4 EXISTING TRANSPORT DEMAND

4.1 Person Trip Survey and Methodology for Existing Transport Demand Estimate

4.1.1 Objective and Scope of the Survey

(1) Objective of Survey

The objective of the survey is to obtain information required to evaluate the transport demand and its characteristics in Chengdu. The transport survey supports the study in terms of identifying transport demand patterns of permanent, temporary and floating population as well as vehicle origin and destination (OD).

(2) Scope of Survey and Sampling

The total current population in Chengdu is 3.1 million, which consists of about 2.6 million permanent population and 0.5 million of temporary population. In the person trip survey, which is the core survey of the study, 45,000 people of at least 6 years of age were interviewed. About 3,500 people or 8 percent of the total interviewees stayed in hotels and hostels in Chengdu. The vehicle OD survey covered 5,000 sample vehicles or 8.3 percent of the total vehicles (about 60,000) registered for business use.

(3) Survey Respondents

The Public Securities Bureau provided a sample list of respondents for the survey, but the list did not include demographic information of respondents (for example, address, owner, sex, age, etc.), which had to be obtained in the field survey.

(4) Methodology

The interviews to respondents were undertaken in coordination with the Bureau of Public Securities.

(5) Survey Items

Table 4.1.1 shows the survey items covered.

The survey questionnaire included all the necessary items and the forms were designed based on the results of a similar survey, which was undertaken in 1987. The data based on the interviews of respondents were presented as part of the supplementary information.

Table 4.1.1 Survey Items

Permanent and Temporary Residents	For Transient Population	Origin-Destination of Vehicles
Household information • Address • Number of family/household members (sex and the civil status) • Number of years of stay in Chengdu • Plans of moving out to another city/ municipality outside Chengdu • Household income • Number of vehicles owned (if any) **Household Member Information** • Sex • Age • Civil status • Profession • Office/school Address • Any form of savings and/or investments • Monthly income • School (type) • Driving license (type) • Registration of motorcycle • Plans of buying motor cycle • Plans of buying motor vehicle **Trip Characteristics** • Date • Weather • Number of trips made • Trip origin • Origin Facility • Time Trip Started • Trip destination • Destination Facility • Time of arrival • Purpose of trip • Mode of transport • Time spent on each mode of transport • Location of stations • Time spent on waiting • Types of motor vehicles used	**Data on Individual** • Place to stay in the night • Sex • Age • Profession • Place to visit • Destination • Mode of transport • Purpose of trip **Trip Characteristics** • Date • Weather • Number of trips made • Trip origin • Origin Facility • Time started • Trip destination • Destination Facility • Time of arrival • Purpose of trip • Mode of transport • Time spent on each mode of transport • Location of stations • Time spent on waiting • Types of motor vehicles	**Workplace** • Address • Sex of driver(s) • Age of driver(s) • Type of fuel used • Model of vehicle used **Trip Characteristics** • Date • Number of trips • Place of origin and destination • Facilities • Parking area used • Passengers • Date started • Time started • Date of arrival • Time of arrival • Distance traveled • Purpose • Goods transported • Expressway toll fee

(6) Survey Implementation

All survey data was collected, collated, inputted in the database and processed with the assistance of Chengdu Planning and Design Institute, the Chengdu's Bureau of Public Securities and the Computer Center of the Southwest Communications University.

1) Sampling

The sampling was done by the Bureau of Public Securities with the assistance of their substation staff.

2) Training of Survey staff

Prior to the training of surveyors, selected supervisors were trained on the key aspects of the survey, and the surveyors were then trained by the supervisors.

Survey manuals have been prepared according to the local conditions of Chengdu focusing mainly on the objectives, survey items and definition of a "trip".

3) Field survey

The supervisors were responsible in collating and validating the survey results in coordination with the other departments providing assistance in the conduct of survey interviews. Survey interviewers clearly explained the scope, purpose and data requirements to respondents, and the survey forms were filled by the interviewers themselves. Thus, the field surveys had been conducted relatively smoothly owing to the full support and assistance of the Bureau of Public Securities.

4) Coding

The filled forms were edited by the supervisors and then coded. The coding process includes:

- Coding of address: 125 Zones (3 digits)
- Coding of trip OD and bus stations:
  - **OD:** 125 Zones (3 digits) and other outside 34 Zones
  - **Bus Stations:** Correspondence table of bus stations and their codes prepared in advance

5) Data Encoding and Processing

The data was encoded and manually typed/inputted after having been verified and validated by the supervisors.

(7) Survey Schedule

Table 4.1.2 presents the entire schedule of the person-trip survey.

Table 4.1.2 Survey Schedule of the Person-Trip Survey

Items	Schedule (Year 2000)
1. Survey preparation	
▪Formulation of Questionnaire	May 8 - June 11
▪Sampling	June 12 – 18
▪Preparation of survey materials	June 12 – 18
2. Conduct of Survey/Implementation	
▪Training of survey supervisors and interviewers	June 19 – 23
▪Field Survey	
- Registered and temporary population	June 26 - 30
- Floating population	July 17 - 18
- Origin-Destination of Vehicles	June 22 - July 14
▪Validation	
- Registered and temporary population	July 1 – 11
- Floating population	July 19 - 24
- Origin-Destination of Vehicles	July 1 – 20
3. Coding	
▪Trip OD and bus station	
- Registered and temporary population	July 14 - 21
- Floating population	July 25 - 29
- Origin-Destination of Vehicles	July 19 - 25
4. Data Processing (for permanent and temporary residents)	
▪Data Encoding	July 17-Aug. 19
- Registered and temporary population	July 28-Aug. 6
- Floating population	Aug. 2- 19
- Origin-Destination of Vehicles	
▪Data Check	Aug. 1 - 19
- Registered and temporary population	Aug. 19 – 20 &
- Floating population	Aug. 7 - 8
- Origin-Destination of Vehicles	
▪Data correction	Aug. 1 - 30
- Registered and temporary population	Aug. 20 - 30
- Floating population	Aug. 8 - 30
- Origin-Destination of Vehicles	

4.1.2 Study Area and Zoning

The study area covered the six (6) Central Districts and five (5) neighboring counties. The zoning was determined as follows:

(1) Study Area

Traffic zones were defined based on:

- size of zone, to ensure the accuracy of public transport planning
- administrative division
- administrative boundaries of Public Securities Bureau's substation (basis of population statistics and sampling)
- location of major roads existing or planned (particularly when zone is too large)

- Longquanyi District, Xindu County and Pi County are divided into five zones by township.

(2) Outside the Study Area

The area outside the Study Area was divided into 34 zones (refer to Table 4.1.4).

- Zones inside the Chengdu city were divided according to administrative boundaries and transport conditions;
- Zones inside the Sichuan province were divided according to administrative boundaries and transport conditions;
- The outer area of the Sichuan province was divided according to the current configuration of transport system and administrative division. Area that has a close relationship with Chengdu was taken as a single zone.

Table 4.1.3 Traffic Zones of Study Area

Zone No.	District County Name [1/]	Zone Name	Zone No.	District County Name	Zone Name	Zone No.	District County Name	Zone Name
1	Jinjiang	Banxianjie	21	Jinjiang	Liulichang A	41	Qingyang	Gulounanjie A
2	Jinjiang	Niushikou	22	Jinjiang	Liulichang B	42	Qingyang	Gulounanjie B
3	Jinjiang	Lianhuachi	23	Jinjiang	Gaodianzi	43	Qingyang	Huangtianba
4	Jinjiang	Shahepu	24	Qingyang	Xinhuaxilu A	44	Qingyang	Shiren A
5	Jinjiang	Dongdingzijie	25	Qingyang	Xinhuaxilu B	45	Qingyang	Shiren B
6	Jinjiang	Wangjiabajie	26	Qingyang	Shangwangjiaguaijie A	46	Qingyang	Supoqiao A
7	Jinjiang	Zhiquanjie	27	Qingyang	Shangwangjiaguaijie B	47	Qingyang	Supoqiao B
8	Jinjiang	Chunxilu	28	Qingyang	Baijiatangjie A	48	Qingyang	Supoqiao C
9	Jinjiang	Dongkangshi	29	Qingyang	Baijiatongjie B	49	Qingyang	Wenjiachang
10	Jinjiang	Dangbajie	30	Qingyang	Huangwajie	50	Jinniu	Xiangnongshijie A
11	Jinjiang	Tianyashibei	31	Qingyang	Xiyuheyanjie A	51	Jinniu	Xiangnongshijie B
12	Jinjiang	Hepingjie	32	Qingyang	Xiyuheyanjie B	52	Jinniu	Jiefanglu A
13	Jinjiang	Renminnanlu A	33	Qingyang	Dongtongshunjie	53	Jinniu	Jiefanglu B
14	Jinjiang	Renminnanlu B	34	Qingyang	Zhongliecishijie	54	Jinniu	Xiaojiacun
15	Jinjiang	Yanshikou	35	Qingyang	Qingyangzhengjie A	55	Jinniu	Qingyangbeilu
16	Jinjiang	Renmindonglu	36	Qingyang	Qingyangzhengjie B	56	Jinniu	Shichuan Industry University
17	Jinjiang	Zitongqiaozhengjie	37	Qingyang	Qingyangzhengjie C	57	Jinniu	Southwest Jiaotong University
18	Jinjiang	Dongfengnanlu	38	Qingyang	Beidajie	58	Jinniu	Simaqiao
19	Jinjiang	Junlongjie	39	Qingyang	Citangjie	59	Jinniu	Yangliucun
20	Jinjiang	Dongguang	40	Qingyang	Binbijie	60	Jinniu	Caojiaxiang

(continue)

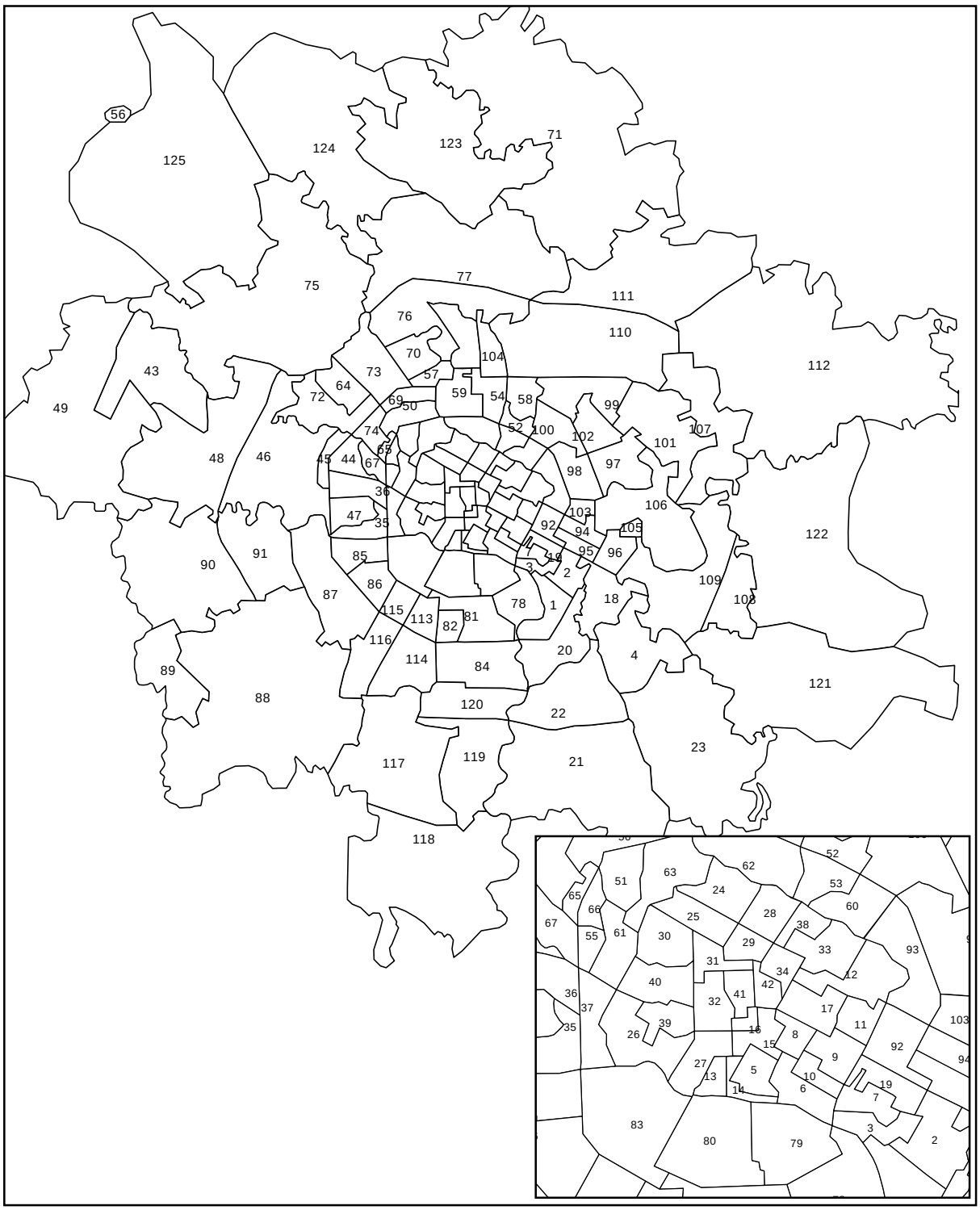
Zone No.	District County Name 1/	Zone Name	Zone No.	District County Name	Zone Name	Zone No.	District County Name	Zone Name
61	Jinniu	Xi'anlu	91	Wuhou	Jitou B	121	Longquang	Honghe Town
62	Jinniu	Renminbeilu	92	Chenghua	Wangpingjie	122	Longquanyi	Shiling Town
63	Jinniu	Beixiangzi	93	Chenghua	Mengzhuiwan	123	Xindu County	Dafeng Town
64	Jinniu	Chadianzi	94	Chenghua	Shuanglin	124	Pi County	Anjing Town
65	Jinniu	Fuqin A	95	Chenghua	Shuangqiaozi A	125	Pi County	Xipu Town
66	Jinniu	Fuqin B	96	Chenghua	Shuangqiaozi B			
67	Jinniu	Baiguolin	97	Chenghua	Jianshelu A			
68	Jinniu	Wukuaishi	98	Chenghua	Jianshelu B			
69	Jinniu	Guangrong-Xiaoqu	99	Chenghua	Fuqinglu A			
70	Jinniu	Jiulidi	100	Chenghua	Fuqinglu B			
71	Jinniu	Tianhuizhen	101	Chenghua	Erxianqiao			
72	Jinniu	Yingmenkou A	102	Chenghua	Tiaodenghe			
73	Jinniu	Yingmenkou B	103	Chenghua	Xinhonglu			
74	Jinniu	Yingmenkou C	104	Chenghua	North Railway Station			
75	Jinniu	Tuqiao	105	Chenghua	Wannianchang			
76	Jinniu	Dongzikou A	106	Chenghua	Taoxilu			
77	Jinniu	Dongzikou B	107	Chenghua	Shengdengsi			
78	Wuhou	Wangjianglu	108	Chenghua	Baohe A			
79	Wuhou	Zhiminlu	109	Chenghua	Baohe B			
80	Wuhou	Xiaotianzhujie	110	Chenghua	Qinglongchang A			
81	Wuhou	Tiaosanta	111	Chenghua	Qinglongchang B			
82	Wuhou	Yulin	112	Chenghua	Longtanshi			
83	Wuhou	Jiangxijie	113	Gaoxin	Xiaojiahe A			
84	Wuhou	South Railway Station	114	Gaoxin	Xiaojiahe B			
85	Wuhou	Shuangnan	115	Gaoxin	Fangcaojie A			
86	Wuhou	Yongfengchang A	116	Gaoxin	Fangcaojie B			
87	Wuhou	Yongfengchang B	117	Gaoxin	Shiyangchang A			
88	Wuhou	Cuqiao	118	Gaoxin	Shiyangchang B			
89	Wuhou	Jinhua	119	Gaoxin	Sanwayao A			
90	Wuhou	Jitou A	120	Gaoxin	Sanwayao B			

1/ Those not specified as county are districts.

Table 4.1.4 Traffic Zones Outside Study Area

Area	Zone No .	Zone Name	Areas Included
Chengdu City	126	South of Longquanyi Distict	Longquan Town , Damian Town, Tong'an Town, Baihe Town, Chadian Town, Longquan Village, Ping'an Village, Shanquan Village
	127	North of Longquanyi Distict	Luodai Town, Xihe Town, Wen'an Town, Yihe Town, Huangtu Town, Xiping Town, Chang'an Village, Wanxing Village, Qingshui Village
	128	South of Qingbaijiang Distict	Qingquang Town, Hexing Town, Longwang Village, Fuhong Village, Renhe Village, Yunding Village
	129	North of Qingbaijiang District	Dawan Town, Mimu Town, ChengVillage Town, Datong Town, Xiangfu Town, Yaodu Town, Rixin Town, Huayan Town, Yuhong Village
	130	East of Xindu County	Shibantan Town, Taixing Town, Mulan Village
	131	Centre of Xindu County	Xindu Town, Majia Town, Xinmin Town, Sanhe Town, Longhu Town, Juntun Village
	132	West of Xindu County	Liji Town, Qingliu Town, Xinfan Town, Longqiao Town, Banzhuyuan Town, Long'an Village, Zhuyou Village
	133	Pi County	Whole County (except Anjing Town and Xipu Town)
	134	Wenjiang County	Whole County
	135	Shuangliu County	Dongsheng Town, Yong'an Town, Baijia Town, Jiujiang Town, Huangshui Town, Peng Town, Wenxing Town, Jinqiao Town, Gongxing Village, Huangjia Village, Shengli Village
	136	West of Shuangliu County	Dalin Town, Jiancha Town, Jitian Town, Zhengxing Town, Taiping Town, Yongxing Town, Huayang Town, Zhonghe Town, Huanglongxi Town, Sanxing Village, Hejiang Village, Xinglong Village, Wan'an Village, Baisha Village, Xinxing Village
	137	North of Jintang County	Zhao Town, Fuxing Town, Zhaojia Town, Sanxing Town, Guancang Town, Qingjiang Town, Qixian Village, Yunxiou Village
	138	South of Jintang County	Huaikou Town, Zhugao Town, Tuqiao Town, Wufeng Town, Yunhe Town, Guangxing Town, Gaoban Town, Jinlong Town, Baiguo Town, Longsheng Town, Jiulong Town, Sanxi Town, Zhuanlong Town, Youxin Village, Huangjia Village, Pingqiao Village
	139	Pengzhou City	Whole City
	140	Dujiangyang City	Whole City
	141	Chongzhou City	Whole City
	142	Dayi County	Whole County
	143	Qionglai City	Whole City
	144	Xinjin County	Whole County
	145	Pujiang County	Whole County
Sichuan Province	146	East of Sichuan Province	Suining City, Nanchong City, Guang'an City, Dachuan Prefecture
	147	Northeast of Sichuan Province	Deyang City, Mianyang City, Guangyuan City, Bazhong Prefecture
	148	Northwest of Sichuan Province	Aba Autonomous
	149	West of Sichuan Province	Ya'an Prefecture, Ganzi Autonomous
	150	Southwest of Sichuan Province	Meishan Prefecture, Leshan City, Liangshan Autonomous, Panzhihua City
	151	South of Sichuan Province	Ziyang Prefecture, Neijiang City, Luzhou City, Zigong City, Yibin City
Country	152	Chongqing City	Whole City
	153	Guizhou Province	Whole Province
	154	Yunnan Province	Whole Province
	155	Tibet Autonomous Province	Whole Province
	156	West China	Shan'xi Province, Gansu Province, Qinghai Province, Ningxia Autonomous Province, Xinjiang Autonomous Province
	157	Center China	Shanghai City, Zhejiang Province, Jiangsu Province, Anhui Province, Hubei Province
	158	South China	Hu'nan Province, Jiangxi Province, Fujian Province, Guangdong Province, Guangxi Autonomous Province, Hainan Province, Hongkong, Taiwan
	159	North China and Northeast China	Beijing City, Tianjing City, Hebei Province, Shanxi Province, Shandong Province, He'nan Province, Neimenggu Autonomous Province, Liaoning Province, Jilin Province, Heilongjiang Province

Figure 4.1.1 Zoning of the Study Area



4.1.3 Methodology for Existing Transport Demand Estimate

(1) Person Trip Related Surveys

The person trip related surveys are classified according to trip maker and location of trip. The residents consist of registered population, temporary population and floating population. Locations of trips, on the other hand, are of three types: trips which start and end in the study area, trips which move between inside and outside the study area, trips which start and end outside the study area.

Table 4.1.5 Person Trips and Surveys

			Location of Trip		
			Inside Study Area	Between Inside and Outside Study Area	Outside Study Area
Trip Maker	Residents	Registered Population	**Person Trip Survey**	**Cordon Line OD Interview Survey**	
		Temporary population	**Car OD Survey**		
		Floating Population	**Floating Population Survey**		
	Non-Residents				**Out of Scope**

The surveys consist of person-trip survey, car origin and destination (OD) survey, floating population survey and a roadside OD survey at the cordon line. Traffic volumes were also counted both at the screen line and the cordon line at the same time when the OD survey was carried out. The scope of surveys is:

1) **Person Trip Survey**: Surveyors visited the families randomly selected, and interviewed them on their personal data/characteristics and their daily travel activities. This survey covered the registered and temporary population. It, therefore, aimed to capture the trips of the people who lived in the study area.

2) **Car Origin and Destination Survey**: The samples were selected from the registered vehicles for business use, and their daily activities were surveyed. The drivers of the cars were either from the registered or temporary population. Therefore, some part of the business trips surveyed may overlap the result of the person-trip survey. However, the result of the car OD survey can complement the business trip that could not be captured well by the person-trip survey.

3) **Floating Population Survey**: Chengdu City is the capital of the Sichuan Province, which has a lot of tourist sites. Many people come into Chengdu City on business or sightseeing. Therefore, the floating population survey was carried out in order to understand the trip behavior of the floating population who stay in hotels and hostels in Chengdu City.

4) **Cordon Line OD Interview Survey**: This survey mainly aimed to understand the travel pattern of non-residents that is out of the scope of the person-trip survey. This survey also focused on trip characteristics of public buses (bus routes, OD, number of passengers, etc.) and bus passengers.

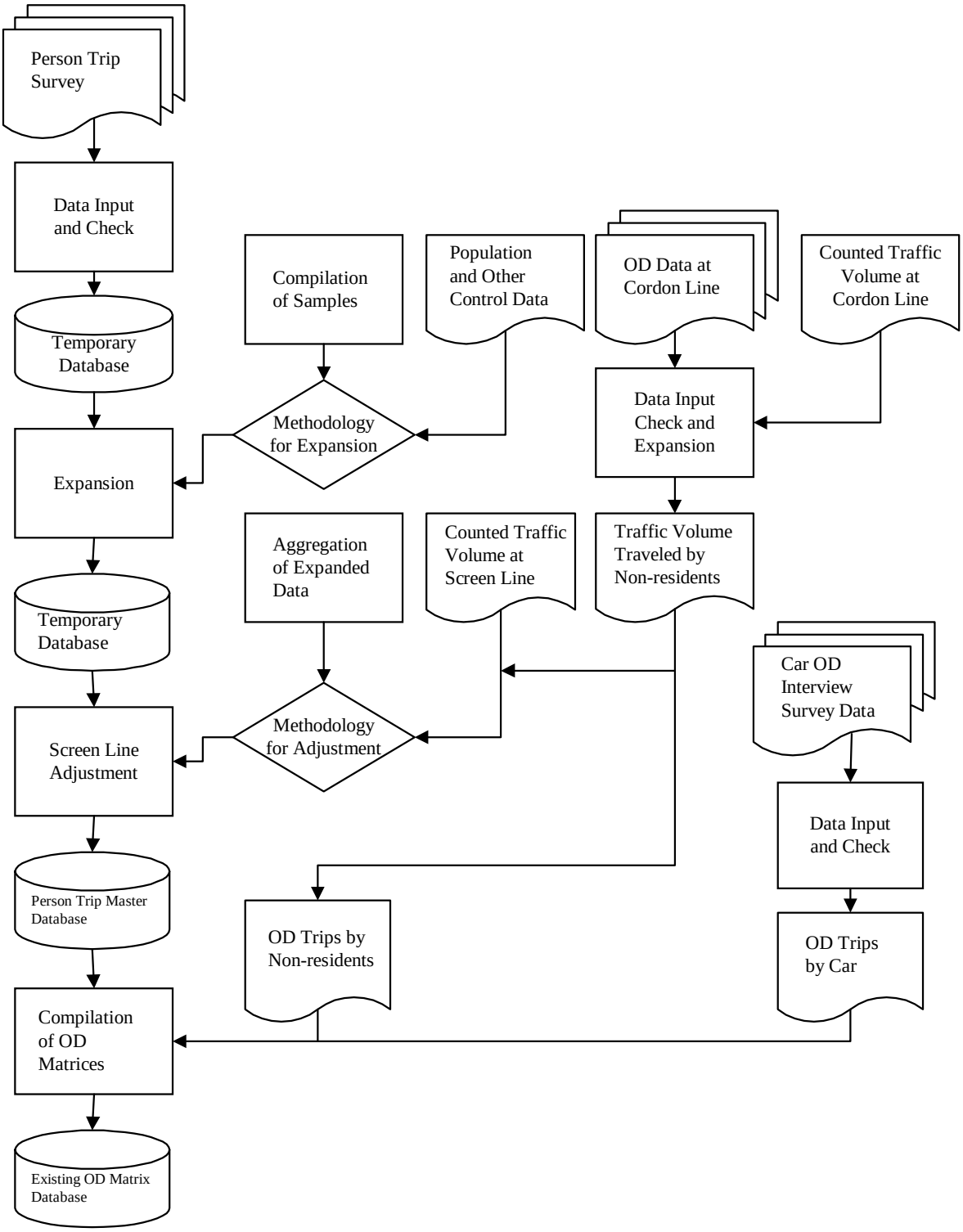
5) **Traffic Volume Count Survey (Cordon Line and Screen Line)**: Traffic volumes were counted both at the cordon line and the screen line at the same time when the OD survey was conducted. The traffic volume counted was compared with the trips aggregated based on the result of the person-trip survey. Since the average occupancy ratio by mode was necessary for this comparison, it was also measured at the screen line.

(2) Transport Estimate of Existing Demand

Figure 4.1.2 shows the outline of data processing pertinent to the person trip and the present origin-destination matrix database. This process can be roughly divided into four (4) steps: input and check of data, expansion of data, screen line adjustment and compilation of OD matrix.

After coding the stated data into numeric data, all information was inputted, validated and checked. The person trip survey is a sample survey and needs expansion in order to represent the characteristics of the entire population. Expansion is in general related closely to a methodology of sampling. In this study, several means of expansion have been tested, and the one, which was considered most accurate, was employed. After the expansion, the next step was to calculate the traffic volume by vehicle type crossing the screen line from the expanded person trip results, and then compared them with the actually counted traffic volume on the screen line. However, the counted volume contains the trips made by non-residents, which must be excluded when the comparison is done. The initially identified expansion factors were then adjusted based on this comparison. After the adjustment, origin-destination matrices were compiled based on the person trip master database, the OD matrix of trips made by non-residents and the OD matrix of cars.

Figure 4.1.2 Data Processing for Person Trip Related Database



(3) Number of Effective Samples

Tables 4.1.6 to 4.1.9 show the number of samples after the validation and data check were conducted. In general, validation, checking and correction process is time-consuming. The following activities were conducted taking into account the time constraints.

1) All the 125 traffic zones must have effective data.
2) A household must have necessary sheets of answers. If there was a missing sheet, it recovered by reviewing the original survey sheet.
3) Sex, age and occupation in personal attribute data are indispensable for the analysis. Errors in these data should be corrected based on the original survey sheet, if any. If the correction was difficult, the whole information of this household was excluded.
4) Origin, destination, purpose and mode of trip used are indispensable for the analysis on existing travel demand. Errors in these data should be corrected based on the original survey sheet, if any. If the correction was difficult, the whole information of this household was excluded.
5) Although the logical check was done, it was not reflected on the correction.

As a result, the number of effective samples became 32,676 people (71.4% of total) while the total number of interviewed samples was 45,734 people or 19,241 households. As the total population was 3,089,900 including 474,500 temporary population, the sample rate was 1.15%.

Table 4.1.6 Number of Effective Samples in Person Trip Survey

Area (District)	Total of Survey		No. of Effective Samples			Rate of Effective Samples (%)	Population		Sample Rate (%)
	Household	Person	Permanent	Temporary	Total		Permanent	Temporary	
Jinjiang	2,880	7,030	4,923	582	5,505	78.3	386,500	53,300	1.3
Qingyang	3,075	7,795	4,932	589	5,512	70.7	459,100	121,700	0.9
Jinniu	5,088	10,337	5,764	1,748	7,512	72.7	549,900	104,800	1.1
Wuhou	2,766	6,867	3,453	491	3,944	57.4	399,000	122,900	0.8
Chenghua	3,532	8,958	5,655	750	6,405	71.5	527,500	45,600	1.1
Gaoxin	932	2,059	1,502	110	1,612	78.3	122,900	14,100	1.2
Others	968	2,688	2,041	145	2,186	81.3	170,500	12,100	1.2
Total	19,241	45,734	28,261	4,415	32,676	71.4	2,615,400	474,500	1.1

As for the Car OD survey, 5,172 effective samples of motor vehicles or 8.0% of total vehicle registered population (64,750 vehicles) were compiled in the database after the validation and checking. In the OD interview survey at cordon line stations, at

least 3.0% of the traffic volumes counted were interviewed for all transport modes except bus. The selected bus traffic crossing the cordon line was stopped and their drivers were interviewed. Besides, bus passengers randomly selected were interviewed regarding their trip behavior. The sample rate of interviewed buses was relatively high at 11.6%.

Table 4.1.7 Effective Samples on Car OD Survey

Area (District)	No. of Registered Vehicles	No. of Samples Interviewed	No. of Effective Samples	Sample Rate (%)
Jinjiang	19,531	788	765	3.9
Qingyang	14,914	903	874	5.9
Jingniu	11,368	1,395	1,352	11.9
Wuhou	9,800	558	503	5.1
Chenghua	8,814	1,588	1,545	17.5
Gaoxin	323	126	119	36.8
Others	---	14	14	---
Total	64,750	5,372	5,172	8.0

Table 4.1.8 Effective Samples of OD Survey at Cordon Line (All Stations)

	24-hour Traffic Volume	No. of Interviewees	Sample Rate (%)
Pedestrian	11,316	371	3.3
Bicycle	52,750	1,557	3.0
Motorcycle	37,154	1,705	4.6
Car	75,808	3,846	5.1
Taxi	7,054	532	7.5
Cargo Vehicle	54,970	3,375	6.1

Table 4.1.9 Effective Samples of Bus OD Survey at Cordon Line (All Stations)

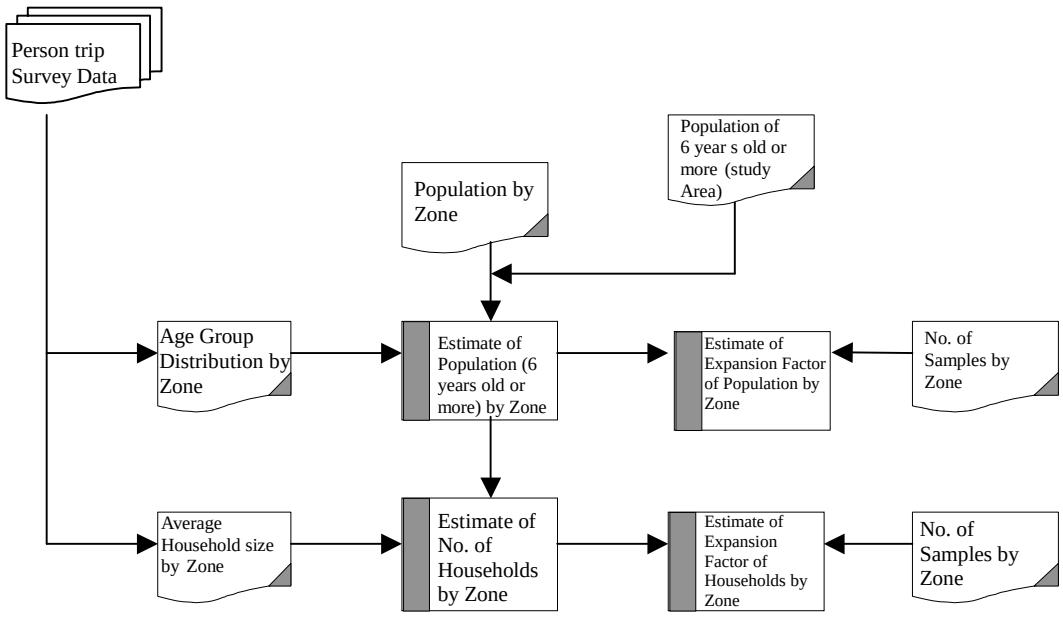
Direction	24-hour Traffic	No. of Drivers Interviewed	Sample Rate (%)	No. of passengers Interviewed
From Inside to Outside Study Area	10,754	1,240	11.5	1,508
From Inside to Outside Study Area	10,681	1,238	11.6	1,685
Total	21,435	2,478	11.6	3,193

(4) Expansion Factor

In the process of expansion, the bias of the sampled data can be eliminated if the expansion factor is set according to the distribution of a known attributes, so that no statistically significant difference appears.The sampling was done by household in the person trip survey. If there is a bias in the household size and in the sex/age structure of households, the expanded result shows a deviation from the actual sex/age structure. Taking this into account, the expansion was done independently based on the number of households and on the population. The expansion factor by the registered and the temporary population were respectively examined. The expansion factor of the total population including temporary population, however, was employed in consideration of the consistency with the statistics.

For the expansion, population over 6 years old should be estimated. This was done by multiplying the existing population by the ratio of population over 6 years old counted by the person trip survey. The average expansion factor was 90.5 for households and 88.6 for individuals, which means one person sample has a weight of 89 people. Figure 4.1.3 illustrates the calculation steps for expansion factors.

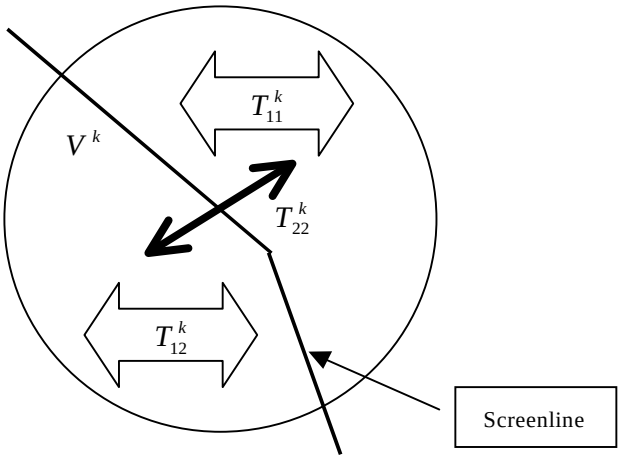
Figure 4.1.3 Calculation of Expansion Factors



(5) Screen Line Adjustment

Screen line adjustment aims to adjust the number of trips aggregated from the person trip database to the traffic volume actually counted. The adjustment factor at the screen line can be calculated by comparing the screen line traffic and the number of person trips (V^k / T^k_{12}). This adjustment factor was employed to adjust all trips (T^k_{11}、T^k_{22}、T^k_{12}) in the Study Area.

Figure 4.1.4 Concept of Adjustment by Screen Line Traffic Volume



V^k: Screen line traffic of vehicle type k

T^k_{12}: Person trip traffic crossing the screen line of vehicle k

T^k_{11}, T^k_{12} : Person trip traffic not crossing the screen line of vehicle type k

The following table shows the result of comparing the traffic volume calculated based on the person trip survey with the traffic volume actually counted. The traffic volume calculated from the person trip survey is the number of person trips, while the traffic volume counted is the number of vehicle trips. Therefore, the number of person trips was converted to the number of vehicle trips by using the average occupancy ratio by transport mode. Besides, the traffic volume counted includes the trips made by non-residents that should be excluded when the comparison was done.

The adjustment factor computed is 1.61 on average, which means 62% of the traffic was covered by the person trip interview survey. This is relatively low. However, the accuracy of vehicle trips has been improved by using the results of Car OD survey.

Table 4.1.10 Results of Screen Line Adjustment

Mode of Transport	Traffic Volume Calculated from Person Trip Survey					Traffic Volume Counted				Adjust-ment Factor
	from West to East		from East to West			Vehicle Traffic Volume on Screen line	Traffic Volume of Non-Residents		Total Vehicle Traffic Volume	
	No. of Person Trips	No. of Vehicle Trips	No. of Person Trips	No. of Vehicle Trips	Total No. of Vehicles		Vehicle Traffic Volume on Cordon line	Vehicle Volume to/from Railway Station		
Walk	43,731	43,731	39,492	39,492	83,223	128,045	0	0	128,045	1.54
Bicycle	225,782	225,782	231,394	231,394	457,176	594,849	4,280	0	590,569	1.29
Tricycle	5,956	3,901	6,031	3,950	7,852	21,803	742	72	20,989	2.67
Motorcycle	16,244	11,051	16,771	11,410	22,462	29,240	3,884	53	25,303	1.13
Motor Tricycle	1,722	956	1,661	922	1,878	6,302	737	0	5,565	2.96
Taxi	23,885	21,630	23,855	21,603	43,232	131,324	301	5,561	125,462	2.90
Car	42,708	20,672	43,472	21,042	41,715	161,730	11,729	577	149,424	3.58
Small Truck	10,596	5,579	11,922	6,277	11,856	28,118	5,314	0	22,804	1.92
Large Truck	6,511	3,317	6,603	3,363	6,680	21,589	7,438	0	14,151	2.12
Large bus (Public Transport)	56,433	1,892	57,491	1,927	3,819	12,464		89	12,375	3.24
Small bus (Public Transport)	26,482	2,354	26,898	2,391	4,745	11,003		813	10,190	2.15
Others	110	110	110	110	220	739	384	0	355	1.61
Total	460,160	340,975	465,700	343,882	684,856	1,147,206	34,809	7,165	1,105,232	1.61

(6) Passenger Occupancy by Type of Vehicle

The following table shows the average number of passengers by type of vehicle. The data was collected from the field survey conducted at 16 stations on the Screen Line and the figures in the table are the average numbers. These figures were applied in the screen line adjustment in the previous section.

Table 4.1.11 Average Occupancy by Type of Vehicle

Mode of Transport	Average Occupancy (persons/vehicle)
Tricycle	1.53
Motorcycle	1.47
Motor Tricycle	1.80
Taxi	2.10
Car	2.07
Small Truck	1.90
Large Truck	1.96
Large bus	29.83
Small bus	11.25

4.2 Outline of Person Trip

4.2.1 Number of Trips in the Study Area

The number of trips traveled by residents in the Study Area and non-residents is summarized in the following table. Total person trips per day are 8.5 million and person trips traveled by residents in the study area are 7.9 million or 93.6 percent of the total. The number of person trips crossing the Cordon Line is 940 thousand (or 11%) of which, 867 thousand trips are by road transport and 73 thousand trips are by train. The number of person trips crossing the Cordon Line by residents is 383 thousand (44% of total of trips crossing the Cordon Line). According to the OD survey at the railway station, 60 thousand passengers (82.7%) are non-residents. 48.6% trips of the railway passengers counted are transfer passengers changing their mode of transport at the north railway station, adding little load on the transport system of Chengdu.

Table 4.2.1 Number of Trips in the Study Area

Trip Distance	Mode	Trips by Residents in the Study Area (000/day)	Trips by Non-Residents (000/day)	Total (000/day)
Inside Study Area	Road	7,528.9	-	7,528.9
Between Study Area and Outer Area	Road	383.0	484.0	867.0
	Railway	12.6	60.1	72.7
Total		7,924.5	544.1	8,468.6

Note: including pedestrians

A trip production rate of 2.56 was calculated by dividing the total number of trips by the total population of 3,089.9 thousand (registered population: 2,615.4 thousand, temporary population: 474.5 thousand). This figure is significantly higher than the trip production rate of 2.16 by the person trip survey conducted in 1987.

This section focuses on the trips traveled by residents in the Study Area, and analyzes the characteristics of trip makers, the characteristics of trips, the existing network and the public transportation system. Forecasting models for the future travel demand is discussed in chapter 5 based of the result of this analysis.

4.2.2 Number of Trips by Purpose and Transport Mode

(1) Trips by Purpose

Table 4.2.2 presents the number of trips by purpose. “To work” trips account for 17.7% (1,400 thousand trips) and “to school” trips account for 7.0% (557 thousand trips), of total trips with walking trips included. The working population (1,723.6 thousand) shares 60% of the total population of 6 years old and over, 81% of which make “to work” trips. The rest of the working population can be individual workers who don’t need to make a commuting trip daily.

It is remarkable that the number of trips with private purpose consists 21% of total trips, which is much higher than that of "to work" trips. Person trips with shopping purposes comprise half of the private purpose trips. The number of trips for dining outside and social purposes is ranked as 2nd. Accordingly, the Study Team needed to pay attention to not only peak hours but also off-peak hours when a master plan was discussed. Business purpose trips are 7.5% of the total trips (or 600 thousand person trips). "To home" trips are 46.8% of the total number of person trips. "To home" trips should be half of the total trips if all people take two trips (e.g. commuting and going home). Therefore, about 6% of the people take more than three trips (e.g. commuting, shopping and going home).

Table 4.2.2 Number of Person Trips by Trip Purpose

Trip Purpose	All Trips			Excluding Walk Trips		
	No. of Trips (1,000)	Percent to Total (%)	Percent to Purpose (%)	No. of Trips (1,000)	Percent to Total (%)	Percent to Purpose (%)
Work	1,401	17.7		1,131	20.6	
School	557	7.0		336	6.1	
Home	3,709	46.8		2,546	46.4	
Private	1,663	21.0	100.0	977	17.8	100.0
Shopping	817	10.3	49.1	411	7.5	42.1
Dining/Social	373	4.7	22.4	231	4.2	23.6
Sightseeing/Entertainment	222	2.8	13.3	131	2.4	13.4
Others	157	2.0	9.5	122	2.2	12.5
Accompany Others	95	1.2	5.7	82	1.5	8.4
Business	595	7.5	100.0	495	9.0	100.0
Sales/Delivery	313	3.9	52.6	270	4.9	54.5
Meeting	120	1.5	20.1	99	1.8	20.1
Mechanical Work	50	0.6	8.3	42	0.8	8.5
Agriculture	16	0.2	2.7	5	0.1	0.9
Others	97	1.2	16.3	79	1.4	16.0
Total	7,924	100.0		5,486	100.0	

(2) Modal Choice

Based on the person-trip survey, walk trips account for 31% and bicycle trips 44%. Both account for 75% or 5,909 thousand trips. The share of trips by bus is very small at 10% or 807 thousand trips, by car and taxi about 10% and the number of motorcycle trips is only 206 thousand trips.

Table 4.2.3 Mode of Transportation

Mode of Transport	All Trips		Excluding "Home" Trips	
	No. of Trips (1,000)	Ratio (%)	No. of Trips (1,000)	Ratio (%)
Walk	2,439	30.8	1,275	30.3
Bicycle	3,470	43.8	1,823	43.2
Motorcycle	206	2.6	112	2.6
Taxi	372	4.7	194	4.6
Car	474	6.0	272	6.4
Truck	153	1.9	89	2.1
Bus	807	10.2	449	10.6
Others	5	0.1	2	0.1
Total	7,924	100.0	4,215	100.0

Figure 4.2.1 and Table 4.2.4 show the modal choice by trip purpose. The share of commuting and going to school trips by bicycle is more than 50% meanwhile the share of private purpose trips by bicycle is lower at 30%. This shows that bicycles are used to avoid traffic jam in peak hours and public transport is used in off-peak hours. They seem to take bus when they have enough time for traveling.

Figure 4.2.1 Modal Choice by Trip Purpose

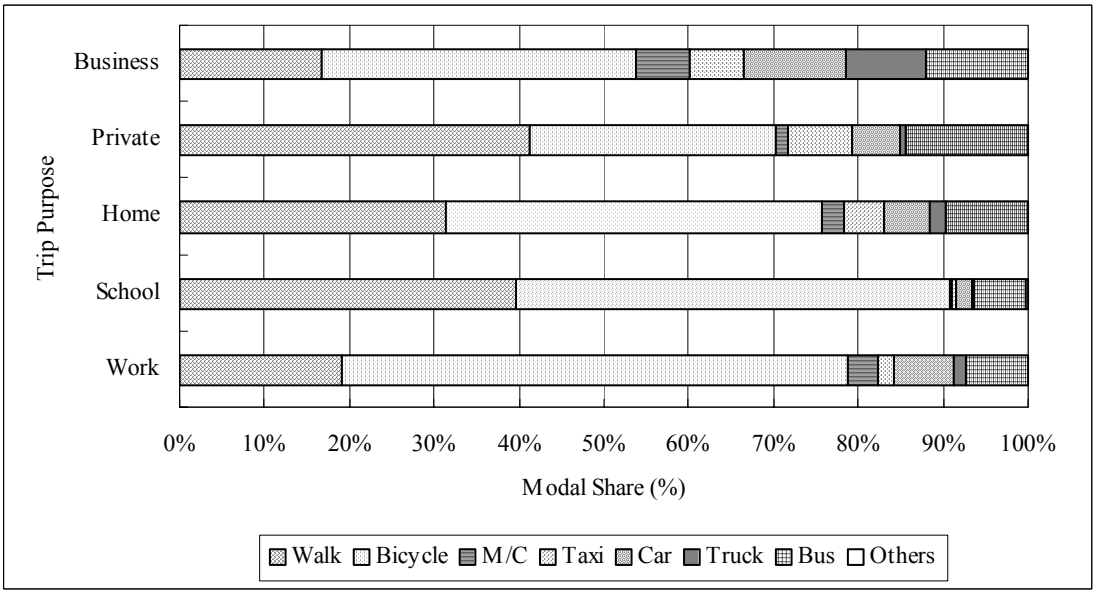


Table 4.2.4 Number of Trips by Mode and by Trip Purpose

Trip Purpose	Mode of Transport								Total
	Walk	Bicycle	Motorcycle	Taxi	Car	Truck	Bus	Others	
To work	269	835	49	26	97	20	104	0	1,401
(%)	19.2	59.6	3.5	1.9	6.9	1.4	7.4	0.0	100.0
To School	221	285	1	3	10	1	35	1	557
(%)	39.6	51.2	0.2	0.5	1.8	0.2	6.2	0.2	100.0
Home	1,164	1,647	94	178	203	64	358	2	3,709
(%)	31.4	44.4	2.5	4.8	5.5	1.7	9.7	0.1	100.0
Private	686	482	24	127	92	12	240	1	1,663
(%)	41.2	29.0	1.4	7.6	5.6	0.7	14.4	0.0	100.0
Business	100	220	37	38	72	56	70	1	595
(%)	16.7	37.1	6.3	6.4	12.1	9.5	11.8	0.1	100.0
Total	2,439	3,470	206	372	474	153	807	5	7,926
(%)	30.8	43.8	2.6	4.7	6.0	1.9	10.2	0.1	100.0

4.2.3 Number of Trips by Hour and Travel Time by Mode

(1) Generation and Attraction by Hour

Figure 4.2.2 and Table 4.2.5 indicate that the number of attracted trips is highest between 8 am and 9 am and the peak hour ratio is calculated at 17%. On the other hand, the peak hour of trip generation for bicycle is between 7 am and 8 am, for motorcycle, car and bus between 8 am to 9 am. More than 90% of the total trips are generated and attracted between 7 am and 7 pm while the trips made during the rest of the period is very few.

Figure 4.2.2 Trip Generation by Mode and by Hour

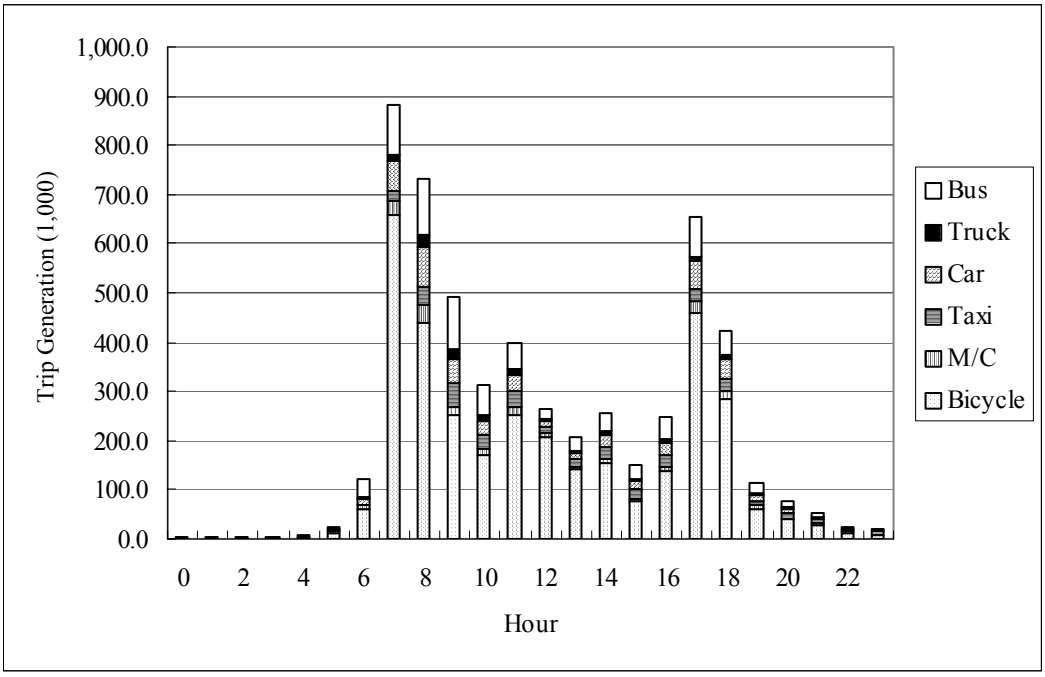


Figure 4.2.3 Trip Attraction by Mode and by Hour

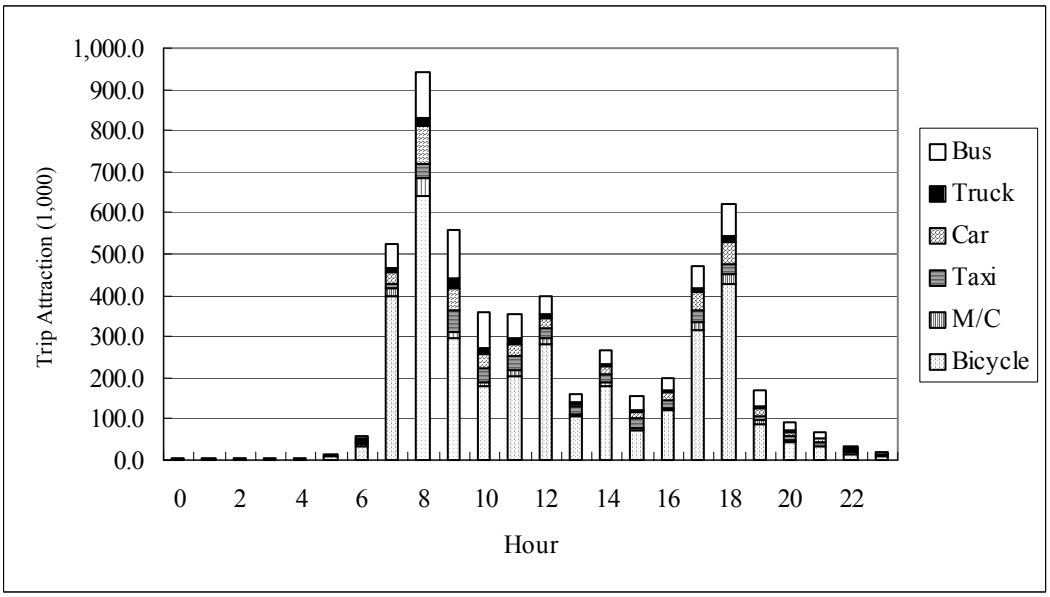


Table 4.2.5 Trip Generation by Mode and by Hour

Hour	Bicycle	Motorcycle	Taxi	Car	Truck	Bus	Total
0 - 1	1.4	0.4	1.1	0.5	0.3	0.9	4.6
1 - 2	2.9	0.2	0.9	0.4	0.2	1.0	5.5
2 - 3	1.5	0.1	0.0	0.4	0.0	0.2	2.3
3 - 4	1.6	0.8	0.0	0.0	0.0	0.0	2.4
4 - 5	3.1	1.4	0.2	0.3	0.6	1.4	7.0
5 - 6	14.1	2.2	1.1	2.9	1.3	1.8	23.4
6 - 7	60.0	7.3	3.5	10.2	6.4	34.5	121.9
7 - 8	656.7	32.2	19.1	60.1	13.5	99.7	881.2
8 - 9	438.9	35.1	39.7	80.4	23.8	113.9	731.7
9 - 10	252.3	14.6	50.9	47.3	22.5	104.8	492.4
10 - 11	172.6	8.9	30.1	27.0	12.2	60.8	311.6
11 - 12	253.6	12.7	36.3	29.8	12.7	55.2	400.3
12 - 13	207.2	8.0	12.9	13.6	4.2	18.8	264.6
13 - 14	142.8	5.5	15.9	9.0	7.2	27.8	208.3
14 - 15	154.1	9.1	25.0	22.3	8.7	37.7	257.0
15 - 16	75.7	5.0	21.5	14.7	5.6	28.8	151.2
16 - 17	137.9	8.6	24.7	23.3	7.7	46.2	248.3
17 - 18	457.9	24.7	24.1	59.2	8.7	80.1	654.8
18 - 19	283.1	17.6	24.1	41.0	7.8	48.4	422.0
19 - 20	62.6	5.0	9.1	12.8	4.4	21.8	115.7
20 - 21	39.3	3.3	11.0	8.7	3.0	13.9	79.2
21 - 22	29.2	1.8	8.8	5.1	1.0	6.5	52.4
22 - 23	12.8	0.6	4.3	3.9	1.1	2.0	24.7
23 - 24	8.4	0.5	7.4	1.5	0.2	0.6	18.6
24 hour	3,469.7	205.5	371.7	474.2	153.2	806.8	5,481.1

Table 4.2.6 Trip Attraction by Mode and by Hour

Hour	Bicycle	Motorcycle	Taxi	Car	Truck	Bus	Total
0 - 1	1.7	0.1	0.3	0.3	0.3	0.4	3.2
1 - 2	1.9	0.1	1.5	0.5	0.2	1.1	5.3
2 - 3	3.5	0.2	0.2	0.6	0.3	0.4	5.1
3 - 4	1.0	0.5	0.7	0.3	0.0	0.4	3.0
4 - 5	2.9	1.0	0.2	0.1	0.0	0.9	5.2
5 - 6	9.4	1.6	0.7	1.7	1.0	0.7	15.1
6 - 7	34.1	5.8	2.1	4.8	4.5	5.3	56.5
7 - 8	397.8	22.1	8.8	27.3	8.3	58.1	522.4
8 - 9	640.8	44.3	33.8	91.8	19.3	109.4	939.3
9 - 10	294.1	16.3	51.9	55.3	22.7	116.6	556.9
10 - 11	179.2	8.9	34.2	34.8	16.5	85.5	359.2
11 - 12	205.8	10.3	36.2	29.0	13.6	59.1	354.0
12 - 13	283.9	12.1	24.8	22.8	9.7	43.2	396.5
13 - 14	108.1	4.2	16.5	7.9	4.5	20.3	161.5
14 - 15	178.7	9.4	19.2	19.5	7.6	33.3	267.8
15 - 16	74.4	4.8	22.1	14.4	7.0	31.3	154.0
16 - 17	119.0	6.2	20.8	16.8	6.8	30.5	200.1
17 - 18	315.5	19.1	29.6	42.2	9.9	52.7	469.1
18 - 19	425.3	24.3	24.7	57.2	10.3	81.9	623.7
19 - 20	89.2	6.4	11.2	20.8	4.2	38.9	170.7
20 - 21	44.1	4.1	10.5	10.6	3.5	20.5	93.2
21 - 22	32.7	2.2	10.4	8.3	1.8	10.5	65.8
22 - 23	16.5	0.8	5.7	4.7	0.8	5.1	33.5
23 - 24	10.2	0.7	5.6	2.2	0.4	0.6	19.7
24 hour	3,469.7	205.5	371.7	474.2	153.2	806.8	5,481.1

(2) Travel Time by Mode of Transport

In the person-trip survey, departure and arrival time of the trips were asked. Travel time by mode can be estimated based on this information. Figure 4.2.4 shows the modal share by travel time. Travel time of walk trips is almost less than 30 minutes. More than 97% of bicycle trips are within 60 minutes. The share of bus trips rises from 30 to 45 minutes. The share of car trips becomes higher from around 60 minutes of travel time. The average travel time of bus is the longest at 53 minutes followed by that of car (42 minutes). It is difficult to judge whether the travel time by bus is actually longer than that by car for the same distance or people take bus for longer distance trips.

Figure 4.2.4 Travel Time by Mode of Transport

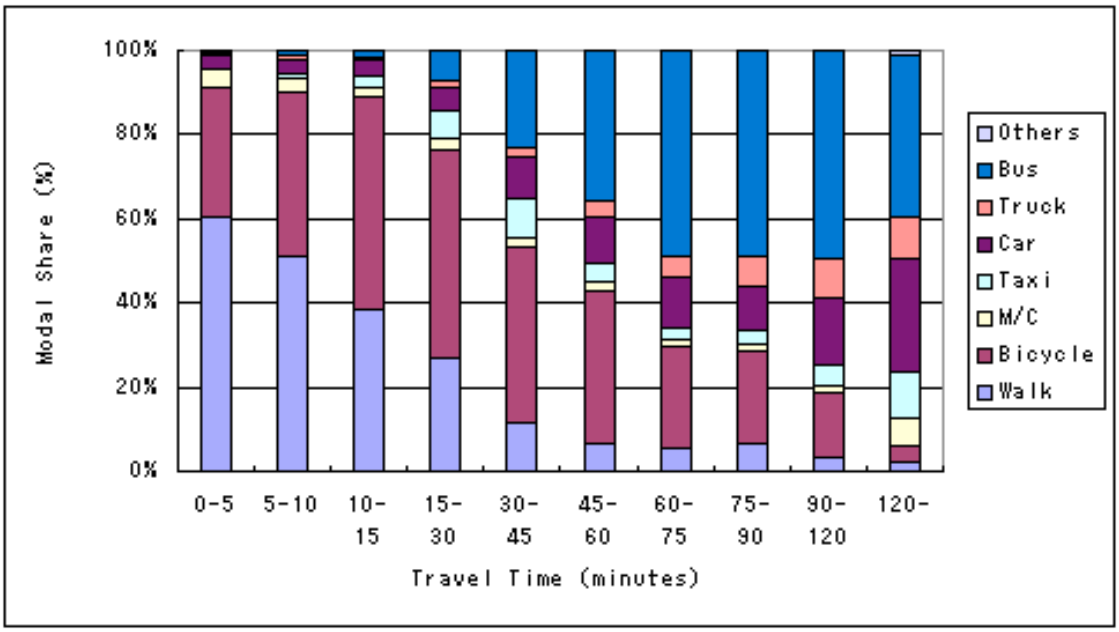


Table 4.2.7 Average Travel Time by Mode of Transport

Mode	No. of Trips by Travel Time (1,000)										Total	Average Travel Time (min.)
	0-5	5-10	10-15	15-30	30-45	45-60	60-75	75-90	90-120	120-		
Walk	169	802	428	837	84	37	8	8	2	1	2,376	21
Bicycle	87	620	564	1,529	309	207	35	27	10	2	3,389	28
M/C	11	46	25	83	16	12	2	2	1	3	200	30
Taxi	1	25	32	193	73	25	4	4	3	5	365	36
Car	8	48	38	181	72	62	17	13	10	13	464	42
Truck	1	19	11	51	17	22	7	9	6	5	147	46
Bus	2	15	15	214	168	201	71	60	31	18	797	53
Others	0	0	1	1	1	0	0	0	0	0	4	63
Total	280	1,576	1,114	3,088	741	566	144	123	63	48	7,743	

4.2.4 Trip Generation and Attraction by Zone

Figures exhibiting trip generation/attraction by trip purpose and by mode are displayed in the following pages. Findings from the figures are as follows:

(1) Trip Generation and Attraction by Purpose

1) Many of the person trips are often generated in the "belt" area surrounded by the Inner Ring and the 2nd Ring Road. Trips are also generated outside the 2nd Ring Road such as Tianhui Town (71), Tuqiao (Jinniu District), Cuqiao (88) (Wuhou District), Longquanyi District (122) and Xipu Town (125) (Pi County).

2) On the other hand, person trips often concentrate within the central areas (Yanshikou (15), Renmin Dong-Lu (16)), the North Railway Station area (Xiaojiacun (54), Qingyang Bei-Lu (55), Renmin Bei-Lu (62)) and the southern areas inside the 1st Ring Road (Zhimin Lu (79), Xiaotianzhujie (80) and Jiangxijie (83)).

3) The purpose of person trips in Xiaojiacun is mainly business and in Zongfu Lu is mostly private trips. The person trips attracted in the southern areas inside the 1st Ring Road, are equally shared by “to work” trips and private trips.

4) The person trips attracted in the areas outside the 2nd Ring Road are mostly “to work” trips such as those to Jianshe Lu (97) and Taoxi Lu (106).

(2) Trip Generation and Attraction by Mode

1) 900,000 person trips attracted to Xiaojiacun (54) are still huge even after trips by walk and bicycle are excluded.

2) A lot of trips by car and bus concentrate in the area inside the Inner Ring Road, where the share of private trip is relatively high.

3) Bicycle trips are concentrating in Jianshe Lu(97), Taoxi Lu(106) and Huangtianba (43) where the share of commuting trips is high.

4) The share of trip by motorcycle is high in the zones in the belt area between the 3rd Ring Road and the Outer Ring Road, such as Longquan District (122), Honghe Town (121), Gaodianzi (23), Liulichang (21), Shiyangchang (117) and Cuqiao (88). In the area between the 2nd Ring Road and the 3rd Ring Road, zones such as Tianhui Town (71), Tuqiao (75), Longquanyi District (122), Xipu Town (125) have a lot of trip generation.

Figure 4.2.5 Trip Generation/Attraction by Purpose

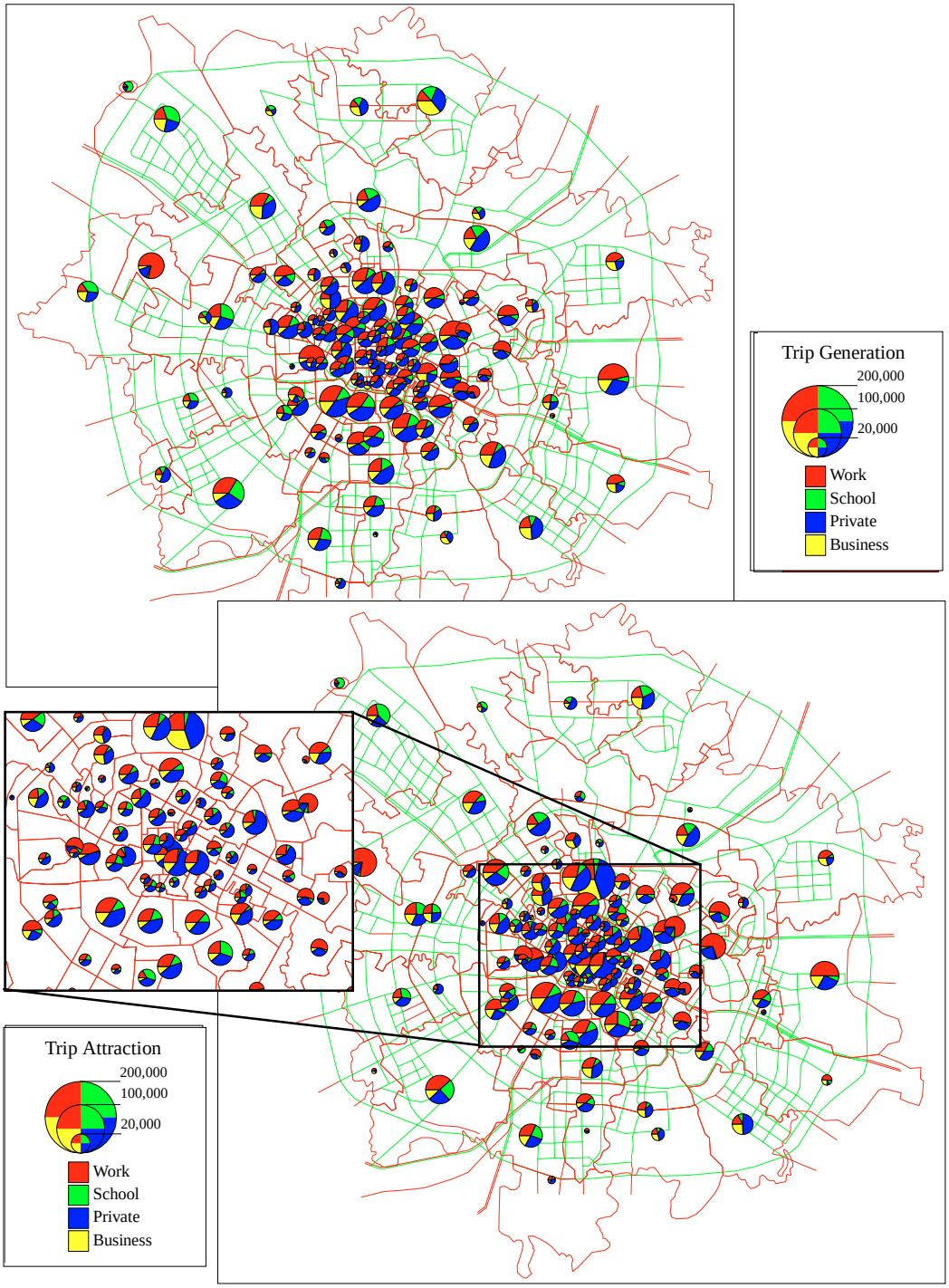


Figure 4.2.6 Trip Generation /Attraction by Mode

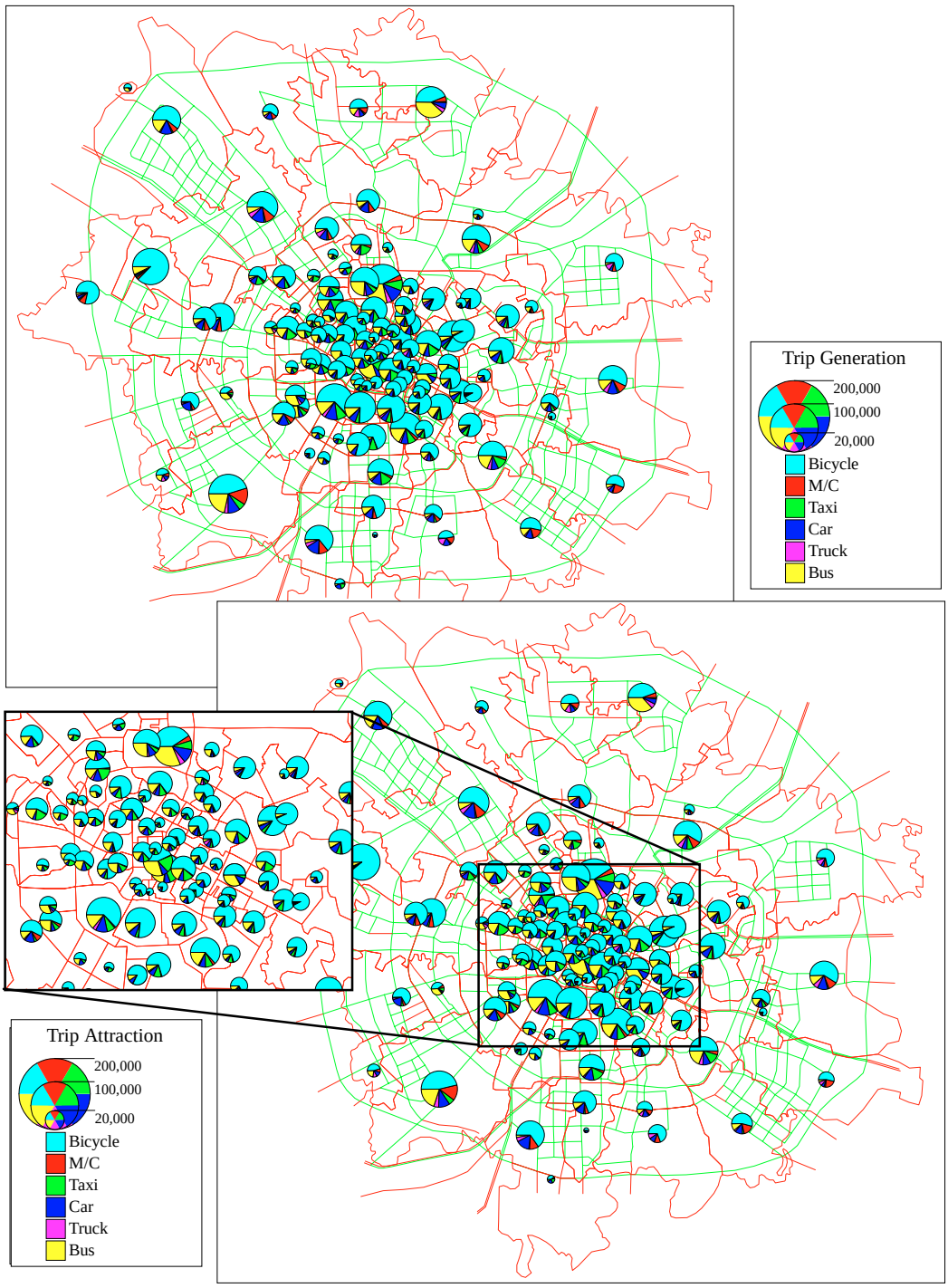
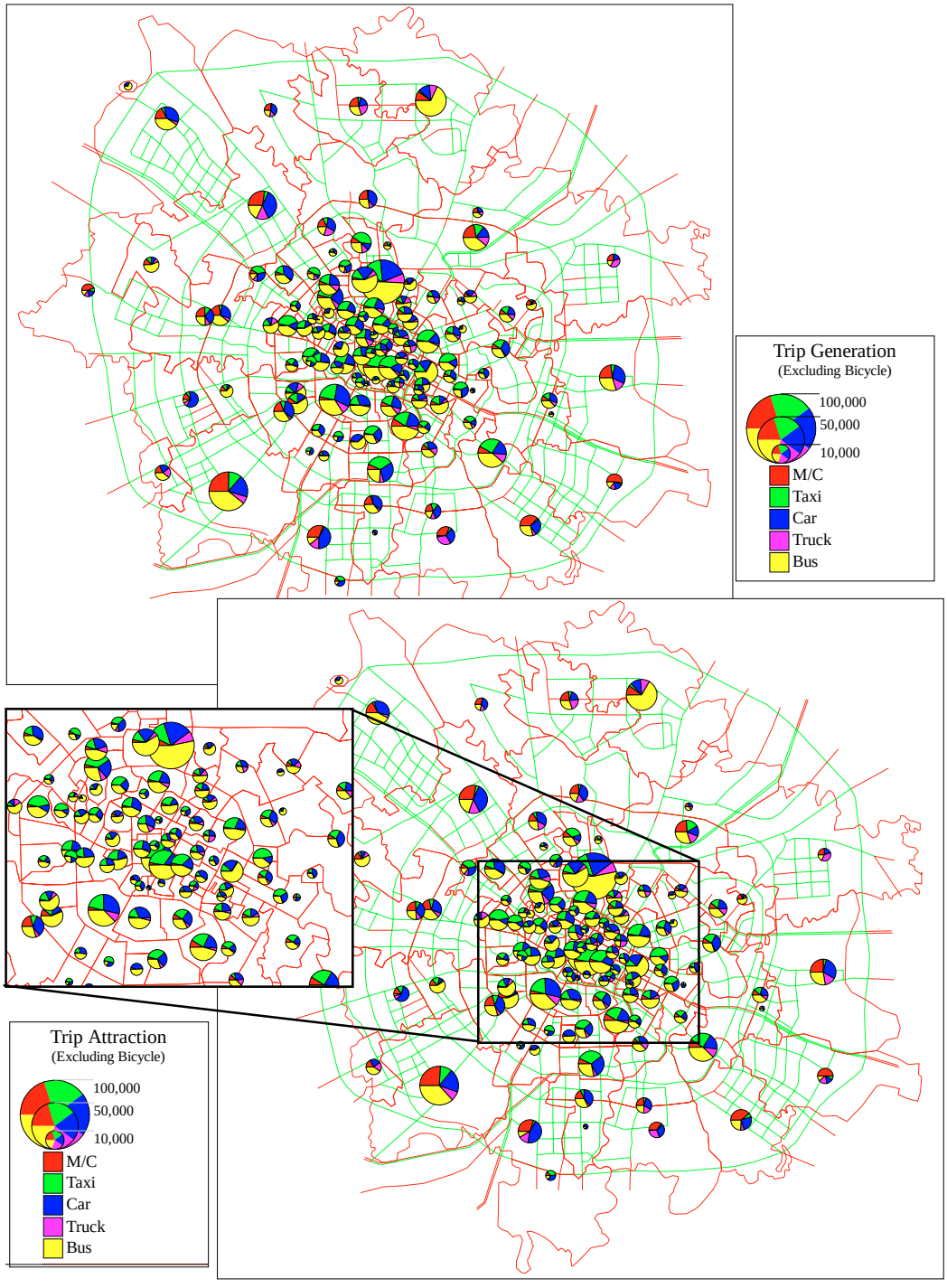


Figure 4.2.7 Trip Generation /Attraction by Mode (Excluding Bicycle)



4.3 Transport Demand Distribution

4.3.1 Transport Demand Distribution

(1) Traffic Volume of Medium Zone

Detailed trip information, such as trip purpose, transport mode, the place of origin and destination and travel time, was captured in the person-trip survey. The traffic zoning presented in Figure 4.1.1 was used to code the information of origin and destination places. Traffic zone system has 125 small zones in the Study Area, and 34 zones outside; there are 159 small zones in total. However, this zoning is too detailed to understand the outline of traffic volume between areas. Thus, the small zones were integrated into a medium-size zones and the traffic characteristics are discussed in this section by this zoning.

The medium zone system is presented in Figure 4.3.1. The 125 small zones in the Study Area were integrated into 26 medium zones: 4 zones are inside the Inner Ring Road, 7 are between the 2nd and Inner Ring Roads, 7 are between the 2nd and 3rd Ring Road, and 7 are outside the 3rd Ring Road.

Figure 4.3.1 Medium Zone System

Travel demand for work, school, private and business trips are displayed in the following pages by the medium zone system. The person-trip survey classifies both private and business trips into more specific purposes; e.g. (a) “shopping and dining

outside" and "sales, meeting and mechanical work". These specific purposes are integrated into private and business in the following figures. "To home" trip (since this is a return trip from other purposes) and "walk" trip (since this does not affect vehicle traffic on road) were excluded from the figures. Therefore, the figures show only traffic of bicycles, private cars and public buses. The findings from the figures are as follows:

"Work" trip: The 4 zones which are located inside the Inner Ring Road attracted more than 188,000 "work" trips, and 1/4 of these trips are generated in the same zones. The zones between the Inner Ring Road and the 2nd Ring Road attracted 430,000 "work" trips which is twice the number of trips that concentrated in the zones inside the Inner Ring Road. There are 210,000 "work" trips generated from zones outside the 3rd Ring Road and more than 3/4 of these trips don't commute inside the 3rd Ring Road. Considering origin and destination zones of "work" trips, majority of OD is within zones between the Inner Ring Road and the 2nd Ring Road. The generated "work" trips from this area to the zones outside the 2nd Ring Road are large, especially from zone 6 to zone 12 or zone 13.

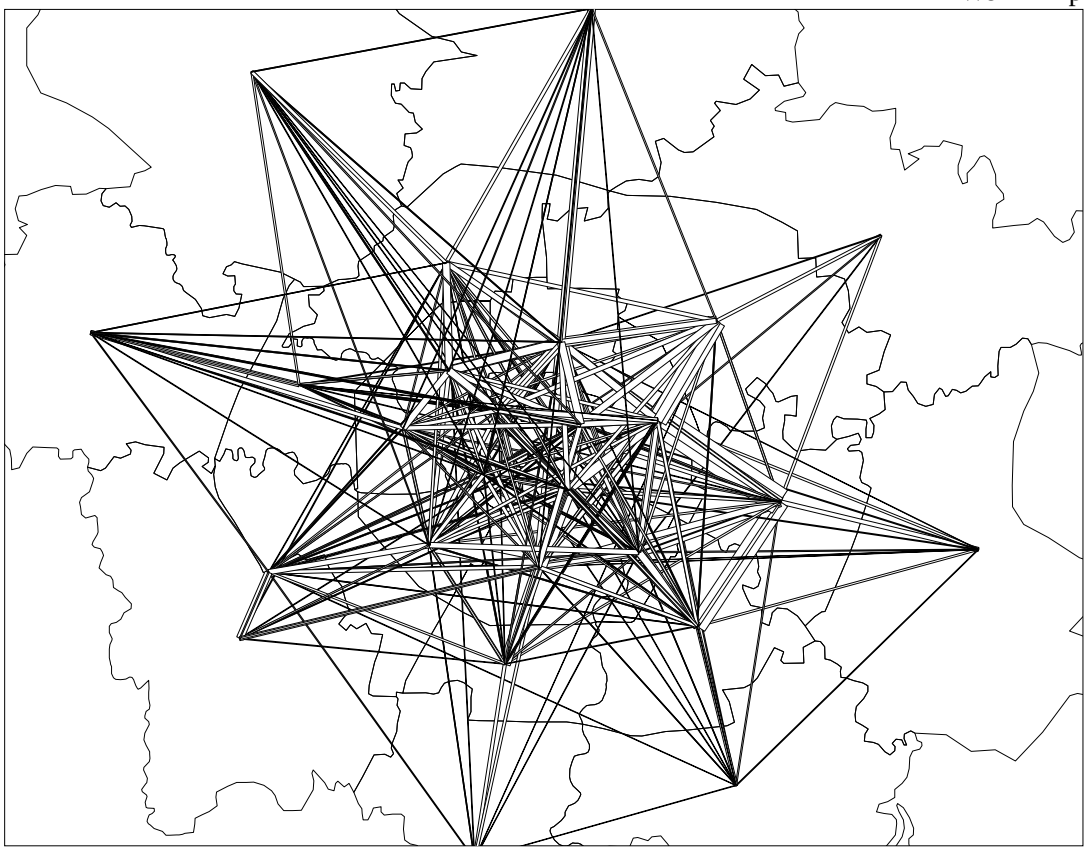
"School" trip: Many of the "school" trips concentrated in the following zones: 82,000 trips in zone 8; 22,000 trips in zone 5; 18,000 trips in zone 1; and 17,000 trips in zone 23. The OD trips concentrating in zone 23 does not look significant in the figure because most of these trips are generated from the same zone 23; 16,000 trips out of 17,000 are intra-zonal traffic. Even if intra-zonal trips are excluded, there are still 3 zones (zones 1, 8 and 11) that have a large number of "school" trips attracted. According to the OD matrices, trips to zone 1 mostly originate from zones 2, 4, 5 and 6; and trips to zone 8 originate mainly from neighboring areas of zones 9 and 15.

"Private" trip: Zone 2 attracts 139,000 "private" trips, which are higher than other zones. Four zones in the Inner Ring Road attract 274,000 "private" trips in total, sharing 30% of all the person trips. Other zones generating "private" trips, which concentrate in the central area, are located widely within the 3rd Ring Road. These trips are evenly distributed; and they obviously go farther than "to school" and "to work" trips. Zones 5 and 6, which are located between the inner and the 2nd Ring Road, also attract a large number of "private" trips. A large number of "private" trips from the zones outside the 3rd Ring Road concentrate to the inner area of the 2nd Ring Road.

"Business" trip: 70,000 trips of business purposes are mostly attracted in the north railway station area (zone 5), and "business" trips are particularly heavy in zones 2, 11 and 8. Zone 5 attracts "business" trips, which are mostly from zones 25 and 26 that are outside the 3rd Ring Road. Thus, the northern part of the Study Area is a center of concentration of business trips.

Figure 4.3.2 Distribution of Traffic Demand between Medium Zones

Work Trip



School Trip

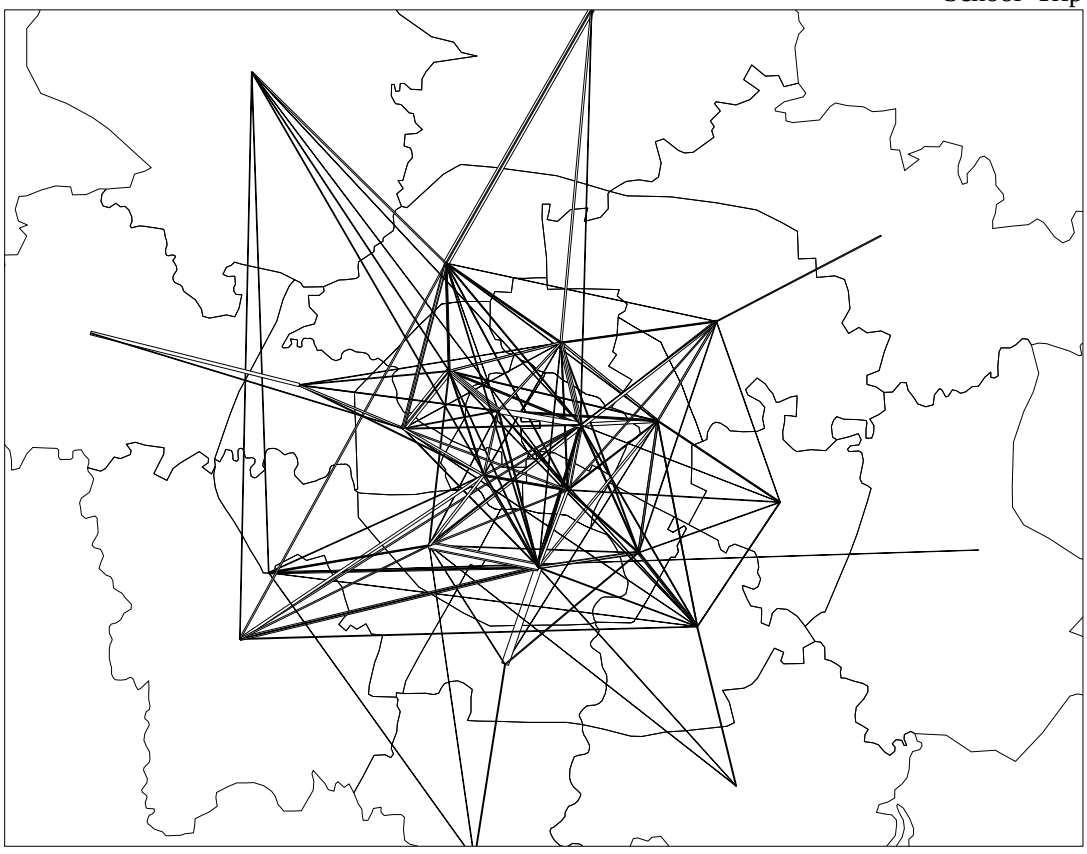
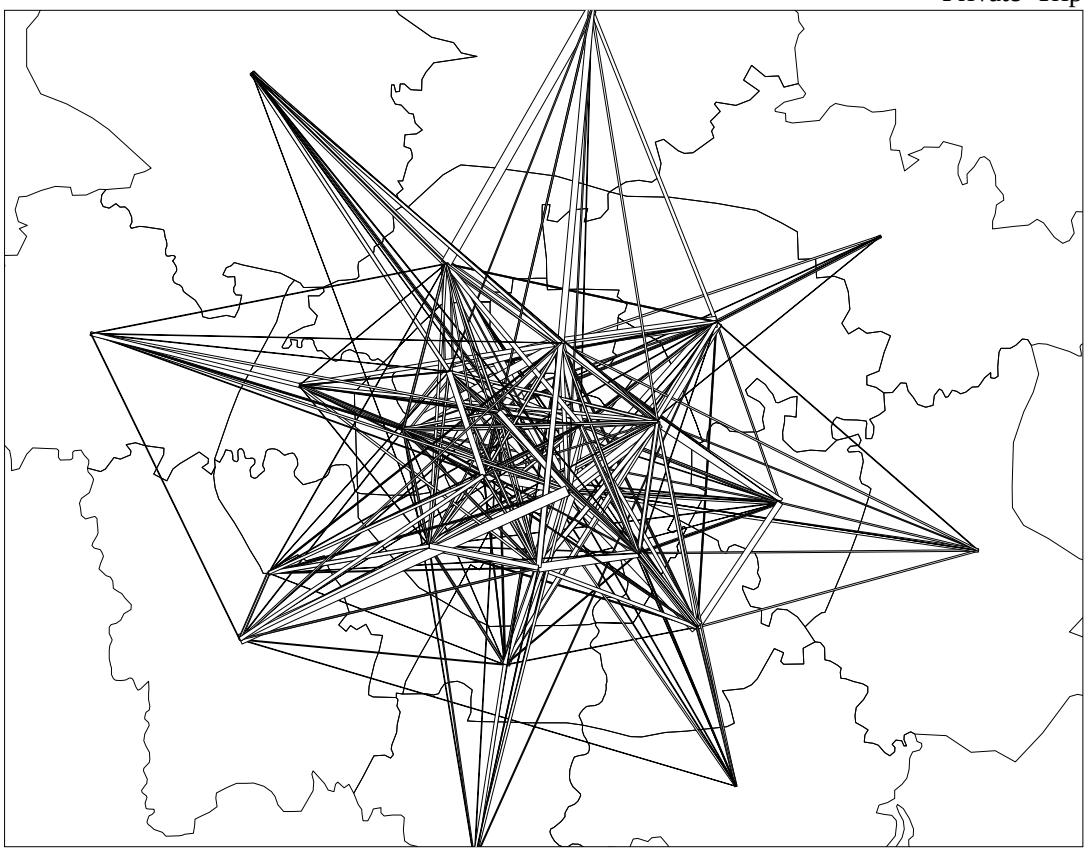
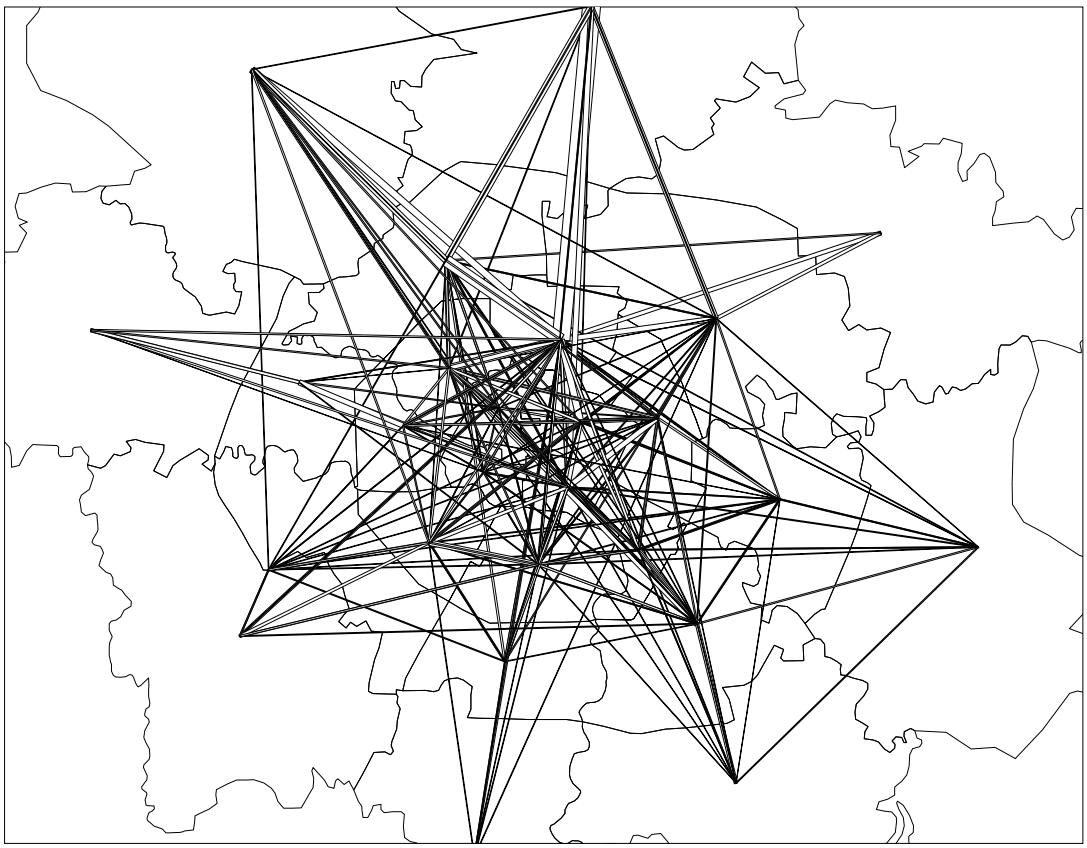


Figure 4.3.3 Distribution of Traffic Demand between Medium Zones

Private Trip



Business Trip



(2) Traffic Volume by Corridor Section

This section describe the mode of transport used in inter-zonal traffic based on the corridor-based large zones that were further integrated from the medium zones as explained in the previous section. Figure 4.3.4 presents the volume of person trips aggregated from the existing OD matrices, inside and between the corridors. In the figure, the volume in the upper row means the number of trips by all modes of transportation except "walk" trips with all purposes except "To home"; the volume in the middle exhibits that by bicycle and the volume in the bottom that by bus.

Given this traffic volume, the corridor extending eastward (II) has the highest number of trips. The 365,000 trips crossing the 2nd Ring Road in this corridor is noted while that crossing the Inner Ring Road is 307,000 trips. This is followed by the corridor extending southward (III). The section of the Inner Ring Road has 293,000 trips while the 2nd ring road has 220,000 trips. On the other hand, the traffic volume in the circumferential direction within zones between the Inner and the 2nd Ring Road is less than 100,000 trips; lower than the traffic volume in the radial directions. Trips by public bus are numerous in the corridor extending northward (I). About 40,000 to 60,000 bus trips are generated in other directions. Trips by bicycle are mostly generated along the corridor extending southward (III) and westward (IV). In conclusion, trips by bus mostly originate from the northern area, trips by car mostly originate from the southern and the western direction and all modes are equally used in the eastern direction.

The estimated traffic volumes are presented in Tables 4.3.1 and 4.3.2.

Figure 4.3.4 Traffic Volume by Corridor

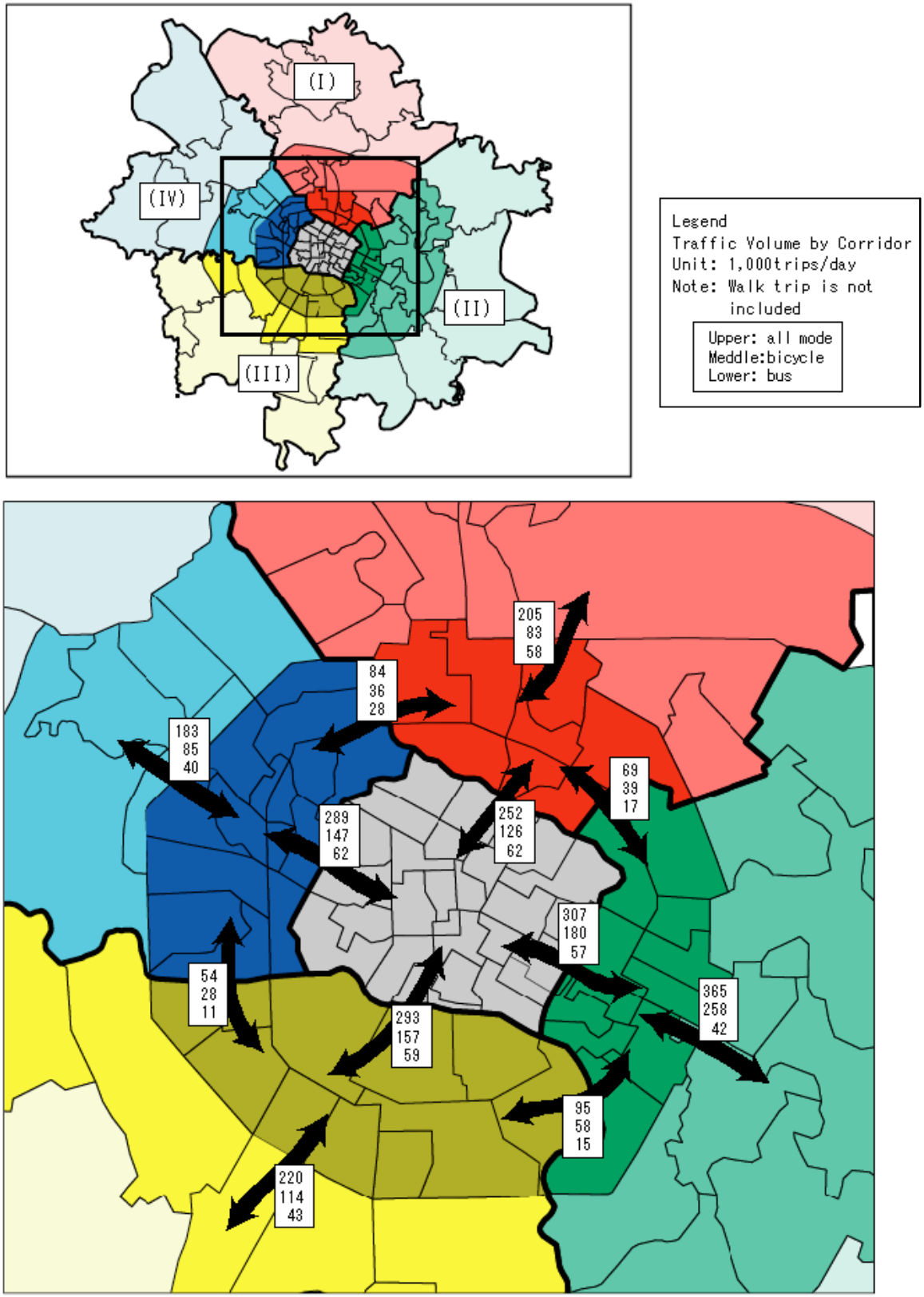


Table 4.3.1 Characteristics of Trip in Radial Direction

Corridor	Vehicle Type	Total No. of Trips		Intra-zonal		Radial Direction		Traffic Volume on Inner Ring Road		Traffic Volume on 2nd Ring Road	
				No. of Trips	Rate	No. of Trips	Rate	No. of Trips	Rate	No. of Trips	Rate
		('000)	(%)	('000)	(%)	('000)	(%)	('000)	(%)	('000)	(%)
I	Bicycle	1,124	59.3	559	49.7	230	50.4	126	50.1	83	40.6
	Motorcycle	87	4.6	34	38.5	21	4.7	4	1.8	12	5.7
	Car	260	13.7	50	19.2	81	17.7	51	20.3	44	21.4
	Truck	76	4.0	24	31.4	19	4.2	8	3.4	9	4.4
	Bus	350	18.4	75	21.3	105	23.0	62	24.5	58	28.0
	Total	1,896	100.0	741	39.1	456	100.0	252	100.0	205	100.0
II	Bicycle	1,707	69.0	831	48.7	405	68.1	180	58.7	258	70.7
	Motorcycle	102	4.1	66	64.6	15	2.5	6	1.9	7	2.1
	Car	316	12.8	96	30.4	89	15.1	61	19.7	54	14.8
	Truck	66	2.7	37	56.3	6	1.0	4	1.1	3	0.8
	Bus	284	11.5	66	23.1	79	13.3	57	18.6	42	11.7
	Total	2,475	100.0	1,095	44.2	594	100.0	307	100.0	365	100.0
III	Bicycle	1,389	62.4	829	59.7	259	55.8	157	53.5	114	51.8
	Motorcycle	106	4.8	67	63.3	16	3.4	3	1.2	7	3.2
	Car	363	16.3	126	34.6	101	21.8	70	24.0	51	23.4
	Truck	54	2.4	27	49.5	8	1.8	4	1.2	5	2.1
	Bus	313	14.1	117	37.2	80	17.2	59	20.1	43	19.6
	Total	2,226	100.0	1,165	52.3	464	100.0	293	100.0	220	100.0
IV	Bicycle	1,430	65.2	898	62.8	259	54.6	147	50.6	85	46.3
	Motorcycle	81	3.7	43	53.4	15	3.3	4	1.4	6	3.5
	Car	340	15.5	112	32.9	103	21.7	71	24.4	45	24.5
	Truck	45	2.0	16	35.3	10	2.0	6	2.1	7	3.6
	Bus	298	13.6	66	22.3	87	18.4	62	21.4	40	22.1
	Total	2,194	100.0	1,136	51.8	474	100.0	289	100.0	183	100.0

Table 4.3.2 Characteristics of Trip in Circumferential Direction

Circular Direction	Vehicle Type	I – II		II – III		III - IV		IV - I	
		No. of Trips	Rate	No. of Trips	Rate	No. of Trips	Rate	No. of Trips	Rate
		('000)	(%)	('000)	(%)	('000)	(%)	('000)	(%)
Inside 2nd Ring Road	Bicycle	39	57.1	58	61.7	28	51.5	36	43.4
	Motorcycle	1	1.2	1	1.3	1	2.4	1	1.6
	Car	10	15.2	19	19.9	13	24.7	17	19.8
	Truck	1	1.8	1	1.5	0	0.2	2	2.4
	Bus	17	24.8	15	15.6	11	21.1	28	32.8
	Total	69	100.0	95	100.0	54	100.0	84	100.0
Between 2nd Ring Road and 3rd	Bicycle	19	59.0	8	64.4	1	51.4	5	43.9
	Motorcycle	2	5.9	0	3.1	0	0.0	2	20.7
	Car	3	10.0	1	11.5	1	48.6	3	24.1
	Truck	2	5.8	1	6.4	0	0.0	0	0.8
	Bus	6	19.2	2	14.7	0	0.0	1	10.6
	Total	32	100.0	12	100.0	2	100.0	11	100.0

4.3.2 Trips during Peak Hour and Off-Peak Hour

Table 4.3.3 shows the number of trips attracted by hour and purpose, and peak ratio in the whole Study Area (except “walk” trips). As shown in the table, there is no concentration of traffic before 6 a.m. The morning peak hour is usually between 7:00 a.m. to 9:00 a.m. During this peak hour, “work” and “school” trips are concentrated at 75% to 80% of their respective total trips. The peak of “work” trips starts at 8:00 a.m. while “school” trips at 7:00 a.m. It is also noted that there is another less significant peak hour at 1:00 p.m. to 2:00 p.m. due to lunch.

On the other hand, compared with the peak hour ratio of “work” and “school” trips, the peak hour ratio of “private” trips is not very high with only 14% attracted at about 8:00 a.m., 32% of trips at 9:00 a.m. and 16% of trips at 10:00 a.m. The peak hour of “business’’ trips are similar to that of “work” trips, which also occur between 7:00 a.m. to 10:00 a.m. On the over-all, the peak hour ratio is considerably high at 29%, which takes place at 8:00 a.m.

Table 4.3.3 Trips Attracted by Hour and by Purpose

	Work		School		Private		Business		Total	
Hour	No. of Trips ('000)	Rate (%)	No. of Trips ('000)	Rate (%)	No. of Trips ('000)	Rate (%)	No. of Trips ('000)	Rate (%)	No. of Trips ('000)	Rate (%)
0 - 1	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
1 - 2	2	0.1	0	0.0	1	0.1	1	0.1	4	0.1
2 - 3	1	0.1	0	0.0	1	0.1	0	0.1	3	0.1
3 - 4	0	0.0	0	0.0	1	0.1	2	0.3	3	0.1
4 - 5	2	0.1	0	0.0	2	0.1	2	0.4	6	0.1
5 - 6	5	0.3	0	0.1	3	0.2	7	1.3	15	0.4
6 - 7	18	1.3	6	1.1	33	2.0	26	4.5	83	2.0
7 - 8	282	20.3	267	48.4	70	4.3	66	11.4	684	16.5
8 - 9	693	50.0	139	25.3	230	14.0	136	23.6	1,199	28.9
9 - 10	111	8.0	11	2.0	517	31.6	142	24.6	782	18.8
10 - 11	22	1.6	2	0.3	266	16.2	61	10.5	350	8.4
11 - 12	15	1.1	3	0.5	82	5.0	19	3.3	119	2.9
12 - 13	27	1.9	9	1.6	43	2.6	15	2.6	94	2.3
13 - 14	57	4.1	36	6.6	39	2.4	14	2.4	147	3.5
14 - 15	115	8.3	67	12.3	79	4.8	31	5.3	292	7.0
15 - 16	11	0.8	2	0.4	63	3.8	21	3.6	97	2.3
16 - 17	6	0.4	2	0.3	34	2.1	13	2.2	55	1.3
17 - 18	5	0.4	3	0.5	41	2.5	6	1.1	55	1.3
18 - 19	8	0.6	2	0.3	41	2.5	5	0.9	56	1.3
19 - 20	3	0.2	1	0.2	52	3.2	3	0.6	60	1.4
20 - 21	3	0.2	0	0.0	24	1.5	3	0.5	30	0.7
21 - 22	1	0.1	0	0.0	10	0.6	2	0.3	13	0.3
22 - 23	1	0.1	0	0.0	3	0.2	1	0.1	5	0.1
23 - 24	1	0.0	0	0.0	1	0.1	1	0.1	2	0.1
24 hour	1,387	100.0	550	100.0	1,636	100.0	578	100.0	4,151	100.0

The following table compares the traffic volume during peak hours (7:00 a.m. - 9:00 a.m.) with all-day traffic by mode of transport and trip purpose. This table likewise shows

that the peak hour ratio of “work” trips by car is the highest at 54% and that the peak hour ratio of “school” trips is the highest by bus.

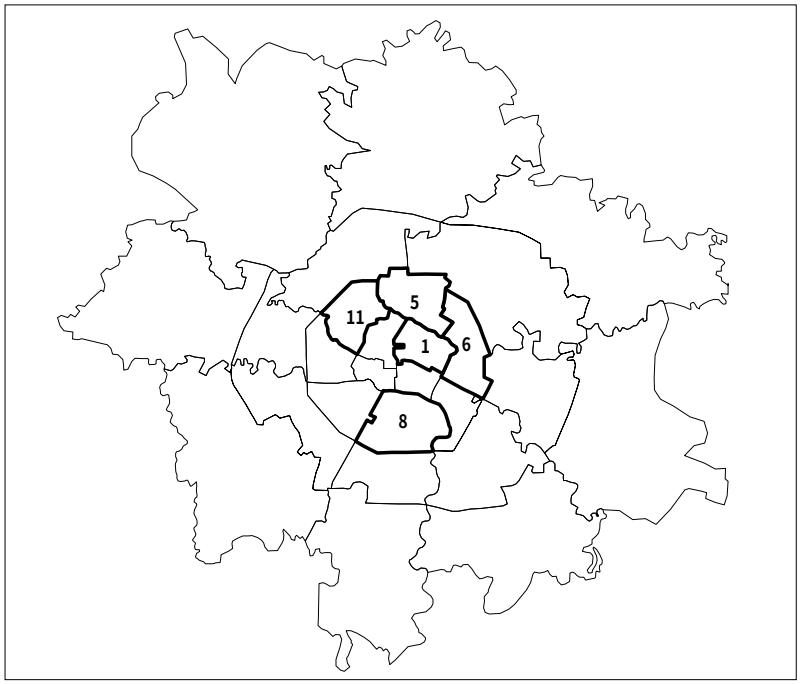
Table 4.3.4 Transport Mode by Purpose during Peak Hour

		Walk	Bicycle	Motorcycle	Car	Truck	Bus	Total
All-Day Traffic Volume (1,000)	Work	268.6	832.9	48.9	117.4	18.4	100.8	1,387.2
	School	220.5	284.5	1.0	11.9	1.2	31.2	550.4
	Private	683.5	477.6	23.1	207.9	11.4	232.8	1,636.2
	Business	98.9	219.6	36.1	104.9	49.6	68.5	577.6
	Total	1,271.5	1,814.6	109.1	442.2	80.6	433.3	4,151.4
Peak Hour Traffic Volume (1,000)	Work	121.4	426.3	25.3	63.5	6.9	50.0	693.5
	School	63.7	61.1	0.2	3.8	0.3	10.1	139.2
	Private	97.9	73.0	4.5	26.7	1.0	26.7	229.8
	Business	24.5	57.3	11.5	21.2	8.1	13.8	136.4
	Total	307.5	617.6	41.5	115.2	16.4	100.6	1,198.8
Peak hour Ratio (%)	Work	45.2	51.2	51.7	54.1	37.5	49.6	50.0
	School	28.9	21.5	21.9	31.9	28.9	32.4	25.3
	Private	14.3	15.3	19.3	12.8	9.1	11.5	14.0
	Business	24.7	26.1	31.8	20.2	16.4	20.2	23.6
	Total	24.2	34.0	38.0	26.1	20.4	23.2	28.9

4.3.3 Structure of Trips Concentrating Central Area

In Section 4.3.1, medium zone OD table was used to determine the concentration of trips. In this section, zones 1, 5, 6, 8 and 11 shown in Figure 4.3.5, are selected for analyzing the traffic characteristics in detail due to their large trip attraction. These zones are located in the central urban area of Chengdu inside the 2nd Ring Road. Trip attraction is large in these zones due to heavy concentration of business/commercial activities, though their land use is different in terms of public facilities and, among others, shopping/entertainment facilities.

Figure 4.3.5 Analyzed Zones



The number of trips attracted in these zones by purpose is shown in Table 4.3.5. In zone 1, “private” trips show the highest trip attraction; in zone 5, “business” trips dominate; zone 6 attracts both “work” and “private” trips; and zone 8 attracts “school” trips. In zone 11, the share of “business” trips is relatively high.

Table 4.3.5 Number of Attracted Trips by Purpose

Zone	Work			School			Private			Business			Total		
	Trip Attraction* ('000)	No. of Intra-zonal Trips ('000)	Intra-zonal Rate (%)	Trip Attraction* ('000)	No. of Intra-zonal Trips ('000)	Intra-zonal Rate (%)	Trip Attraction* ('000)	No. of Intra-zonal Trips ('000)	Intra-zonal Rate (%)	Trip Attraction* ('000)	No. of Intra-zonal Trips ('000)	Intra-zonal Rate (%)	Trip Attraction* ('000)	No. of Intra-zonal Trips ('000)	Intra-zonal Rate (%)
1	65.9	19.7	29.9	27.2	13.9	51.0	116.5	57.8	49.7	26.4	9.1	34.6	236.0	100.6	42.6
	27.9			11.5			49.3			11.2			100.0		
5	115.7	51.9	44.9	33.9	21.5	63.3	149.6	76.5	51.1	76.3	16.8	22.0	375.5	166.7	44.4
	30.8			9.0			39.8			20.3			100.0		
6	103.8	57.1	55.0	23.0	12.4	53.8	126.5	58.1	45.9	21.6	9.1	41.9	274.9	136.6	49.7
	37.8			8.4			46.0			7.9			100.0		
8	88.6	41.8	47.2	61.7	33.0	53.4	117.0	65.3	55.9	32.9	13.6	41.4	300.2	153.7	51.2
	29.5			20.5			39.0			11.0			100.0		
11	63.7	27.3	42.8	23.9	12.2	51.1	101.5	59.1	58.3	41.6	19.9	47.8	230.7	118.5	51.4
	27.6			10.4			44.0			18.0			100.0		

Note: *Upper row includes number of trips in '000 while lower in %

The mode of trips concentrating to these five zones is presented in Table 4.3.6. The result indicates that in zone 1, the percentage of trips by “walk” is high; in zones 6 and 8, the share of bicycle is high; in zones 11 and 5, the percentage of car and bus is high. In addition, the “origin” zones of the trips are presented in Table 4.3.7.

Table 4.3.6 Number of Attracted Trips by Mode

Zone*	Walk	Bicycle	Motorcycle	Car	Truck	Bus	Total
1	159.3	185.2	4.2	40.9	7.6	33.9	431.1
	36.9	43.0	1.0	9.5	1.8	7.9	100.0
5	204.5	243.2	12.4	65.6	14.0	103.8	643.7
	31.8	37.8	1.9	10.2	2.2	16.1	100.0
6	165.1	280.7	3.6	55.5	3.7	50.0	558.6
	29.6	50.2	0.6	9.9	0.7	8.9	100.0
8	186.1	269.7	6.6	50.7	4.1	42.1	559.2
	33.3	48.2	1.2	9.1	0.7	7.5	100.0
11	150.0	191.9	4.6	63.2	7.1	55.2	471.9
	31.8	40.7	1.0	13.4	1.5	11.7	100.0

Note: *Upper row includes number of trips in ’000 while lower %

Table 4.3.7 Origin Zone of Attracted Trips

Purpose		Intra-zonal Trips ('000)	Top 5 Zones									
			1		2		3		4		5	
			Origin Zone	Trip Attraction ('000)	Origin Zone	Trip Attraction ('000)	Origin Zone	Trip Attraction ('000)	Origin Zone	Trip Attraction ('000)	Origin Zone	Trip Attraction ('000)
1	Work	19.7	2	6.0	5	5.2	8	4.9	4	4.5	11	3.8
	School	13.9	2	1.8	6	1.6	5	1.3	4	1.3	8	0.9
	Private	57.8	5	10.2	2	7.7	4	7.5	8	5.1	6	3.5
	Business	9.1	6	2.5	5	2.4	2	2.1	11	1.8	9	1.7
5	Work	51.9	1	9.0	4	6.8	12	6.7	11	6.4	8	5.8
	School	21.5	1	3.2	6	1.4	26	1.3	4	1.2	11	1.1
	Private	76.5	11	10.9	12	7.5	6	7.0	18	6.8	4	5.9
	Business	16.8	26	11.4	18	7.6	11	4.6	1	4.4	25	4.4
6	Work	57.1	12	6.6	13	6.4	5	4.8	2	4.0	1	4.0
	School	12.4	1	2.2	7	1.6	5	1.5	4	1.0	13	0.9
	Private	58.1	12	11.5	5	11.4	13	8.2	2	4.7	9	4.7
	Business	9.1	5	1.8	13	1.4	14	1.3	12	1.1	11	1.0
8	Work	41.8	9	8.9	15	5.7	5	4.3	4	3.7	1	3.3
	School	33.0	15	8.1	9	5.6	23	2.4	2	1.7	16	1.5
	Private	65.3	15	7.9	2	5.3	9	4.7	1	4.2	7	4.2
	Business	13.6	9	3.3	15	2.6	23	1.8	14	1.4	5	1.2
11	Work	27.3	5	5.9	4	5.1	18	3.2	1	2.9	9	2.7
	School	12.2	10	4.0	4	1.5	18	1.2	1	1.1	5	0.9
	Private	59.1	10	9.1	18	7.5	5	5.2	4	3.1	25	2.7
	Business	19.9	14	4.2	18	3.1	5	3.0	6	2.0	25	1.7

4.3.4 Outline of Cordon Line Survey Result

The Cordon Line Survey was undertaken in order to obtain information on the trips of non-residents, which can't be covered by the person-trip survey. The survey was conducted at designated stations beside the road. Traffic volume was counted during the Cordon Line Survey.

Figure 4.3.6 shows the traffic volume counted at every designated survey station during the Cordon Line Survey. At survey stations 1, 7, 15 and 22, vehicle traffic volume (except bicycles) exceed 10,000 trips. Particularly, 14,000 vehicles were counted at the station along the highway approaching to the airport.

Table 4.3.8 presents the number of passengers at the railway stations in Chengdu. At the north railwa station, the number of passengers (both boarding and alighting) accounted for 70,000 passengers daily. These figures were not obtained by the Cordon Line Survey, but they were provided by the Government from the records of boarding and alighting.

Figure 4.3.6 Traffic Counted at Cordon Line Survey Stations (24 hours)

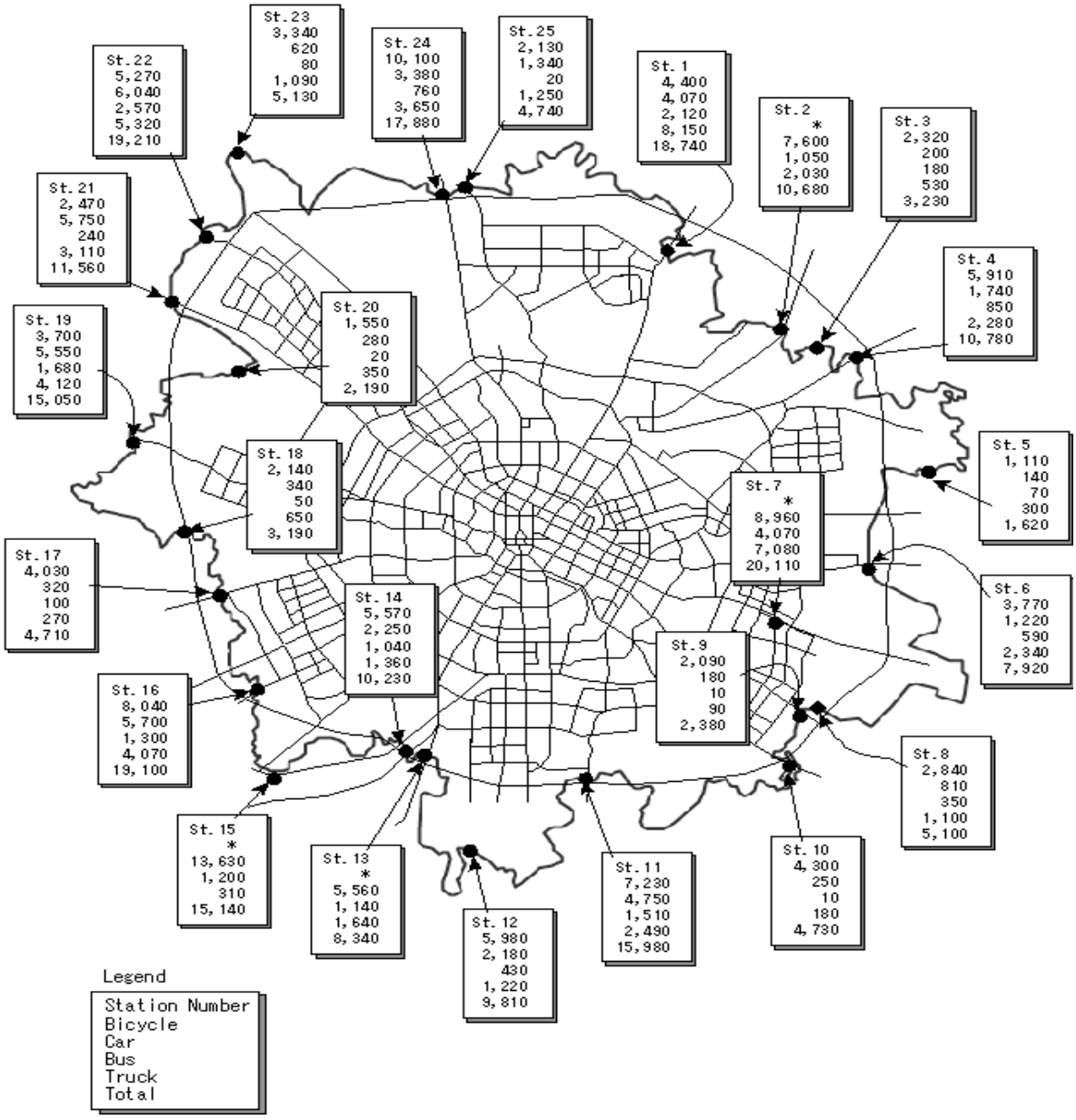


Table 4.3.8 Number of Railway Passengers Boarding and Alighting at Stations

Station	Route	Departure	Arrival	Total
North	Bao-Cheng Railway	15,584	15,230	30,814
	Cheng-Yu Railway	13,946	13,728	27,674
	Cheng-Kun Railway	6,311	6,213	12,524
	Total	35,841	35,171	71,012
South		581	1,100	1,681

Note: Counted between 6 a.m. July 7 and 6 a.m. July 8, 2000. (Chengu City)

In order to analyze the trip characteristics of non-residents in the survey area, it is necessary to expand the sampled trips to represent the whole trips according to the traffic volume counted at the Cordon Line Survey stations. The trips made by residents passing through the cordon line were excluded from the total traffic volume to capture the trips of non-residents in the survey area.

Table 4.3.9 Number of Samples from Bus OD Interview Survey

Survey Station Number	Traffic Volume	Driver		Passenger
		No. of Samples	Sample Rate (%)	No. of Samples
1	2,117	209	9.9	304
2	1,051	174	16.6	166
3	177	94	53.1	147
4	853	91	10.7	152
5	70	10	14.3	18
6	586	80	13.7	131
7	4,073	331	8.1	477
8	353	74	21.0	120
9	9	0	0.0	0
10	8	0	0.0	0
11	1,513	223	14.7	308
12	429	88	20.5	95
13	1,138	117	10.3	112
14	1,044	109	10.4	185
15	1,202	37	3.1	132
16	1,300	117	9.0	152
17	98	53	54.1	35
18	48	0	0.0	0
19	1,680	167	9.9	113
20	15	0	0.0	0
21	239	63	26.4	67
22	2,571	343	13.3	348
23	77	10	13.0	11
24	761	88	11.6	94
25	22	0	0.0	0

In the bus OD interview survey, buses selected at random were stopped, bus drivers were interviewed, and bus passengers were interviewed. For stopped buses, bus passengers selected at random who were interviewed about the characteristics of their trips. Therefore, the sampled passengers were expanded by multiplying by the total number of passengers in the bus then by multiplying by the total number of buses crossing the Cordon Line during the day. Table 4.3.9 shows the survey results used in developing expansion factors at each station. No passenger was interviewed at some survey stations where the traffic volume of bus was very small. For these stations, the expansion was neglected.

After the expansion, the Cordon Line crossing trips by transport mode were estimated and the results are presented in Table 4.3.10. Percentage of the resident and non-resident was roughly the same. However, the resident passengers had a tendency to travel by mostly car and bus, while non-residents take only public transport.

Table 4.3.10 Cordon Line Traffic Volume by Mode of Transport

Mode of Transport	Residents in Study Area		Non-Residents		
	Vehicle Trips ('000)	Person Trips ('000)	Vehicle Trips ('000)	Person Trips ('000)	Average Occupancy
Walk	6.8	6.8	4.5	4.5	1.00
Bicycle	23.9	23.9	19.2	19.2	1.00
Tricycle	4.7	7.2	5.0	7.6	1.53
Motorcycle	13.6	20.1	17.8	26.2	1.47
Motor Tricycle	3.1	5.6	2.6	4.6	1.80
Car	44.7	92.6	31.1	64.3	2.07
Taxi	5.8	12.1	1.3	2.7	2.10
Small Bus	4.3	71.0	5.0	83.4	16.52
Large Bus	4.2	103.2	8.3	205.8	24.83
Small Truck	11.6	22.1	14.3	27.1	1.90
Large Truck	8.9	17.5	18.5	36.2	1.96
Others	0.5	1.0	1.2	2.3	1.96
Total	132.2	383.0	128.7	484.0	
(%)	50.7	44.2	49.3	55.8	

4.4 Structure of Bus Trips

Section 4.2 presented an overview of the modal share in the whole Study Area. The following three sections now focus on bus, bicycle and private vehicle trips with the objective of discussing about who makes a trip by which transport mode.

4.4.1 Characteristics of Bus Users

Figure 4.4.1 displays the comparison of the persons who made a bus trip at least once a day, and the persons who made a trip by all transport modes. The figure shows that bus passengers are relatively numerous in the age group of 20's or 60's. Refer to Table 4.4.1. With respect to occupation of bus passengers, the percentage of clerical workers, commercial workers and housewives is higher than the percentage of other passengers while the percentage of laborers, pupils and students is lower. It is considered that workers use bicycle and, pupils and students travel by walking.

Figure 4.4.1 Bus Trip Distribution by Age Group

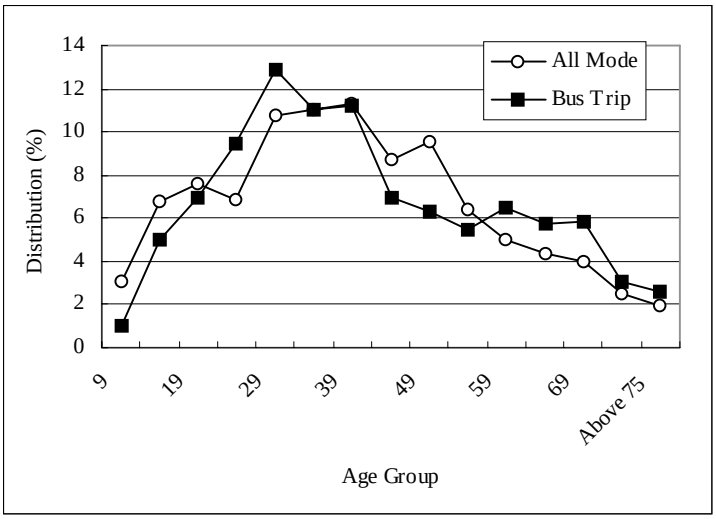


Table 4.4.1 Number of Bus Trips by Age Group

Age Group	All Mode		Bus Trip	
	(1,000)	(%)	(1,000)	(%)
6 - 9	82.3	3.1	1.8	1.1
10 - 14	180.4	6.7	8.5	5.0
15 - 19	204.6	7.6	11.8	6.9
20 - 24	183.6	6.9	16.1	9.5
25 - 29	288.9	10.8	22.0	12.9
30 - 34	296.5	11.1	18.8	11.0
35 - 39	303.6	11.3	19.2	11.2
40 - 44	234.4	8.7	11.8	6.9
45 - 49	255.3	9.5	10.8	6.3
50 - 54	171.6	6.4	9.3	5.4
55 - 59	134.5	5.0	11.1	6.5
60 - 64	116.5	4.3	9.9	5.8
65 - 69	108.1	4.0	9.9	5.8
70 - 74	68.0	2.5	5.2	3.1
75 or more	52.0	1.9	4.4	2.6
Total	2,680.2	100.0	170.7	100.0

Figure 4.4.2 Bus Trip Distribution by Occupation

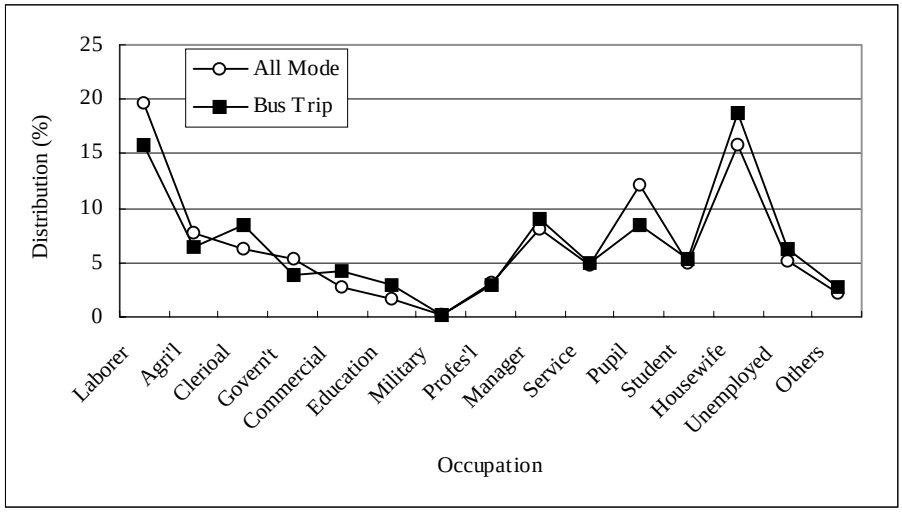


Table 4.4.2 Number of Bus Trips by Occupation

Occupation	All Mode		Bus Trip	
	(1,000)	(%)	(1,000)	(%)
Laborer	525.3	19.6	26.9	15.8
Agricultural	207.1	7.7	10.9	6.4
Clerical	167.2	6.2	14.5	8.5
Government	145.0	5.4	6.5	3.8
Commercial	72.8	2.7	7.2	4.2
Education	46.7	1.7	4.9	2.9
Military	3.1	0.1	0.2	0.1
Technical/Professional	81.9	3.1	4.9	2.9
Manager	219.0	8.2	15.4	9.0
Service	129.6	4.8	8.6	5.0
Pupil	323.1	12.1	14.3	8.4
Student	134.9	5.0	9.0	5.3
Housewife	425.7	15.9	32.1	18.8
Unemployed	139.4	5.2	10.6	6.2
Others	59.5	2.2	4.6	2.7
Total	2,680.2	100.0	170.7	100.0

The following table compares the bus trip share of the registered population and that of temporary population. The bus trip share of the registered population is 9.5% while that of temporary population 15.0. This is significantly different. This clearly shows that temporary residents make trips depending on public transport since they have no private transportation.

Table 4.4.3 Bus Trip Share of Registered/Temporary Population

Population	Number of Trips by Bus (1,000)	Number of Trips (1,000)	Bus Trip Rate (%)
Registered	657	6,922	9.5
Temporary	149	998	15.0

Table 4.4.4 shows the comparison of the occupation and income level of bus trip makers (at least once a day) with those of trip makers of all modes. The percentage of all-mode passengers with the income level of RMB200-500 and 500-1,000 per month, is high at 35.5% and 46.0% respectively while that of bus passengers with the income level of RMB500-1,000 is the highest at 49.0% followed by the income level of RMB200-500 at 31.6%. This suggests that income level of bus passengers is relatively higher than that of all passengers.

Table 4.4.4 Number of Bus Trips by Income Level

Income Level	All Mode		Bus Trip	
	(1,000)	(%)	(1,000)	(%)
RMB200/month or less	88.4	5.4	5.2	5.0
200-500	580.6	35.5	32.8	31.6
500-1,000	752.1	46.0	50.8	49.0
1,000-2,000	176.8	10.8	13.7	13.2
2,000-3,000	27.1	1.7	0.9	0.9
3,000 or more	11.5	0.7	0.2	0.2
Total	1,636.5	100.0	103.6	100.0

Comparing the volume of bus trips by trip purpose with the all-mode trips made, the proportion of “work” and “school” trips by bus is lower. On the other hand, bus is preferred for “private” trips such as dining/social purposes and sightseeing/entertainment purposes (see Table 4.4.5).

Table 4.4.5 Number of Bus Trips by Purpose

Trip Purpose	All Mode		Bus Trip	
	(1,000)	(%)	(1,000)	(%)
Work	2,801.2	33.2	103.5	23.1
School	1,113.1	13.2	34.7	7.7
Shopping	1,633.2	19.4	85.3	19.0
Dinning/Social	745.4	8.8	60.9	13.6
Sightseeing/Entertainment	443.1	5.3	46.1	10.3
Other Private	314.6	3.7	36.9	8.2
Accompanying Others	189.9	2.3	10.7	2.4
Sales/Delivery	625.7	7.4	38.5	8.6
Meeting	239.6	2.8	14.2	3.2
Mechanical Work	99.2	1.2	4.2	0.9
Agricultural	31.7	0.4	0.4	0.1
Other Business	193.6	2.3	13.1	2.9
Total	8,430.4	100.0	448.5	100.0

4.4.2 Distribution of Bus Trips

Figure 4.4.3 exhibits the trip generation and attraction by bus by traffic zone (125 zones in the study area). Both the generation and attraction of bus trips are highest in zone 54 where the north bus terminal (Xiaojiacun) near the north railway station is located. The trip generation by bus is 39,000 and the attraction 48,000. The figure excludes "home" trips so it does not matter whether trip generation and attraction volume differ from each other. In addition, the trip generation and attraction are very high in zone 71 (Tianhui Town) and zone 88 (Cuqiao), the area outside the 3rd Ring Road. There are some other zones with very high traffic volume within the Inner Ring Road and along the 2nd Ring Road.

Figure 4.4.3 Trip Generation and Attraction by Bus

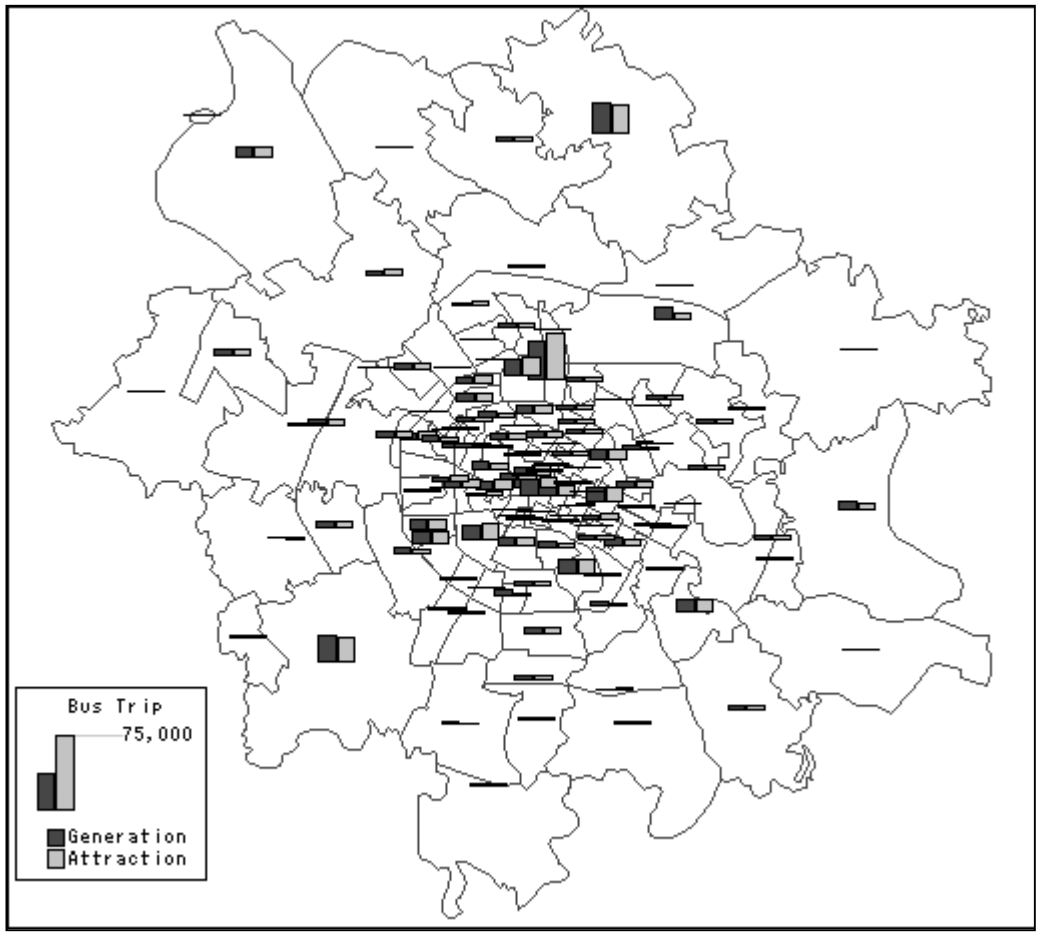


Figure 4.4.4 shows the traffic distribution of bus trips among traffic zones. The transport desire lines from Tianhui Town to the north railway station and from Cuqiao to the central area surrounded by the Inner Ring Road are very notable. In addition, the public transport traffic from each zone along the 2nd Ring Road to the area inside the Inner Ring Road is particularly heavy. Comparative analysis on these public transport volumes and the transport capacity of public transport is presented here after. This provides a basis on what will be the appropriate role of public transport service.

Figure 4.4.4 Bus Trip Distribution

4.4.3 Bus Transfer Points

Bus transfer is an important issue relevant to traffic demand using public transport. This relates to the number of bus passenger transfer and locations of bus transfer points. These are important factors in developing and improving public transport services.

Table 4.4.6 presents the number of linked and unlinked trips by bus. No matter how many times bus transfers are made, a linked trip is counted as only one trip. On the other hand, an unlinked trip means an actual bus passenger. According to this figure, the difference between these two numbers of trips is only 95,000 trips (12% of the total trips), which is the number of transfers. In the person-trip survey, interviewees were reluctant to answer about the transfer of public transport. The achievement or rate of completion on this data was very low, probably due to the interviewees not being familiar to the transfer points or the survey questionnaire related to transfers was quite difficult to understand.

Table 4.4.6 Linked and Unlinked Trips by Bus

No. of Linked Trips (1,000)	No. of Unlinked Trips (1,000)
806.8	901.6

Considering the above situation, the number of transfers calculated from the person trip database is displayed in Figure 4.4.5 based on traffic zones. Zone 110 (Qinglonchang) has the biggest number of transfers where Qinglongchang Central station is located. This is followed by zone 3 (Lotus zone) where the Jiuyanqiao Station is located. In addition, there are many other transfer points in zone 53 (Jiefanglu), zone 58 (Simaqiao), zone 72 (Yingmenkou), zone 78 (Wangjianlu) and zone109 (Baohe), which are not considered as primary bus stops/stations. In addition, although the trip generation and attraction volume are high, bus transfers are relatively few at the north railway station.

Figure 4.4.5 Major Bus Transfer Points

Source: Person-Trip Survey

4.4.4 Perception of Bus Passengers

The result of the interview of bus users is analyzed regarding bus service and bus related facilities in this section.

- Reason of bus use：Table 4.4.7 indicates the reasons for taking the bus. The biggest reason is “the cost is cheap” (33%) and the next is “there are no other means than bus” (14%). About 10% users think that the bus is safe. This result suggests that bus users select their transport mode by comparing it to the bicycle ride.

Table 4.4.7 Reasons of Using Bus

Reason	Reply 1/ (%)
Fast	4.3
Cheap	33.3
no transfer	11.7
short walk if using buses	2.6
no other means to take	5.8
difficult to take other means	13.5
independent to the weather	9.2
Comfortable	3.2
Safe	10.1
else	6.3
Total	200.0

Source: Survey on Bus User Perception

1/ Respondent selected two items

- Problems of bus stops and bus terminals: Table 4.4.8 shows the problems of bus stops and bus terminals based on the answers from bus users. The most frequently pointed out problem is a poor facility for waiting (i.e. chairs and ceilings) (74%). The other problems include traffic jams (27%), lack of information of operation (running schedule, etc.) (23%) and poor environment for pedestrians (21%).

Table 4.4.8 The Problems of the Bus Services

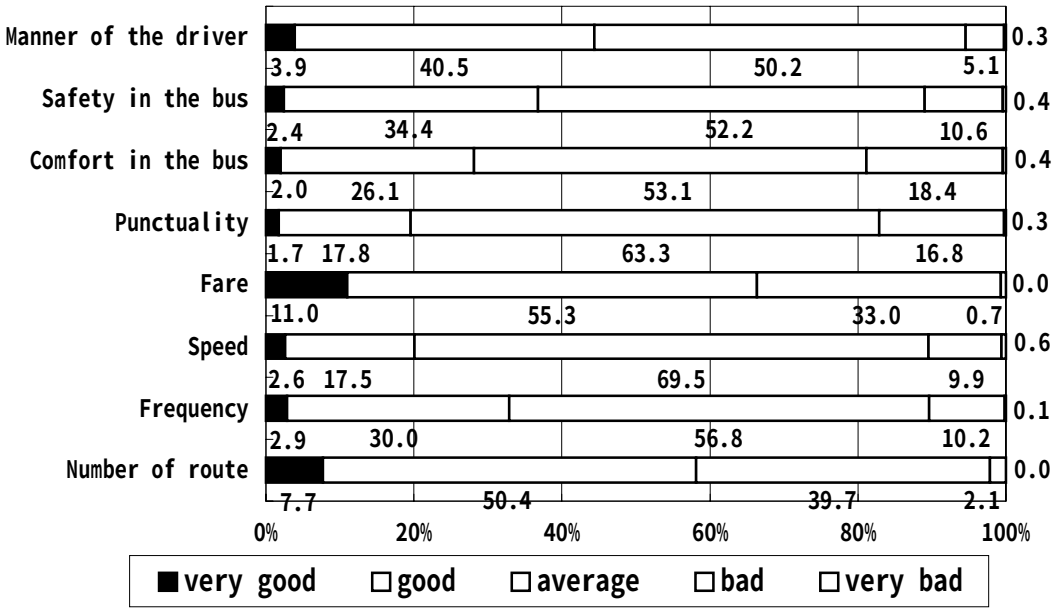
Problems	Percent Distribution1/（％）
Difficult to transfer	19.8
Information of bus service (destination and time schedule) is insufficient.	22.6
Poor facility of the waiting room (i.e. chairs and ceilings)	74.2
Traffic jam	27.4
Crowded at the bus stop and terminal	13.4
Environment for pedestrian is poor	21.0
Dirty	13.8
Low level safety	2.7
Others	5.1
Total	200.0

Source: Survey on Bus User Perception

1/ Respondents selected two items.

- Opinion for level of bus services: Figure 4.4.6 shows the opinions of bus users on the bus services. Most people think that the bus services are not so bad. More than half of the people think that the fare and the number of routes are good or very good. On the other hand, most people think comfort in the bus and punctuality services are not satisfactory.

Figure 4.4.6 Evaluation of the Bus Service by the Bus Users



Source: Survey on Bus User Perception

- Important factor of bus services: Table 4.4.9 shows the factors of bus services which people think important. The most common answers are frequency of bus services (42%) followed by speed (39%), and punctuality of the bus services (37%). Most of the items are fundamental for bus services. Some people think the comfort in the bus is also important (24%).

Table 4.4.9 Items Found Important by the People

Service Items	Answers (%)[1/]
Number of route	9.0
Frequency	41.6
Speed	38.6
Fare	6.8
Punctuality	36.8
Comfort	24.4
Safety in the bus	18.2
Manner of the driver	15.6
Total	200.0

Source: Survey on Bus User Perception

1/ Two items chosen by respondent.

4.5 Structure of Bicycle Trips

4.5.1 Characteristics of Bicycle Users

Figure 4.5.1 presents the comparison of the number of persons who made a trip by bicycle and persons who made a trip by all modes. Unlike bus passengers, the rate of usage of bicycle was generally high among people between 10 to 50 years old. People aged 50 years old and over seldom take bicycle trips.

Figure 4.5.1 Bicycle Trip Distribution by Age Group

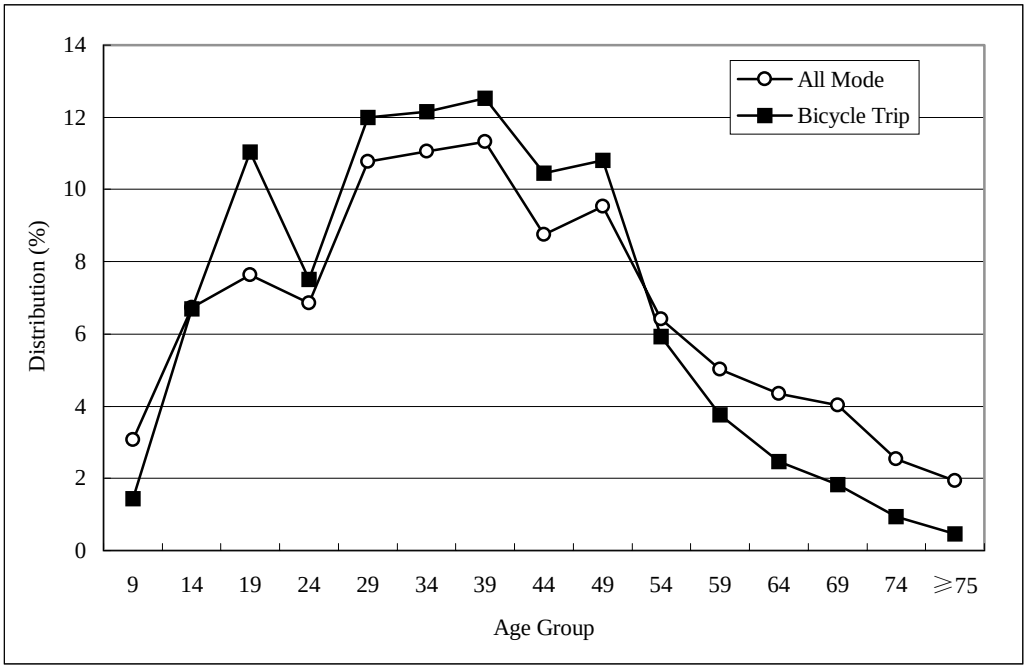


Table 4.5.1 Number of Bicycle Trips by Age Group

Age Group	All Mode		Bicycle Trip	
	(1,000)	(%)	(1,000)	(%)
6 - 9	82.3	3.1	19.1	1.4
10 - 14	180.4	6.7	88.5	6.7
15 - 19	204.6	7.6	146.3	11.0
20 - 24	183.6	6.9	99.4	7.5
25 - 29	288.9	10.8	159.0	12.0
30 - 34	296.5	11.1	161.0	12.1
35 - 39	303.6	11.3	166.0	12.5
40 - 44	234.4	8.7	138.5	10.5
45 - 49	255.3	9.5	143.1	10.8
50 - 54	171.6	6.4	78.5	5.9
55 - 59	134.5	5.0	49.7	3.8
60 - 64	116.5	4.3	32.8	2.5
65 - 69	108.1	4.0	24.2	1.8
70 - 74	68.0	2.5	12.5	0.9
75 Or more	52.0	1.9	6.2	0.5
Total	2,680.2	100.0	1,324.8	100.0

Figure 4.5.2 illustrates the bicycle use by type of occupation The figure shows that the percentage of bicycle use has almost the same distribution as all-mode passengers. However, laborers register the highest bicycle use. On the other hand, the rate of bicycle use by housewives is significant low.

Figure 4.5.2 Bicycle Trip Distribution by Occupation

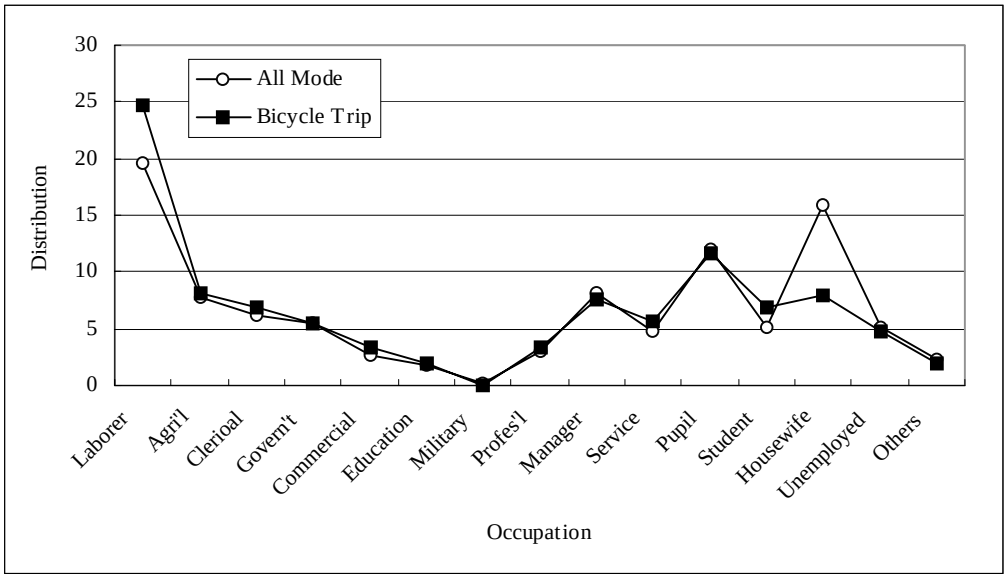


Table 4.5.2 Number of Bicycle Trips by Occupation

Occupation	All Mode		Bicycle Trip	
	(1,000)	(%)	(1,000)	(%)
Laborer	525.3	19.6	326.5	24.6
Agricultural	207.1	7.7	106.8	8.1
Clerical	167.2	6.2	90.3	6.8
Government	145.0	5.4	72.7	5.5
Commercial	72.8	2.7	43.3	3.3
Education	46.7	1.7	25.2	1.9
Military	3.1	0.1	0.8	0.1
Technical/Professional	81.9	3.1	44.9	3.4
Manager	219.0	8.2	101.0	7.6
Service	129.6	4.8	74.8	5.6
Pupil	323.1	12.1	154.1	11.6
Student	134.9	5.0	90.5	6.8
Housewife	425.7	15.9	105.3	8.0
Unemployed	139.4	5.2	63.8	4.8
Others	59.5	2.2	24.8	1.9
Total	2,680.2		1,324.8	

Table 4.5.3 presents a comparison of income distribution among bicycle users and all trip makers. The income level of bus users is relatively higher as discussed in the previous section while the income level of bicycle users is similar to that of all-mode passengers on the average (e.g. 38.0% belonged to income level of RMB200-500 and 47.9% had income of RMB500-1000).

Table 4.5.3 Number of Bicycle Trips by Income Level

Income Level	All Mode		Bicycle Trip	
	(1,000)	(%)	(1,000)	(%)
RMB 200/month or less	88.4	5.4	43.8	4.9
200-500	580.6	35.5	342.0	38.0
500-1,000	752.1	46.0	431.0	47.9
1,000-2,000	176.8	10.8	73.6	8.2
2,000-3,000	27.1	1.7	7.9	0.9
3,000 or more	11.5	0.7	2.5	0.3
Total	1,636.5	100.0	900.8	100.0

Table 4.5.4 shows the comparison of the number of trips by bicycle and the number of all-mode trips by trip purpose. Unlike the bus users where “private” trips are higher, bicycle use is high in “work” and “school” trips while bicycle usage is low in both “private” and “business” trips.

Table 4.5.4 Number of Bicycle Trips by Purpose

Trip Purpose	All Mode		Bicycle Trip	
	(1,000)	(%)	(1,000)	(%)
Work	2,801.2	33.2	835.4	45.8
School	1,113.1	13.2	285.0	15.6
Shopping	1,633.2	19.4	252.1	13.8
Dining/Social	745.4	8.8	102.0	5.6
Sightseeing/Entertainment	443.1	5.3	41.8	2.3
Other Private	314.6	3.7	51.9	2.8
Accompanying Others	189.9	2.3	34.1	1.9
Sales/Delivery	625.7	7.4	122.6	6.7
Meeting	239.6	2.8	35.5	1.9
Mechanical Work	99.2	1.2	20.4	1.1
Agricultural	31.7	0.4	2.4	0.1
Other Business	193.6	2.3	39.6	2.2
Total	8,430.4	100.0	1,822.7	100.0

4.5.2 Distribution of Bicycle Trips and Travel Distance

(1) Distribution of Bicycle Trips

Figure 4.5.3 illustrates the trip generation and attraction by bicycle. Obviously, there are many bicycle trips generated from and attracted in each zone. Zones where a lot of bicycle trips generate and attract are zone 98 (Jianshelu), zone 83 (Jiangxijie), zone 80 (Xiaotianzhujie), zone 54 (Xiaojiacun), zone 78 (Wangjianglu) and so on. These zones are all densely populated and located along the area neighboring outside the 2nd Ring Road. The desire lines of bicycle trips are illustrated in Figure 4.5.4. Compared with the desire lines for bus trips, there are many bicycle trips between neighboring zones at short distance. Traffic volume between zone 6 and 12 indicate the highest volume with more than 50,000 trips. This is followed by the trips between zone 1 and 2 with 40,000 trips, and zone 2 and 8, which records 40,000 trips. There are many bicycle trips generating from the central area inside the 1st Ring Road.

Figure 4.5.3 Trip Generation and Attraction by Bicycle

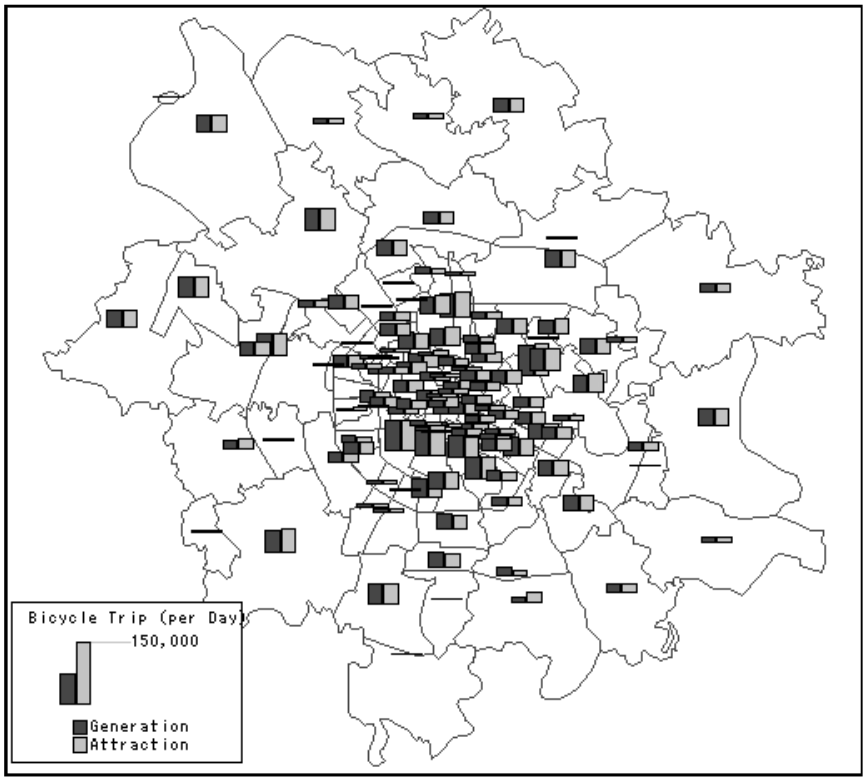
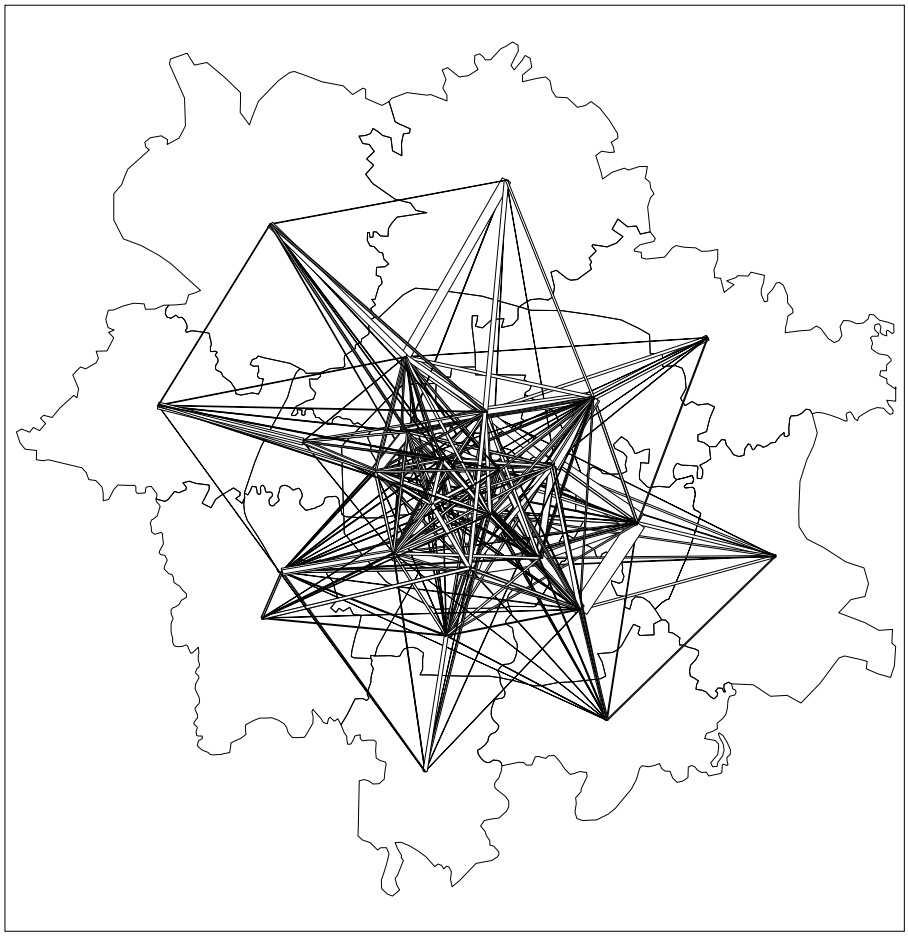


Figure 4.5.4 Distribution of Bicycle Trips



(2) Travel Distance of Bicycle Trips

It was shown in the previous section that bicycles are used for trips between neighboring zones. Therefore, compared with the travel distance of bus trips, that of bicycle trips is shorter. The next figure displays the distribution of bicycle trips by travel distance and their cumulative distribution. Travel distance was calculated based on the distance of straight lines between the centers of traffic zones. Based on this chart, it can be determined that about 1/4 of bicycle trips travel is between 1 km and 2 km. From the cumulative distribution in the chart, 80% tile value is 4.8 km, and 90% tile value is 6.4 km.

Figure 4.5.5 Distribution of Bicycle Trips by Travel Distance

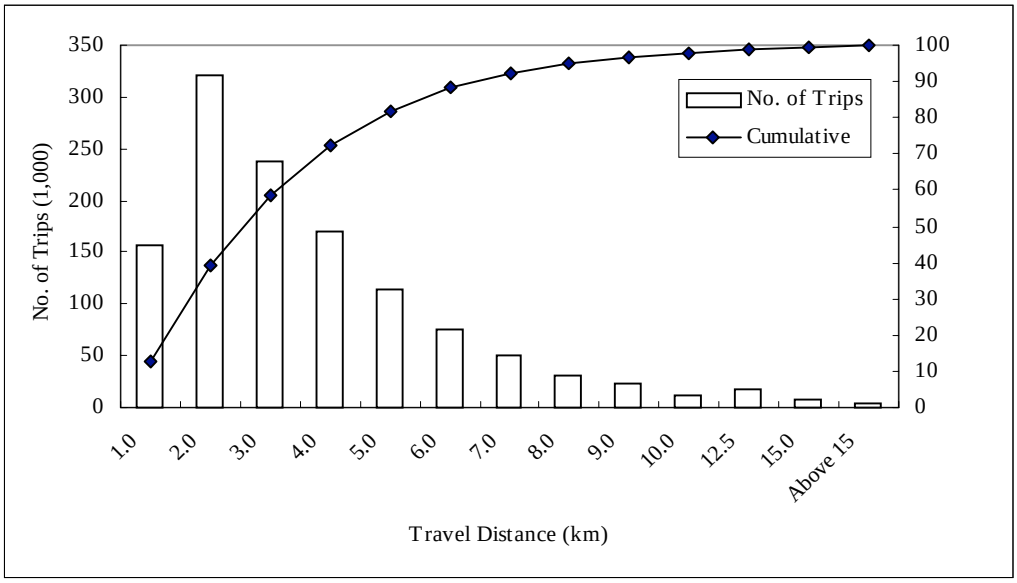


Table 4.5.5 Number of Bicycle Trips by Travel Distance

Travel Distance (km)	Bicycle Trip		All Mode	
	(1,000)	(%)	(1,000)	(%)
0.0 - 1.0	157.1	12.9	369.0	14.3
1.0 - 2.0	320.5	26.3	613.7	23.8
2.0 - 3.0	237.1	19.5	398.4	15.4
3.0 - 4.0	169.7	13.9	317.9	12.3
4.0 - 5.0	115.0	9.4	247.3	9.6
5.0 - 6.0	76.3	6.3	185.1	7.2
6.0 - 7.0	49.5	4.1	122.2	4.7
7.0 - 8.0	30.7	2.5	88.5	3.4
8.0 - 9.0	23.7	1.9	70.8	2.7
9.0 - 10.0	11.1	0.9	48.1	1.9
10.0 - 12.5	17.1	1.4	78.5	3.0
12.5 - 15.0	6.9	0.6	28.0	1.1
15.0 or more	4.2	0.3	14.6	0.6
Total	1,219.0	100.0	2,582.2	100.0

4.5.3 People's Perception on Shifting from Bicycle to Bus

People's perception on shifting from bicycle use to bus use is discussed based on the result of interview survey to bicycle users.

- Reason of bicycle use: Table 4.5.6 shows the reason why bicycle riders choose bicycle among various transport means. Most common answer is that trip time is short (63%). Also, difficult to use other transportation means (43%), no need to transfer (32%), cheap fare (32%) are the common answers.

Table 4.5.6 Reasons for the Use of Bicycles

Reason	Answer（％）[1/]
Trip time is short	63.3
Cheap fare	31.7
No need to transit	32.4
Short walking distance	5.9
No other means to take other than bicycles	5.0
Difficult to use other transportation	42.7
Independent from the weather	2.0
Comfort	3.6
Safety	4.5
Others	8.9
Total	200.0

Source: Survey on Bicycle User Perception

1/ Two items chosen by respondent

- Reason not to take a bus: Table 4.5.7 shows the reason why bicycle riders do not use bus. The most common reason is, the trip time is long (43%), and the next is, because of the transfer (24%). These results closely related to the reason above why people use bicycle. Also congestion in the bus (24%) shows that people make a point of comfort in the bus.

Table 4.5.7 Reasons Why Bicycle Users Do Not Use the Bus

Reason	Answer (%)[1/]
Distance is short, so no needs to take bus.	21.2
No bus stop nearby	9.7
Impossible to arrive the destination unless transferring the bus	24.4
Too few buses	9.4
Time consuming	42.8
The price of tickets is expensive	7.3
Bus can not run as the schedule	20.6
The Last bus in a day comes back too early	6.4
Bus is too crowded	23.8
No air condition system	5.6
I think bus is boring	16.0
Others	13.0
Total	200.0

Source: Survey on Bicycle User Perception

1/ Two items chosen by respondent

- Intention of shifting to bus use if bus service level is improved: Table 4.5.8 shows the intention of shifting to bus if bus service level is increased according to the items

improved. (i) Improvement of comfort makes 66% bicycle users convert to bus, (ii) Improvement of accessibility does 70%, (iii) Reduction in time does 78%, (iv) Improvement in punctuality does 86%. But, (v) Improvement for all items mentioned above, makes 79% people convert, which seems to be contradictory low with the other results. (vi) If fares are doubled with the improvement of all services above, only about 36% of the people signified shifting from using the bus. This shows that the resistance on price increases is still strong.

Table 4.5.8 Intention of Bicycle Users to Shift to Bus with Improved Service

(%)

Condition of Bus (Improved Points)	Taking Bus	Not Taking Bus
1. Installing the air condition system, and not too crowded	66.1	33.9
2. Adding the bus stops and routes, reducing about 50% of time, which consumed before coming to the nearest bus stop.	69.6	30.4
3. Even including the time for waiting and transferring the bus, it cost less time than the vehicle I am using now.	77.8	22.2
4. Setting the bus exclusive lane, and buses can run on time.	85.8	14.2
5. Completing the 4 improved points above, and keeping the same price.	78.5	21.5
6. Completing the 4 improved points above, and doubling the current price.	36.2	63.8

4.6 Structure of Vehicle Trips

It is commonly said that business trips can't be exactly surveyed in a person-trip survey. Therefore, this study carried out a car OD survey focusing on the vehicles registered for business use. The result of analysis based on the database compiled from the car OD survey is discussed in this section in order to clarify the structure of vehicle trips.

4.6.1 Characteristics of Samples

(1) Number of Samples

According to the report of the Public Securities Bureau of Chengdu city, there are approximately 65,000 registered vehicles for business use in the Study Area. About 5,000 vehicles were randomly sampled for the survey and 5,172 vehicles were surveyed. Therefore, the sample rate is about 8% of total vehicles, with the sampling distribution shown in Table 4.6.1 at 63.3% for cars, 22.3% for trucks, 14.1% for others.

Table 4.6.1 Number of Samples in Car OD Survey

Type of Vehicle	No. of Samples	Sampling Distribution (%)
Cars	3,287	63.6
Light Vans	650	12.6
Trucks	505	9.8
Middle Sized Vehicles	279	5.4
Big Vehicles	91	1.8
Others	360	7.0
Total	5,172	100.0

As the samples are selected randomly from the registered records, the distribution of the sample offices can reflect that of the existing whole offices having registered business vehicles in the Study Area.

(2) Trip Rate of Business Use Car

The following table shows the total samples by industry and the corresponding number of trips made. Among the different industries, the manufacturing sector has the highest percentage share of 16.4%, followed by the public services such as government agencies and others. Among the private enterprises, the relatively large registrations of 10.3% in transportation and postal services against the total are still not so high, similar to commercials. The trip production rate of business use cars is 2.24 times a day. The medical and health care industry have the highest proportion of 2.55 trips for each vehicle each day, followed by 2.53 of the scientific research and 2.47 of the transportation and postal service. If the same survey is conducted in Japan or in other countries, the number of vehicular trips in the transportation sector must be higher than the other industries. However, this tendency is not shown in this survey results.

Table 4.6.2 Number of Sample Vehicles by Industrial Sector

Industry	No. of Samples	Sample Rate (%)	Vehicle Trips	Trip Rate (%)
Agriculture, Forestry and Fishery	84	1.6	184	2.19
Mining and Water Industry	79	1.5	159	2.01
Construction	501	9.7	1,130	2.26
Manufacturing	848	16.4	1,949	2.30
Transportation and Post	532	10.3	1,316	2.47
Commercial	478	9.2	1,097	2.29
Finance and Insurance	260	5.0	538	2.07
Real Estate	39	0.8	82	2.10
Services	383	7.4	837	2.19
Medical, Health Care, Physical and Social Wealth	95	1.8	242	2.55
Education, Culture and Broadcasting Services	334	6.5	737	2.21
Scientific Research and Technical Services	179	3.5	453	2.53
Government Agencies and Social Community	657	12.7	1,420	2.16
Others	703	13.6	1,452	2.07
Total	5,172	100.0	11,596	2.24

(3) Facilities of Trip Destination and Parking Style

The following figure shows the proportion of vehicle trip destinations. Government and municipal offices and factory/workshop have relatively higher percentage of

23.6% and 17.5% respectively, with the similar distribution of the number of offices by industry. In addition, residence/apartment is also included in parking destinations, which indicates that some registered vehicles are also used for going home.

Figure 4.6.1 Destination Facilities of Vehicle Trip

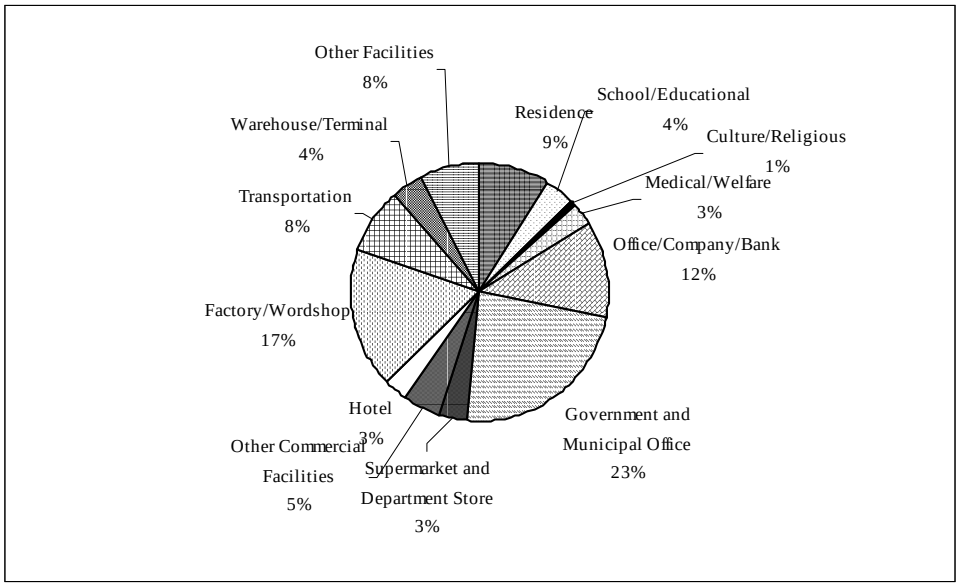


Table 4.6.3 shows the parking style in the trip destinations. 86% of vehicles are parked in the parking facilities outside a road or the place belonging to the destination. Parking on the road amounts to 10% out of the total, whether free or charged. Therefore, the proportion of using roads for parking is very small. The use of the parking lots outside roads shows that the parking spaces of the buildings at destinations shares about 1/3 of the total, and the charged parking space by month or by hour covers moderate 14%.

Table 4.6.3 Parking Style by Trip Destination

Parking Place	Charged/ Free	Type	Number of Trips	Rate to Total (%)	Rate of Parking Outside Road (%)
On-Road	Subtotal		1,270	11.0	
	Charged		588	5.1	
	Free		682	5.9	
Off-Road	Subtotal		9,926	85.6	100.0
	Charged	Monthly	361	3.1	3.6
		Hourly	643	5.5	6.5
		Toll Parking Lot in Stores, etc	380	3.3	3.8
	Free of Charge	Home Garage	1,000	8.6	10.1
		Parking Area in Destination	6,617	57.1	66.7
		Free Parking Lot in Stores, etc	286	2.5	2.9
		Open Space at Station	144	1.2	1.5
		Other Areas	495	4.3	5.0
No Parking			400	3.4	
Total			11,596	100.0	

The analysis above describes the parking situation for all business vehicles so that the private use of business vehicles are included. The following figure shows the parking style by facility of the destination place. Parking in the parking space of

destinations that is free of charge, commonly covers over 2/3 in any facility, but charged parking space in residence/apartment by month adds up to 21%. Compared with other destinations, parking on the road outside residence is as high as 17%. In a supermarket or department store, over 60% of vehicles are parked free of charge.

Figure 4.6.2 Parking Style by Destination Facility

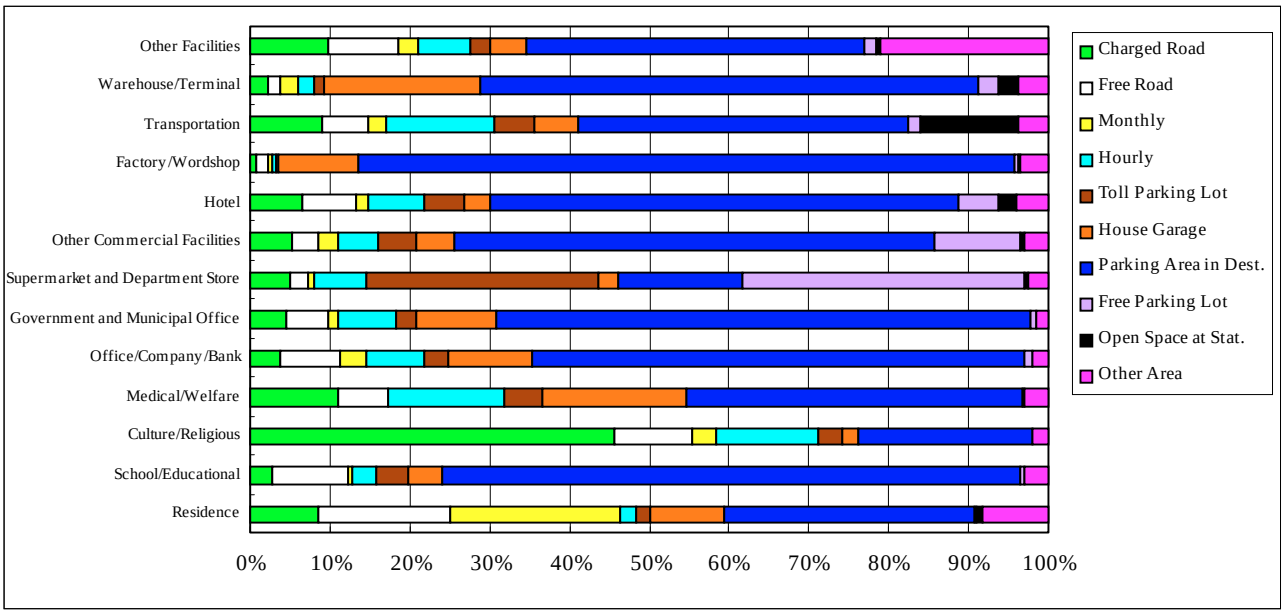


Table 4.6.4 Number of Vehicle Trips by Destination Facility and Parking Style

Type of Facility at Destination	Road		Outside Road								No Parking	Total	Rate (%)
			Charged			Free of Charge							
	Charged	Free of Charge	Monthly	Hourly	Toll Parking Lot in Stores, etc.	Home Garages	Building Lots for Work	Free Parking Lot in Stores	Open Space at Station	Other Facilities			
Residence/Apartment	81	157	200	19	17	88	296	4	7	78	80	1,027	8.9
School/Educational Facility	11	40	2	13	17	17	302	2	0	13	4	421	3.6
Cultural/Religious Facility	46	10	3	13	3	2	22	0	0	2	3	104	0.9
Medical/Welfare	34	20	0	45	15	56	131	1	0	9	16	327	2.8
Office/Company/Bank	51	105	44	100	42	147	849	14	1	26	10	1,389	12.0
Government and Municipal Offices	121	146	30	200	65	275	1,820	14	5	39	20	2,735	23.6
Supermarket and Department Stores	18	9	2	24	107	9	57	129	2	9	0	366	3.2
Other Commercial Facilities	30	17	14	29	26	27	335	61	2	17	5	563	4.9
Hotel	21	21	5	22	16	10	186	16	7	13	24	341	2.9
Factory/Workshop	13	32	12	9	4	202	1,667	10	4	72	10	2,035	17.5
Transportation Facility	74	47	18	109	41	46	335	13	99	31	141	954	8.2
Warehouse/Terminal	10	7	9	9	6	85	274	11	12	16	19	458	3.9
Other Facilities	78	71	22	51	21	36	343	11	5	170	68	876	7.6
Total	588	682	361	643	380	1,000	6,617	286	144	495	400	11,596	100.0
Ratio （ % ）	5.1	5.9	3.1	5.5	3.3	8.6	57.1	2.5	1.2	4.3	3.4	100.0	

(4) Purpose of Vehicle Trips

Table 4.6.5 describes the number of trips using business cars by trip purpose. The proportion of trips with business purpose shares more than 50% and that with sales and meeting trips are relatively high.

Table 4.6.5 Number of Vehicle Trips by Purpose

Trip Purpose	Number of Trips	Proportion (%)		
Work	2,007	17.3		
School	33	0.3		
Home	781	6.7		
Private	2,213	19.1	100.0	
Shopping	148		6.7	
Dinning/Social	73		3.3	
Sightseeing/Entertainment	113		5.1	
Others	134		6.1	
Accompany Others	1,745		78.9	
Business	6,562	56.6		100.0
Sales/Deliver	2,045			31.2
Meetings	2,351			35.8
Mechanical Work	523			8.0
Agriculture	37			0.6
Others	1,606			24.5
Total	11,596	100.0		

4.6.2 Distribution of Vehicle Trips

In the previous section, the characteristics of business car trips were analyzed by using the samples collected by the car OD survey. The samples were expanded to the total number of registered vehicles in the Study Area to make an OD matrix of vehicle trips in this section. Based on the OD matrix, the distribution of vehicle trips was analyzed. Since only the total number of vehicles in six districts is available, these six figures were applied to the expansion. The expansion factors can be calculated with the total number of registered vehicles and samples, which are displayed in Table 4.1.7 in the previous section. The average sample rate was 8%, so the average extended modulus is 12.5.

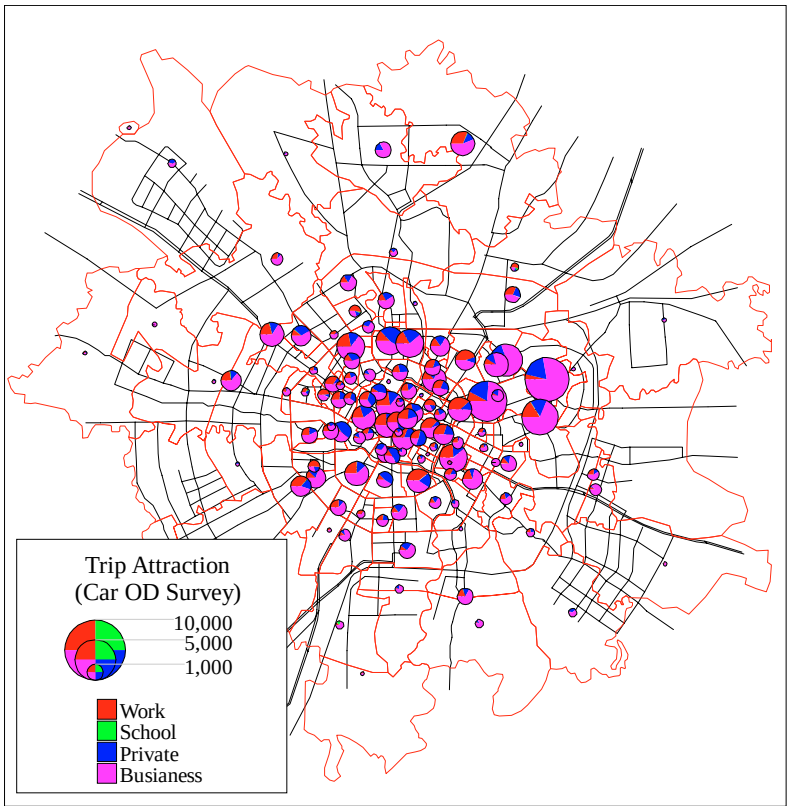
(1) Trip Generation and Attraction by Purpose

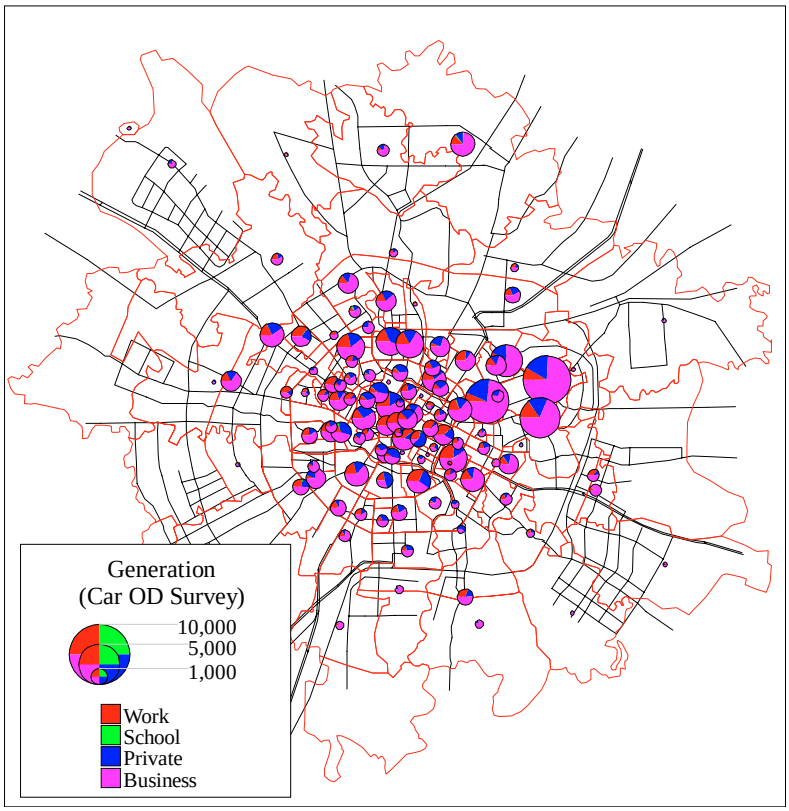
The following figure shows the vehicle trip generation and attraction by trip purpose with the traffic zones. There is not much difference in the volumes of both generation and attraction of vehicle trips. Many vehicle trips are generated from and attracted to the following zones:

- industrial zones outside the 2nd Ring Road such as zone 99 (Fuqinglu), 101 (Erxianqiao) and 106 (Taoxilu),
- the zones near the north station such as zone 54 and 59 (Yangliucun),
- the area along the 1st Ring Road like zone 19 (Junlongjie) and 98 (Jianshelu),
- the central area like zone 31 (Xiyuheyanjie).

The number of vehicle trips for business cover 60% to 70% in any districts. However, the private trip concentrates on the commercial areas within the 1st Ring Road such as zone 8 (Chunxlu), 14 (Renminnanlu), 25 (Xinhuaxilu) and 37 (Qingyangzhengjie), 59 (Yangliucun), 80 (Xiaotianzhujie) and so on. The figure shows that the trip of vehicles focuses on the east part of the Study Area according to the location of the business enterprises.

Figure 4.6.3 Vehicle Trip Generation and Attraction by Purpose

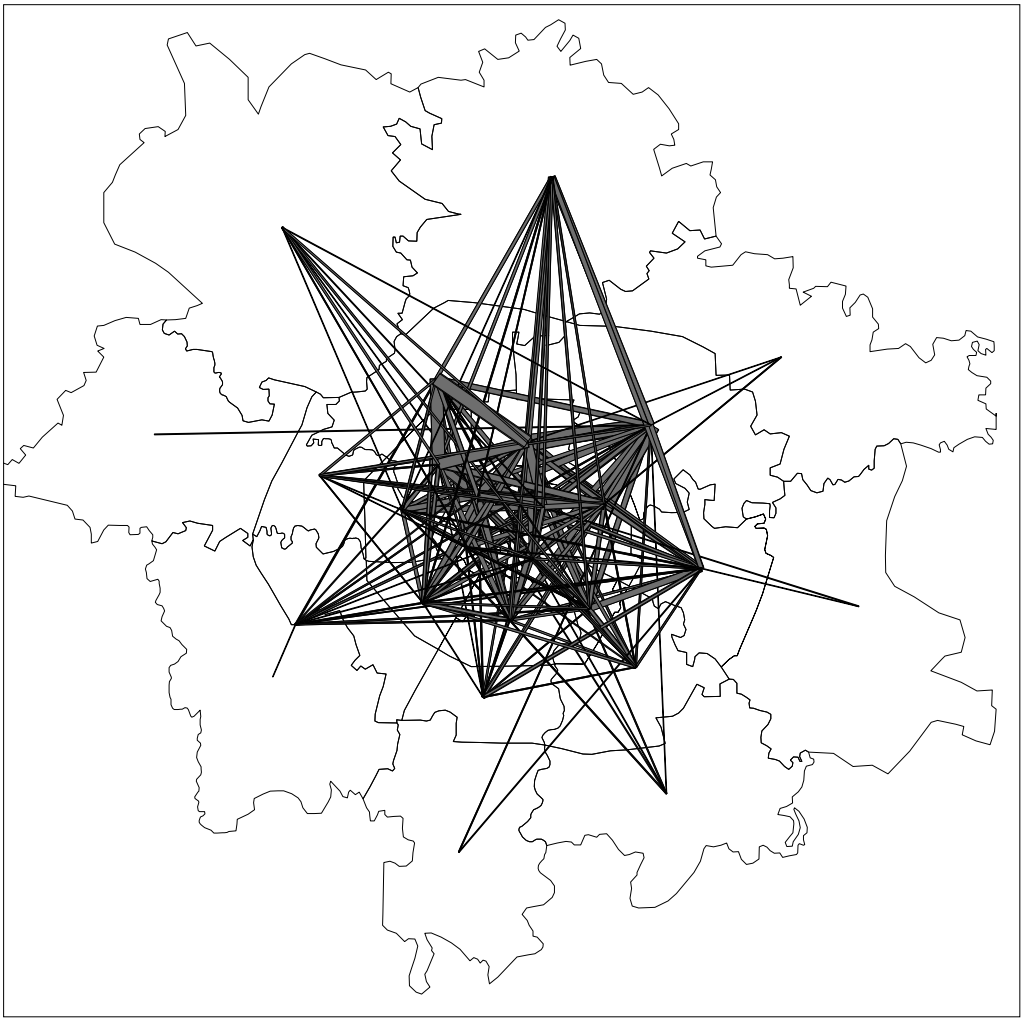




(2) Distribution of Vehicle Trips

The following figure illustrates the desire lines of the vehicle trips between the medium zones shown by the Figure 4.3.1. The areas concentrated by vehicle trips include zone 5, 6, 11, 12 and 18. They are frequently visiting these areas by vehicles. The distribution between zone 6 and 12 involves about 3,000 vehicle trips, followed by the distribution between zone 5 to 12, 5 to 18, 11 to 18 with more than 2000 vehicle trips respectively.

Figure 4.6.4 Distribution of Vehicle Trips



4.6.3 People's Perception on Shifting from Car to Bus

The tendency of car users for shifting to bus use is analyzed with the findings of interviewing them.

- Reasons for car use: Table 4.6.6 shows the reasons for using a car. Most reasons are focused on saving time (48%), seconded by the inconvenience of other means of transportation (40%), cheap (23%), comfort (22%), etc.

Table 4.6.6 Reasons for Using Buses

Reasons	Answers (%)
Saving Time	47.9
Cheap	23.3
No Need for Transference	13.2
Short Distance of Walking	1.0
No Other Available Means of Transportation	9.1
Inconvenience of Other Means of Transportation	40.2
Independent of Weather	10.6
Comfort	22.1
Safe	7.9
Other Reasons	24.5
Total	200.0

- Reasons for not using bus: Table 4.6.7 shows the reasons why they deny buses. Most reasons focus on spending too much time (39%), hating buses (35.4%); Being crowed in buses (24%) also ranks high. It's evident that people attach great importance to the comfort of buses.

Table 4.6.7 Reasons for Refusing Buses

Reasons	Answers(%)
Distance Not So Long to Take Buses	2.4
No Bus Stations Nearby	4.8
Transference of Buses	16.2
Lack of Buses	8.3
Spending Too Much Time By Bus	39.2
Expensive Bus Fees	0.8
Inconvenience of Time (without Fixed Time)	17.6
Early Completion of Last Buses	1.8
Crowded in Buses	18.8
No Air Conditioners	12.5
Hating Buses	35.4
Other reasons	42.2
Total	200.0

- Intension for Taking Buses according to their Improvement: Table 4.6.8 shows the items of improvement in bus services and the subsequent tendency for shifting. 34% car users turn to bus user for the improvement of the comfort of buses, 43% for distance improvement, 37% for saving time, 45% for punctuality. The rate of shifting to buses is about 60% lower than that of bicycle users.

Table 4.6.8 Intension for Shifting to Bus Use

Better Conditions of Buses	Use(%)	Not Use(%)
1 Buses with Air Conditioners and without Being Crowded	34.3	65.7
2 Increasing Bus Stations and Bus Lines to Save about Half an Hour to the Nearest Bus Stations	42.8	57.2
3 Saving More Waiting and Transferring Time	37.3	62.7
4 Establishing Bus Lines for Exclusive Use to Improve the Punctuality Of Buses	44.7	55.3
5 Achieving All the Above Mentioned 4 Items of Improvement and Maintaining the Current Prices	37.3	62.7
6 Achieving all the Above Mentioned 4 Items of Improvement and Double the Current Prices	17.0	83.0

4.7 Assessment of Present Air Quality

4.7.1 Present Evaluation of Air Pollution by Diffusion Simulation

In order to understand the present state of air pollution resulting from vehicular traffic in Chengdu City, a simulation was done based on the relationship of the present level of air pollution from car exhaust with the distribution result of the additional vehicular traffic classified according to types of vehicles. The investigation process was as follows:

(1) It was divided in the interval of 1 km up to the 3rd Ring Road of the study area. In particular, the area of 12 km^2 was divided in the interval of 500m around the Tianfu Square within the 2nd Ring Road.
(2) Survey data on August 13 and 14 and calculation result of the simulation were calibrated first.
(3) The under painting density was estimated from the calibrated result, and unit of exhaust of the average speed was revised.
(4) The target air pollutant under study was carbon monoxide (CO) which influences the earth warming. Other gas unit varies according to other pollutants, and a car exhaust distribution map is alike.

The data used are as follows:

(1) Unit of exhaust used was the value that a road construction item, environment influence evaluation standard (1996; JTJ005-96) by the issue of the Chinese Traffic Ministry.

(2) Chengdu is located in the center of Sichuan Basin. So wind is weak and inversion layer is very common. Thus data was calculated using the minimum value (i.e. wind speed is 0.5m/s, a Steady Degree F), in the air pollution.

(3) Traffic volume was in terms of PCU.

Figure 4.7.1 shows the intersperse figure of the calculation result and the observation result. The relative coefficient was 0.73 and the background density value is estimated at about 2.7ppm (about 1.17 times, 3.16g/m3) as this result. The liner line indicated that 0.67 times revision is needed for the calculated values. The simulation of the car exhaust was done using the present traffic volume on this calibration. The distribution map of the daily average CO density was shown in Figure 4.7.2.

The analysis shows that the value goes above 30ppm near Tianfu Square, the middle section of Renmin Lu and at Fuqin Lu, which indicates serious air pollution in these areas. It is therefore quite necessary to analyze the areas separately and make certain plans for regional traffic measures.

Figure 4.7.1 Comparison of the Observed and Computed Values

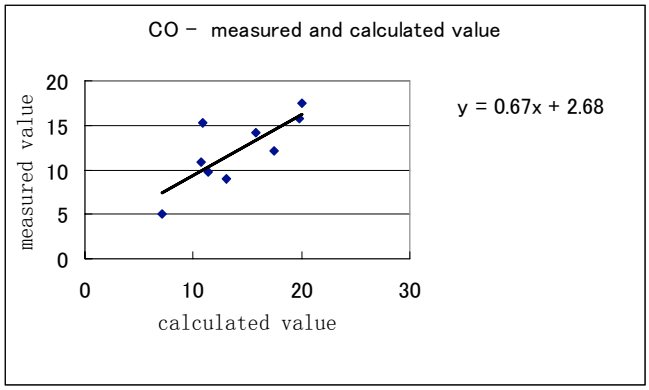
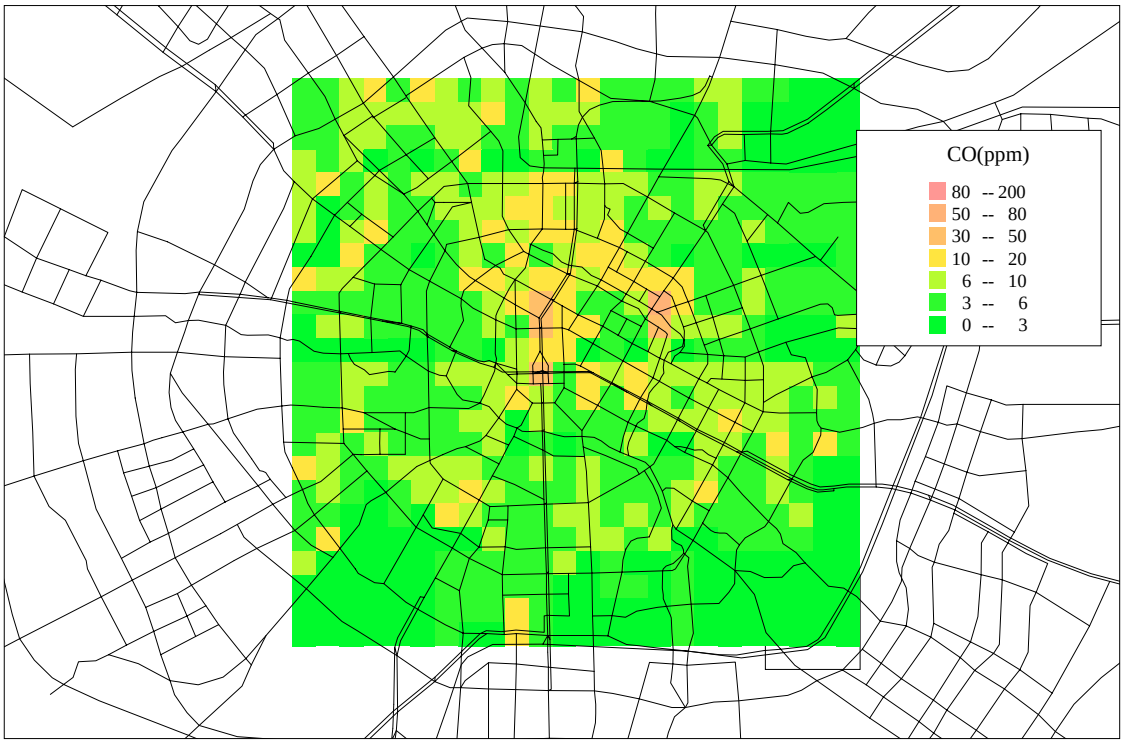


Figure 4.7.2 Concentration Distribution Map of Carbon Monoxide (CO) in 2000

(Daily Average, Steady Degree F)



4.7.2 Comparison of the Traffic Pollution Indicators with Other Cities

The following is a discussion on the problem of traffic pollution based on the report of the countermeasures for the problems of urban traffic pollution issued by the Ministry of Transport in Japan (1998：Chairman, Dr. Hideo Nakamura).

The levels of traffic pollution in Chengdu were compared with data from 13 cities in Japan and three other countries in order to make a comprehensive and objective analysis. Comparison was made with the following cities, as follows:

Table 4.7.1 Countries and Cities Compared with Chengdu's Traffic Pollution

Name of Countries	Name of Cities
Japan	Sapporo City, Sendai City, Chiba City, Tokyo 23 district, Kawasaki City, Yokohama City, Nagoya City, Kyoto City, Osaka City, Kobe City, Hiroshima City, Kita Kyushu City, Fukuoka City.
Foreign country	Indonesia, Jakarta City, China, Dalian City, Egypt, Cairo city bloc (Cairo, Kituba, CCM).

In setting the evaluation standard, relevant data concerning city traffic pollution are needed to get the average value and the standard deviation. Table 4.7.2 shows the results.

Table 4.7.2 Criteria for Comparative Evaluation

M+ σ	M+ σ /2	Average Value M	M- σ /2	M- σ
1 （ 16% ）	2 （ 15% ）	3 （ 38% ）	4 （ 15% ）	5 （ 16% ）
Evaluation value high		Evaluation value low		

The main factors resulting in pollution (directly or indirectly) were classified into four categories: pollution resource, traffic unit, traffic stream, and others, with each category further classified into large, medium or small.

As part of the analysis, the degree of air pollution and traffic conditions were evaluated as well (Table 4.7.3). Evaluation was conducted first on the smaller items and based on the result of the evaluation, the medium items were then evaluated. When evaluating the medium items, the more serious small items were prioritized, and this procedure was also employed to the large items.

Table 4.7.3 Evaluation Items Used

	Items	Contents	Notes
1	Sale of lead-containing petrol		
2	Sale of lead-free petrol	222.4 kl/day	Evaluation according to the automobiles in use per day
3	Sale of CNG	11,505m3	32.5m3×354 autos
4	Sale of light petrol	75.4 kl/day	Evaluation according to the automobiles in use per day
5	Lead amount in lead-containing petrol	g/l	
6	Sulphur amount in light petrol	g/l	
7	Frequency of check-up by mechanic	time/5 years	Buses once/year
8	Number of automobile repair shops	/shop	
9	Number of cars	163,000 cars	Whole city
10	Cars in use for more than 10 years	114,000 cars	Evaluation value：bus total rate×0. 7
11	Price for new cars (1800cc)	149,000 RMB	112,000 – 185,000 RMB
12	Price for old cars (1800cc)	RMB	
13	Average years of use for cars	3.5 years	Evaluation value：composed of the years buses in use
14	Number of motorcycles	292,000 vehicles	100 –125cc as the majority (whole city)
15	Price for new motor bicycles	30000 RMB	Sale total limited to 2,000 vehicles per year
16	Price for old motor bicycles	RMB	
17	Number of taxis	7,330 buses	
18	Number of taxis with CNG	700 buses	
19	Price for new taxis	78,000 RMB	Xiali/Fukang：135,000 RMB
20	Number of buses	2,027 buses	534 medium-sized buses included
21	Number of buses in use for more than 10 years	202 buses	
22	Price for new buses	150,000 RMB	
23	Price for old buses	RMB	Out of sale
24	Average years of use for buses	4.8 years	
25	Length of bus roads	800km	10.1km/per bus
26	Buses in use km/year	46,904.6 bus km/year	
27	Length of special roads for buses	Km	
28	Length of roads	824.6km	Exclusive of the small streets（ ×5 ）
29	Road area	28.5km^2	Road width average 35m^2,minor roads 7m^2
30	Length of main roads	378.0km	
31	Length of highways	（ 55.9 ）km	
32	Length of road in busy areas	22.12km	No.1 road line 14.7km/14bus stops
33	Ticket price in busy areas	RMB/km	
34	Traffic frequency in busy areas	Time/per day	A bus every 4 minutes in road line No.1(285 times/per day)
35	Number of intersections	229	Within 2nd Ring Road; exclusive of the small intersections
36	Number of intersections with traffic signs	109	Within 2nd Ring Road
37	Number of intersections at the cubing highways	7	Within 2nd Ring Road
38	Number of traffic monitoring instrument	Number	
39	Parking capacity of the fee-charging parking garages	Number of automobiles	Target 0.8m^2/person
40	Area of the busy areas (those investigated)	585.543km^2	Within 2nd Ring Road 200km^2
41	Beginning salary of new university graduates	1,300 RMB/year	Average evaluation value
42	Minimum wage per day	30 RMB	GDP11,103 RMB/365 per day
43	Number of people who have driving licenses		
44	Driving speed of the common automobiles at rush hours	22.6Km/hour	
45	Driving speed of buses at rush hours	13.7Km/hour	
46	Traffic sharing rate(common automobiles)	7.9%	
47	Traffic sharing rate (buses)	10.2%	
48	Traffic sharing rate (taxis)	4.7%	
49	Traffic sharing rate (motorcycles)	2.6%	
50	Traffic sharing rate (bicycles)	43.8%	
51	Traffic sharing rate (on foot)	30.8%	
52	Traffic sharing rate (underground)	0.9%	Based on the number of traveling passengers
53	Population downtown	2427,200	
54	Traffic accident cases / year	41,940/year	Inside Chengdu
55	Number of traffic accident victims/year	1,348 people/year	Inside Chengdu

Table 4.7.4 Problem Analysis Checklist

General Evaluation Items	Main Evaluation Items	Medium Evaluation Items	Individual Evaluation Items
Air pollution situation	Air pollution	$N0_2$	Maximum density per day
			Average density in residence per day Maximum density per year
		SO_2	Average density per day
			Average density in residence per day
			Maximum density per year
		SPM	Average density per day
			Average density per year
		Lead	Gas consumption lead containing /acre×100
			Maximum density per year
		CO	Average density per year
	Health threat	Health threat	Air pollution charge number（ year ）/population
Traffic situation	Speed	Common automobiles	Average mixture degree of the main roads （ average value according to the road extension data ）
			Average speed in main roads at rush hours (average value according to traffic transportation amount)
			Number of autos in driving （ pcu ）/road area total
			Number of autos（ pcu ）/road area total
		Bus	Average driving speed of the main roads at rush hours （ average value according to traffic transportation amount ）
	Traffic share rate	Common auto	Traffic share rate
		Bus	Traffic share rate
		Truck	Traffic share rate
		Walking & bicycle	Traffic share rate
Pollution sources			
Fuel	Fuel constituents	Lead amount in petrol	Average content (according to the whole sale: both cases with or without lead)
			Lead content in lead-containing petrol
		Sulphur amount in fuel	Sulphur amount
			Sulphur amount in light petrol
	Amount of fuel use	Percentage of sale on market	Sale of lead-containing petrol/sale of fuel×100
			CNG sale/fuel sale×100
			Light petrol sale/fuel sale ×100
Automobiles	Gas exhaust limitation	Common autos	Gas restriction have and have-not
			CO restriction
			HC restriction
			NO_X restriction
		Large autos	Gas restriction have and have-not
			CO restriction
			HC restriction
			NO_X restriction
		Bus	Gas restriction have and have-not
			CO restriction
			HC restriction
			NO_X restriction
	Repair capability	Common autos (large types included)	Gas-exhaust have or have-not
			Real situation of auto checking (once/every 5 years)
			Auto fixing factory total (every 10 autos)
		Bus	Gas-exhaust have or have-not
			Real situation of auto checking (once/every 5 years)
	Years in use	Common autos (large types included)	Percentage of the autos in use by more than 10 years
			Price of new autos: old auto price in use more than 10 years ×100
			Average years for use
		Bus	Percentage of the autos in use by more than 10 years
			price of new autos: old auto price in use more than 10 years ×100
			Average years for use

(continue)

Traffic Volume

Automobile traffic	Automobile	Total vehicles	Total autos/population
			Total auto increase rate
		Purchase maintaining cost	New autos（ 1800ｃｃ ）price/the beginning salary of university graduates (year)×100
			Old auto price/ the beginning salary of university graduates (year)×100
			Maintenance tax / the beginning salary of university graduates (month)×100
		Driving license	Number of people granted driving license
			Increase rate of the amount of people granted driving license
	Motorcycle	Total vehicles	Total vehicles/population
		Purchase maintaining cost	New auto price/the beginning salary of university graduates (year)×100
			Old auto price/ the beginning salary of university graduates (year)×100
			Maintenance tax / the beginning salary of university graduates (month)×100
		Driving license	Number of people granted driving license
	Volume restriction	Restriction for large autos	If there are restrictions of the large auto's entering into downtown
		Restriction for cars	If there are restrictions of the car's entering into downtown
Public traffic facilities	Bus	Total routes for auto	Road length/area of the busy areas
			Total buses//area of the busy areas
			Running bus total km/area of the busy areas
			Running bus total km/area of roads
		Fee charge	Driving expense/wage per day ×100
	Truck system	Roads adjustment	Road length/area of the busy areas
			Bus-stop total/area of the busy areas
		Correlation	Tracks connected with the bus routes/area of the busy areas
		Service	Average traffic frequency per day
		Fee charge	Traffic cost per km/daily wage×100

Total Traffic Control

Road maintenance Standard	Road network	Common roads	Road length/area of the busy areas
			Road area/area of the busy areas×100
			Road area/total autos
			Road length/total autos
			Cubing road intersections/total intersections×100
		Highways	Highway length/area of the busy areas
		Parkings	Parking capacity of the fee-charge parkings/total autos×100
Traffic control	Total traffic control	Traffic restriction	Total of intersections with traffic lights/total intersections×100
			Traffic monitoring instrument/main road length
		Bus-driving restriction	Maintenance and length of the roads for bus only/main road length×100

Others

Traffic safety	Accident	Traffic accident	Number of accidents/total autos×1000
		Victims in the accident	Number of accidents/total cars×1000
	Safety measures	Safety education	During traffic safety month
Air pollution monitoring	Air pollution monitoring	Monitoring instrument	Number of instrument/area of the busy areas
General Evaluation Items	Main Evaluation Items	Medium Evaluation Items	Individual Evaluation Items

Data used in the tables come from the data generated by this study and data which were deduced from the results of the study. The target subjects of the study are defined as those within Second Ring Road and differentiated the collected data and evaluation contents.

Table 4.7.5 indicates the comparison of results of evaluation with Chengdu, Dalian, Jakarta, and Cairo. However, comparative analysis is not very comprehensive given the differing base years of the survey. Generally, Chengdu results are as follows;

- It registers environmentally green zone.
- It has worse public transport system.
- Control on traffic volume and flow is worse.
- It is improving on fuel in public transport.

Table 4.7.5 Comparison of Causes for Traffic Pollution

	Emission sources					Original traffic volume				
	Fuel		Vehicle			Private Car		Public Transport		Restriction
	Component	Used amount	Emission control	Maintenance Level	Distribution of used car	Car	Bicycle	Bus	Railway	Restriction of Traffic Volume
Chengdu	C	C	C	C	C	C	C	D	E	D
Dalian	C	C	C	D	D	C	B	D	C	D
Jakarta	D	D	C	E	E	D	D	D	E	C
Cairo	E	D	C	E	E	D	D	E	D	E
Nagoya	A	E	C	A	B	E	C	A	A	D

Chengdu：2000，Dalian：1997, Jakarta：1996,Cairo：1998, Nagoya：1995

Evaluation of the reasons for traffic pollution is presented in Table 4.7.6 where the average values, standard deviation values of individual cities on separate items and the comparative values for Chengdu City are listed as well according to the following evaluation criteria: “Excellent”(above + σ or below $-\sigma$); “Good” (between σ and $\sigma/2$ or between $-\sigma$ and $\sigma/2$); “Average” (between positive and negative $\sigma/2$); “Evaluation Values Differentiation”（between σ and $\sigma/2$ or between $-\sigma$ and $\sigma/2$); “Bad”（above $+\sigma$ or below $-\sigma$). In terms of procedure, the small items were evaluated first listing them into the bigger items as the priority items, with the worst items in bigger items into the big items as the priority items for further evaluation. The process adopted is similar to the “whole body diagnosis” of people.

Table 4.7.6 Evaluation of Causes of Traffic Pollution

	Traffic flow			Others		
	Level of road network	Traffic Control		Safety of Traffic	Faculty of Road side	Monitoring of Pollution
	Road network	Traffic Control System	Separate of Passenger	Traffic Accident	Greenbelt Zone	Network of Monitoring Exhaust Gas
Chengdu	E	E	C	E	B	E
Dalian	D	D	C	B	D	E
Jakarta	D	D	D	D	D	E
Cairo	E	E	E	D	E	E
Nagoya	B	A	A	A	C	A

Countermeasures addressing the traffic pollution need to be developed in the next phase. Table 4.7.7 illustrates the countermeasures developed by the Committee (MOT) that was also used in the study. In this table there are vertical items to the causes and horizontal items to the general main countermeasures such as emission sources, traffic volume, traffic flow and others. The general main countermeasures consist of some of middle level countermeasures. ◎ indicates the best effective countermeasure and ○ indicates the better effective countermeasure in middle level.

Table 4.7.7 Pollution Sources and Corresponding Measures

Items investigated			Judgement	Pollution Sources				Traffic Volume						Total traffic			Others		
				1.Fuel improvement	2.Strict with gas exhaust restriction	3.Introduce & improve auto checking system	4.Introduce auto types with less pollution sources	1.Traffic restriction for autos to the downtown area	2.Control of total autos	3.Improvement of bus service standard	4.Maintenance of track traffic	5.Taxi and the standard bus traffic system	6.Improvement of the central bus station	1.Road maintenance	2.Set up traffic regulations and better the traffic service function	3.Traffic control	1.Green belt	2.Traffic safety and environmental protection	3.Improve the traffic monitoring system
1Pollution sources	1fuel	1constituents	C	◎	○		◎												
		2consumption amount	C	○	○	○													
	2vehicles	1gas exhaust restriction	C		◎	○	◎										○	○	○
		2controlling result	C		◎	◎	○											○	○
		3usage year distribution	C			◎	○		○										
2Total traffic volume	1individual traffic	1autos	C					◎	◎	○	○	○		○	◎	○		○	○
		2motorcycles	C					○	◎	○	○				○			○	
	2public traffic	1buses	D					◎	○	◎	○	○	◎	◎	○	○		○	
		2track use	E					◎	○	○	◎		◎					○	
	3traffic restriction	1total traffic restriction	D					◎		◎		○	○	◎	◎	◎		○	○
3Total road traffic	1road maintenance	1road networks	E					○		○			○	◎			○		
	2traffic control	1traffic restriction	E					◎		○		○	○	○	◎	◎		○	○
		2pedestrian separation	C							○				◎	◎	○		○	
4Others	1traffic safety	1traffic accident	E											○	◎	○		◎	
	2road-side traffic facilities	1green belt	B											○			◎	○	
	3air monitoring	1monitoring	D	○	○	○	○										○	◎	◎

Evaluation Criteria:

A：Excellent B：Good C：Average (deterioration possible if enough attention not given)

D：Bad (needs improvement) E：Terrible; (immediate improvement required)

Solutions: ◎：Efficient ○：Effective

From Table 4.7.7, the necessity of taking traffic pollution control measures becomes necessary given the evaluation data. The following are some of the proposed countermeasures:

(1) There was no problem with the fuel and vehicles as far as pollution sources are concerned (for items with C rating):

- Fuel improvement (CNG included);
- Stricter regulations on gas exhaust;
- Automobile-checking improvement;
- Introduction of automobiles with less pollution possibilities (CNG autos included).

(2) Efforts needed as follows (for items with D and E rating):

- Total control of vehicles;
- Total vehicle restriction;

- Bus road reservation by controlling vehicles;
- Improvement of bus service;
- Road network adjustment;
- Re-adjustment of the traffic control system;

(3) In view of the total traffic volume, efforts are needed to lessen gas exhaust by speed control. Without problems in road adjustment though, the adjustment to slow speed results in traffic congestion.
- Road adjustment including parking; and
- Improvement of the traffic monitoring system to determine the time of traffic congestion.

(4) Other problems connected with Chengdu's traffic environment (e.g., high rate of traffic accidents and traffic victims compared with the total number of vehicles) may be addressed by the following:
- Enhancement of traffic safety and environmental consciousness;
- Chengdu government's efforts at increasing the greenbelt area particularly along the roadsides and similar efforts should be pursued to increase CO^2 absorption;

Improvement of the environment monitoring system is ongoing with most of the facilities for environmental monitoring near the residential areas. To monitor the vehicle gas exhaust, those areas found in the pollution density study as seriously polluted should be supervised.