Traffic Demand Forecasting Based on Four-Stage Method

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Abstract: Traffic demand forecasting is an significant part city planning ,which can eliminate and avoid some traffic hidden trouble in advance and traffic problems. Shihezi is one of the focus of economic and social development in Xinjiang area, also is the key development area of Xinjiang in the large-scale development in west China. In this paper, using the method of four stages, there is a result of the traffic demand forecast, which can be intuitive show planning in potential transportation volume, can be a theoretical basis of the development of city public transportation planning in Shihezi, and has practical significance.

Keywords: Traffic demand forecast; Four stage method; OD distribution matrix

1. Introduction

The "four stage" method is a kind of advanced traffic planning theory which was introduced from abroad in the last century. It is widely used and accurate. Ren Qi Liang[1] used the "four stages" method to forecast the bus passenger flow in the Nan'an district of Chongqing. Guo Fan Liang[2] makes use of the "four stages" method to forecast the traffic demand of Kashi Economic Development Zone. Chen Gui Fu et al.[3]used the "four stage" method for road traffic demand forecasting. Thus, the "four stage method" has been matured in the demand forecast. In this paper, the "four stages" method[4-7] is used to forecast the traffic demand of Shihezi in 2020, which aims to provide the basis for the development of urban transportation in Shihezi.

2. Traffic District Division

2.1. The principle of the division

In the analysis of public traffic demand forecast, it is necessary to integrate the scattered traffic sources into several traffic areas. It should be noted that the boundaries are not real, but to facilitate the study of the artificially created space.
Principle of division of traffic district[8]:
1).The characteristics of the traffic district should be the same.
2).The division of traffic district should make natural or artificial structure as the boundary, in order to facilitate the investigation.
3).The division of the traffic district as far as possible to protect the integrity of the administrative divisions, in order to facilitate the use of existing government statistics, reduce the difficulty of the investigation.
4).The structure of road network should be considered in traffic district division.
5).To ensure the integrity of traffic district access
6).The number of traffic district should be appropriate, usually the area of the city centre is divided into smaller, suburban areas can be divided into larger.

2.2. The results of Shihezi traffic district division

According to the natural boundaries and artificial barriers, the results are shown in the following Figure 1:

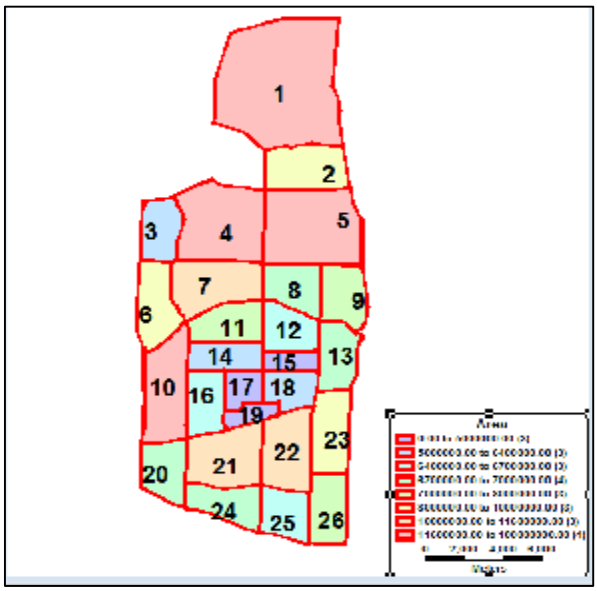

Figure 1. Traffic District Division

2.3.Population Analysis of Traffic District

The prediction of the Urban population is largely related to these factors: the nature of the land use in each region of the city, the function of each region and the population of each traffic district. According to the social and economic development of Shihezi and the

nature of land use in 2020, the population scale of Shihezi in the year of 2020 can be obtained. It is about 550 thousand people.

3. Traffic Demand Forecasting

3.1. Forecasting Process

The Flow Chart of Traffic Demand Forecast is shown as Figure 2.

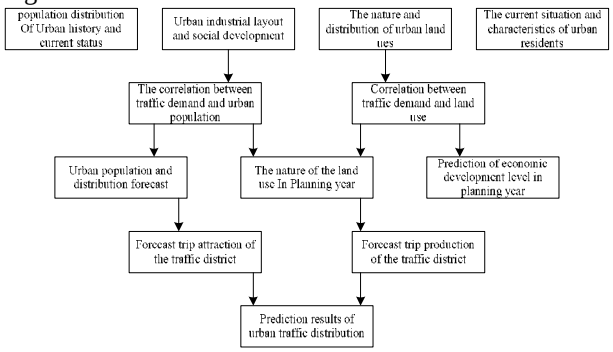

Figure 2. The Flow Chart of Traffic Demand Forecast

3.2. Trip Generation Forecast

The residents trip generation forecast includes two parts: the residents trip production forecast and the resident trip attraction forecast.

3.2.1. Residents Trip Production Forecast

Residents trip production forecast, first of all, to analyze the main factors that affect the residents' trip, in order to take the corresponding forecasting methods according to the characteristics of those factors. Based on the statistics of the residents' trip survey data, the main influencing factors can be obtained. For example, through the statistics analysis found that the degree of social development, occupation, working time system is the main factors. Further analysis found that the city which has experienced a period of development, the structure of the occupation is stable. Therefore, for this kind of city Residents trip production forecast can be predicted without considering the impact of occupational structure.

The number of trips per capita is an important index to measure the intensity of traffic travel, and is also an important factor to determine the total size of the trip. The number of trips per capita is mainly related to the nature of land use、the intensity of social and economic activities、the age structure of the population,、the ownership of the vehicle, employment and other factors, also has increased with the improvement of people's living standards. The study forecast based on shihezi 2015 citizens travel rate 3.98 times/day, 2020 residents travel rate was 4.06 times/day.

According to the Shihezi regional land layout, planning total population is assigned to each traffic area, then The number of population per traffic district in 2020 and the residents travel rate in 2020 multiplication, can be obtained the number of residents trip production of Shihezi in 2020.

3.2.2. Resident Trip Attraction Forecast

There are many factors that affect the residents' trip attraction, such as land use, the location of the traffic district and the characteristics of the building. According to the future land use planning of the traffic district, the location and the characteristics of the traffic district, the weight value of the land to the trip attraction is determined. According to the land use planning, the relevant model was used to predict the resident trip attraction of each traffic district.

Another important factor affecting the amount of resident trip attraction is the trip attraction rate, and the trip attraction rate is a ratio, which reflects the intensity of the attraction points to attract passengers.

According to the nature of land use and the degree of economic development in different regions, and according to the empirical value of domestic and other similar cities, the paper finds out the trip attraction rate of different land types in Shihezi area.

The amount of trip attraction in a city should be equal to the number of trip production, as shown in Table 4.

Table 1. The Trip Attraction Rate of Different Land Types

Land type	Industrial	Educational research	Commercial service facilities	Administrative office	Traffic	Arts and sports	Reside	Business office
The rate of Trip attraction time/ (day*m2)	0.02	0.039	0.24	0.19	8	0.02	0.02	0.09

Table 2. The Number of Population Per Traffic District in 2020

Index	1	2	3	4	5	6	7	8	9	10
Population (ten thousand people)	10.08	3.95	0.52	3.67	3.80	1.16	3.17	0.72	1.40	0.90
index	11	12	13	14	15	16	17	18	19	20
Population (ten thousand people)	1.04	1.39	1.42	0.20	0.67	1.08	1.05	0.31	6.25	4.39
index	21	22	23	24	25	26				
Population (ten thousand people)	0.64	0.83	4.19	1.32	0.41	0.48				

Table 3. The Forecast of the Trip Generation in 2020

index	1	2	3	4	5	6	7	8	9	10
P	409436	160523	20953	149098	154453	47242	128790	29306	56787	36601
A	98609	110531	17184	72360	45346	49033	154370	87608	24620	58446
index	11	12	13	14	15	16	17	18	19	20
P	42055	56358	57717	6293	27151	43950	42659	12479	253599	178307
A	95108	83435	15065	29226	10290	31863	79899	42565	357987	261749
index	21	22	23	24	25	26				
P	25867	33627	169912	53542	16735	19558				
A	71106	68865	247015	67855	33039	19826				

P is trip production, A represents trip attraction.

3.3. Traffic Model Split

According to the city planning and transportation planning of Shihezi, adopting the policy of "the common development of car traffic and public transport, giving priority to the development of public transport, limiting the use and development of motorcycles and guiding the use of cars". In this paper, the Logit model[9] will be used to forecast the traffic share of Shihezi, and finally the travel mode of residents in Shihezi will be shown in Table 5.

Prediction model:

$$y_i = \frac{\exp(-l R_i / R)}{\sum_{j=1}^{9} \exp(-l R_i / R)} \quad (1)$$

y_i is the share rate of the i traffic mode, %; R_i is the traffic impedance of the i traffic mode, fare: yuan; R is the average impedance value of various traffic modes; l is the model parameters, this paper l =3.5.

Table 4. The Traffic Share of Shihezi in 2020

travel mode / Time	Public vehicle	Bus	Car	Private cars	Taxi	Motorcycle	Bicycle	Walking	Others
2015	20%	5%	1%	7%	1%	4%	15%	44%	2%
2020	40%	4%	1%	8%	5%	3%	9%	28%	2%

As shown in the Table 4, under the guidance of the relevant traffic development policy, the development of conventional bus and rail transit traffic, will make the residents travel more convenient. With the improvement of people's living standards, the proportion of taxis and private cars will naturally increase.

3.4. Trip Distribution Forecast

Trip distribution is an important part of the "four stage" method[10].The trip distribution of residents is the process of converting the trip generation of the each traffic district into the trip exchange among the traffic district.

According to the development level of Shihezi City, this paper selects the double constrained gravity model.The basic form of the double constrained gravity model :

$$\begin{aligned} T_{ij} &= K_i K_j P_i A_j / f(t_{ij}), \\ K_i &= \left[\sum K_j A_j / f(t_{ij})\right]^{-1} \\ K_j &= \left[\sum K_i P_i / f(t_{ij})\right]^{-1} \end{aligned} \quad (2)$$

t_{ij} is the amount of trip from i to j; p_i is the amount of trip production of the traffic district i; A_j is the amount of trip attraction of the traffic district j; K_i, K_j is the balance coefficient; $f(tij)$ is impedance function. Based on the specific situation of Shihezi residents trip, the following specific forms of impedance function is used:

$$T_{ij}^2 = K_i^2 K_j^2 P_i^2 A_j^2 / t_{ij}^a \quad (3)$$

a is the model parameters, this paper a =1.35.According to the above distribution model, the OD distribution matrix of Shihezi residents in 2020 is obtained. The results are shown in Table 6, and the trip expectation line of each traffic district in 2020 is shown in Figure 3.

4. Conclusion

In this paper, based on the investigation of the present situation of public transport in Shihezi, the four stage method and TransCAD software are used as the operating platform, and then the trip generation, trip distribution, mode division and resident trip OD are obtained.Through the method of generating rate, we can get the trip generation;The improved Logit model is established to get the share of the travel mode of Shihezi in 2020;Based on the double gravity model, the OD distribution matrix of Shihezi residents in 2020 was obtained.

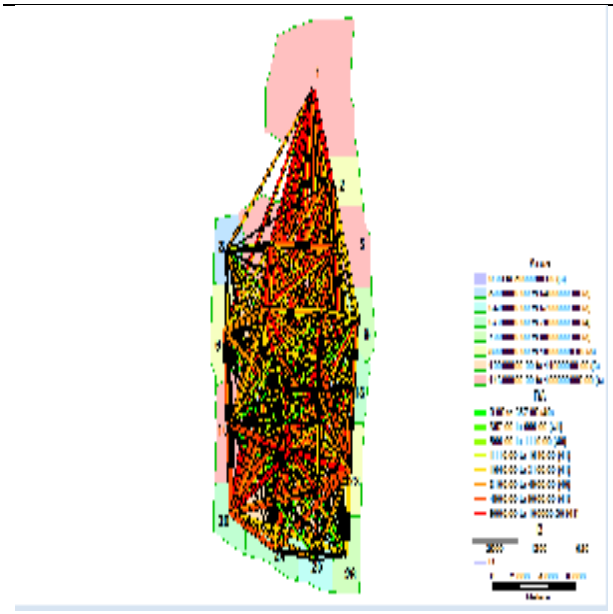

Figure 3. Trip distribution in 2020

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Table 5. OD Distribution of Road Passenger Flow

OD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
1		28658	3431	16061	10124	9122	30422	16230	4815	10084	17236	15180	2765	5007	1780	5282	13297	7153	70769	49892	11769	11731	47510	11837	5775	3505
2	12031		1336	6377	4627	3480	11762	6880	2030	3801	6628	6196	1128	1910	721	1999	5066	2836	26949	18655	4546	4625	18779	4552	2241	1365
3	1167	1082		889	439	599	1705	784	218	551	906	716	126	256	84	274	648	333	3379	2551	587	531	2136	574	264	157
4	8958	8473	1458		3425	3512	12409	6052	1655	3672	6792	5437	951	1864	633	1909	4936	2508	25549	17663	4130	3973	15981	4065	1926	1167
5	9319	10147	1188	5652		3217	11129	6899	2020	3516	6238	5984	1088	1784	692	1872	4730	2689	25316	17143	4234	4346	17674	4221	2083	1272
6	2350	2136	453	1622	900		4266	1792	491	1384	2190	1621	283	640	193	674	1572	782	8039	6066	1387	1230	4873	1337	606	356
7	6940	6392	1144	5075	2758	3778		5890	1533	3518	7217	5027	865	1825	582	1816	4605	2269	23334	16324	3788	3528	14194	3670	1690	1026
8	1538	1553	218	1028	710	659	2447		423	695	1333	1327	218	367	146	369	971	542	5019	3310	800	828	3379	792	390	239
9	3022	3035	402	1862	1377	1196	4219	2804		1292	2347	2292	424	664	263	691	1759	1006	9377	6249	1554	1610	6569	1542	763	468
10	1644	1476	264	1073	623	876	2514	1195	336		1500	1217	216	500	151	659	1329	653	7029	5328	1190	1012	3936	1106	490	286
11	2076	1901	321	1466	816	1024	3810	1694	450	1108		1644	278	629	195	601	1580	745	7765	5088	1217	1134	4488	1167	537	322
12	2774	2698	385	1781	1188	1150	4027	2560	667	1364	2495		452	758	344	753	2001	1183	10355	6498	1636	1658	6777	1604	772	475
13	2775	2697	371	1711	1186	1101	3806	2308	678	1328	2313	2483		701	315	742	1926	1132	10176	6461	1640	1748	7211	1609	802	497
14	282	256	42	188	109	140	451	218	60	173	294	234	39		29	99	263	114	1215	763	186	169	666	175	79	47
15	1220	1177	168	779	516	514	1749	1055	288	634	1108	1292	215	351		360	988	605	5008	3013	768	787	3229	746	359	222
16	1828	1648	279	1184	704	905	2754	1347	381	1398	1725	1426	256	607	182		1797	812	9214	5894	1507	1209	4655	1333	573	334
17	1837	1668	263	1223	710	843	2789	1416	387	1126	1813	1513	265	645	199	718		851	10040	5134	1275	1213	4671	1183	548	325
18	549	519	75	345	224	233	764	439	123	308	475	497	87	156	68	180	473		2542	1452	375	389	1565	361	173	106
19	13642	12375	1915	8829	5302	6015	19718	10209	2880	8311	12428	10922	1955	4158	1408	5134	14006	6380		38314	9471	9215	35505	8860	4171	2475
20	9116	8120	1371	5786	3403	4302	13075	6381	1819	5972	7720	6496	1177	2474	803	3113	6788	3455	36317		8080	6456	23503	7526	3220	1836
21	1108	1020	162	697	433	507	1564	795	233	687	951	843	154	311	105	410	869	460	4626	4164		925	3171	1018	416	238
22	1491	1400	198	905	600	607	1966	1111	326	788	1197	1153	221	381	146	444	1116	644	6075	4490	1248		5021	1150	600	348
23	8878	8359	1174	5354	3588	3535	11628	6662	1956	4512	6964	6930	1343	2209	880	2514	6317	3807	34419	24037	6294	7383		6048	3112	2010
24	2403	2201	343	1479	931	1053	3266	1696	499	1378	1966	1781	325	630	221	782	1738	954	9330	8361	2194	1838	6570		1053	549
25	762	705	102	456	299	311	978	544	161	397	588	558	106	184	69	219	524	297	2857	2327	583	624	2199	685		203
26	897	833	118	536	354	354	1151	647	191	449	685	665	127	215	83	247	603	353	3287	2573	648	702	2754	692	394	