

CHAPTER 5 METHODOLOGY OF THE TRAFFIC SURVEY

5.1 Outline of the Traffic Survey

5.1.1 Basic Policy of the Traffic Survey

(1) Objectives of the Traffic Survey

The objectives of the traffic survey are as follows:

- 1) To analyze the characteristics and issues of transportation in Kathmandu Valley.
In order to cope with the existing problems and issues of transportation in Kathmandu Valley, traffic conditions and its characteristics will be analyzed.
- 2) To grasp the variation of traffic movement from the previous M/P (1993).
Traffic survey had been conducted in 1991 for the M/P (1993). By comparing the traffic survey result with the previous survey result from the M/P (1993), a variation of traffic movement will be identified.
- 3) To formulate basic data for traffic demand in the future.
In this survey, the future traffic demand in 2022 will be forecasted. Traffic survey results obtained will then form the fundamental data for the forecast.

(2) Basic Policy for the Traffic Survey

Traffic survey was conducted based on the following policies:

- 1) Consistency with the traffic survey in the M/P (1993).
Consistency of survey methods such as zoning, location of survey point, and survey duration is required for comparison of survey result between 1991 and 2022.
- 2) Reflection of urbanization in recent years.
Urban expansion and transition of land use affects traffic movement. Decision of the survey method should be made considering the urbanization of the survey area.
- 3) Traffic surveys which considers countermeasure for improvement of traffic condition.
To solve the current traffic issues, multiple measures including road development and public transport improvement are required. The traffic survey method should be decided taking into consideration of those measures.

5.1.2 Traffic Survey Items and Schedule

(1) Survey Items

In establishing the previous M/P (1993), the following traffic survey was carried out in December 1991.

- 1) Home Interview Survey (Person Trip Survey)
- 2) Traffic Survey
 - Roadside OD Survey
 - Roadside Traffic Counts
 - Intersection Traffic Counts
 - Vehicle Speed Survey
- 3) Public Transport Survey/Firm Interview Survey

In this survey, 11 types of traffic survey were conducted. These 11 types of traffic survey items are categorized into household interview survey, traffic surveys, and bus transport surveys (Table 5.1.1).

Table 5.1.1 Traffic Survey Item

1) Household Interview Survey (Person Trip Survey)
2) Traffic Survey
a) Roadside Interview (OD) Survey
b) Traffic Count Survey
c) Screen Line Survey
d) Traffic Count Survey of Major Intersection
e) Travel Speed Survey
f) Parking Survey
3) Bus Transport Survey
a) Bus Traffic Count Survey
b) Bus OD Survey
c) Bus Passenger Interview Survey
d) Public Transport Firm Interview Survey

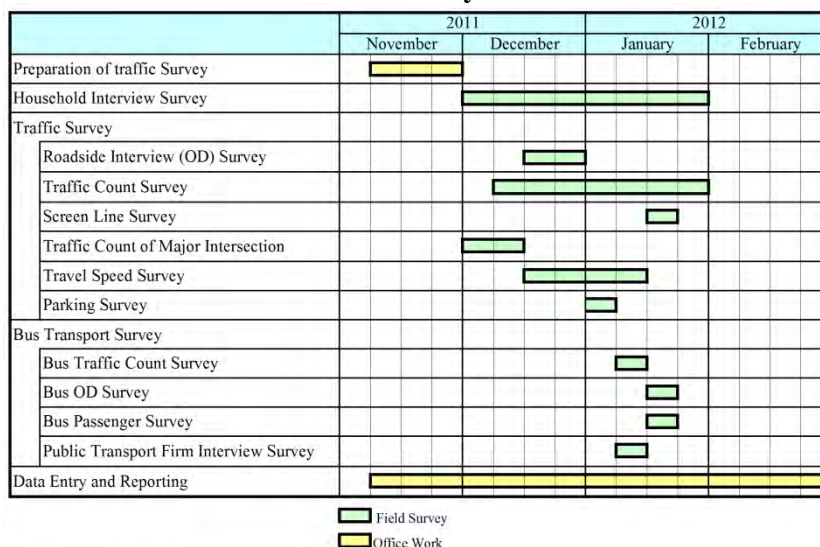
Table 5.1.2 Comparison of Traffic Survey Items between the survey in the previous M/S and this time

Items	Survey in the previous M/S (1993)	Survey in this time
1) Household Interview Survey (Person Trip Survey)	Target Area: – KMC – LSMC – BMC – Nearby area of Thimi and Kirtipur Sample households: – 5,521 samples (actual surveyed value)	Target Area: – Kathmandu district except a part of southwestern area – Lalitpur district except a part of southern area – Bhaktapur district Sample households: – 18,000 samples (target value)
2) Traffic Survey	-	-
a) Roadside Interview (OD) Survey	15 locations	18 locations
b) Traffic Count Survey	29 locations	44 locations
c) Screen Line Survey	None	10 locations
d) Traffic Count Survey of Major Intersection	8 intersections	10 intersections
e) Travel Speed Survey	10 routes	16 routes
f) Parking Survey	None	1 route
3) Bus Transport Survey	-	-
a) Bus Traffic Count Survey	None	2 bus parks
b) Bus OD Survey	None	2 bus parks
c) Bus Passenger Interview Survey	None	2 bus parks
d) Public Transport Firm Interview Survey	31 firms (only land transportation firms)	80 firms

(2) Survey Schedule

The traffic survey was commenced on December 3, 2011. The overall implementation schedule of the survey is shown in Table 5.1.3.

Table 5.1.3 Survey Schedule

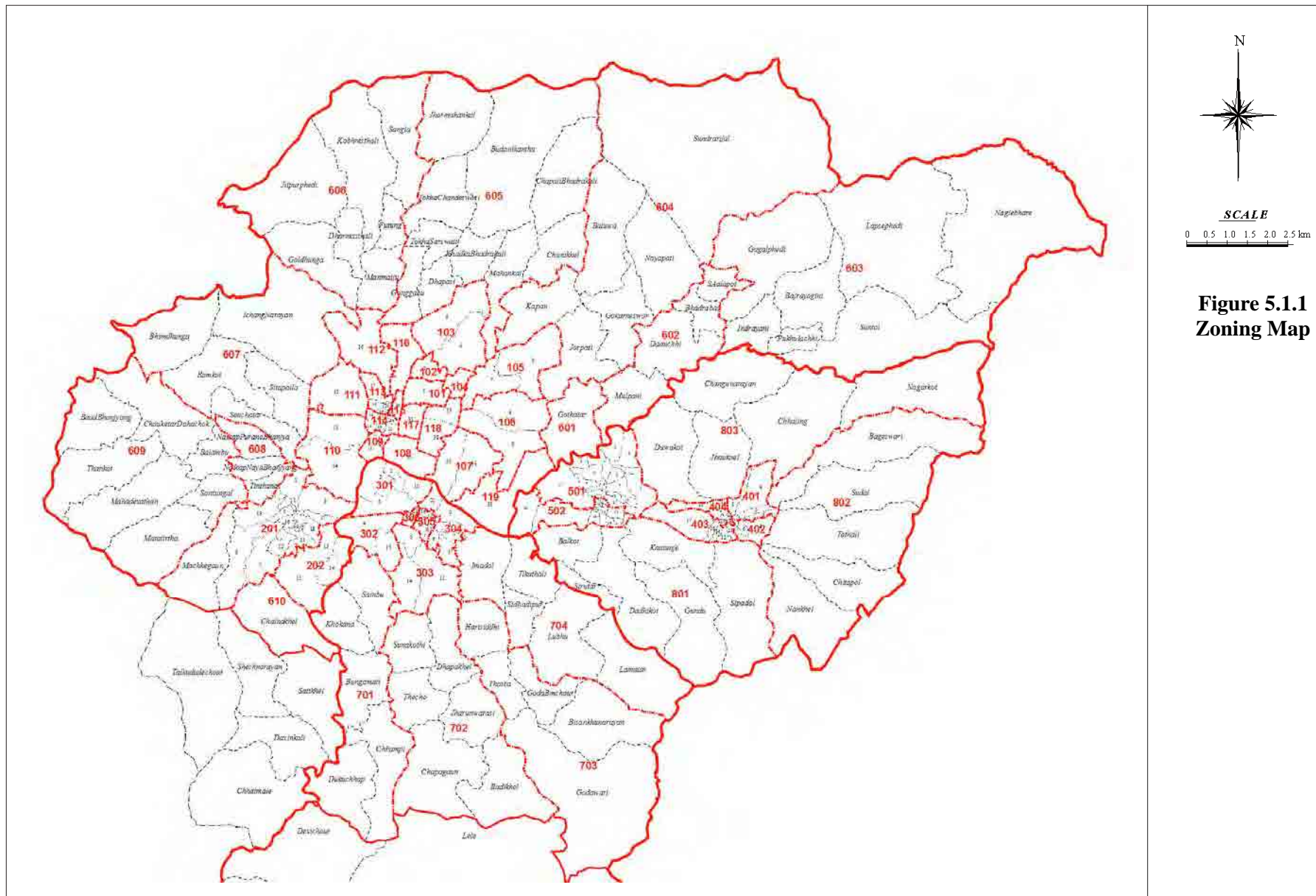


5.1.3 Zoning in Traffic Survey

The survey area was divided into separate traffic zones. Basically, the method of zoning was consistent with the zoning of the M/P (1993) in which each traffic zone is constituted of wards and VDCs. Considering the recent urban expansion, several zones in the peripheral area of the city center were divided into smaller zones. The total number of zones within the survey area was 50. Compared with the M/P (1993), the total number of zones was increased by 5 from the previous 45. Zoning map of the Kathmandu Valley is shown in Figure 5.1.1.

Table 5.1.4 Number of Zones

District	Area	No. of Zones	No. of Ward	No. of VDC
Kathmandu	Kathmandu N.P.	19	35	
	Kirtipur N.P.	2	15	
	Rural Area	10		56
Lalitpur	Lalitpur	6	21	
	Rural Area	4		21
Bhaktapur	Bhaktapur N.P.	4	17	
	Madhiapur Thimi N.P.	2	17	
	Rural Area	3		16
Total		50	105	91



5.2 Household Interview Survey

5.2.1 Basic Concept and Outline of Household Survey

(1) Basic concept of household interview survey

1) Person Trip Survey:

Person trip survey is a method for analyzing transport by capturing persons' movement based on the idea that persons' movement is the source of traffic.

2) Household Interview Survey:

In order to capture the movement of persons, surveyors visited different homes and made interview about the movements (trips) of persons of a certain day. The survey was a sample survey and targeted persons were selected randomly from the population of the survey area.

(2) Outline of the Survey

Outline of household interview survey is shown in Table 5.2.1 below.

Table 5.2.1 Summary of Household Interview Survey

Type of survey	Purpose	Method	Contents of survey
Household interview survey	To capture people's movement such as origin, destination, trip purpose, travel time etc.	Interview to household members at their home and make questions	Sample households: 18,000 within the survey area

5.2.2 Survey Area

The survey area of the household interview survey in 1991 was limited to the Kathmandu municipality, Lalitpur Municipality, and Bhaktapur Municipality. Considering the expansion of urban area and the distribution of population, the survey area of household interview survey in 2011 was expanded to the Kathmandu Valley which excludes mountainous area of three districts. Figure 5.2.1 shows comparison of the survey areas in 1991 and 2011 surveys.

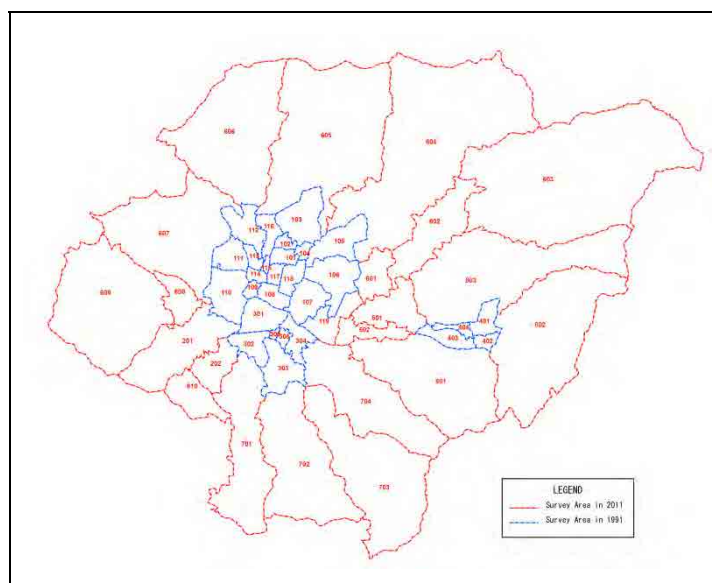


Figure 5.2.1 Survey Area of Household Interview Survey In 1991 and 2011

5.2.3 Sampling Rate

The “Preliminary Result of National Population Census 2011” which contained the total population and number of household by district was issued in September 2011. No other data was released until July 2012. An accurate population and number of household in Kathmandu survey area in 2011 could not be captured since there was no other population statistics available other than the Census 2001. In this study, a method for sampling and population estimation was established using the following assumption:

- 1) Total population and number of household in Kathmandu, Lalitpur, and Bhaktapur districts in 2001 and 2011 are shown in the following table.

Table 5.2.2 Population and Number of Household in the Districts in 2001 and 2011

	No. of Household	Population	Household Size persons/household
2001 Three Districts*	345,562	1,645,091	4.76
2011 Three Districts*	656,672	2,501,788	3.82

*Three districts: Kathmandu, Lalitpur, and Bhaktapur

Source: Population Census – 2002, Central Bureau of Statistics

National Population Census 2011 (Major Highlights of the Preliminary Results), Central Bureau of Statistics

- 2) The survey area excluded five VDCs in Kathmandu District and 20 VDCs in Lalitpur District. Population and number of household in the survey area were estimated based on the proportion of the survey area to the district. Estimated population and number of households are shown in Table 5.2.3.

Table 5.2.3 Estimated Population and Number of Households in the Survey Area in 2011

	No. of Household	Population	Household Size persons/household
2011 Survey Area	643,100	2,444,151	3.80

Source: JICA Survey Team

- 3) Since the statistics of population by age group in 2011 was not issued, the population with age five years and above, the target of the household survey, was estimated by using the ratio of the 2001 population with age five years and above.

Table 5.2.4 Estimation of Population of Five Years and Above in 2011

Ratio of Population of Five Years and Above in 2001 in the Survey Area	Estimated Population of Five Years and Above in 2011 in the Survey Area
0.920	2,248,600

Source: JICA Survey Team

[Sampling rate and number of samples]

Statistically, the relation between population, sampling rate and relative error is expressed in the following numerical formula:

$$RSD(A) = K \sqrt{(ZK-1)/(1-r)/r/N}$$

Where,

RSD(A): Relative error 20%

K: Confidence coefficient 1.96

N: Total number of trips in the study area

ZK: Number of categories

r: Sampling rate

Sampling rate to estimate the trip generation/attraction by zone by trip purpose by travel mode on the condition of a 20% relative error and a 1.96 confidence coefficient was calculated as shown below:

N: Total number of trip

Population in Survey Area (2,248,600) × Basic unit of trip generation (1.72 trip/person –M/P (1993)) = 3,868,000 trips/day

ZK: Number of categories

Number of zones (50) × Number of trip purposes (6) × Number of travel modes (4) = 1,200 categories

Sampling rate (r) was calculated at 2.8%. The presumed number of household in the survey area was 643,100 as shown in Table 5.2.3. As a result, the number of necessary samples was 18,000 households considering validity of the survey sheet.

5.2.4 Questionnaires for Household Interview

Questionnaires for home interview consisted of 1) questions for household, 2) information of family members, and 3) questions for trips made by family members. Modal split will be essential in future traffic demand forecast. Therefore, questions, related to selection of modes, such as income and reason of selection, are made.

Table 5.2.5 Questionnaire of Household Interview

Category	Question Item	Detail
Household Information	Address	
	Number of household members	
	Type and number of vehicles owned by household	
	Monthly income	
Household Member Information	Age, Sex	
	Driver license	
	Occupation	
	Address of workplace/school	
	Monthly income	
	Reason of using private cars for commuting	
Household Member Trip Information	Starting place	
	Place category	Home, School, Workplace
	Address	
	Destination	
	Place category	Home, School, Office, Factory, Shop, Restaurant, Hospital, etc.
	Address	
	Trip information	
	Trip purpose	See Table 5.2.6
	Travel mode and access mode	See Table 5.2.7
	Departure time	
Arrival time		

5.2.5 Grouping of Trip Information

The answers in the questionnaire are classified to a few items to make it easy for the interviewee to answer. The following tables show the categories of trip purpose and travel mode.

Table 5.2.6 Trip Purpose Category

Number	Trip Purpose
1	To work
2	To school
3	To home
4	Business
5	Shopping
6	Dining
7	Leisure/Recreation
8	Medical/Treatment
9	Others

Table 5.2.7 Travel Mode Category

Number	Travel Mode
1	Walk
2	Bicycle
3	Motorcycle
4	Car
5	Truck
6	Taxi
7	Tempo
8	Minibus
9	Bus
10	Others

5.2.6 Survey Method

(1) Sampling

In the survey area, resident basic registration or registry of voters was not available and the materials for random sampling of household were not prepared. Therefore, sampling of household was done through the following procedure.

- 1) Traffic zone was divided to small areas and the target numbers of sample households were decided.
- 2) Sampling of household was done so that the samples spread widely and evenly in the area.

(2) Interview

The Living Standard Survey 2010/2011 showed that the literacy rate in urban Kathmandu Valley is 84.2%. Since not all residents in the survey area are literate, the questionnaire forms were filled by the surveyor in the presence of household members. Interviews were made in the evening during workdays and in the daytime on holidays.

5.2.7 Number of Collected Data

A total number of 18,100 households were interviewed in December 2011 and January 2012 for the survey. Total number of household members was 72,062 excluding invalid member data. Total population of ages five years and above in 2011 in the survey area was assumed to be 2,248,000 by the Survey Team. Sampling rate was 3.13%, which exceeded the sampling rate calculated in Section 5.2.2.

Table 5.2.8 Total Number of Collected Data for Household Interview Survey

Total number of collected household data	18,100
Valid household data	17,592
Total number of valid household member data	70,524
Sampling rate	3.13%

Source: JICA Survey Team

5.2.8 Data Expansion

The household interview survey was a sample survey, so collected data required expansion. The expansion was done by applying the following calculation to the data of each zone.

Expansion factor for each zone = Population with age five years and above by zone ÷ Number of sampled household members by zone

Number of trips produced by the population in each zone = Number of trips captured by the household interview survey × Expansion factor

As a result of the calculation, expanded total number of trips was obtained as shown in Table 5.2.9.

Table 5.2.9 Estimated Total Number of Trips by Data Expansion

Number of trips captured by the household interview survey (trips)	99,399
Average expansion rate	35.04
Estimated number of trips by data expansion (trips)	3,483,393

Remark: Number shown above is total number of calculation in each zone.

Source: JICA Survey Team

5.3 Traffic Survey

5.3.1 Outline and Summary of Traffic Survey

The traffic survey was carried out consistent with the previous M/P (1993). The survey took into account the variation of urbanization and land use of the Kathmandu Valley in recent years. Survey points, zoning and method of analysis were decided based on the present traffic conditions in the Kathmandu Valley. Future traffic demand forecast will be conducted reflecting the population distribution and economic growth. Table 5.3.1 shows the summary of traffic survey conducted under this survey:

Table 5.3.1 Summary of Traffic Survey

No.	Type of Survey	Purpose	Method	Contents of Survey
1	Roadside interview survey	To capture vehicle origin, destination, trip purpose, etc. Survey points surrounding the Ring Road and surrounding the Bhaktapur urban area compose cordon lines which control the result of household interview survey.	Interview with drivers at survey points on arterial roads Sampling rate was 20% of all the vehicles.	Survey point: 18 points, 16 hrs , 1 day (workday)
2	Traffic count survey	To capture traffic movement during workdays and weekends.	Traffic counts by direction and by type of vehicle at survey points along arterial roads	Total survey points: 44 ----- Survey point: 15 points 24 hrs, 1 day (workday) 16 hrs, 2 days (workday) (Total 3 days on workdays) and 16hrs, 1 day (weekend) ----- Survey point: 29 points 16 hrs 3 days (workday) and 16 hrs 1 day (weekend)
3	Screen line survey	To confirm the accuracy of person trip survey by counting the number of vehicles crossing the rivers.	Traffic count at the crossing point such as Bagmati River, Bishnumati River, Manahara River and Dhobi Khola	Survey point: 10 points 24 hrs, 1 day (workday)
4	Traffic count survey of major intersections	To optimize signal system at major intersections.	Traffic count by vehicle type and by direction (straight, left turn, right turn) at major intersections	Survey point: 10 points 3 hrs during morning peak and 3 hrs during evening peak, 1 day (workday)
5	Travel speed survey	To analyze vehicle speed affected by traffic congestion.	Investigation of travel time by running each route	Survey route: 16 routes 3 rounds per day 1 day (workday) 1 day (weekend)
6	Parking survey	To capture parking demand of trucks.	Counting number of parking vehicles along Ring Road where many parking vehicles are observed regularly at night	Survey route: Ring Road 1 day (workday) and 1 day(weekend) 1 time(starting 11 pm)

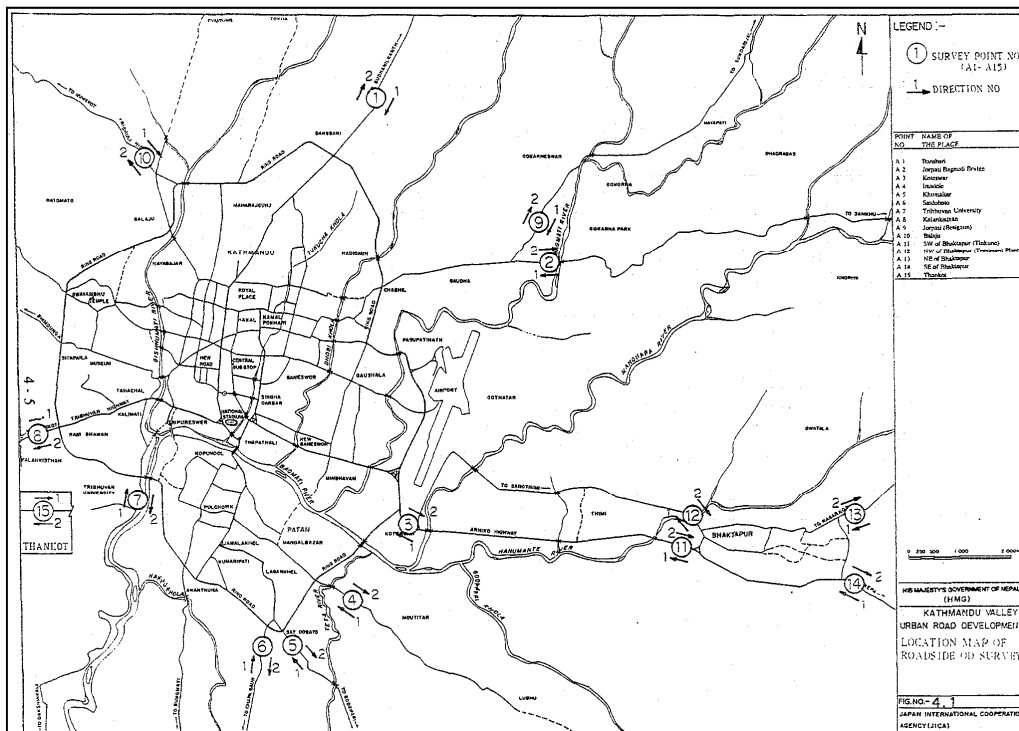
5.3.2 Roadside Interview Survey (Origin-Destination: OD)

(1) General

Roadside interview surveys were conducted to supplement the household interview by the movement of vehicles, especially cargo related vehicles and vehicles that originated outside the survey area. The methods of conducting OD survey were by stopping sample vehicles at roadsides and asking the driver questions related to their trips.

(2) Survey Point

Roadside interview surveys were conducted at 15 points on major arterial roads in the previous M/P (1993).



Source: JICA Study on the previous M/P (1993)

Figure 5.3.1 Location of Roadside Interview (OD) Survey in the previous M/P (1993)

In this survey, OD surveys were conducted at 18 points among which, 15 points corresponded to the previous M/P (1993). The following three points were added:

- 1) One survey point was added to investigate the origin and destination of trips entering and exiting Tribuvan International Airport, the gate to the Kathmandu Valley. The interview was made to clarify the purpose of the visit, period of stay, and course of the tour, etc.
- 2) One survey point was added to identify future traffic demands of trips along the Arniko Highway, a major road linking the Kathmandu Valley, the eastern and southern area of Nepal.
- 3) One survey point was added to investigate the origin and destination of trips between the northern part of the Kathmandu Valley and city center of Kathmandu.

The location of survey points is shown in Figure 5.3.2.

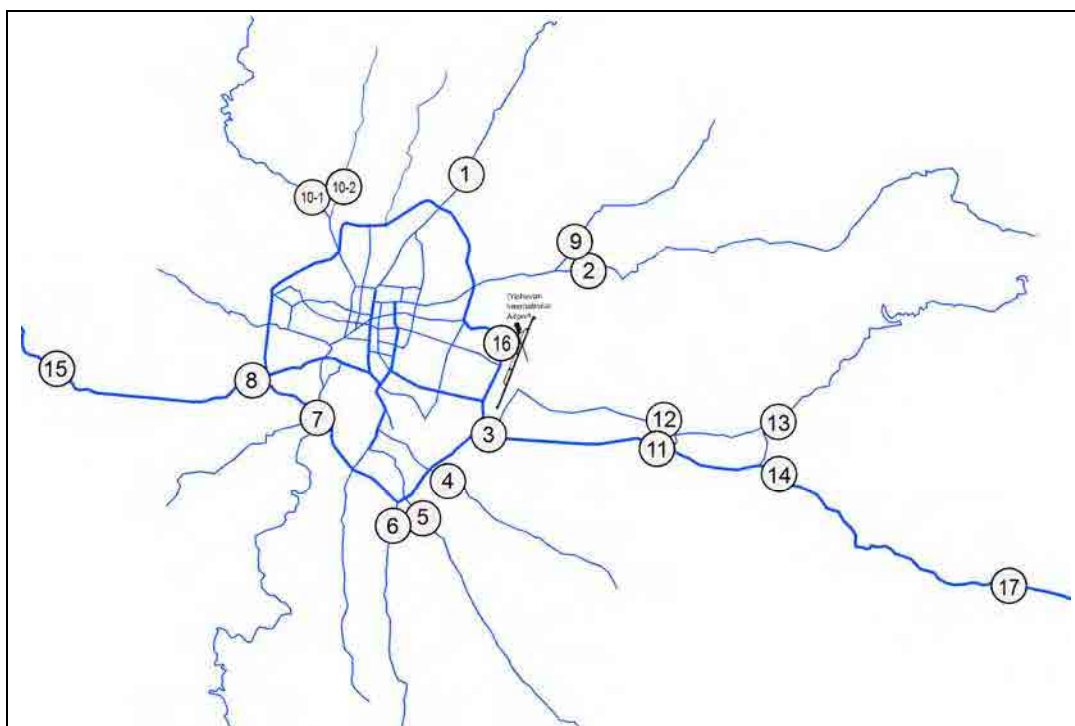


Figure 5.3.2 Location of Roadside Interview (OD) Survey (2012)

Table 5.3.2 Roadside Interview (OD) Survey Point

No.	Date	Road	Location	Time
1	29 Dec.	Budhanikantha Road	Near Budhanikantha, at curved road	6:00-22:00
2	28 Dec.	Sankhu Road	Near Bagmati Bridge, Jorpati, on Sankhu Road	6:00-22:00
3	23 Dec.	Arniko Highway	Koteswor, before Jadhikuti Junction	6:00-22:00
4	22 Dec.	Lubhu Road	After Ashowk Stupa	6:00-22:00
5	20 Dec.	Godawari Road	Near NAST office	6:00-22:00
6	21 Dec.	Chapangaun Road	Near open space, approx. 500 m south of Ring Road	6:00-22:00
7	18 Dec.	Dakshinkali Road	Before reaching TU Gate	6:00-22:00
8	3 Jan.	Tribuvan Highway	Near Kalanki Petro Pump, Kalanki-Thankot Road	6:00-22:00
9	26 Dec.	Sundarijal Road	Sundarijal Road	6:00-22:00
10-1	1 Jan.	Trisuli Road	Near Trisuli Bus Park after bypass	6:00-22:00
10-2	2 Jan.	Phutung Road	Near Trisuli Road	6:00-22:00
11	5 Jan.	Arniko Highway	At Sallagali, Bhaktapur	6:00-22:00
12	6 Jan.	Thimi Road	Before reaching Bhaktapur	6:00-22:00
13	8 Jan.	Nagarkot Road	Near bus stop	6:00-22:00
14	9 Jan.	Arniko Highway	Negkhel, near Basbari	6:00-22:00
15	4 Jan.	Tribuvan Highway	Thankot Check Post	6:00-22:00
16	27 Dec.	Airport Entrance	Near present security check point	6:00-22:00
17	10 Jan.	Arniko Highway	Near small bridge after crossing Banepa	6:00-22:00

(3) Questionnaire for Roadside Interview

Items in the questionnaire of roadside interview survey are shown in Table 5.3.3.

Table 5.3.3 Questionnaire of Roadside Interview Survey

Category	Question Item	Detail
Vehicle information	Type of vehicle	11 types shown in Table 5.3.4
	Number of passengers	
Trip information	Purpose of the trip	9 categories same as household survey
	Trip frequency	
	Place of origin	
	Expected travel time	
Information of shipment	Type of cargo	Survey point 14, 15, and 17 only
	Cargo volume	
Parking	Length of parking in Kathmandu	
	Parking place	

Table 5.3.4 Vehicle Category

Number	Vehicle Category
1	Bicycle
2	Motorcycle
3	Tempo
4	Taxi
5	Microbus (-16 persons)
6	Minibus (26-35 persons)
7	Large Bus (35-50 persons)
8	Passenger Car
9	Light Truck
10	Heavy Truck
11	Others

At the east and west survey points (Nos. 14, 15, and 17) interviews were made for capturing movement of cargo traffic from outside of the Kathmandu Valley. Survey results were utilized together with the parking survey results for analyzing the need for truck parking in the city area.

(4) Total Number of Roadside OD Interviews

The survey was conducted on workdays and holidays at 17 locations from December 2011 to January 2012, resulted to 17,139 completed interviews as listed in Table 5.3.5. The total number of each type of vehicle is shown in Table 5.3.6.

Table 5.3.5 Number of Roadside OD Interviews

No.	1	2	3	4	5	6	7	8	9	
Road	Budhanilkanttha Road	Sankhu Road	Arniko Highway	Lubhu Road	Godawari Road	Chapagaun Road	Dakshinkali Road	Tribuvan Highway (Kalanki)	Sundarijal Road	
Total No. of Vehicles	16,914	12,114	59,980	17,462	13,189	14,449	10,574	21,668	4,327	
Total No. of Interviews	1,118	978	1,180	753	672	748	603	1,365	458	
Sample Rate	6.6%	8.1%	2.0%	4.3%	5.1%	5.2%	5.7%	6.3%	10.6%	
No.	10-1	10-2	11	12	13	14	15	16	17	Total
Road	Trisuli Road	Phutung Road	Arniko Highway (Bhaktapau)	Thimi Road	Nagarkot Road	Arniko Highway (Bhaktapau)	Tribuvan Highway (Thankot)	Airport Entrance	Arniko Highway (Banepa)	
Total No. of Traffic	7,954	8,031	29,528	8,943	7,202	15,446	9,864	18,135	9,933	285,783
Total No. of Interviews	606	683	1,278	799	581	1,091	1,847	1,345	1,034	17,139
Sample Rate	7.6%	8.5%	4.3%	8.9%	8.1%	7.1%	18.7%	7.4%	10.4%	6.0%

Source: JICA Survey Team

Table 5.3.6 Vehicles Interviewed in OD Surveys

Vehicle Type	Total No. of Traffic	No. of Interviews	Sample Rate
Motorcycle	181,600	2,955	1.6%
Tempo	2,789	454	16.3%
Car	46,914	4,281	9.1%
Taxi	16,207	3,130	19.3%
Light Truck	27,212	4,546	16.7%
Heavy Truck	11,061	1,773	16.0%
Total	285,783	17,139	6.0%

Source: JICA Survey Team

At each location, expansion factors which were the ratio of the number of interviewed vehicles and the corresponding traffic counts were calculated. These factors were then used to expand origin-destination pairs at survey locations.

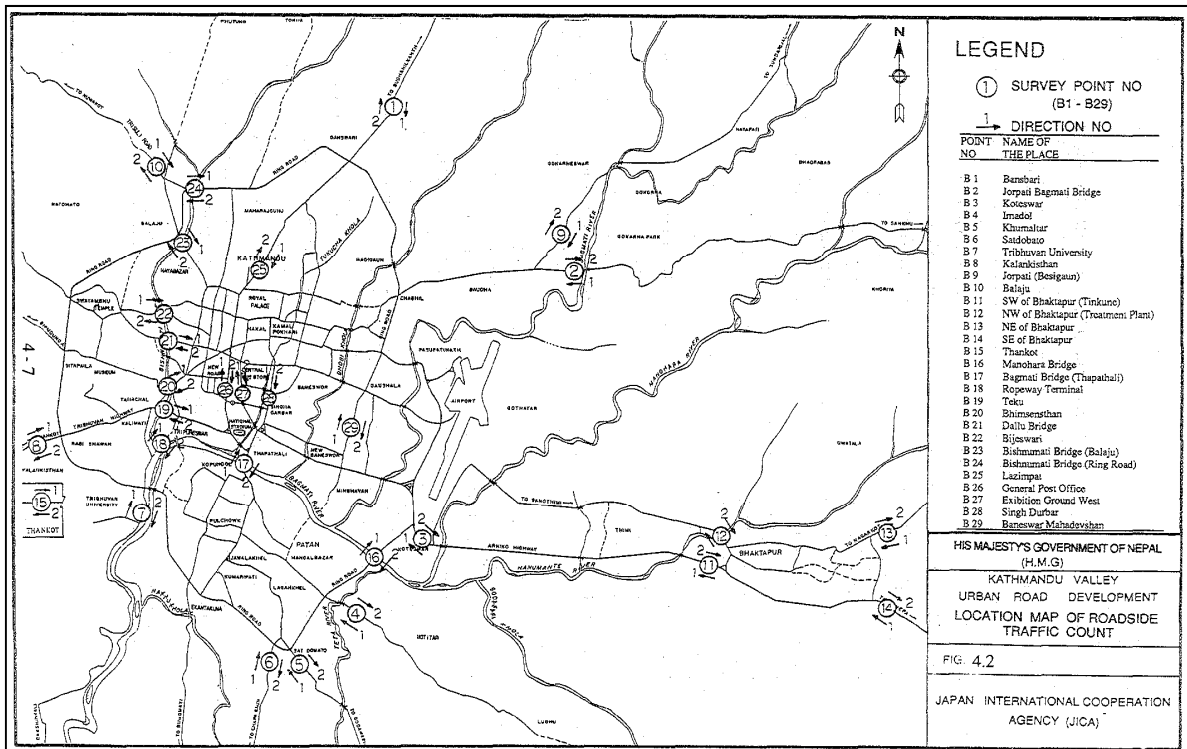
5.3.3 Traffic Count Survey

(1) Survey Method

Traffic count survey was conducted for the clarification of general traffic movement in the survey area. In addition to the 29 survey points selected in the previous M/P (1993), 15 survey points were added based on the following viewpoints.

- 1) Two points for additional OD survey points (Airport, Arniko Highway).
- 2) Four points at the gate of the Kathmandu Valley on national highway and feeder road for the clarification of traffic movement outside the city center.
- 3) Three points at the outside Ring Road for the clarification of traffic movement caused by expansion of the urban area.
- 4) Three points on the Ring Road for the clarification of traffic movement.
- 5) One point on the Arniko Highway for the clarification of traffic movement between the Kathmandu Valley and the east area of Nepal.

The location of traffic count survey points are shown in Figure 5.3.4. Vehicle category for traffic count survey is the same as the roadside interview survey shown in Table 5.3.4.



Source: JICA Study on the previous M/P (1993)

Figure 5.3.3 Location Map of Traffic Count Survey in the previous M/P (1993)

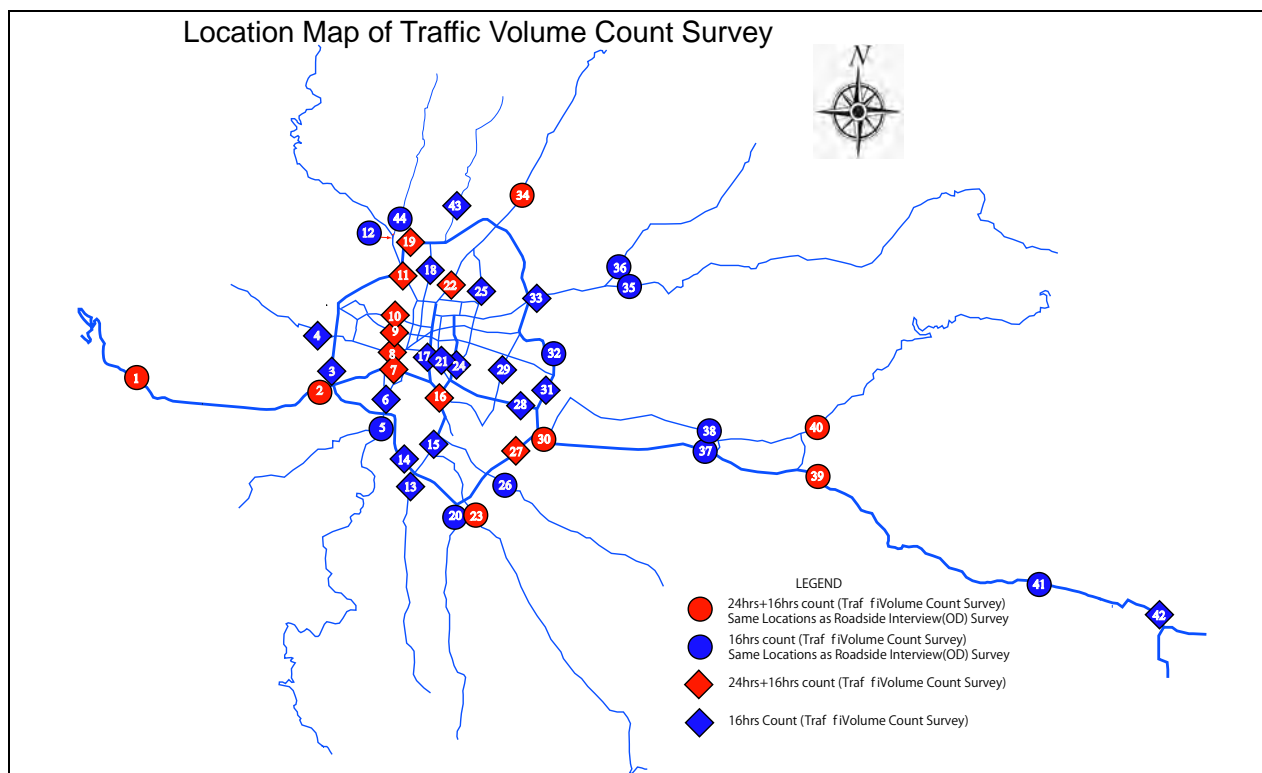


Figure 5.3.4 Location Map of Traffic Count Survey (2012)

Table 5.3.7 Location of Survey Points

No.	Survey Point	Survey Hours	No.	Survey Point	Survey Hours
1	Thankot	24 hr 16 hr	23	Satdobato to Godawari Road	24hr 16hr
2	Kalankisthan (to towards Thankot Road)	24 hr 16 hr	24	Supreme Court Ram Shah Path	16 hr
3	Baphal	16 hr	25	Bhatbateni	16 hr
4	Madol (Road to Bhimdunga)	16 hr	26	Gorkwo to Lubhu Road, at the Bridge	16 hr
5	Balkhu (TU Road)	16 hr	27	Manahara Bridge, Balkumari	24hr 16hr
6	Kuleshwar (between Kalimati & Balkhu)	16 hr	28	Bagmati River Bridge, New Baneshwar	16hr
7	Bisunumati River Bridge (Teku-Kalimati Road)	24 hr 16 hr	29	Near Public School, Mid Baneshwar	16 hr
8	Bisunumati River Bridge (Paropakar-Chauni Road)	24 hr 16 hr	30	Koteshwor, to Bhaktapur Road	24 hr 16 hr
9	Bisunumati River Bridge (Dallu)	24 hr 16 hr	31	Ring Road, between Tinkune to Sinamangal Chowk	16 hr
10	Bisunumati River Bridge (Sobha Bagwati)	24 hr 16 hr	32	Airport Entrance	16 hr
11	Bisunumati River Bridge (near Balaju Junction)	24 hr 16 hr	33	Chabihil to Bauddha Road	16 hr
12	Near Balaju Bypass, (Balaju-Trisuli 13Road)	16 hr	34	Basbari	24 hr 16 hr
13	Nakkhu Bridge	16 hr	35	Bagmati River Bridge, Jorpati	16 hr
14	Ring Road between Balku & Ekantakuna in front of Apartment Building Chowk	16 hr	36	Arubari, Jorpati, to Sundarijal Road	16 hr
15	Pulchowk (Sajha)	16 hr	37	Bhaktapur West, Bhaktapur-Kathmandu Road	16 hr
16	Bagmati River Bridge (Kupundole)	24 hr 16 hr	38	Thimieast, Bhaktapur Road	16 hr
17	Jamal Exam Controller/Nach Ghar	16 hr	39	Jagati, Bhaktapur East	24 hr 16 hr
18	Golphupakha	16 hr	40	Khariapati, Nagarkot	24 hr 16 hr
19	Bisunumati River Bridge (near Balaju Bypass) on Ring Road	16 hr	41	Banepa (Suman Parajuli Bikash & Tika Ram)	16 hr
20	To Chapagaun Road	16 hr	42	Dhulikhel	16 hr
21	Annapurna Hotel Durbar Marg	16 hr	43	Tokha Road	16 hr
22	Lazimpat	24 hr 16 hr	44	Phutung Road	16 hr

(2) Data Adjustment

Traffic survey was carried out from December 10, 2011 to January 28, 2012. However, fuel shortage was reported in the newspapers to have started from December 28, 2011. Therefore traffic surveys conducted during this period were affected

Resurveys were conducted to capture the variation of traffic in the fuel shortage period and to correct the survey results obtained in the fuel shortage period. Resurvey points were selected from the survey points from December 10 to 27, 2011 in which traffic was considered normal, and the survey points from December 28, 2011 to January 28, 2012 in which traffic was considered to be affected by the fuel shortage. Resurveys were carried out on February and March.

As a result of the resurvey, the following phenomena were noted:

- 1) Traffic volume from the end of December 2011 to January 2012 of diesel vehicles such as light trucks, micro buses, minibuses, and heavy trucks were decreased as compared with the traffic volume in March 2012.
Large buses and heavy trucks were surmised to have purchased fuel outside the valley since they are operating inter-regions. Large buses and heavy trucks also replaced the light trucks, mini- and microbuses.
- 2) Traffic volume of passenger cars and motorcycles from the end of December 2011 to January 2012 decreased as compared with the traffic volume in March 2012.
- 3) Traffic volume of taxis from the end of December 2011 to January 2012 increased as compared with the traffic volume in March 2012. This may be due to car drivers opted to commute and use taxi instead.
- 4) Traffic volume of tempo was almost the same as the traffic on March 2012

The ratio of the traffic volume in the survey from December 28 to January 28 and re-survey in March are shown as follows;

Table 5.3.8 Ratio of Traffic Volumes Between Normal Traffic and Unusual Traffic due to Fuel Shortage

Vehicle Type	Passenger Car	Taxi	Light Truck	Tempo	Micro Bus	Mini Bus	Large Bus	Heavy Truck	Motor-cycle
Ratio	1.13	0.65	1.51	1.01	1.26	1.28	0.81	1.13	1.11

Source: JICA Survey Team

Traffic volumes surveyed from December 28, 2011 to January 2012 were adjusted by the above-mentioned ratios as adjustment factors.

5.3.4 Screen Line Survey

The purpose of screen line surveys was to confirm the accuracy of person trip survey data by comparing the total number of trips crossing certain traffic obstacles like rivers, with total number of trips summed up from OD table. In this survey, sections of trunk rivers, such as the Bagmati River, Bishnumati River, Manahara River and Dhobi Khola within the area surrounded by the Ring Road, composed the screen line survey points where a 24-hr traffic count was conducted.

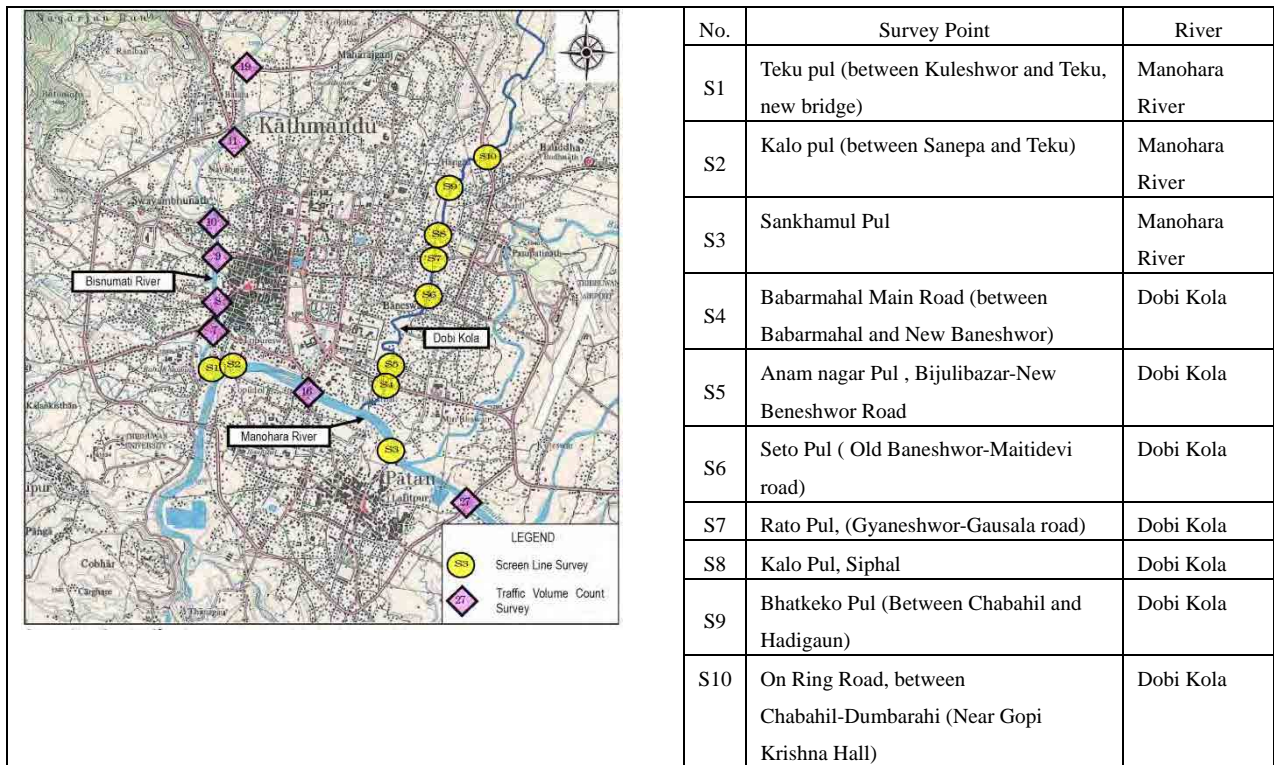
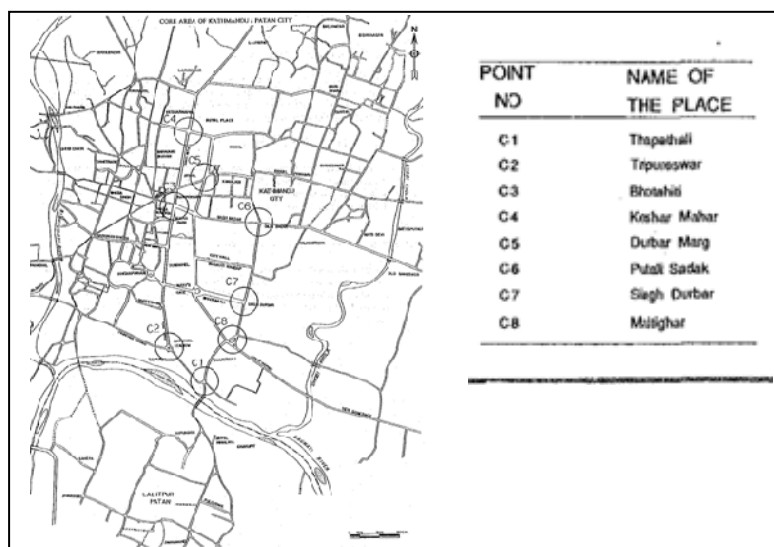


Figure 5.3.5 Survey Point for Screen Line Survey (2012)

5.3.5 Traffic Count Survey of Major Intersections

In the previous M/P (1993), traffic count surveys of major intersections were conducted at the city center targeting the improvement of traffic condition. Presently, it is presumed that the traffic at the city center is already saturated. Measures for alleviating the traffic situation are required in the peripheral area of the city center. Applying this concept, traffic count survey of major intersection was conducted at peripheral areas of the city center and at intersections of the Ring Road. Ten survey points were chosen. Each survey was conducted for three hours during peak hours in the morning and three hours during peak hours in the evening for one workday.

The method of the survey is to count the traffic volume according to the type of vehicle at every direction of the intersection.



Source: JICA Study on the previous M/P (1993)

Figure 5.3.6 Survey Point for Traffic Count Survey of Measured Intersections (1993)

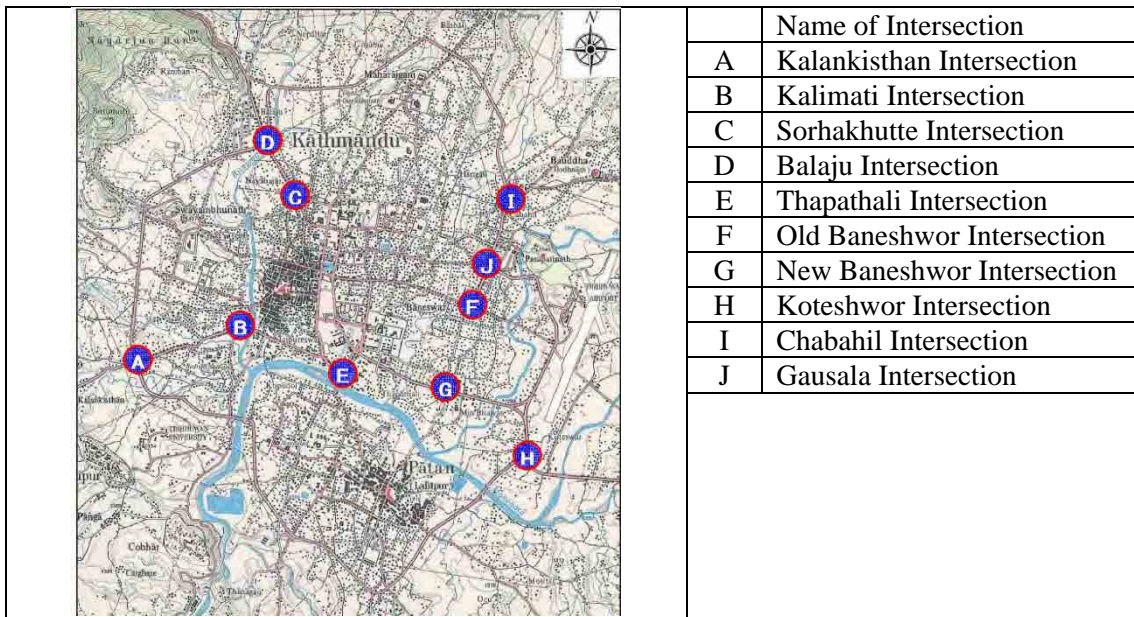


Figure 5.3.7 Survey Point for Traffic Count Survey of Major Intersections (2012)

5.3.6 Travel Speed Survey

Travel speed survey was conducted on 16 major routes, of which, seven routes corresponded to the routes in the previous M/P (1993) (Route 1 to Route 7). Considering the expansion of the urban area, the survey was conducted with an additional nine radial routes which connect the city area to the outskirts of the city (Route 8 to Route 16). The method of the survey is to make a round trip on the selected routes in the morning, daytime, and evening by car and observe the travel time between certain points.

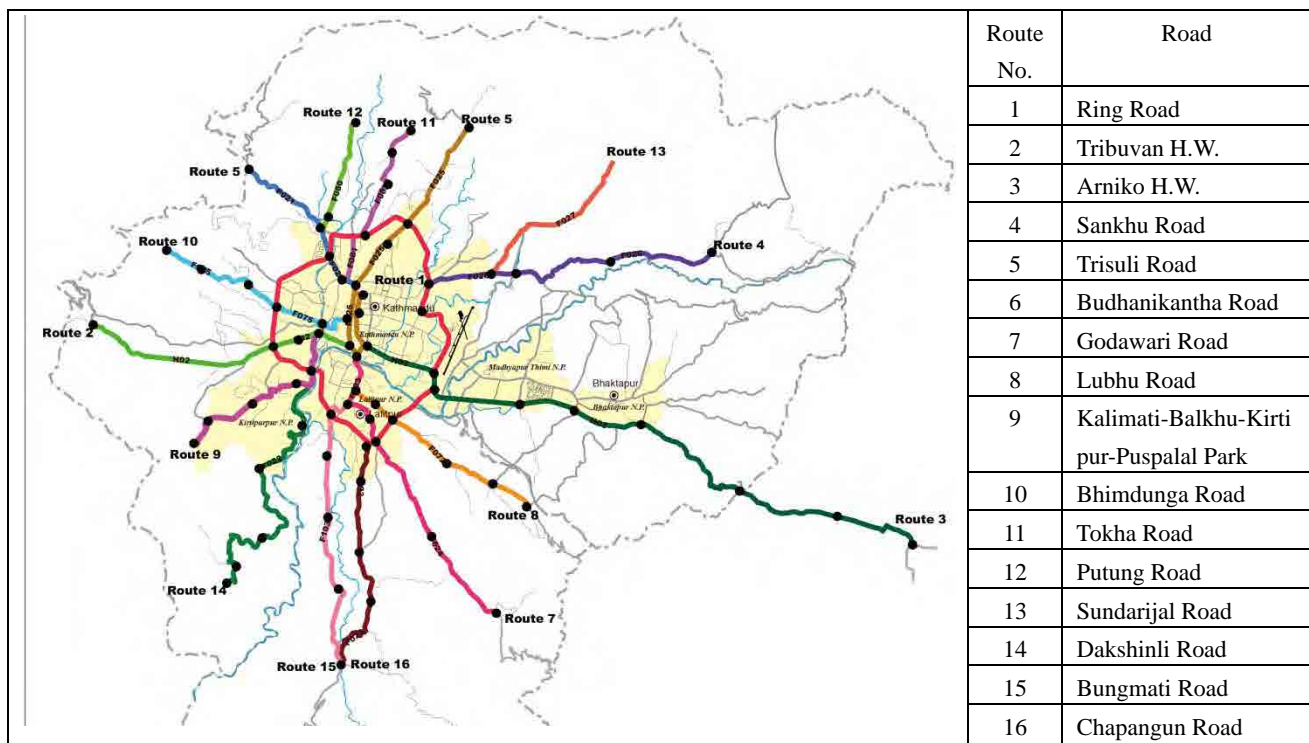


Figure 5.3.8 Route for Travel Speed Survey

5.3.7 Parking Survey

In order to examine the parking problem of the freight truck which is becoming one of the transport issues in the Kathmandu Valley, the parking survey for vehicle parking in the Ring Road was carried out. The survey method was to count the number of all types of vehicle parked on both sides within the ROW of the Ring Road after 11 pm. The result will be utilized for the establishment of measure to control parking of vehicles, especially freight trucks, on the Ring Road.

5.4 Bus Transport Survey

5.4.1 Outline System of Bus Transport Survey

Bus transport surveys were conducted in the following items:

- 1) Bus traffic count survey,
- 2) Bus OD survey,
- 3) Bus passenger interview survey, and
- 4) Public transport firm interview survey.

Before starting the above survey, the Survey Team made a discussion with the ADB Study Team on “The Kathmandu Valley Sustainable Urban Transport Project” and reviewed the survey method and schedule stated above for any necessary adjustments.

The Survey Team also understands that DOR is now examining the subway or LRT (Light Rail Transit) development program in the long-term. The JICA Survey Team exchanged opinions with the DOR regarding the program and reviewed the survey method before the commencement of the survey.

The following is the summary of the bus transport survey:

Table 5.4.1 Summary of Bus Transport Surveys

No.	Type of Survey	Purpose	Method	Contents of the Survey
1	Bus traffic count survey	To capture the total number of bus transport operating from bus terminals.	Count number of bus transport at Old and Gongabun Bus Park by type (bus, minibus, tempo)	Survey point: 2 points 24 hrs, 1 day (workday)
2	Bus OD survey	To capture the operating routes of bus transport coming into bus terminal.	Interview bus drivers at bus terminals about the departing point and destination. Sampling rate was 20%	Survey point: 2 points 24 hrs, 1 day (workday)
3	Bus passenger interview survey	To capture the travel demand and needs of bus transport passengers.	Interview bus transport passengers about the origin, destination, and needs at two bus terminals	Survey point: 2 points 24 hrs, 1 day (workday) 2,500 passengers (2,000 at Old, 500 at Gongabun)
4	Public transport firm interview survey	To obtain information regarding the operation and administration of bus transports.	Interview bus transport operating firms	100 firms

5.4.2 Bus Traffic Count Survey

In order to capture the number of buses operating from the Old Bus Park and Gongabun Bus Park, the number of buses by type was counted on the entrance road at the two bus parks. The survey was conducted for 24 hours both on a workday and on a holiday.

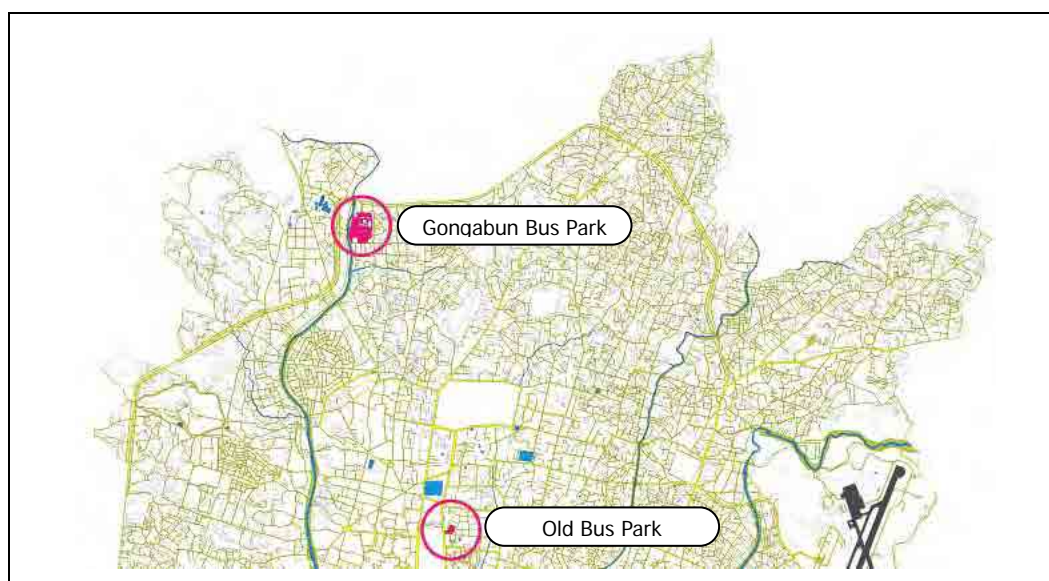


Figure 5.4.1 Locations of the Old Bus Park and Gongabun Bus Park

5.4.3 Bus OD Survey

To capture the operation route of buses at the two bus parks, the OD of operating buses were asked to the sampled drivers at the entrance of the two bus parks. The number of passengers on each bus were also counted. Target sample rate was 20%.

As a result, 1,157 buses were interviewed at the Old Bus Park and 693 buses were interviewed at the Gongabun Bus Park. Sampling rate was shown in Table 5.4.2.

Table 5.4.2 Result of Bus OD Interview Survey

		Micro Bus	Minibus	Large Bus	Total
Number of Samples	Old Bus Park	548	560	49	1,157
	Gongabun Bus Park	188	394	111	693
Sampling Rate	Old Bus Park	0.247	0.266	0.228	0.255
	Gongabun Bus Park	0.407	0.325	0.288	0.336

Source: JICA Survey Team

5.4.4 Bus Passenger Interview Survey

Bus passenger interview survey was conducted to supplement the household interview survey by capturing the characteristics of bus passengers. For this purpose, an interview was made to the passengers departing from two bus terminals. Target number of samples were 2,000 at the Old Bus Park and 500 at the Gongabun Bus Park.

Table 5.4.4 shows the total number of interviewee of the bus passenger interview survey.

Table 5.4.3 Questionnaire of Bus Passenger Interview Survey

Category	Question Item	Remark
Personal information	Sex, age	
	Occupation	8 categories same as household interview
	Monthly income	21 categories same as household interview
Trip information	Purpose of the trip	
	Origin of the trip	
	Trip destination	
	Access mode	
	Trip frequency	
	Bus fare	
	Travel time	
Opinion on bus service	Demand for bus service	
	Willingness to pay for better service	

Table 5.4.4 Result of Bus Passenger Interview Survey

		Micro Bus	Minibus	Large Bus	Total
Number of Interview	Old Bus Park	774	607	629	2,010
	Gongabun Bus Park	117	96	302	515

Source: JICA Survey Team

5.4.5 Public Transport Firm Interview Survey

Public transport firm interview survey was carried out to analyze the operation of public transports from the operator's side. Interview items are shown in Table 5.4.5.

Table 5.4.5 Questionnaire of Public Transport Firm Interview Survey

Category	Question Item	Remark
Bus operation by firm	Number of public service vehicles	
	Number of operation by route	
Operation organization	Number of drivers and conductors	
Operation cost	Operation cost per day	
	Average life of vehicles	

After confirming with the operating firms of public transports by member list of the Federation of Nepalese National Transport Entrepreneurs (FNTE), 80 firms including the association of bus companies were selected and interviewed. The type of public transport firm is shown in Table 5.4.6.

Table 5.4.6 Types of Firms Interviewed in the Survey

Type of Firm	Number
Bus/tempo operating firm	72
Truck transport firm	2
Car/van transport firm	5
Taxi firm	1
Total	80

Source: JICA Survey Team

CHAPTER 6 PRESENT TRAFFIC CONDITION

6.1 Movement of Persons (Results of Household Interview Survey)

A person trip survey was introduced to this survey based on the idea that movement of persons is the source of traffic. Therefore in this section, the movement of persons is described as the source of traffic.

6.1.1 Characteristics of the Population

(1) Occupation

Table 6.1.1 shows the population composition by occupation obtained from the interview of household members. Workers including employer and employee occupied 33% of the total population.

Table 6.1.1 Composition of Population by Occupation

	Employer	Employee	Student	Housekeeper	Unemployed	Total
Population by Occupation	275,540	532,670	763,390	376,670	495,880	2,444,150
Percentage (%)	11.3	21.8	31.2	15.4	20.3	100.0

Source: JICA Survey Team

(2) Residential and Working Place, School Place

Going to work and to school are activities which cause regular traffic movement. Table 6.1.2 shows the numbers and percentages of working population and students of each large zone. The average percentage of the working population and students were approximately 33% and 31%, respectively. Generally, the percentage of the working population was high in urban areas and low in rural areas.

Table 6.1.2 Proportion of Working Population and Students at Residence by Large Zone

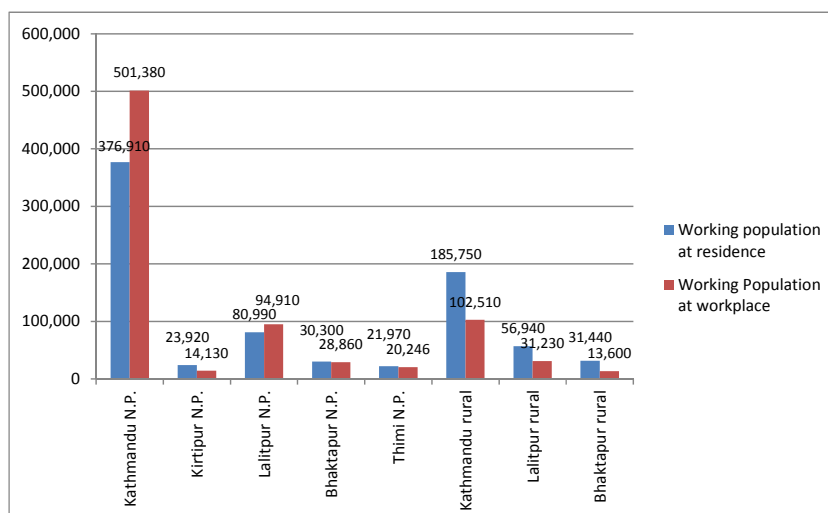
Zone	Name of Zone	Total Population	Working Population		Students	
			Population	Percentage of Population	Population	Percentage of Population
100	Kathmandu NP	1,006,640	376,910	37.4	306,340	30.4
200	Kirtipur NP	70,120	23,920	34.1	22,280	31.8
300	Lalitpur NP	223,290	80,990	36.3	66,460	29.8
400	Bhaktapur NP	83,890	30,300	36.1	27,070	32.3
500	Thimi N.P.	84,260	21,970	26.1	26,070	30.9
600	Kathmandu Rural	642,860	185,750	28.9	212,350	33.0
700	Lalitpur Rural	198,210	56,940	28.7	58,900	29.7
800	Bhaktapur Rural	134,880	31,440	23.3	43,930	32.6
Survey Area Total		2,444,150	808,210	33.1	763,390	31.2

Source: JICA Survey Team

Figure 6.1.1 shows the number of the working population that was counted at residential and work places. In Kathmandu N.P. and Lalitpur N.P., the number of people at workplaces exceeded the number of people at residences, showing that the working population flows into these areas from outside. Kathmandu N.P., which occupied 38% of the population of the survey area, covered 62% of the working population at work places.

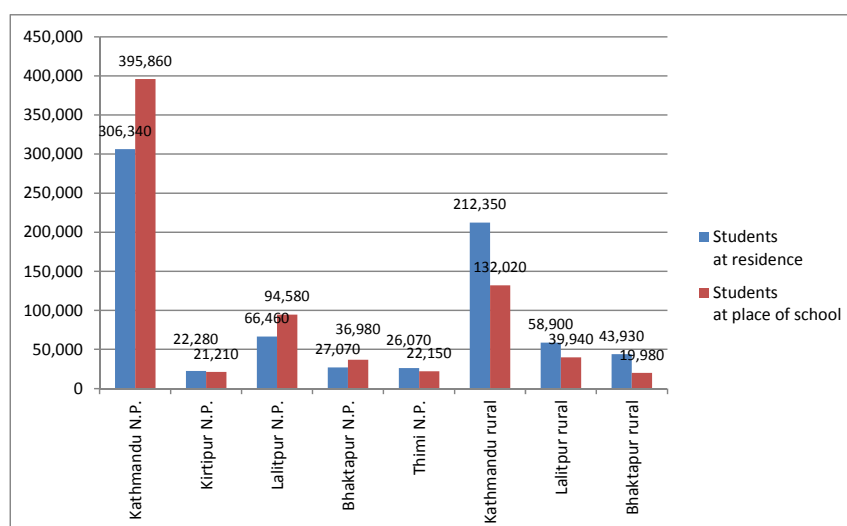
In terms of students as shown in Figure 6.1.2, Kathmandu N.P., Lalitpur N.P., and Bhaktapur N.P. received students from peripheral areas.

Needless to say, three municipalities are the center of urban activities and attract influx of commuters.



Source: JICA Survey Team

Figure 6.1.1 Working Population at Residences and Workplaces



Source: JICA Survey Team

Figure 6.1.2 Number of Students at Residences and Place of School

(3) Vehicle Ownership

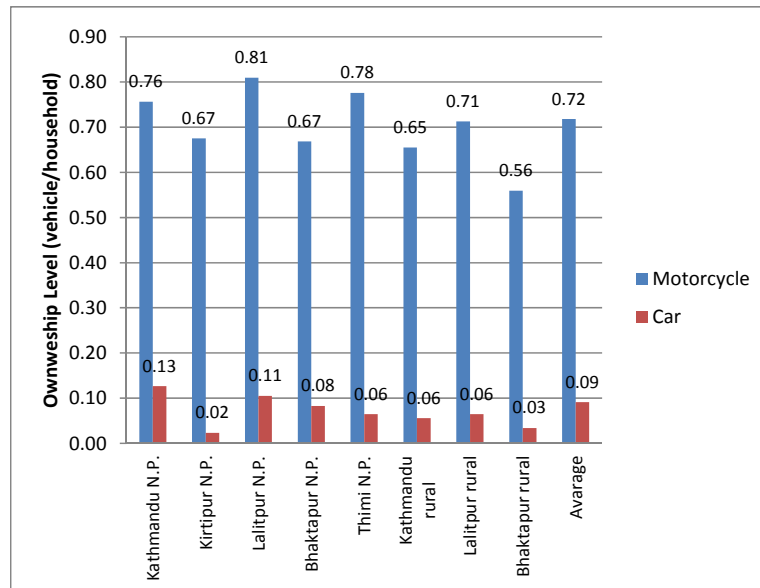
The total number of vehicles obtained in the household survey is shown in Table 6.1.3. The total number of vehicles in the survey area was approximately 500,000, out of which 450,000 were motorcycles. The average ownership level of vehicle was quantified as one vehicle per one thousand persons.

Table 6.1.3 Number of Vehicles in the Survey Area

	Motorcycle	Passenger Car	Truck	Car Total	Vehicle Total
Number of Vehicles	448,600	52,200	4,800	57,000	505,600
Ownership Level (vehicle/1,000 persons)	183.5	21.4	2.0	23.3	206.9

Source: JICA Survey Team

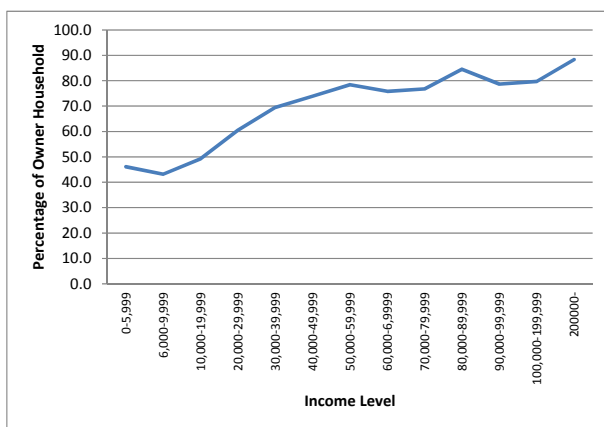
According to the ownership level in each zone as shown in Figure 6.1.3, no particular trend can be identified.



Source: JICA Survey Team

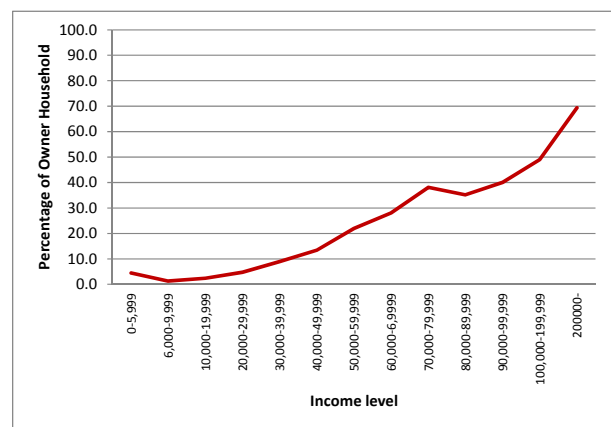
Figure 6.1.3 Ownership Level by Large Zone

The relationships between vehicle ownership and household income were observed in Figure 6.1.4 and Figure 6.1.5. Motorcycles are owned even by low income households, and even in households which can afford cars, motorcycle ownership is still growing.



Source: JICA Survey Team

Figure 6.1.4 Household Income and Motorcycle Ownership



Source: JICA Survey Team

Figure 6.1.5 Household Income and Car Ownership

6.1.2 Trip Generation

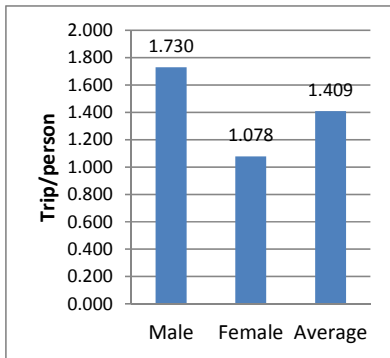
(1) Trip Production Rate

The total number of trips made by residents in the survey area was 3,483,393 trips. The trip generation rate is the average number of trips made by one person.*

* Trip production rate is expressed in two ways. One is gross production rate which is calculated by number of trips divided by total number of population five years and above. The other is net trip production rate which is calculated by number of trips divided by number of population five years and above that made trips on the survey day. In this report, trip production rate was expressed by gross trip production rate.

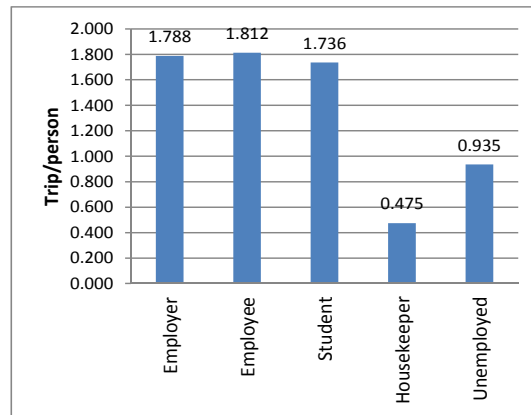
The average trip production rate in the survey area was 1.409. The trip production rate of males was much higher than of females as shown in Figure 6.1.6.

The trip production rate varied by occupation as shown in Figure 6.1.7. The trip production rates by employers, employees, and students were much higher than housekeepers and unemployed people.



Source: JICA Survey Team

Figure 6.1.6 Trip Production Rate by Sex



Source: JICA Survey Team

Figure 6.1.7 Trip Production Rate by Occupation

The reason for the low trip production rate of females was attributed to ratio of trip generation of persons (trip generated by persons/all person). As shown in Figure 6.1.8, the ratio of trip generation of females 30 years old and above was extremely low. This leads to the low trip production rate of female. The net trip production rate of females was close to that of males as shown in Figure 6.1.9.

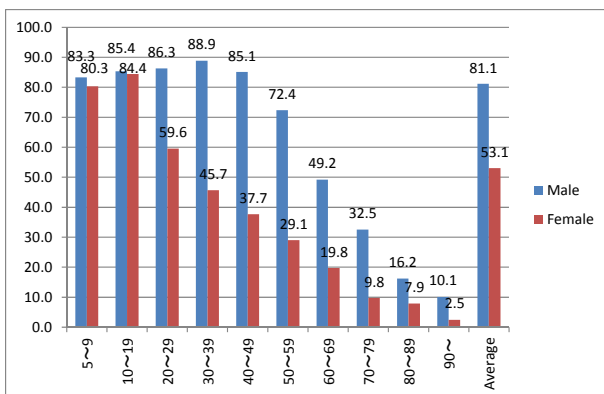


Figure 6.1.8 Ratio of Trip Generation by Sex and Age

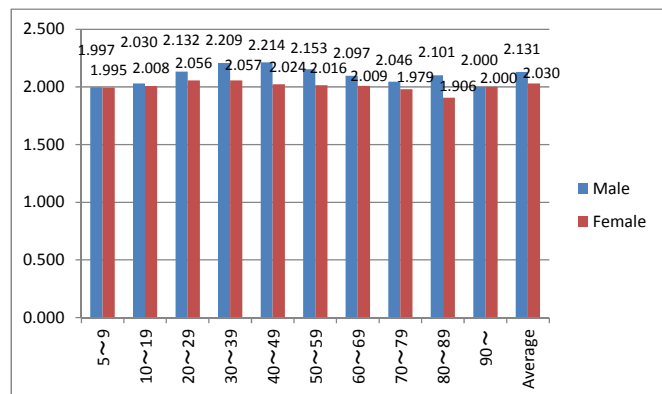
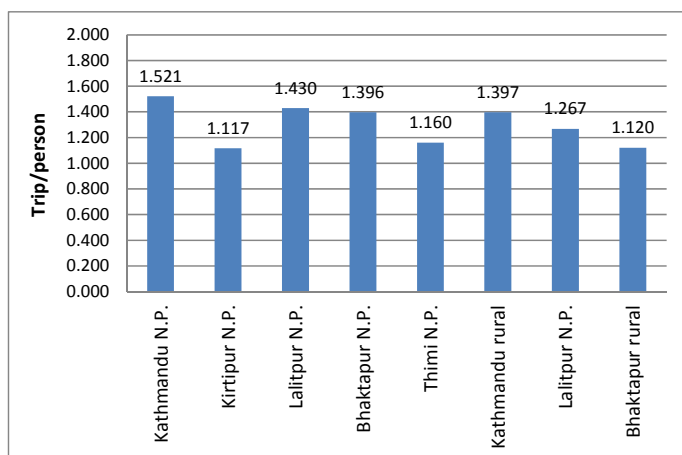


Figure 6.1.9 Net Trip Production Rate by Sex and Age

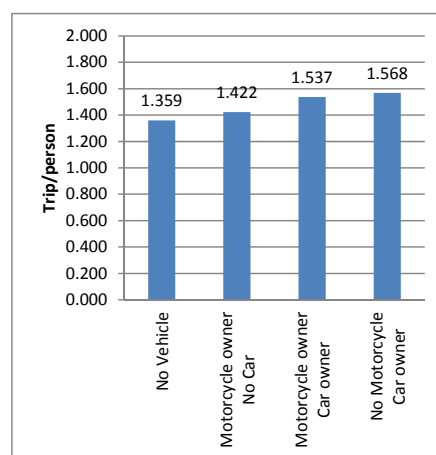
Figure 6.1.10 shows the trip production rate by large zone. The trip production rates in urban areas such as Kathmandu N.P., Lalitpur N.P., and Bhaktapur N.P. were generally high reflecting rapid urban activities. Note that Kathmandu rural is similar to urban areas while Kirtipur is similar to rural areas.

The trip production rate of people having vehicles was higher than people without vehicles because vehicles enable people to move actively.



Source: JICA Survey Team

Figure 6.1.10 Trip Production Rate by Large Zone



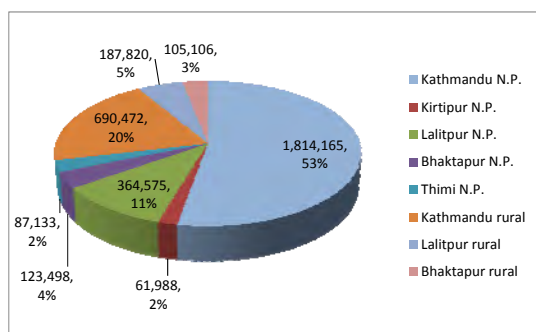
Source: JICA Survey Team

Figure 6.1.11 Trip Production Rate by Ownership of Vehicles

(2) Trip Generation and Attraction

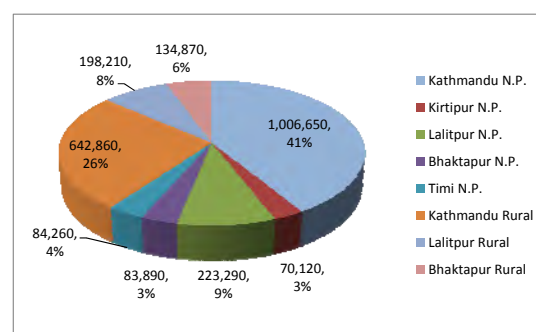
1) Trip Volume

Figure 6.1.12 shows the composition of trip generation by large zone. Kathmandu N.P. occupied 53% of trip generation although its population accounted for 41% of the survey area as shown in Figure 6.1.13. This indicated that Kathmandu N.P. is still evolving as the center of various activities in the survey area.



Source: JICA Survey Team

Figure 6.1.12 Composition of Trip Generation by Large Zone



Source: JICA Survey Team

Figure 6.1.13 Composition of Population by Large Zone

2) Trip Purpose

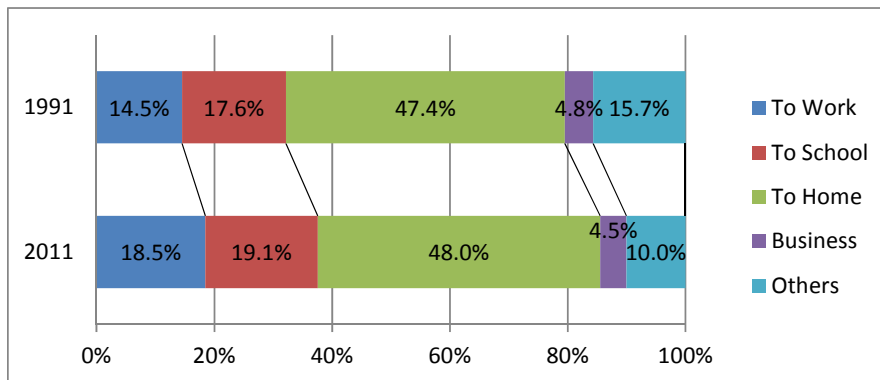
A trip is produced to achieve one's objective. Therefore, trip purpose is a basic characteristic of the trip to analyze how traffic movement is produced. Nine categories of trip purposes in the interview survey were combined into five categories as shown in Table 6.1.4.

Table 6.1.4 Trip Purpose Categories in Chapter 6

Trip Purpose Categories in Chapter 6	Trip Purpose Categories Used in the Survey Stage
To Work	01. To Work
To School	02. To School
To Home	03. To Home
Business	04. Business
Others	05. Shopping, 06. Dining 07. Leisure/Recreation, 08. Medical, Treatment, 09. Others

The previous M/P (in 1993) implemented a household survey in 1991, of which the survey area was limited to Kathmandu N.P., Lalitpur N.P., and Bhaktapur N.P. A comparison of the composition

of trip purposes between 1991 and 2011 showed that the proportion of the purpose “Others” decreased while “To Work” and “To School” increased a little. Work and school activities increased more than the other activities.



Source: JICA Survey Team

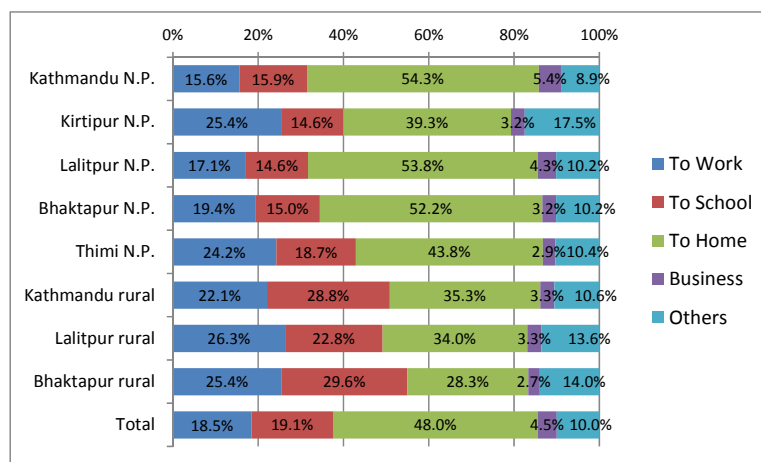
Figure 6.1.14 Comparison of Trip Purposes between 1991 and 2011

Table 6.1.5 Trip Composition by Purpose

Trip Purpose	Number of Trips	Percentage (%)	Small Purpose Category	Number of Trips	Percentage (%)
To Work	634,461	18.5			
To School	657,030	19.1			
To Home	1,649,236	48.0			
Business	153,469	4.5			
Others	344,197	10.0	Shopping	136,533	4.0
			Dining	14,068	0.4
			Leisure/Recreation	62,419	1.8
			Medical, Treatment	30,606	0.9
			Others	100,761	2.0
Total	3,438,393	100.0	Others Total	344,197	10.0

Source: JICA Survey Team

Figure 6.1.15 shows the composition of trip purposes by large zone. The proportion of trips going home was large in urban areas, while the proportion of trips going to work and to school was large in rural areas. This shows that the urban areas are attracting the commuter trips.

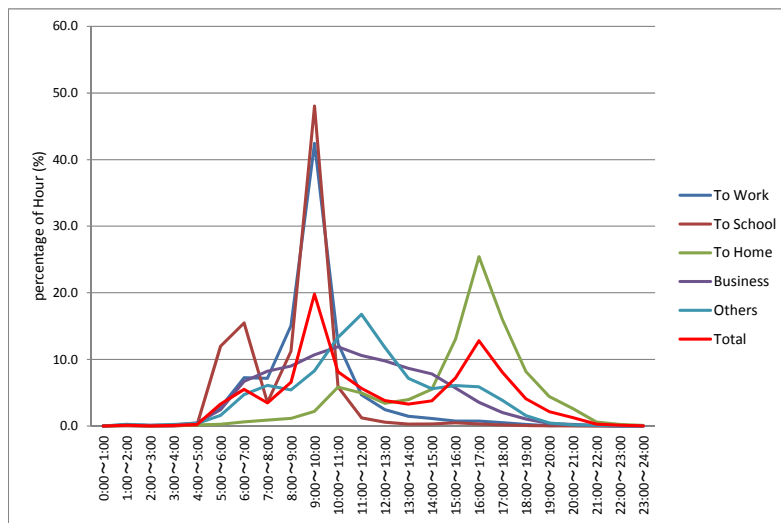


Source: JICA Survey Team

Figure 6.1.15 Proportion of Trip Purposes by Large Zone

3) Hourly Trip Generation

Figure 6.1.16 shows the hourly variation of trip generation by purpose. The peak rate of trip generation for all purposes was 20% which occurred from 9:00 to 10:00. The major trip purposes in peak hour were going to work and to school at peak rates of 42% and 48%, respectively.



Source: JICA Survey Team

Figure 6.1.16 Hourly Trip Generation by Purpose

6.1.3 Trip Distribution

1) Travel Distance by Purpose

The average trip length for all trip purposes was 5 km, as shown in Table 6.1.6. All trip purposes showed similar trip length of around 5 km. The longest average trip length was for “Others”, while the shortest was “To School”.

Table 6.1.6 Average Trip Length by Purpose

	To Work	To School	To Home	Business	Others	Average
Average Trip Length (km)	5.4	4.5	5.0	4.9	5.6	5.0

Source: JICA Survey team

2) Trip Distribution

Figures 6.1.18 to 6.1.23 shows the persons’ movement volume between zones as represented by the width of lines. Figure 6.1.17 shows the trip distribution for all purposes.* The concentration of trips to Kathmandu N.P. (100) and Lalitpur N.P. (300) was evident, and the movement between both municipalities was largest.

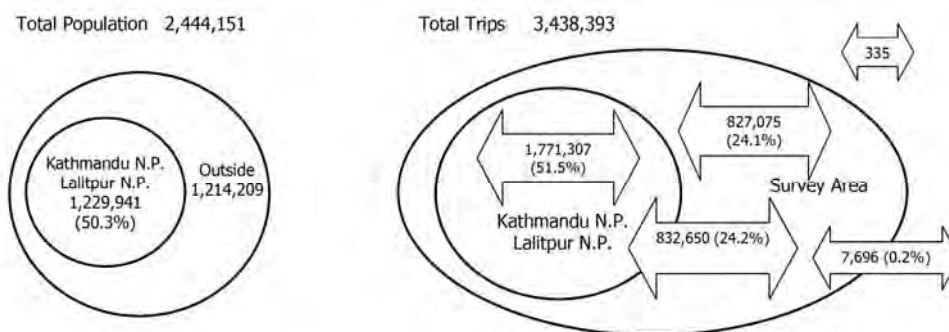
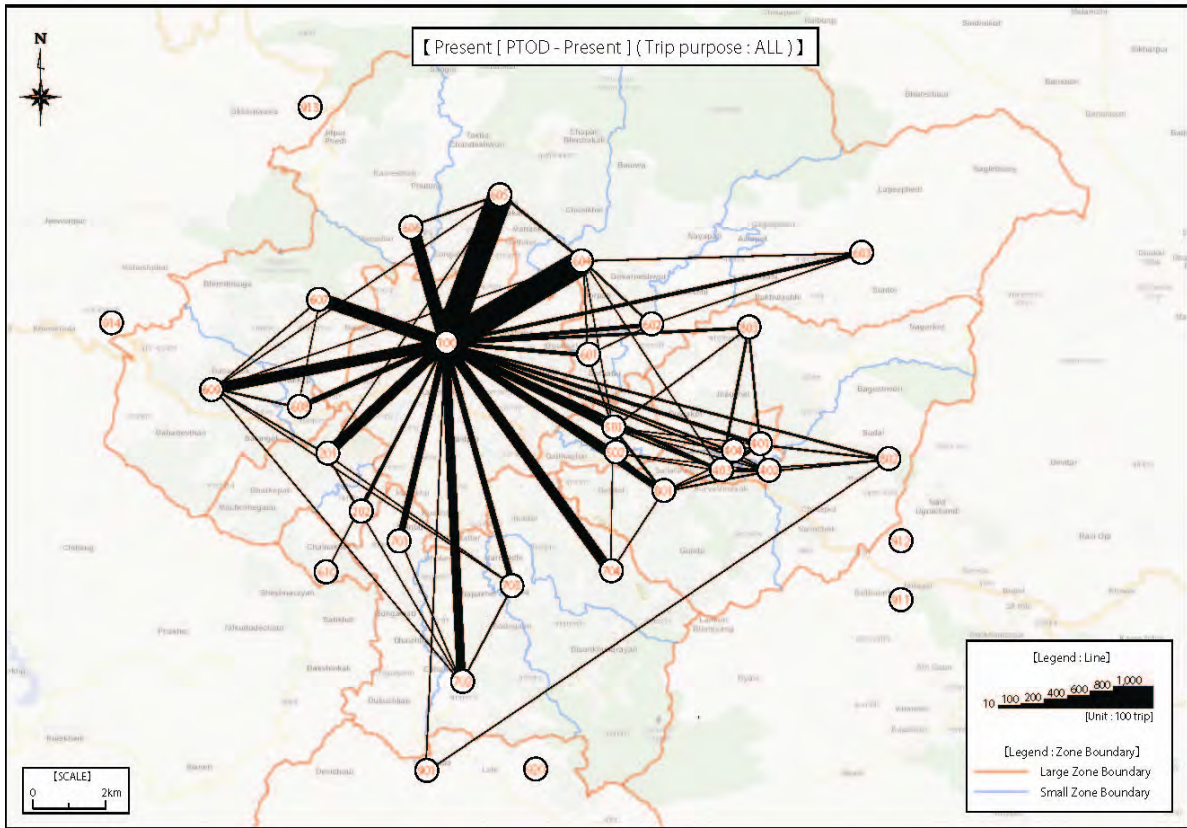


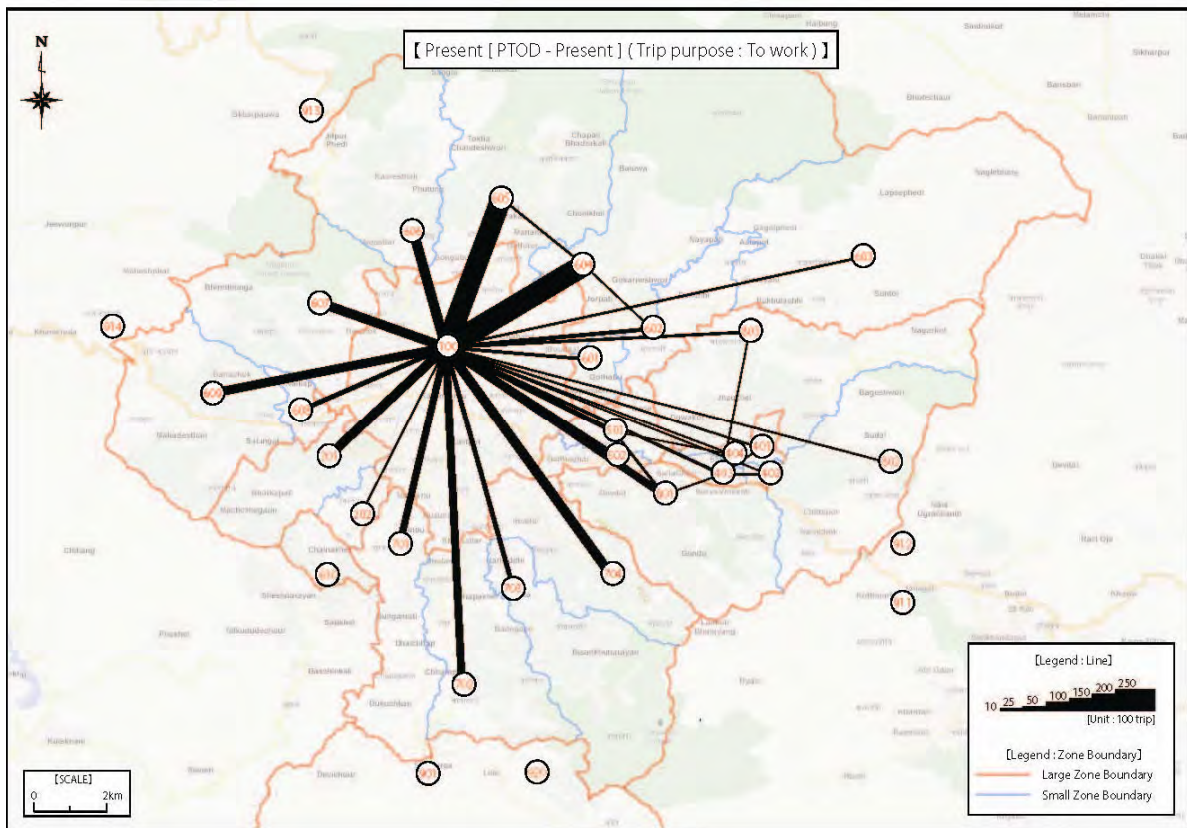
Figure 6.1.17 General Person Trip Movement in the Survey Area

* In the figure of trip distribution, traffic zones were collected to express the movement more clearly.



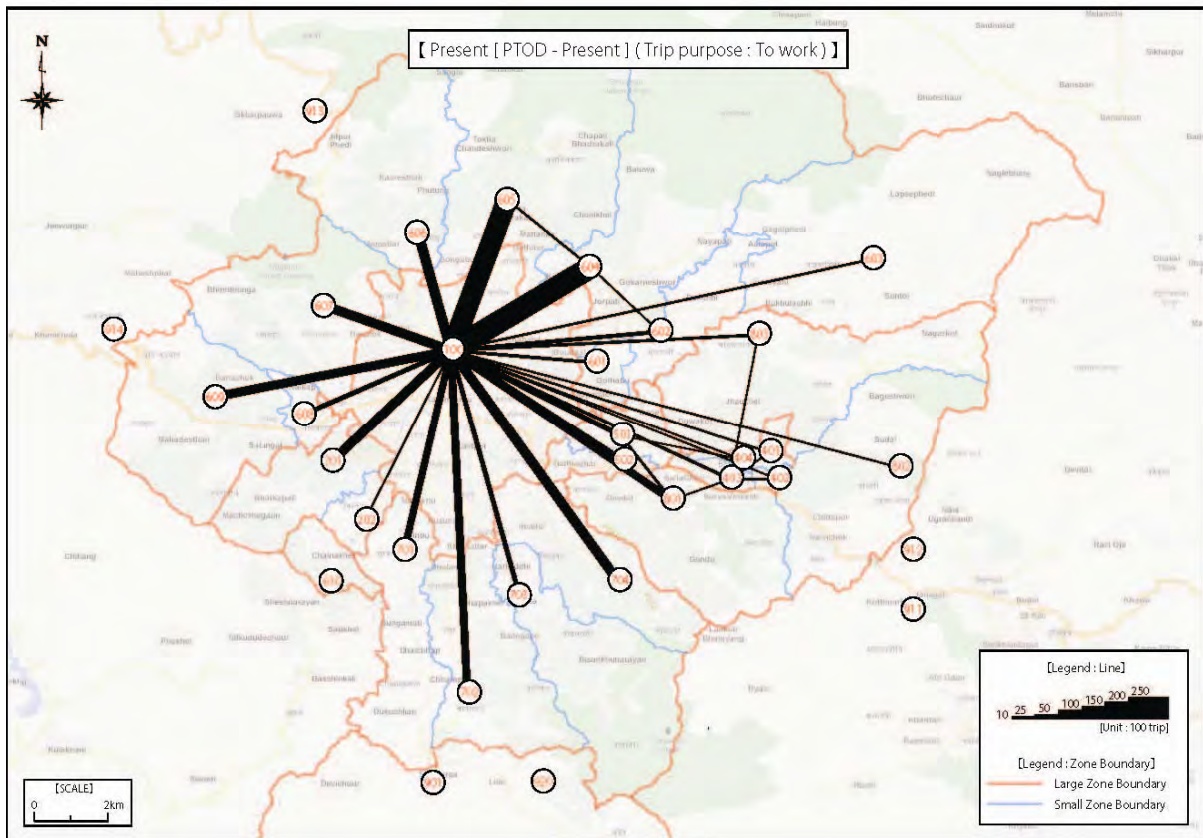
Source: JICA Survey Team

Figure 6.1.18 Person Trip Desire Line Map (All Purposes)



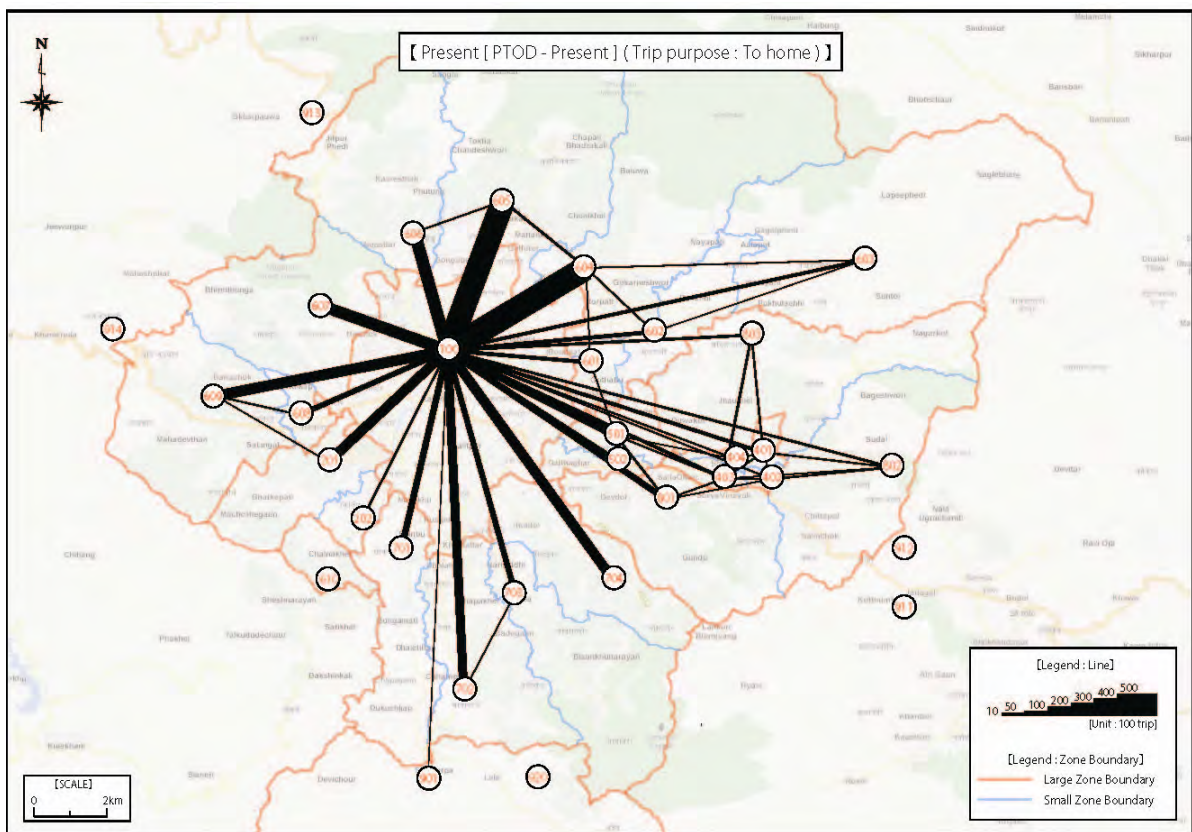
Source: JICA Survey Team

Figure 6.1.19 Person Trip Desire Line Map by Purpose (To Work)



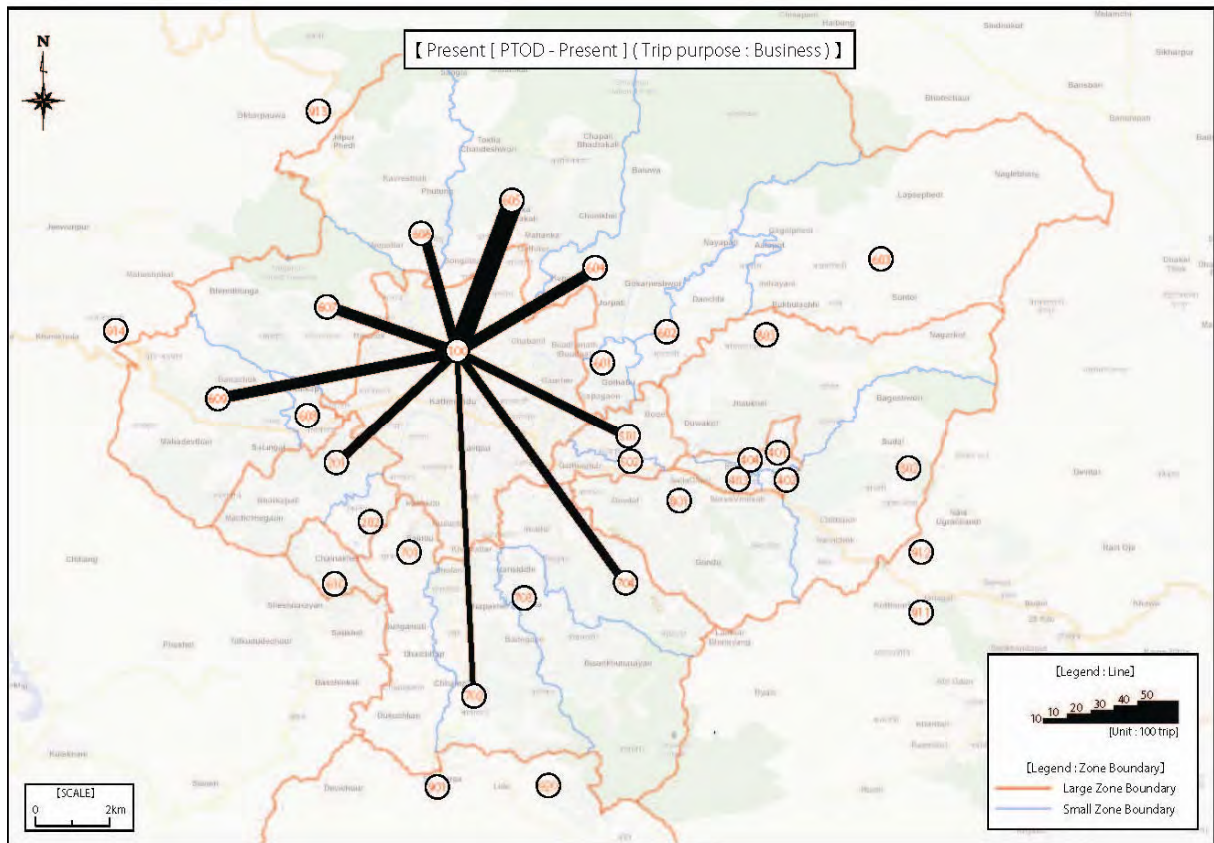
Source: JICA Survey Team

Figure 6.1.20 Person Trip Desire Line Map by Purpose (To School)



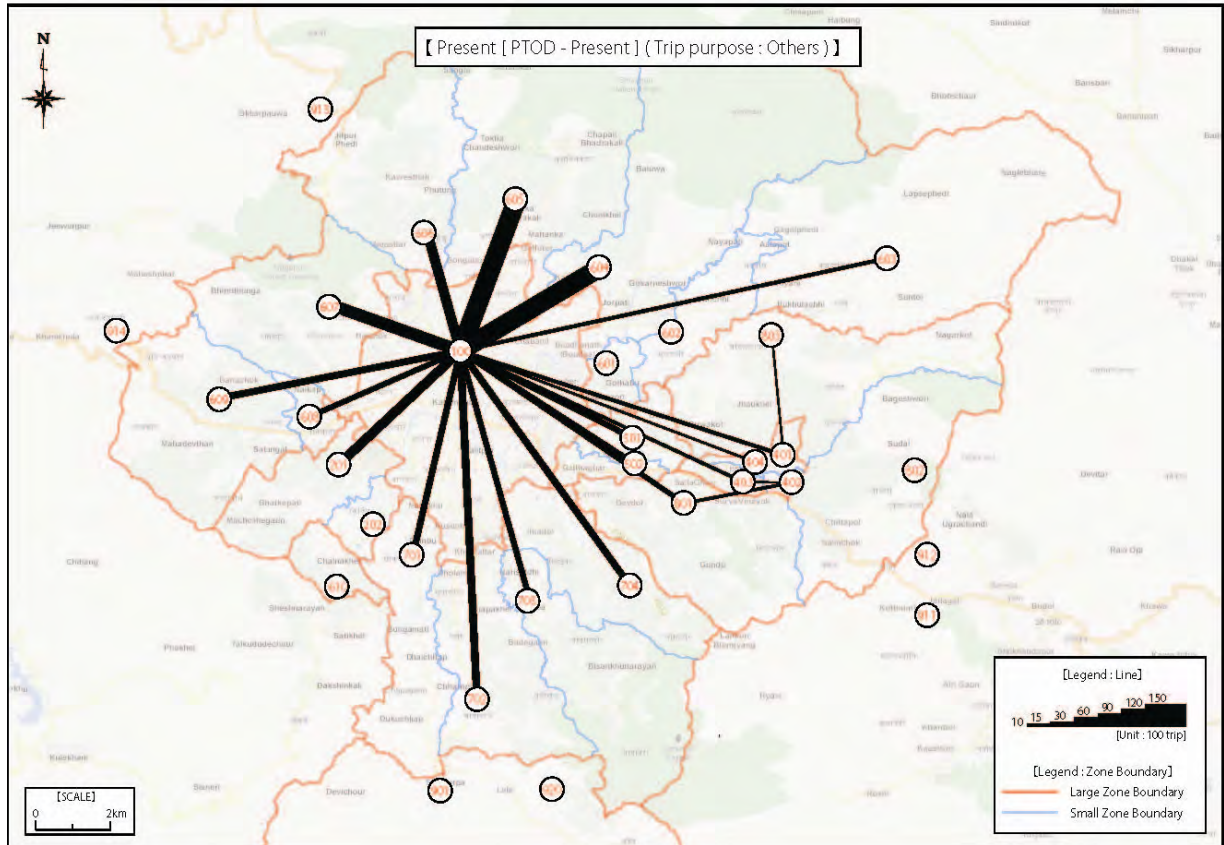
Source: JICA Survey Team

Figure 6.1.21 Person Trip Desire Line Map by Purpose (To Home)



Source: JICA Survey Team

Figure 6.1.22 Person Trip Desire Line Map by Purpose (Business)



Source: JICA Survey Team

Figure 6.1.23 Person Trip Desire Line Map by Purpose (Others)

6.1.4 Travel Mode

(1) Selection of Travel Mode

The most adequate travel mode was selected to achieve one's objective considering one's conditions. The major elements for selecting travel mode will be analyzed here. The nine categories of trip purposes in the interview survey were reduced to five categories, as shown in Table 6.1.7.

Table 6.1.7 Trip Categories in Chapter 6

Travel Mode Categories in Chapter 6	Trip Purpose Categories Used in the Survey Stage
Walk	01. Walk
Bicycle	02. Bicycle
Motorcycle	03. Motorcycle
Car	04. Car, 05. Truck, 06. Taxi
Bus	07. Tempo, 08. Minibus, 09. Bus

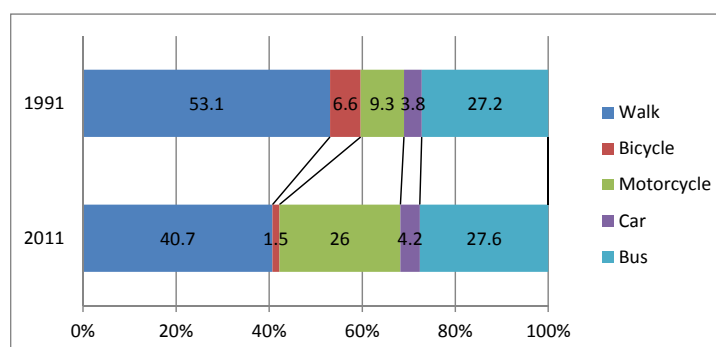
1) Composition of Travel Mode

The total number of trips by travel mode is shown in Table 6.1.8. Walking has the largest share among travel modes. But if compared with the 1991 survey, the percentage of travel mode by walking decreased largely, while the travel mode by motorcycle increased to fill that decrease.

Table 6.1.8 Trip Composition by Mode

Travel Mode	Number of Trips	Percentage
Walk	1,398,378	40.7
Bicycle	52,445	1.5
Motorcycle	893,126	26.0
Car	145,980	4.2
Bus	948,464	27.6
Total	3,438,393	100.0

Source: JICA Survey Team

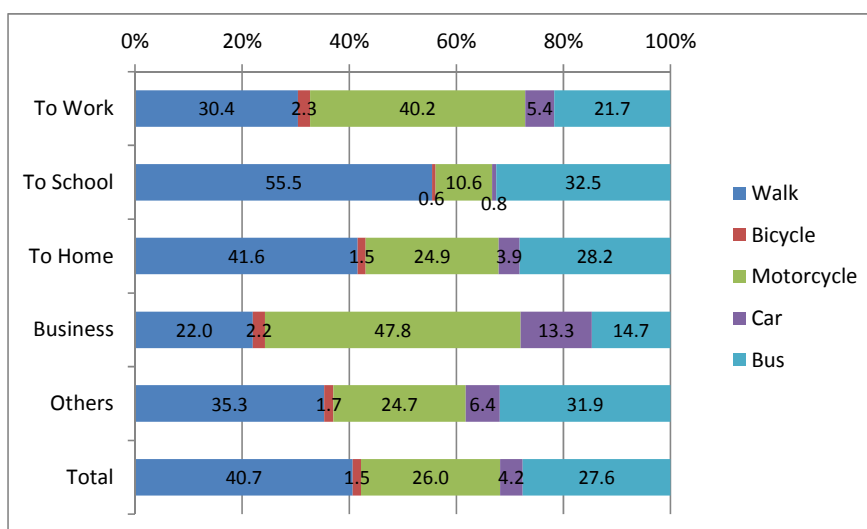


Source: JICA Survey Team

Figure 6.1.24 Comparison of Travel Modes between 1991 and 2011

2) Trip Purpose and Travel Mode

Trip purpose was one of the elements for selecting travel mode. The features of the relation between travel mode and trip purpose were observed in the trip purposes "To School" and for "Business". Travel mode by walking showed a large percentage of trip purpose "To School", while by motorcycles and cars showed large percentage of trip purpose for "Business".



Source: JICA Survey Team

Figure 6.1.25 Travel Mode by Trip Purpose



Source: JICA Survey Team

Figure 6.1.26 Trip Purpose by Travel Mode

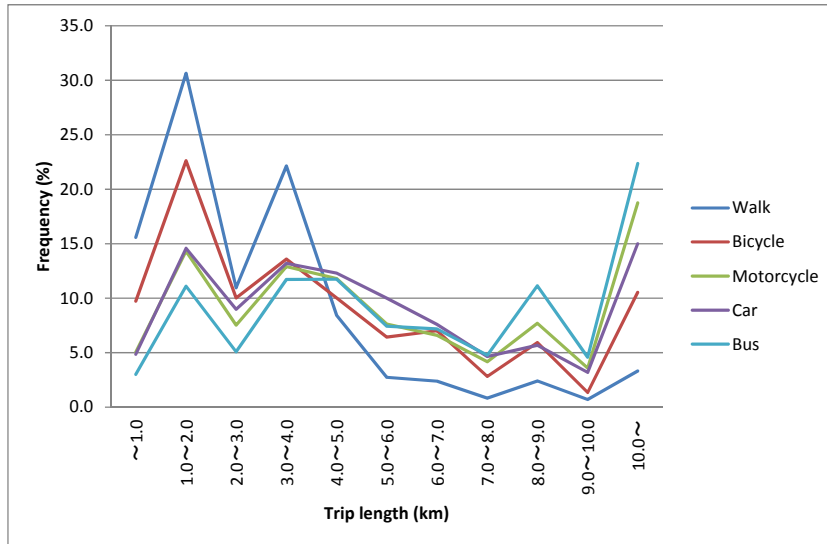
3) Travel Distance and Mode

Travel distance was another element for selecting travel mode. Table 6.1.9 shows the average trip length by mode. Compared with the trip length by purpose shown in Table 6.1.6, the differences were larger. The shortest average trip length was from walking, and the longest was from bus. The percentages of bus, car and motorcycle increased as the trip lengths grow longer, as shown in Figure 6.1.27.

Table 6.1.9 Average Trip Length by Mode

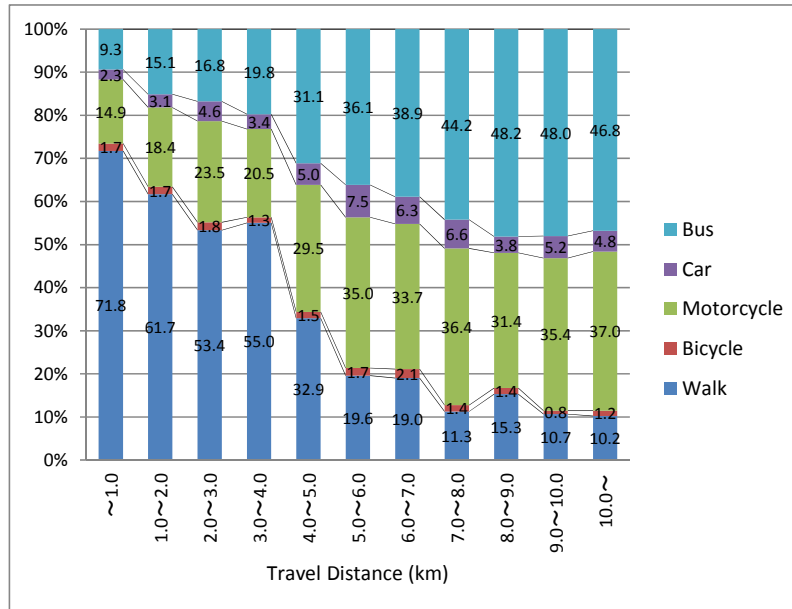
	Walk	Bicycle	Motorcycle	Car	Bus	Average
Average Trip Length (km)	3.0	4.6	6.1	5.6	8.9	5.0

Source: JICA Survey Team



Source: JICA Survey Team

Figure 6.1.27 Trip Length by Travel Mode

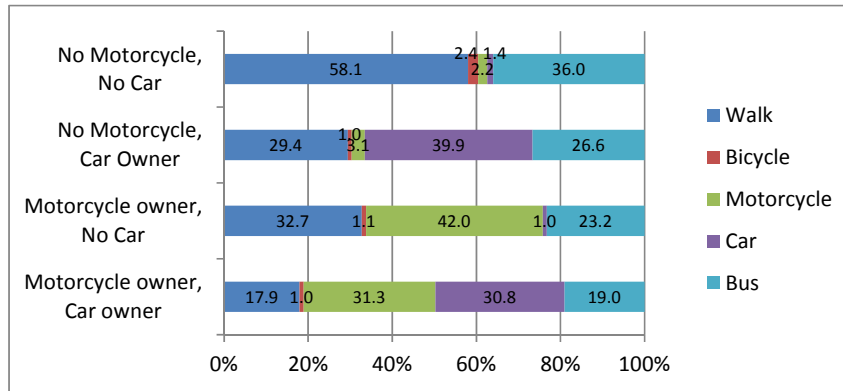


Source: JICA Survey Team

Figure 6.1.28 Travel Mode by Distance

4) Vehicle Ownership and Mode

Definite differences in selection of mode existed between vehicle owners and non-owners. Figure 6.1.29 shows the modal share for four types of owner/non-owner.

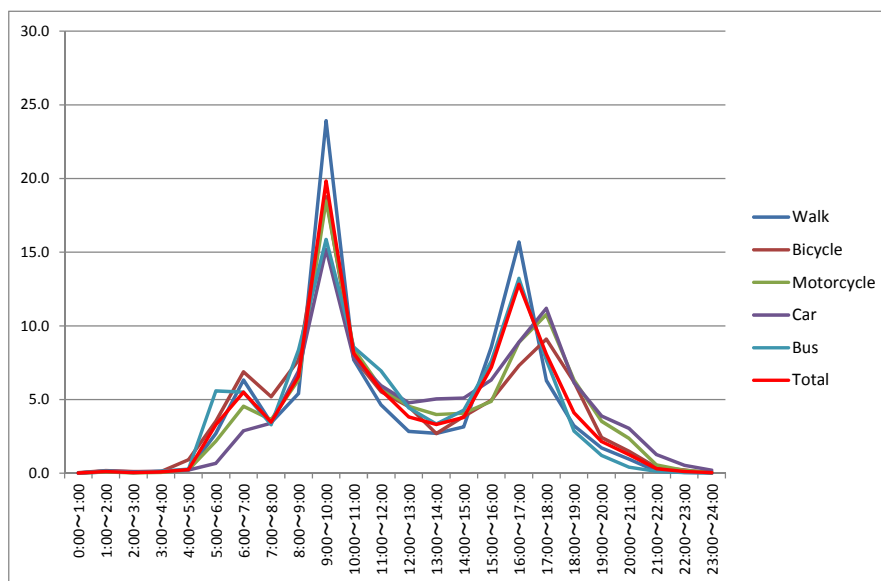


Source: JICA Survey Team

Figure 6.1.29 Travel Mode by Vehicle Ownership

(2) Hourly Variation

Hourly variation of trip generation was similar between travel modes, because hourly trip generation was originated in the trip purpose. Of the total trips, 15% to 24% were concentrated in the peak hours of 9:00 to 10:00. Note that the concentrations of trips became less than half before and after the peak hour.



Source: JICA Survey Team

Figure 6.1.30 Hourly Trip Variation by Travel Mode

(3) Trip Generation/Attraction in Central Area

Figure 6.1.31 shows the trip generation and attraction density* in Kathmandu N.P., Lalitpur N.P., and Bhaktapur N.P. Central area of Kathmandu N.P. (113, 114, and 115) and Lalitpur N.P. (305) showed high trip density of trips by walk, motorcycle, and bus. All these areas comprised the historical and commercial center of the Kathmandu Valley, wherein a secure environment for pedestrians is needed. Therefore, measures to protect pedestrians from vehicle accidents are required in these areas.

*: Trip generation/attraction density: Number of generation and attraction trips divided by zone area.

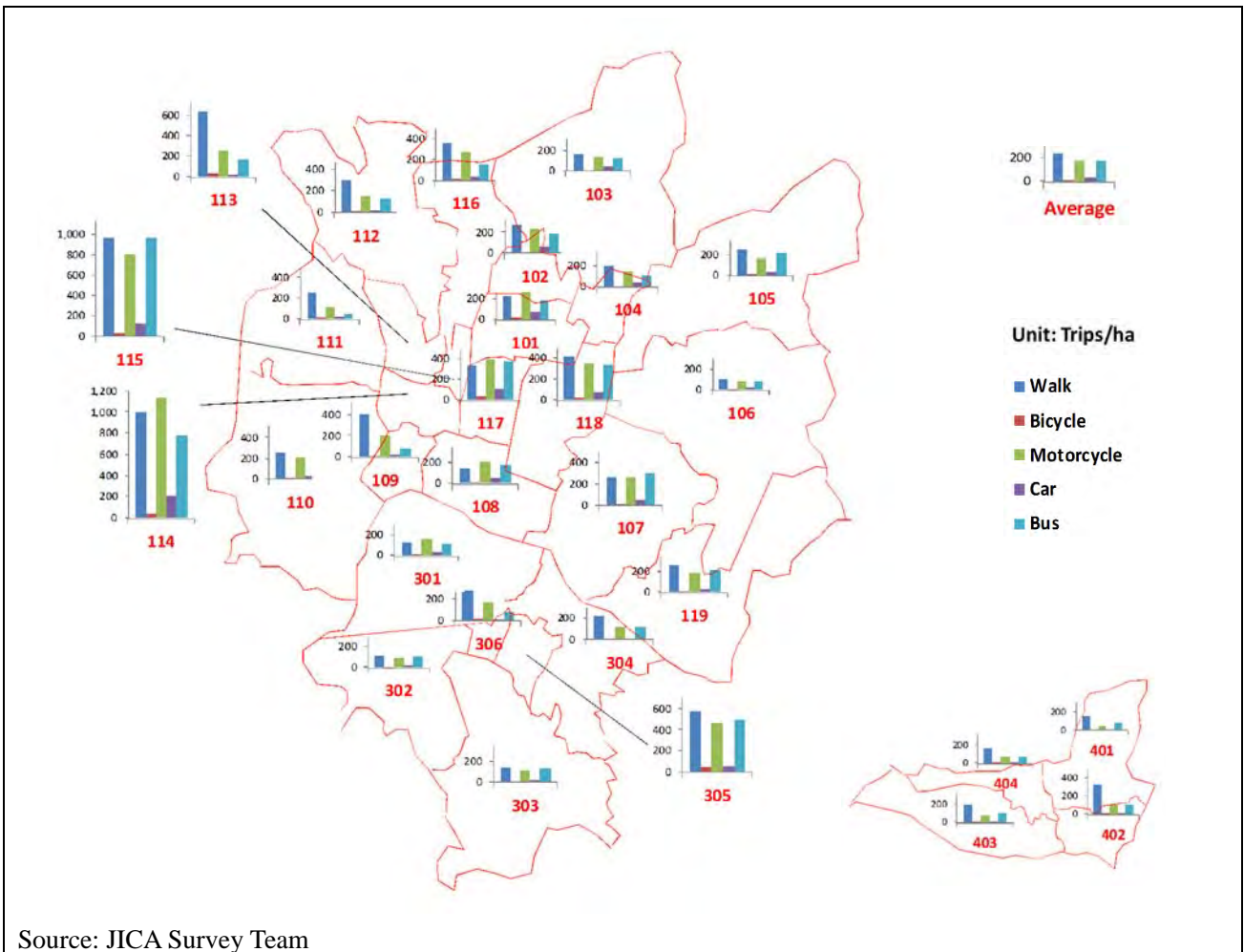
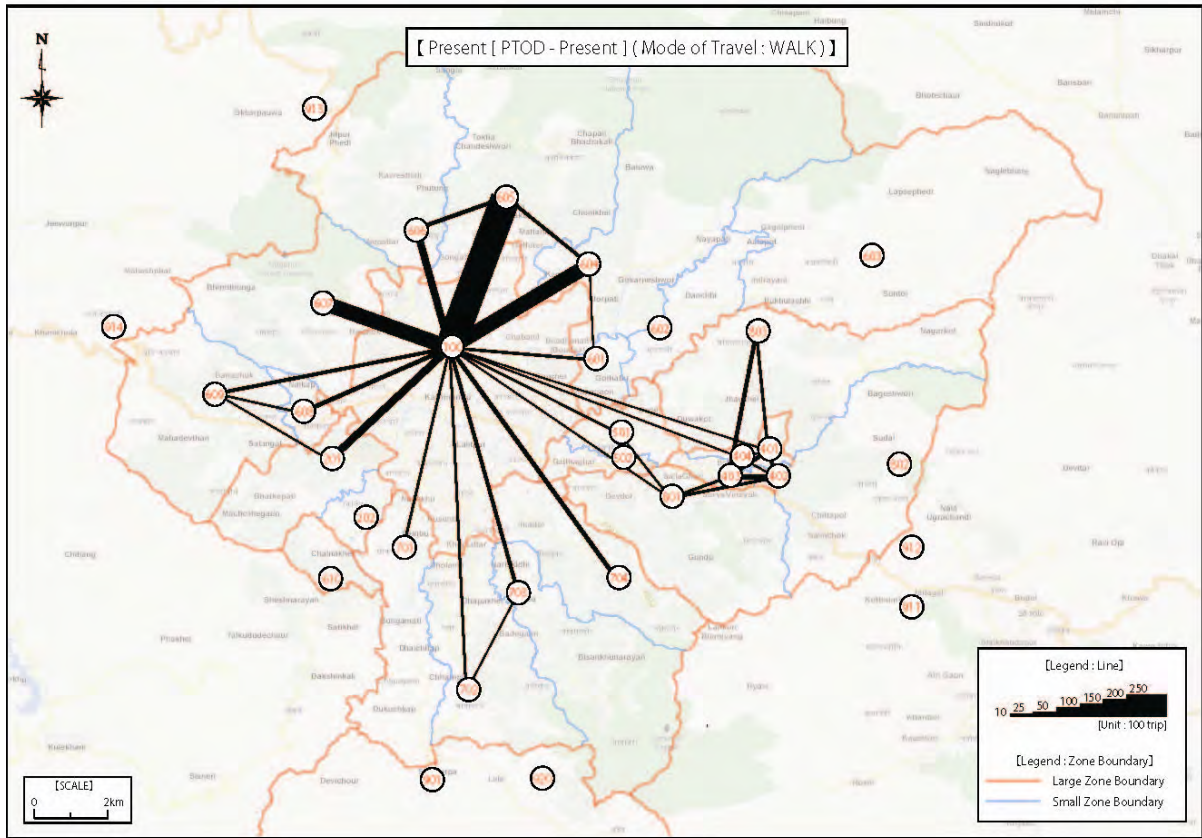


Figure 6.1.31 Trip Generation/Attraction Density in Central Area

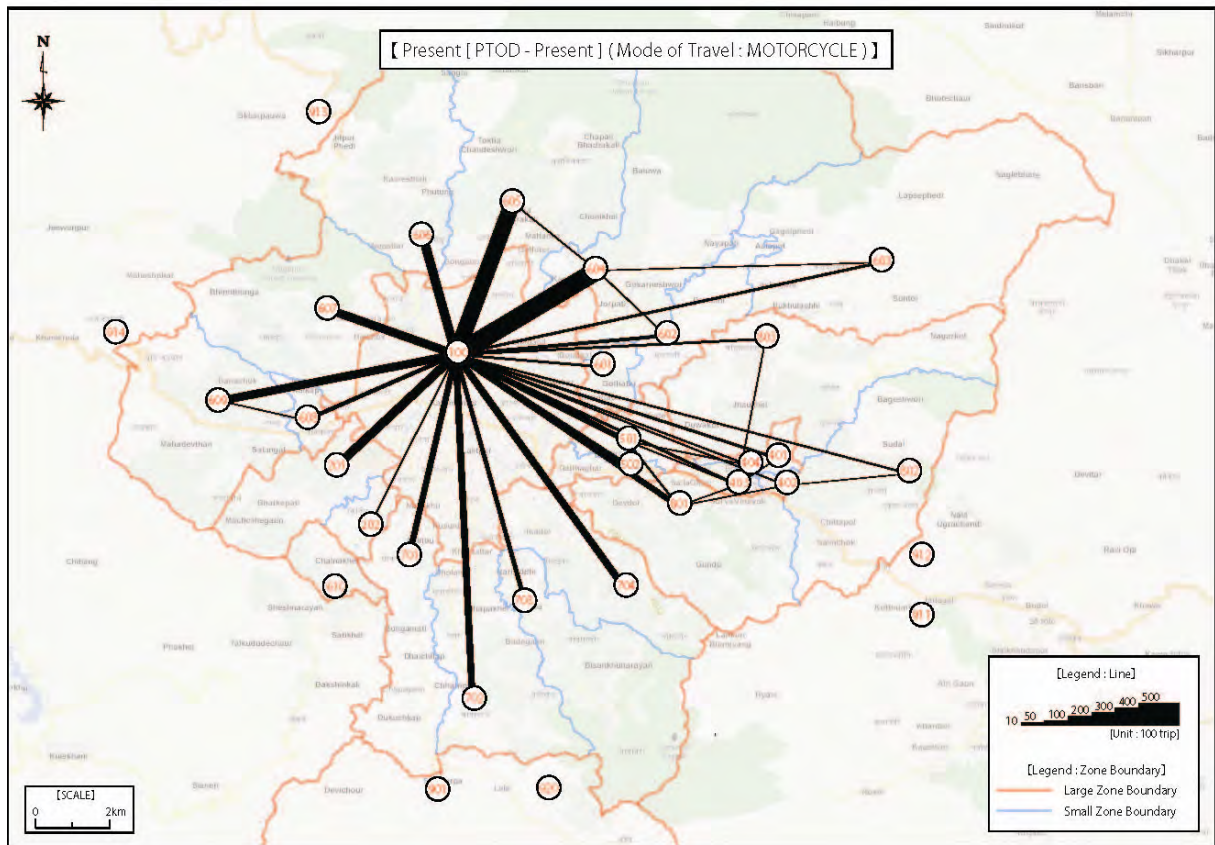
(4) Trip Distribution by Mode

Figure 6.1.32 to Figure 6.1.35 show the person trip distribution by each travel mode. Concentration at Kathmandu and Lalitpur are common trend for all travel modes, and large movement between Kathmandu and Lalitpur is notable.



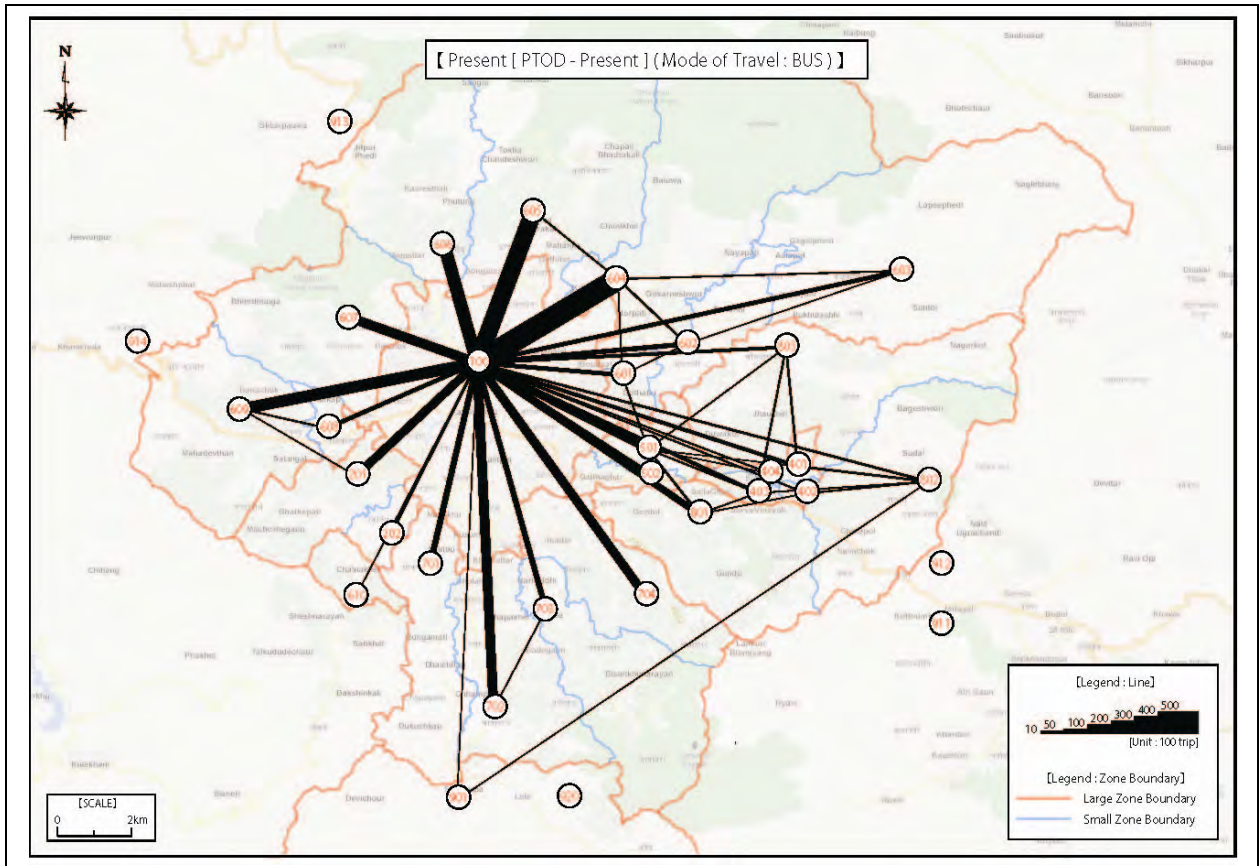
Source: JICA Survey Team

Figure 6.1.32 Person Trip Desire Line Map by Mode (Walk)



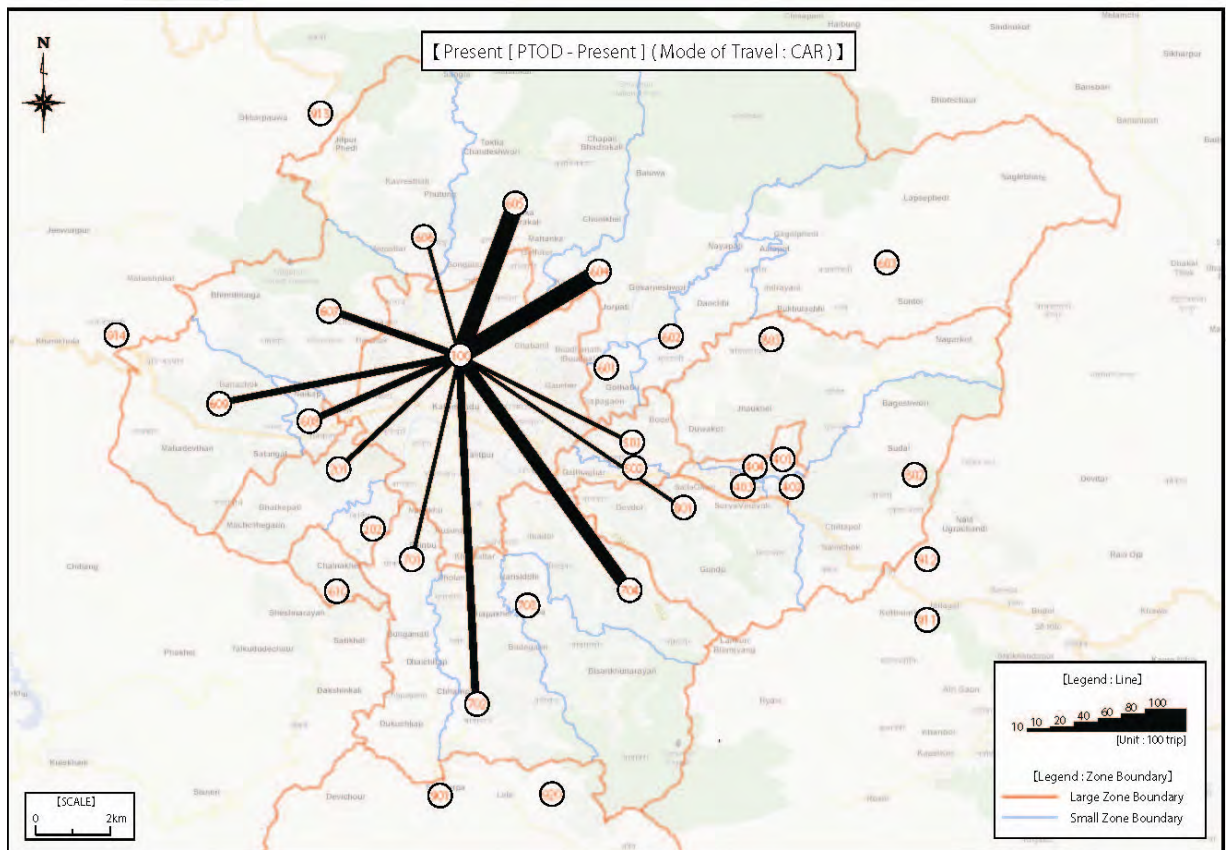
Source: JICA Survey Team

Figure 6.1.33 Person Trip Desire Line Map by Mode (Motorcycle)



Source: JICA Survey Team

Figure 6.134 Person Trip Desire Line Map by Mode (Bus)



Source: JICA Survey Team

Figure 6.135 Person Trip Desire Line Map by Mode (Car)

6.2 Vehicle Movement

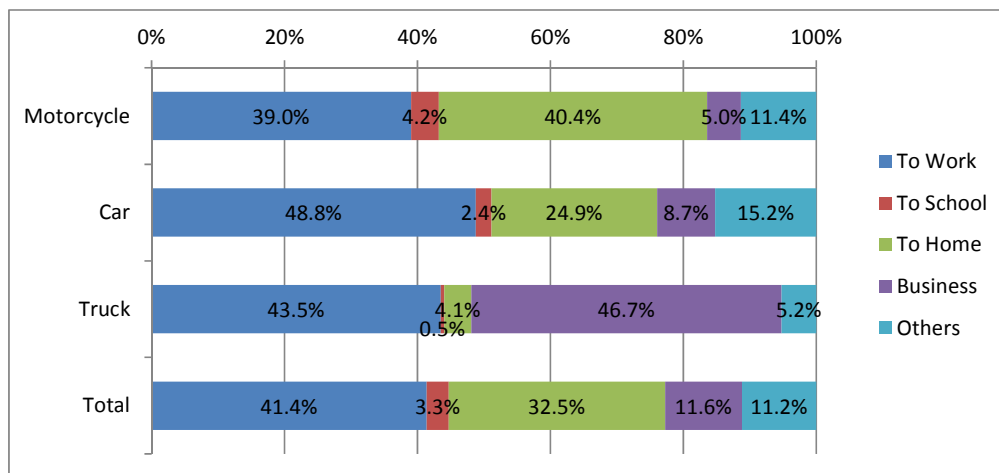
6.2.1 Vehicle Movement (Results of Roadside Interview Survey)

Vehicle movement is discussed in this section based on the results of the roadside interview survey. Note that the major objective of the roadside interview survey was to capture vehicle movement at the Ring Road boundary and the survey area boundary. Therefore the vehicles considered were limited to those which crossed the survey points. Also, information obtained from the roadside interview survey came from the vehicle drivers.

(1) Trip Purpose

The composition of trip purposes of drivers by vehicle type is shown in Figure 6.2.1.

The trip purpose compositions of motorcycle and car were similar; however the percentages for the trip purposes “Business” and “Others” were larger in travel mode by car. Compared with those two vehicle types, the trip purpose composition of truck was different, as it has a larger percentage for “Business”.

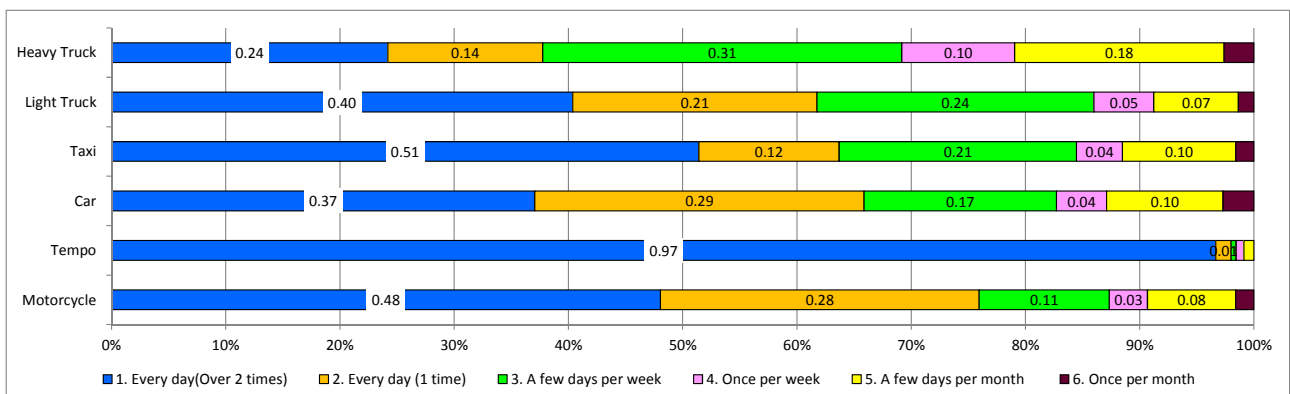


Source: JICA Survey Team

Figure 6.2.1 Trip Purpose by Vehicle Type

(2) Trip Frequency

Figure 6.2.2 shows that more than 60% of car, taxi, and light truck drivers used their vehicles more than once a day. Approximately 40% of heavy truck drivers had a trip frequency of more than once a day.



Source: JICA Survey Team

Figure 6.2.2 Trip Frequency of Each Vehicle Type

(3) Trip Length

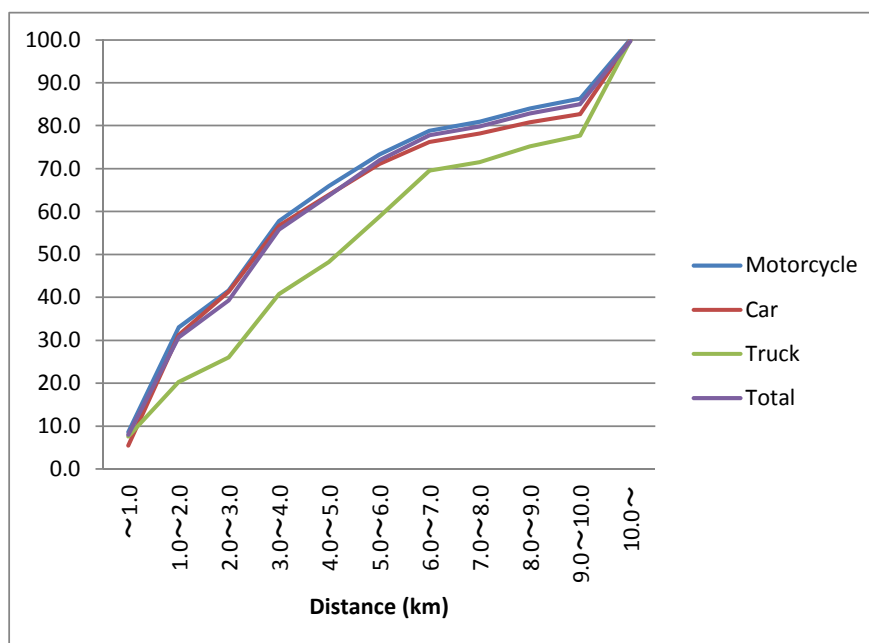
The average trip length shown in Table 6.2.1 indicates that the trip lengths of motorcycles and cars were around 5 km, and the average trip length of trucks was a little longer at 6.8 km.

Since the survey was conducted mainly at the boundary of the Ring Road, which has a radius of 3.0 km to 5.0 km, the average trip length was considered appropriate.

Table 6.2.1 Average Trip Length by Vehicle Type

	Motorcycle	Car	Truck	Average
Average Trip Length (km)	5.0	5.4	6.8	5.2

Source: JICA Survey Team



Source: JICA Survey Team

Figure 6.2.3 Accumulated Trip Length Frequency

(4) Vehicle Characteristics

The average number of passengers per vehicle type was surveyed in the roadside OD survey. The results of which are shown in Table 6.2.2.

The average number of passengers of passenger cars, light trucks, heavy trucks, and taxis were almost two passengers. The average number of passengers of buses is shown in Section 5.3.2 Bus OD Survey.

Table 6.2.2 Average Number of Passengers

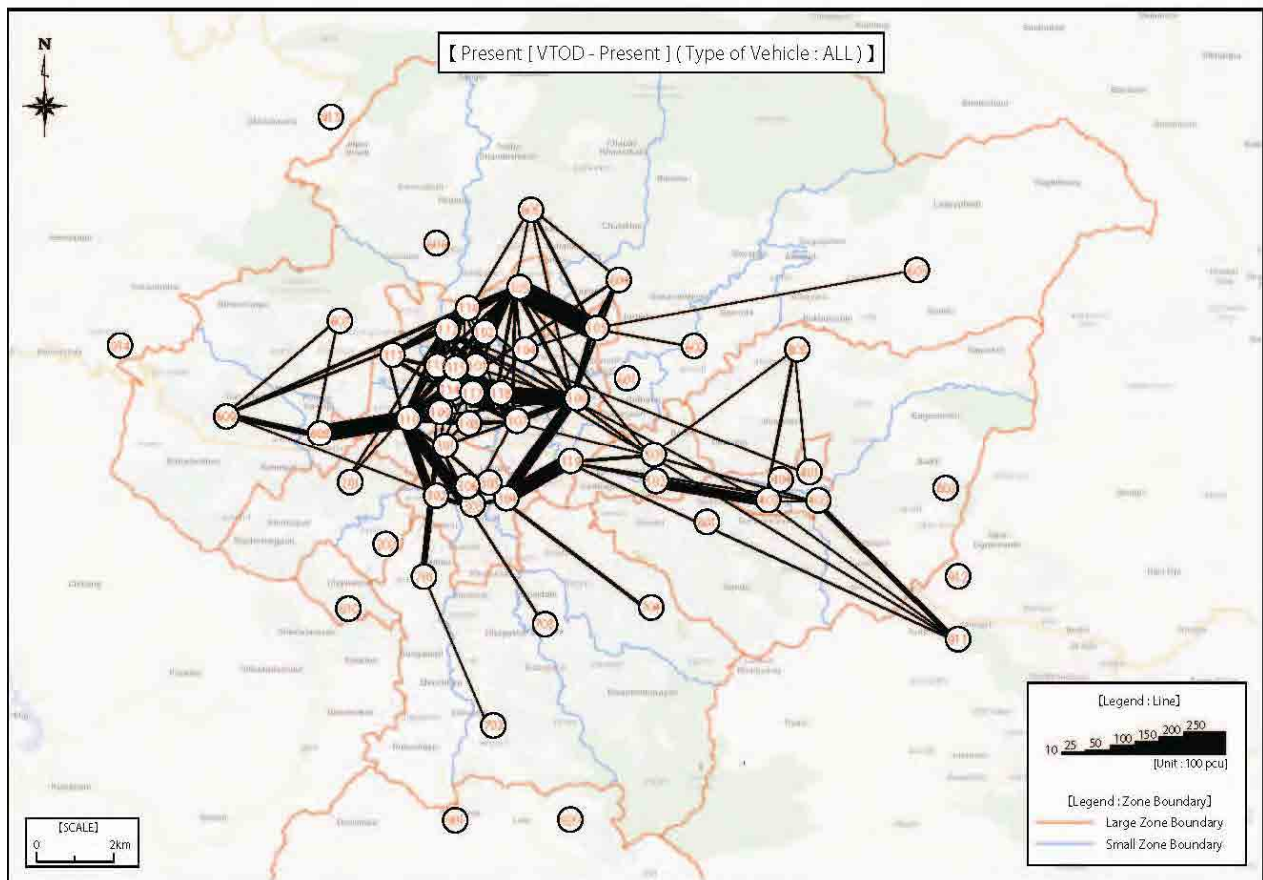
	Motorcycle	Tempo	Car	Taxi	Light Truck	Heavy Truck	Average of Total
Average Passenger (person/vehicle)	1.1	7.8	1.9	2.0	1.8	1.9	1.4

Unit: Persons/vehicle

Source: JICA Survey Team

(5) Movement within Survey Area

The desire lines of all vehicle types are shown in Figure 6.2.4. In general, almost all the desire lines of car trips concentrated toward Kathmandu N.P. and Lalitpur N.P. In addition, Bhaktapur N.P. is functioning as the center of the eastern rural area.



Source: JICA Survey Team

Figure 6.2.4 Vehicle Trip Desire Line Map (All Vehicle Types)

(6) Movement to/from Outside the Survey Area

1) Vehicle Movement

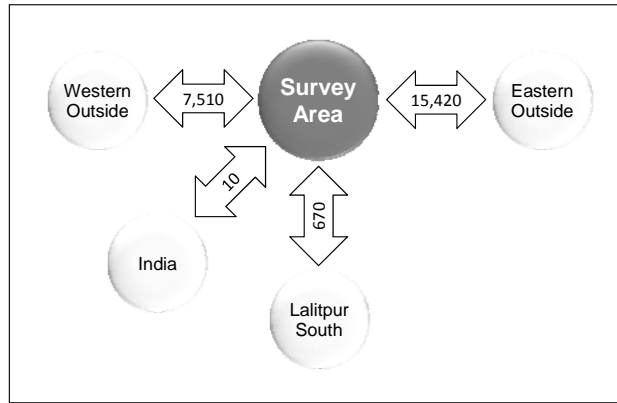
Around 24,000 vehicles go in and out of the survey area. The eastern area outside the survey area has the largest connection with the survey area and occupied two thirds of the total vehicles.

Table 6.2.3 Vehicle Movement to/from Outside

	Motorcycle	Bus	Car	Truck	Total
Lalitpur South	30	30	200	410	670
Eastern Area Outside	8,400	1,270	1,590	4,160	15,420
Western Area Outside	3,180	480	1,510	2,340	7,510
India	0	0	0	10	10
Total	11,610	1,780	3,300	6,920	23,610

Unit: Vehicles

Source: JICA Survey Team



Unit: Vehicles

Source: JICA Survey Team

Figure 6.2.5 Vehicle Movement to/from Outside the Survey Area

2) Movement of Commodity

Information on the type of commodities carried by vehicles were asked at the survey points of the boundary of the survey area. The primary commodities carried included construction materials, miscellaneous, and agriculture. A notable feature in Thankot was that 78% of outbound trucks had no cargoes. It shows that incoming commodities exceeded outgoing commodities.

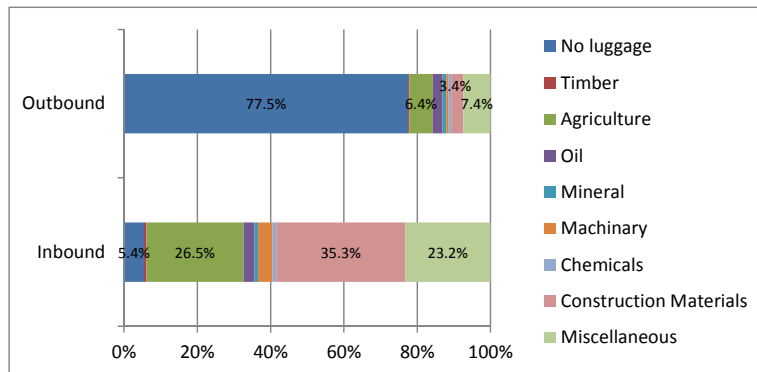


Figure 6.2.6 Composition of Commodities Carried by Trucks in Thankot

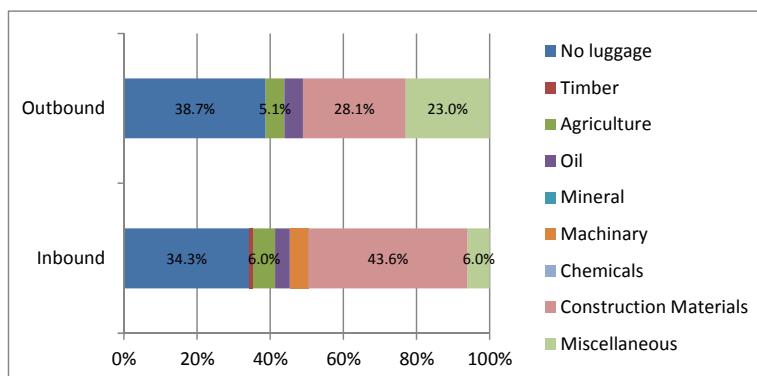


Figure 6.2.7 Composition of Commodities Carried by Trucks in Nagkhel

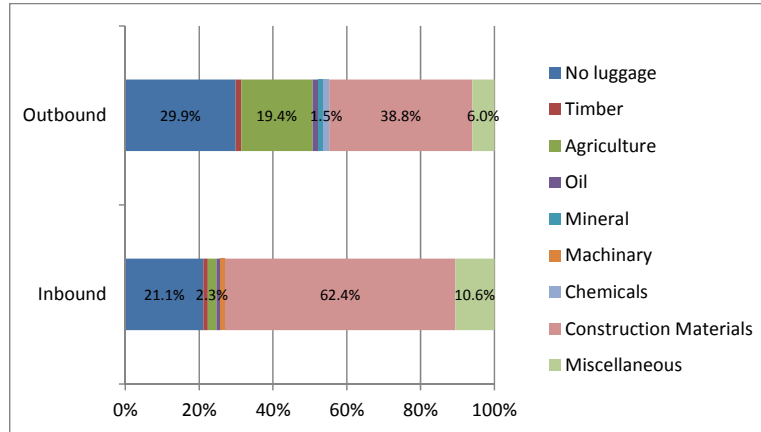
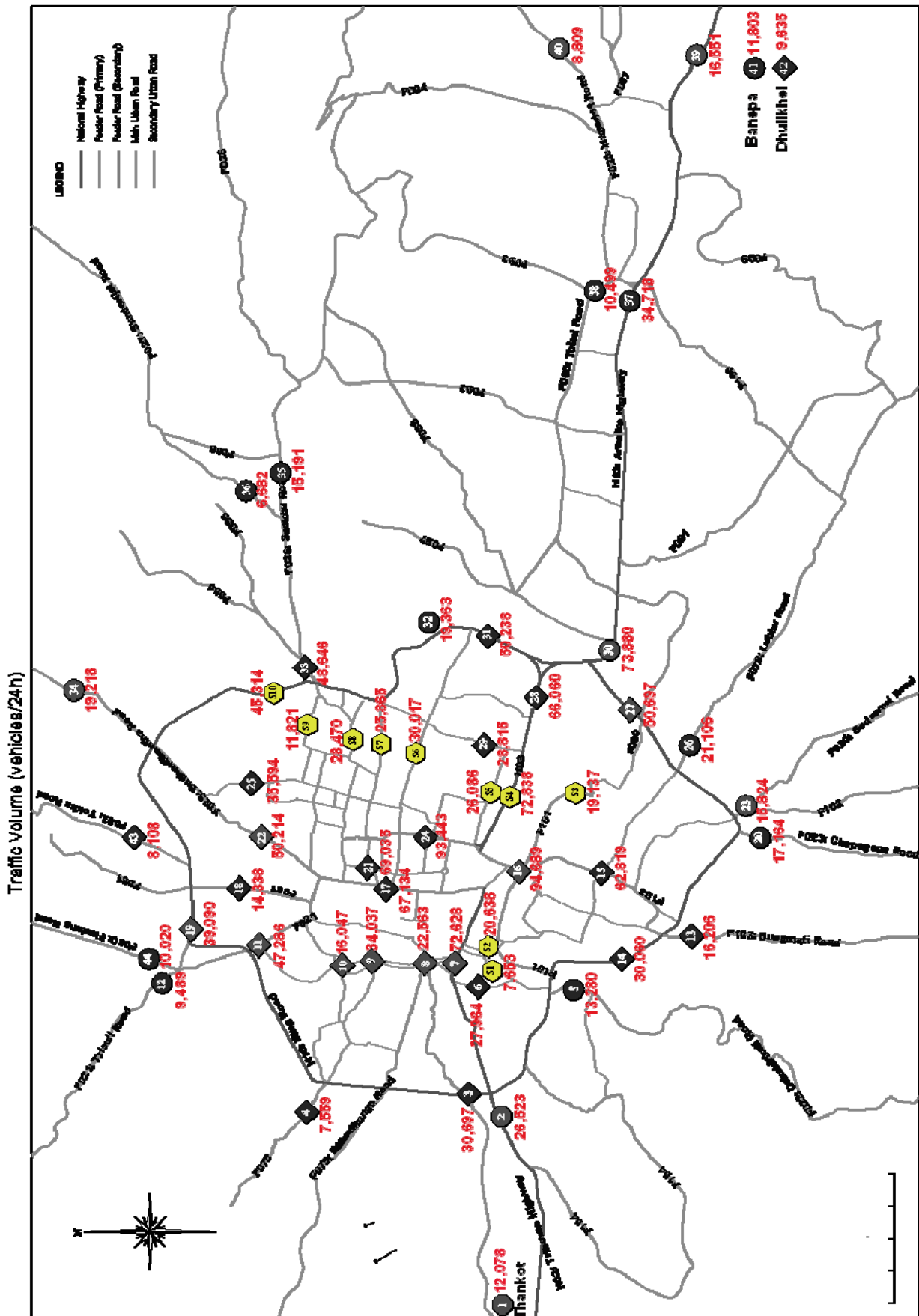


Figure 6.2.8 Composition of Commodities Carried by Trucks in Banepa

6.2.2 Traffic Condition on the Roads

(1) Traffic Volume

Figure 6.2.9 shows the traffic volume of all vehicle types in 24 hours. The largest volume was observed at no. 16 (Thapathali). The second largest was observed at no. 24 (in front of the Supreme Court) and third was at no. 30 (Koteshwor). Inside the Ring Road, the traffic volume exceeded 20,000 at most of the points. Detailed information on the traffic survey results are shown in Appendix. 1.1.



Resource: JICA Survey Team

Figure 6.2.9 Daily Traffic Volume (24-Hour Traffic, All Vehicle Types)

(2) Vehicle Increase (Comparison of Traffic Volumes with Survey in 1991)

Figure 6.2.10 shows the comparison of traffic volumes at 29 locations between the surveys in 2011 and in 1991.

Past traffic volumes in 1991 were obtained from “The Study on Kathmandu Valley Urban Road Development”. The traffic volumes of all vehicle types excluding tempo had increased.

Especially, the traffic volume of motorcycles had dramatically increased from 1991.

The average growth rate of traffic volume of motorcycles was 19.8 from 1991 traffic (annual growth rate was 16% per year).

The growth rate of traffic volumes at the points located within the Ring Road was from 1.0 up to 2.5. However, traffic volumes at the points located outside of the Ring Road were more than 2.5.

The top five points with the highest growth rates are shown in Table 6.2.4.

Table 6.2.4 Highest Growth Rate Points

Highest Growth Rate Point	Growth Ratio
No.12 (B10)	9.45
No.40 (B13)	8.97
No.39 (B14)	6.96
No.20 (B6)	6.48
No.38 (B12)	6.11

Table 6.2.5 Average Growth Ratio by Each Vehicle Type from 1991

	Bicycle	Motorcycle	Tempo	Taxi	Microbus, Minibus	Large Bus	Passenger Car	Light Truck	Heavy Truck
Total increase (survey in 2011/survey in 1991)	0.97	19.80	0.72	3.36	10.64	1.38	5.58	7.33	2.42
Annual growth rate (1991-2011, %)	-0.15	16.10	-1.63	6.3	12.55	1.62	8.98	10.47	4.52

Source: JICA Survey Team

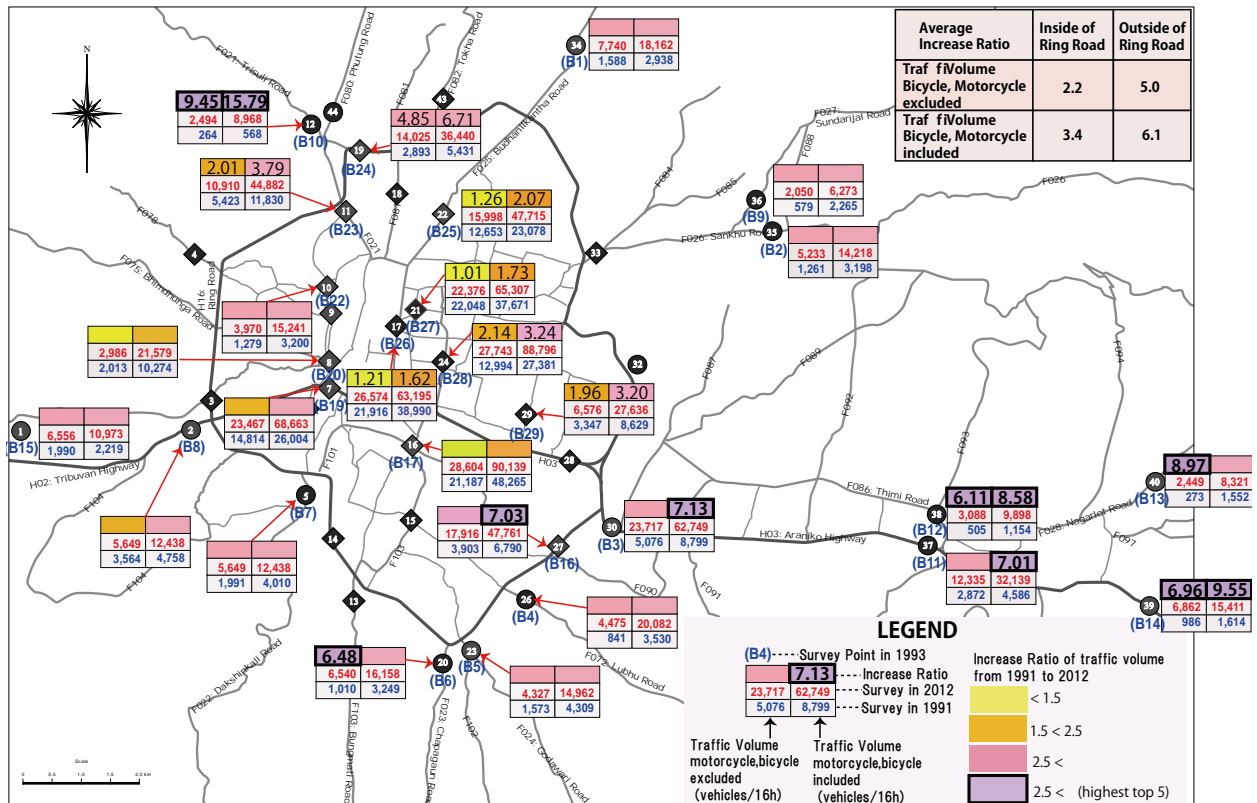


Figure 6.2.10 Comparison of Traffic Volume between 2011 and 1991 (16-Hour Traffic, Excluding Bicycle and Motorcycle)

(3) Hourly Variation

1) Day-Night Ratio

Normally, day-night ratio is defined as 24-hour traffic versus 12-hour (7:00-19:00) traffic. However, 16-hour (6:00-22:00) traffic was counted at all survey points for this survey. Two types of day-night ratio were calculated based on 24-hour count at 15 points.

Day-night ratio Type B was used for the conversion from 16-hour traffic to 24-hour traffic. Day-night traffic ratio by each road classification is shown in Table 6.2.6.

Table 6.2.6 Day-Night Ratio

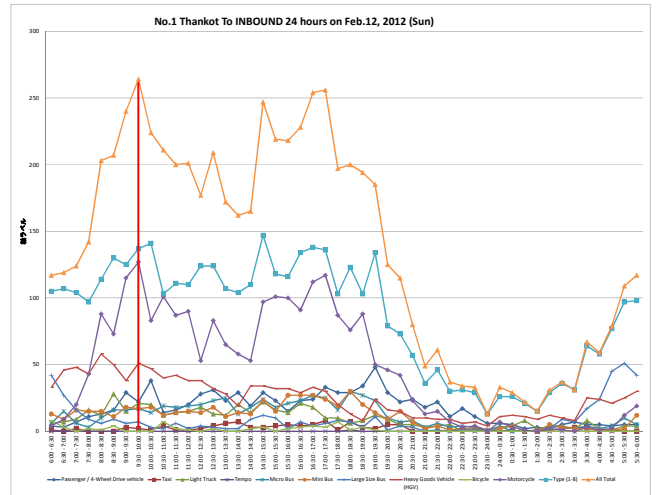
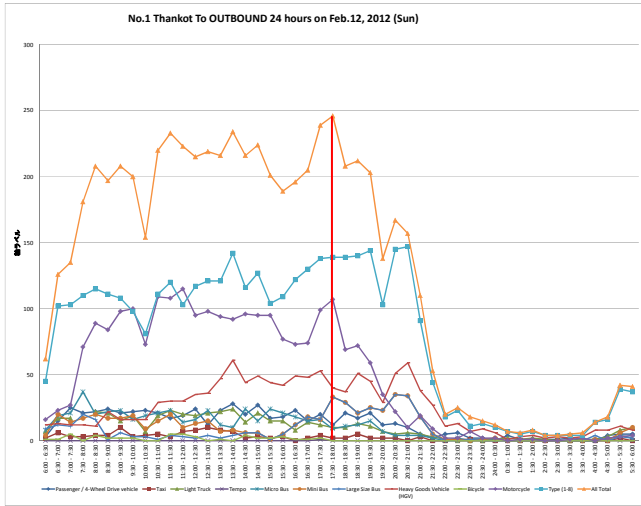
Road Classification	Day-night Ratio Type A 24-hour traffic/12-hour (7:00-19:00) traffic	Type B 24-hour traffic/16-hour (6:00-22:00) traffic
National Highway	1.23	1.07
Feeder Road	1.19	1.05
Urban Road	1.18	1.04

Source: JICA Survey Team

2) Hourly Variation

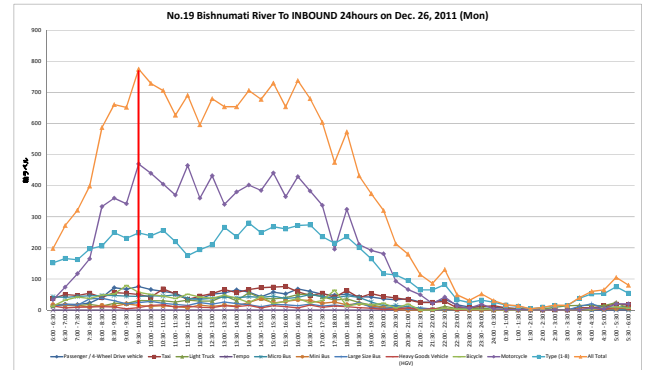
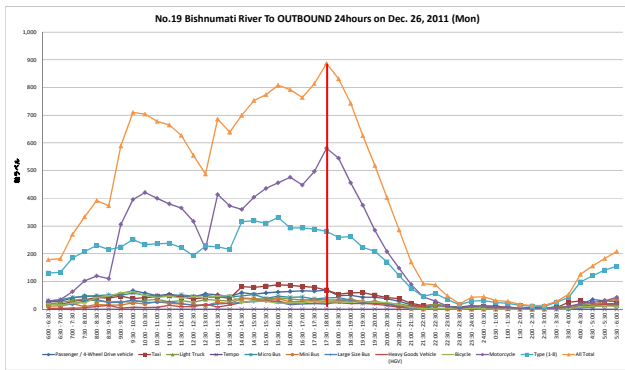
Based on the results of the traffic count survey, hourly variation at the Ring Road, Arniko Highway, Tribuvan Highway, and Kuponde are illustrated in Figure 6.2.11 and Figure 6.2.12. The peak hour of traffic in Arniko Highway and Tribuvan Highway was from 9:30 to 10:30 in the morning and from 18:00 to 18:30 in the evening.

On the other hand, the peak hour at Kuponde was from 9:30 to 10:30 in the evening and from 16:30 to 17:30 in the evening. The hourly traffic volume gradually decreased after 18:00.



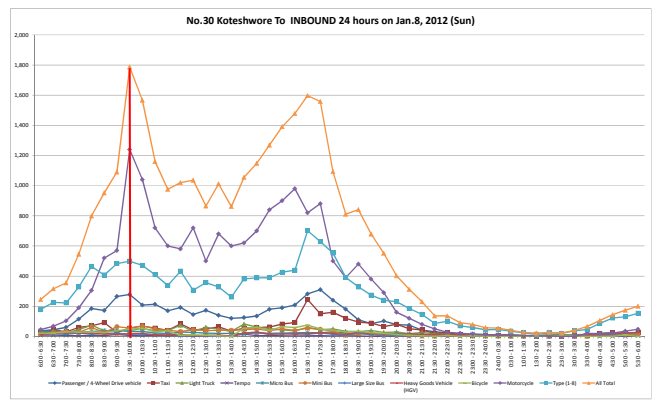
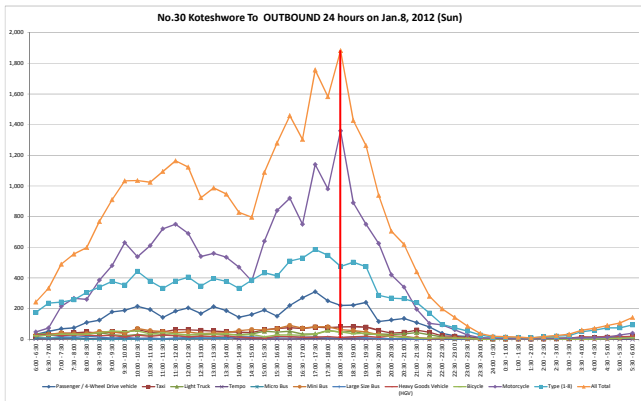
Tribuvan Highway Thankot (from east to west)

Tribuvan Highway Thankot (from east to west)



Ring Road near Gongabun (from east to west)

Ring Road near Gongabun (from west to east)



Arniko Highway near Koteswore (from east to west)

Arniko Highway near Koteswore (from west to east)

Figure 6.2.11 Hourly Variation at the National Highway (1)

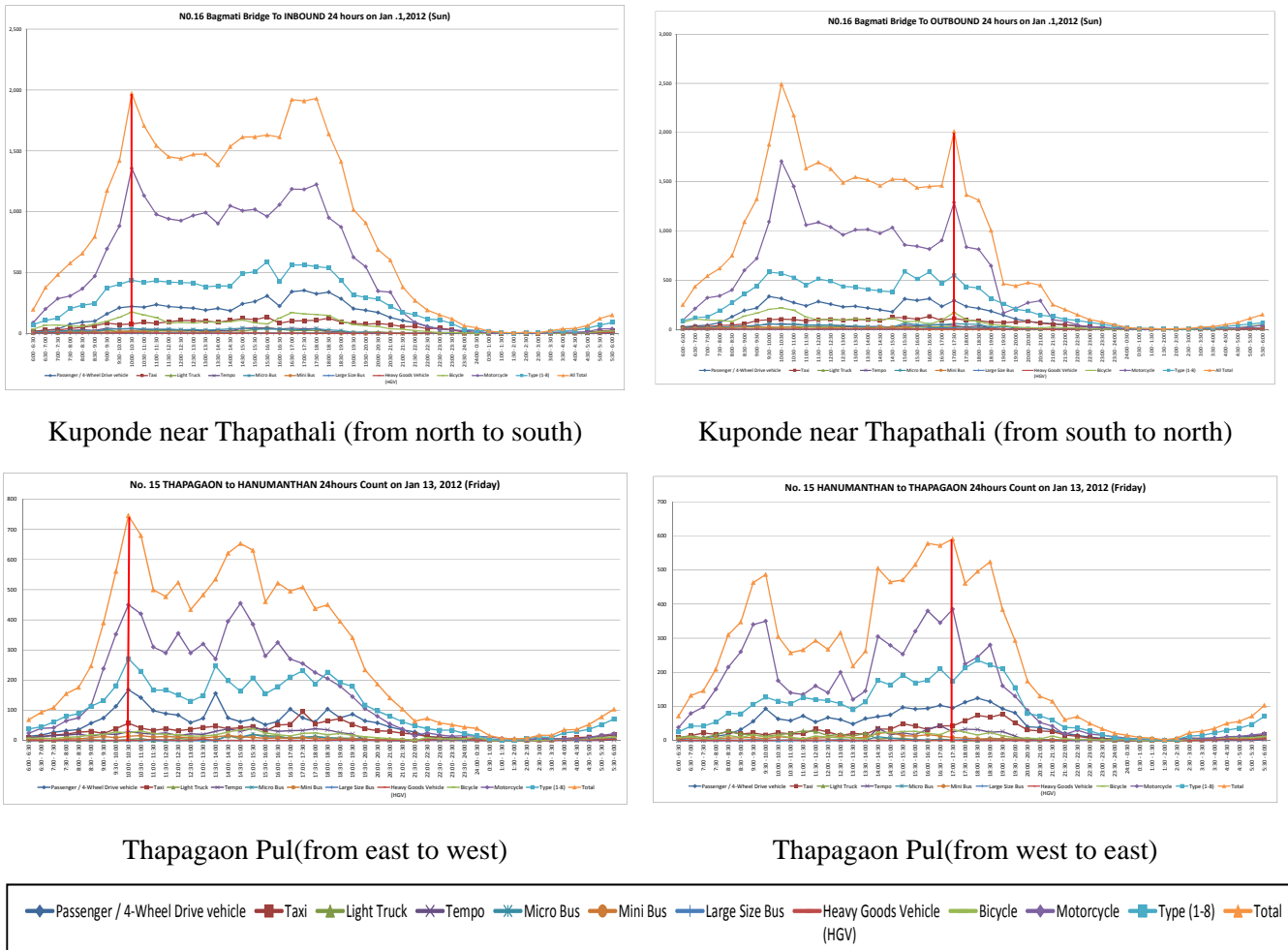


Figure 6.2.12 Hourly Variation at the National Highway (2)

(4) Traffic Volume and Capacity

1) Passenger Car Unit (PCU)

PCU is a metric unit which represents various sized vehicles as one unit. The following PCU for each vehicle type was adopted based on the Nepal Road Standards (2027). However, the PCU for motorcycles and bicycles were 0.3 and 0.2, respectively, as based from Vietnamese standards considering the same traffic situation.

There is no PCU for tempos and minibuses in the Nepal Road Standards (2027). The JICA Survey Team adopted 1.0 as the PCU of tempos, and 1.5 as the PCU of minibuses based on the size of each vehicle.

Table 6.2.7 shows the PCU values applied in the Survey.

Table 6.2.7 Passenger Car Unit

Vehicle Type	Bicycle	Motorcycle	Car	Taxi	Light Truck	Tempo	Microbuses	Minibus	Large Bus	Heavy Truck
Ratio	0.2	0.3	1.0	1.0	1.5	1.0	1.5	3.0	4.0	4.0

Source: JICA Survey Team, Nepal Road Standards (2027)

2) Road Capacity

The extent of traffic congestion is expressed by traffic volume capacity ratio. The traffic capacity ratio of each traffic survey point was calculated as 24-hour traffic volume (V_{24}) versus 24-hour traffic capacity (C_{24}). The capacity of the roads was calculated based on the following formulas with referring the results of the road inventory survey:

a) Calculation of Design Capacity

$$C_L = C_B \times \gamma_L \times \gamma_C \times \gamma_N \times \gamma_I$$

C_L : Possible capacity (PCU/h/lane)

C_B : Basic traffic capacity 2,200 (PCU/h)
2,500 (PCU/h)

Multi-lane road, one direction
Two-lane road, both direction

γ_L : Lane width adjustment factor

γ_C : Lateral clearance adjustment factor

γ_N : Bicycle and motorcycle adjustment factor

γ_I : Land use adjustment factor

$$C_D = C_L \times \gamma_P \times \gamma_j$$

C_D : Design capacity (PCU/h)

C_L : Basic traffic capacity

γ_P : Service level

γ_j : Intersection adjustment factor

b) Calculation of 24-hour Capacity

$$C_{24} = C_D \times 500 / (K \times D) \times R_{24} \quad \text{Multi-lane road}$$

$$C_{24} = C_D \times 100 / K \times R_{24} \quad \text{One-lane road and two-lane road}$$

C_{24} : 24-hour capacity (PCU/24 hr)

K : Ratio of ADT against the 30th hourly traffic volume

D : Directional distribution

R_{24} : Day-night ratio (24-hour traffic/12-hour traffic)

Details of the calculation of road capacity are shown in Appendix 1.4.1. Table 6.2.8 shows the road capacities as calculated by the above formulas.

Table 6.2.8 Road Capacity

	Urban (Inside the Ring Road)	Rural (Outside the Ring Road)
Narrow 2-lane	6,000	7,000
2-lane	17,000	20,000
4-lane	52,000	57,000
6-lane	75,000	83,000

3) Traffic Volume/Capacity Ratio

Figure 6.2.13 shows the traffic volume/capacity (V/C) ratio at each traffic survey point. The top five survey points with the highest V/C ratio are shown in Table 6.2.9.

Table 6.2.9 Highest Traffic V/C Ratio

Survey Point	V/C Ratio
S8	2.76
9	2.70
31	2.69
27	2.41
19	1.98

Figure 6.2.14 shows the traffic V/C balance at river sections. At all the river sections, traffic volume exceeded the capacity. Figure 6.2.15 shows the V/C balance at the outer and inner cordon sections. The outer cordon line is the circle outside the Ring Road, and inner cordon line is the circle surrounding the city center composed of the Dhobi Khola, the Bagmati River, the Bishnumati River, and the northern section of the city center. With regards to the inner cordon line, all the sections showed deficiency in capacity. Especially, the northern section showed large deficiency. As for the outer cordon line, the northeastern section showed deficiency of capacity.

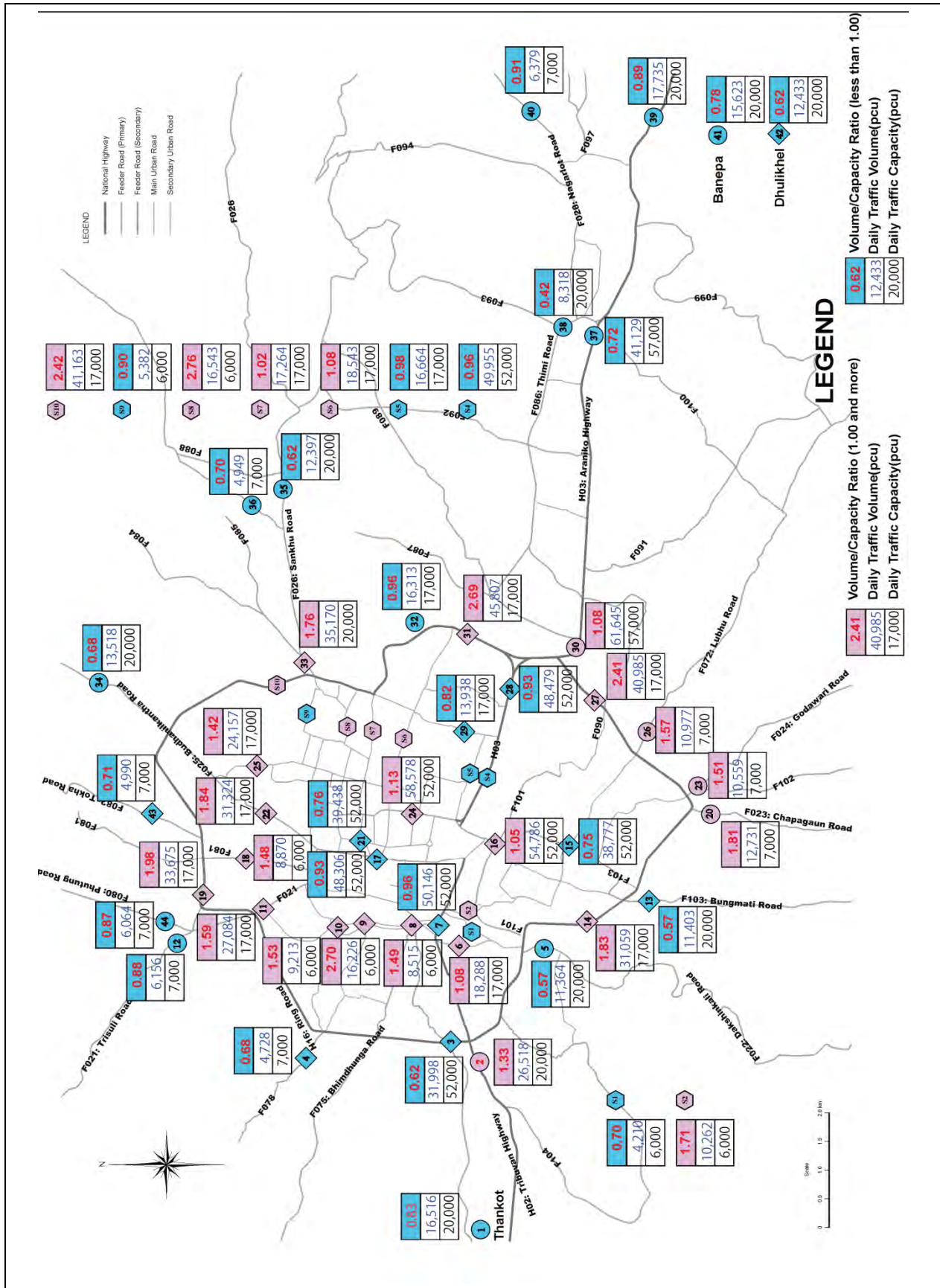


Figure 6.2.13 Traffic Volume in PCU and V/C Ratio in 24 Hours

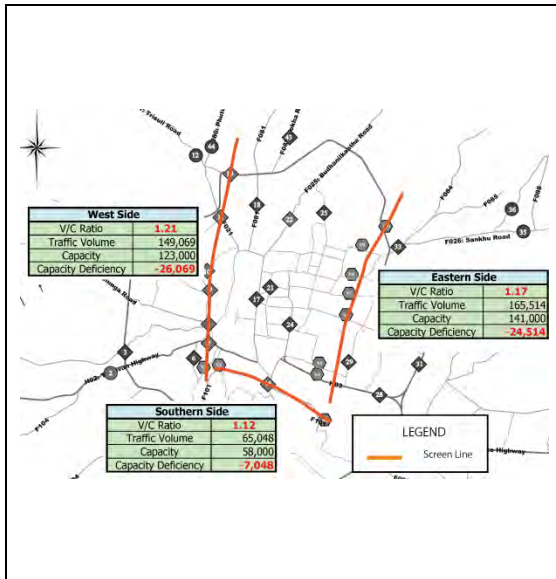


Figure 6.2.14 V/C Balance at River Crossing

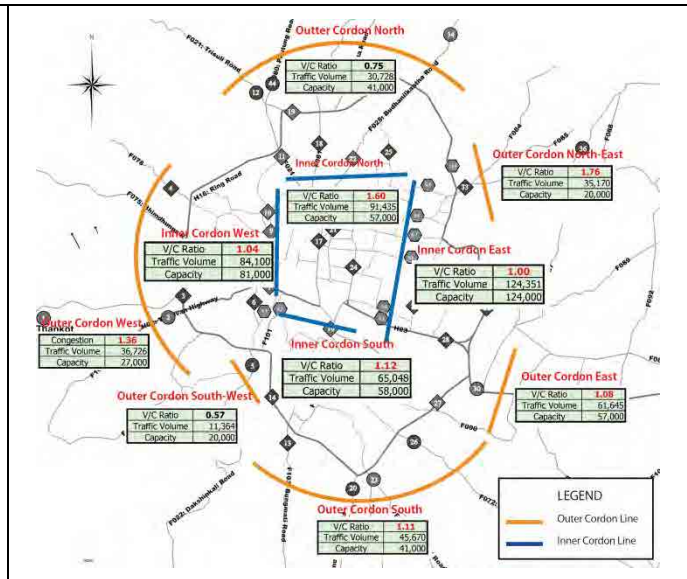


Figure 6.2.15 V/C Balance at the Cordon Line

(5) Travel Speed of Vehicle

Travel speed survey was carried out on 16 routes. Table 6.2.10 shows the average travel speed on each survey route by direction in the morning, daytime, and evening.

The results of the travel speed survey were as follows:

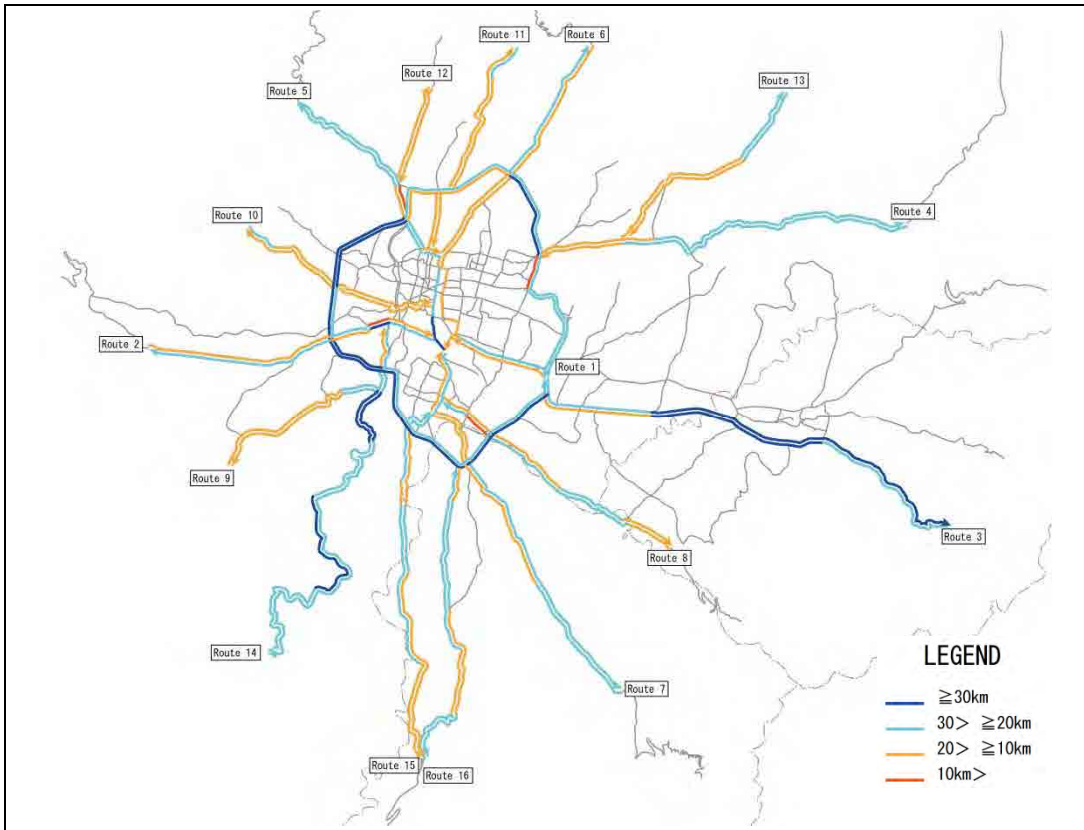
- Average speed on Arniko Highway was more than 20 km/h.
- The travel speeds on other surveyed roads were less than 20 km/h.
- Travel speeds in the evening were less as compared with the travel speeds in the morning and daytime.
- Travel speeds on weekdays were less as compared with travel speeds on holidays.
- Travel speeds within the Ring Road were less than 20 km/h.
- The five lowest average travel speeds occurred during the evening on Route No. 2 at 8.78 km/h, Route No. 12 at 10.0 km/h, Route No. 10 at 10.49 km/h, Route No. 5 at 10.94 km/h, and Route No. 6 at 11.06 km/h.

Table 6.2.10 Average Travel Speed by Route

Route No.	Road Name	Length (Km)	Type of day	Direction	Average Speed(km/h)		
					Morning	Daytime	Evening
1	Ring Road (clockwise from Tinkune)	28.30	Weekday	Inner	22.40	23.52	17.02
				Outer	25.66	21.55	17.76
			Holiday	Inner	21.08	21.89	18.33
				Outer	22.79	22.49	20.93
2	Thapathali – Kalimati –Kalanki – Thankot Road	9.40	Weekday	Inbound	12.82	13.57	12.76
				Outbound	17.75	16.64	8.78
			Holiday	Inbound	20.75	21.33	20.75
				Outbound	17.43	19.60	19.37
3	Old Bus Park – Tinkune –Koteshwor – Banepa –Dhulikhel Road	30.60	Weekday	Inbound	29.36	34.18	29.58
				Outbound	29.44	32.76	23.34
			Holiday	Inbound	35.92	36.33	31.67
				Outbound	37.46	36.33	34.88
4	Chabahil – Jorpati – Sankhu Road	13.20	Weekday	Inbound	18.38	20.15	22.43
				Outbound	15.82	18.44	16.47
			Holiday	Inbound	17.58	18.47	19.21
				Outbound	20.88	17.90	16.88
5	Keshar Mahal – Balaju –Modku (Trisuli Road)	8.00	Weekday	Inbound	12.93	17.23	11.29
				Outbound	17.00	16.28	10.94
			Holiday	Inbound	14.18	15.90	14.14
				Outbound	15.22	15.90	30.80
6	Jamal – Lazimpat –Maharajgunj –Budhanilkanta Road	12.15	Weekday	Inbound	12.39	11.96	11.06
				Outbound	16.99	12.87	11.17
			Holiday	Inbound	21.77	20.39	19.32
				Outbound	21.05	20.01	17.01
7	Thapathali – Lagankhel –Satdobato – Godavari Road	14.30	Weekday	Inbound	14.35	16.92	12.80
				Outbound	18.46	17.21	14.93
			Holiday	Inbound	18.45	21.55	14.32
				Outbound	16.29	19.15	18.92
8	Pulckowk – Patan Durbar –Gorwko – Siddhipur – Lubhu– Lamatar	10.70	Weekday	Inbound	14.75	15.90	14.69
				Outbound	14.02	15.03	12.62
			Holiday	Inbound	18.48	15.73	15.29
				Outbound	17.80	16.94	18.27
9	Kalimati – Balkhu – TU –Kirtipur – Batkepati –Puspahal Park	8.80	Weekday	Inbound	15.23	14.43	14.23
				Outbound	15.58	14.28	13.80
			Holiday	Inbound	15.60	16.99	12.91
				Outbound	14.00	17.69	15.43
10	New Road – Paropakar –Chauni – Sitapaila – Ramkot– Bhimdunga Road	10.40	Weekday	Inbound	13.52	12.87	10.49
				Outbound	12.48	12.60	12.48
			Holiday	Inbound	13.86	14.00	15.52
				Outbound	15.01	13.79	15.13
11	Lainchour – Samakhushi –Tokha – Jhor Road	10.90	Weekday	Inbound	15.84	12.49	13.34
				Outbound	12.45	15.97	13.67
			Holiday	Inbound	13.67	13.89	11.78
				Outbound	14.32	13.36	12.76
12	Balaju bypass – Phutung Road	3.30	Weekday	Inbound	15.60	13.14	10.00
				Outbound	11.26	10.65	11.78
			Holiday	Inbound	12.50	13.14	12.00
				Outbound	12.86	12.25	11.26
13	Jorpati – Nayapati –Sundarijal Road	7.10	Weekday	Inbound	13.07	14.73	14.42
				Outbound	13.91	15.64	15.93
			Holiday	Inbound	15.26	15.26	14.42
				Outbound	16.31	15.26	14.58
14	Balkhu – Chovar –Dakshinkali Road	16.80	Weekday	Inbound	23.43	19.77	23.16
				Outbound	22.77	21.27	22.93
			Holiday	Inbound	20.01	20.33	19.16
				Outbound	21.19	23.00	20.15
15	Jawalakhel - Ekantakuna –Vaisepati – Bungamati –Tika Bhairav Road	14.00	Weekday	Inbound	17.12	16.20	15.01
				Outbound	15.66	16.09	15.26
			Holiday	Inbound	16.41	16.00	15.85
				Outbound	14.86	14.71	15.05
16	Lagankhel – Satdobato –Chapagaun – Tika Bhairab -Lele Road	15.30	Weekday	Inbound	18.08	19.11	17.78
				Outbound	16.53	15.87	15.98
			Holiday	Inbound	20.21	20.69	17.75
				Outbound	17.04	17.05	15.61

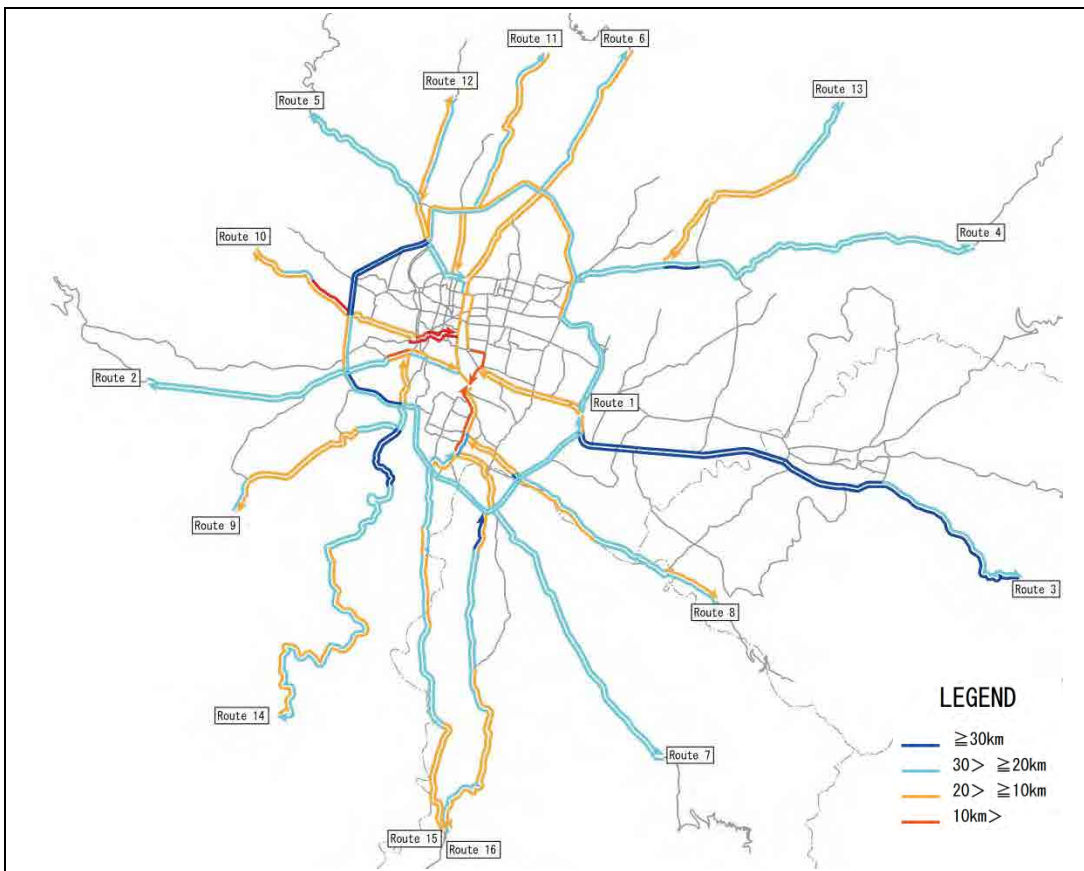
Note: Red number --- lowest speed, Red with yellow marker----Lowest Travel Speed top 5

Source: JICA Survey Team



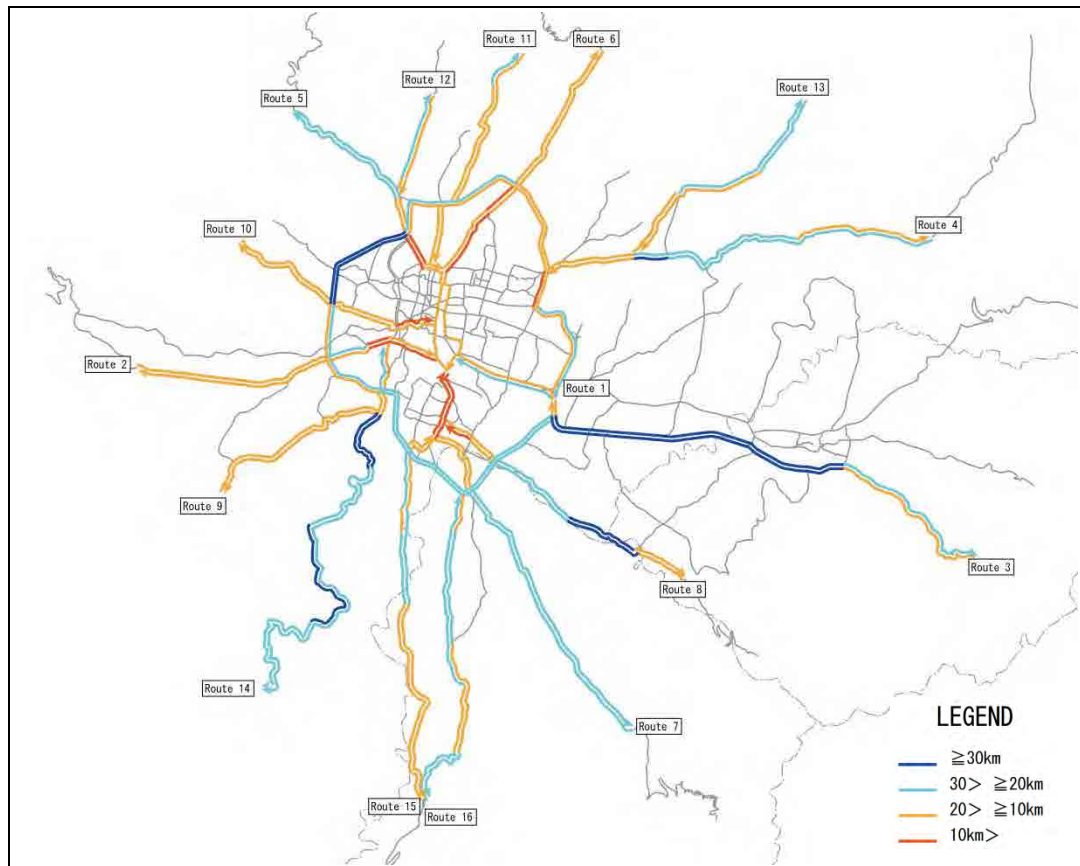
Source: JICA Survey Team

Figure 6.2.16 Vehicle Speed on Major Roads (Morning)



Source: JICA Survey Team

Figure 6.2.17 Vehicle Speed on Major Roads (Daytime)



Source: JICA Survey Team

Figure 6.2.18 Vehicle Speed on Major Roads (Evening)

(6) Average Passenger per Vehicle

The average number of passengers by vehicle type is shown in Table 6.2.11. The average number of passengers of all vehicle types, excluding tempos and taxis, was less than 2.0.

Table 6.2.11 Average Number of Passengers by Vehicle Type

Vehicle Type	Motorcycle	Tempo	Car	Taxi	Light Truck	Heavy Truck	Average
Passengers	1.1	7.8	1.9	2.0	1.8	1.9	1.4

Unit: Person/Vehicle

Source: JICA Survey Team

6.2.3 Traffic Condition at Intersection

Intersection traffic count survey was carried out to obtain traffic volume and vehicle type data of directional traffic flow at ten selected at-grade intersections.

(1) General

Intersections are complex and severe individual locations because of many vehicular movements (though, left-turn and right-turn from each approach road) and pedestrian crossings.

(2) Intersection Analysis

The degree of saturation at each intersection was calculated as shown in Table 6.2.12.

The degree of saturation at each intersection was calculated by the following formula:

$$X = \Sigma (x)$$

$$x = v/s$$

- X: Degree of saturation of intersection
- x: Degree of saturation by signal phase
- v: Traffic volume of lane group
- s: Saturation flow rate of lane group

Where

$$s = s_0 N f_w f_{HV} f_g f_{RT} f_{LT}$$

- s_0 : Ideal saturation flow rate per lane, 2,000 PCU
- N : Number of lanes in the lane group
- f_w : Adjustment factor for lane width
- f_{HV} : Adjustment factor for heavy vehicles in the traffic flow
- f_g : Adjustment factor for approach grade
- f_{RT} : Adjustment factor for right turns in the lane group
- f_{LT} : Adjustment factor for left turns in the lane group

All of the degrees of saturation were more than 0.9, which is the desirable maximum requirement factor of traffic control at intersection.

Especially, the degrees of saturation at Chabahil, New Baneshwor, Thapathali, Balaju, Kalanki, and Sorakhutte intersections were more than 1.80. Urgent improvement of these intersections are required.

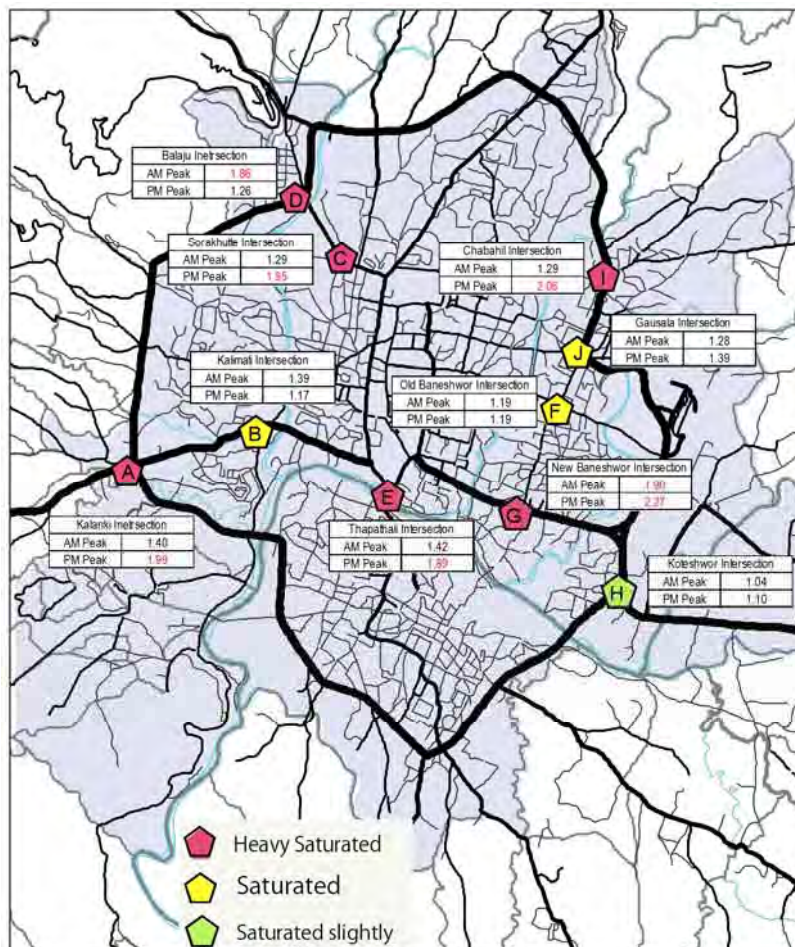


Figure 6.2.19 Degree of Saturation at Major Intersections

Table 6.2.12 Degree of Saturation

No	Name of Intersection	Type of Intersection		Morning 9:00-10:00	Evening 16:00-17:00
1	Gausala Intersection	4-legs	Police Control	1.28	1.39
2	Chabahil Intersection	4-legs	Police Control	1.30	1.86
3	Old Baneshwor Intersection	4-legs	Police Control	1.19	1.33
4	New Baneshwor Intersection	4-legs	Police Control	1.26	2.27
5	Thapathali Intersection	4-legs	Police Control	1.42	1.89
6	Kalanki Inetrsection	4-legs	Police Control	1.40	1.99
7	Balaju Inetrsection	4-legs	Roundabout	1.85	1.64
8	Kalimati Intersection	3-legs	Police Control	1.39	1.17
9	Sorakhutte Intersection	3-legs	Police Control	1.29	1.82
10	Koteshwor Intersection	3-legs	Signal Control	1.04	1.10

Note: Shaded: Up to fifth highest saturated intersection

Red: Highest degree of saturation

Source: JICA Survey Team

Table 6.2.13 Traffic Flow at Major Saturated Intersections

	Traffic Flow at Morning Peak(9:00-10:00)	Traffic Flow at Evening Peak(17:00-18:00)
New Baneshwor Intersection		
	Degree of Saturation: 1.26 > 0.9	Degree of Saturation: 2.27 > 0.9
Kalanki Intersection		
	Degree of Saturation: 1.40 > 0.9	Degree of Saturation: 1.99 > 0.9

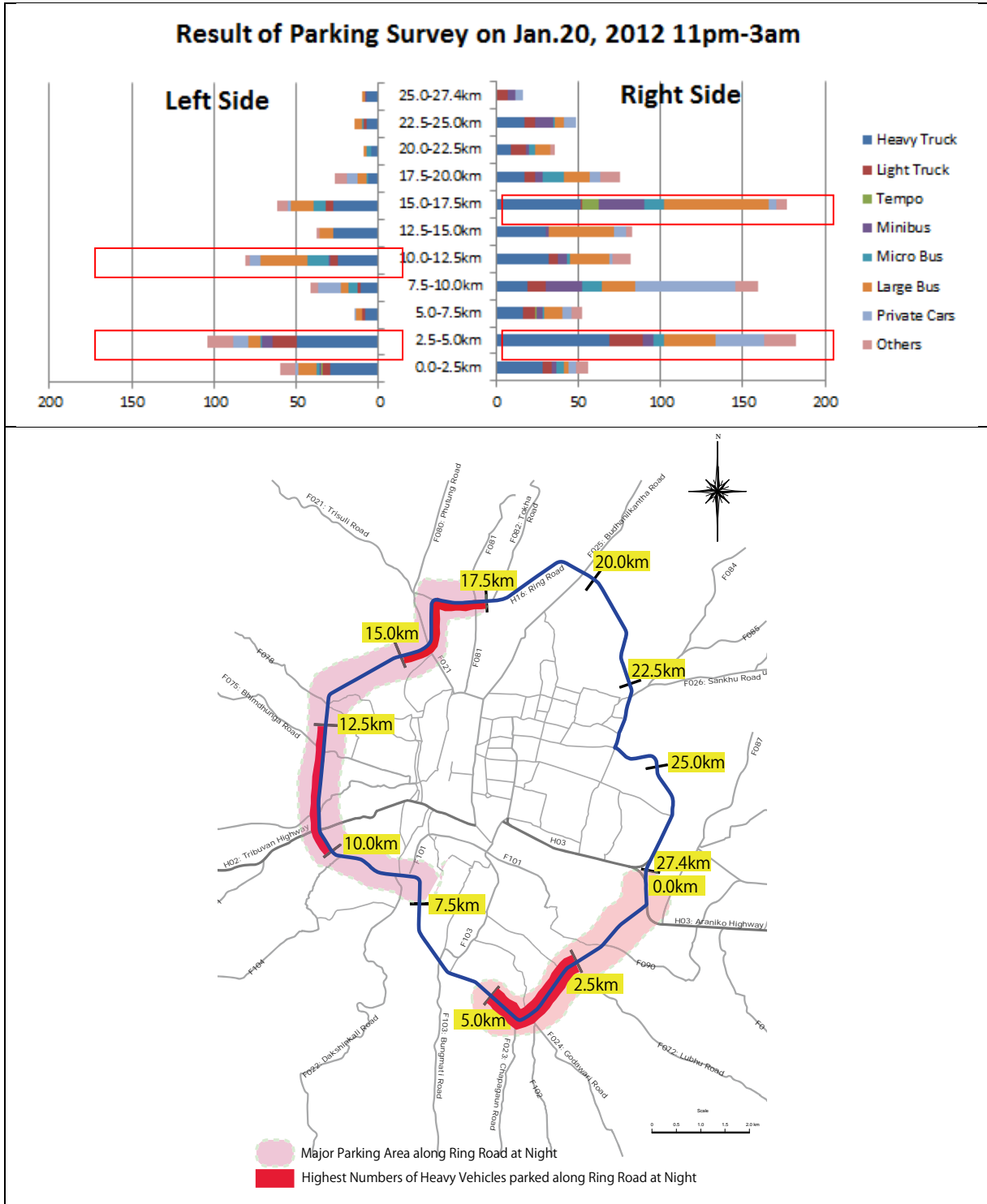
Thapathali Intersection		
	Degree of Saturation: 1.42 > 0.9	Degree of Saturation: 1.89 > 0.9
Chabahil Intersection		
	Degree of Saturation: 1.30 > 0.9	Degree of Saturation: 1.86 > 0.9
Balaju Intersection		
	Degree of Saturation: 1.85 > 0.9	Degree of Saturation: 1.64 > 0.9

Source: JICA Survey Team

6.2.4 Parking Condition in the Ring Road

Parking survey along the Ring Road was carried out on January 20 and 23, 2012.

Around 35 to 40% of parked vehicles along the Ring Road at night were heavy trucks. Major parking sections were near major junctions connecting with the radial national highway and feeder roads such as Kalanki Intersection, Balaju Intersection, and Satdobato Intersection. Radial feeder roads do not have enough space within the road reserve.



Source: JICA Survey Team

Figure 6.2.20 Results of Parking Survey

Table 6.2.14 Summary of Results of Parking Survey

		Start Point : Tinkune	Satdobato	Ekantakuma	Balkhu	Kalanki Sitapalla	Halchowk	Balaju Bypass	Maharajgunj	Chabahil	Chabahil Gaushala	Airport Tinkune	Total
Direction	Vehicle Type	0.0-2.5 km	2.5-5.0 km	5.0-7.5 km	7.5-10.0 km	10.0-12.5 km	12.5-15.0 km	15.0-17.5 km	17.5-20.0 km	20.0-22.5 km	22.5-25.0 km	25.0-27.4 km	
Left Side	Heavy Truck	29	50	8	11	25	28	28	6	5	7	7	204
	Light Truck	5	14	2	2	4	0	4	0	0	2	0	33
	Tempo	1	0	0	0	0	0	0	0	0	0	0	1
	Minibus	1	7	0	0	1	0	0	0	0	0	1	10
	Micro Bus	2	1	0	5	13	0	8	1	2	1	0	33
	Large Bus	11	7	4	5	29	8	13	6	2	5	2	92
	Private Cars	2	9	1	14	6	0	2	6	0	0	0	40
	Others	9	16	0	4	3	2	7	8	0	0	0	49
Total	60	104	15	41	81	38	62	27	9	15	10	462	

Right Side	Heavy Truck	28	69	16	19	32	30	51	17	9	17	0	288
	Light Truck	6	20	8	11	6	0	1	7	9	7	7	82
	Tempo	0	0	1	0	0	0	10	0	0	0	0	11
	Minibus	3	7	3	22	5	2	28	4	2	11	5	92
	Micro Bus	4	6	1	12	2	0	12	13	4	1	0	55
	Large Bus	3	31	11	21	24	40	64	16	9	5	0	224
	Private Cars	5	30	6	60	2	7	4	6	0	8	4	132
	Others	7	19	6	14	11	4	7	12	3	0	0	83
Total	56	182	52	159	82	83	177	75	36	49	16	967	

Note: Survey direction is when going clockwise. Right side is inner side and left side is outer side.

Shaded: Upto fifth highest numbers of parking vehicles

Red: Highest numbers of parking heavy vehicles

Blue: Second highest numbers of parking heavy vehicles

6.3 Bus Operation and Movement

6.3.1 Bus Operation

(1) Bus Operation by Public Transport Firms

Regular route buses are operated by 69 firms. Among them, 51 are operating within the Kathmandu Valley, 21 are operating outside, and three are operating in both areas. Six thousand public vehicles are operated regularly for general passengers. The numbers of operating buses and their operation routes are shown in Table 6.3.1. The total number of operations within the Kathmandu Valley is around 33,000.

As shown in Table 6.1.8, the total number of person trips using bus was approximately 948,000. Therefore, if 15 is applied as the average number of passengers per bus, it would correspond with the number of person trips.

Table 6.3.1 Number of Operating Buses by Public Transport Firms

		Number of Operation Route	Number of Operating Bus	Number of Operation
Within Kathmandu Valley	Tempo	21	913	7,749
	Micro Bus	90	2,036	14,120
	Minibus	107	2,036	9,822
	Large Bus	2	320	1,140
	Total	220	5,295	32,835
Out of Kathmandu Valley	Tempo	0	0	0
	Micro Bus	12	140	220
	Minibus	10	160	260
	Large Bus	65	380	380
	Total	87	680	1,160
Total	Tempo	21	910	7,749
	Micro Bus	102	2,120	14,340
	Minibus	117	2,240	10,082
	Large Bus	67	700	1,520
	Total	307	5,970	34,000

Source: JICA Survey Team

(2) Bus Routes

The operation routes of each public vehicle type are shown Figure 6.3.1.

Since almost all the large buses connect the Kathmandu Valley and other regions, the operation routes concentrate on highways, the Ring Road, or major feeder roads. Regarding minibuses and the microbuses, their routes are almost overlapping, however, microbuses operate on minor feeder roads inside the city center and in the suburbs. Tempos operate within the Kathmandu N.P. and Lalitpur N.P. areas on rather short trips.

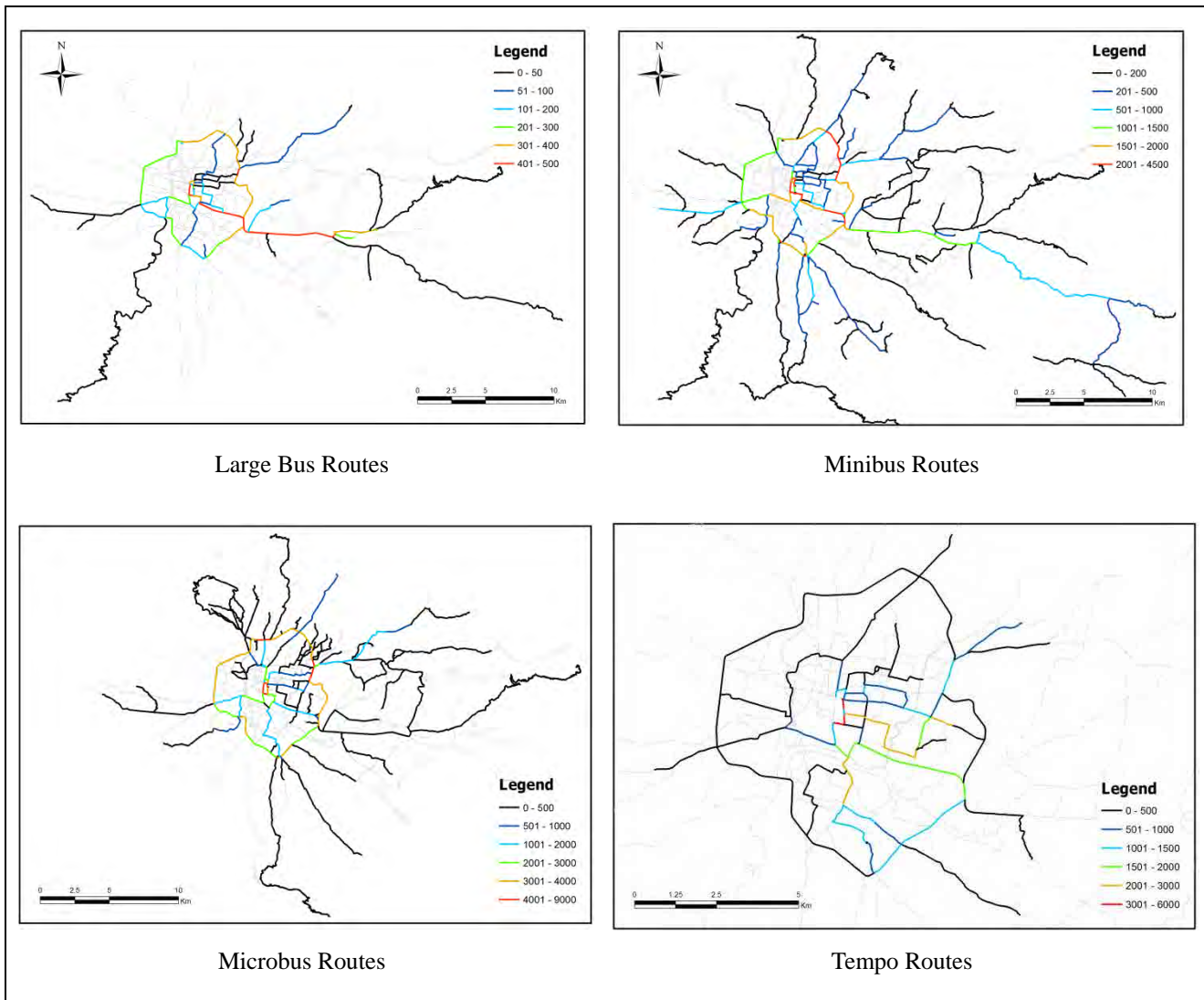


Figure 6.3.1 Existing Bus Routes

6.3.2 Bus Operation at Stations

(1) Bus Stations

As shown in the figure above, most of the existing bus routes have their bus stations in the Kathmandu City center area. Among the bus stops located in the city center, the major bus stations are Old Bus Park, Ratna Park, N.A.C., and Sahid Gate. Bus stations other than the Old Bus Park are located along the roadside of major streets in the city center, occupying road space.

Outside Kathmandu City center, there are two bus stations functioning as bus parks. One is Lagankhel, at the center of Lalitpur Municipality, and the other is Gongabun Bus Park (New Bus Park), located at the northern part of the Ring Road.

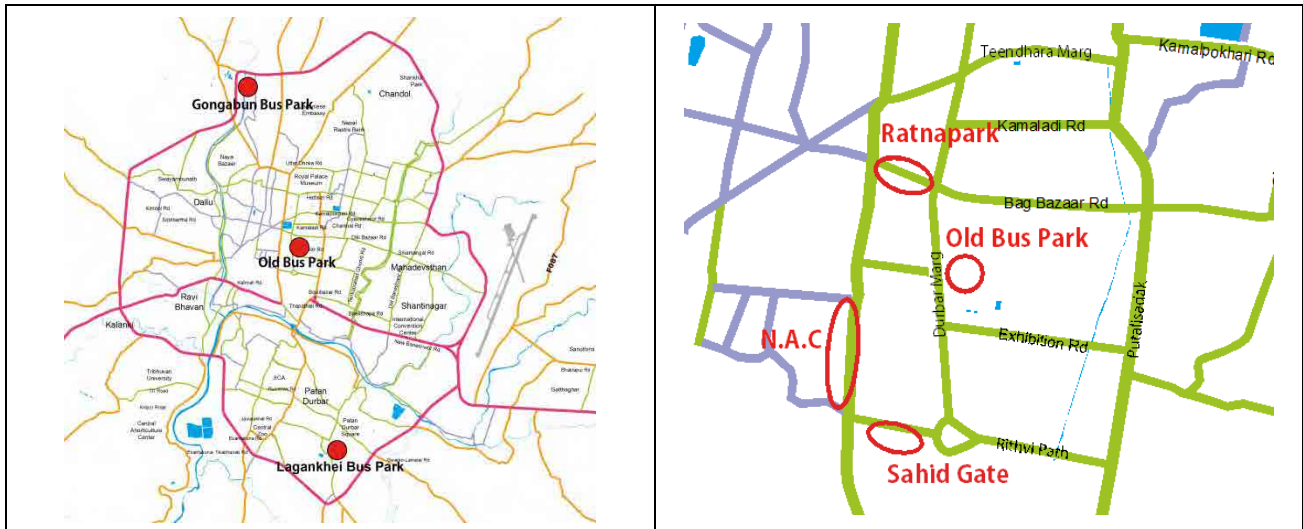


Figure 6.3.2 Major Bus Stations in Kathmandu City Center

Information on the number of operations at each bus station were obtained from the public transport firm interview survey and the bus count survey carried out by the Survey Team. The number of operations originating from those stations is shown in Table 6.3.2. The total number of operations starting from Kathmandu City center was around 12,900. Operations from Ratna Park and N.A.C. outnumbered the operations from Old Bus Park. The area of Old Bus Park is not adequate for managing all the buses coming into the city center area. Since bus stations other than Old Bus Park are located along the roadside of the trunk roads in the city center, buses are hampering the traffic.

Table 6.3.2 Bus Operations from Bus Stations

	Large Bus	Minibus	Micro Bus	Tempo	Total
Old Bus Park	110	1,115	1,086	0	2,311
Ratnapark	45	288	3,438	1,025	4,796
NAC	0	367	2,042	2,444	4,853
Sahidget	0	69	833	0	902
Kathmandu Center (total)	155	1,839	7,399	3,469	12,862
Lagankhel	80	1,324	2,584	1,200	5,144
Gongabun Bus Park	169	605	230	0	1,004

Remark: Data of Old Bus Park and Gongabun Bus Park are from the bus count survey. Other stations are from the public transport firm interview survey.
Source: JICA Survey Team

(2) Bus Operations at the Old Bus Park and Gongabun Bus Park

1) Number of Operations

Bus traffic survey was conducted at the Old Bus Park and Gongabun Bus Park for 24 hours on one workday and one holiday. The total numbers of departing buses at the Old Bus Park and Gongabun Bus Park on the workday were 2,311 and 1,004, respectively. According to the function of the bus parks, the number of large buses at Gongabun Bus Park exceeded the Old Bus Park. As compared with the survey on the holiday, the number of buses was almost the same at the Old Bus Park, while the number was less at the Gongabun Bus Park. The ratio of daily traffic to daytime traffic of large buses was 1.3 to 1.6 which was higher than minibuses and minibuses.

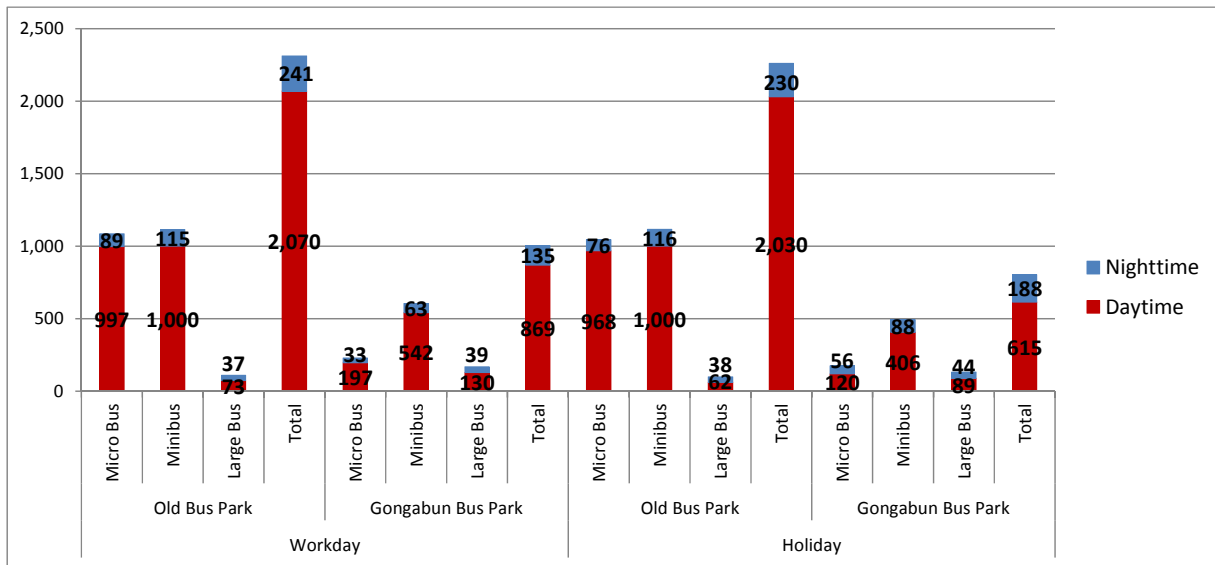
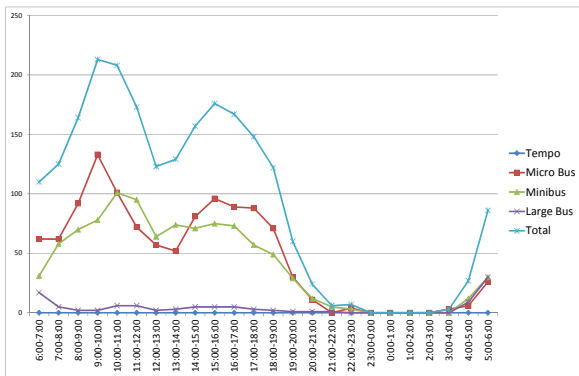


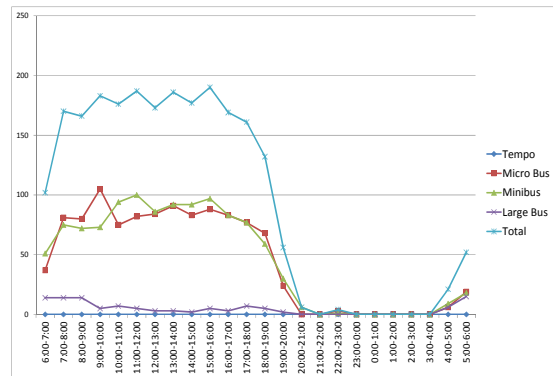
Figure 6.3.3 Total Number of Buses by Type at the Old Bus Park and Gongabun Bus Park (Departure)

2) Hourly Variation

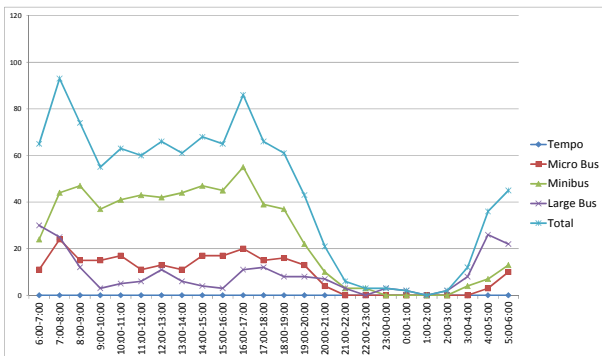
Figure 6.3.4 and Figure 6.3.5 show hourly variation of bus arrivals and departures at both bus parks. Most of bus arrivals and departures began at 4:00 and continued in 16 hours until 21:00. This trend is consistent in every type of bus.



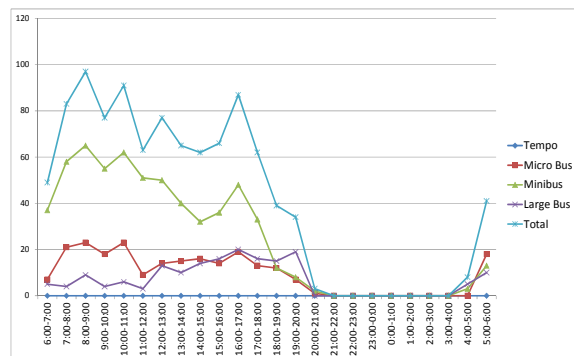
Old Bus Park Arrival (Workday)



Old Bus Park Departure (Workday)



Gongabun Bus Park Arrival (Workday)



Gongabun Bus Park Departure (Workday)

Figure 6.3.4 Hourly Bus Traffic Variation at Old Bus Park and Gongabun Bus Park (1)

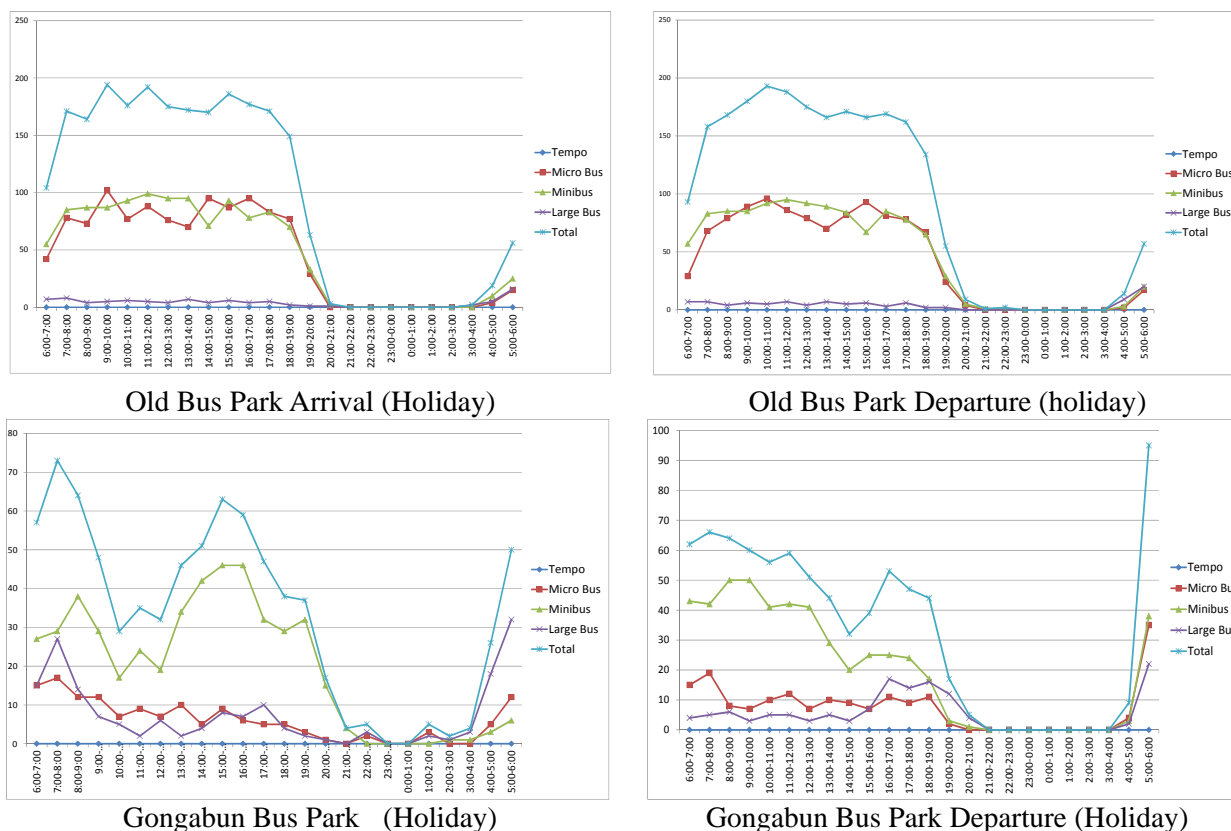


Figure 6.3.5 Hourly Bus Traffic Variation at the Old Bus Park and Gongabun Bus Park (2)

3) Average Number of Passengers

Bus OD interview survey included counting passengers in the bus. The results are shown in Table 6.3.3. It showed that the number of passengers in arriving buses was less than in departing buses.

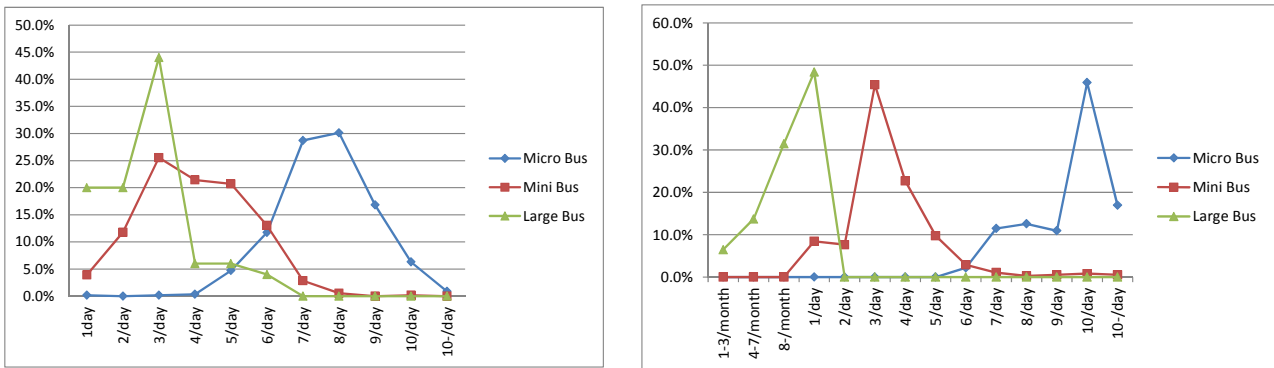
Table 6.3.3 Average Number of Passenger of Bus

		Microbus	Minibus	Large Bus
Old Bus Park	Arrival	7.3	12.3	18.4
	Departure	16.0	22.4	32.7
Gongabun Bus Park	Arrival	4.2	6.1	15.2
	Departure	6.2	8.9	30.5

Source: JICA Survey Team

4) Operation Frequency of Buses

Interviews with bus drivers were conducted to get information on operation frequency of buses. The maximum operation frequency was ten times a day, and the minimum was one to three times a month. Disposition of bus types is common in both bus parks, that is minibuses were the most frequent, followed by microbuses, and large buses were the least.



Old Bus Park

Gongabun Bus Park

Figure 6.3.6 Operation Frequency of Buses from the Old Bus Park and Gongabun Bus Park

6.3.3 Bus Passengers at the Old Bus Park and Gongabun Bus Park

(1) Number of Passengers

According to the average number of passengers, the total number of passengers from/to bus parks can be estimated. Around 88,000 passengers, which were 3.6% of the total population of the Kathmandu Valley, were assumed to pass the Old Bus Park as the bus park used on every workday.

Table 6.3.4 Number of Passengers to/from Bus Parks

		Microbus	Minibus	Large Bus	Total
Old Bus Park	Arrival	8,300	12,100	1,900	22,400
	Departure	17,400	25,000	3,600	46,000
Gongabun Bus Park	Arrival	1,000	3,700	3,300	8,000
	Departure	1,400	5,400	5,200	12,000

Source: JICA Survey Team

(2) Trip Purpose

Passenger interview survey was conducted to passengers departing from the Old Bus Park and Gongabun Bus Park. Interview items include personal information such as age, occupation, trip purpose, origin and destination, access mode, bus fare, etc.

The trip purpose of bus passengers is shown in Figure 6.3.7. At the Gongabun Bus Park, the percentage of “To Home” was larger because it included daily returns to home as well as returns to the countryside.

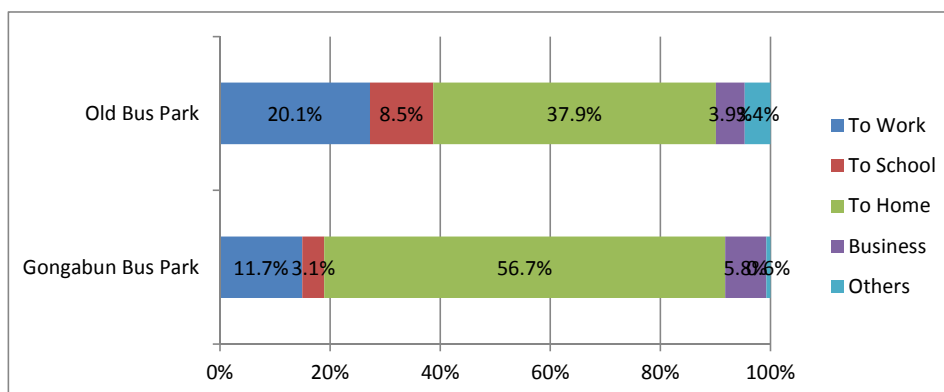


Figure 6.3.7 Trip Purpose of Passengers Departing from the Old Bus Park and Gongabun Bus Park

(3) Travel Time Frequency

Figure 6.3.8 shows the accumulated travel time frequency of passengers departing from the two bus parks. Fifty percent of passengers departing from the Old Bus Park completed their travel within 45 minutes. In contrast to Old Bus Park, 50% of passengers from the Gongabun Bus Park traveled for more than two hours.

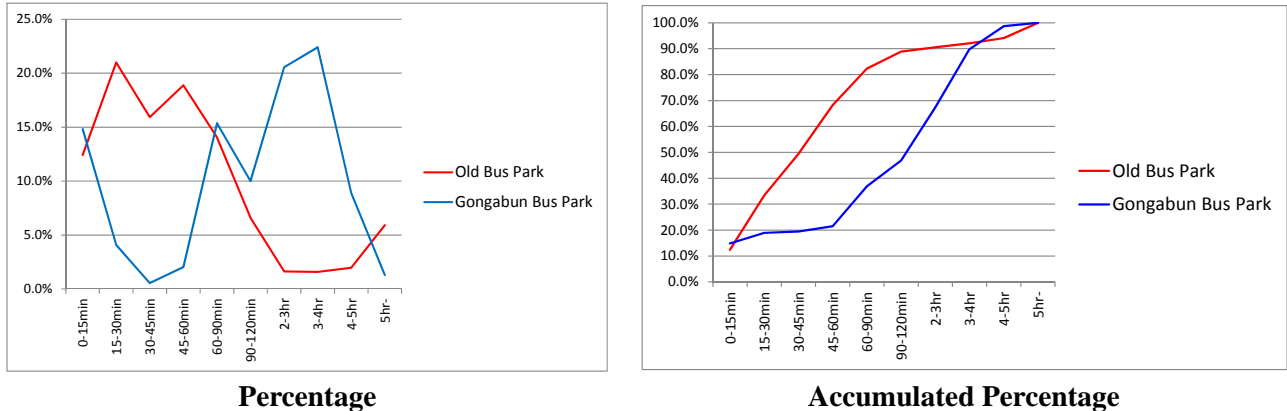


Figure 6.3.8 Travel Time Frequency of Passengers Departing from Old Bus Park and Gongabun Bus Park

(4) Access Mode to Bus Parks

The primary access mode to the Old Bus Park was by tempo, and 75% of passengers arrived by modes other than walking. Since the Old Bus Park served as the central terminal within the survey area, passengers accessing the Old Bus Park by walking were limited. According to the function of transfer station to all over the Nepal, the primary access modes to the Gongabun Bus Park were by tempo and minibus, and only 6% of access mode was by walking.

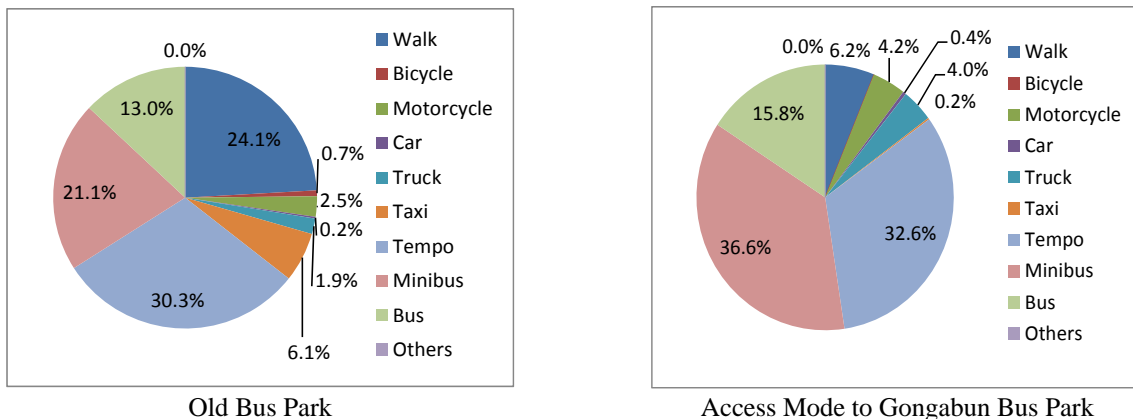


Figure 6.3.9 Access Mode to the Old Bus Park and Gongabun Bus Park

(5) Trip Frequency

Figure 6.3.10 shows that 86% of the passengers used bus more than once a day at the Old Bus Park. In contrast, 49% of passengers used bus a few times per year at the Gongabun Bus Park for travel to remote areas.

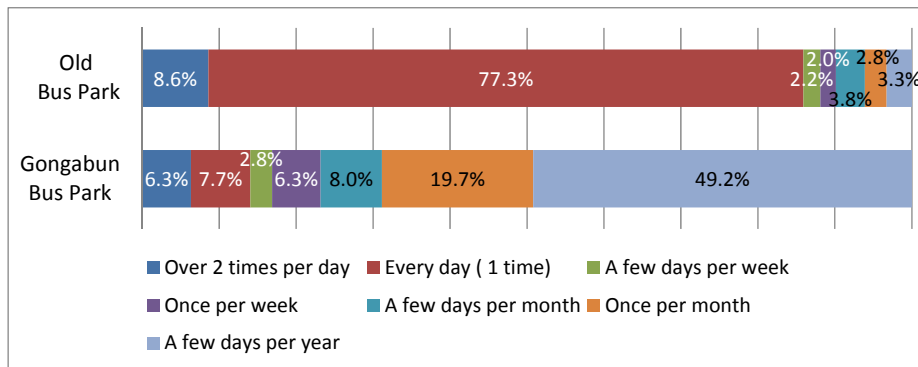


Figure 6.3.10 Trip Frequency of Passengers Departing from the Old Bus Park and Gongabun Bus Park

(6) Request on Bus Operations

The requirement for bus service improvement was questioned in the bus passenger interview survey. More than 50% of passengers at the Old Bus Park requested improvements on travel time and fare. Naturally, passengers at the Gongabun Bus Park requested improvements on safety and comfort for long trips.

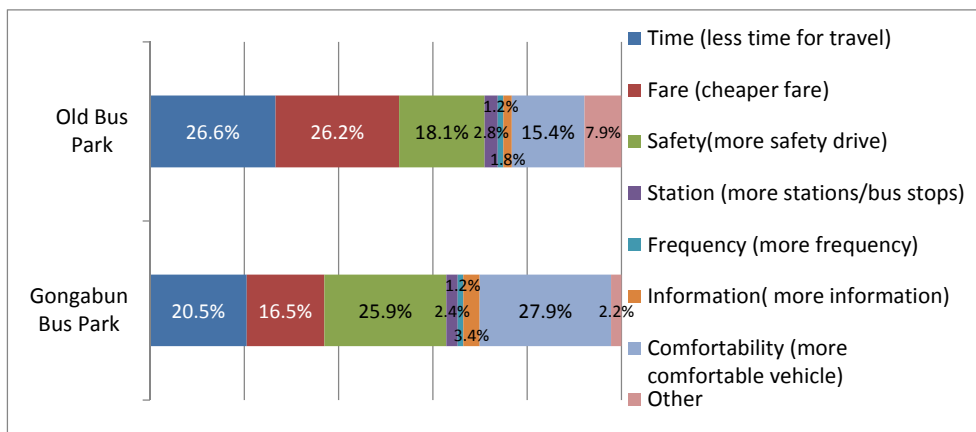


Figure 6.3.11 Requests on Bus Operations by Bus Passengers