Synergistic Planning of Urban Renewal and Road Space in Urban Villages in China

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Abstract. The effective development of road space for urban renewal in urban village zones can effectively improve the resilience of the transportation system, divert large flows to relieve traffic congestion, form a reasonable and orderly spatial environment, and help guarantee the normal operation of urban construction facilities and functions. This paper selects Tonglang Village in Shenzhen as the research object and uses a hierarchical linear model combined with built environment and individual attributes to analyze the problems and directions of effective development of road space for urban renewal. The study shows that the density of traffic stops and the density of the road network in terms of walking time to the station improve the travel mode more significantly. At the same time, the improvement of road space in urban village areas can effectively improve the usage of public transit mode.

Keywords: Urban village renewal · built environment · hierarchical linear model · road space

1 Introduction

Urban development brings an increasing traffic demand in modern cities, especially in high-density urban areas. The urban village is one of the most typical high-density urban areas waiting for urban renewal in China. Due to a lack of urban planning in the past, the urban village areas cannot be matched with the later master planning, and the road maintenance problems causes road space resources shortage, the lack of resilience, huge renewal costs and other problems. Therefore, the road infrastructure and road space resources are unable to meet the transportation needs of urban renewal requirement. Taking Shenzhen as a case city, this paper explores the relationship between the built environment and road space in urban villages in Shenzhen.

China is one of the largest countries experiencing large scale of urban renewal. In many areas of China, especially large and medium-sized cities undergoing accelerating urbanization, as one of the main targets of urban renewal, the need for renewal and regeneration of "urban villages" is particularly urgent. As an informal residential community, the urban village shows many inconsistencies with the development of the city. Traditional renewal of urban villages often adopt demolition and reconstruction ways,

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which play an important supporting role in improving land use efficiency and promoting sustainable urban development. However, as a low-cost living space, urban villages accommodate a large number of newly-increased urban employment populations and emigration populations from areas with high housing costs, which improved the flexibility of urban development. At the same time, the high-density population concentration of urban villages has relieved the trend of job-housing im-balance, and hence reduced the overall transportation cost of the city. Therefore, the urban village plays a role of a double-edged sword; the problem of urban villages cannot be solved blindly by demolition. Nowadays, differentiated and diversified renewal strategies are developing, and gradually the proportion of demolishment and reconstruction of urban villages are limited, which is constructive to encourage the comprehensive renovation and functional regeneration of urban villages to promote the organic and effective urban renewal.

In view of the current situation of prominent contradiction between land use and road land in urban villages in Shenzhen, this paper aims to improve the built environment of urban villages to better encourage the use of public transportation during road space improvement. This research will better relieve population pressure and conduct public transportation-oriented road in high-density development areas in the process of urban renewal.

2 Literature Review

With the introduction of the "5Ds" indicator system for built environment by Ewing et al. [1], Chen et al. used MD-GWR to quantify the relationship between built environment and ridership behavior around public transport stations and proposed construction recommendations to attract ridership to public transport; walking is closely related to land use diversity, intersection density, and the number of destinations within walking distance. Walking is closely related to land use diversity, intersection density, and the number of destinations within walking distance metrics. Bus and train use were similarly associated with proximity to transit and street network design variables, with land use diversity as a secondary factor [2]. Numerous scholars have verified the existence of a significant effect of the built environment element system on residents' travel mode choice. Some of these variables reflect excellent influence effects.

A large number of studies have confirmed that a variety of built environment factors have significant relationship with travel mode choice, and some results also support the development of new urbanism, which is to change residents' travel behaviour by developing a more compact and mixed-use built environment, thereby reducing the negative impact of massive use of motor vehicles. However, the existing empirical results of the relationship between the built environment and travel behavior are still controversial. For example, a study in Beijing found a significant relationship between land use and travel speed and travel distance, but in a similar study in Los Angeles, however, no similar results were found. Given inconsistent empirical results, it is necessary to study the causes of such differences. The understanding of the relationship between the built environment and travel behaviour still requires more in-depth research. The differences in some research conclusions may be the by-products of different methods, data and empirical case cities or regions. In addition, a number of more complex methodological problems, also resulted in the different empirical conclusions[9].

Hao Yu selected a heterogeneous built environment in terms of influencing factors and analyzed residents' behavior and found that land use mix heterogeneity, transportation facility density heterogeneity and occupancy-dwelling relationship heterogeneity all have a very significant effect on residents' commuting mode choice, pointing out that occupancy-dwelling relationship heterogeneity has a positive correlation [3]. The influence of built environment on the share of walking in non-commuting trips was analyzed by a SEM model by Snap Chen [4]. Jinhyun Hong, Qing Shen used a Bayesian hierarchical model with a methodological framework to revisit the impact of built environment factors on transportation in Seattle. Residential density, non-residential density, intersection density and downtown distance were selected for the built environment factors and analyzed separately for residential and work environments [5].

3 Data and Methodology

In order to select a suitable urban village, it is necessary to use the plot ratio, road network density, and the population as comprehensive reference. After a comprehensive judgment, the Tonglang Village in Nanshan District in Shenzhen is selected as a case village in this research, and the built environment of Tonglang villages is shown in Table1.

Hierarchical Linear Model (HLM) is often used to analyze hierarchical data with different levels of attribute variables in the model. Unlike general linear regression and multiple linear regression, HLM is more applicable to nested data.

The first level variables of the model are individual characteristics variables of residents in Tonglang village, and the second level variables of commuter transportation mode as cluster variables, where individual variables include years of residence, age, gender, etc.; cluster variables include walking time to station, road network density, traffic station density, public service facility density, and intersection density.

Table 1. The built environment attributes in Tonglang village

Tonglang Village	Floor area	No.of Bus station	Plot ratio	No.of crosses	Walking time to bus station
Tonglang Village(north)	25790	1	\	17	720
Tonglang Village(south)	29724	1	\	11	660
Sum	55514	2	3.52	28	700

4 Results

Based on one-way random effects ANOVA, the between-group variance of travel convenience for residents of Tonglang village was 0.578, the within-group variance was 1.476, and the within-group correlation coefficient ICC(1) was 0.281 ($p < 0.01$), and about 28.1% of the variation in travel convenience was generated by geospatial variation in the built environment. There is a high degree of interclass correlation, so it is suitable for using HLM analysis. The degree of correlation is shown in Table 2.

Using HLM software to fit the parameters of the random regression coefficient model, the relationship between the individual attributes of the residents of Tonglang village and the influence of travel convenience, as shown in Table 2. Gender and age are the key individual attributes that affect the travel convenience in Tonglang village. The age of Tonglang village residents has a greater negative effect on the convenience, combined with the analysis of the characteristics of urban villages, with the growth of age traffic behavior habits and values cannot be better informed about urbanized transportation services and thus affect the travel convenience which refers to the walking distance to bus stop.

The influence of built environment attributes on the travel convenience is shown in Table 3. The built environment factors affecting the convenience of travel for residents in Tonglang Village include: intersection density, road network density, traffic station density, public service facility density, and walking time to the station; among them,

Table 2. The degree of correlation

ICC	Degree of correlation
ICC<0.059	Low
0.059 < ICC<0.138	Medium
ICC>0.138	High

Table 3. The influence of individual attributes on the travel convenience

	gender	income	age	Car ownership
β	0.204	0.096	-0.368	0.373
p-value	0.012	0.014	0.000	0.214

Table 4. The influence of built environment attributes on the travel convenience

	road network density	traffic station density	intersection density	public service facility density	walking time to the station
α	0.265	0.048	-0.281	-0.192	-0.079
p-value	0.020	0.410	0.000	0.002	0.470

intersection density public service facility density and walking time to the station have a negative effect on the convenience of travel, and the effect of intersection density and public service facility density is more obvious. In the field survey, the density of public service facilities in Tonglang Village is not enough, and the density of intersections is moderate but unevenly distributed and the intersections in the old village are disorganized, which leads to more damage to the connected paths and generates more pedestrian-vehicle conflicts and pedestrian crossing time, which affects the travel convenience of Tonglang Village residents. The effect of road network density is better than that of traffic station density, indicating that the residents of Tonglang Village are more dependent on the road network density, which is more obvious for pedestrians and non-motorized travelers.

In the analysis of the road network density in Tonglang village, the higher the road network density, the more developed the road traffic network and the higher the convenience of travel, which is consistent with the model assumptions. The analysis of convenience under the moderation of travel mode change and residence time change found that the improvement of convenience by switching travel modes at the same time was significantly better than that by residence time change. It indicates that the public travel mode in Tonglang Village is more dependent on the road network density for other travel modes. While residents with different residence time bring little impact on travel convenience by switching travel modes. Therefore, the urban renewal of Tonglang Village focuses on matching the planning of different travel modes with different road network densities, which is more conducive to reducing the possibility of traffic congestion, optimizing road space and optimizing residents' travel conditions. In urban renewal and planning, the configuration of public service facilities should be taken into account, and by increasing the density of public service facilities, the travel demand of residents can be reduced, thus improving the convenience of travel for residents.

In the three-layer analysis, the intersection density index of Tonglang Village reflects negative effects on the joint adjustment of travel convenience, changes in travel mode, and changes in residential time. This article believes that there are two main reasons for this. Firstly, the increase in intersections means an increase in traffic lights, increased losses, complex routes, and conflicting routes. This has affected different modes of travel to varying degrees, reducing the convenience of travel. Second, the setting of intersections is unreasonable. Due to the comprehensive influence of individuals, culture, economy, and other factors, the setting and density of intersections in urban villages are different from those in the central area.

5 Conclusion

A general method was established to analyze individual attributes and built environment in Shenzhen urban villages, considering the influence range of different variables from the perspective of mutual influence and correlation between group level and individual level. In the second level of analysis, intersection density, public service facility density, and walking time to station have a negative effect on travel convenience, while road network density and traffic station density have a positive effect. In the complete parameter fit, the most obvious positive effect is for road network density, walk time to station and traffic station density, which are adjusted by travel mode, respectively. The most obvious negative effect is that the intersection density is adjusted by travel mode. Taking travel convenience as a research object, the urban renewal and road space development is proposed to consider the impact of built environment on the effect of Tonglang village by investigating the actual situation of the sub-point.

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