

Experimental Design of TransCAD-Based Road Traffic Management Planning

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Abstract. Aiming at the characteristics of difficult practice teaching in Road Traffic Management Planning and Organization, a simulation experiment is designed for traffic demand forecasting teaching of this course. By taking the "four-stage method" as an example, this paper discusses the theory and practical teaching application of traffic zone division, traffic survey and analysis, traffic demand prediction and scheme evaluation based on TransCAD simulation platform. The establishment process of the experiment in the practical teaching is expounded from the aspects such as experiment purpose, experiment design and content, and experiment case implementation.

Keywords: road traffic management planning; experimental design; public security colleges.

1. Introduction

The training of professional talents in traffic management engineering in public security colleges and universities is oriented to fully adapt to the professionalization and actualization of police work in the new era [1]. At present, traffic management engineering research direction mainly includes road traffic order management, road traffic accident management, road traffic control and road traffic organization planning. The Road Traffic Safety Law clearly states that "local people's governments at all levels above the county level should adapt to the needs of road traffic development, according to road traffic safety laws and regulations and relevant national policies, the development of road traffic safety management planning, and organization and implementation". This shows that the road traffic management planning and organization is an important course in the direction of road traffic organization planning in public security colleges and universities in traffic management engineering.

As the main core content of the course[2], road traffic demand forecasting is a key part of road traffic management planning based on traffic surveys and analysis of the current situation, and the process of seeking the development pattern and future trend of the traffic system. The traditional single theory teaching does not adapt to the new era of teaching mode of practical reform needs. Road traffic system is the only "surface" traffic system among the five major modes of transportation. The complexity of the "surface" traffic system makes it difficult or even impossible to get a good practical teaching effect, and the experimental teaching environment is more difficult to meet the requirements of combat-oriented teaching. Based on TransCAD simulation system, this paper discusses the application of TransCAD simulation platform in theoretical and practical teaching, and designs simulation experiments for teaching traffic demand forecasting. From the aspects of experimental purpose, experimental design and content, etc., the process of establishing experiments in practical teaching is elaborated with the implementation of experimental cases. According to the teaching practice, the suggestions related to the construction of curriculum thinking are put forward.

2. Experimental purpose

The purpose of the experimental design of road traffic management planning is to theorize the key and difficult points of the course, to enable students of public security colleges and universities to establish a practical work system of road traffic management planning and organization, to clarify the technical route of road traffic investigation and analysis and the importance of database

establishment, to understand the basic principles of traffic cell division, to be familiar with the operation of traffic planning software, and to master the process and steps of road traffic demand prediction. They will be able to apply the "four-stage method", i.e. traffic occurrence and attraction prediction, traffic distribution prediction, mode division prediction and traffic distribution prediction, to solve the actual traffic planning problems.

3. Experimental simulation platform

At present, in the teaching of traffic management engineering, the more widely used traffic test simulation platform mainly includes TransCAD and VISSIM[3,4]. TransCAD has strong graphic analysis function and good interface, mainly applied in macroscopic traffic planning, is organized by the core of road sections, which is more suitable with the experimental design purpose of road traffic management planning, and because it has excellent graphical analysis function and good interface, and the software has been launched for the use of teaching network version, more conducive to carry out practical teaching. On the other hand, more schools have introduced VISSIM micro-simulation software into the teaching[5], which is more often used to solve the problems of "points" and "lines" in the traffic system, while road traffic management planning mainly involves solving the problems of the traffic system. The main problem of road traffic management planning is to solve the problem of "surface" of the traffic system, i.e. the problem of regional traffic system. In summary, TransCAD software is identified as the simulation platform for this experiment[6,7].

4. Experimental design and experimental

The technical route of this experimental design is shown in Figure 1.

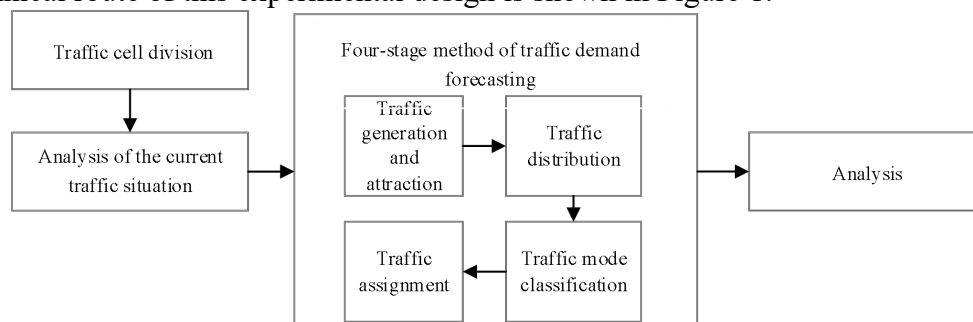


Figure 1. Experimental technology

4.1 Traffic cell division

Traffic cell delineation is an important basis for completing the experiment and affects the workload and accuracy of the traffic experiment. Students need to complete the traffic cell delineation according to certain rules and principles.

It is worth noting that when completing the traffic subdivision within the planning area, it is also important to pay attention to connection between the interior and exterior of the planning area. From the perspective of combining the simulation platform application with the actual teaching, it would take a lot of time to use drawing tools (e.g., AutoCAD) to perform the traffic subdivision operation, and this process is not the focus of the experimental teaching. This part of the experiment focuses on mastering the basic concepts and principles of traffic cell division.

4.2 Analysis of Current Traffic Situation

The traffic survey in road traffic management planning focuses on the origin and destination survey, i.e., OD survey, which includes residential travel OD survey, traffic flow OD survey, and cargo flow OD survey in terms of survey objects, on the basis of which the current situation is analysed. The origin and destination surveys are the basis for the next stage of traffic demand forecasting experiments based on the four-stage method [8]. In terms of experimental teaching

combined with the TransCAD simulation platform, when creating the database and traffic cell attributes, students are made to independently organize and edit the relevant basic information of social activities and land use, find the correct correspondence, create the corresponding data table files and draw the desired line diagram through software operations. Thus, on the basis of mastering the key theoretical knowledge, students' interest in learning is improved, and engineering concepts and awareness that may be lacking in the future work of public security college students are cultivated.

4.3 Traffic demand forecast

Traffic demand forecasting is the process of predicting future traffic conditions based on the past and current situation of the road traffic system and its external systems, and seeking the development pattern and future trend of the traffic system based on historical experience, objective information and logical judgment, the purpose of which is to determine the OD matrix of travel for each characteristic year in the current, near, medium and long term, as well as the traffic flow of each road in the future year, in order to make an assessment of future urban traffic. The planning scheme is evaluated, which is a key part of road traffic management planning and is the teaching focus of this experimental design. The traffic demand forecasting function module is the core function module of the TransCAD simulation platform. In terms of the experimental teaching of the TransCAD simulation platform, the modules of traffic generation and attraction (traffic generation), traffic distribution, traffic mode classification and traffic assignment are applied to further deepen the mastery and understanding of the process and steps of the four-stage method of traffic demand forecasting in the theoretical teaching through practical operation. The functional modules of the simulation platform provide a variety of commonly used forecasting models and methods for students to choose from for the four stages of traffic demand forecasting, thus making the characteristics of each forecasting model and method in each stage of forecasting clear to students.

4.4 Analysis of Results and Discussion

On the basis of the first three stages, the results of traffic demand forecasting are analyzed and discussed, and the solutions are verified and evaluated. The main purpose of road traffic management planning in public security traffic management is to achieve smooth road flow and improve road service level under the premise of ensuring road traffic safety, based on this, combined with the experimental teaching of TransCAD simulation platform, students can use the display function of various types of graphics in the simulation platform, using the comparison method, variable control method, etc., to display the saturation (V/C ratio) as the basis for. The students can use various graphical display functions in the simulation platform to display the traffic distribution results based on saturation (V/C ratio) to compare the road traffic service level before and after the implementation of the scheme, so as to make a comprehensive analysis and evaluation of the rationality of the planning scheme and further improve the traffic organization and management ability of the students in public security colleges.

5. Experimental implementation

This experiment takes the road traffic planning of Dalian Xinghai Square area as an example. As shown in Figure 2, the square is an overall oval shape, and the road network intersecting it divides the surrounding area into several zones. The area attracts a large amount of traffic in a short period of time during the event and requires the implementation of one-way traffic organization and management planning. Through this experiment, the one-way traffic organization road network flow can be quantified, and combined with qualitative analysis, the scheme can be evaluated more scientifically and the rationality of the one-way traffic organization scheme can be verified.

5.1 Modeling

Start TransCAD, initialize the settings, import Figure 2, establish the geographic file; traffic cell division, according to the imported geographic base map file, delineate the boundaries of each traffic cell, define the attributes of the traffic cell, set the traffic cell ID number, as shown in Figure 3.

Establish the road network, input the road network data, define the road network attributes, mainly including: road capacity, vehicle travel speed, road direction and other information as shown in Figure 4.



Figure 2. Satellite screenshot of square

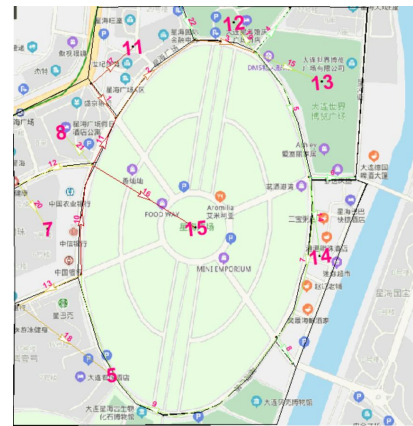


Figure 3. Traffic cell division

5.2 Simulation calculation

Traffic generation and attraction forecasting, on the one hand, can be based on the data in the traffic survey database to establish historical traffic generation data, which can be used as the basis to select the corresponding forecasting model (such as the original unit method, cluster analysis method, etc.) for traffic generation forecasting.



Figure 4. Road network

Figure 5 Results before implementation

Figure 6 Results after implementation

On the other hand, the actual measured road network passenger flow can be used to back propagate, and according to the OD backpropagation basis matrix, the traffic generation and attraction prediction of the current situation can be obtained, and the future traffic generation and attraction can be predicted by regression analysis method traffic distribution prediction[9], based on the previous stage, set the travel impedance, select the growth coefficient method or gravity model method for traffic distribution prediction, and obtain the predicted OD distribution matrix. Traffic distribution prediction, assign the predicted OD distribution to the road network, build and load the network file, and after completing the OD matrix index conversion, select the prediction model (the more commonly used model is user equilibrium prediction or system optimal model) to complete the traffic distribution prediction, as shown in Figure 5.

5.3 Simulation calculation

In order to compare the traffic distribution results before and after the implementation of the planning scheme, the road network information was modified and simulated again according to the previous scheme design, and the results are shown in Figure 6, and the specific road network data comparison is shown in Figure 7.

The comparative analysis shows that the implementation of the scheme can effectively improve the road congestion around the square and improve the overall road network service level. Through the experimental design and implementation of the above cases, students can have a deeper understanding and awareness of the significance of road traffic management planning, further deepen the understanding of the key points and difficulties in theoretical teaching, students can design different road traffic planning schemes according to different cases, rely on this platform for quantitative analysis, while combining qualitative analysis to verify what they have learned, forming a complete theory to practice and then to The closed-loop teaching experiment design of theory to practice and then to theory.

ID	Length[m]	cap	speed	time	ID1	AB_flow	BA_flow	TOT_flow	AB_Time	BA_Time	MAX_Time	AB_voc	BA_voc	MAX_voc
1	110.84	0	2600.00	30.00	3.63	1	1361.0000	1361.0000	2722.0000	3.7388	3.7388	0.5312	0.5312	0.5312
2	296.20	0	2600.00	30.00	9.87	2	1737.0000	1737.0000	3474.0000	10.1788	10.1788	0.6581	0.6581	0.6581
3	159.29	0	2600.00	30.00	5.31	3	1113.0000	1113.0000	2226.0000	5.3379	5.3379	0.4281	0.4281	0.4281
4	148.23	0	2600.00	30.00	4.94	4	860.0000	860.0000	1720.0000	4.9499	4.9499	0.3308	0.3308	0.3308
5	363.50	0	2600.00	30.00	12.12	5	363.0000	363.0000	726.0000	12.1175	12.1175	0.1296	0.1296	0.1296
6	120.24	0	2600.00	30.00	4.01	6	322.0000	322.0000	644.0000	4.0081	4.0081	0.1238	0.1238	0.1238
7	437.25	0	2600.00	30.00	14.57	7	127.0000	127.0000	254.0000	14.5749	14.5749	0.0489	0.0489	0.0489
8	81.06	0	2600.00	30.00	2.70	8	299.0000	299.0000	598.0000	2.7023	2.7023	0.1535	0.1535	0.1535
27	73.05	0	100000.00	30.00	0.01	27	322.0000	322.0000	644.0000	0.0100	0.0100	0.0032	0.0032	0.0032
10	290.50	0	2600.00	30.00	9.68	10	943.0000	943.0000	1886.0000	9.7100	9.7100	0.3627	0.3627	0.3627
11	136.39	0	2600.00	30.00	4.55	11	2950.0000	2950.0000	5900.0000	5.6998	5.6998	1.1346	1.1346	1.1346
12	202.94	0	2600.00	30.00	6.76	12	650.0000	650.0000	1300.0000	6.7686	6.7686	0.2500	0.2500	0.2500
13	181.53	0	2600.00	30.00	6.05	13	721.0000	721.0000	1442.0000	6.9555	6.9555	0.2773	0.2773	0.2773
28	56.52	0	100000.00	30.00	0.01	28	1361.0000	1361.0000	2722.0000	0.0100	0.0100	0.0138	0.0138	0.0138
29	64.33	0	100000.00	30.00	0.01	29	860.0000	860.0000	1720.0000	0.0100	0.0100	0.0086	0.0086	0.0086
24	29.07	0	100000.00	30.00	0.01	24	836.0000	836.0000	1672.0000	0.0100	0.0100	0.0084	0.0084	0.0084
31	25.97	0	100000.00	30.00	0.01	31	721.0000	721.0000	1442.0000	0.0100	0.0100	0.0072	0.0072	0.0072
23	835.10	0	2600.00	30.00	27.84	23	302.0000	302.0000	604.0000	27.8373	27.8373	0.1162	0.1162	0.1162
30	14.59	0	100000.00	30.00	0.01	30	650.0000	650.0000	1300.0000	0.0100	0.0100	0.0055	0.0055	0.0055
26	314.87	0	100000.00	30.00	0.01	26	3065.0000	3065.0000	6130.0000	0.0100	0.0100	0.0386	0.0386	0.0386
25	43.89	0	100000.00	30.00	0.01	25	399.0000	399.0000	798.0000	0.0100	0.0100	0.0040	0.0040	0.0040
22	96.80	0	2600.00	30.00	3.23	22	836.0000	836.0000	1672.0000	3.2319	3.2319	0.3215	0.3215	0.3215

(a) Before program implementation

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ID	Length[m]	cap	speed	time	ID1	AB_flow	BA_flow	TOT_flow	AB_Time	BA_Time	MAX_Time	AB_voc	BA_voc	MAX_voc		
1	110.84	0	2600.00	30.00	3.63	1	1297.0000	65.0000	1362.0000	3.7230	3.6947	0.4388	0.0250	0.4388		
2	296.20	-1	2600.00	30.00	9.87	2	--	1248.0000	1248.0000	--	9.9521	--	0.4880	0.4880		
3	159.29	-1	2600.00	30.00	5.31	3	--	518.0000	518.0000	--	5.3110	--	0.1992	0.1992		
4	148.23	0	2600.00	30.00	4.94	4	55.0000	--	55.0000	4.9411	--	0.0212	--	0.0212		
5	363.50	-1	2600.00	30.00	12.12	5	--	573.0000	573.0000	--	12.1210	12.1210	--	0.2204	0.2204	
6	120.24	0	2600.00	30.00	4.01	6	--	263.0000	291.0000	4.0080	4.0081	4.0081	0.0100	--	0.1012	0.1012
7	437.25	-1	2600.00	30.00	14.57	7	--	338.0000	338.0000	--	14.5755	14.5755	--	0.1302	0.1302	
8	81.06	0	2600.00	30.00	2.70	8	0.0000	363.0000	363.0000	2.7021	2.7022	2.7022	0.0000	--	0.1296	0.1296
27	73.05	0	100000.00	30.00	0.01	27	28.0000	263.0000	291.0000	0.0100	0.0100	0.0100	0.0003	--	0.0026	0.0026
10	290.50	-1	2600.00	30.00	9.68	10	--	655.0000	655.0000	--	9.6880	9.6880	--	0.2519	0.2519	
11	136.39	-1	2600.00	30.00	4.55	11	--	2480.0000	2480.0000	--	5.1189	5.1189	--	0.9538	0.9538	
12	202.94	0	2600.00	30.00	6.76	12	573.0000	457.0000	1030.0000	6.7670	6.7656	6.7670	0.2204	--	0.1750	0.2204
13	181.53	0	2600.00	30.00	6.05	13	680.0000	0.0000	680.0000	6.9554	6.9511	6.9554	0.2615	--	0.0000	0.2615
28	56.52	0	100000.00	30.00	0.01	28	65.0000	1297.0000	1362.0000	0.0100	0.0100	0.0100	0.0006	--	0.0130	0.0130
29	64.33	0	100000.00	30.00	0.01	29	55.0000	0.0000	55.0000	0.0100	0.0100	0.0100	0.0006	--	0.0086	0.0086
24	29.07	0	100000.00	30.00	0.01	24	0.0000	730.0000	730.0000	0.0100	0.0100	0.0100	0.0000	--	0.0073	0.0073
31	25.97	0	100000.00	30.00	0.01	31	680.0000	0.0000	680.0000	0.0100	0.0100	0.0100	0.0068	--	0.0068	0.0068
23	835.10	-1	2600.00	30.00	27.84	23	--	25.0000	25.0000	--	27.8367	27.8367	--	0.0096	0.0096	0.0096
30	14.59	0	100000.00	30.00	0.01	30	573.0000	457.0000	1030.0000	0.0100	0.0100	0.0100	0.0057	--	0.0046	0.0057
26	314.87	0	100000.00	30.00	0.01	26	2676.0000	967.0000	3643.0000	0.0100	0.0100	0.0100	0.0268	--	0.0057	0.0268
25	43.89	0	100000.00	30.00	0.01	25	0.0000	363.0000	363.0000	0.0100	0.0100	0.0100	0.0000	--	0.0036	0.0036
22	96.80	1	2600.00	30.00	3.23	22	730.0000	--	730.0000	3.2297	--	3.2297	0.2600	--	0.2600	0.2600

(b) After the implementation of the program

Figure 7. Comparison of traffic distribution road network data

6. Conclusion

As an important course in the direction of road traffic organization planning in traffic management engineering in public security colleges and universities, the practical teaching of the course Road Traffic Management Planning and Organization can be realized by relying on the

TransCAD simulation platform, and TransCAD can be better applied in the practical teaching of traffic cell division, traffic investigation and analysis, traffic demand prediction and program evaluation, etc.

The experimental design can improve the quality of teaching, help students learn and understand the theoretical knowledge, cultivate students' practical ability, and make them establish engineering concepts and awareness.

7. Acknowledgments

This paper is supported by Dalian Intelligent Transportation Communication Safety and Emergency Command Engineering Research Center(2021-153), Doctoral Scientific Research Foundation of Liaoning Police College (2020LNPCBS-202) and Educational Commission of Liaoning Province (LNBKJG11432202104).

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