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Evaluation of urban redevelopment impact on non-motorized traffic

Yanli Wang [a,*], Liang Li [b], Xiaoyu Zhu [c], Bing Wu [a], Linbo Li [a]

[a] Key Laboratory of Road and Traffic Engineering of Ministry of Education, Tongji University, Shanghai 201804, China

[b] China Sinogy Electric Engineering Co., Ltd., Shanghai 200061, China

[c] National Center for Smart Growth Research and Education, University of Maryland, College Park, MD 20742, USA

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ABSTRACT

As an important component of city evolution, urban land redevelopment has an impact on transportation system. The current traffic impact analysis (TIA) is lack of a comprehensive component for non-motorized transportation under redevelopment. For a better guidance of land redevelopment and non-motorized transportation planning, it is necessary to evaluate the negative impact of redevelopment on non-motorized traffic in the TIA. In this paper, an evaluation framework for the impact analysis is built up. We organized the procedures and components of impact evaluation, and proposed the corresponding qualitative and quantitative evaluation indicators for non-motorized traffic under redevelopment. Level of service (LOS) and its criterion are employed for external impact evaluation, and level of safety, convenience, independence, and comfort which are four aspects of quality of service (QOS) are proposed to analyze the internal impact. The framework is applied to a redevelopment study in Shanghai, China. The case study results indicate that the redevelopment from a residential area to a mixed commercial area has a significant impact on non-motorized traffic. The potential negative impact from both external and internal traffic can be minimized by reasonable improvements in the internal land use design.

1. Introduction

Currently, with the rapid development of urbanization, land redevelopment becomes an importation part of city evolution in addition to urban sprawl and new town construction. This is especially important for the metropolitans where the available building land is limited and the part of the pre-existing land use is not efficient to afford the increasing development in population and economy. Therefore, land redevelopment is critical to maintain the urban vitality and cities upgrade (Friedman et al., 2004; Woodbury and Bauer, 1953). Many researchers from urban planning and economy attempted to utilize the urban area fully by studying when, where and how to redevelop (Capozza and Sick, 1991; Childs et al., 1996; Williams, 1997). However, redevelopment causes a lot of issues on

* *Corresponding author*. Tel.: +86 21 69583904; fax: +86 21 69583007.
E-mail address: yanliwang2012@gmail.com (Y. Wang).

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travel behavior, transportation system, and travel demand, even though it improves the efficiency of land use.

Unlike the new development, urban redevelopment is a reconstruction on a previously developed area. Specifically, redevelopment changes the land use between types of urban land, while new development is changing non-urban land into urban land. Usually, development locates in suburbs, and redevelopments locate in old urban areas with more complex surrounding environment and land use. Therefore, compared to building new facilities in new development projects, redevelopment projects also need to deal with the internal and external existing transportation facilities and travel demand especially non-motorized traffic (Koll-Schretzenmayr, 1999).

On one hand, non-motorized travel including walking, bicycling and bicycle-derived modes such as scooters (Guitink and Flora, 1995; Iacono et al., 2010; Plaut, 2005; Rietveld, 2001) is the main travel mode in old cities. For example, non-motorized mode share is more than 50% in Shanghai, China (Xiong et al., 2010). It is a healthy and sustainable travel mode (Rietveld, 2001), and plays an essential role in urban transport in most of the developing countries (Replogle, 1992). However, facilities and environment for the non-motorized traffic are required but are often ignored in transportation planning, and the impact on the traffic is not well evaluated. On the other hand, when land use changes under redevelopment, the travel demand and behavior including non-motorized travel will be influenced (Guo et al., 2007; Rodríguez and Joo, 2004), and it is necessary to evaluate the impact of redevelopment in the project proposal. Therefore, many previous studies formed a relatively complete transportation impact analysis system in United States and other countries (Dey and Fricker, 1994; Muldoon and Bloomberg, 2008). However, only a few of them emphasized the impact of redevelopment (Hulse et al., 2004; Wang et al., 2011), especially for the non-motorized traffic.

This study focuses on constructing an evaluation framework and criterions of non-motorized traffic under urban redevelopment. This framework can be applied to analyze the impact of land redevelopment and provide suggestions for decision making and land use design. The impact mentioned in this paper refers to negative impact. The objective of this study is to fulfill the gap of land use redevelopment and non-motorized traffic evaluation in traffic impact analysis (TIA), which is critical to support the redevelopment plan and minimize the potential negative impact. In the next section, the impact mechanism and factors of land redevelopment on the non-motorized traffic are summarized. After that, the framework with evaluation procedures and corresponding indicators for non-motorized traffic are proposed and described in detail in Section 3. In Section 4, a case study of Shanghai, China is analyzed as an example of this framework and the results are discussed. The important conclusions and further research are emphasized in the final section.

2. Impact mechanism on non-motorized traffic demand

In this section, we focus on land use, facilities and environments that may be changed in redevelopment and their impact on non-motorized traffic. Land is the source of social activities, and decides the generation of activities and the trips temporally and spatially. In addition, the traffic system carries the traffic with limited capacities. Therefore, traffic demand is subject to the dual constraints of land use and transportation facilities.

2.1. *Land use factors*

Non-motorized traffic is highly affected by land use factors. For example, compact, mixed use neighborhoods have more non-motorized shopping or recreational travel than auto-oriented neighborhoods (Cervero and Radisch, 1996; Handy, 1996). Required by city expansion and profit maximization, redevelopment is usually accompanied with transformation in function (such as the changing of the residential land for commercial purposes) and increase in land use intensity. Therefore, the results of the trip generation, trip distribution, mode choice and the final trip assignment will be various from previous redevelopment.

First, when the function of the land use changes, the trip purpose, rate and mode share will be different. For example, according to "Technical Standards of Traffic Impact Analysis of Shanghai Construction Project" (SUPDRI, 2010), if a plot of residential land with shabby houses is redeveloped into commercial office building in Shanghai downtown, the daily trips rate will be 0.30 per construction square instead of 0.07. And the non-motorized share will be 32% after redevelopment instead of 50% before redevelopment. Also the trip generation by time of day is different, e.g. the trip production coefficient of peak hour is 0.20 before, but about 0.05 after; and the trip attraction coefficient of peak hour is not more than 0.05 before, but about 0.25 after.

Second, the intensity of land use is also correlated with the trip density. In the above example, if the site with shabby houses is rebuilt into high-rise housing, then the daily trip rate will be still around 0.07 per construction square, but the total number of trips will increase, and the non-motorized mode share will decline by nearly 10%.

Overall, both the function and intensity of the redevelopment site will affect the non-motorized traffic demand. Then combined with surrounding land use functions, the short distance trips will redistribute and the final non-motorized traffic will also reallocate spatially. For example, a residential site surrounded by housing units, is redeveloped into a shopping center. Then it will attract most of the shopping trips by surrounding residents from other shopping destinations. Those home-based shopping trips are short and more likely to be non-motorized. On the contrary, if a shopping center surrounded by housing is redeveloped into housing, the results are opposite.

2.2. *Transport facilities and traffic environment*

Transport facilities and traffic environment after the redevelopment are also correlated to non-motorized share, route and safety (Cao et al., 2009; Reynolds et al., 2009). An appropriate design can increase quality and quantity of non-motorized traffic, such as provision of crossing facilities, exclusive bicycle lanes, as well as a comfortable sidewalk