



# Transportation and spatial development: An overview and a future direction



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## ABSTRACT

This paper provides a comprehensive review of urban land use and transport interaction (LUTI) studies over the last five decades and discusses future directions of LUTI studies. We found that the current LUTI models perform well in practical applications with regard to urban policy and infrastructure planning. However, there is concern that a vast fragmented array of models may have limitations in coping with emerging practical requirements, particularly as the analytical requirements for urban policies concerned with sustainability are growing wider and deeper. This paper provides insight into the two viable directions of LUTI studies: one is more flexible and complex, and involves intensive modeling at the local scale; the other involves simplified modeling at regional, national, and global scales. The co-evolution of these two approaches is expected to contribute to sustainability science. By cross referencing these two distinct approaches a balance can be found between the details of reality and the abstraction of theory thus increasing knowledge within the field. This would further enhance the potential of LUTI studies as urban environments become more dynamic and unpredictable.

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## 1. Introduction

It has been almost half a century since the interaction between transportation and land use was analyzed for urban planning and policies. Vast amounts of research have been conducted into the interaction between transportation and land use by applying spatial and economic modeling. Given the nature of the city, which is a complex system of economic, social, and political activities, a rich variety of research approaches have been used to comprehend the complicated structure of the urban activities and predict its future state. Despite the extensive research efforts, no universal method or model has been developed. Rather than applying a universal model to address practical requirements, the analytical methods in use vary. Consequently, the approaches can be differentiated by the context of planning policies. Researchers have made efforts to conceptualize the models, develop them, and apply them to various cases to address the issues of space and time.

Recent urban planning and policy perspectives are becoming both wide ranging and more detailed, especially in conjunction with emerging environmental issues (Irwin, 2010), to respond to

the demand to address environmental pressures. Consequently, a variety of new analytical methods have been developed in the field of urban planning. Some studies have proposed the importance of the fine granularity of spatial and social units in impact assessments (Wegener, 2004). Other works have attempted to analyse the global impact of environmental policies (Seto et al., 2014). However, the direction of research in terms of contributing to sustainability science is yet to be specified.

International academic groups have been formed to discuss and advance the field of urban planning, and contribute to improving understanding of complex urban issues and policy implications. Special Interest Group 1 (SIG1) for “Transport and Spatial Development” in the World Conference on Transportation Research Society (WCTRS), has been one of the largest international research arenas for land use and transportation interaction (LUTI) studies, and has inherited the international study group on land-use/transportation interaction (ISGLUTI) (Webster et al., 1988; Webster and Dasgupta, 1991). SIG1 was established in 1988 as the first SIG in WCTRS and has advanced knowledge in this area through publications and by periodically organizing academic sessions and seminars. In the early stage of SIG1 activities, aggregate/large-scale econometric models were elaborated and applied to practical planning and decision making in some cities in Europe and North America. Building on such successful experiences, its research interests have been extended to disaggregate/

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microscopic modeling to capture diversified travel behaviors and the complexity of land-use transportation changes with innovative approaches, such as activity-based modeling and microsimulation. WCTRS has recently reformed a SIGs organization and the legacy of the former SIG1 has been inherited by SIG-F1. One of the major focuses of SIG-F1 is sustainable land-use transportation systems given energy and environmental constraints, an aging society, and a knowledge society with global diffusion of information communication technologies (ICTs) (Kobayashi et al., 2007). The current research topics require more innovative approaches on spatial analysis, which cover diversified aspects, such as an investigation of social interaction behaviors, multi-scale modeling on time and space, and accessibility/usability evaluations of social and spatial equity. These approaches are to be integrated into urban modeling.

The purpose of this article is to provide an overview of the past development of analytical frameworks of transportation and spatial development, and discuss the research directions in this field, especially focusing on, but not limited to, modeling research in association with the activities of WCTRS SIG-F1. The significance of this paper is twofold: (a) it provides wider coverage of LUTI studies and a substantial literature review, and (b) it discusses the future directions of this field in transdisciplinary perspective, and in association with significant activities of the major academic societies.

This paper is organized as follows. In Section 2, an overview of past LUTI models is provided based on a classification of the model (Iacono et al., 2008); recent needs for LUTI modeling and other aspects of spatial analysis are summarized. In Section 3, the feasibility of future directions for LUTI studies are discussed. Two opposite directions—elaboration and simplification—are reviewed in addition to the potentially notable contribution of LUTI studies to sustainability science. The paper concludes with comments on future challenges.

## 2. Review of land use and transportation interaction (LUTI) models

Originally, in the 1960s, the major interest in transportation and spatial development studies was the interaction between transportation provision and land use change. It was then a critical issue for transportation infrastructure planning because infrastructure development induced unprecedented travel demands and congestion. Transportation development had been gradually recognized to have various impacts on the environment and society, which also required consideration in the modeling.

In this section, the past development of LUTI models is briefly reviewed. Hitherto, well-organized review papers for the models have already been published (Harris, 1985; Mackett, 1985; Kain, 1987; Wegener, 1987; Webster et al., 1988; Berechman and Small, 1988; Boyce, 1988; Aoyama, 1989; Webster and Paulley, 1990; Batty, 1994; Harris, 1994; Wegener, 1994; Southworth, 1995; Wilson, 1997; EPA, 2000; Banister, 2003; Wegener, 2004; Hunt et al., 2005; Iacono et al., 2008; Acheampong and Silva, 2015). Therefore, we do not consider the details of each model in this paper. Rather, we take an overview of model development by considering the circumstances of theories and practical requirements. As Iacono et al. (2008) described it, the LUTI studies can be divided into three categories: gravity-based modeling, econometric modeling, and microsimulation/other computer-based modeling. We apply these categories to the organization of the following literature review.

Fig. 1 shows a brief history of LUTI studies in conjunction with research needs relative to policies, related research, and academic group launches. In general, LUTI models have evolved because of the push from related analytical theories and the pull of political needs for research. Broadly speaking, initial LUTI models can be categorised into spatial interaction and gravity type modeling.

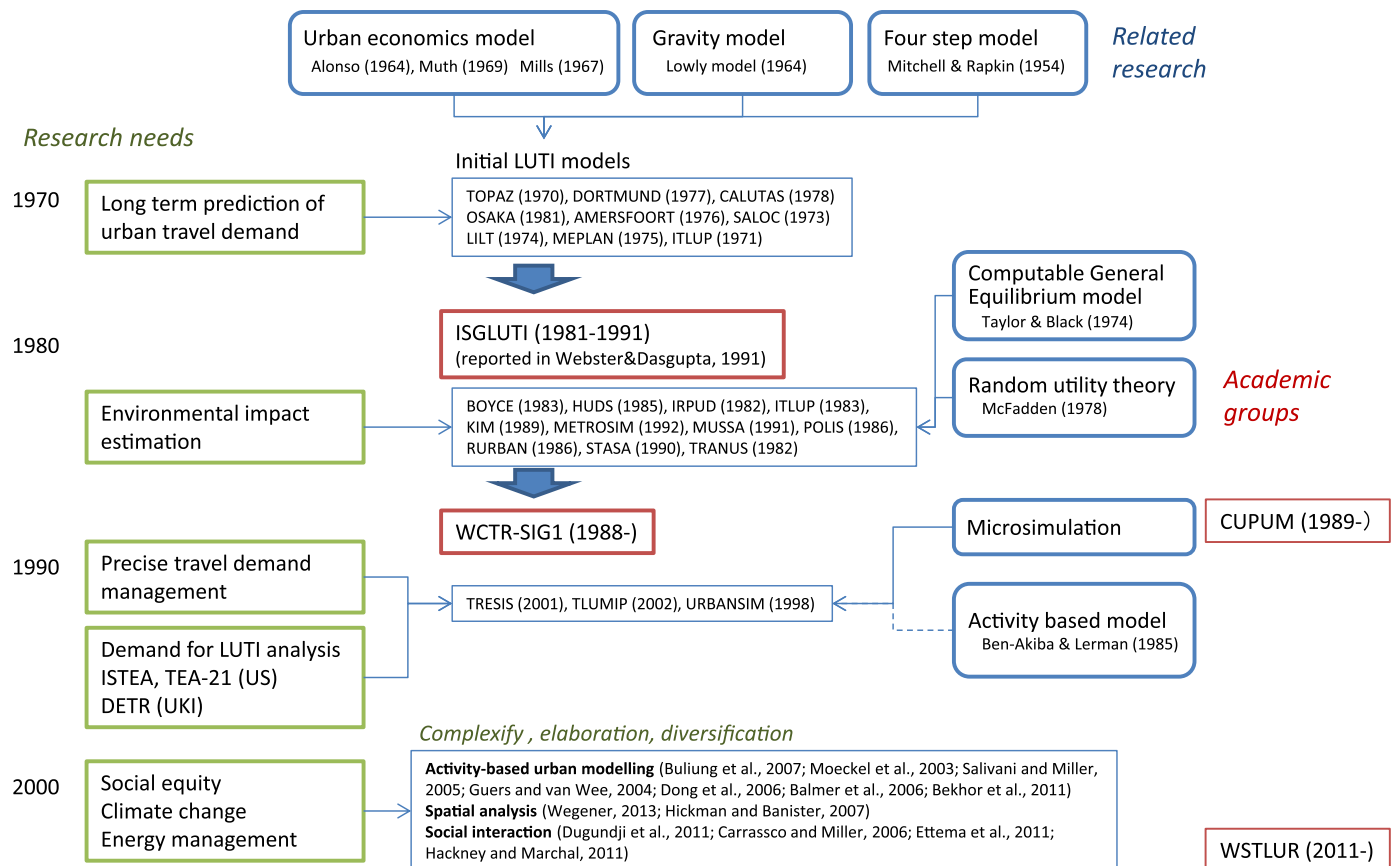


Fig. 1. A summary of evolution of LUTI models, related research, and policy needs.

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