CHAPTER 5

TRAFFIC SURVEY AND ANALYSIS

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5.1 TRAFFIC SURVEY

5.1.1 Outline of the Traffic Survey

In order to obtain the present traffic condition on the bridges of Pasig and Marikina Rivers, to calibrate Origin-Destination (OD) table and to forecast the future traffic demand, the traffic volume count survey on the bridges along Pasig and Marikina Rivers is conducted in the Study.

The survey is undertaken on the following 17 bridges on the both Rivers:

Along the Pasig River	Along the Marikina River
1. Delpan Bridge	1. Vargas Bridge
2. Jones Bridge	2. Rosario Bridge
3. Mac Arthur Bridge	3. Marcos Bridge
4. Quezon Bridge	4. Marikina Bridge
5. Ayala Bridge	5. San Jose Bridge
6. Nagtahan Bridge	
7. Pandacan Bridge	
8. Lambingan Bridge	
9. Makati-Mandaluyong	
10. Guadalupe Bridge	
11. C-5 Bridge	
12. Bambang Bridge	

The location map of the traffic survey is shown in **Figure 5.1.1-1.**

The traffic survey was conducted in the months of November and December 2002. The survey at each bridge was conducted for two (2) days:

- Weekday (anyday from Monday to Friday)
- Weekend (Sunday only)

The survey duration is 24 hours at every survey point

The vehicles are classified into seven (7) types and are shown as follows:

- Car/Taxi/Pick Up/Van Jeepney
- Large Bus
- Truck 2-3 axle
- Truck 4 and more axle
- Tricycle
- Motorcycle

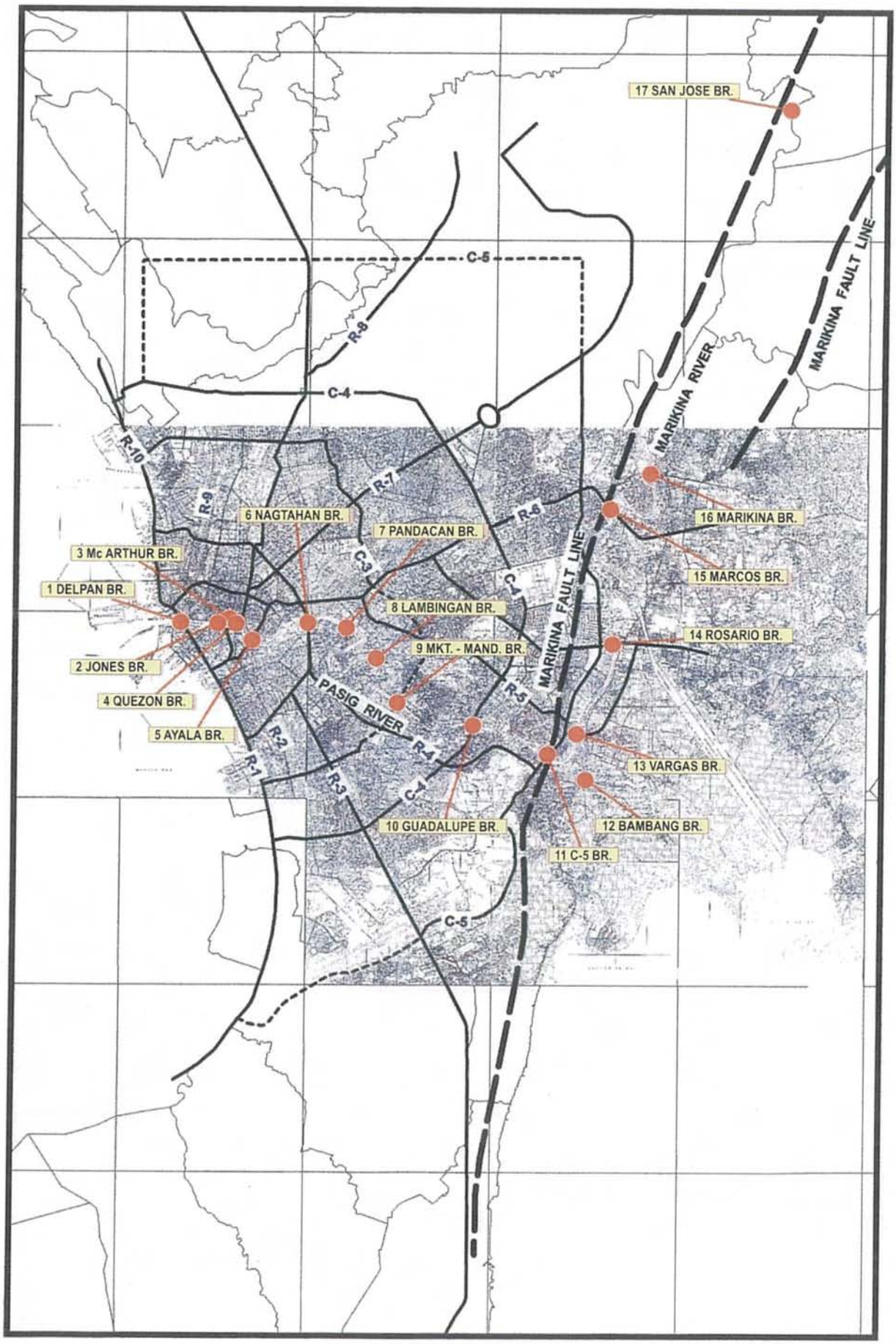


Figure 5. 1.1-1 Location Map of Traffic Survey

5.1.2 Results of Traffic Survey and Analysis

(1) Vehicular Traffic Volume

The results of the traffic survey are summarized in **Table 5.1.2-1** but the details in presented in **Appendix 5.1.2-1**. It is noted that the traffic survey is done only for 4-wheel vehicles because the 2-wheel vehicle traffic is relatively small.

Table 5.1.2-1 Traffic Volume on Bridges of Pasig and Marikina Rivers in 2002
(Results of Traffic Count Survey)

Unit: Vehicle / day

No.	Bridge Name	Counted Traffic Volume in 2002 (Weekday)					Counted Traffic Volume in 2002 (Weekend)				
		P. Car	Jeepney	Bus	Truck	Total	P. Car	Jeepney	Bus	Truck	Total
Pasig River											
1	Delpan Bridge	44,721	4,320	164	11,600	60,865	37,207	2,825	68	3,395	43,495
2	Jones Bridge	40,910	9,060	133	745	50,848	42,324	9,425	246	468	52,463
3	Mc Arthur Bridge	21,799	14,505	1,132	227	37,663	20,894	14,264	970	178	36,306
4	Quezon Bridge	47,934	21,279	1,880	2,004	73,097	41,136	22,106	880	1,000	65,122
5	Ayala Bridge	36,573	1,249	854	1,501	40,177	30,493	638	589	689	32,409
6	Nagtahan Bridge	70,482	2,745	394	7,942	81,535	60,365	2,030	290	3,632	66,317
7	Pandacan Bridge (New)	19,446	0	366	860	20,328	12,787	3	4	237	13,301
8	Lambingan Bridge	22,087	6,268	22	1,240	29,616	16,395	6,703	4	412	23,514
9	Makati-Mandaluyong	44,062	0	21	1,970	46,018	26,643	4	37	337	27,021
10	Guadalupe Bridge	162,874	0	49	2,970	181,297	123,072	0	15,138	2,351	140,561
11	C-5 Bridge	85,838	0	24	9,631	95,863	57,016	0	281	6,033	63,330
12	Bambang Bridge	6,214	8,817	15,453	509	15,564	6,482	9,397	3	308	16,190
Total		602,940	68,243	20,492	41,196	732,871	474,814	67,395	18,510	19,040	579,759
Marikina River											
13	Vargas Bridge	32,063	12,954	48	2,830	47,895	27,644	11,419	11	615	39,689
14	Rosario Bridge	54,121	11,893	1,788	7,850	75,652	48,758	12,878	1,751	2,716	66,103
15	Marcos Bridge	52,778	8,960	383	4,812	66,933	57,094	10,903	302	4,698	69,997
16	Marikina Bridge	35,926	9,783	424	1,226	47,359	36,335	10,894	407	883	48,519
17	San Jose Bridge	3,446	635	12	1,269	5,362	3,848	676	0	519	5,043
Total		178,334	44,225	2,655	17,987	243,201	173,679	46,770	2,471	6,431	229,351
GRAND TOTAL		781,274	112,468	23,147	59,183	976,072	648,493	114,165	20,981	25,471	809,110

The following observations can be deduced from the traffic survey data;

- Guadalupe Bridge has the heaviest traffic volume among 17 bridges of Pasig and Marikina Rivers with 181,300 vehicles during weekdays and 140,000 vehicles during weekends,
- Following Guadalupe Bridge, C-5 Bridge and Nagtahan (C-2) Bridge have the second and third heaviest traffic volume,
- As for the Marikina River, Rosario Bridge has the heaviest traffic volume among five (5) other bridges, and

- On the overall, the traffic volume on weekdays is about 20% larger than that on weekends (Sunday). Only three (3) bridges have traffic volumes greater during weekends than weekdays, namely Jones Bridge, Marcos Bridge and Marikina Bridge.

(2) Passenger Car Unit (PCU) Conversion

On the basis of results of traffic survey, the Average Annual Daily Traffic (AADT) volume was calculated by the following formula:

$$ADDT = \frac{(5\ days\ x\ WDDT + 1.1\ x\ WEDT^1 + 1.0\ WEDT^2)}{7}$$

Where: ADDT : Annual Average Daily Traffic Volume

WDDT : Daily Traffic Volume at Weekday

$WDDT^1$: Daily Traffic Volume at Weekend (Saturday)

WEDT2 : Daily Traffic Volume at Weekend (Sunday)

The estimated ADDT was converted to Passenger Car Unit (PCU) by the following conversion factor.

Car : 1.00	Jeepney : 1.5
Bus : 2.00	Truck : 2.0

The estimated ADDT in terms of PCU is shown in **Table 5.1.2-2.**

Table 5.1.2-2 Average Annual Daily Traffic (AADT) Volume on Bridges of Pasig and Marikina Rivers in 2002

Unit: PCU / day

No.	Bridge Name	Annual Average Daily Traffic (unit: PCU)				
		P. Car	Jeepney	Bus	Truck	Total
Pasig River						
1	Delpan Bridge	43,106	5,900	276	14,021	63,303
2	Jones Bridge	41,919	13,949	338	1,010	57,216
3	Mc Arthur Bridge	21,839	21,960	2,200	324	46,323
4	Quezon Bridge	46,579	32,747	3,214	2,597	85,137
5	Ayala Bridge	35,271	1,626	1,574	1,919	40,390
6	Nagtahan Bridge	68,454	3,855	696	10,143	83,148
7	Pandacan Bridge (New)	17,726	2	34	1,028	18,790
8	Lambingan Bridge	20,695	9,732	32	1,514	31,973
9	Makati-Mandaluyong Bridge	39,466	2	92	2,195	41,755
10	Guadalupe Bridge	153,260	0	31,158	4,241	188,659
11	C-5 Bridge	78,418	0	732	13,034	92,184
12	Bambang Bridge	6,383	13,676	36	684	20,779
	Sub-Total	573,116	103,449	40,382	52,710	769,657
Marikina River						
13	Vargas Bridge	31,195	19,019	76	3,309	53,599
14	Rosario Bridge	53,285	18,537	3,604	9,633	85,059
15	Marcos Bridge	54,827	14,507	728	5,921	75,983
16	Marikina Bridge	36,562	15,384	850	1,712	54,508
17	San Jose Bridge	3,616	984	18	1,593	6,211
	Sub-Total	179,485	68,431	5276	22,168	275,360
	Grand Total	**752,601**	**171,880**	**45,658**	**74,878**	**1,045,017**

(3) Vehicle Composition

Figure 5.1.2-1 illustrates the vehicle composition of major bridges. From this figure, the following are taken as the various functions of the bridges:

- Delpan Bridge has a largest share of truck traffic with 17% of the truck trip share,
- Quezon and Vargas Bridge have large shares of jeepney traffic with jeepney trips of 30% and 27% respectively, and

  Guadalupe Bridge has a large share of bus traffic at 9% bus trip but without jeepney traffic due to restriction of jeepney traffic.

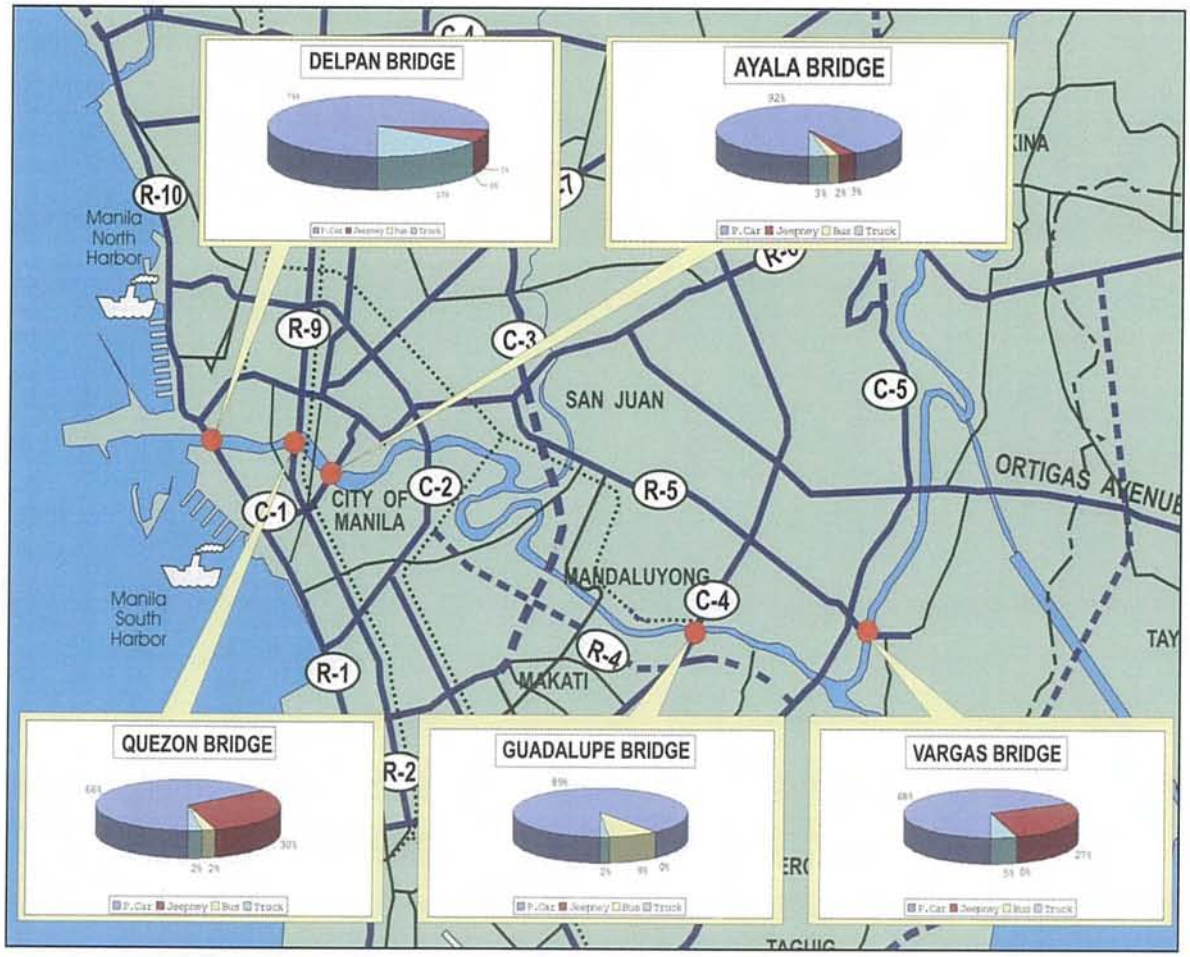


Figure 5.1.2-1 Vehicle Composition of Major Bridges

(4) Hourly Variation

Figure 5.1.2-2 and **5.1.2-3** present the hourly variation of traffic volume of Ayala and Guadalupe Bridges, respectively. From these figures, the following observations can be made:

- On weekdays, the peak hour of Ayala Bridge occurred in the afternoon between 13:00 and 14:00 with a rate was of about 8.5% total traffic volume. On weekends, the peak hour occurred in the afternoon between 15:00 and 16:00 with a rate of about 8.3% of the total traffic volume.

- However, Guadalupe Bridge, has a peak hour of Direction 2 (from Ortigas to Makati City) occurring in the morning between 8:00 to 9:00 with a rateof about 7.0%. However, there is no obvious peak hour of Direction 1 (from Makati City to Ortigas) recorded.

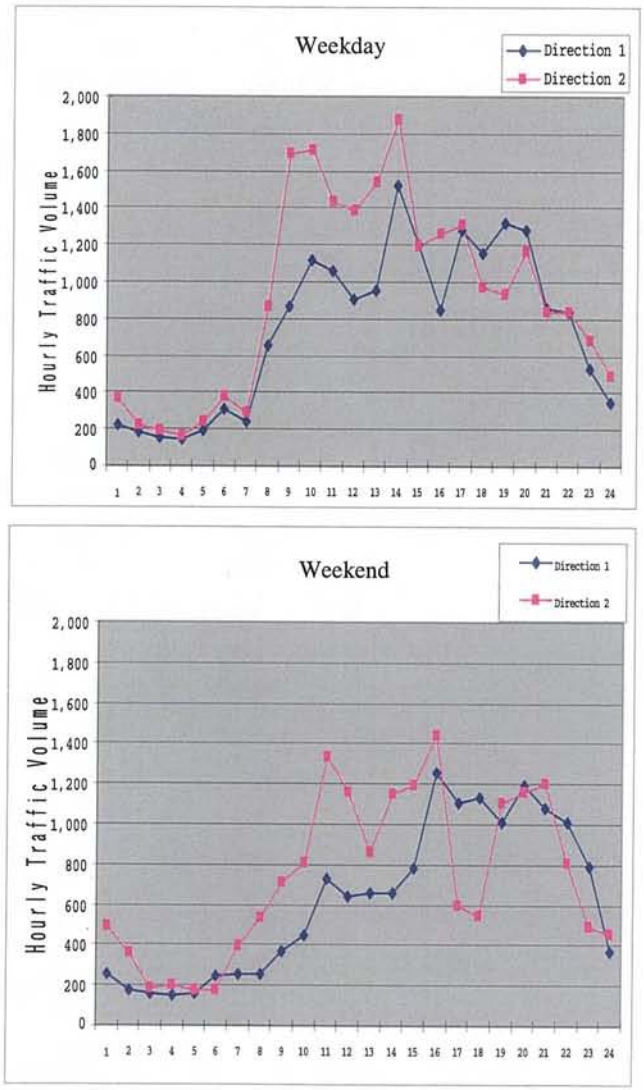


Figure 5.1.2-2 Hourly Variation of Traffic Volume on Ayala Bridge

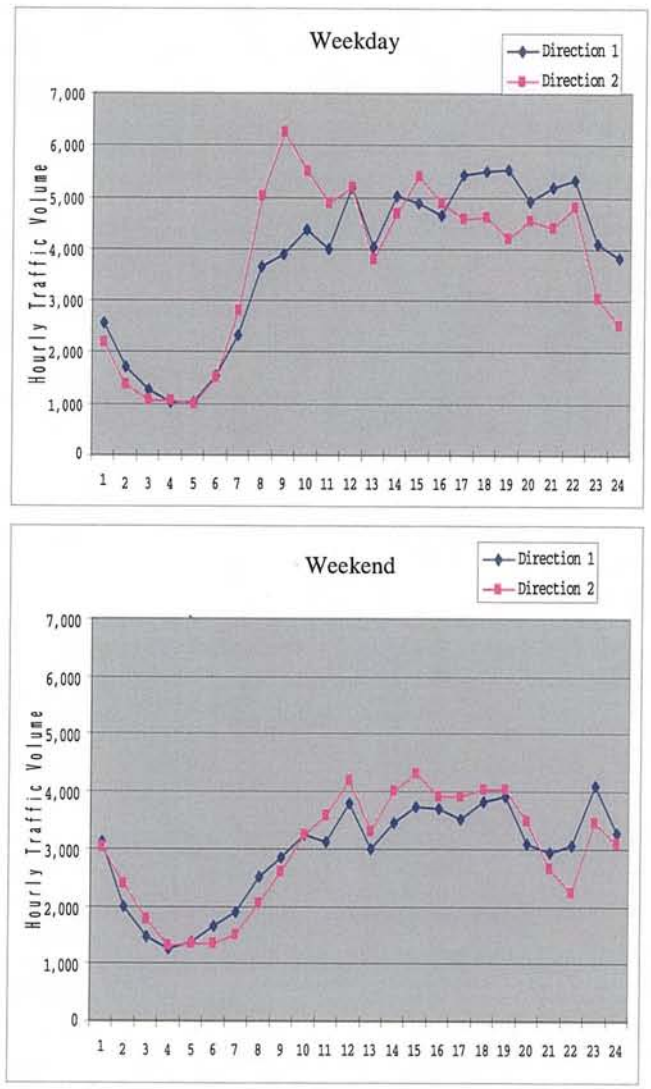


Figure 5.1.2-3 Hourly Traffic Volume on Guadalupe Bridge

5.2 FUTURE TRAFFIC DEMAND

5.2.1 Calibration of OD Traffic Volume

In order to update the vehicular OD Matrix previously prepared by the MMUTIS, the following approach for the future traffic demand projection was employed:

Step 1: Conduct traffic survey on the seventeen (17) bridges of Pasig and Marikina Rivers.

Step 2: Calibrate vehicle OD matrix by types of vehicle in 2002.

Step 3: Forecast future vehicle OD matrix and traffic assignment to road network.

Step 4: Analyze Level of Service (LOS).

The detailed calibration procedure for traffic demand forecast is shown in **Figure 5.2.1-1.**

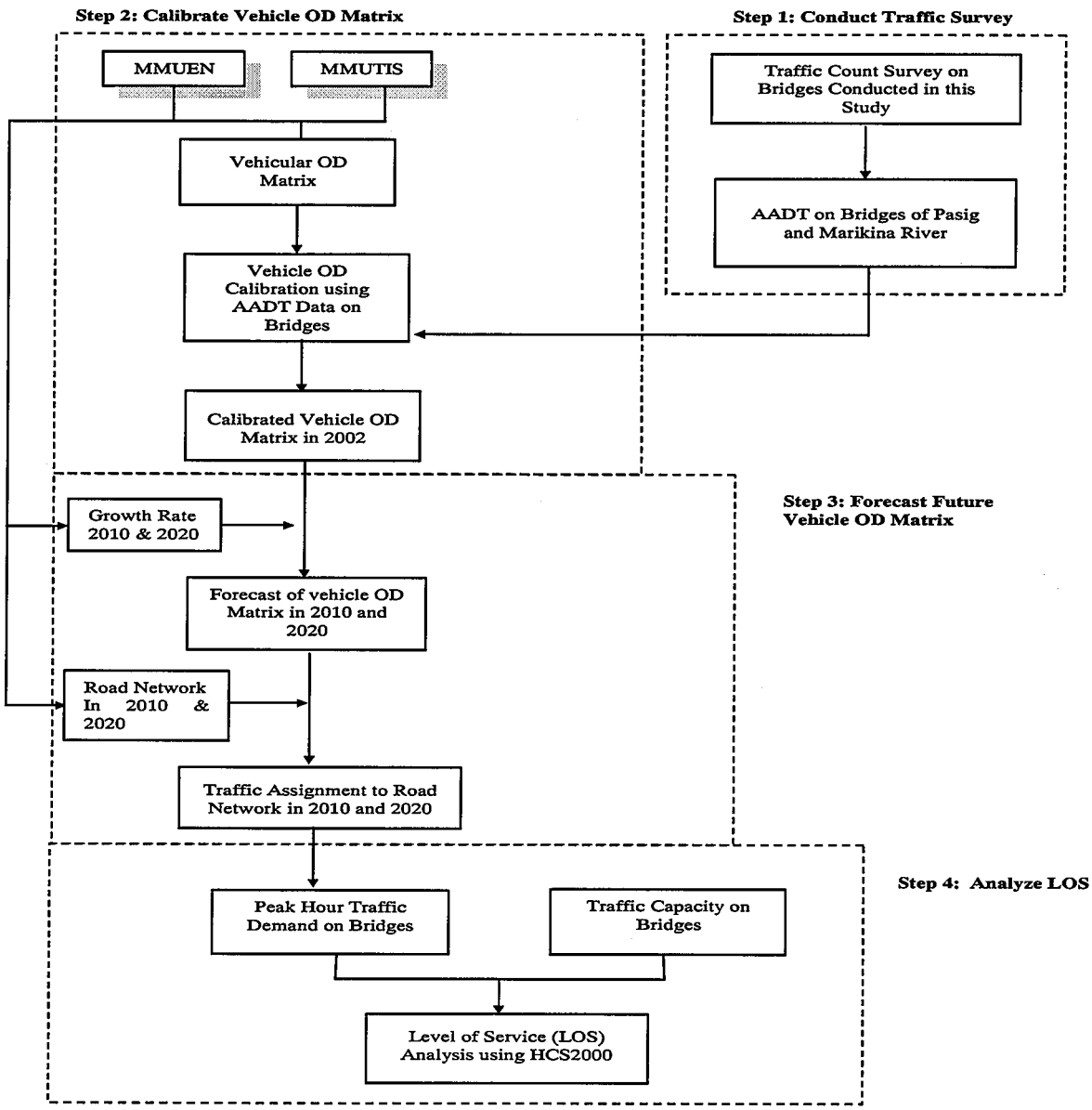


Figure 5.2.1-1 Calibration Process for Traffic Demand Forecast and Capacity Analysis

Following the procedure mentioned above, the traffic volumes on the bridges in Pasig and Marikina rivers are estimated using JICA Strada Model. The estimated traffic volumes are compared with actual counted traffic volume as shown in **Table 5.2.1-1**. According to this table, there are some difference between the actual and the estimated traffic volume. Such difference can be derived from the following reasons:

- Land use and urban developments in the northern and southern part as well as the eastern part and western part of Metro Manila Area (MMA) is not the same as the initial scenario drawn by MMUTIS.
- When the assigned traffic is adjusted, the traffic volume on Pasig / Marikina rivers compared well with the MMUTIS Study, but some biases remained in some areas.

The differences on the traffic volume between MMUTIS OD and actual count are shown in **Table 5.2.1-1**. These differences are adjusted for OD pairs and route / road points. After the adjustment, the final comparison between actual counted and estimated traffic volume is shown in **Table 5.2.1-1**. The difference, as presented in the table, can be seen to be within the acceptable level.

Table 5.2.1-1 Comparison between Observed and Assigned Traffic Volume in 2002

Unit PCU per day

		Actual Counted Traffic Volume 1) (a)	Traffic Assigned based on MMUTIS OD2) (b)	Ratio (a)//b)	Assigned Traffic Volume (200) based on Calibrated OD this Study (c)	Ratio (a)/(c)
Pasig River						
1	Delpan Bridge	63,303	70,791	0.89	55,426	1.14
2	Jones Bridge	57,216	36,266	1.58	32,637	1.75
3	Mc Arthur Bridge	46,323	22,837	2.03	45,307	1.02
4	Quezon Bridge	85,137	34,904	2.44	87,234	0.98
5	Ayala Bridge	40,390	50,290	0.80	41,733	0.97
6	Nagtahan Bridge	83,148	62,798	1.32	60,968	1.36
7	Pandacan Bridge (New)	18,790	22,916	0.82	52,165	0.36
8	Lambingan Bridge	31,973	7,236	4.42	23,703	1.35
9	Makati-Mandaluyong	41,755	18,016	2.32	30,578	1.37
10	Guadalupe Bridge	188,659	167,599	1.13	159,194	1.19
11	C-5 Bridge	92,184	76,645	1.20	94,704	0.97
12	Bambang Bridge	20,779	24,086	0.86	47,683	0.44
	Total	769,657	594,384	1.29	731,332	1.05
Marikina River						
13	Vargas Bridge	53,599	22,677	2.36	59,578	0.90
14	Rosario Bridge	85,059	114,222	0.74	80,561	1.06
14	Marcos Bridge	75,983	55,178	1.38	76,314	1.00
16	Marikina Bridge	54,508	39,796	1.37	65,688	0.83
17	San Jose Bridge	6,211	13,520	0.46	4,480	1.39
	Total	275,360	245,393	1.12	286,621	0.96
	GRAND TOTAL	**1,045,017**	**839,777**	**1.24**	**1,017,953**	**1.03**

Notes: 1) Traffic count survey conducted in this Study
2) Traffic assignment using MMUTIS OD
3) Traffic assignment using calibrated OD table made in this Study

5.2.2 Future Vehicle OD Matrix

Based on the calibrated OD traffic volume in 2002, the future OD traffic volume is estimated using the growth rate method of the following formula:

$X_{ij}^{T} = X_{ij} * G_i^{T} / G_i$

Where: X_{ij}^{T} : OD traffic volume in year T

X_{ij} : Present OD traffic volume

G_i^{T} / G_i : Growth rate of vehicle traffic in zone I

In the above formula, the growth rate (G_i^{T} / G_i) of the zone between 2002, 2010 and 2015 is employed similar to that in the MMUTIS study.

Future OD traffic volume is forecasted using the followings:

- Years to be forecasted:
  - 2010
  - 2015

  The vehicle OD matrix in 2020 is estimated using extrapolation method of the OD matrices of 2010 and 2015

- Vehicle Type:

  The 4 types of vehicle traffic are converted into Passenger Car Unit (PCU).

The OD traffic volume in 2002, 2010, 2015, and 2020 is shown in **Appendix 5.2.2-1**.

5.2.3 Traffic Assignment to Road Network

(1) Traffic Assignment Model

The traffic assignment to road network is made using STRADA highway-type incremental assignment model. The traffic assignment can be calculated by the following traffic assignment step. (See **Figure 5.2.3-1**).

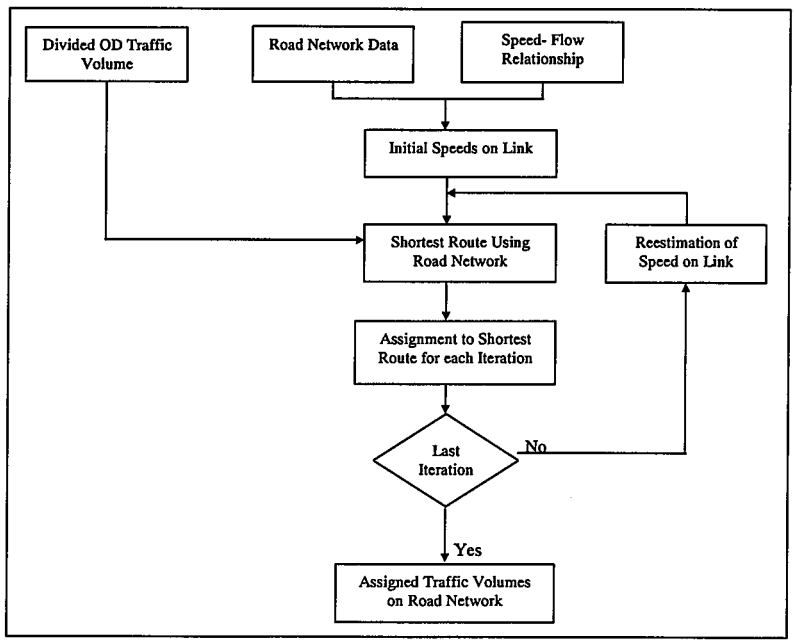


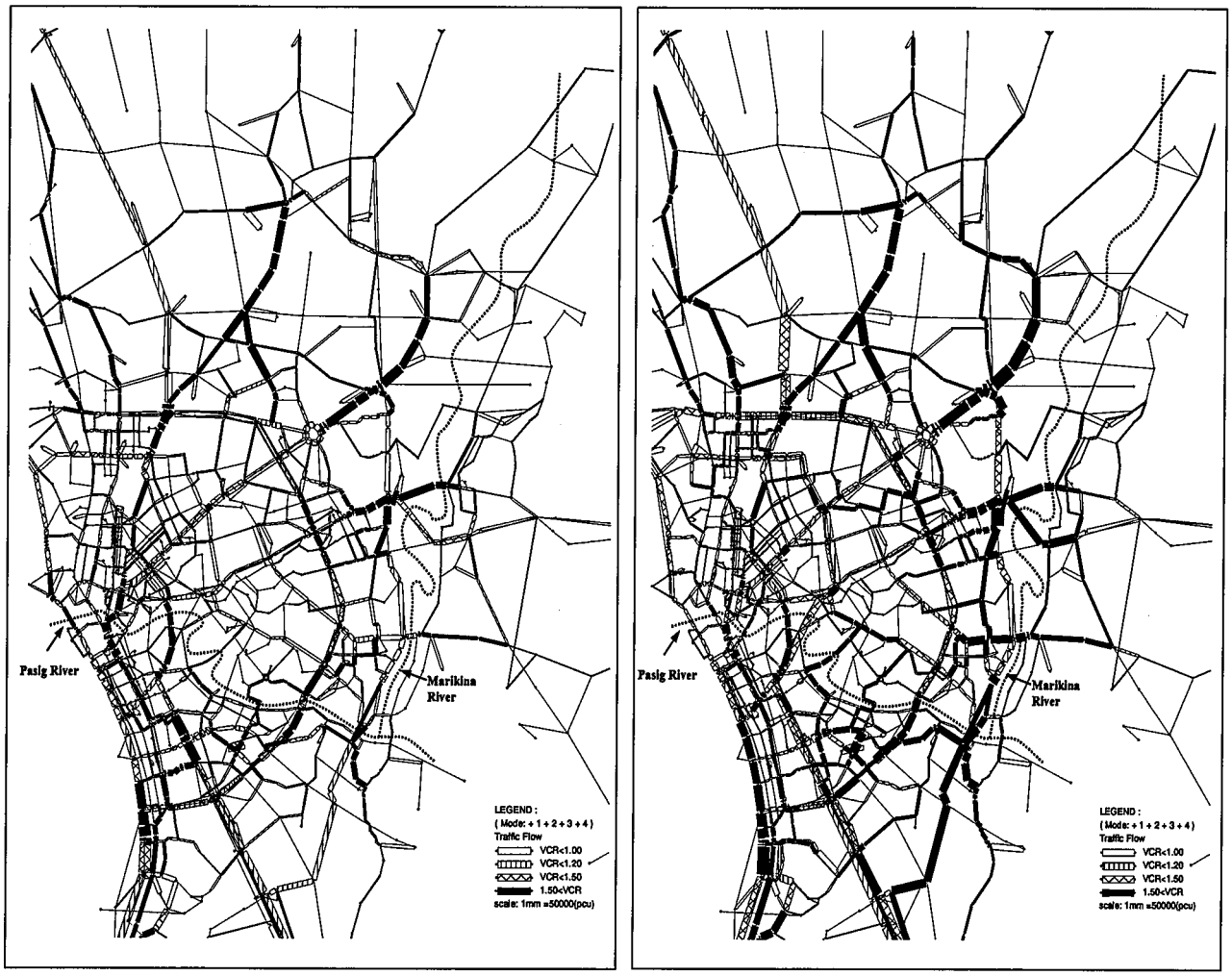
Figure 5.2.3-1 Traffic Assignment Method

(2) Road Network Conditions

The MMUTIS Study has developed a plan for road development for 2015 and is the only road network master plan that obtained the consensus of the relevant government agencies. In under this condition, this study principally adopts the MMUTIS road network for the year 2020.

(3) Results of Traffic Assignment

Figure 5.2.3-2 shows the forecasted traffic volume of the road network in 2010 and 2020.



YEAR 2010 **YEAR 2020**

Figure 5.2.3-2 Forecasted Traffic Volume and Congestion of Road Network

Table 5.2.3-1 presents the estimated traffic volume on bridges of Pasig River and Marikina River and **Figure 5.2.3-3** shows the estimated traffic volume on major bridges

Table 5.2.3-1 Estimated Traffic Volume on Bridges of Pasig River and Marikina Rvier

		2002	2010	2020
Pasig River				
1	Delpan Bridge	63,303	74,500	86,700
2	Jones Bridge	57,216	61,700	67,000
3	Mc Arthur Bridge	46,323	61,000	86,600
4	Quezon Bridge	85,137	88,000	94,800
5	Ayala Bridge	40,390	47,100	70,900
6	Nagtahan Bridge	83,148	111,000	117,300
7	Pandacan Bridge	18,790	27,300	39,000
8	Lambingan Bridge	31,973	41,000	85,900
9	Makati-Mandaluyong Bridge	41,755	57,600	73,700
10	Guadalupe Bridge	188,659	232,000	241,100
11	C-5 Bridge	92,184	98,900	129,400
12	Bambang Bridge	20,779	40,000	59,200
	Total	769,657	940,100	1,151,600
Marikina River				
13	Vargas Bridge	53,599	54,700	60,200
14	Rosario Bridge	85,059	99,600	163,600
15	Marcos Bridge	75,983	95,600	145,000
16	Marikina Bridge	54,508	122,800	148,300
17	San Jose Bridge	6,211	15,800	38,400
	Total	275,360	388,500	555,500
	Grand Total	1,045,017	1,328,600	1,707,100

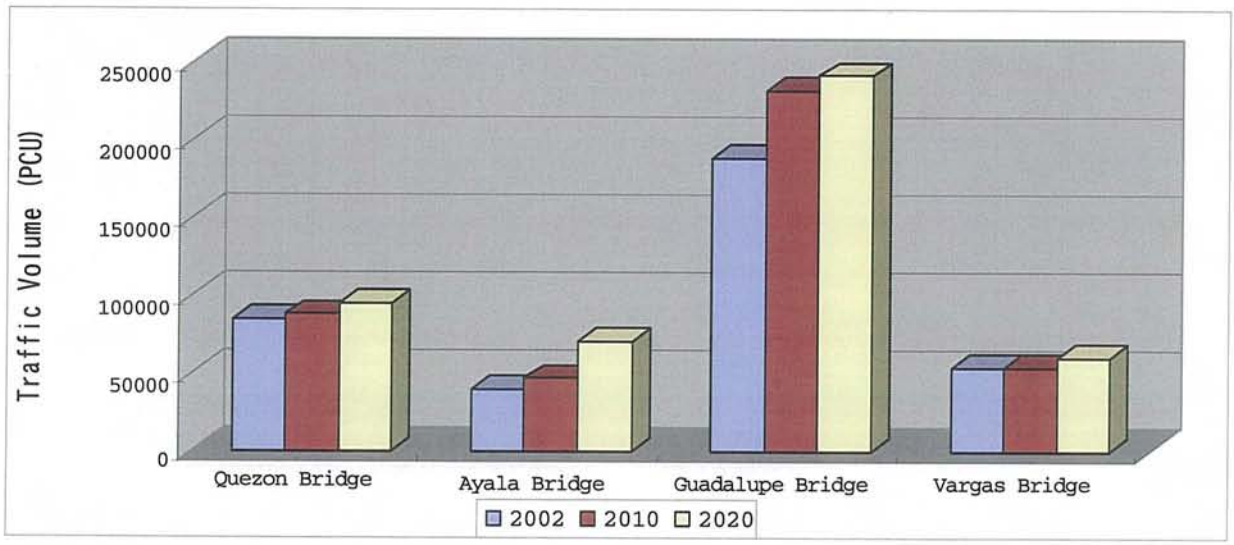


Figure 5.2.3-3 Estimated Traffic Volume on Major Bridges of Pasig River and Marikina River

5.3 ANALYSIS OF LEVEL OF SERVICE (LOS)

5.3.1 Method for Analysis of LOS

According to the Highway Capacity Manual, the traffic capacity is defined as "the maximum number of vehicles, which has a reasonable expectation of passing over a given section of a lane or roadway in one direction or in both directions during one hour".

Level of service (LOS) of the road and corresponding traffic flow situation and traffic volume / capacity ratio are taken as follows:

LOS Criteria Description (Volume / Capacity (v/c))

Level A: Free flow traffic, density less than 7 and v/c less than 0.26
B: Reasonably free flow traffic, density 7 -11 and v/c 0.27 – 0.41
C: Near free flow traffic, density 12 – 16 and v/c 0.41 – 0.59
D: Speeds begin to decline, density 17 -22 and v/c 0.60 – 0.81
E: Heavy Traffic, v/c 0.82 – 1.00
F: Saturation volume

Note: In case of free flow speed is taken as 70km/h

The level of service (LOS) of each bridge is calculated using the following steps:

Step 1: Computation of flow rate (V_p)
Step 2: Computation of heavy vehicle factor, recreational vehicle factor, etc.
Step 3: Calculation of V_p based on Step 1 & 2
Step 4: Calculation of LOS, density and flow rate (Vp)

The highway capacity manual developed software to compute the traffic capacity of the freeway or multilane highways. Based on the input data prepared from the field survey of 17 bridges on the Pasig and Marikina rivers, the traffic capacity is calculated using the Traffic Capacity Software 2000 (TCS 2000).

It is noted that traffic demand and congestion degree are computed assuming that there is no new bridge being constructed. It also noted that the LOS and V/C ratios are only indicated for the bridge sections, not shown are those for the homogeneous road sections.

5.3.2 Results of Analysis

Based on the hourly traffic capacity and the peak hour traffic volume, LOS, density and congestion degree (V/C) are calculated. The results of analysis are shown in **Figure 5.3.2-1**. From this figure, the following observations can be deduced:

- The traffic on the bridges on the major arterial roads such as Nagtahan, Guadalupe, C-5, Rosario, and Marcos Bridges are generally heavily traffic congested at present, so that the LOS of these bridges are either "E" or "F" which means almost saturated situation of traffic.

- As for the Ayala Bridge, the present LOS is calculated as "D" level which means just before saturation level. After a few years, the LOS of Ayala Bridge is expected to become "E" level and then "F" level.

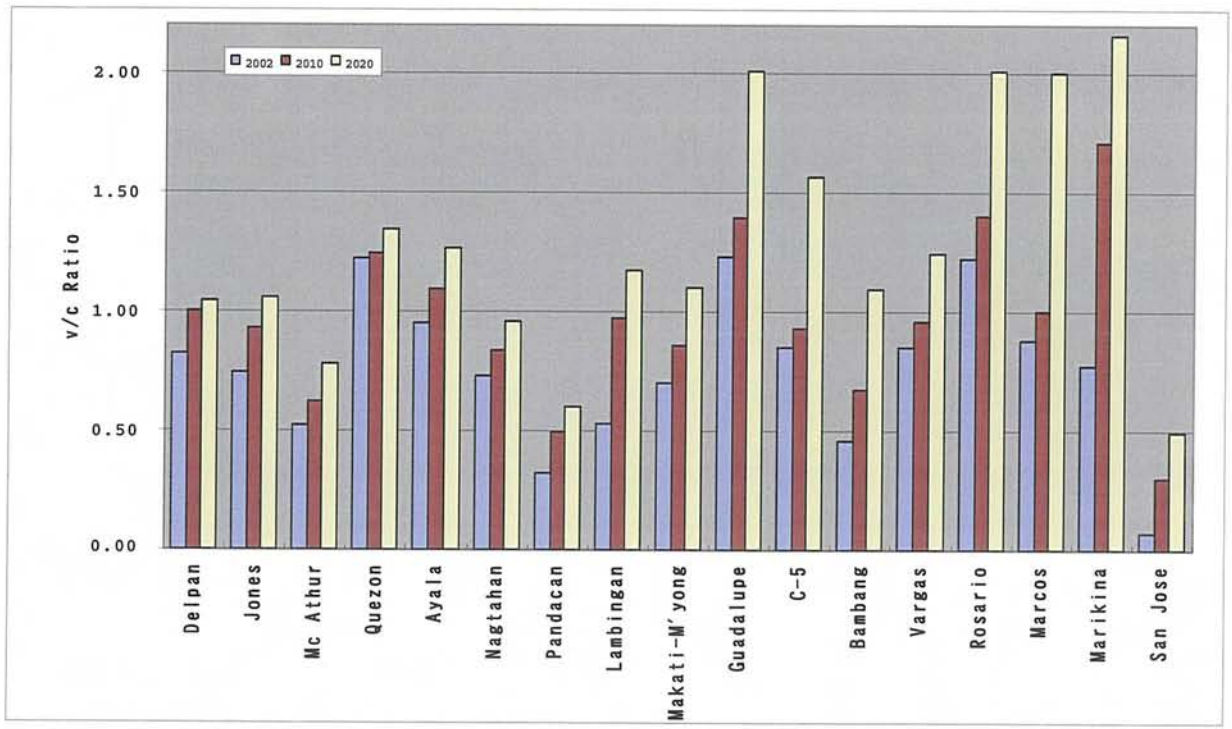


Figure 5.3.2-1 V/C Ratios for the Bridges under the Study

Table 5.3.2-1 shows Level of Service (LOS) and congestion degree. According to this table, the present LOS of all bridges along Pasig and Marikina Rivers is over level "C" of Pasig River and level "E" of Marikina River (except San Jose Bridge). It is expected to become level "F" by 2010. Judging from these table and figure, it is necessary to construct new bridges both on Pasig and Marikina Rivers by 2010.

Table 5.3.2-1 Future Traffic Congestion on Bridges Crossing Pasig and Marikina Rivers

No	Name of Bridges	LOS			Density (PC/km/ln)			Flow Rate Vp (PC/h/ln)			Congestion Degree		
		2002	2010	2020	2002	2010	2020	2002	2010	2020	2002	2010	2020
Pasig River													
1	Delpan Bridge	E	F	F	21	27	28	1,633	2,006	2,084	0.82	1.00	1.04
2	Jones Bridge	D	E	F	20	26	30	1,402	1,761	2,009	0.74	0.93	1.06
3	Mc Athur Bridge	C	D	D	14	17	21	987	1,169	1,486	0.52	0.62	0.78
4	Quezon Bridge	F	F	F	34	31	38	2,327	2,122	2,546	1.22	1.12	1.34
5	Ayala Bridge	D	E	F	17	20	30	1,213	1,616	2,028	0.85	0.71	1.39
6	Nagtahan Bridge	D	D	E	17	17	24	1,388	1,381	1,841	0.73	0.73	0.97
7	Pandacan Bridge	B	C	D	8	12	16	611	924	1,145	0.32	0.49	0.60
8	Lambingan Bridge	C	E	F	15	27	33	1,003	1,845	2,220	0.53	0.97	1.17
9	Makati-Mandaluyong Bridge	D	E	F	19	24	31	1,338	1,639	2,096	0.70	0.86	1.10
10	Guadalupe Bridge	F	F	F	33	38	54	2,332	2,652	3,812	1.23	1.40	2.01
11	C-5 Bridge	E	E	F	20	23	42	1,610	1,759	2,976	0.85	0.93	1.57
12	Bambang Bridge	C	D	F	13	19	31	1,461	2,102	3,439	0.46	0.67	1.09
Marikina River													
13	Vargas Bridge	E	E	F	23	27	35	1,614	1,832	2,364	0.85	0.96	1.24
14	Rosario Bridge	F	F	F	34	39	56	2,322	3,652	3,812	1.22	1.40	2.01
15	Marcos Bridge	E	E	F	25	28	56	1,761	1,992	3,997	0.88	1.00	2.00
16	Marikina Bridge	D	F	F	21	46	58	1,538	3,421	4,316	0.77	1.71	2.16
17	San Jose Bridge	A	A	C	6	7	12	129	569	931	0.06	0.28	0.47