Special issue: Land Use and Sustainable Mobility

Editorial

Henk Meurs
Nijmegen School of Management/MuConsult
University of Nijmegen
The Netherlands
h.meurs@nsm.kun.nl

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Introduction

Concerns about the sustainability of current land use and transportation practices are increasingly issues of policy concern in most countries of the world. There is a call for better coordination between land use and transport. A number of factors motivate such attention (Gorham, 1998) Firstly, growth in car ownership and use show no signs of abating. Secondly, technology seems unable to fully solve the environmental and other problems associated with motorized transport. Problems have remained with respect to CO_2, noise and the non-emissions related impacts of vehicles. Thirdly, the building costs of new infrastructure have increased, whereas the benefits provided by such infrastructure, are increasingly questioned (Cervero, 2003). In cases where new road infrastructure is provided primarily to relieve congestion, these roads tend to provide at best only temporary relief. The increased capacity tends to induce new traffic in the relatively short run through spatial, temporal, and modal changes in travel patterns and, in the longer run, through land-use changes caused by changes in overall accessibility levels (Downs 1992; Goodwin, 1996). These insights have increased the attention for measures other than infrastructure construction (Banister, 2002). Fourthly, just one strategy, e.g. completely based on technology or pricing, cannot solve the problems alone. For example, price signals, clearly being a necessary part of any strategy to restrain the growth of car use, cannot be relied upon as the sole element of this strategy. Substantial increases in the cost of car use would be required for having a meaningful change in travel behavior, technology acquisition, or a restructuring of social activities. This appears to have insufficient public and political support

The close relationship between urban land use and transport is common knowledge among spatial and transport planners. The spatial separation of human activities creates the need for travel and the transport of goods. The idea is that better coordination will reduce the need for travel and lead to shifts from the car to other modes of transport. Not surprisingly, a number of authors seem to support the idea that spatial planning may be an effective means of addressing transport problems, at least complementary to other strategies. A study often cited with respect to the impact of land use on travel behavior is the study of Newman and Kenworthy (1989), who analyzed 32 cities. They found a negative correlation between

residential density and transport-related energy consumption. This study has been criticized, mainly because of methodological flaws. In a recent update the negative correlation still remains (though less strong) after having corrected these factors (Newman and Kenworthy, 1999). Several other studies have shown similar effects. North American studies by Cervero (1996) and Cervero and Kockelman (1997) found that higher densities, in combination with mixed land use and neighborhood design being measured by a large number of variables such as attractiveness for transit passengers and pedestrians, reduce car ownership levels, trip rates and commuting distances. Ewing *et al*. (1994) concluded that density and land-use mix are the main factors that reduce the demand for motorized transport. Friedman *et al*. (1994) concluded that mixed land-use neighborhoods induce less travel than adjacent non-mixed land-use areas. Handy (1996b) provides an overview of many North American studies. She concluded that:

- high *density* leads to fewer trips, reduced car use, reduced energy consumption and greater trip speeds;
- *mixed functions* have a slightly negative effect on car use, but not in all situations;
- *decentralization of work* to suburban areas often leads to shorter trips but also to increased car use;
- an increased *public transport supply* results in more public transport use compared with car use, but the causal relationships are open to debate;
- with regard to urban *morphology* the results are not clear, but a polycentric structure appears to be the most efficient in terms of energy consumption in traffic;
- the bigger the city the longer the trips, but there is no direct relationship between city *size* and choice of transport mode.

Meurs and Haaijer (2001) found that about 30% of the variation in number of trips are explained is by a wide variety of spatial factors, including density, characteristics of houses, existence of facilities in the neighborhoods and characteristics of the street patterns. This study demonstrates that not only density, but also a wide variety of design features affect transport demand.

These findings stimulated new interest in transport-oriented urban developments, often labeled as ënew urbanismí and ësmart growthí. New urbanism refers to a design-oriented approach to planned development requiring less open space and reducing open space (Ewing, *et al.* 1994; CNU, 2000). It includes high-density development, mixed land uses, narrow streets, which are pedestrian-friendly, and increasing interaction between public and private space. In 1998 Maryland adopted ësmart growthí legislation requiring local governments to create more compact urban forms having the key features of new urbanism.

However, despite the claims of affecting travel with design and planning initiatives, a wide body of empirical literature is less conclusive. Downs (1992) conducted some simple simulations and concluded that a large increase in density would result in a very small reduction in average commuting distance. Schimek (1996) found the relationship between travel behavior and residential density of great significance. Specifically, a 10 percent increase in density is associated with a 0.7 percent decrease in VMT. From all the evidence available, it appears that in order to realize significant reductions in car travel, enormous changes in development density would be required. Most literature demonstrates only small

effects of urban form variables on travel behavior; however, conclusions differ considerably depending on the method used. Kitamura *et al*. (1997) stated that there are still uncertainties as to whether the observed association in most cases is real or whether it is an artifact of the close relationship between demographic, socio-economic and transport supply characteristics of the data.

The ambiguity in research results with respect to the impact of land use on travel behavior implies that no clear conclusions can be drawn with respect to desired strategies for land use planning. Too many uncertainties still exist with respect to the potential of adjusting land use planning policies to achieve sustainable mobility. To obtain a clearer view of the link between these two clusters of factors, the Dutch Organization Novem, The Netherlands Agency for Energy and the Environment, decided (in 2000) to organize an international state-of-the-art conference. From a number of countries experts were invited to take part in this conference by submitting papers reviewing the studies that were carried out in their country. The authors were also asked to discuss the specific situation in their own countries with respect to state-of-the-art research and policies in their countries. A selection of the contributions is published in the form of this special issue. In addition, Meurs and Van Wee [this volume] assessed the contributions in this issue and provide directions for further work.

Overview of the contributions in this volume

US American research (Robert Cervero, USA)

Methodological aspects
Cervero has some criticisms of the methodological aspects of the research carried out in the USA so far. Some studies focus on specific aspects of trips (travel times and cost) and traveler characteristics in order to analyze their choice of transport mode, but fail to take into account the influence of specific aspects of land use. Other studies focus on specific aspects of the built environment (density, mixed land use, etc.), but fail to take into account the characteristics of the transport system. In most American studies only different types of neighborhoods are compared without any attempt to identify individual effects. As a result no useful insights have been gained so far into the relative contributions of both these groups of factors. However, this problem is difficult to resolve, due to a lack of data and the methodological problems involved in isolating individual effects, which are actually interrelated.

Results
The research done in the USA until now has shown a weak link between land use and travel behavior. According to Cervero this is mainly due to the fact that travelers do not pay all the costs of their transport. Free and widely available parking, in particular, leads to incorrect pricing. Paid parking would create a better balance between land use and transport.

Apart from this, there are some specific spatial factors to be identified as having an impact on the way in which mobility develops:

- Urban density: as urban density increases, car use diminishes and use of public transport and walking increases.
- Mixed land use (mixed functions): it has been found, for example, that mixing retail with offices can lead to a reduction of 6% in car use.
- Design, e.g. by creating facilities for pedestrians.

The combined effect of these factors will be greater than the impact of each factor individually. Hence, the sum of the effects of these measures will be larger than expected if all three strategies are used in combination.

Research on the effects of road network design has shown that grid-like road patterns are more automobile and public transport-friendly than street networks with fewer intersections. However, the effects could hardly be quantified.

Recommendations
Based on studies in San Francisco, Cervero concludes that strengthening the position of city centers and the position of clusters around the edge of the city (concentrated decentralization) promotes car mobility. The ample availability of parking space encourages car use as well. These developments should therefore be discouraged if car use is to be reduced.

The USA also has wide experience with ësmart growth strategiesí. These are programs, which are intended to promote sustainable mobility developments and impose penalties on developments, which lead to car-dependent urban sprawl. Examples include incentive-based programs with impact fees, location-efficient mortgages, and regulatory-based programs with limits on growth such as those introduced in Portland and Florida. With the impact fees developers are rewarded for reducing the number of car trips related to a certain land use. In the case of location-efficient mortgages, subsidies are given on mortgages in residential areas having a high density.

According to Cervero integral policy that looks at land use and transport at the same time is difficult to achieve in the USA because it is considered to be too much an intrusion on oneís privacy. The ësmart growthí initiatives, however, do not limit freedom but offer opportunities to people who want to live in an attractive area that is not dominated by the motor car.

United Kingdom research (Peter Headicar - UK)

Research
Research has shown that the compact city policy, in which population growth and employment are concentrated, has only a limited effect on the distances traveled and the share of the car, even when spatial measures are combined with other policies. Headicar gives three underlying reasons for this:

1. The slow pace at which land use changes.
2. The importance of certain destinations on the edge of the city.
3. People are not very inclined to seek destinations close by.

The first is related to the number of changes in land-use variables that can be achieved; it is not related to the effect of each unit of change.

As judged from data on a national scale there are major differences in travel behavior between different types of towns and cities, which is shown by the differences in car use and ownership, for example. This appears to confirm the influence of urban density on mobility. Headicar, however, has some reservations. For example, the major differences in the make-up of the population between cities may provide the best explanation for the differences. He also concluded that the differences are relatively small compared with the expected overall growth in car use.

Data from local scale reveal major differences in traffic energy consumption between areas. This effect is partly due to differences in the population and partly due to the spatial planning of the neighborhoods. For example, the distance traveled by car by people living on the edge of Oxford was 30% less than that of people living in the new towns around Oxford. The main reasons for this were the commuting differences and the stringent parking policy in Oxford and hence not the socio-economic characteristics of the population. A unique set of variables on a local scale, which have an impact on mobility, was not found in UK.

On the basis of a number of studies, Headicar concludes that the effects of spatial planning at local level could be much greater than on a national scale. Headicar concludes that a major impact may well be possible by developing more and smaller residential areas in the vicinity of centers of employment instead of one or two large residential areas to serve just a few centers of employment. It was also notable that the construction of new residential areas close to the motorways generated a disproportionate amount of traffic.

Policy

National policy in UK is aimed at encouraging the local authorities to have their spatial planning and land-use policies led by the idea of reducing the need to travel, through the application of a compact city policy, densification and mixed functions. Therefore, there is no intention (in the first instance) to pursue a policy of discouraging car mobility. The central government enforces this policy by assessing plans at the planning stage and checking that the stated goals are met once the plans are implemented.

Recommendation

Spatial planning measures were to be implemented alongside a carefully prescribed mobility policy, in order to achieve some effects. However, there is insufficient political will in the UK for any such policy, which would require many carrot-and-stick measures

Scandinavian Studies (Petter Naess, Norway)

Naess describes how the issue of spatial planning in relation to mobility policy is approached in the Scandinavian countries (specifically Norway and Denmark). He does this on the basis of a number of general studies in this area and a specific study carried out in Frederikshaven (Denmark). This town is looked at in more detail in terms of the influence of the urban structure on the mobility of people.

Research

According to Naess, many Scandinavian researchers have established a relationship between urban structure and mobility, which encourages certain forms of travel behavior while discouraging other forms. Concepts such as accessibility (in terms of time, cost and effort) are central to this. He assumes that there are multiple factors determining travel behavior. Besides personal characteristics such as age, gender and status, there are also other personal factors involved such as ethics, values and lifestyles. Every form of human behavior (including travel) is influenced by obstacles and incentives, and urban structure is just one of those. Most Scandinavian studies in the field of land use and transport consider only a small number of these factors. In the course of time the number of factors taken into consideration has increased.

Based on a collection of studies carried out in the Scandinavian countries, Naess shows the importance of urban planning concepts such as density, concentration of activities, location of residential areas in relation to city center facilities and employment centers and the infrastructure and public transport network. The parking regime also affects transport choices.

There exists a widely held view that there is little competition between car and public transport (see, for example Bly *et al*., 1987). In studies done in Oslo it was shown that this competition is relevant during peak hours. Improving throughput on the roads (increasing capacity) led to increased car use at the expense of public transport use. People appear to be very sensitive to changes in travel time.

The paper reports on a specific study in Denmark concerning the relationship between residential areas and travel in a small town, Frederikshaven.This study investigated whether certain groups or subgroups could be defined that respond in a different way to the influence of urban structure. It also considered whether there might be a relationship between residential situation and a reduced need for travel, and whether less travel was compensated for by more and longer trips during holiday periods. It turns out that the location of the residential area in relation to the town center was an important variable in determining travel behavior. People who live in or close to the town center do not compensate for their reduced need for travel with more trips outside the urban area in holiday periods.

Recommendations

Based on the literature described in his paper, Naess concludes that an urban development policy, aiming at limiting traffic flows and reducing CO_2 emissions caused by car use, would be greatly served if the following are taken into account:

1. Prevent sprawling developments.
2. Increase housing density in the center and in areas surrounding the center.
3. Facilitate further growth in the number of jobs in the center and in the areas surrounding the center.
4. When adding necessary developments to the city, it has to be ensured that there is a sufficient economic basis, an adequate level of facilities (sufficient concentration), and a good public transport link with the city center.
5. Reduce or freeze the number of parking places and the road capacity in the city zone.

Studies from Switzerland and Austria (Anja Simma, Austria)

Based on a study done in the province of Upper Austria in Austria, Simma shows how lifestyle characteristics, spatial structure and travel behavior are linked. The paper presents the results of a specific (modeling) study.

Research
The research area was like a miniature version of Austria, with all the landscape features of the country and an urban concentration in the provincial capital Linz. Information was gathered in an extensive survey to which there was a high response rate (70%), and information was obtained from more than 120,000 households and 330,000 individuals. The study sets out to test three hypotheses:

1. Car ownership is mainly influenced by personal characteristics and the number of facilities which can easily be reached;
2. The number of trips only depends on personal characteristics, because these define the social role of the person in question and therefore define their activities.
3. Spatial structure has a major impact on the intensity of traffic flows.

The analyses showed the importance of lifestyle characteristics on travel behavior including household characteristics and the employment status of members in the household. However, access to a set of basic facilities and the distance to the main urban center (i.e. Linz) were also important determinants influencing travel behavior. As the number of basic facilities increased and the distance to Linz decreased, more trips took place over shorter distances and more often with slower modes of transport. From this Simma concludes that given the fact that there is only one urban center in the region, it would be a good idea to build either in the immediate vicinity of the city or to provide the functions offered by the city in the peripheral areas too. Mixing functions on a smaller spatial scale and offering a good and flexible public transport system can have a positive effect on car dependency.

Dutch research (Bert van Wee and Kees Maat - The Netherlands)

Research
The overview of Van Wee and Maat clearly shows that relatively many studies (both empirical and model studies) have been carried out at the spatial scales of the cities and regions. As to the Dutch situation these studies, particularly those based on simulation models, generally indicate that land use can have a major impact on mobility, certainly in

relative terms (relative changes in travel behavior related to relative changes in land use). Hardly any research has been done at the lowest level of scale (street, neighborhood and district) while, according to both authors, it is here that there are ample opportunities for influencing mobility behavior.

Policy
In the Netherlands, weighty government policy documents about the future spatial development of the country marked the way in which the land has been used since the 1970s. The fourth Policy Document on Spatial Planning (1991 ñ 1996) went most into detail. For example, it included goals for improving the economic basis of the cities, reducing growth in mobility, offering all the most important functions (houses, employment and facilities) close to each other and preventing further suburbanization in rural areas. To achieve these goals, instruments were introduced which were intended to promote the further densification of existing urban areas and to increase housing density in new expansion areas. Also in the area of employment, specific policy was developed in which labor-intensive activities should mainly be situated close to public transport stops.

Recommendations
Van Wee and Maat are careful in drawing general conclusions with respect to the impact of land use on travel behavior, due to the specific characteristics of the Netherlands. With its relatively high level of building density, short distances and specific spatial structure, particularly in the west of the country (the conurbation known as the Randstad), the situation is ideal for promoting public transport, cycling and walking. The bike as a mode of transport for short distances is preferred and is, in urban regions, the major competitor with public transport. Furthermore, the Dutch have always lived in areas with high levels of building density. Maat and Van Wee therefore conclude that the nature of the link found in the Netherlands between spatial planning characteristics and travel behavior must also exist in other countries, but specific land-use concepts will generally have a different level of significance.

Conclusion

The contributions in this issue focus on the potential effects of land use planning on travel behavior to make it more sustainable. Hence, most of the authors focus on the potential of physical land use policies on reducing the negative effects of mobility. It should be stressed that other considerations also justify a better coordination between land use and transport policies. For example, better coordination facilitates individuals access to spatially segregated activities. It may promote local and regional economic growth. It may lead to efficient use of public funds and so on.

Most contributions summarize research in the research in their countries as well as policies. In most countries land use does have an impact on travel behavior, although the effects are modest. In addition, it is shown that effects at local and regional scales are important.

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