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A land use and transportation integration method for land use allocation and transportation strategies in China ☆

Hailong Su [a], Jia Hao Wu [b,c,d,*], Yinghui Tan [a], Yuanqiu Bao [b,c], Bing Song [b,c], Xinghua He [d]

[a] Research Center for Urban Planning and Development of Fudan University, China
[b] W & S Solutions, CA, USA
[c] Wu & Song Associates, Shanghai, China
[d] Shanghai Maritime University, China

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ABSTRACT

In this paper, we will first review literature of the land use and transportation interaction and then develop a new land use allocation methodology called Three Stages-Two-Feedback Method (Integration Method) for both land use allocation and the transportation policy options with a practical implementation. Then we apply this method in an urban general planning project in China with more than 1.2 million populations. In this project, we evaluated three land use allocation strategies and three transportation policy options using two application tools (with and without feedbacks) using this method implemented in a land use planning system UPlan and a transportation planning system Emme. The results show that the use of the feedback method (Application Two) results in a vehicle distance reduction and the increase in the service coverage area of transit bus stops at the same time. Due to the use of transportation accessibility and the congestion measures with a MSA implementation, the accessibility measure shows a convergent process over iterations. This nice feature can be used for alternative comparisons. Future research subjects are also discussed.

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1. Introduction

Increasing demand for industrial and residential lands may result in climate changes, biodiversity losses, deteriorating air quality, and traffic congestion. The increase in travel demand results from different spatial activities with different land use patterns. On the other hand, the transportation system plays an important role in land use change because of its accessibility and travel costs. ICF (2005) describes the methods and approaches to understand the link between transportation investment and land development and indicates that transportation agencies are recognizing induced land development as an impact of transportation capacity projects. Thus to facilitate future transportation planning and policy, it is vital to understand and model how land use change interacts with transportation, explore the dynamics and drivers of land-use change, and reflect the change in transportation policies.

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* Corresponding author at: W & S Solutions, 5776 Hopyard Rd., Suite 170, Pleasanton, CA 94588, USA.
E-mail address: jiahao.wu@wu-song.com (J.H. Wu).

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1.1. Rapid urban developments in China

The rapid urban and economy development in China has greatly improved the living standards and created social activities among different regions. On the other hand, it has resulted in serious challenges to the society. In 2006, the Chinese GDP reached 5.5% of the total world GDP and now is ranked second in 2010, next to the US, while its energy consumption consists of 15% of the total world energy consumption and 90% of rivers passing through the urban area have been polluted to certain extend. To maintain a sustainable social development, the Central Government's new "Twelve Five-Year Plan" has called for energy saving and environmental friendly societies. This plan will serve as a new regulation for urban general plans.

Land use allocations have had direct impacts on the urban spatial patterns, future urban developments, and transportation systems in general. Since the urban transportation energy consumption accounts for 30% of China's total energy consumption, the transportation system is a major emission generator in China. In the San Francisco area, the transportation sectors generate 40% of the emission. Thus the subject of the land use allocation based on the transportation condition has been very crucial due to the energy and environment constraints in both China and the US. In February, 2010, the China Ministry of Housing and Urban–Rural Development issued a legal document called "Urban Comprehensive Transportation System Planning Procedure," which requires that both transportation system planning and urban general planning need to be done in a coordinated way and will serve as a legal requirement for development of urban and transportation planning procedures in China.

The 1991 Intermodal Surface Transportation Efficiency Act (ISTEA) marked a major turning point in how transportation modeling is conducted. Prior to the Act, in transportation planning procedures, travel demand models were run with the same land use inputs for all scenarios, so changes in land uses due to network improvements were not accounted for. However, a study in the Sacramento, California region indicates that vehicle hours of delay could be reduced by 13.3% for the transit alternative with land use measures and auto pricing policies, compared to 5.2% for the highway alternative (Johnston and Rodier, 1999). A simulation study in the Portland, Oregon region indicates that vehicle hours of delay could be reduced by 65.9% in the transit investment alternative with land use measures only, compared to 43% for the highway alternatives (Cambridge Systematics Inc., 1996). Walker et al. (2007) described the use of UPlan for the urban development. Metropolitan Transportation Commission (MTC, 2009) in San Francisco Bay Area indicated that the integration of land use and transportation were performed in its 2035 Transportation Plan. Thus, although the planning procedures used in China are different, these US practices and findings may still serve as many lessons and insights to the future regional and urban development in China. Especially, the land use and transportation modeling approaches used in the US may be reviewed, refined, and used for applications in China, since a proper land use model with transportation considerations may help reduce vehicle distance traveled.

1.2. Research contributions to practice and literature

In this paper, we develop a new land use allocation methodology called Three Stages-Two-Feedback Method (Integration Method) for both land use allocation and the transportation policy options with a practical implementation. To best of our knowledge, the method presented for the City of Luohe case was developed for the first time in China. Although there are research results published in China regarding the integrated land use and transportation, there is no paper (to the best of our knowledge) where the proposed method for a real citywide urban general plan with more than one million populations was implemented and used. Here are specific contributions.

1. Contributions of this research to the practice may include the following items. (1) This is the first time that this method with the land use allocation model software UPlan and transportation model software Emme is used for a real city of more than one million population in the Central China based on the City draft general plan; (2) There are many land use modeling methods available with extensive data requirement. In many cases, these methods may not be applicable in current Chinese situations due to the lack of the data or data restriction. This method has been developed based on the available data in the current urban and transportation planning environment in China, which can be used in this modeling process; (3) This method is reasonable and intuitive from implementation and planning point of view; (4)The results can be easily refined, explained, and justified; (5) The land use allocation rules and transportation models can be refined and adjusted in an iterative way; and (6) This process can be adapted to facilitate the planning process following the new Chinese regulation, which is similar to the SB 375 in California to reduce vehicle distance travelled and encourage the development of the transit systems. Most importantly, the model is inexpensive in terms of the data collection as compared with other analytical methods and applicable in China for planners and citizen groups.
2. Contributions to the literature may consist of the following: (1) The new method includes a development of a unique Three-Stage –Two-Feedback method from the urban land use allocation down to the transportation planning process with three stages (Land Use Sketch Planning, Land Use Refinement, Transportation policy Planning) and two feedbacks with special MSA (Method of Success Averages) implementations at Stage 1 and Stage 3; (2) A new accessibility for the system consideration is defined and used based on both land use data and the transportation data, which connects truly these two important components; (3) A congestion measure for the local consideration is defined and used to prevent the over-development in certain development areas so that the transportation measure will be used to reflect the development impacts; (4) An integration between UPlan and Emme with a MSA process (tested numerically with a real

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