TEACHING MATERIAL GUIDANCE

1) Title of the material

de Koning, R.; Tan, W.G.Z.; Van Nes, A. Assessing spatial configurations and transport energy usage for planning sustainable communities. Sustain. 2020, 12, doi:10.3390/su1219814.

https://www.mdpi.com/2071-1050/12/19/8146/htm

2) Which section of the SUMP it is relevant to?

This paper presents analyses of the influence of spatial configurations of the road system and land use on car traffic and associated energy use in urban transport. The conclusions of the article can be used to plan changes in the spatial development and to plan the development or transformation of the road system (e.g. introducing traffic calming measures or limiting accessibility for selected groups of traffic participants in selected areas of the city). Therefore, the article can be linked especially to the second, third, fourth and eleventh parts of the SUMP circle, which deal respectively with: determination of planning framework (in particular assess planning requirements and define geographic scope – **subsection 2.1**), analyse mobility situation (especially analyse problems and opportunities for all modes of transport - **subsection 3.2.**), scenario building and joint evaluation (developing scenarios of possible futures - **subsection 4.1.**).

3) Which Mobility Manager knowledge this material is the most relevant to?

It is related to Urban and spatial planning (section 3 of the Mobility Manager competencies) but also to Transport and mobility planning (section 1 of the Mobility Manager competencies) especially 1c (understanding of travel behaviour) as well as to Data analysis for mobility planning especially 5a (data collection and analysis), 5b (transport modelling and simulation) and 5c (traffic demand forecasting).

4) Problem approached and content overview

Problem approach – how to improve land-use planning and transform the road network to reduce traffic and energy consumption. This paper aims to understand how spatial configurations affect energy use in urban transport and to propose an integrated evaluation approach that considers spatial configuration analysis concerning transport energy use at micro and macro scales. Comparing Bergen in Norway and Zurich in Switzerland, spatial configurations were found to be positively correlated with transport energy use. Street structures suitable for pedestrian traffic and less suitable for car traffic tended to show lower energy use. Nine typologies of transport and use patterns are then described to support the planning of more sustainable transport modes.

Assessing the spatial configuration of cities requires a combination of expertise and methods usually separated by domains: traffic engineering, which calculates traffic flows and transport energy consumption, architects and urban designers, who analyse urban space and form, and urban planners, who can translate indicators into workable policies.

The article brings together the above disciplines to pose the following research questions: How can theories of urban form and movement contribute to integrated assessment methodologies for sustainable communities and inform urban planning policy and practice? and what spatial configurations influence transport energy use by private vehicles in cities and what are the observed categories?

Using the examples of Bergen in Norway and Zurich in Switzerland, this paper presents an analysis of the spatial configuration of cities (street structure) based on the economic process theory of natural traffic with a spatial syntax analysis for modelling transport energy consumption using MATSim.

The variables are spatially correlated in GIS (Geographical Information Systems) to find out how the spatial configuration of the built environment can influence transport energy consumption at local and regional scales. An evaluation of selected micro and macro scales variables that are related to spatial configurations was proposed.

The findings showed that the relationship between spatial configuration and transport energy consumption depends on different degrees of mutual accessibility at different scale levels, from the local (micro) to the city-wide (macro) scale. When comparing cities, positive and significant correlations were observed between streets with a variable spatial syntax of "angular choice" with a large metric radius (macro-scale, i.e. suitable for the car option) and transport energy consumption. The analysis identifies nine typologies of spatial configurations by aggregating route choice variables and indicates their usefulness in reducing transport energy consumption. The article concludes by proposing strategies and spatial planning based on these nine typologies to reduce transport energy consumption and achieve sustainable urban forms.

5) Who could be interested in this material?

This article is aimed at students and others looking for inspiration for sustainable urban mobility planning, taking into account land-use planning and street layout transformations to reduce car traffic. Students specialising in mobility management will find here information on how to assess the spatial configuration of cities. City planners and managers must balance the need for efficient traffic flow and increased network capacity as urban areas become larger while ensuring that they continue to operate at a human scale to ensure accessibility for all. The activities described can be helpful for those developing measures within SUMPs.

6) What is worth mentioning as an innovative factor for the reader?

This paper proposes an integrated evaluation approach consisting of three steps: generation of aggregated angular selection buffers resulting in route typologies, spatial comparison of spatial configurations and energy consumption by overlay, and statistical correlation of spatial configurations and transport energy consumption. The results show a clear correlation between spatial configurations and transport energy consumption, as illustrated by nine typologies. These typologies exemplify how theories of urban form and movement contribute to transport and land-use planning policy and practice.

This approach allows us to clarify the relationship between spatial configurations and transport energy consumption. energy consumption. The use of spatial syntax allows for a value-free assessment of a city and correlating it with simulated and actual transport energy consumption. By combining the results of state-of-the-art analysis techniques with transport energy use, and revealing these results with the theory of natural movement and the natural process of urban transformation, the results highlight what kind of street network spatial configurations are necessary conditions to support and facilitate sustainable transport and land use patterns in existing cities. This assessment approach allows policymakers and practitioners to identify potential locations in their cities that may support certain modes of transport and which should be avoided, and to provide insights into what kinds of spatial configurations would facilitate vibrant urban areas.

Spatial configurations that facilitate and enable car traffic tend to have higher transport energy consumption, while those that facilitate walking, cycling or public transport tend to have lower transport energy consumption. The former areas with low local angular choice values perpetuate dependence on private vehicles and mono-functional low-density areas that become part of urban sprawl. This creates complex and unsustainable transport patterns for travel to work, shopping, leisure and home. Furthermore, it can exacerbate transport inequalities between those who have access to private vehicles and those who do not. The latter are areas with short urban blocks, characterised by high values of segment integration and angular choice. Short urban blocks favour the use of walking or cycling as a mode of transport. Walking and cycling are the modes of transport with the lowest energy consumption. Both modes of transport are highly desirable in most cities in the pursuit of sustainability. Both cases show that short city blocks (or fine-grained urban structure on a local scale) with main routes through them are necessary conditions for public transport and walkability. Areas with such conditions are highly desirable for improving sustainable transport outcomes. These areas also tend to naturally develop into vibrant, highly urbanised areas with high densities and high levels of land use mix, supporting retail, commercial and social interaction. Therefore, planners and policymakers should refrain from designating new routes for heavy vehicle traffic only within the urban core and increase opportunities for walking (and slower modes of transport) in current and potential socio-economic centres. Specifically, this can be achieved by upgrading the current urban fabric through the introduction of short urban blocks and fine mesh street networks.

The above approach and research findings contribute new insights to current academic discussions on transport and land-use patterns concerning energy consumption. The findings confirm a positive correlation between car-oriented spatial configurations and higher energy consumption. This is a critical element in addressing sustainability issues, especially in light of the energy transition predicted in the coming decades. Besides, examining what conditions are necessary to support walkable, livable, and liveable urban areas for those with and without access to private vehicles contributes to the larger societal goals of creating and maintaining sustainable communities and cities. space Syntax, which derives from precise concepts of urban space that apply regardless of cultural, economic, social, or aesthetic context, allows for a value-free assessment of a city. Moreover, thanks to the Space Syntax method, it is possible to calculate spatial relationships independent of socio-economic data. The MATSim model aggregates traffic data in a traffic network based on data related to the location of urban functions. Therefore, overlapping and correlating these two models contributes to the knowledge of the relationship between the spatial configuration of cities and transport energy consumption.

Planners and policymakers can use these results to understand how spatial configurations affect transport energy consumption. Furthermore, the approach using mainly open map data can be applied to different cities and regions around the world. Knowing the conditions needed to create walkable and livable areas enables practitioners to plan and design more integrated streets, distinguish which streets are desirable and which are less so, and contribute to additional savings in energy consumption when the desired change is implemented. The results of studies in Bergen and Zurich show that urban areas with short city blocks or a dense street network with a well-connected main route through these areas favour low transport energy consumption. Revealing streets and areas with high or low energy consumption based on a value-free city assessment can also promote institutional innovation towards more sustainable mobility.

7) Limitations

The proposed approach faces limitations in terms of availability of transport energy data in different contexts for different transport modes, the accuracy of simulation of energy data, complex operations of combining analyses on multiple platforms and reproducibility of results due to previous limitations.

Energy recording data for walking and cycling are limited. Walking as a mode of transport is more complex than car transport. The challenge for future research is to add pedestrian flow registration to current approaches and simulation models. Similarly, the energy consumption per person for public transport such as trams and buses is more complex but should be included.

As for the simulations of energy consumption, they are at best an approximation of actual consumption. As mentioned in the selection of variables for transport energy consumption, energy losses during braking and changes of speed and direction at stops bends, hills and other elements were not taken into account. Energy consumption in vehicle production and other costs were also omitted. Only passenger transport was considered in the simulation, not freight transport. The latter is a major cause of pollution and emissions in the EU and should be included in future studies. On the other hand, current technological innovations have also led to more energy-efficient cars. The accuracy of an agent-based simulation is therefore highly dependent on the available input data.

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The cross-city comparison allows an external validation of the results. Although the approach is based on the value-free Space Syntax method, it is not possible to interpret the results without local knowledge and field confirmation.

The main application of the integrated assessment approach presented in this paper is as a first step towards creating an energy classification for different types of streets and roads. However, the model needs to be tested in other cities before it can be used to assess and diagnose urban plans. The model is at least a first step towards understanding what conditions are necessary for certain spatial configurations to achieve sustainable mobility for sustainable communities and cities.

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