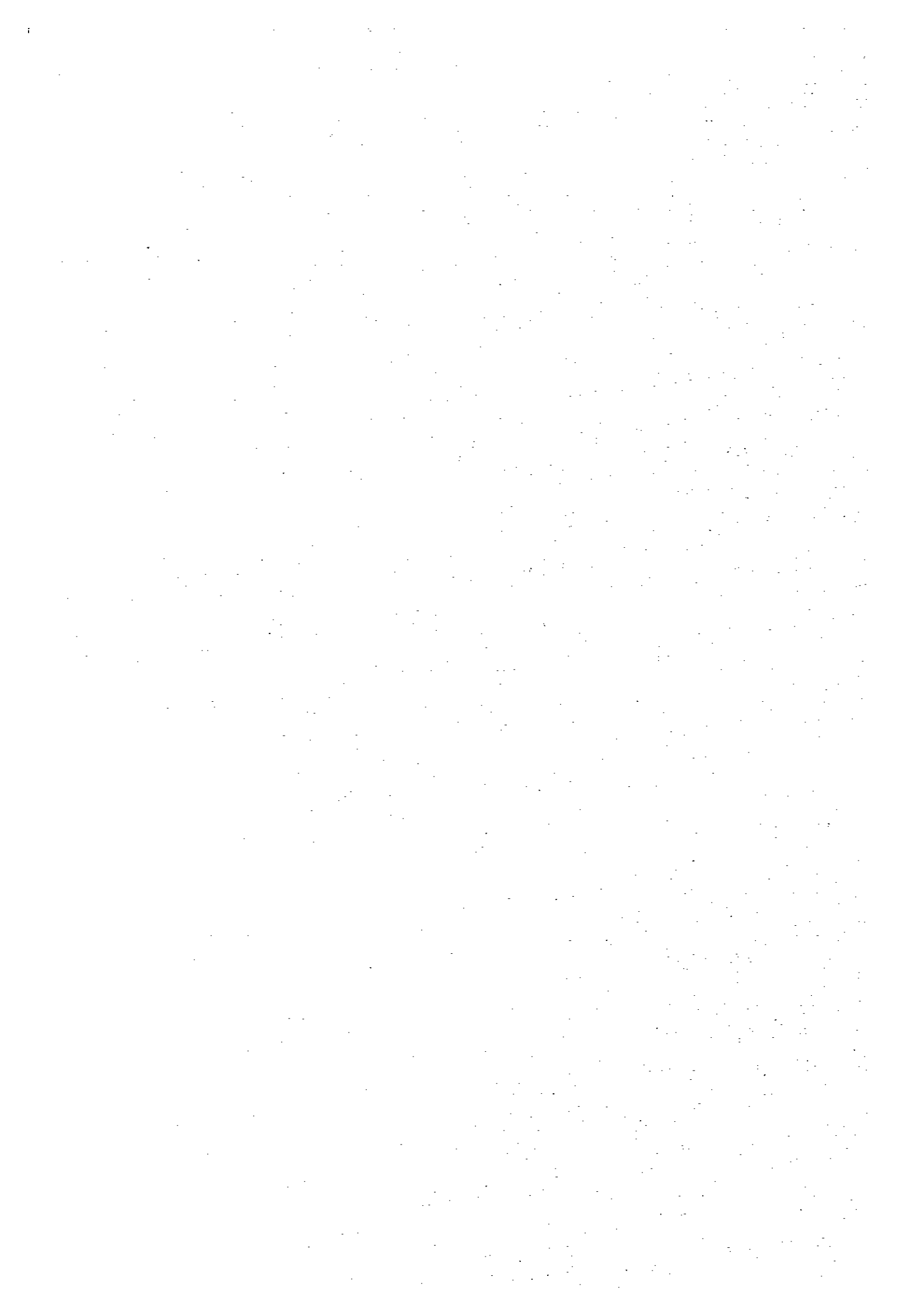


## **VIII CONCLUSION AND RECOMMENDATION**



## **VIII CONCLUSIONS AND RECOMMENDATIONS**

### **(1) Necessity of Improvement of Public Transport System**

Considering the present tendency where vehicle traffic volume is increasing day by day, if a policy for improvement of the public transport system in Guatemala Metropolitan Area is not introduced immediately, a serious situation will occur in the near future. Therefore the subject projects of the Study were examined and recommended.

### **(2) Economic Evaluation of the Whole Project Package**

Since the functions of the Projects are deeply related to each other, the examination of the whole project package should be considered first. The entire investment cost will be Q.1,331 million and the foreign currency portion will be 44% of the total amount. The economic internal rate of return (EIRR) of the whole project package shows a high return of 29%, and its net present value at a discount rate of 12% will be Q.770 million.

### **(3) Economic Evaluation by Project Category**

Using the economic rate of return as the economic evaluation indicator by categorized project package, 30% of the EIRR of public transport projects will be better than the 17% of road projects. The exclusive busway projects show a high return of 38%.

### **(4) Implementation Schedule of the Projects**

The order of the construction of the Projects was mainly decided by considering the relationship between the Projects. Also the result of economic evaluation of each project was considered in deciding the construction order. The construction of FEGUA Exclusive Busway and Avenida Petapa with high EIRR has priority. The construction of the Interregional Bus Terminals should logically be completed before the construction of the Urban Bus Center. Considering the importance and the urgency for improving traffic safety and environment, the Bus Inspection and Maintenance Center should be constructed at an early stage.

### **(5) Financial Resources of the Projects**

The principles to identify financial resources are public transport priority policy and beneficiaries pay policy. Therefore the introduction of a toll road system is recommended for the operation of newly constructed roads. Also some toll systems are recommended for the operation of the public transport facilities.

It is necessary to obtain foreign loans with favorable conditions for the foreign currency portion of the construction cost.

### **(6) Financial Evaluation of the Project Package**

The financial internal rate of return (FIRR) for East-West Corridor and Petapa Road is 8.4% using a toll rate of Q.3. The FIRR for Public Transport Facility projects is 6.4% in the case of Q.5 of bus transit tariff of the Exclusive Busway, Q.7.5 of use fee of the Urban Bus Center and Q.10 of use fee of the Inter-Regional Bus Terminals. Concerning the Bus Inspection and Maintenance Center, even if a tariff system is adopted, it is very difficult to recover the investment cost. Therefore, it is expected to raise a special fund or donation from foreign governments or non government organizations for the construction cost and a subsidy from the surcharge of the gasoline tax for the operation.

### **(7) Organization of Project Implementation**

The creation of a public corporation under the Municipality for the construction, operation and maintenance of the new roads is recommended.

For the Exclusive Busway, the Urban Bus Center and the Interregional Bus Terminal projects, the establishment of a mixed capital entity (third sector) is recommended.

The bus inspection and maintenance center shall be administered and operated directly by the municipality.

### **(8) Institutional Development**

The reform and development of laws and regulations are essential for the creation of new organizations, support of operation and obtaining of fund resources.

### **(9) Consideration for Environmental Betterment**

Comparing to the “without project” case, total vehicle operating distance and total vehicle operating hours will be reduced in the “with project” case. This means the reduction of vehicle generated pollution such as air pollution and noise.

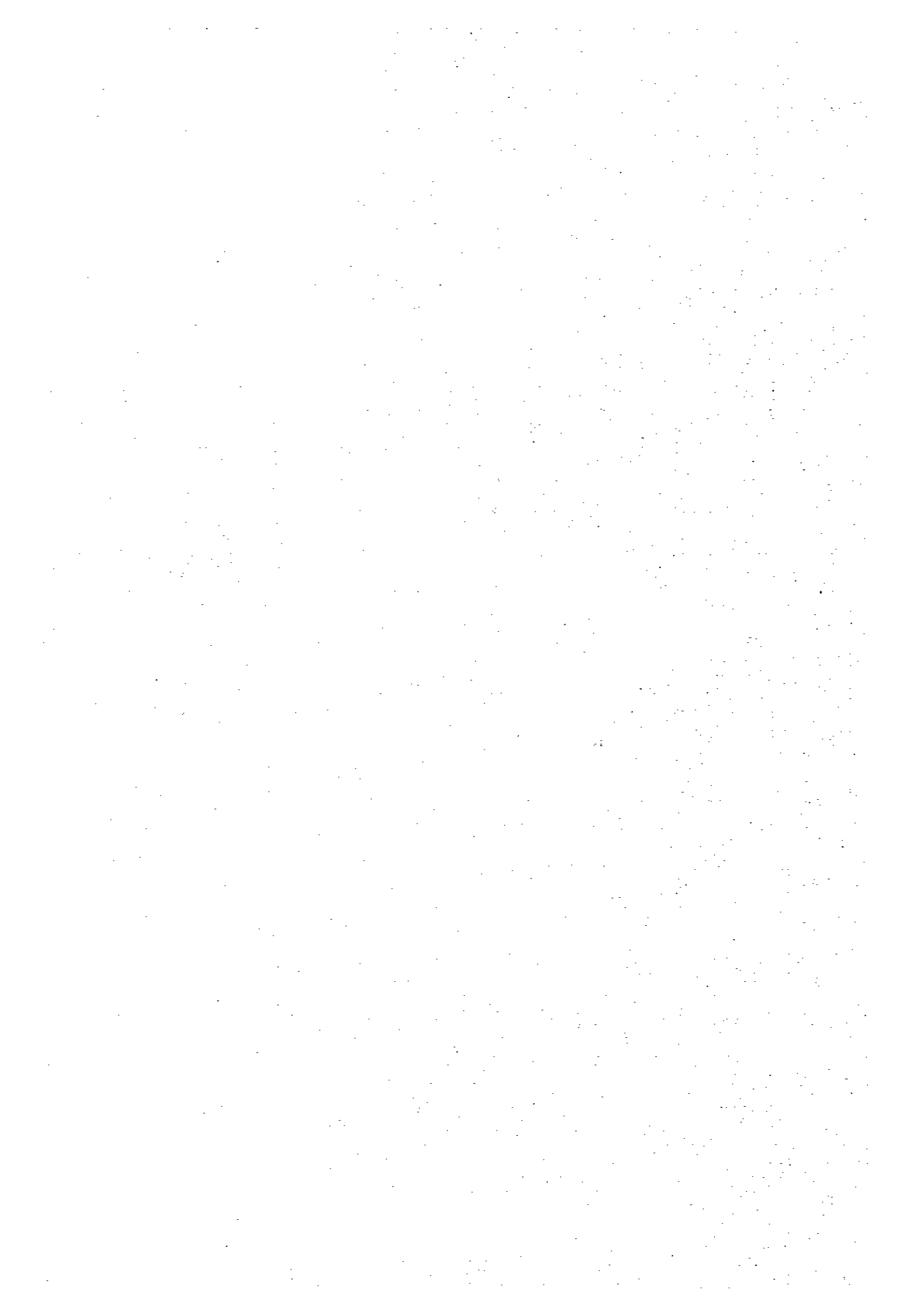
Further more, after the commencement of operations of Bus Inspection and Maintenance Center, total exhaust materials shall be reduced as a result of reduction in unit volume of pollution, therefore overall environment shall be improved finally.

### **(10) Further Study**

Further studies related to the Study are recommended as follows;

- ♦ Detailed design for the projects of which implementation is recommended at the early stages.
- ♦ Urban development study in the area where the development axis is the FEGUA exclusive busway.
- ♦ Urban environmental control study as the basis for a more integrated and developed center for the inspection of all types of vehicles.
- ♦ Studies related to the Master Plan such as traffic management plan, feasibility study on the middle and outer ring road, and urban planning study in northern and eastern part of the Metropolitan Area.

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### Annex 3. Abbreviations

AASHTO	: American Association of State Highway and Transportation Official
ANAM	: Asociación Nacional de Municipalidades
B/C	: benefit-cost ratio
BOD	: biochemical oxygen demand
BOT	: build, operate, and transfer
CACIF	: Committee of Agri-mining and Finance Association
CAMINOS	: General Bureau of Highway
CBD	: central business district
CBR	: California Bearing Ratio
CENMA	: Central de Mayoreo
CIF	: cost, insurance, and freight
CITES	: Convention on International Trade in Endangered Species of Wild Flora Fauna
CONAMA	: National Commission of Environment
CONAP	: National Council for Protected Areas
DAVHI	: Direction of Human Settlement and Housing
DIGEBOS	: General Direction of Forest and Wild Life
EAP	: economically active population
EIA	: environmental impact assessment
EIRR	: economic internal rate of return
FEQUA	: Guatemala Railway
FOB	: free on board
F/S	: feasibility study
GDP	: gross domestic product
GPS	: Global Position system
GRP	: gross regional products
HCM	: Highway Capacity Manual
INE	: National Institute of Statistics
IGGS	: Guatemala Institute of Social Insurance
IGM	: Military Geography Institute
IGN	: Ignition
IVA	: Value Added Tax
JICA	: Japan International Cooperation Agency
LOS	: Service Level of Road
MCTO	: Ministry of Communications, Transport and Public Works
M/P	: Master Plan
MTCP	: Ministry of Transportation, Communications and Public Works
NGO	: non government organization
NPV	: Net Present Value
OD	: origin-destination
PC	: prestressed concrete
PCU	: passenger car unit
PN	: Promissory Note
PWL	: power level of the noise
QV	: Quod Vide

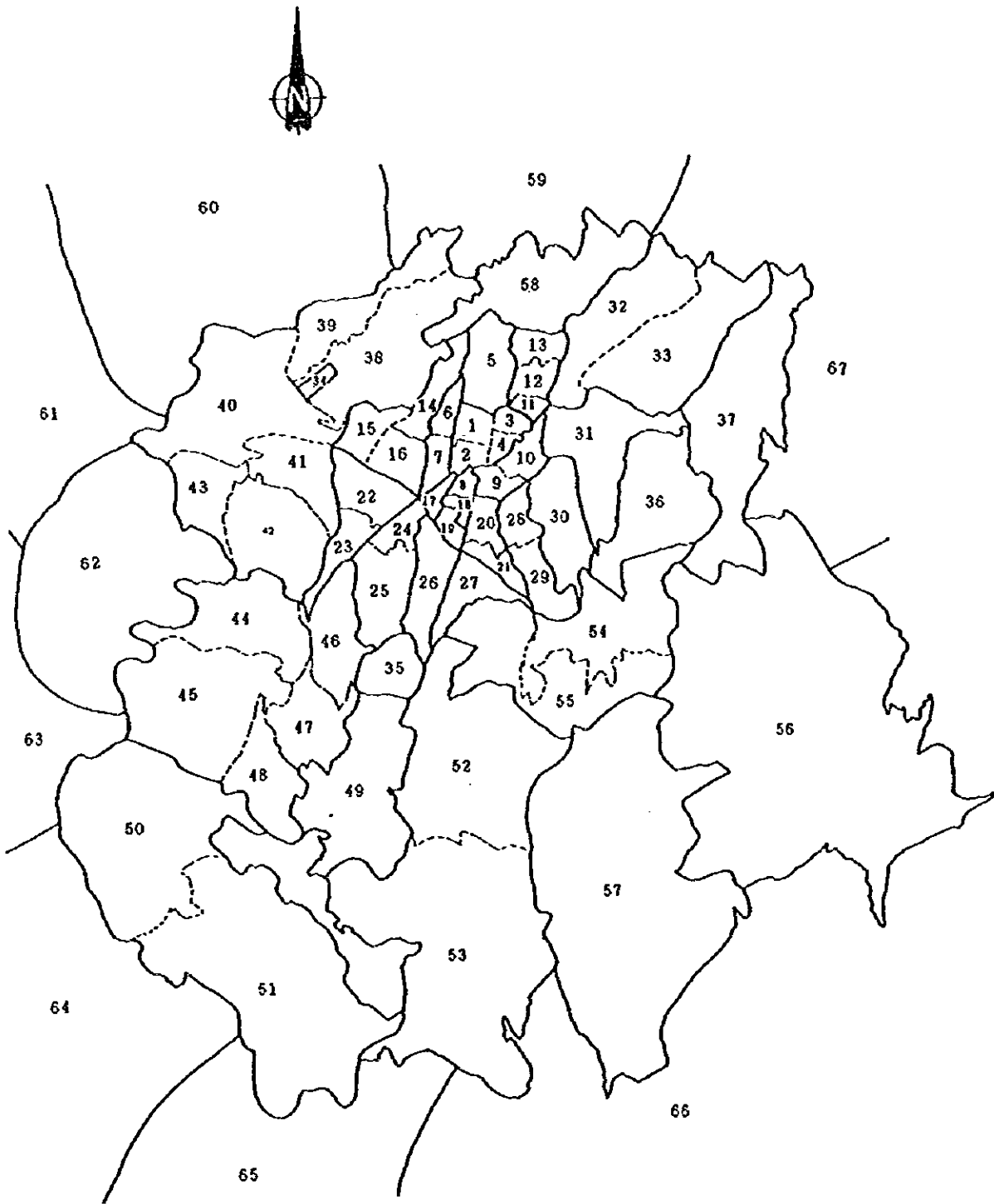


<b>SEGEPLAN</b>	<b>: General Secretariat of National Council of Economic Planning</b>
<b>SPM</b>	<b>: suspended particulate matter</b>
<b>STA</b>	<b>: station</b>
<b>T/R</b>	<b>: terms of reference</b>
<b>TT</b>	<b>: travel time</b>
<b>UBC</b>	<b>: Uniform Building Code</b>
<b>USAC</b>	<b>: San Carlos University</b>
<b>V/D</b>	<b>: venereal disease</b>
<b>VIVIENDA</b>	<b>: Vice-Ministry of Housing</b>
<b>VOC</b>	<b>: vehicle operation costs</b>
<b>WHO</b>	<b>: World Health Organization</b>

Annex 4. OD tables

Zone Reference Table

Traffic Zone for Demand Forecast	Zone Type		Integrated Zone for Land Use
		Postal Zone (Zona/ Municipality)	
1		1	1
2			1
3			1
4			1
5		2	1
6		3	1
7			1
8		4	1
9		5	1
10			1
11		6	1
12			1
13			1
14		7	1
15			1
16			1
17		8	1
18		9	1
19			1
20		10	1
21			1
22		11	1
23			1
24		12	1
25			1
26		13	1
27		14	1
28		15	1
29			1
30		16	2
31		17	2
32		18	2
33			2
34		19	3
35		21	1
36		24	2
37		25	2
38	Mixco		3
39			3
40			3
41			3
42			3
43			3
44	V.Nueva		4
45			4
46			4
47			4
48			4
49	Petapa		5
50	Amatitlan		4
51			4
52	V.Canales		5
53			5
54	Sta.C.Pinula		6
55			6
56	San Jose Pinula		6
57	Fraijanes		6
58	Chinautla		1



Traffic Zone Map

# OD Table in Year 2010, Car-1

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	
1	6809	7622	8435	9248	10061	10874	11687	12500	13313	14126	14939	15752	16565	17378	18191	19004	19817	20630	21443	22256	23069	23882	24695	25508	26321	27134
2	1070	1184	1298	1412	1526	1640	1754	1868	1982	2096	2210	2324	2438	2552	2666	2780	2894	3008	3122	3236	3350	3464	3578	3692	3806	3920
3	1070	1184	1298	1412	1526	1640	1754	1868	1982	2096	2210	2324	2438	2552	2666	2780	2894	3008	3122	3236	3350	3464	3578	3692	3806	3920
4	1070	1184	1298	1412	1526	1640	1754	1868	1982	2096	2210	2324	2438	2552	2666	2780	2894	3008	3122	3236	3350	3464	3578	3692	3806	3920
5	1070	1184	1298	1412	1526	1640	1754	1868	1982	2096	2210	2324	2438	2552	2666	2780	2894	3008	3122	3236	3350	3464	3578	3692	3806	3920
6	1070	1184	1298	1412	1526	1640	1754	1868	1982	2096	2210	2324	2438	2552	2666	2780	2894	3008	3122	3236	3350	3464	3578	3692	3806	3920
7	1070	1184	1298	1412	1526	1640	1754	1868	1982	2096	2210	2324	2438	2552	2666	2780	2894	3008	3122	3236	3350	3464	3578	3692	3806	3920
8	1070	1184	1298	1412	1526	1640	1754	1868	1982	2096	2210	2324	2438	2552	2666	2780	2894	3008	3122	3236	3350	3464	3578	3692	3806	3920
9	1070	1184	1298	1412	1526	1640	1754	1868	1982	2096	2210	2324	2438	2552	2666	2780	2894	3008	3122	3236	3350	3464	3578	3692	3806	3920
10	1070	1184	1298	1412	1526	1640	1754	1868	1982	2096	2210	2324	2438	2552	2666	2780	2894	3008	3122	3236	3350	3464	3578	3692	3806	3920
11	1070	1184	1298	1412	1526	1640	1754	1868	1982	2096	2210	2324	2438	2552	2666	2780	2894	3008	3122	3236	3350	3464	3578	3692	3806	3920
12	1070	1184	1298	1412	1526	1640	1754	1868	1982	2096	2210	2324	2438	2552	2666	2780	2894	3008	3122	3236	3350	3464	3578	3692	3806	3920
13	1070	1184	1298	1412	1526	1640	1754	1868	1982	2096	2210	2324	2438	2552	2666	2780	2894	3008	3122	3236	3350	3464	3578	3692	3806	3920
14	1070	1184	1298	1412	1526	1640	1754	1868	1982	2096	2210	2324	2438	2552	2666	2780	2894	3008	3122	3236	3350	3464	3578	3692	3806	3920
15	1070	1184	1298	1412	1526	1640	1754	1868	1982	2096	2210	2324	2438	2552	2666	2780	2894	3008	3122	3236	3350	3464	3578	3692	3806	3920
16	1070	1184	1298	1412	1526	1640	1754	1868	1982	2096	2210	2324	2438	2552	2666	2780	2894	3008	3122	3236	3350	3464	3578	3692	3806	3920
17	1070	1184	1298	1412	1526	1640	1754	1868	1982	2096	2210	2324	2438	2552	2666	2780	2894	3008	3122	3236	3350	3464	3578	3692	3806	3920
18	1070	1184	1298	1412	1526	1640	1754	1868	1982	2096	2210	2324	2438	2552	2666	2780	2894	3008	3122	3236	3350	3464	3578	3692	3806	3920
19	1070	1184	1298	1412	1526	1640	1754	1868	1982	2096	2210	2324	2438	2552	2666	2780	2894	3008	3122	3236	3350	3464	3578	3692	3806	3920
20	1070	1184	1298	1412	1526	1640	1754	1868	1982	2096	2210	2324	2438	2552	2666	2780	2894	3008	3122	3236	3350	3464	3578	3692	3806	3920
21	1070	1184	1298	1412	1526	1640	1754	1868	1982	2096	2210	2324	2438	2552	2666	2780	2894	3008	3122	3236	3350	3464	3578	3692	3806	3920
22	1070	1184	1298	1412	1526	1640	1754	1868	1982	2096	2210	2324	2438	2552	2666	2780	2894	3008	3122	3236	3350	3464	3578	3692	3806	3920
23	1070	1184	1298	1412	1526	1640	1754	1868	1982	2096	2210	2324	2438	2552	2666	2780	2894	3008	3122	3236	3350	3464	3578	3692	3806	3920
24	1070	1184	1298	1412	1526	1640	1754	1868	1982	2096	2210	2324	2438	2552	2666	2780	2894	3008	3122	3236	3350	3464	3578	3692	3806	3920
25	1070	1184	1298	1412	1526	1640	1754	1868	1982	2096	2210	2324	2438	2552	2666	2780	2894	3008	3122	3236	3350	3464	3578	3692	3806	3920











OD Table in Year 2010, Bus-3

2010	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																															
1123	1135	1146	1158	1170	1182	1194	1206	1218	1230	1242	1254	1266	1278	1290	1302	1314	1326	1338	1350	1362	1374	1386	1398	1410	1422	1434	1446	1458	1470	1482	1494	1506	1518	1530	1542	1554	1566	1578	1590	1602	1614	1626	1638	1650	1662	1674	1686	1698	1710	1722	1734	1746	1758	1770	1782	1794	1806	1818	1830	1842	1854	1866	1878	1890	1902	1914	1926	1938	1950	1962	1974	1986	1998	2010	2022	2034	2046	2058	2070	2082	2094	2106	2118	2130	2142	2154	2166	2178	2190	2202	2214	2226	2238	2250	2262	2274	2286	2298	2310	2322	2334	2346	2358	2370	2382	2394	2406	2418	2430	2442	2454	2466	2478	2490	2502	2514	2526	2538	2550	2562	2574	2586	2598	2610	2622	2634	2646	2658	2670	2682	2694	2706	2718	2730	2742	2754	2766	2778	2790	2802	2814	2826	2838	2850	2862	2874	2886	2898	2910	2922	2934	2946	2958	2970	2982	2994	3006	3018	3030	3042	3054	3066	3078	3090	3102	3114	3126	3138	3150	3162	3174	3186	3198	3210	3222	3234	3246	3258	3270	3282	3294	3306	3318	3330	3342	3354	3366	3378	3390	3402	3414	3426	3438	3450	3462	3474	3486	3498	3510	3522	3534	3546	3558	3570	3582	3594	3606	3618	3630	3642	3654	3666	3678	3690	3702	3714	3726	3738	3750	3762	3774	3786	3798	3810	3822	3834	3846	3858	3870	3882	3894	3906	3918	3930	3942	3954	3966	3978	3990	4002	4014	4026	4038	4050	4062	4074	4086	4098	4110	4122	4134	4146	4158	4170	4182	4194	4206	4218	4230	4242	4254	4266	4278	4290	4302	4314	4326	4338	4350	4362	4374	4386	4398	4410	4422	4434	4446	4458	4470	4482	4494	4506	4518	4530	4542	4554	4566	4578	4590	4602	4614	4626	4638	4650	4662	4674	4686	4698	4710	4722	4734	4746	4758	4770	4782	4794	4806	4818	4830	4842	4854	4866	4878	4890	4902	4914	4926	4938	4950	4962	4974	4986	4998	5010	5022	5034	5046	5058	5070	5082	5094	5106	5118	5130	5142	5154	5166	5178	5190	5202	5214	5226	5238	5250	5262	5274	5286	5298	5310	5322	5334	5346	5358	5370	5382	5394	5406	5418	5430	5442	5454	5466	5478	5490	5502	5514	5526	5538	5550	5562	5574	5586	5598	5610	5622	5634	5646	5658	5670	5682	5694	5706	5718	5730	5742	5754	5766	5778	5790	5802	5814	5826	5838	5850	5862	5874	5886	5898	5910	5922	5934	5946	5958	5970	5982	5994	6006	6018	6030	6042	6054	6066	6078	6090	6102	6114	6126	6138	6150	6162	6174	6186	6198	6210	6222	6234	6246	6258	6270	6282	6294	6306	6318	6330	6342	6354	6366	6378	6390	6402	6414	6426	6438	6450	6462	6474	6486	6498	6510	6522	6534	6546	6558	6570	6582	6594	6606	6618	6630	6642	6654	6666	6678	6690	6702	6714	6726	6738	6750	6762	6774	6786	6798	6810	6822	6834	6846	6858	6870	6882	6894	6906	6918	6930	6942	6954	6966	6978	6990	7002	7014	7026	7038	7050	7062	7074	7086	7098	7110	7122	7134	7146	7158	7170	7182	7194	7206	7218	7230	7242	7254	7266	7278	7290	7302	7314	7326	7338	7350	7362	7374	7386	7398	7410	7422	7434	7446	7458	7470	7482	7494	7506	7518	7530	7542	7554	7566	7578	7590	7602	7614	7626	7638	7650	7662	7674	7686	7698	7710	7722	7734	7746	7758	7770	7782	7794	7806	7818	7830	7842	7854	7866	7878	7890	7902	7914	7926	7938	7950	7962	7974	7986	7998	8010	8022	8034	8046	8058	8070	8082	8094	8106	8118	8130	8142	8154	8166	8178	8190	8202	8214	8226	8238	8250	8262	8274	8286	8298	8310	8322	8334	8346	8358	8370	8382	8394	8406	8418	8430	8442	8454	8466	8478	8490	8502	8514	8526	8538	8550	8562	8574	8586	8598	8610	8622	8634	8646	8658	8670	8682	8694	8706	8718	8730	8742	8754	8766	8778	8790	8802	8814	8826	8838	8850	8862	8874	8886	8898	8910	8922	8934	8946	8958	8970	8982	8994	9006	9018	9030	9042	9054	9066	9078	9090	9102	9114	9126	9138	9150	9162	9174	9186	9198	9210	9222	9234	9246	9258	9270	9282	9294	9306	9318	9330	9342	9354	9366	9378	9390	9402	9414	9426	9438	9450	9462	9474	9486	9498	9510	9522	9534	9546	9558	9570	9582	9594	9606	9618	9630	9642	9654	9666	9678	9690	9702	9714	9726	9738	9750	9762	9774	9786	9798	9810	9822	9834	9846	9858	9870	9882	9894	9906	9918	9930	9942	9954	9966	9978	9990	10002

## Annex 5. Data for VOC Calculation

According to the survey in Guatemala, data required for the calculation of VOC are estimated as shown below.

Data-1 Average Annual Vehicle Running km  
(Unit: km/year\*vehicle)

Passenger Car	Bus	Truck		
		Light	Medium	Heavy
20,000	70,000	70,000	120,000	100,000

(Source) JICA Master Plan Study

Data-2 Average Life of Vehicles  
(Unit: year)

Passenger Car	Bus	Truck		
		Light	Medium	Heavy
10	10	10	10	10

(Source) JICA Master Plan Study

Data-3 Price of a New Vehicle (February 1996)  
(Unit: Q/vehicle)

	Passenger Car	Bus	Truck		
			Light	Medium	Heavy
Market Price	68,000	270,000	150,000	230,000	390,000
IVA (%)	10	10	10	10	10
Import Duty (%)	20	5	10	10	10
Economic Price	51,500	234,000	124,000	190,000	322,000

(Source) Interviews with Ministry of Public Finance and vehicle dealers

Data-4 Salvage Value  
(Unit: Q/km)

Passenger Car	Bus	Truck		
		Light	Medium	Heavy
6,324	0	0	0	0

(Source) JICA Master Plan Study

Data-5 Price of Gasoline, Diesel and Engine Oil (February 1996)

(Unit: Q./liter)

	Gasoline	Diesel	Engine Oil
Market Price	2.42	2.00	12.00
IVA (%)	10	10	10
Distribution Tax (Q./liter)	0.53	0.20	---
Import Duty (%)	10	10	10
Economic Price	1.52	1.47	9.92

(Source) Survey in gas stations and interview with Ministry of Energy and Mines

Data-6 Fuel Consumption by Vehicle Running Speed

(Unit: liter/km)

km/h	Passenger Car	Bus	Small Truck	Medium Truck	Heavy Truck
5	0.451	0.527	0.408	0.463	0.519
10	0.393	0.503	0.374	0.433	0.492
15	0.340	0.463	0.336	0.400	0.463
20	0.302	0.426	0.307	0.355	0.404
25	0.277	0.397	0.282	0.329	0.375
30	0.255	0.372	0.262	0.307	0.352
35	0.236	0.351	0.243	0.285	0.326
40	0.219	0.329	0.228	0.268	0.308
45	0.207	0.313	0.216	0.254	0.293
50	0.198	0.299	0.208	0.244	0.280
55	0.190	0.291	0.202	0.238	0.273
60	0.185	0.285	0.202	0.234	0.265
65	0.182	0.291	0.205	0.236	0.268
70	0.179	0.298	0.208	0.241	0.275
75	0.177	0.307	0.216	0.251	0.286
80	0.176	0.318	0.225	0.262	0.298

(Source) JICA Master Plan Study

Data-7 Economic Price of a Tire

(Unit: Q./tire)

	Passenger Car	Bus	Truck		
			Light	Medium	Heavy
Market Price	250	1,200	900	1,000	1,900
Import Duty (%)	---	---	---	---	10
IVA (%)	10	10	10	10	10
Economic Price	227	1,091	545	909	1,570

(Note) Other than tires for heavy trucks, uses of tires domestically produced are assumed.

(Source) Interviews with spare parts dealers and bus operating companies.

**Data-8 Number of Replaced Tires**

	Passenger Car	Bus	Truck		
			Light	Medium	Heavy
Vehicle Running Distance (km)	200,000	700,000	700,000	1,200,000	1,000,000
Running Distance per Tire (km)	25,000	25,000	25,000	30,000	50,000
Times of Tire Replacement	7	27	27	39	19
Number of Tires per Vehicle	4	6	4	6	10
Number of Tires Replaced	28	162	108	234	190

(Note) Other than tires for heavy trucks, uses of tires domestically produced are assumed.  
 (Source) Interviews with spare parts dealers and bus operating companies.

**Data-9 Wage of Crew**

	Passenger Car	Bus	Truck		
			Light	Medium	Heavy
Crews per Vehicle		1 driver 1 assistant	1 driver	1 driver	1 driver 1 assistant
Wage of Driver (Q./day)	0	100	100	100	400
Wage of Assistant (Q./day)	0	50			200
Annual Wage per Vehicle (Q./yea)*	0	45,000	30,000	30,000	180,000

(Note) \* 300 working days per year  
 (Source) Interviews with bus operating companies.

**Data-10 Vehicle Insurance Rate**

(Unit: %)

Passenger Car	Bus	Truck		
		Light	Medium	Heavy
5	5	5	5	5

(Source) JICA Master Plan Study

**Data-11 Weight for Calculation of VOC of "Car"**

Car			
Passenger Car	Truck		
	Light	Medium	Heavy
0.6706	0.2529	0.0765	0.0000

(Source) JICA Master Plan Study







11/11/11