relation, since it is very difficult to empirically isolate impacts of land use on transport.

A subcategory of theoretical studies includes literature regarding modelling studies: a great variety of models have been devised in order to simulate land use-transport interaction and to support decisions for urban policies. Four "generations" of land use-transport interaction models can be identified (Timmermans, 2003):

- a first wave of aggregate spatial interaction based models, such as the TOMM, PLUM, ITLUP/DRAEM/EMPAL/METROPILUS, LILT, IRPUD models, that were generally large scale and aimed at being as much comprehensive as possible;
- a second wave of models that were based upon utility maximizing multinomial logit, like MEPLAN, TRANUS, BASS/CUF, MUSSA e RURBAN, CATLAS e METROSIM, DELTA, UrbanSim, IMREL, TILT, Uplan models;
- a third wave of activity-based, micro-simulation models, like the ILULTE, Ramblas, Irvine, ILUMASS and the cellular automata and multi-agent models. These models, inspired by the self-organizing systems and complexity theories, are again aimed at providing a comprehensive simulation of urban dynamics.

As Harry Timmermans outlines, after a first optimistic wave regarding the first model developed during the 1960s, those models were criticized as being too data hungry and costly. While the following models have been developed in order to solve the problems of the previous ones, "the more fundamental criticism still remains", and the "basic principles that were discussed [...] considerable time ago, are still on the agenda" (Timmermans, 2003; p. 21). It is then important to consider land use-transport interaction models like a useful tool that can help providing some rough qualitative indication for policy scenarios rather than accurate forecasting tools of the likely impact of land use and transport scenarios.

The general idea in theoretical studies and models is to strategically simplify reality in order to simulate an environment in which different urban design features can be clearly linked to travel. It must be considered that hypothetical studies' aim is not that of providing an explanation for travel behaviour. Rather, this kind of studies is meant to imagine or simulate the consequences of alternative urban patterns on travel behaviour, having made certain basic assumptions (Handy *et al.*, 2005). The key limit of theoretical studies and models is right here, since most of the existing simulations don't take into account several essential characteristics of the urban environment and of inhabitants behaviour. On the other hand, urban complexity is hard to be modelled, and simplifications are often the only way to cast some light on this relation.

Among the most problematic aspects of theoretical studies and models there is their reliance on mobility styles that belong to the 1950s: the difficulty and inadequacy of land use-transport models in representing reality becomes much greater with current lifestyles, but as a matter of fact the majority of hypothetical studies and models are still built on the basic assumptions of half a century ago. If by the beginning of the second half of the last century lifestyles were chiefly systematic, work-home travel being the predominant share, as everybody knows nowadays context conditions have considerably changed, non-work travel representing a much greater share of total mobility (Boarnet & Sarmiento, 1998).

Randall Crane and Lisa Schweitzer (Crane & Schweitzer, 2003) delineate a logical model summarising some of the reasons why the urban configuration may not influence people's mobility styles or have different outcomes from the desired ones (Fig. 2).

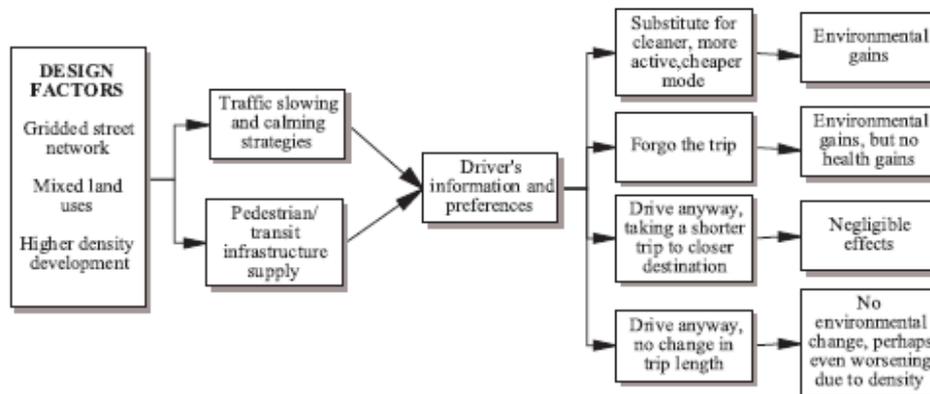


Fig. 2: Logical model of the relationship between community design and mobility choices. Source: Crane & Schweitzer, 2003, p. 242.

As the image shows, urban features, like a gridded network, mixed and uses and a high density of the built environment are not associated to a single reaction of drivers. Rather, according to drivers' preferences (and actually to many other factors that influence their preferences), different mobility choices can come out from the same urban features.

Considering the deep change in people's lifestyles, a change in the theoretical assumptions is needed in order to simulate how people behave with relation to a given pattern of activities location. Albeit most of current studies still refer to the old set of theories, some scholars are trying to challenge them and to introduce different perspectives. The work of David Levinson and Kevin Krizek (2008) moves towards this direction: the following image, taken from their last book, shows a possible different approach to land use-transport interactions.

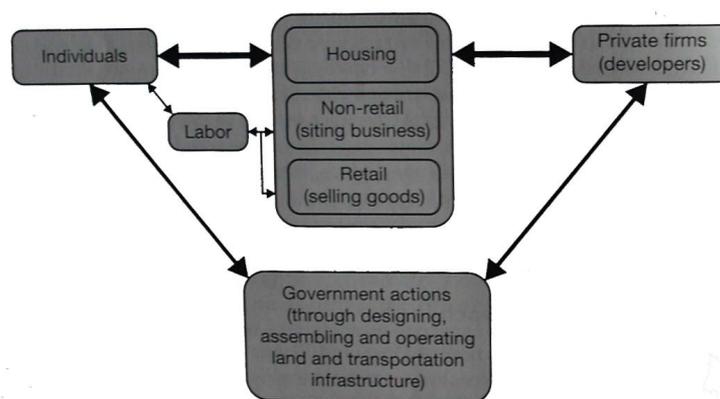


Fig. 3: Conceptual framework for understanding land use-transport interactions. Source: Levinson & Krizek, 2008, p.10.

Trying to overcome the weaknesses of previous approaches, Levinson and Krizek suggest a more comprehensive perspective that, even recognizing the importance of reductionist approaches – that sometimes are needed in

order to understand some specific aspects, might allow to see the whole from the parts. As the figure shows, and using the authors' words,

“Individuals (and their households) consume land (where they live) and space on transportation infrastructure (provided, in large part, by the government). Individuals also consume housing that is (or, at one time, was) provided by developers as well as goods that retailers sell. Developers respond to firms' preferences for land uses and locations, and are influenced by the property rights and transportation infrastructure that government provides.” (Levinson & Krizek, 2008; p. 11).

It is through the analysis of the behaviour of these three fundamental agents (individuals, firms and agents) that it will be possible to better understand their actions, and consequently to simulate people's movements through nets.

This new perspective on the relation between land use and transport provides an opportunity to re-open the debate over this topic, that was otherwise harmfully following a more and more rhetoric and weak path.

Analytical studies

Analytical studies are devoted to identify and describe travel behaviour, and in some cases to find and demonstrate the causal links between travel and the built environment.

A huge amount of studies deal with this issue, so that it would be hard to give a brief overview of them. For the purposes of this paper is then more useful to point out some general considerations about these studies.

As written above, land use and transport are undoubtedly linked but their precise relationship is far from being understood, especially in terms of causality, so that this presumed relation has been defined like “a cluster of unsubstantiated beliefs” (Giuliano 1995, p. 3).

Many scholars have addressed the relationship between the spatial characteristics of cities and the mobility styles trying to find answers to the open questions and bringing up some new ones, especially since the 1980s, because of the increasing concerns over environmental issues and thanks to the evolution of support tools (to quote the most recent and central ones, Banister *et al.*, 1997; Boarnet & Sarmiento, 1998; Breheny, 1997; Cervero, 2003; Haedigar & Curtis, 1998; Handy *et al.*, 2005; Kitamura *et al.*, 1997; Naess, 2005; Newman & Kenworthy, 1999; Stead, 2001; Wang & Lo, 2007).

Despite the amount of studies, existing research provides more controversies than clear findings, often leading to contrasting or counterintuitive results, so that, after a broad literature review, Robert Ewing and Robert Cervero (2001) came to the following conclusions:

- urban form does influence travel times, more than how travellers' socioeconomic features do;
- socioeconomic features have more influence than urban form on trip number and frequency;
- urban form exert a strong influence on travel distances;
- both urban form and socioeconomic features determine mode choice.

As some scholars pointed out (Handy *et al.*, 2005), statistical correlations are not able to attest whether a causal relation exists or not. The detection of a correlation between urban patterns and mobility styles is then much different from the existence of causal links. As Handy (quoting Singleton and Straits, 1999) reports,

“Scientific practice dictates four criteria for establishing causality between an independent variable (the cause) and a dependent variable (the effect): the cause and effect are statistically associated (association), the cause precedes the effect in time (time order), no third factor creates an accidental or spurious relationship between the variables (non-spuriousness), and the mechanism by which the cause influences the effect is known (causal mechanism). Most studies have met the first criterion but have not met the other three. (Handy *et al.*, 2005; p. 429)”.

A less strict way of considering causality is that suggested by Petter Naess (2005), that, calling back the Australian philosopher Mackie and his theory of the “INUS condition”, points out that

“Both in daily life and in science the term ‘cause’ is used in very different senses, for example about a necessary condition and as a sufficient condition. Immediately, it seems clear that urban structural conditions cannot be attributed the status as a sufficient condition for a certain travel behavior. [...] It appears more reasonable to attribute urban structural conditions, e.g. the location of the residence, the status of contributory (partial) causes of travel behavior, i.e. as one among several causes included in a causal relationship, but without the ability to produce the effect alone. (Naess, 2005; p. 173)”.

This way of dealing with the relation between transport and land use seems to be more reasonable, since, as mentioned above, the detection of unquestionable causal links is more than a hard task, implying huge research efforts and – up to now, not leading to indisputable findings.

Conclusions

Considering the above mentioned critical aspects of both theoretical and analytical studies it can be noticed that mixed findings that emerges from the analytical description of the relation between urban structure and inhabitant's mobility styles often reflect the controversial theoretical supposition that "better" urban design would necessary imply more balanced modal shares.

As Randall Crane writes: "The world is a very complicated place. It's rarely easy to sort out cause and effect or even what exactly is happening at any point in time, let alone why" (Crane, 1999; p. 7). Although the growing attention to this topic and the efforts to investigate the potential for causal links between urban design and mobility styles, many gaps and considerable disagreement remains.

What seems to be neglected, and rarely emerges from literature on this topic, is the goal towards which scientific efforts are directed. Albeit some very broad objectives can be identified, such as those pointed out by Levine and reported in the first part of this paper, it seems – especially for the analytical studies, that most of the efforts have been, and are, devoted to the detection of clear and unmistakable links between travel and the urban form. As mentioned above, most of the analytical studies are devoted to demonstrate the existence of these links, the most recent ones trying to explain it too.

The difficulty, if not the impossibility of demonstrating the existence of clear links leads to wondering if it is worth devoting so much attention and efforts to this issue, or if it would be wise to bring the debate back to the definition of clear and non rhetoric goals in order to define a good direction to move towards.

It is not obvious, nor necessarily true, that the current tendency to refer anything to the detection of causal links is the best or the only one. As mentioned above, the effort of the scientific community towards the detection of causal links is growing, while on the other hand the debate over the general theoretical underpinnings and over the problems and the goals that should be the cornerstones of those studies seems to gradually disappear from the debate.

Without denying the importance of causal links and of their detection, it is necessary to re-open the debate and to bring back the attention to the basic theoretical underpinnings and to the definition of the core objectives, discussing and likely redefining them.

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