JOURNAL OF TRANSPORTATION SYSTEMS ENGINEERING AND INFORMATION TECHNOLOGY
Volume 14, Issue 2, April 2014
Online English edition of the Chinese language journal

Available online at www.sciencedirect.com
ScienceDirect

Cite this article as: J Transpn Sys Eng & IT, 2014, 14(2), 13−18.

RESEARCH PAPER

Analysis Method of External Traffic Demand in City Area

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Abstract: To overcome the disadvantages of the existing method, a "dual four-stage" method" is put forward to analyze external traffic demand in city area considering the characteristics of external traffic. The method is carried out by two steps, and in the first step the city area is regarded as an overall traffic zone and the "four-stage" method of regional traffic demand analysis is used to obtain the total generation volumes of internal–external (IE) & external–internal (EI) trips of city area as well as the traffic volumes of both directions of all the arterial highways through the city in planning years. In the second step, the planning area of city is divided into several parts as internal traffic zones, and the external traffic zones are set near the junctions of highways and cordon line, then the "four-stage" method is applied for the second time to obtain the trip generation and distribution of IE & EI trips and (external-external) EE trips for internal traffic zones and external traffic zones in planning years. The application of the analysis on external traffic demand for comprehensive transportation planning of Zhenjiang City shows that the proposed method combines the advantages of influence area method and Cordon Line method it overcomes disadvantages of the two methods, and the results are more consistent with the real situation.

Key Words: traffic engineering; external traffic; "dual four-stage" method; traffic zones

1 Introduction

External traffic demand analysis involves estimating the volume of internal–external (IE) trips and its distribution, the volume of external–internal (EI) trips and its distribution, the volume of external–external (EE) trips and its distribution at all entrances and exits in city area, which provides references for the connection planning of arterial highways in city area. When it comes to the analyzing method, the extensive involvement aspects and complex impact factors of external traffic result in the urgent need of an effective and efficient approach that can be widely applied. In view of the existing researches both at home and abroad, the analyzing methods are mainly classified into two types: the determinism model and probability model. The former one is a conventional method which mainly consists of "four-stage" method[1-3], multiple regression model[4-5] and spatial economic model[6-8]. To be specific, in the "four-stage" method, the traffic zones are usually determined by two methods such as the influence area method[1] and Cordon Line method[2, 3]. Considering the pros and cons, the influence area method analyzes the generation, attraction and distribution of external traffic under the real transport circumstances, but it takes efforts for the researchers or professionals to get some basic data about the society, economy, etc. in the current stage and planning years. Moreover, the obtained OD (origin-destination) matrix cannot always reflect the relationship between regional road network and external traffic distribution, as expected. In contrast, the Cordon Line method does not require the basic social-economy data of the external regions, and the generated OD matrix directly shows the correlation between regional road network and external traffic distribution. However, this method generally ignores the essential relationships between external traffic and the development of society and economy. Besides, the multiple regression mode and spatial economic model are only utilized for the small-scaled cities with balanced and stable social economies and simple road network structure. The probability model[9, 10] is an approach developed in recent years to overcome the shortcomings of multiple regression model by Logit model. However, it only makes partial improvements to determinism approach and cannot be fully used for large-scaled cities with complex road networks

Received date: Jul 11, 2013; Revised date: Sep 6, 2013; Accepted date: Oct 12, 2013
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DOI: 10.1016/S1570-6672(13)60135-X

that may also experience tremendous changes in structures in coming years.

Therefore, on the basis of previous research achievements, this article proposes a "dual four-stage" method to analyze external traffic demand by integrating the micro-analysis and meso-analysis to reflect the characteristics of external traffic in large-scaled city areas.

2 Dual four-stage method of external traffic demand analysis in city area

2.1 Steps of dual four-stage method

The "dual four-stage" method divides the whole analyzing work into two procedures, and implements the "four-stage" method once in each procedure. In particular, the first process is conducted on the regional level. It regards the city area as an overall traffic zone, and the outside regions can be separated into several external traffic zones by the method of influence area (Fig. 1). Then, it establishes the network model of region arterial highways and estimates the traffic demand through the "four-stage" method. Several major values are yielded in the period of the planning year: the total volume of IE & EI trips generated in the city area, the traffic volume of each arterial highway on both directions at cordon line. The second procedure is performed on the city level. In this case, the city area is divided into certain internal traffic zones by defining the city clusters or districts as the basic units, and external traffic zones are set near the junctions of arterial highways and cordon line while it assumes that all these zones are generation and attraction sites of external traffic. The process is illustrated in Fig. 2. Then a new round of "four-stage" method is applied to analyze external traffic demand at the city area. Therefore, the volume of IE & EI trips and its distribution, the volume of EE trips and its distribution at cordon line for each arterial highway are computed, together with the traffic volume of each highway section within the city's planning region. Fig. 3 elaborates the operations of the dual "four-stage" method.

2.2 Key points of dual four-stage method

There exist some close connections between the two steps of the dual "four-stage" method. For instance, the first step of macroscopic analysis supports the second step with the fundamental traffic data, and the second step of meso-analysis further allocates the traffic data into all the city clusters or districts. This ensures the integration of macro-analysis and meso-analysis, and the match of external traffic distribution and road network. The highlighted key points are the calculation of the external traffic OD matrix of the base year and the analysis of external traffic generation in planning year in the second step.

2.2.1 Processing the external traffic OD matrix of the base year

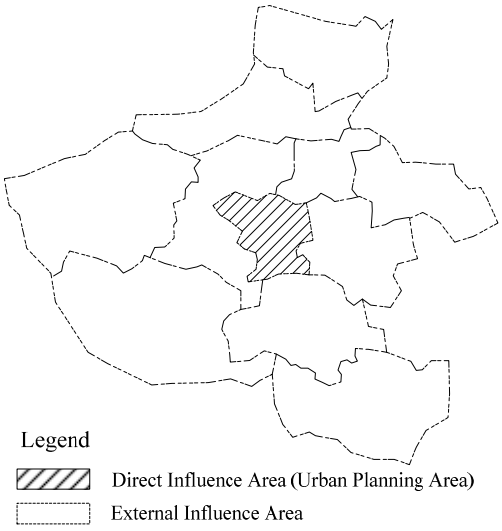

Fig. 1 Layout of traffic zones in regional

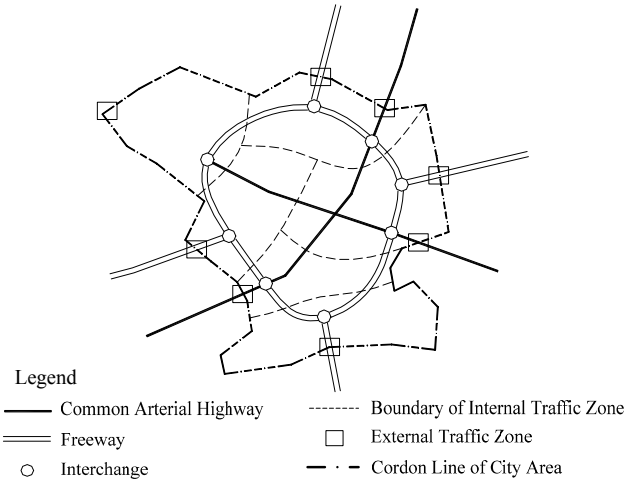

Fig. 2 Layout of traffic zones in city area

Assuming the city area can be divided into n_1 internal traffic zones and thus numbered as a_j(j=1,2, ⋯, n_1) according to the characteristics of urban land and social-economy. If taking the city area as an overall zone W_1, we have $W_1 = \sum_{j=1}^{n_1} a_j$. In addition, suppose there exist n arterial highways through the city and we can set n external traffic zones at the cordon line, which are numbered as W_i(i=2, ⋯, n+1). The whole OD matrix structure of base year is shown in Table 1.

The OD matrix of EE trips $G_{n\times n}$ in Table 1 can be easily obtained by OD survey carried on the cordon line. However, we are unable to directly calculate the OD matrix of IE trips $C_{n_1\times n}$ and the OD matrix of EI trips $R_{n\times n_1}$, mainly because in the traffic survey, it is simple to observe if a vehicle is entering into or out of the town but relatively hard to distinguish its exact destination. Hence, the traffic distribution relation between external traffic zones W_i (i= 2, ⋯, n+1) and internal traffic zones a_j (j= 1, ⋯, n_1) cannot be worked out in this step.

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