VI PROJECT IMPLEMENTATION PROGRAM

VI PROJECT IMPLEMENTATION PROGRAM

18. Cost Estimation

18.1 Cost Estimation Conditions

(1) Contract Method

Guatemala City has executed construction projects by either force account, closed tender or open tender. Usually the contract method for large scale construction projects such as large bridges is by international competitive open tender. It is assumed for the purpose of this cost estimation that all the projects are contracted through international bids.

(2) Construction Method

Large scaled construction projects such as grade separation intersections, at grade interchanges and new arterial road construction use heavy construction equipment in Guatemala City. Cost estimation assumes a construction method using an efficient arrangement of construction equipment and is tendered under international tendering procedure.

(3) Base Year for Cost Estimation

Cost calculations are based on the material cost, labor cost and equipment cost estimated at January 1996 prices. Imported materials costs include all import taxes and at January 1996 rates and the exchange rate applied is 1US$=6.14Q

(4) Foreign and Local Currency Portions

Of the total cost, the proportion foreign currency and local currency have also been estimated. Classification into foreign and local currency components is based on the following principles.

1) Foreign currency

- Wages of foreign personnel;
- Overheads and profit of foreign firms;
- Imported equipment, materials and supplies;
- Partial cost of domestic materials

2) Local currency

- Domestic equipment, materials and supplies
- Wages of local personnel;
- Overhead and profit of local firms;
- Taxes

18.2 Cost Estimation Procedure

(1) Method

The cost estimation procedure is shown in Figure 18.1. The direct construction cost of each work item is estimated by the accumulating method which combines the cost of labor, equipment and material as in the normal estimation method. In the case of projects using heavy construction machines, the machine expenses occupy a major share of the work items. Although it may change widely depending on using time of the machine, the cost of a machine is calculated by combination and capacity of the machines. Machine working times are estimated considering a combination of typical construction machines and machine capacities.

The indirect construction cost can be calculated by the accumulation of each work item cost.

Indirect costs which include temporary facilities, field management expenses and general management expenses are a percentage of the direct construction cost. The project costs also include for contingencies, land acquisition and compensation cost which are calculated and added separately.

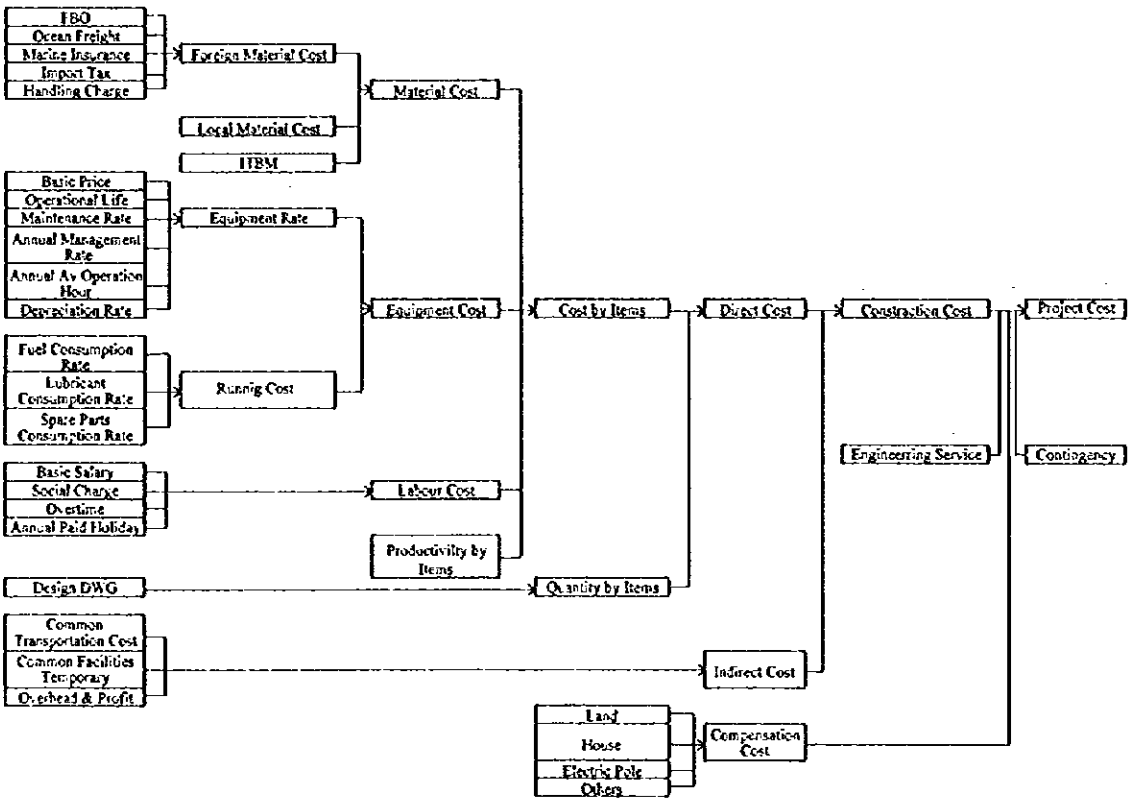

Figure 18.1 Cost Estimation Procedure

(2) Labor cost

Basic salaries have been calculated over a whole year including holidays. Unit labor costs include 30 hours of overtime work per month. Basic salary includes social charges which account for 35% of the average wage. Social charges such as worker's accident compensation insurance and pension are born by the company and the individual labor. Unit labor costs are classified into 5 categories which are drivers, foremen, operators, skilled labors and unskilled labors.

Table 18.1 Unit Labor Cost

Classification	Unit	Foreign (US$)	Local (Q)
Driver	hour	0	33
Foreman	hour	0	44
Operater	hour	0	39
Skilled Labor	hour	0	24
Unskilled Labor	hour	0	11

(3) Material Cost

Material costs are divided into domestic products and imported materials. The CIF (cost, insurance, and freight) prices of imported materials which are not available in Guatemala are estimated from foreign prices. Material costs are estimated including charges and levies for import tax, handling charge, consumption tax in the country.

Where the selling prices of imported materials are known, 25% of the selling prices are regarded as handling charge, of which 7.5% of the selling price is transportation expense. 50% of the transportation expenses are estimated as the foreign portion. Consumption tax of 10% is added to the material costs.

In the case of domestic products, the majority of the cost component of raw materials is regarded as expenses of the production plants, equipment, transportation, and fuel which would have been imported. The unit costs and assumed foreign and local currency portions for the major materials are shown in Table 18.2.

Table 18.2 Foreign Currency Portion in Raw Material (%)

Description	Foreign currency portion	Local currency portion
Cement	54.0	46.0
Sand	54.0	46.0
Crusher stone	54.0	46.0
Steel	72.5	27.5
Reinforcement	72.5	27.5
Wood	54.0	46.0
Concrete product	54.0	46.0
Asphalt	81.5	18.5
Gasolin	43.4	56.7
Diesel oil	48.4	51.6
Hevy oil	55.3	44.7
Electricity	30.0	70.0

(4) Machine Cost

The construction machine costs are estimated assuming that the machine will be assigned to other projects when not being used for the projects. All construction machines could be supplied in Guatemala. Machine costs include import tax, consumption tax and all other expenses except operator and driver costs which are calculated in labor costs.

Machinery cost could be divided into rental cost and operation cost.

rental cost per hour = ((basic price (1.0 - residual value ratio)) x depreciation rate + annual maintenance rate per hour + management rate per hour.

depreciation rate = 1/(annual operation hour x operation life)

Operation costs include fuel, lubricant, spare parts, wages of management and maintenance costs per hour.

(5) Land Acquisition and Compensation Costs

The costs of land acquisition and compensation were estimated by category using the result of the market price investigation.

Table 18.3 Land Cost Estimation

(Unit: Q./m^2)

Land not used	20
Agricultural area	50
Industrial area	80
Commercial area	600
Residential area A	220
Residential area B	120

Table 18.4 Compensation Cost Estimation

(Unit: Q./Unit)

House Category A	100
House Category B	50
Office Building (2~4 stories)	150
Office Building (more than 5 stories)	200

(6) Indirect Costs

Temporary work costs which include transportation of machines and plant, mobilization and demobilization, installation and removal of such temporary facilities as power supply, environmental protection, safety facilities, quality and progress control, utilities, and field office maintenance. Field management costs include wages, office supplies, and other expenses included at field offices, while general administration includes the overhead at the contractors head office.

These indirect costs can vary substantially from one contractor to another and are also dependent on the scale of the project, and a number of assumptions must be made for their estimation. Therefore, for simplicity of estimation, indirect cost has been estimated to be 30% of direct cost from previously implemented projects. The foreign currency portion and the local currency portion of indirect costs are shown in Table 18.5.

Table 18.5 Indirect Cost Component (%)

Description	Foreign portion	Local portion	Total
1.Common temporary facilities			
1-1 Transportation	1.0	0.5	1.5
1-2 Mobilization	0.5	1.0	1.5
1-3 Temporary facilities	0.5	1.0	1.5
1-4 Environment control	0.2	0.3	0.5
1-5 Safety facilities	0.1	0.4	0.5
1-6 Public services charge	0.0	0.5	0.5
1-7 Quality control	1.0	1.0	2.0
1-8 Field office maintenance	0.5	1.5	2.0
Subtotal	3.8	6.2	10.0
2.Field management	3.0	7.0	10.0
3.General management	10.0	0.0	10.0
Total	16.8	13.2	30.0

(7) Engineering Services Cost

Engineering Service costs vary and depend on the scales of the project, tender processing and contract method. Based on previous experiences in Guatemala, the engineering service cost is estimated at 10% of the total of direct and indirect costs. The currency portion of foreign and local is allocated in the same ratio as the total cost.

(8) Contingency

A contingency allowance has been included in the total cost to allow for unexpected costs identified in the detail design and construction stage. In view of the fact that the subject projects are to be implemented in urban areas where unexpected difficulties such as traffic congestion, resettlement of inhabitants and scope of construction of related roads are highly possible, 10% of total construction and engineering service cost is assumed as physical contingency.

(9) Estimation for Building Cost

Surveys were conducted on the unit costs of structural materials (such as cement, sand, reinforcing steel and structural steel, etc.), finishing materials (such as aluminum window/door frames, glass, plywood and paint, etc.), plumbing materials (such as pipes, ducts and sanitary ware, etc.) and electrical materials (such as electric cords, receptacles and lighting fixtures, etc.) and also on the ongoing wages of engineers, welders, reinforcing bar placers and tilers, etc., and their productivity using a questionnaire. In addition, reference materials were obtained from construction companies and architectural design office in Guatemala City, and interviews were conducted with people working for these companies. During the interviews, the construction cost was clarified for three different building grades, i.e., high grade buildings, such as hotels and hospitals, medium grade buildings, such as offices and schools, and low grade buildings, such as factories and warehouses, etc.

The construction cost surveyed for these three building grades is the total cost of constructing a building of a specific grade as of January, 1996 in US dollars. The cost per unit floor area includes the direct construction cost (including the cost of finishing work, structural work, plumbing work, electrical work and exterior work), indirect construction cost, various expenses, overhead, profit and taxes, etc.

a) High grade buildings: hotels, hospitals and high quality housing, etc.: 400-500 US$/$m^2$

b) Medium grade buildings: offices, schools and stores, etc.: 300-400 US$/$m^2$

c) Low grade buildings: factories and warehouses, etc.: 200-300 US$/$m^2$

All the replies made by the interviewed construction companies and architectural offices in Guatemala City fell within the above range for each building grade and, therefore, these assumed unit figures are judged to be adequate for estimation of the construction cost in the Study.

The construction cost consists of the following items.

1) Direct Construction Cost
   a) architectural work (finishing work)
   b) structural work (foundations, pillars, beams, floors, walls and roof, etc.)
   c) plumbing work (water supply and sewer systems, sanitary system, air-conditioning and ventilation system, etc.)
   d) electrical installation work (main power line, lighting and telephone lines and fixtures, etc.)
   e) exterior work (site roads, perimeter fencing, gates and landscaping, etc.)
2) Indirect Construction Cost:
   common temporary facilities cost, site office cost and general administration cost (20 - 30% of direct construction cost)
3) Engineering Service Fee:
   10 - 15% of combined cost of direct and indirect construction costs
4) Contingency Reserve:
   10 - 15% of combined cost of direct and indirect construction cost above

As described above, the construction cost is the sum of the direct construction cost, indirect construction cost, engineering service cost and contingency reserve. The method used to estimate the direct construction cost, which accounts for a large part of the construction cost, is described next.

Firstly, the preliminary design was conducted for the five subject projects of Urban Bus Center, Inter-regional Bus Terminals (North, West and South) and Bus Inspection and Maintenance Center, and the plans, elevation, cross-section and finishing schedule were prepared for each project. Using these plans and finishing schedule, the estimated construction cost of each component of the planned buildings was classified into one of four grade categories (Grade A = 400 US$/$m^2$, Grade B - 300 US$/m2, Grade C = 200 US$/$m^2$ and Grade D for exterior work = 50 US$/$m^2$) depending on the purpose of use of the building (workshop, terminal, commercial facility or office) and the level of importance of each room, etc. (bus berth, store site, manager's office, reception room, waiting room, toilet or storage). These plans were also used to calculate the area of each room and the resulting figure was multiplied by the corresponding unit cost to establish the construction cost of each type of room. The construction cost of each room in one building was then totaled to establish the construction cost of the building in question. The cost of exterior work, involving sidewalks and landscaping, etc., was estimated using the relevant unit costs and calculated area for external work.

The cost of exterior work was then added to the building cost to achieve the construction cost which, at that stage, included both the direct and indirect construction costs.

The construction cost was then divided into the direct construction cost (75%) and indirect construction cost (25%). Meanwhile, the foreign portion and local portion of the financial costs were divided into 60% and 40% respectively. The rate of the engineering service fee was set at 12% of the sum of the direct and indirect construction costs.

Compensation for land acquisition and house relocation, etc., is accounted for only in the case of the Inter-regional Bus Terminal West where some people actually live on the privately owned project site. Compensation was not considered in the case of the other project sites because of the use of public land. In order to deal with contingencies, an amount equivalent to 10% of the sum of the direct and indirect construction costs was reserved.

The estimation results for the Urban Bus Centre Project, Inter-regional Bus Terminal North, West and South Project and Bus Inspection and Maintenance Centre Project based on the above-described estimation conditions are given in the table below.

18.3 Construction Cost

For the cost estimation of the present stage which suffices to assign investment priority order without determining detailed work conditions and specifications, cost items are grouped into those of which can be expressed by a finished work quantity such as unit price per square meter of pavement areas. For actual cost estimation, each cost item is conceived of in three stages: plant products, site products, and work items. The work items conform with cost items for unit price contracting. Plant product and site product are items in the breakdown of each work item. Plant products are materials produced and delivered by a field plant, such as batching plant and asphalt mixture. The pavement concrete is placed, compacted, finished and cured into surface concrete pavement, which is a site product. A work item is for example a pavement consisting of a site product: an aggregate sub base course, and expansion joint. The unit price of each work item, such as per square meter in the case of pavement, is multiplied by the quantity calculated from the design in estimating each cost item.

Table 18.6 Product Summary

Description	Unit	Finan cial		Economic	Total	Total	
		Foreign($)	Local(Q)	Local(Q)	Financial(Q)	Economic(Q)	Foreign(%)
Asphalt Surface	m^3	56	244	165	589	510	58.6
Cutting	m^3	2	18	13	30	25	40.2
Embankment	m^3	3	22	16	41	35	46.5
Median	m^2	22	120	86	257	223	53.4
Seal Coating	m^2	0	1	1	2	2	35.6
Sidewalk Pavement	m^2	17	165	128	268	231	38.5
Slope Protection	m^2	53	279	210	607	538	54.0
Soil Spoil	m^3	0	7	5	8	6	17.4
Traffic Sign	Km	5,292	19,948	12,905	52,438	45,395	62.0
Concrete	m^3	29	169	129	347	307	51.3
PC Concrete	m^3	39	288	221	526	459	45.2
Structure Concrete	m^3	32	267	205	465	403	42.5
Foundation Concrete	m^3	27	188	144	357	313	47.3
Equip. Backfill	m^3	0	8	6	10	8	17.2
Erection 16t	Ton	55	543	400	883	740	38.5
Erection 40t	Ton	65	650	480	1,050	880	38.1
Cantilever Erection	m^2	112	652	455	1,341	1,144	51.4
Girder Bed	Unit	387	3,022	2,240	5,396	4,614	44.0
Grout Mortar	m^3	261	829	540	2,430	2,141	65.9
Grouting	m	1	4	3	10	9	61.5
Prestressing	Ton	3,300	21,834	15,247	42,094	35,507	48.1
Reinforcing	Ton	287	2,742	2,127	4,502	3,887	39.1
Staging	m^3	4	42	28	69	55	39.0
Steel Forming	m	10	71	51	134	114	46.9
Wood Forming	m	4	87	68	114	95	23.9
Structure Excavation	m^3	2	18	14	27	23	34.0
Support	m^3	7	56	37	98	79	43.1
Shoe Metal 1	Set	30,706	82,774	39,822	271,310	228,358	69.5
Shoe Metal 2	Set	2,599	7,401	3,691	23,359	19,649	68.3
Shoe	Set	599	3,536	2,391	7,214	6,069	51.0
Cantilever Box Girder	m^2	345	2,389	1,708	4,507	3,826	47.0
I Girder Type 1 Tr	m^2	111	901	666	1,581	1,346	43.0
I Girder Type 5 Tr	m^2	178	1,324	966	2,417	2,059	45.2
I Girder Type 5 Er	m^2	144	1,096	804	1,977	1,685	44.6
Abut T H10m	m^3	53	487	373	811	697	40.0
Abut B H20m	m^3	68	660	509	1,078	927	38.8
Pier H8m	m^3	53	479	367	807	695	40.6
Pier H30m	m^3	55	500	384	841	725	40.5
Pier H40m	m^3	58	511	390	870	749	41.3
Pier H60m	m^3	63	539	410	923	794	41.6
Pier H80m	m^3	60	528	406	897	775	41.1
Cbox H7mB12m	m	2,251	20,138	15,180	33,958	29,000	40.7
Cbox H7mB36m	m	5,923	54,747	41,114	91,116	77,483	39.9
CCPile 1000mm	m	122	873	641	1,621	1,389	46.1
CCPile 1500mm	m	197	1,444	1,075	2,652	2,283	45.5
CC manual Pile 1500mm	m	153	1,579	1,200	2,518	2,139	37.3
CC manual Pile 3000mm	m	486	4,538	3,471	7,523	6,456	39.7

Table 18.7 Project Cost of East West Corridor

Station		Foreign (US$)	Local (Q)	Total (Q)
STA 0+00 - STA 17+00	(Road)	0	0	0
(Sun Juan - San Nicolas)	(Bridge)	0	0	0
	(Land)	0	0	0
STA 17+00 - STA 24+50	(Road)	160,068	933,199	1,976,015
(Sun Nicolas -8a Calle)	(Bridge)	0	0	0
	(Land)	0	5,136,800	5,136,800
STA 24+50 - STA 77+00	(Road)	999,753	7,573,945	13,712,427
(8a Calle - Periferico)	(Bridge)	0	0	0
	(Land)	0	3,529,400	3,529,400
STA 77+00 - STA 122+50	(Road)	1,790,724	14,526,232	25,521,279
(Periferico - Mercado)	(Bridge)	12,419,792	102,806,061	179,063,584
	(Land)	0	47,279,733	47,279,733
(A) Direct Cost		15,370,337	125,899,437	220,273,305
(B) Indirect Cost (A)*30%		4,611,101	37,769,831	66,081,991
(C) Supervision (A+B)*10%		1,998,144	16,366,927	28,635,530
(D) Construction Cost (A+B+C)		21,979,582	180,036,195	314,990,825
(E) Land Acquisition		0	55,945,933	55,945,933
(F) Contingency (D)*10%		2,197,958	18,003,619	31,499,083
E-W Project Cost (D+E+F)		24,177,540	253,985,748	402,435,841
			32,852	Q/m

Table 18.8 Project Cost of Petapa Road

Station		Foreign (US$)	Local (Q)	Total (Q)
STA 0+00 - STA 26+20	(Road)	895,931	7,843,724	13,344,741
(Petapa - El Frutal)	(Bridge)	286,283	2,682,672	4,440,447
	(Land)	0	3,300,000	3,300,000
STA 0+00 - STA 27+00	(Road)	0	0	0
(Petapa - El Frutal)	(Bridge)	0	0	0
	(Land)	0	0	0
STA 27+00 - STA 72+80	(Road)	1,592,297	13,127,295	22,903,998
(El Frutal - Pamplona)	(Bridge)	4,447,440	34,919,603	62,226,883
	(Land)	0	6,103,000	6,103,000
STA 72+80 - END	(Road)	0	0	0
(Pamplona - Station FEGUA)	(Bridge)	0	0	0
	(Land)	0	0	0
(A) Direct Cost		7,221,950	58,573,294	102,916,069
(B) Indirect Cost (A)*30%		2,166,585	17,571,988	30,874,821
(C) Supervision (A+B)*10%		938,854	7,614,528	13,379,089
(D) Construction Cost (A+B+C)		10,327,389	83,759,811	147,169,978
(E) Land Acquisition		0	9,403,000	9,403,000
(F) Contingency (D)*10%		1,032,739	8,375,981	14,716,998
E-W Project Cost (D+E+F)		11,360,128	101,538,792	171,289,976
			23,464	Q/m

Table 18.9 Project Cost of East - West Exclusive Busway

Station		Foreign (US$)	Local (Q)	Total (Q)
STA 0+00 - STA 17+00	(Road)	340,772	2,700,685	4,793,022
(Sun Juan - San Nicolas)	(Bridge)	0	0	0
	(Land)	0	0	0
STA 17+00 - STA 24+50	(Road)	43,766	26,458	533,180
(Sun Nicolas -8a Calle)	(Bridge)	0	0	0
	(Land)	0	0	0
STA 24+50 - STA 77+00	(Road)	308,879	2,092,564	3,989,080
(8a Calle - Periferico)	(Bridge)	1,212,649	8,942,224	16,387,889
	(Land)	0	0	0
STA 77+00 - STA 122+50	(Road)	396,809	2,53,639	4,980,048
(Periferico - Mercado)	(Bridge)	4,298,662	34,947,446	61,431,231
	(Land)	0	23,689,867	23,689,867
(A) Direct Cost		6,601,536	51,491,016	92,024,449
(B) Indirect Cost (A)*30%		1,980,461	15,447,305	27,607,335
(C) Supervision (A+B)*10%		858,200	6,693,832	11,963,178
(D) Construction Cost (A+B+C)		9,440,197	73,632,153	131,594,961
(E) Land Acquisition		0	23,689,867	23,689,867
(F) Contingency (D)*10%		944,020	7,363,215	13,159,496
E-W Project Cost (D+E+F)		10,384,216	104,685,235	168,444,324
			13,751	Q/m

Table 18.10 Project Cost of FEGUA Exclusive Busway

Station		Foreign (US$)	Local (Q)	Total (Q)
STA 0+00 - STA 26+20	(Road)	0	0	0
(Petapa - El Frutal)	(Bridge)	0	0	0
	(Land)	0	0	0
STA 0+00 - STA 27+00	(Road)	957,480	9,079,835	14,958,761
(Petapa - El Frutal)	(Bridge)	1,488,914	11,326,450	20,468,382
	(Land)	0	3,780,000	3,780,000
STA 27+00 - STA 72+80	(Road)	438,674	2,875,044	5,568,504
(El Frutal - Pamplona)	(Bridge)	2,373,931	18,847,288	33,423,224
	(Land)	0	0	0
STA 72+80 - END	(Road)	1,432,292	10,096,400	18,890,675
(Pamplona - Station FEGUA)	(Bridge)	5,020,295	40,353,943	71,178,554
	(Land)	0	5,136,800	5,136,800
(A) Direct Cost		11,711,586	92,578,959	164,488,101
(B) Indirect Cost (A)*30%		3,513,476	27,773,688	49,346,430
(C) Supervision (A+B)*10%		1,522,506	12,035,265	21,383,453
(D) Construction Cost (A+B+C)		16,747,569	132,378,912	235,217,984
(E) Land Acquisition		0	8,916,800	8,916,800
(F) Contingency (D)*10%		1,674,757	13,238,791	23,521,798
E-W Project Cost (D+E+F)		18,422,326	154,543,503	267,656,582
			15,208	Q/m

Table 18.11 Project Cost of Urban Bus Center

	Foreign (US $1,000)	Local (Q.1,000)	Total (Q.1,000)
Direct Construction Cost	11,757.80	48,128.50	120,321.39
Indirect Cost	3,919.30	16,042.80	40,107.30
Engineering Service	1,881.20	7,700.60	19,251.17
Compensation			
Contingency	1,567.70	6,417.10	16,042.78
Project Cost	19,126.00	78,289.00	195,722.64

Table 18.12 Project Cost of North Inter-regional Bus Terminal

	Foreign (US $1,000)	Local (Q.1,000)	Total (Q.1,000)
Direct Construction Cost	624.60	2,556.70	6,391.74
Indirect Cost	208.20	852 20	2,130.55
Engineering Service	100.00	409.20	1,023.20
Compensation			
Contingency	83.30	340.90	852.36
Project Cost	1,016.10	4,159.00	10,397.85

Table 18.13 Project Cost of West Inter-regional Bus Terminal

	Foreign (US $1,000)	Local (Q.1,000)	Total (Q.1,000)
Direct Construction Cost	2,077.80	8,505.10	21,262.79
Indirect Cost	692.60	2,835.00	7,087.56
Engineering Service	332 50	1,360.90	3,402.45
Compensation		15,000.00	15,000.00
Contingency	277.00	1,134.00	2,834.78
Project Cost	3,379.9	28,835.00	49,587.59

Table 18.14 Project Cost of South Inter-regional Bus Terminal

	Foreign (US $1,000)	Local (Q.1,000)	Total (Q.1,000)
Direct Construction Cost	1,645.20	6,734.40	16,835.93
Indirect Cost	548.40	2,244.80	5,611.98
Engineering Service	263.20	1,077.40	2,693.45
Compensation			
Contingency	219.40	897.90	2,245.02
Project Cost	2,676.20	10,954.50	27,386.37

Table 18.15 Project Cost of Bus Inspection and Maintenance Center

	Foreign (US $1,000)	Local (Q.1,000)	Total (Q.1,000)
Direct Construction Cost	2,588.60	10,595.90	26,489.90
Indirect Cost	554.30	2,268.90	5,672.30
Engineering Service	285.70	1,169.50	2,923.70
Compensation			
Contingency	314.30	1,286.50	3,216.30
Project Cost	3,742.90	15,320.80	38,302.21

18.4 Operation and Maintenance Cost

Maintenance work is classified into routine maintenance work and periodic maintenance work. Routine maintenance work is required irrespective of traffic volume and includes such works as grass cutting and the cleaning of road side ditch or culverts. Periodic maintenance work is required depending on traffic volume and road surface condition and includes such works as overlay, patching, sealing, and other road surface repair, as well as the repair of bridge slabs.

(1) Conditions for Estimation

Operation and maintenance costs of the following cases are estimated.

a) Entity for Exclusive Busway East West Corridor Route

b) Entity for Exclusive Busway FEGUA Route

c) Entity for Urban Bus Center

d) Entity for North Inter-regional Terminal

e) Entity for West Inter-regional Terminal

f) Entity for South Inter-regional Terminal

g) Entity for Bus Inspection and Maintenance Center

h) Entity for East West Corridor and Petapa Road

i) Entity for the 2 busway, Urban Bus Center and Terminal

The estimates are based on the following formulae.

1) Personnel cost

Sigma (Annual personnel expenses x No. of staff of the category)
where the annual personnel expenses are estimated base on the current expenses of the corresponding municipality staff.

2) Office space rent

Average rent/sqm x Office space requirement + 10% of value added tax
where the average rent including water and electricity is estimated based on the current rent level.

3) Electricity charge

Estimation is based on the tariff of the Electricity Company for commercial, industrial, government and municipal use applicable to the demand between 11kw and 225kw.

Monthly charge = Q12.1446 x Demand in kw in the invoice + Q0.3835 x First 100kwh + Q0.3515 x Net 100kwh + Q0.3180 x Additional kwh + 10% of value added tax

4) Water and sewerage charge

Estimation is based on the tariff of the Water Corporation.

Monthly charge = Q2.50 x Consumption in cum + Q2.50 x Consumption x 20% for sewerage + Q10.00 + 10% of value added tax

5) Telephone charge

Estimation is based on the tariff of Guatel (Guatemala Telecommunications Company) for non-residential classification. (1 unit = 1.5 minutes)

6) Office supply expenses

Consumption is assumed considering the corresponding data of the existing terminal at Zone 4 and the municipality workshop.

7) Vehicle cost

Estimated vehicle operating cost/km x Total distance of operation
where the unit vehicle operating cost includes depreciation of the vehicle

8) Insurance cost

According to the general standard in Guatemala, 0.3% of the construction and equipment cost and 10% of value added tax is assumed to be the annual insurance charge.

9) Miscellaneous

5% of the costs estimated by item is assumed to be miscellaneous expenses.

10) Total operation cost except for maintenance replacement of buildings, constructions or equipment
    - In cases to rent office space : 1) + 2) + 5) + 6) + 7) + 9)
    - In cases to own office space : 1) + 3) + 4) + 5) + 6) + 7) + 8) + 9)

11) Maintenance of facility

    Buildings: 2% of the construction cost

12) Maintenance of equipment

    5% of the initial cost is assumed for maintenance and replacement of the equipment

13) Total maintenance cost

    Maintenance cost of buildings + Maintenance cost of equipment = 11) + 12)

14) Total operation and maintenance cost

    Total operation cost + Total maintenance cost = 10) + 13)

(2) Estimations of Operation and Maintenance Cost

Table 18.16 Summary Operation and Maintenance Cost

Item	Entity for East West Corridor and Petapa Road	Entity for Busway, Urban Bus Center and Terminals	Bus Inspection and Maintenance Center
Personnel cost	1,968.000	998,000	1,003,000
Office space rent	66,000	0	0
Electricity	0	594,000	92,400
Water and sewerage charge	0	119,900	10,000
Telephone charge	13,200	11,000	4,400
Office supply expenses	79,200	66,000	39,600
Vehicle cost	54,000	54,000	36,000
Insurance cost	0	725,400	105,600
Miscellaneous	109,020	128,000	65,000
Total operation cost	2,289,420	2,696,000	1,356,000
Maintenance of buildings/construction	1,029,143	4,394,960	327,480
Maintenance of equipment	-	0	790,000
Total maintenance cost	1,029,143	4,394,960	1,117,480
Total operation and maintenance cost	3,318,563	7,090,960	2,473,480

(Note) Cost borne by the tenants is not included.

19. Implementation Plan

The implementation schedule of each project was principally decided according to the following criteria;

- Progress of other related projects such as the extension of Anillo Periferico (Middle Ring Road)
- Land availability
- Preferable order of construction
- Economic return of the project
- Leveled allocation of annual investment amount

The construction of the Exclusive Busway FEGUA Route and the Petapa Road should start at an early stage for their relatively easy commencement of construction and the high rate of economic return. The top priority should be placed on open-up of the busway section between the FEGUA Central Station and Ciudad Real before completion of large scale facilities. The operation of buses along the section will promote the succeeding development, namely grade up of the section with large scale facilities and the extension from Ciudad Real to Villa Nueva. On the contrary, the East West Corridor and its Exclusive Busway can well be constructed at a later stage due to the difficulty of compensation for relocation from built-up areas along the route and the huge amount of the investment cost.

Considering the importance of traffic safety and environmental improvement, the Bus Inspection and Maintenance Center should be constructed and operated at an earliest possible stage.

Before constructing the Urban Bus Center, the three Inter-regional Bus Terminals should be completed and the function of the existing Zone 4 Terminal as an inter-regional bus terminal should already be transferred to these new terminals. More specifically, the roles and demand of the center vary according to development of related facilities and their operation and so the center's development should accord with the following phases.

1) Present Phase

The whole sale market, the middle and long distance bus terminal and the suburban bus terminal are to be relocated from the western side to the eastern.

2) Second Phase; after relocation the wholesale market place to CENMA

The market area is to become vacant.

3) Third Phase; after integration of the suburban extra-urban buses into the urban bus network

The suburban extra-bus terminal area at the eastern side is to become vacant.

4) Fourth Phase; after the inter-regional bus terminal is relocated to the West or South Bus Terminal

The inter-regional terminal area is to become vacant except an area for routes to the east

5) Fifth Phase; after opening Busway FEGUA Route

A bus center can be opened at the western side to connect routes on the FEGUA right of way and others on ordinary roads. Urban center functions can be developed at the eastern side.

6) Sixth Phase; after opening of Exclusive Busway East West Route

A bus center should be completed to connect the two Exclusive Busways and also ordinary roads. The urban center can be further developed.

Unit Q. thousand

CONSTRUCTION SCHEDULE	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
1 East West CORRIDOR								35,414	45,210	107,271	107,271	107,271	
2 Petapa Road			9,403	80,943	80,943								
3. Exclusive Busway-E-W Corridor Route								19,384	28,710	50,801	34,774	34,774	
4. Exclusive Busway-FEGUA Route		2,568	49,795	47,226	47,226	34,447	58,530	27,863					
5. Urban Bus Center						39,145	39,145	11,743					
6. North Inter-regional Bus Terminal		3,119	7,279										
7. West Inter-regional Bus Terminal			15,000	13,535	20,753								
8. South Inter-regional Bus Terminal			5,216	19,170									
9. Bus Inspection and Maintenance Center		11,491	26,812										
TOTAL	0	17,178	113,504	160,875	148,922	73,592	97,675	94,405	73,920	158,072	142,045	142,045	0

Figure 19.1 Implementation Schedule

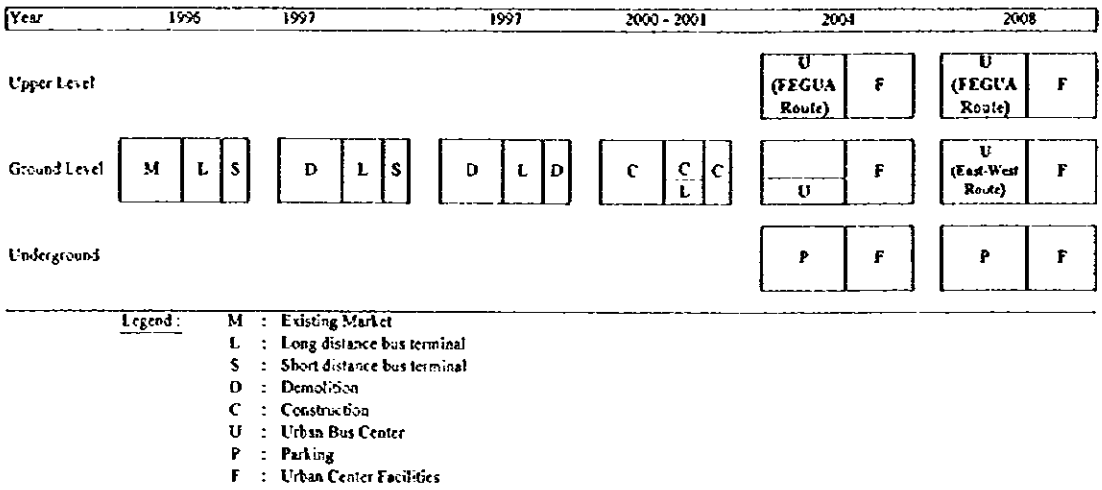

Figure 19.2 Stage Development of Urban Bus Center

20. Project Management Plan

20.1 Introduction

All of the projects studied in this report are concerned with public capital. The public capital is generally defined as the capital which often becomes to be short or imbalanced under the principle of the market economy. If recommended projects are performed by only the private sector, various problems might be brought about since the management of private enterprises must be dominated by the profit motive. Nowadays, the recent development of transportation activities reflecting economic growth has begun to bring about a large increase in the transportation demand in the Metropolitan Area of Guatemala, which means that the urgent improvement of the road infrastructure and the public transportation system is necessary. However, considering the weak financial situation of the Guatemala Municipality, if there is recourse only to the public sector, it will be difficult to improve all the necessary infrastructure. In this case non-governmental vitality should be introduced into the public sector. Therefore, with respect to the introduction of the non-governmental vitality, the BOT method has recently begun to attract attention throughout the world. As a result, at first, the possibility of the application of this method to the proposed projects was examined in the following section.

20.2 Possibility of Application of BOT Method

BOT is the abbreviation for "Build, Operate, and Transfer". Foreign enterprises with technology and capital set up a joint concern with some local public corporations working in the field of public utilities or public works. The joint venture concerned constructs and operates the project. When the contract comes to an end by mutual agreement, the ownership is transferred to the public sector. In developing countries with the highest economic growth rates, the supply of infrastructure is always insufficient in spite of the rapid increase of demands for infrastructure. Most of those countries face difficulties in carring out infrastructure improvement projects by themselves because of lack of capital and concern for the increment of the external debt. Therefore, some countries start to improve the infrastructure by the BOT method. However, the BOT method has both merits and demerits. The followings are some merits of the BOT method;

a) An important huge amount of funds for the project is supplied by the external enterprise. On the other hand, the burden of the local public corporation can be very low.

b) Public external debt can be avoided.

c) During the operating period of the project, technology transfer can be expected.

d) Since the project is easy to start at an early stage, the lack of supply can be remedy soon.

On the other hand, the following demerits should be taken into account;

a) In case the project is able to function as a network, it is better to pool the profit. The BOT method has a tendency to select only the highly profitable projects (so called "skimming the cream"), which neglects many unprofitable but necessary projects.

b) If each project is implemented independently by BOT methods, different systems and standards for the hardware and the software of the project may be applied, resulting in important social losses for the operation and maintenance.

c) Since external enterprises come to participate in joint ventures in the developing countries under various investment risks, they must seek high-return projects, which may increase the burden of users by raising the level of user charge. To increase user charge more than necessary is not desirable from the viewpoint of income distribution.

d) Since the external enterprise under the BOT method operates the project only during the concession period, the level of maintenance might be insufficient. In this case after finishing the concession term, the transferred facility or equipment might be almost useless.

As a result of examining the above-mentioned merits and demerits, the application of the BOT method to the proposed projects was judged not recommendable by the following reasons;

a) The present level of bus fare is very low, therefore, the introduction of the BOT method will result in increase of the bus fare, since the BOT enterprises will try to obtain higher profit.

b) According to the results of the financial analysis (See Chapter 22), all projects except Urban Bus Center were not sufficiently profitable for private enterprises. If the Municipality permits a private enterprise to undertake this highly profitable project, that enterprise can benefit from the so called "cream skimming", which corresponds to the above demerit (1).

c) In the prospect that projects are not profitable, actually, will not to be attract private enterprises to participate in the concession of the BOT.

Instead of the introduction of the BOT method, establishment of other organizations is recommended in the following section;

20.3 Recommendation of New Organization

Considering the existing difficult financial situation, limited staff, lack of managing experience, etc., it is not easy for the Municipality to undertake the construction and management works of all these projects, especially, the operation of the bus terminals (one Urban Bus Center and three Inter-regional Bus Terminals), including the management of building and parking. Since the business of this kind can be run well by the private sector, it is desired to introduce the non-government vitality.

As explained in more detail in Chapter 22, each project will not be profitable except the Urban Bus Center project, therefore, it is not desirable to establish an independent entity to perform each project. It is recommended to manage the projects with similar role or function under the same appropriate entity. Considering the function of each project, the recommended nine projects are categorized into three groups: (1) Toll Roads, (2) Public Transportation, and (3) Inspection. For these three groups, the following entities are recommended to undertake projects;

(1) Public Corporation for Toll Road Projects

The Municipality establishes an independent organization with a self-supporting accounting system for operation of the toll road projects. Any private enterprise does not intervene in this public corporation.

(2) Third Sector for Public Transportation Projects

A new organization, called as Third Sector, is established to implement the public transportation projects by financing the necessary equity and operating capital under the cooperation of the public sector and private sector .

(3) New Section in the Municipality for Inspection

It is desirable for the Municipality to perform the bus inspection and maintenance project since the revenue is not expected much but the project is useful from the social welfare aspect.
Accordingly, the implementation entity for each project can be summarized in Figure 20.1.

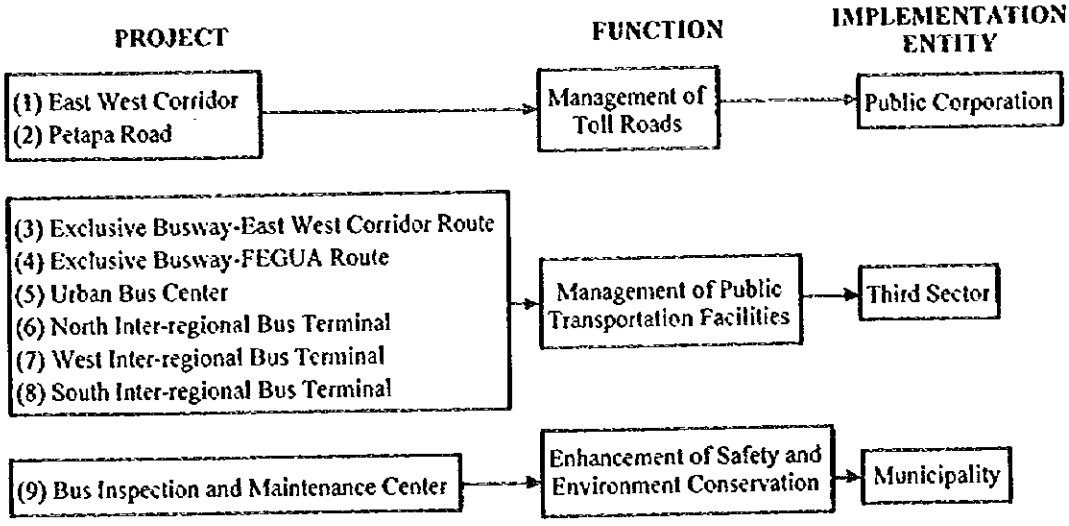

Figure 20.1 Implementation Entity for Each Project

20.3.1 Establishment of the Public Corporation for Toll Road Projects

The public corporation responsible for operating the toll road projects should be established under the Mayor of the Guatemala Municipality and the Board of Directors as the toll road corporation. Therefore, the operation, management, administration, accounting, etc., are supervised by the Municipality. The organization structure of this corporation and the main responsibilities of each section are shown in Figure 20.2 and Table 20.1. The staff composition of this corporation by the year 2010 is shown in Table 20.2.

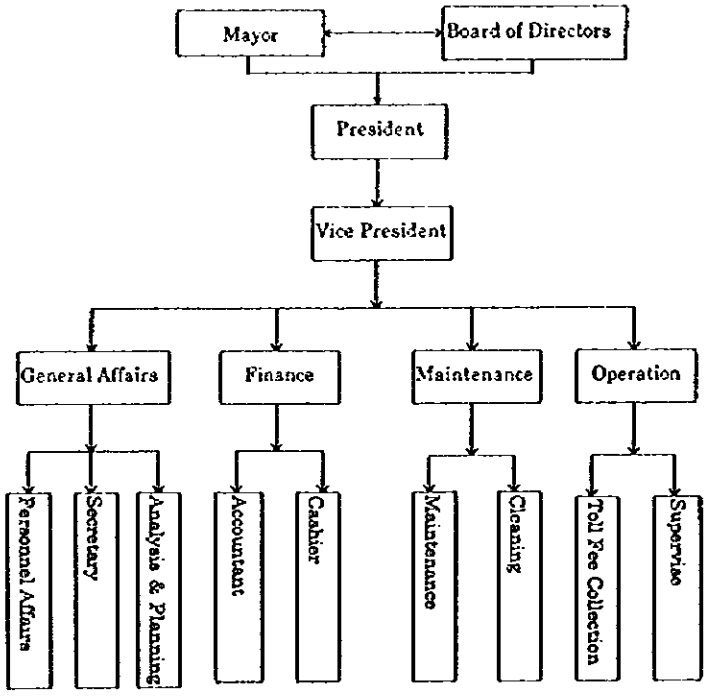

Figure 20.2 Organization of Toll Road Corporation

Table 20.1 Main Duty of Each Section in Toll Road Corporation

Department	Section	Responsibility
General Affairs	Personnel Affairs	• General personnel affairs • Personnel management
	Secretary	• Secretarial work • Public Relation
	Analysis & Planning	• Data Collection • Analysis & study • Planning
Finance	Accountant	• Accountant's Business • Loan Handling
	Cashier	• Paying & Receiving money
Maintenance	Maintenance	• Maintenance of facilities
	Cleaning	• Cleaning of facilities
Operation	Toll Fee Collection	• Toll fee collection
	Supervision	• Supervision of toll fee collection

Table 20.2 Number of Staff in the Toll Road Corporation

Position	Number of Staff
President	1
Vice President	1
Senior Administrator	1
Administrator	1
Senior Accountant	1
Accountant	2
Chief Inspection Officer	1
Inspection Officer	3
Senior Engineer	2
Engineer & Mechanic	4
Chief Toll Fee Collector	10
Toll Fee Collector	60
Others	15
Total	102

20.3.2 Third Sector for Public Transportation Projects

In case of promoting the project under the third sector, the management sense of the private enterprises and the public nature in the public sector are merged and made use of both merits. Generally, the following merits can be counted;

1) Through obtaining the management method of the private enterprises, the management efficiency is increased.

2) The budget restraint of the each fiscal year in the public sector is relievd.

3) The formation of the consensus among the regional people is easy.

4) The support and help by the public administration through vitalized use of the public land acquisition are expected. The general outline of setting up this entity is shown in Figure 20.3.

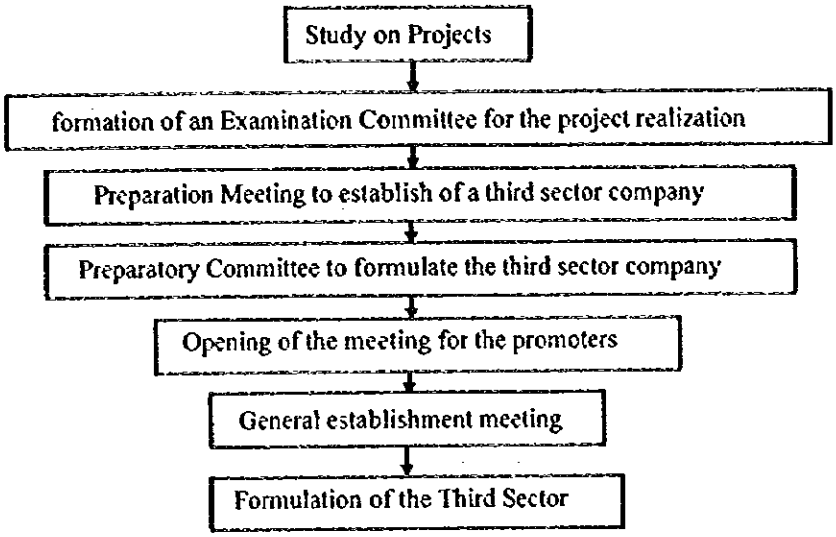

Figure 20.3 Formulation of a Third Sector

The entity responsible for public transportation management also includes the management of tenants, parking lots and advertisement, therefore, it is desirable for this entity to be run by the third sector. In this case the joint venture private enterprises can transfer their expertise and know-how to the established third sector. The organization of this third sector and the main duties of each section are shown in Figure 20.4 and Table 20.3, respectively. The staff composition of this third sector company by the year 2010 is shown in Table 20.4.

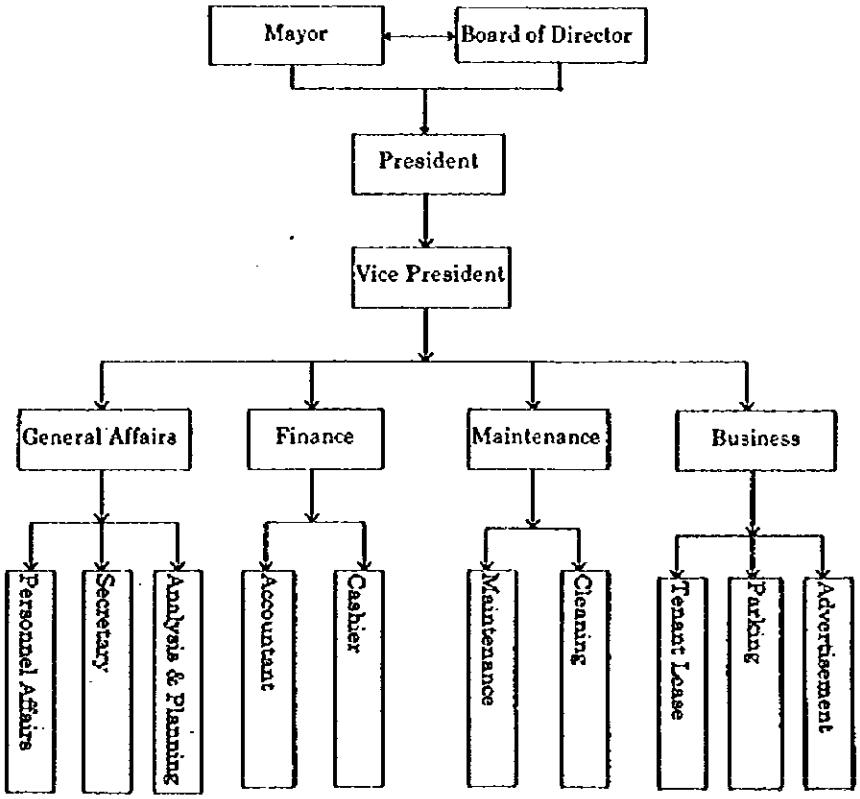

Figure 20.4 Organization of Public Transportation

Table 20.3 Main Duties of Each Section in Public Transportation Entity

Department	Section	Responsibility
General Affairs	Personal Affairs	• General personnel affairs • Personnel management
	Secretary	• Secretarial work • Public Relation
	Analysis & Planning	• Data Collection • Analysis & study • Planning
Finance	Accountant	• Accountant's Business • Loan Handling
	Cashier	• Paying & Receiving money
Maintenance	Maintenance	• Maintenance of facilities
	Cleaning	• Cleaning of facilities
Operation	Buss Fee Collection	• Bus fee collection
	Supervision	• Supervision of bus fee collection
Business	Tenant Lease	• Find a tenant • Collection of tenant fee • Maintenance of building
	Parking	• Collection of parking fee • Maintenance of parking lots
	Advertisement	• Find clients (marketing) • Collection of advertisement fee

Table 20.4 Number of Staff in Third Sector Company for Public Transportation Entity

Position	No. of Staff
President	1
Vice President	1
Senior Administrator	1
Administrator	6
Senior Accountant	1
Accountant	6
Chief Inspection Officer	3
Inspection Officer	12
Senior Engineer	2
Engineer & Mechanic	5
Guard	20
Total	58

20.3.3 Bus Inspection and Maintenance Center

This center provides a pure public service, therefore, this center is recommended to be formulated as one section in the Municipality. The organization of the Bus Inspection and Maintenance Center and the main duties of each section are shown in Figure 20.5 and Table 20.5, respectively. The staff composition of this section by the year of 2010 is shown in Table 20.6.

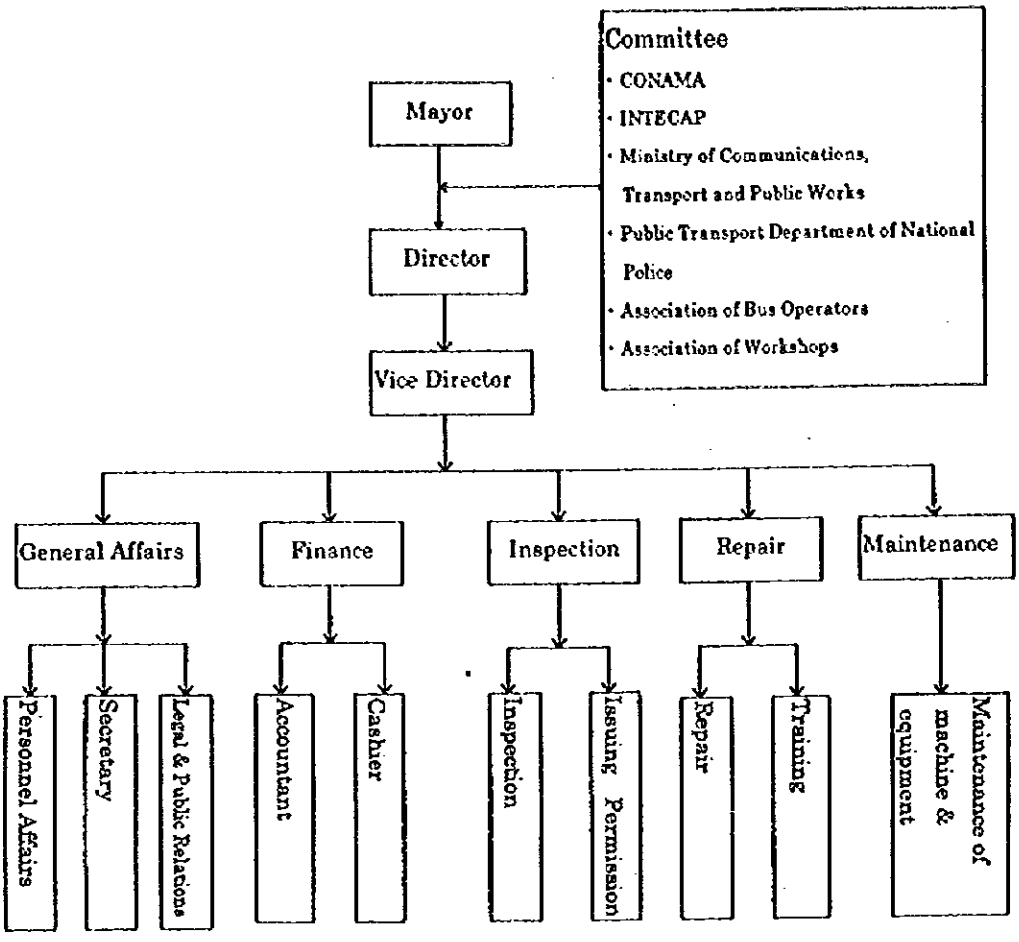

Figure 20.5 Organization of Bus Inspection and Maintenance Center

Table 20.5 Main Duties of Each Section in Bus Inspection and Maintenance Center

Department	Section	Responsibility
General Affairs	Personal Affairs	• General personnel affairs • Personnel management
	Secretary	• Secretarial work • Public Relation
	Legal & Public Relations	• Formulation of regulations • Publicity activities
Finance	Accountant	• Accountant's Business • Collection of inspection fee and repair fee
	Cashier	• Paying & Receiving money
Inspection	Inspection	• Bus inspection
	Issuing Permission	• Issuing Permission
Maintenance	Repair	• Repairing damaged buses
	Parts Management	• Management of parts
Training	Training	• Training of Mechanics

Table 20.6 Number of Staff in Bus Inspection and Maintenance Center

Position	Number of Staff
Manager	1
Deputy Manager	1
Senior Administrator	1
Administrator	2
Senior Accountant	1
Accountant	2
Chief Registration Officer	1
Registration Officer	4
Mechanic	10
Assistant Mechanic	10
Senior Inspection Officer	2
Inspection Officer	4
Total	44

Note : Mechanics include sheet metal worker, painter, auto parts clerk, and instruction coordinator.

VII PROJECT EVALUATION

VII PROJECT EVALUATION

21. Economic Evaluation

21.1 Evaluation Method

Economic internal rate of return (EIRR), economic benefit-cost ratio (B/C) and economic net present value (NPV), whose formulae are shown below, were calculated in order to examine the economic feasibility of the projects.

$$EIRR = i_0 : \sum_{t=1}^{n} (B_t - C_t) / (1+i_0)^t = 0$$

$$B/C = \sum_{t=1}^{n} B_t / (1+r)^t \Big/ \sum_{t=1}^{n} C_t / (1+r)^t$$

$$NPV = \sum_{t=1}^{n} (B_t - C_t) / (1+r)^t$$

where n : project life (34 years for this study)
t : t th year from 1997
B_t : total benefits of the project in the year t
C_t : total cost of the project in the year t
r : discount rate (opportunity cost of capital, 12% for this study)

Period for evaluation extends 34 years, starting from 1997 and ending in 2030. Residual value was calculated as a minus cost in 2031. In the economic analysis, 10% of the construction costs and 90% of the land and compensation costs were counted as residual value in the next year following the evaluation period.

Because of close relationship among the projects in function and implementation, the projects were evaluated as a whole and in packages, followed by the evaluation of individual projects. Composition of the packages is as follows:

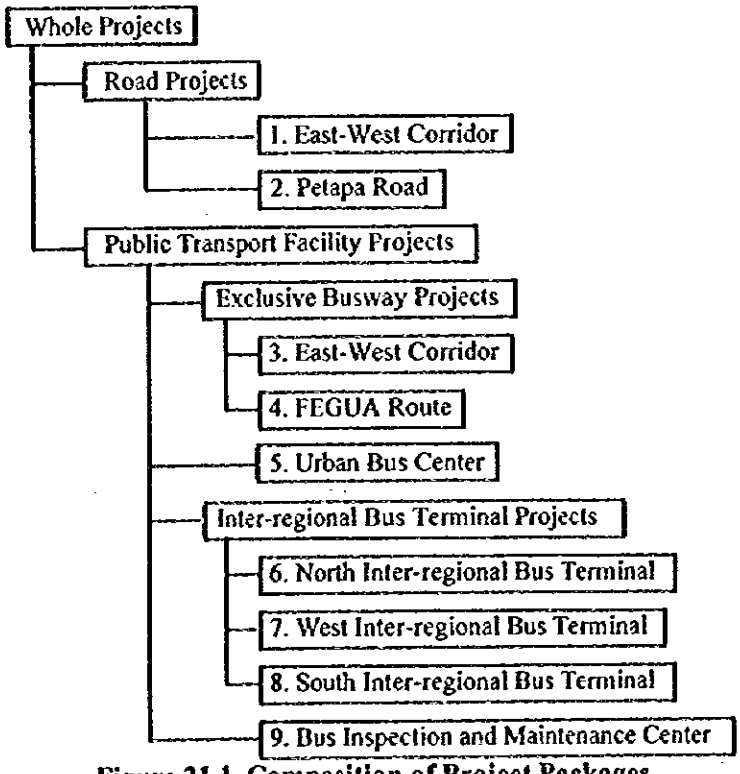

Figure 21.1 Composition of Project Packages

Sensitivity analyses were made on the variation of construction costs, total traffic demands, operation costs and commercial benefits to illustrate the difference in feasibility for each variation. Economic viability in case of the decrease in total trip production and commercial benefits in the bus center and terminals, as well as the increase in project costs, were examined in the sensitivity tests.

21.2 Benefits of the Projects

(1) Methods for Benefit Estimation

By nature of feasibility studies, direct positive impacts caused by the projects were counted as benefits in the cost-benefit analysis, while indirect impacts are also examined in the master plan studies. The Projects will result in savings of vehicle operation costs (VOC) and of traveling time (TT). The difference in costs, such as VOC and TT, between the "with the project" case and the "without the project" case is counted as benefits of the respective project.

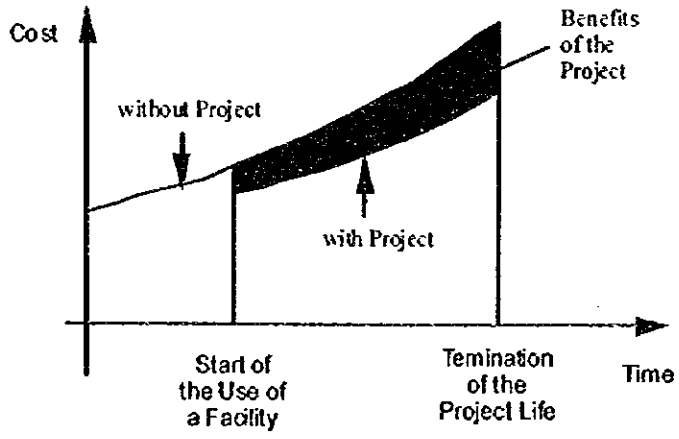

Figure 21.2 Benefits of a Project

In the "without" case, no other projects are assumed in principle. The benefit from each project or package is the difference in costs between the case that no project proposed by the Study is implemented and the case that only the respective project or package is completed. In the evaluation of Exclusive Busway projects, however, respective road projects are assumed both in the "with" and the "without" cases. For the evaluation of Urban Bus Center, roads and exclusive busway projects, and West and South Inter-regional Bus Terminals are assumed to have been implemented even in the "without" case. Table 21.1 shows assumed projects in the "without" case and Table 21.2 shows comparison made for calculation of benefits from VOC and TT savings.

Benefits were estimated yearly up to 2010 for the evaluation of the whole project and project packages. The benefits in 2010 are supposed to continue after 2010 up to the end of the evaluation period. Besides, for the evaluation of individual projects, benefits in 2010 are assumed to occur from the commissioning to the end of the evaluation period.

Table 21.1 Assumed Projects in the "Without" Case

(Δ: assumed projects)

package		Whole Projects								
		Road		Public Transport Facility						
				Exclusive Busway		---	Inter-regional Bus Terminal			---
projects		assumed projects in "without" case - marked with Δ								
		1	2	3	4	5	6	7	8	9
		E-W Corridor	Petapa Road	E-W Route	FEGUA Route	Urban Bus Center	North	West	South	Bus I/M Center
Roads										
1	E-W Corridor.	---								
2	Petapa Road		---							
Exclusive Busway										
3	E-W Route	Δ		---						
4	FEGUA Route		Δ		---					
5	Urban Bus C.	Δ	Δ	Δ	Δ	---		Δ	Δ	
Inter-regional Bus Terminal										
6	North						---			
7	West							---		
8	South								---	
9	Bus I/M Center									---

(Note) In economic analysis of each project listed in each *row*, when some of the columns in respective row are marked with Δ, projects listed on the top of those *columns* are assumed even in the "without" case. For example, in economic analysis of East West Exclusive Busway project, East West Corridor project is assumed even in the "without" case. The benefits from East West Exclusive Busway project are the difference in costs between the two conditions; the condition where only the East West Corridor project is completed and the condition where both the East-West Corridor and the East West Exclusive Busway are completed.

Table 21.2 Comparison of Benefits Estimation

Project	"without"	"with"
0. No Projects		
Road Projects		
1. East-West Corridor	(0)	(1)
2. Petapa Road	(0)	(2)
Exclusive Busway Projects		
3. East-West Corridor Route	(1)	(1+3)
4. FEGUA Route	(2)	(2+4)
5. Urban Bus Center	(1+2+3+4+6+7)	(1+2+3+4+5+6+7)
Inter-regional Bus Terminal Projects		
6. North	(0)	(6)
7. West	(0)	(7)
8. South	(0)	(8)
9. Bus Inspection and Maintenance Center	(0)	(9)
Package		
- Whole Projects	(0)	(1+2+3+4+5+6+7+8+9)
- Road Projects	(0)	(1+2)
- Public Transport Facility Projects	(1+2)	(1+2+3+4+5+6+7+8+9)
- Exclusive Busway Projects	(1+2)	(1+2+3+4)
- Inter-regional Bus Terminal Projects	(0)	(6+7+8)

(Note) Numbers show total of VOC and value of TT after the projects numbered in the left columns are implemented. The benefits of individual projects and project packages from savings in VOC and TT were calculated by comparison between the "with" and the "without" cases.

In addition to the savings in VOC and TT, commercial benefits, such as revenue from tenants, parking and advertisement, were counted in the economic analysis, after conversion into economic values, for the Urban Bus Center and Inter-regional Bus Terminals. The benefits from commercial activities, which will increase up to 2016 corresponding to the scale of the activities, are estimated yearly and counted in benefit streams according to the change in financial revenue.

(2) Unit VOC

The calculation of unit VOC was made in the same manner applied in the Master Plan Study by JICA (1992) with revisions of prices and other conditions from collected and estimated data . The results of the estimation are shown in the table below.

Table 21.3 Unit VOC

(Unit: Q./km)

Running Speed (km/h)	Car	Bus
5	1.514	3.706
10	1.439	3.671
15	1.368	3.612
20	1.313	3.558
25	1.275	3.515
30	1.243	3.478
35	1.214	3.447
40	1.189	3.415
45	1.171	3.392
50	1.158	3.371
55	1.147	3.359
60	1.141	3.350
65	1.139	3.359
70	1.138	3.370
75	1.140	3.383
80	1.144	3.399

Fuel costs were calculated using fuel consumption data applied in the Master Plan in the Appendices and revised economic price of fuel.

Table 21.4 Fuel Cost per Vehicle

(Unit: Q./km)

Running Speed (km/h)	Passenger Car	Bus	Truck		
			Light	Medium	Heavy
5	0.685	0.775	0.600	0.681	0.763
10	0.597	0.739	0.550	0.637	0.723
15	0.516	0.681	0.494	0.588	0.681
20	0.458	0.626	0.451	0.522	0.594
25	0.421	0.584	0.415	0.484	0.551
30	0.387	0.547	0.385	0.451	0.517
35	0.358	0.516	0.357	0.419	0.479
40	0.332	0.484	0.335	0.394	0.453
45	0.314	0.460	0.318	0.373	0.431
50	0.301	0.440	0.306	0.359	0.412
55	0.288	0.428	0.297	0.350	0.401
60	0.281	0.419	0.297	0.344	0.390
65	0.276	0.428	0.301	0.347	0.394
70	0.272	0.438	0.306	0.354	0.404
75	0.269	0.451	0.318	0.369	0.420
80	0.267	0.467	0.331	0.385	0.438

The costs other than fuel costs were calculated as shown in the table below. Repair and maintenance costs other than tire replacement were obtained from the interview survey with bus companies.

Table 21.5 VOC other than Fuel Cost per Vehicle

(Unit: Q./km)

	Passenger Car	Bus	Truck		
			Light	Medium	Heavy
Engine Oil	0.025	0.042	0.025	0.050	0.066
Tire Replacement	0.041	0.318	0.106	0.214	0.298
Other Repair and Maintenance	0.060	0.752	0.090	0.226	0.376
Depreciation	0.308	0.386	0.214	0.192	0.390
Interest	0.070	0.273	0.034	0.045	0.138
Insurance	0.170	0.193	0.107	0.096	0.195
Crew	0.000	0.643	0.429	0.250	1.350
Administration	0.000	0.325	0.206	0.143	0.101
Sub-total	0.674	2.932	1.211	1.215	2.914

(3) Value of Traveling Time

In calculation of value of traveling time, the passengers of "Cars" were supposed to be car owners, while that of "Buses" to be non car owners. From data of the supplemental survey, average income of car owners and non car owners estimated as follows;

Average Income: - Car Owners; Q.2,726/month (Q.13.63/hour)
- Non Car Owners; Q.1,682/month (Q. 8.41/hour)

In estimating the saving, the time value only for business related trips was counted. Assuming the ratio of business related trips as 0.49, and average number of remember of passenger of a "Car" and a "Bus" as 1.8 persons and 20 persons respectively, the time value of a "Car" and a "Bus" is estimated as follows;

Time Value: -"Car"; Q.12.02/hour
-"Bus"; Q.82.42/hour

(4) Commercial Benefits

In estimating the project benefits of the Urban Bus Center and three Inter-regional Terminals, revenues from commercial activities were also taken into account. Revenue from tenants in commercial spaces, parking and advertisement fees estimated in the next chapter were counted as economic benefits. Financial revenue is multiplied by 0.9 for conversion into economic benefits, deducting the value added tax as a transfer item.

(5) Benefits of Bus Inspection and Maintenance Center

Bus Inspection and Maintenance Center projects will have various important benefits. The project will contribute much to safe and comfortable operation of buses, which is the only major means of public transportation available to most of the people in the Study Area. The center will enable pollution control caused by emission gas from buses and noise abatement through inspection services. In addition, the project will facilitate efficient public transport services. Further, the project will also reduce many of troubles in bus operation on roads, and consequently will encourage punctual service and decrease waiting time of passengers, and also reduce congestion on roads resulting from bus troubles.

The estimation of benefits in monetary terms resulting from the Bus Inspection and Maintenance Center project, however, is quite difficult. In spite of the importance of the benefits, numerical estimation and forecasts are almost impossible for many of the benefits mentioned above because of the limited availability of data and information. Some unpredictable factors, such as the impact on attitudes or the environmental awareness of bus operators, or strictness of inspection and obedience with respect to orders for repair after inspection, may also be included in the estimation.

Despite the above difficulties, a rough estimation was tried with many assumptions. Following benefits were estimated as benefits of the project:

a) reduced accidents caused by poor-maintenance of buses
b) reduced costs for recovery from health problems caused by air contamination from bus exhaust
c) increased operation ratio of buses
d) less fuel consumption for bus operation

(6) Estimated Benefits

1) Results of Estimation

Estimated benefits are shown in the table below. Benefits of project packages do not necessarily equal to the sum of benefits of respective project components because of the inter-relationship among components. Benefits from savings in VOC and TT were estimated up to 2010, while benefits from commercial activities will increase up to 2016.

Table 21.6 Estimated Benefits

(Q. thousand)

	Benefits in 2016	
	with commercial	without commercial
Whole	370,493	334,415
Roads	94,590	94,590
- East-West Corridor	41,609	41,609
- Petapa Road	37,544	37,544
Public Transport Facilities	276,026	239,949
Exclusive Busways	181,230	181,230
- East-West Corridor Route	23,722	23,722
- FEGUA Route	164,414	164,414
- Urban Bus Center	42,933	13,354
Inter-regional Bus Terminals	37,788	31,020
- North	7,756	6,592
- West	19,236	16,333
- South	9,689	7,258
Bus Inspect./Mainte. Center	14,414	14,414

2) Road Projects

Benefits of road projects are gross savings in VOC and TT to meet the traffic demands of the future.

Table 21.7 Benefits of Road Projects

Project	Benefits in 2010 (Q. thousand/year)			
	VOC	TT	Total	
East-West Corridor	2,145	39,464	41,609	(100%)
- bus	2,276	24,315	26,951	(65%)
- car	-132	15,149	15,018	(36%)
Petapa Road	-1,273	38,816	37,544	(100%)
- bus	5,064	24,499	29,563	(79%)
- car	-6,337	14,318	7,981	(21%)

3) Exclusive Busway Projects

Savings in VOC and TT were also counted as benefits from Exclusive Busway projects. The benefits consist of those for bus passengers, bus operators and other vehicle users.

Table 21.8 Benefits of Exclusive Busway Projects

Project	Benefits in 2010 (Q. thousand/year)			
	VOC	TT	Total	
East-West Corridor Route	-24,238	47,960	23,722	(100%)
- bus	-18,032	48,791	30,759	(130%)
- car	-6,205	-831	-7,037	(-30%)
FEGUA Route	15,914	148,500	164,414	(100%)
- bus	1,214	140,924	142,138	(86%)
- car	14,700	7,577	22,277	(14%)

4) Urban Bus Center and Inter-regional Bus Terminals

The Urban Bus Center and Inter-regional Bus Terminals will also bear savings in TT of bus passengers as well as in VOC of bus operators.

Table 21.9 Savings in VOC and TT by Urban Bus Center and Inter-regional Bus Terminals

Project	Benefits in 2010 (Q. thousand/year)		
	VOC	TT	Total
Urban Bus Center	14,163	-809	13,354
Inter-regional Terminal			
- North	3,377	3,214	6,592
- West	10,004	6,329	16,333
- South	4,576	2,682	7,258

As estimated in the next chapter, financial revenue will gradually increase year by year in each center or terminal according to the development of commercial activities. The economic benefits will expand with the same rate of the increase in the financial revenue up to 2016. Economic benefits from commercial activities in 2016 were estimated as shown below. After 2016, the same value is counted in the benefit streams.

Table 21.10 Economic Benefits of Urban Bus Center and Inter-regional Bus Terminals from Commercial Activities in 2016

year	Urban	Inter-regional Bus Terminal			total
	Bus Center	North	West	South	
2016	29,579	1,164	2,903	2,431	36,077

5) Bus Inspection and Maintenance Center

According to the estimation calculated below, annual benefit of the respective aspects in 2010 will be as follows:

Table 21.11 Benefits of Bus Inspection and Maintenance Center

Counted Benefits	Annual Benefits (Q. thousand)
a) reduced accidents caused by poor maintenance of buses	627
b) reduced costs for recovery from health problems caused by air contamination from bus exhaust	90
c) increased operation ratio of buses	8,713
d) increased fuel efficiency of bus operation	5,479
Total	14,414

a) Reduced Accidents caused by Poor Maintenance of Buses

Accident records in 1992 from the INE, most recent available records, were analyzed. In 1992, 31 accidents were reported to be caused by urban buses in the country. The records from the INE also show that 7.7% of the accidents occurring in 1990-1992 were caused by poor maintenance of vehicles.

The share in the number of urban bus units of the Department of Guatemala to the whole country was 92% according to the registration in the Ministry of Public Finance in 1995. Assuming the same accident rate for one urban bus in the Department of Guatemala and the rest of the country, the number of urban bus accidents in 1992 was 29. As in 1992, the number of urban buses in operation can be estimated at 2,655 units in the Department of Guatemala. Thus, the number of accidents per 100 urban bus units in operation per year can be estimated at 1.1 in the Department in 1992. Supposing the same rate of accidents caused by poor maintenance to the total accidents for any type of vehicle, the number of accidents per 1,000 units of bus per year caused by poor maintenance is 0.83 in the Department.

The number of bus units in operation in the study area in 2010 is estimated at 4,300, which include urban and suburban buses. With the same rate of the above, 3.6 accidents can be estimated to occur caused by poor maintenance of urban buses and suburban buses in the "without" case.

When it is assumed that the inspection and maintenance proposed in the project can reduce the accidents by half caused by poor maintenance, reduced accidents will be 1.8/year. With an insurance rate of 5% of the price of a new bus and half of the insurance to cover traffic accidents, the average cost for one accident can be estimated as Q. 348 thousand. The annual benefits from reduced accidents can be estimated at Q. 627 thousand/year.

b) Reduced Costs for Recovery from Health Problems caused by Air Contamination from Bus Exhaust

The only information obtained on damages caused by environmental deterioration resulting from air contamination, including that from bus operation, is the result of a survey by San Carlos University conducted in June and August of 1995. The survey included interviews with 60 street venders who were exposed to air contamination for an average of 9.9 hours a day, and who carry on their activities near 6 air quality monitoring stations. The questions were asked whether street venders had had health problems, i.e., 13 symptoms which can be caused by air contamination, such as eye irritation, nose secretion, soar throat, headaches, etc., in the last two weeks before the survey. According to the survey, a large portion of the venders had heath problems. Average probability of venders who had suffered at least from one of the symptoms related to eyes, respiratory organs, headache or others are shown below:

Table 21.12 Probability of Suffering from Symptoms of Street Venders in the Last Two Weeks by Category of Symptom

(average of the two surveys in June and August, 1995)

	Trebol	EFPEM	MUSAC	Central Motriz	HINO	USAC	average near 6 monitoring stations
average exposed hours per day	12.0	8.2	8.5	10.7	9.9	9.9	9.86
Eye	60%	80%	40%	75%	55%	60%	62%
Respiratory	60%	75%	35%	80%	70%	55%	63%
Headache or Other	50%	70%	40%	70%	45%	65%	57%

(Source: San Carlos University)

Table 21.13 Result of the Air Quality Monitoring (Annual Average)

		Trebol	EFPEM	MUSAC	Central Motriz	HINO	USAC	average	limits (WHO)	general symptoms in case of high concentration
SPM	$\mu g/m^3$	513	356	112	182	252	94	251.5	240	respiratory illness
NO_2	$\mu g/m^3$	56	55	46	49	52	20	46.3	100	susceptibility to respiratory infection, cuffing, colds, throat irritation
O_3	$\mu g/m^3$	92	78	69	93	93	75	83.3	150	eye and respiratory irritation, reduction of respiratory function
CO	ppm	10	11	N.D.	7	8	N.D.	-	9	headache, fatigue

(Source: Swiss Contact/ProEco)
(Note: SPM-Suspended Particular Materials)

From the tables above, some correlation can be observed between the air quality and the number of street venders who suffer from health problems, such as those in respiratory organs, eyes, and headaches, etc.

According to the Municipality, 3,300 are registered as street venders and some 55% of the total are registered at the Municipality. In this analysis, 6,000 persons are estimated to work along streets during most of the daytime. Some 3,700, 3,800 and 3,400 persons can be estimated to have suffered from health problems in the eyes, respiratory system and others, respectively, at least once every two weeks. According to the result of interviews with 20 street venders at Trebol, EFPEM, HINO and Central Motriz, their response to the health problems are taking rests and/or taking medicines.

In this calculation, it is assumed that 75-80% of venders have been suffered from some of the heath problems, and that 70% of the street venders, or 4,200 persons, taking rests 4 hours in a month and 50% of them, or 3,000 persons, take medicine costing Q.5 at one time to deal with the problems. From the result of the same interviews for this study, average income of the venders can be estimated at around Q.5 per working hour, total costs were estimated at Q.99 thousand for a mouth.

It is said that 60-70% of the air contamination comes from vehicle operation in the Metropolitan Area. Since most of the buses in operation have no emission control devices with inadequate engine installation, substantial portion of air contamination stem from urban bus operation, especially soot, or SPM, and NO_2. Proposed inspection and maintenance program will contribute to improvement of the quality of emission gas from buses. The contribution will result in a decrease in health problems of the venders. In the estimation, it is assumed that the percentage of each health problem is to be reduced to 65%, to 55% of venders taking rests and to 45% taking medicine. The total costs for the recovery "with" the project will be Q.91.5 thousand for a mouth, and the amount to be reduced will be Q.90 thousand per year.

c) Increased Operation Ratio of Buses

Proper inspection and maintenance will enable more than 85% operation ratio. Current bus operation condition are that the buses are operated without adequate inspection or preventive maintenance leading to a major disorder or a fatal mechanical trouble. Much repair work is required when a major disorder or trouble occurs, thus long periods are spent for the repair.

Because of the low ratio of the number of bus units in circulation to the number registered, 60% to 70% in 1996, the portion of units in operation can be assumed as 75% out of the unabandoned units, allowing that some 10% of the registered buses are abandoned with postponed de-registration for some reason. When 90% of operation ratio are the assumed for the 75% of buses in operation, minor problems the going undetected, the current operation ratio can be estimated at some 70%.

In case of proposed inspection and encouragement of preventive maintenance, the operation ratio can be estimated to be raised by 1.5%, assuming one fifth of the coverage of bus maintenance and half of the achievement, thus, around one tenth of fulfillment of the gap between the current status and the ideal condition.

Bus operation costs can be divided into fixed costs and variable costs. Fixed costs occur even if the bus is not operated. According to the data used for VOC calculation, annual fixed costs, such as depreciation, interest, wages of crew, for a bus amount to Q. 174,000/year•unit. With a raise of 1.5% of the operation ratio for 4,300 units in 2010, Q. 8,217 thousand will be saved.

d) Increased Fuel Efficiency of Bus Operation

Good maintenance improves fuel efficiency. According to a local environmental consultant, some 10% to 15% of the fuel efficiency can be improved with adequate engine installation and proper maintenance, taking into account the current conditions of inadequate engine installation, often lack of consideration for the high altitude of the area, and poor maintenance, especially unchanged filters. Examples from the foreign countries show that several percents in fuel efficiency improvement of vehicles can be attained by regular inspections.

With the proposed inspection, however, only a partial improvement can be assumed because of the limited capacity for maintenance, compared to the required maintenance work for 4,300 units of buses in 2010. In this estimation, one tenth of the theoretical improvement, the same rate used in the above estimation of increased operation ratio, a 1% efficiency increase, is assumed as a result of the inspection and maintenance of the project.

In this analysis, the average speed of buses is assumed as 14.7km/hour≈15km/hour. The calculation for fuel efficiency is made for the average speed. From the data of diesel consumption of buses used for VOC calculation at a speed of 15km/hour, 0.463 liter/km is applied as a base case. Then, 0.00463 liter/km can be saved when 1% improvement of the efficiency is taken for all bus operation. Since the running distance of the bus in 2010 in total is estimated at 805 million km/year, 3,727 thousand liters of diesel can be saved. With the economic price of diesel, Q. 1.47/liter, economic benefits from the increased efficiency is estimated at Q. 5,479 thousand.

21.3 Economic Costs of the Projects

Financial costs estimated in the previous chapter were converted into economic costs for the economic evaluation from the viewpoint of the national economy. The conversion is made in the following items:

1) Deduction of Transfer Items, such as Duties and Taxes

2) Wages of Unskilled Labor

3) Land Price

With the above conversion, economic costs of the projects were estimated as follows:

Table 21.14 Economic and Financial Costs of the Projects

	Economic Cost	Financial Cost
Whole	1,214,,997	1,331,223
Roads	494,016	573,726
- East West Corridor	350,182	402,436
- Petapa Road	143,834	171,290
Public Transport Facilities	720,982	757,497
Exclusive Busways	376,109	436,100
- East West Corridor Route	146,843	168,444
- FEGUA Route	229,266	267,656
- Urban Bus Center	199,419	195,723
Inter-regional Bus Terminals	105,305	87,372
- North Terminals	10,946	10,398
- West Terminals	47,170	49,588
- South Terminals	47,189	27,386
Bus Inspect./Mainte. Center	40,149	38,302

(1) Deduction of Transfer Items

For all goods and services, import taxes or custom duties, and other taxes, such as value added tax, called IVA, were deducted in the conversion. Distribution taxes for gasoline and diesel were also eliminated from economic costs.

(2) Wages of Unskilled Labors

Official statistics show that the unemployment rate of the country in 1995 is as low as 4.3%. With this figure, the economic value of the unskilled labor may be almost the same as the wage in the labor market. According to the calculation by the SEGEPLAN, the required labor force in 1995 to achieve the GDP with unchanged productivity from 1980 is estimated at less than 65% of the economically active population, with which figure the marginal unskilled labor force destined for the projects might have almost no economic value because the remaining 35% can be applied for the implementation. The calculation by the SEGEPLAN might ignore some of the activities in the informal sector whose contribution to the national production is hard to be estimated or not accounted in some cases.

In this evaluation, 0.85 of the market price of unskilled labor forces is assumed as the economic value because of substantial improvement of the labor market from the time of the Master Plan Study, where nearly 0.75 was applied for the calculation of the shadow wage.

(3) Land Price

No economic value is accounted for lands of no use, such as valleys or hilly areas. Lands used for residences, commercial establishments, offices or industrial purposes are accounted to be the same price as the market prices in the economic cost. Although some land for the project sites are owned by the Municipality or the Government, the economic values of those lands were estimated with consideration of the physical conditions and possible use, and added in the economic costs.

21.4 Cost Benefit Analysis

(1) Analysis of the Whole Projects and Project Packages

All packages are economically feasible, even though the commercial benefits are not taken into account, with more than 12% of economic internal rate of return (EIRR), positive net present value (NPV) and benefit-cost ratio (B/C) more than one. The whole project shows 28.5% of EIRR with Q. 770 million of NPV, when commercial benefits are included.

Road projects will yield a lower EIRR of 16.5%, compared to Public Transport Facility projects, whose EIRR is 30.2% in package. Exclusive Busway projects show considerably high EIRR, yielding more than 60% of the total NPV.

Table 21.15 Result of Cost-Benefit Analysis of Project Packages

Project Packages	with commercial benefits			without commercial benefits		
	EIRR	NPV Q.million	B/C	EIRR	NPV Q.million	B/C
Whole	28.5%	770	2.07	26.2%	644	1.89
Roads	16.5%	73	1.30	16.5%	73	1.30
Public Transport Facilities	30.2%	647	2.37	27.3%	522	2.09
Exclusive Busways	37.8%	475	3.18	37.8%	475	3.18
Inter-regional Bus Terminals	25.8%	101	2.11	21.4%	68	1.73

(2) Analyses of the Individual Projects

The results of the economic analyses for individual projects were given for reference. However, the process of the analyses was a little different from those for the whole projects and project packages. The separation of costs, as well as benefits, into each project includes some assumptions. Simple reading of the results could be misleading.

East West Corridor and Exclusive Busway-East West Corridor Route projects show lower EIRR with small amounts of negative NPV. Other projects show economic feasibility with more than 12% of EIRR. Projects such as Petapa Road, Exclusive Busway-FEGUA Route, North and West Inter-regional Terminal will be highly viable in economic terms, while Urban Bus Center and South Inter-regional show a little higher EIRR than the opportunity cost of capital (12%).

The economic feasibility of Urban Bus Center will be highly dependent on benefits from commercial activities, while Inter-regional Bus Terminals will be feasible even without commercial benefits.

Table 21.16 Result of Cost-Benefit Analyses of Individual Projects

Project	with commercial benefits			without commercial benefits		
	EIRR	NPV Q.million	B/C	EIRR	NPV Q.million	B/C
Roads						
- East-West Corridor	7.7%	-37	0.71	7.7%	-37	0.71
- Petapa Road	21.6%	79	1.69	21.6%	79	1.69
Exclusive Busways						
- East-West Corridor Route	11.3%	-3	0.94	11.3%	-3	0.94
- FEGUA Route	63.7%	628	4.90	63.7%	628	4.90
- Urban Bus Center	15.6%	30	1.27	2.3%	-64	0.43
Inter-regional Bus Terminals						
- North	91.8%	40	4.06	79.7%	33	3.51
- West	29.2%	59	2.59	26.0%	46	2.24
- South	17.2%	15	1.39	13.0%	3	1.07
Bus Inspect./Mainte. Center	44.1%	58	2.04	44.1%	58	2.04

21.5 Sensitivity Analysis

Sensitivity tests were made for the evaluation of the whole projects and project packages in the following four critical cases:

1) 10% Decrease in Total Trip Production
2) 10% Decrease in Commercial Benefits
3) 10% Increase in Construction Cost
4) 10% Increase in Operation Cost

Sensitivity to economic feasibility of the whole projects in cases of the variation of the above four elements are illustrated below. Variations of 10% in total trip production (-10%) and construction costs (+10%) will have a large effect on the EIRR, while those in commercial benefits (-10%) and operation costs (+10%) will result in a slightly smaller EIRR than that in the base case.

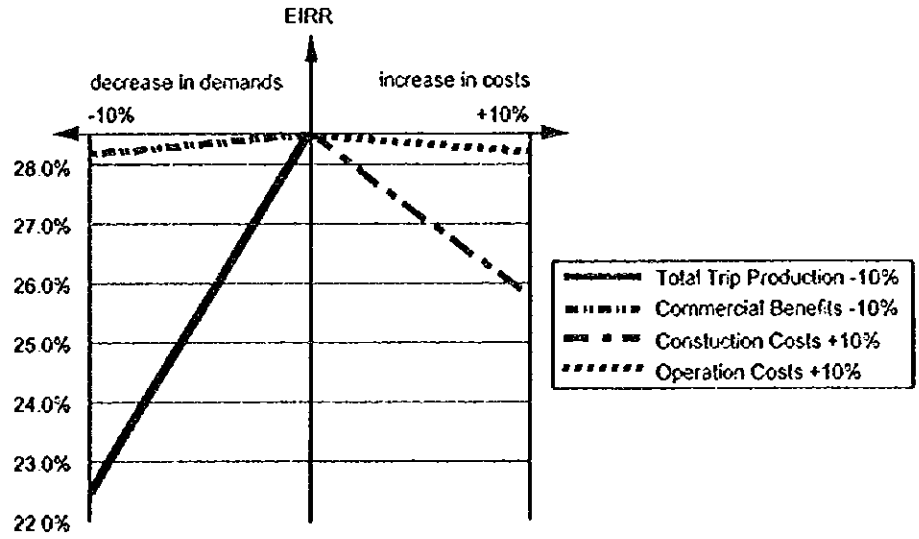

Figure 21.3 Result of Sensitivity Analysis

(1) 10% Decrease in Total Trip Production

A decrease of 10% in total production will result in reduced savings in VOC and TT. The reduced amount of the savings in 2010 will be as follows. Decrease of 10% in trip production will reduce 18.2% of the savings in VOC and TT. The benefits of road projects will be seriously affected by the decrease in trip production.

For the sensitivity test, the reduction of benefits was estimated yearly and counted in the benefits stream.

Table 21.17 Reduced Benefits by 10% Decrease in Total Trip Production

(Q. thousand)

	Benefits in 2010	to Base Case
	without commercial	without commercial
Whole	273,615	81.8%
Roads	66,181	70.0%
Public Transport Facilities	207,434	86.5%
Exclusive Busways	158,352	87.4%
Inter-regional Bus Terminals	24,063	77.6%

Despite a large decrease in the benefits, all project packages remain economically feasible. Decrease of 10% in total trip production will result in 22.5% of the EIRR for the whole projects, with 21% reduction of the base EIRR, and decrease of Q. 260 million in NPV and 0.37 in B/C ratio. Road projects will be barely feasible in case of a 10% decrease in trip production. For Road projects, about 25% of the base EIRR will be reduced in the case.

Table 21.18 Result of Sensitivity Analysis on Total Trip Production

	Total Trip Production-10%			Difference		
	EIRR	NPV Q.million	B/C	EIRR	NPV Q.million	B/C
Whole	22.5%	510	1.70	-6.0% (-21.0%)	-259.8	-0.37
Road Projects	12.3%	4	1.02	-4.2% (-25.5%)	-68.9	-0.28
Public Transport Facilities	26.3%	507	2.06	-3.9% (-12.9%)	-140.6	-0.30
Exclusive Busways	32.9%	379	2.74	-4.9% (-13.0%)	-95.3	-0.44
Inter-regional Bus Terminals	21.5%	67	1.73	-4.2% (-16.4%)	-33.6	-0.39

(2) 10% Decrease in Commercial Benefits

Decrease of 10% in commercial benefits will reduce 0.2% of the EIRR of the whole projects, Q. 13 million of the NPV, and 0.02 of B/C. The change in EIRR corresponds to -0.8% of the base EIRR. Economic feasibility of Urban Bus Center project will be considerably affected by the change in commercial benefits. Roads and Exclusive Busway projects are not affected by the change in commercial benefits because no commercial benefits were taken into account.

Table 21.19 Result of Sensitivity Analysis on Commercial Benefits

	Commercial Benefits-10%			Difference		
	EIRR	NPV Q.million	B/C	EIRR	NPV Q.million	B/C
Whole	28.3%	758	2.05	-0.2% (-0.8%)	-12.6	-0.02
Public Transport Facilities	30.2%	635	2.34	-0.3% (-0.9%)	-12.6	-0.03
- Urban Bus Center	14.5%	20	1.18	-1.1% (-6.9%)	-9.4	-0.08
Inter-regional Bus Terminals	25.5%	99	2.09	-0.2% (-1.0%)	-2.0	-0.02

(3) 10% Increase in Construction Cost

The economic feasibility of projects is highly sensitive to the variation in construction costs. Increase of 10% construction costs will reduce 2.6% of the EIRR of the whole projects. This figure corresponds to 9.2% of the base EIRR. Road projects will be affected most, with almost 10% decrease of the base EIRR, and explains one third of reduction of decrease in NPV of the whole projects.

Table 21.20 Result of Sensitivity Analysis on Construction Cost

	Construction Cost +10%			Difference			
	EIRR	NPV Q.million	B/C	EIRR		NPV Q.million	B/C
Whole	25.9%	710	1.90	-2.6%	(-9.2%)	-60.6	-0.17
Roads	14.9%	51	1.19	-1.6%	(-9.7%)	-21.9	-0.11
Public Transport Facilities	27.8%	608	2.18	-2.5%	(-8.1%)	-38.8	-0.19
Exclusive Busways	34.8%	455	2.92	-2.9%	(-7.8%)	-19.4	-0.26
Inter-regional Bus Terminals	23.8%	94	1.94	-2.0%	(-7.8%)	-7.4	-0.17

(4) 10% Increase in Operation Cost

Increase of 10% in operation cost will decrease 0.16% of the EIRR of the whole projects. The effects on the project feasibility of a variation of the operation costs are much smaller than those by the variation of the construction costs. Bus Inspection and Maintenance Center, Urban Bus Center and Road projects will be more strongly influenced by an increase of increase in operation costs, while Exclusive Busway projects will be scarcely affected by an increase in operation costs.

Table 21.21 Result of Sensitivity Analysis on Operation Cost

	Operation Cost +10%			Difference			
	EIRR	NPV Q.million	B/C	EIRR		NPV Q.million	B/C
Whole	28.3%	761	2.04	-0.16%	(-0.6%)	-8.7	-0.03
Roads	16.3%	70	1.29	-0.14%	(-0.9%)	-2.6	-0.01
Public Transport Facilities	30.1%	641	2.34	-0.16%	(-0.5%)	-6.1	-0.03
Exclusive Busways	37.7%	472	3.15	-0.05%	(-0.1%)	-2.1	-0.03
- Urban Bus Center	15.4%	28	1.25	-0.18%	(-1.2%)	-1.6	-0.02
Inter-regional Bus Terminals	25.6%	100	2.08	-0.16%	(-0.6%)	-1.2	-0.03
- Bus Inspect./Mainte. Center	43.4%	57	1.98	-0.69%	(-1.6%)	-1.3	-0.05

21.6 Socio-economic Considerations

(1) Distribution of the Benefits

Most parts of this chapter deal with economic evaluation, following conventional or traditional approaches to illustrate economic viability of the projects and the project packages. Traditional methods show economic feasibleness of projects in order to chose the most economically efficient project and thus to achieve maximum economic benefits from using the limited resources of the country, such as land, labor force natural resources, capitals and foreign currencies, ignoring income level of the beneficiary groups.

In this Study, however, the benefits can be divided into those for bus passengers, for bus operators and for car users. For calculation of the value of saved traveling time (TT), the average income of bus passengers and car users was estimated, assuming that the average income of bus passengers is equal to that of non car owners and that of car users is equal to car owners. It offers a good chance to consider the socio-economic implications of the projects.

Savings in TT for bus passengers and car users are compared in the below table. The benefit for bus passengers will amount to 4 times of that for car users, as a whole. Most of the benefit from savings in TT caused by Public Transportation Facility projects will be destined to bus passengers. Regarding Exclusive Busway projects, almost all of the benefit will be for bus passengers. Substantial portion of the benefit from Road projects will be received by car users.

Since the benefit from TT saving shares almost 80% of the total benefits and 90% of the benefits excluding commercial ones, as a whole, the figures in the below table tell much about benefits distribution of the Projects.

Table 21.22 Benefits from Saved TT by Type of Beneficiary Group

(unit: Q. million)

Project Packages	Bus Passenger	Car User	Ratio (bus passengers/car users)
Whole	235	59	4.0
Roads	48	31	1.6
Public Transport Facilities	187	28	6.8
Exclusive Busways	193	10	20.0
Inter-regional Bus Terminals	13	0	---

(Note) benefits in 2010

(2) Poverty Situation in Guatemala

Guatemala has serious problems of poverty and income distribution. According to a comparative study on poverty and income distribution by the World Bank, Guatemala is one of the countries that has the most serious inequality in income distribution. A socio-demographic survey in 1989 also revealed that 75% of the population was living below the poverty line, having insufficient purchasing power for a basic basket of goods and services whose costs may amount to around Q.2,000/month for a family, and 58% below the extreme poverty line, being unable to purchase a basic basket of food which costs Q.1,073/month for an average family of 5.38 persons in Guatemala City in January 1996. In the Metropolitan area, where 54% of the population live below the poverty line and 29% under the extreme poverty line in 1989, the seriousness appears less.

The seriousness of unequal distribution itself is a social problem. At the same time, prevailing poverty would be a large factor in hampering the economic growth through blocking efficient use of human resources of the country. Poverty alleviation is one of the most important strategies in national socio-economic development policy. Impacts of projects on income distribution should be an important element in the appraisal of public investment projects.

(3) Income Status of Bus Passengers and Car Users

In a previous section of this chapter, average income of bus passengers and car users were estimated as follows, according to the result of supplemental surveys:

Bus Passengers;	Q. 1,682/person•month (Q. 20.2 thousand/person•year)
Car Users;	Q. 2,726/person•month (Q. 32.7 thousand/person•year)

Assuming 1.6 persons having income in an average family which has 5.38 members, family income can be estimated as follows:

Bus Passengers Family;	Q. 2,624/family•month (Q. 31.5 thousand/family•year)
Car Users Family;	Q. 4,253/family•month (Q. 51.0 thousand/family•year)

Since propensity to consume can be estimated as 0.87 or 0.83 for an average family of bus passengers or car users, respectively, average consumption for a family was be estimated as follows.

Bus Passengers Family;	Q. 2,278/family•month (Q. 27.3 thousand/family•year)
Car Users Family;	Q. 3,517/family•month (Q. 42.2 thousand/family•year)

According to the above estimation, average bus passenger families can consume a little more goods and services which is included in the basic basket. It can be recognized that most of bus passenger families live near or blow the poverty line and that most of car user families live on far above the poverty line. The marginal utility of the benefit of the projects for a bus passenger family would be high because they live in or around critical conditions. The marginal utility of a car user families would be much less than that of bus users.

(4) Social Implication of the Projects

The implementation of the Projects as a whole, would have good impacts against inequality in income distribution, since a large portion of the benefits from the Projects will be destined to the bus passengers and contribute to increase in the consumption of them, and thus to raising the level of the welfare of them, most of whom live blow or around the poverty line.

Public Transportation Facility Projects in general, especially Exclusive Busways, may have large contribution in terms of income distribution in the Metropolitan Area. Compared to the Exclusive Busway projects, Road projects bear less positive impacts on well-being of the people in poverty.

22. Financial Evaluation

22.1 Premise of Financial Analysis

22.1.1 Procurement of Project Cost

As shown in Table 22.1, the total project cost was estimated at Q. 1,390 million including the land cost. Regarding the land cost, the land for Urban Bus Center, North Inter-regional Bus Terminal, South Inter-regional Bus Terminal, and Bus Inspection and Maintenance Center is owned by the Central Government or the Municipality. Considering that this land is expected to be contributed to the implementation entities free, the total necessary cost amounts to Q. 1,331 million.

Table 22.1 Necessary Project Cost (Unit: Q. 1,000)

Name of Project	Foreign Portion	Local Portion	Acquisition of Land	Total
East West Corridor	148,450	198,040	55,946	402,436
Petapa Road	69,751	92,136	9,403	171,290
Exclusive Busway-East West Corridor Route	63,758	80,997	23,689	168,444
Exclusive Busway-FEGUA Route	113,113	145,627	8,916	267,656
Urban Bus Center	117,434	78,289	26,400*	222,123
North Interregional Bus Terminal	6,239	4,159	1,900*	12,298
West Interregional Bus Terminal	20,753	13,835	15,000	49,588
South Interregional Bus Terminal	16,431	10,955	23,500*	50,886
Bus Inspect. and Mainte. Center	22,981	15,321	6,800*	45,102
Total	578,910 (41.7%)	639,359 (46.4%)	171,554 (12.3%)	1,389,823 (100.0%)
Total Cost subtracted the land cost owned by Government or Municipality	578,910 (43.5%)	639,359 (48.6%)	112,954 (8.5%)	1,331,223 (100.0%)

Note: The mark "*" is shown the land owned by the Municipality
(Total land cost is Q. 58,680 thousands)

Judging from the present financial position of the Guatemala Municipality, it is almost impossible to raise this huge amount of project cost. Therefore, according to the function of each project as mentioned in Section 19.3.3, the following fund procurement method is adopted;

1) Toll Road Project

The foreign portion is financed by loans from foreign countries or international lending agencies. The local portion is procured by the Municipality itself.

2) Public Transportation Project

The foreign portion is financed by loans from foreign countries or international lending agencies. Since the assignment to this project group includes the management of tenant leases, parking lots, and advertisement, private enterprises are desirable to participate in the project implementation. Therefore, the Municipality and private enterprises are assumed to provide with the capital for the local portion of the project cost. In this case the capital share of the Municipality is assumed to be 51% of the total local portion in order to maintain its initiative in the management.

3) Inspection Project

The service of this project is desirable to be provided by the Municipality because the content of the service is concerned with emission control from buses, inspection of bus condition, etc. Actually, the results of the financial analysis (explained in Section 22.2) point out difficulties in the project implementation under a self supporting accounting system. Therefore, the construction cost of this project is expected to be donated from foreign countries.

As shown in Table 22.2, 41.8% of the total project cost (except the land cost owned by the Central Government or Municipality) is necessary to be procured from foreign loans. The Municipality and the private sector should provide 41.3% and 14.0%, respectively. However, it must be noted that this fund procurement does not include Q. 58,600 thousand for land contribution from the public sector and Q. 38,302 thousand for the construction of the Bus Inspection Center is considered to be donated from foreign countries.

Table 22.2 Fund Sources of Projects

Fund Source	Amount (Q.1,000)	Share (%)
Foreign Loan	555,929	41.8
Municipality (Land)	550,074 (89,628)	41.3
Private Sector (Land)	186,918 (23,327)	14.0
Foreign Donation	38,302	2.9
Total	1,331,223	100.0

The followings are the detailed explanations on the procurement;

1) Procurement of foreign portion

The foreign portion is assumed to be procured by foreign loans under the following loan conditions;

- Interest Rate 12% per year
- Grace Period 5 years
- Pay Back Period 20 years

2) Procurement of funds from the Municipality

As shown in Table 22.2, the Municipality should prepare Q. 550,074 thousand . Judging from the present financial situation of the Municipality, it is impossible to finance this huge amount from the Municipality's general budget. In addition, it is also difficult for the Municipality to receive loans from local banks, since in the past 20 years the Municipality has not obtained loans from any local banks. Therefore, the Municipality should seek other financial sources.

The Municipality has already enacted a law on the contribution for improvement (Contribución por Mejoras Guatemala), which permits to impose some charge on the property located in the area benefited by the project. In the past years, this law has already applied to two projects. Following these past examples, this law is recommended to be applied to projects of this Study.

It is certain that after project completion, the living conditions will become more comfortable and the property values will increase in the area near the project sites. Considering the population density, agglomeration of business activities, access to the project sites, etc., the area influenced by this project was grouped into three categories as shown in Figure 22.1. By imposing a charge indicated in Table 22.3 to each category, the Municipality can obtain about Q. 642 million, which is sufficient to finance the project cost to be borne by the Municipality.

Table 22.3 Contribution By Category

Category	Content	Area (km^2)	Charge (Q./ m^2)	Contribution (Q.1,000)
A	Highest Contribution Area	15	8	120,000
B	Medium Contribution area	69	6	414,000
C	Lowest Contribution Area	36	3	108,000
Total Contribution		120	5.4	642,000

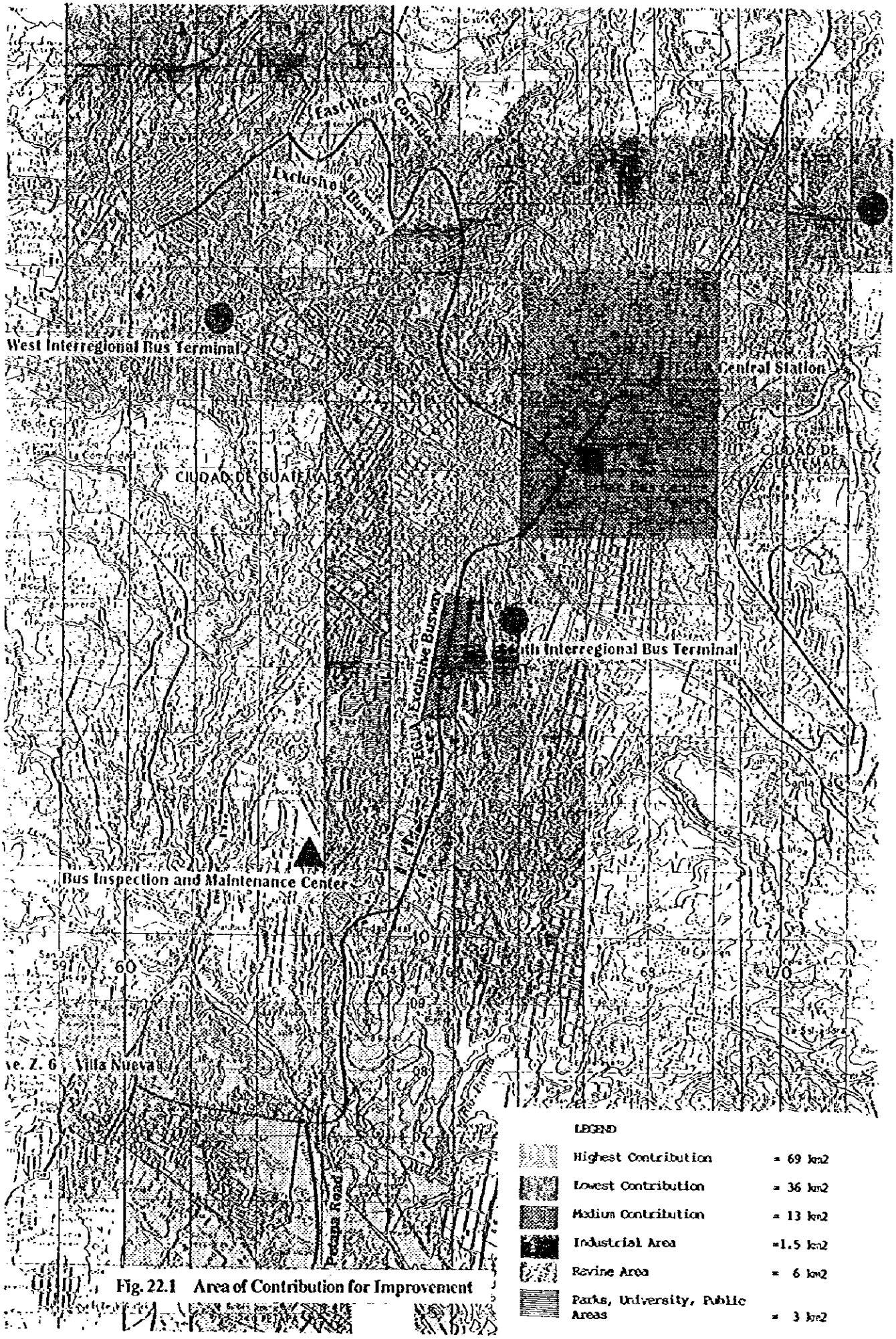

Fig. 22.1 Area of Contribution for Improvement

22.1.2 Sources of Revenue

In order to operate the projects effectively over a long period, it is desirable to obtain an appropriate level of revenue from the project operation. The following are considered to be the revenue sources the subsidy from the Municipality;

- Toll rate
- Tariff for buses to use facilities
- Rent from tenant
- Parking fee
- Charge for advertising inside buildings
- Inspection fee
- Bus repairing expenses

Revenue sources of each project are shown in Table 22.4.

Table 22.4 Revenue from Each Project

Project	Toll Rate	Tariff for Bus	Tenant	Parking	Advertise -ment	Inspection	Bus Repair
East West Corridor	●						
Petapa Road	●						
Exclusive Busway-E-W Corr. Route		●					
Exclusive Busway-FEGUA Route		●					
Urban Bus Center		●	●	●	●		
North Interregional Bus Terminal		●	●	●	●		
South Interregional Bus Terminal		●	●	●	●		
West Interregional Bus Terminal		●	●	●	●		
Bus Inspect. and Mainte. Center						●	●

22.1.3 Expenditure

The following items are considered to be expenditures for the project operation;

1) Administration Cost

For each entity operating the projects, the following cost was estimated; The detail calculation is presented in Appendix.

- Personnel cost
- Office space rental including water and electricity
- Telephone
- Office supply
- Vehicles
- Miscellaneous

2) Maintenance Cost

The maintenance costs of roads and bridges were estimated from the engineering aspect, considering periodical maintenance costs and overlay costs. On the other hand, the annual maintenance costs of buildings were assumed as 2% of the construction costs.

3) Depreciation

Working life of the civil engineering structures (roads and bridges) and buildings were assumed to be 50 years and 40 years, respectively. These are depreciated by the straight-line method with the 10% of residual value. Machinery and equipment are also depreciated by the straight-line method over 10 years. Land is not depreciated.

4) Interest Rate

The interest rate of the foreign loans was assumed as 12 % with 5 years grace period. Capital amortization period is 20 years. The loans from local banks were not considered, since the Municipality has not borrowed money from local banks in the past 20 years.

5) Tax

In Guatemala, 30% of the corporate income tax on the income before the tax are imposed on the private enterprises. However, since the corporate tax related to the third sector is not mentioned in the law, the third sector operating projects was assumed to be imposed 15% of the corporate tax, considering the usefulness of the project for the improvement of the social welfare.

22.2 Financial Analysis

22.2.1 Criteria of Financial Analysis

As a principal criterion for the project viability, the value of FIRR (Financial Internal Rate of Return) was adopted. Calculation of the financial analysis was performed under the real term (not considering inflation), since in the countries with more than 10% inflation, the net income is inevitably ballooned by the inflation, which makes difficult to understand the project viability precisely. At present in Guatemala the inflation rate is about 12% and the prime rate by private banks is estimated about 18% on average. Therefore, if the value of FIRR exceeds 6%, the project is judged to be viable.

22.2.2 Results of Financial Analysis

Under the above-mentioned premises of costs and revenues, the financial analysis was performed, at first, for each project in order to check its project viability. The results are summarized in Table 22.5 (1)~(5).

(1) East-West and Petapa Toll Road Projects

In case East West Corridor and Petapa Road are toll free, the traffic volume of these roads is 43,900 pcu/day and 35,600 pcu/day, respectively. If these roads are used as toll roads, the traffic volume decreases as the toll fee increases. Therefore, it can not be said that a high toll rate improves the financial situation through revenue increase. The relationship between the toll rate and the value of FIRR is shown in Table 22.5 (1), which shows the Petapa Road is viable when the toll rate is set more than Q. 2, on the other hand, the East West Corridor is not viable at any toll rate level. Since the East West Corridor shows the EIRR of 7.7% according to the economic evaluation, and this road can be judged to be necessary from social aspects. Therefore, the East West Corridor is desired to be run by the same entity operating the Petapa road for the pooling of both toll revenues. The detailed analysis of this toll road entity consolidated these two projects is explained in Section 22.2.3 (1).

Table 22.5 (1) FIRR of East West Corridor and Petapa Road

Toll Rate	Q. 1	Q. 2	Q. 3	Q. 4	Q. 5
East West Corridor	-	1.75	5.48	5.65	3.90
Petapa Road	-	5.55	9.21	8.82	5.55

(2) Bus Exclusive Way Projects

The buses using the exclusive busways should pay some transit fee. Since all of the key route buses and main inter-regional buses should pass these exclusive busways, the number of buses using them does not decrease, which means that the higher the transit fee, the more the revenue increases. Judging from the result of the financial analysis as shown in Table 22.5 (2), it seems that unless the bus transit fee exceeds Q.15, these projects are not viable.

Table 22.5 (2) FIRR of Exclusive Busways

Transit Fee	Q.5	Q.10	Q.15	Q.20	Q.25
E-W Corridor Route	-	0.53	5.94	9.62	12.48
FEGUA Route	-	-	2.94	7.47	11.03

(3) Urban Bus Center Project

This project shows the most favorable financial performance among the recommended nine projects. Even if Q.1 is collected as a user fee, the project is viable as shown in Table 22.5 (3).

Table 22.5 (3) FIRR of Urban Bus Center

User Fee	Q.1	Q.2	Q.3	Q.4	Q.5
Urban Bus Center	5.91	7.51	8.94	10.27	11.52

(4) Inter-regional Bus Terminal Project

As shown in Table 22.5 (4), both the South Inter-regional Bus Terminal project and the West Inter-regional Bus Terminal project are not viable even using a the use fee level of Q.25. The North Inter-regional Bus Terminal project is barely viable at a fee of Q.10. According to the economic analysis, the South Inter-regional Bus Terminal is not viable. However, since such inter-regional bus terminals are desirable for the functioning of the system as a whole, other management measures should be examined.

Table 22.5 (4) FIRR of Inter-regional Bus Terminal

User Fee	Q.5	Q.10	Q.15	Q.20	Q.25
North Terminal	3.79	7.53	10.53	13.20	15.66
South Terminal	-	-	1.01	2.58	3.97
West Terminal	-	-	3.15	4.85	6.37

(5) Bus Inspection and Maintenance Center Project

This Bus Inspection and Maintenance Center provides a pure public service, therefore, it is difficult to expect this center to cover not only the construction cost but also the operating cost only from its own revenue. Therefore, it is better to adopt the financial criteria that the yearly negative net income is minimized as much as possible. As Table 22.5 (5) shows, the center can balance the negative net income under the inspection fee of Q. 500 and maintenance fee of Q. 350. Since such an inspection fee level seems to be considerably high, the appropriate subsidy should be considered.

Table 22.5 (5) Net Income of Bus Inspection and Maintenance Center

Inspection Fee	Q.100	Q.150	Q.200.	Q.250	Q.300	Q.350
Maintenance Fee	Q.500	Q.500	Q.500	Q.500	Q.500	Q.500
Maximum Negative Net Income (Q.1,000/year)	Q.1,057	Q.842	Q.627	Q.412	Q.197	Q.0

22.2.3 Recommended Financial Plan by Entity

As mentioned above, among nine recommended projects, some are viable both economic and financial evaluations, others are not so. However, these nine projects are indispensable from the social viewpoint, and it is desirable that projects with a similar function are run by the same entity. With this policy it is important that the deficit of the financially less favorable projects is covered by the financially sound projects. After trials and errors, the following entities are recommended as already explained in Chapter 19. The operation and maintenance cost of each entity is shown in Table 22.6.

Table 22.6 Operation and Maintenance of Three Entities

Item	Toll Road Corporation	Public Transportation Corporation	Bus Inspection & Maintenance Center
Personnel Cost	1,668,000	998,000	643,000
Office Space Rent	66,000	0	0
Electricity	0*	594,000	46,200
Water & Sewerage	0*	119,900	10,000
Telephone	13,200	11,000	4,400
Office Supply Expenses	79,200	66,000	39,600
Vehicle	54,000	54,000	36,000
Insurance	300,000	725,400	52,800
Miscellaneous	109,020	128,000	65,000
Total Operation Cost	2,289,420	2,696,000	1,020,000
Maintenance Cost	30,944,000**	46,582,000**	327,000
Total Cost	33,233,420	49,278,000	1,205,000

Note: "*" including in the office space rent
"**" value of 2010 (the road and bridge maintenance cost varies year by year)

(1) Public corporation running the toll road

Among two toll roads such as East West Corridor and Petapa Road, the profitability of the East West Corridor is not favorable as shown in Table 22.5 (1), since this road passes through many valleys, which makes the construction cost considerably high. In order to recover this large amount of construction cost, this toll road is better to be managed by the same entity as the Petapa Road. Under this unity, the deficit of the East West Corridor is compensated by the revenue of the Petapa Road by pooling both toll revenues and saving the administration cost. In addition, if this operation is performed by the Municipality, the revenue might be transferred to the Municipality's general revenue and interfered with repayment of the foreign loan. Therefore, in case of consolidating the management of both toll roads, the public corporation independent of the Municipality is recommended. Table 22.7 shows the relationship between the toll fee and FIRR in this public corporation.

Table 22.7 FIRR of Toll Road Entity

Toll Rate	Q. 1	Q. 2	Q. 3	Q. 4	Q. 5
Public Corporation (%)	-	3.68	8.37	8.15	5.19

Table 22.6 shows that a toll fee of Q. 3 is sufficient to run this entity. Therefore, the public corporation is recommended to collect Q. 3 per vehicle per trip. Since the average time saving per one vehicle after completion of the project is about 15 minutes, one vehicle can save Q. 3 per one trip, considering that the time value of one vehicle is estimated 12.03/hour, which indicates the Q. 3 of toll fee is reasonable. In the analysis of the financial statements, the various financial indicators indicate the good performance of toll road projects as shown in Table 22.8.

Table 22.8 Financial Indicators of Public Corporation of Toll Road Management

Financial Indicators	
FIRR (Return on Investment)	8.37 %
(Return on Equity)	9.02 %
Operating Ratio	0.45
Debt Service Coverage Ratio (Cumulative)	2.43
(Minimum)	1.51
First Positive Net Income Year	4th year

(2) Third sector running public transportation projects

The public transportation projects are related to the improvement of the efficiency of the bus operation. There are six public transportation projects among the recommended projects, however, the financially viable projects number only two, those are, the Urban Bus Center project and the North Inter-regional Bus Terminal as shown in Table 22.5 (2)~(4). Since the improvement of the public transportation facilities is of significant importance to the Guatemala Metropolitan Area, all project related to the public transportation are indispensable. Therefore, the above six projects including the financially unfavorable projects are recommended to be managed by one entity. Considering that the management of the bus terminal projects includes tenants, parking lots and advertisement, the entity is recommended to be organized under the third sector, because the expertise and know-how on the above business management is expected to be introduced by the private enterprises. As a result, this entity includes the management of the Exclusive Busway projects, the Urban Bus Center project and the Inter-regional Bus Terminal projects.

Using the various levels of charge, the financial analysis was performed as shown in Table 22.9. The premise of the revenue other than bus transit fee of the Exclusive Busway and bus use fee of the Urban Bus Center and Inter-regional Bus Terminals was determined below on the basis of the site survey or the interview survey conducted for in this financial analysis.

Revenue from tenant lease
- Urban Bus Center — Q. 80/m^2/month
- Inter-regional Bus Terminal — Q. 60/m^2/month

Revenue from parking lots
- Urban Bus Center — Q. 8/hour
- Inter-regional Bus Terminal — Q. 6/hour

Revenue from advertisement
- Urban Bus Center — Q. 75/month
- Inter-regional Bus Terminal — Q. 75/month

Table 22.9 FIRR of Public Transportation Entity

Bus Transit Fee per bus (Exclusive Busway)	Q.5	Q.5	Q.5	Q.5	Q.10	Q.10
Use Fee per bus (Urban Bus Center)	Q.5	Q.5	Q.7.5	Q.10	Q.5	Q.10
Use Fee per bus (Inter-Regional Bus Terminal)	Q.5	Q.10	Q.10	Q.10	Q.10	Q.10
FIRR (%)	4.97	5.31	6.44	7.47	7.23	9.14

Note: The above fee is charged for each trip.

In Table 22.8 the higher the fee rises, the more the financial situation improves. However, the buses passing the Exclusive Busways also use the Urban Bus Center. Therefore, the buses using the Exclusive Busways should pay for not only the bus transit fee but also the Urban Bus Center use fee for one trip.

The maximum transit fee of the Exclusive Busway is estimated to be less than Q. 10. The reason is as follows; according to the information obtained from the bus management analysis, the completion of Exclusive Busway increases the operation speed by at least 20% , which results in increasing of the income by 20%. Assuming that the existing bus income per day is Q. 400 and the number of round trips per day is 8, the buses using the Exclusive Busway can obtain Q. 5 (Q.400 x 0.20 / 16 = Q. 5). Therefore, the maximum transit fee using the Exclusive Busway should be less than Q. 5 per one bus. On the other hand, the maximum of the use fee of the Urban Bus Center is estimated at Q.8 for the following reason; entering and leaving the urban bus center saves 15 minutes. If the operation hours of one urban bus are assumed as 12 hours per day, the saved income reaches Q. 8 per bus (Q. 400 / 12 x 0.2 5 = Q. 8.3). As for the Inter-regional Bus Terminals, if the operation hours of one inter-regional bus are 8 hours, the saved revenue is estimated as Q. 10 (Q. 400 / 8 x 0.2 = Q. 10). Since the criteria of the viable financial performance is more than 6% of the FIRR, the following charge level is viable for this entity according to Table 22.8;

- Bus Transit Fee of Exclusive Busway Q. 5
- Use Fee of Urban Bus Center Q. 7.5
- Use Fee of Inter-regional Bus Terminal Q. 10

In this case the value of FIRR is 6.44, which shows the viability of this entity together with the results listed in Table 22.10. Appendix 22.3 (1) - (3) shows three financial statements of this entity.

Table 22.10 Financial Indicators of Third Sector Management

Financial Indicators	
FIRR (Return on Investment)	6.44 %
(Return on Equity)	11.91 %
Operating Ratio	0.29
Debt Service Coverage Ratio (Cumulative)	2.06
(Minimum)	1.26
First Positive Net Income Year	3rd year

(3) Bus Inspection Center Project by the Municipality

The Table 22.5 (5) shows that this project is difficult to be operated financially under the self-supporting accounting system. Since it takes two days for one senior car mechanic (Q. 120/day) and one assistant mechanic (Q. 80/day) to repair a damaged or broken-down bus, the total repair cost amounts to Q. 500 including the indirect cost of Q. 100 (assumed 25% of personnel expenses). Therefore, in order to minimize the negative net income as much as possible (which should be compensated by the Municipality), the inspection fee should be raised.

If this inspection fee is set at Q. 350, it is not necessary for the Municipality to compensate any money to this Center. However, since this service is considered to be a pure public service, it is desirable to decrease the fee level as much as possible, even if a subsidy from the Municipality is introduced. At present, the Municipality obtains about Q. 1,500 thousands from gasoline consumption (corresponding to 2% of the gasoline price). If a surcharge of 0.5% on the gasoline price is admitted, the Municipality could get additional Q. 375 thousands.

Judging from Table 22.5 (5), if the inspection fee is set at Q. 300, the yearly deficit can be covered by a surcharge on the gasoline price. If the inspection fee level is set at Q. 250, the maximum negative net income amounts to Q. 412 thousands. However, since the negative net income does not always exceed Q. 375 thousands every year (in some years the negative net income is less than Q. 375 thousands), it is not necessary for the inspection fee to be fixed at Q.300. It is better to set it at Q. 250. In this case the portion exceeding Q. 375 thousands should be borne by the general budget of the Municipality.

In order to obtain funds for this purpose, the Municipality should make the tax based on property value as close to the market price as possible. At the moment, there is more than 20% difference between them. If the Municipality reduces this difference by only 5%, it can be expected to obtain extra Q.1 million, considering the present revenue of about Q. 20,000 thousand from the property tax. The above deficit is easily covered by this extra revenue.

On average a bus carries 600 passengers per day. If 1% of these passengers do not like to use a non-inspected bus, the yearly revenue loss of the bus is estimated at Q. 1,315 (600 passengers per bus x 0.01 x 313 days/year x Q. 0.7 bus fee per passenger = Q. 1,315). Since the net income ratio of the revenue is 20% according to the interview survey, the net loss of the bus operator can be estimated to be Q. 263 (Q. 1,315 x 0.2 = Q. 263). This indicates that bus owners are better off if they have the inspection even paying Q. 250 per year. As a result, the case with a maintenance fee of Q. 500 and inspection fee of Q. 250 is recommended.

22.2.4 Financial Analysis including Inflation

In the above, the financial analysis was performed in real terms. However, since the actual economy always accompanies inflation, a financial analysis including inflation was tried. In order to perform this financial analysis, the following rates are assumed through examination of the available national statistics in Guatemala;

a) Escalation rate of local capital 13.09% per annum

b) Escalation rate of foreign capital 9.0% per annum

c) Consumer price index 11.6% per annum

d) Decrease of foreign exchange rate 6.4% per annum

Results of the financial analysis including inflation for the above three recommended implementation entities are indicated in Table 22.11. The public corporation for the toll road and the third sector entity for public transportation show a viable financial performance even when inflation is considered, under the criteria of 18% of FIRR. On the other hand, the Bus Inspection Center does not operate viably without some subsidy from the Municipality.

Table 22.11 Results of Financial Analysis Including Inflation

Implementation Entity	Value of FIRR (%)
Public Corporation of Toll Road	21.6
Third Sector of Public Transportation	19.1
Urban Bus Center	-

23. Environmental Impact Assessment

23.1 Environmental Study Method

There is no procedural technical guidelines provided for environmental assessment in Guatemala, although implementation of EIA is under obligation by law. This project provides forecast of environmental impact on each project, its evaluation, and procedures for counter measures based on results obtained by screening and scoping.

From the investigation of present environmental conditions, screening and scoping was made by matrix method, predicting the environmental problems in future. After that necessary countermeasure to maintain the environmental condition for each environmental item was recommended, the future environmental conditions in the case of with the project will be better than in the case of without the project by executing these countermeasures.

Among the present environmental issues, the following items which are considered to be affected at the execution stage can be predicted and assessed with regard to future effects.

- Resettlement
- Ruins and Cultural Heritage
- Soil Erosion
- Flora and Fauna
- Air Pollution
- Noise

(1) Soil and Erosion

In respect to the areas which are easily affected by soil erosion according to the results of the soil survey, the probability of soil erosion shall be predicted for the cases where the planned road is constructed or not.

(2) Flora Fauna

In the surroundings of the project planned area, existence of rare species of the flora and fauna shall be confirmed by literature and interviews. Judgment shall be made whether the execution of the planned project will affect or not, the habitation and growing environment of these rare species.

(3) Air Pollution

In Guatemala City, 60-70% of the air pollution is considered to be of transportation produced origin, that is, vehicles. Therefore, the concentration of pollution in future shall be estimated by comparing the quantity of produced pollutants from vehicles.

Concrete terms, comparing the exhaust gas quantity multiplied by each exhaust coefficient that is respectively assumed for the actual traffic volume in the city and by the estimated traffic volume after the project execution, the future situation of the air pollution can be obtained.

(4) Noise

Power level (PWL) of the noise which is now produced per vehicle shall be obtained, and the situation of roadside noise level shall be predicted by assuming the traffic volume of the principal arterial road and the maintenance conditions of each vehicle in the case of executing the plan in future.

23.2 Impact Prediction

(1) Resettlement

There is some housing to be removed along the right of way of the FEGUA in the existing urban area where the planned road will pass.

In Guatemala City, there are many precarious settlements as shown in Figure 7.2. Although the settlement, specially along the FEGUA railway, are precarious, a community including housing and shops has been established as an accomplished fact. As for the East West Corridor section, the cost for appropriate compensation is necessary to be calculated as expenses. Meanwhile as to the precarious settlements along the FEGUA railway where the Exclusive Busway is planned, a reasonable removal cost cannot be calculated. But the removal is necessary and can be accomplished preparing destination places in some area. Therefore, it is necessary to estimate the housing number which will be affected and the extent of influence for each project and to plan destination places according to the execution time.

According to the on-site study along the FEGUA Route, the squatters' barrack area is 4,780 m long on the eastern side, and 5,730 m long on the western side. The squatters' family number is estimated to be about 600 families in the eastern side and about 800 families in the western side from the results of a study with the aerial photos, etc.

Also according to the study results of the San Carlos University, 1973 families, with a population of 10,654 live along the railway route in 1995. As a part of the plan of Guatemala City, removal projects are being developed at "Santa Faz" and "Lomas de Santa Faz" with payment, as well as "Santa Isabel, Villa Nueva" without payment and "La Autoconstruccion de Vivienda".
The destination areas are indicated in Figure 23.1.

Even though a removal has been actually carried out, another squatter may enter, or an acquired lot in the destination place may be personally sold to another person. Because of such problems, removal or resettlement has not been easily developed.

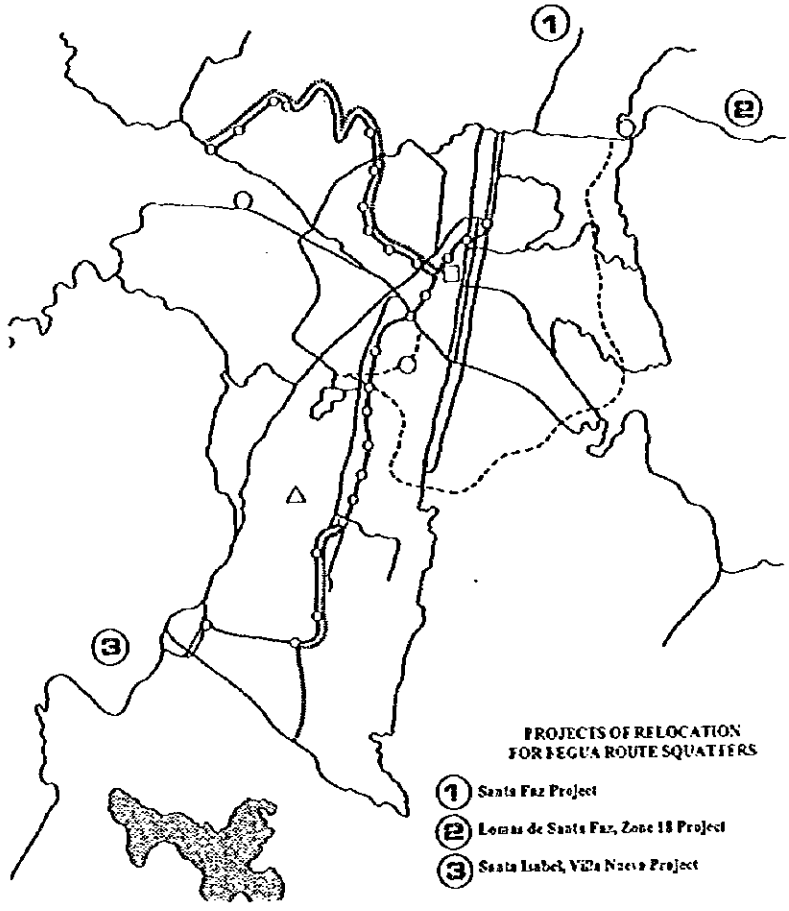

Figure 23.1 Projects of Relocation for FEGUA Route Squatters

(2) Ruins and Cultural Heritage

In Guatemala City there are some housing ruins of the Pre-classic Period, and in Kaminal Juyu and Naranjo, such the ruins have been found. The distribution of the ruins and the known cultural heritage is shown in the Figure 23.2. The East West Corridor passes near Naranjo areas and La Democracia Park where ruins will be found.

According to the "Legislation of Culture Heritage of Guatemala", an area where archaeological ruins are found shall be designated as an "Archaeological Area", and no structure shall be constructed without permission of the Ministry of Culture (Kaminal Juyu is now designated as such an area, but El Naranjo areas and La Democracia Park are not yet designated).

(3) Soil and Erosion

In the widened section of the East West Corridor, the section beyond the Rio Villa Robos of the FEGUA Route of Exclusive Busway and the Petapa Road, the planned roads will pass steep slopes of silt which is a sedimentary formation of Puzzolana partly. With cutting, it is apprehended that there will be some erosion during construction and after the commissioning, if adequate counter-measures are not taken.

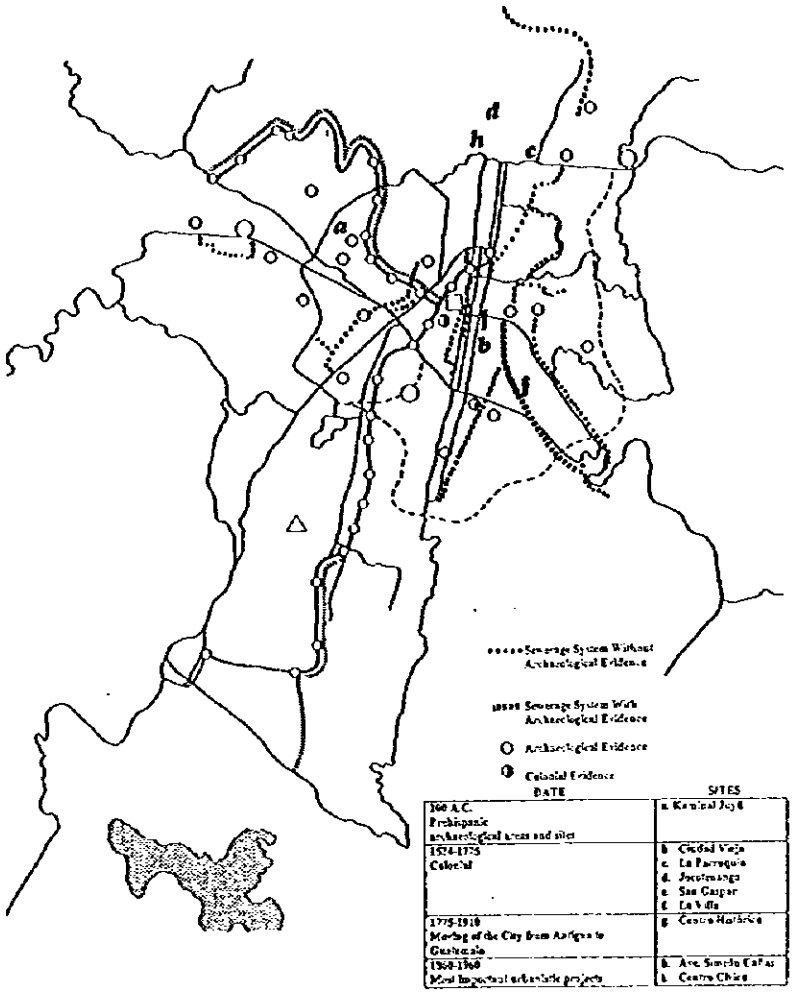

Figure 23.2 Ruins and Heritage.

(4) Flora Fauna

The project area has urbanized very rapidly and there is no environment where a large quantity of the fauna lives and the flora grows. In the steep valleys (Brranco) remaining in the urban area, however, some flora, original and peculiar to the area can be found. Near this valley where people live, some important (useful) plant species have been actually found.

For example, "Quercus" (holmoak, oak) is found near the site of East West Corridor, which is not an important species for the country, but it is difficult to find in and around the Metropolitan Area. In the Naranjo Valley, the species of "Alnus", "Ostria" and "Cretra" with "Quercus" from a small grassland rather than a bush land.

Otherwise, near the planned roads of Exclusive Busway and Petapa Road, plants are increasing on the of the banks of the El Guadron River. Those plants such as "Ficus" and "Pine" are introduced species and seeded by the residents, but the damage to the native species becomes serious. Therefore, native species shall be selected to be planed on the face of slopes.

Morcover, a Red Data List of Flora Fauna was published on May 1966 by the CONAP. In this list there are following three categories:

1) Danger of extinction
2) CITES (International Council to Protect Endangered Species)
3) Endemic species

The confirming place such as the Red Data List of Fauna and Flora is shown in Figure 23.3. In the Metropolitan Area, it is confirmed that the plant species included in 2) of the above list are growing. "Pereskiopsis Kellermait" of 8, "Opuntia Eichilami I Rose" of 9 and "Opuntia Tomentella Berger" of 10 correspond to the CITES, which are shown in the below figure. In addition "Tripogandra Disgrega" of 1, "Peperonia Auroriana" of 2, "Inga Donnel Smithii Pitrie" of 5 and "Parabuteo Unicinctus" of 6 are mentioned as "endemic species". In accordance with experts opinion, "Cistothorus Platenses" is cited as an important species.

The planned route will not pass areas where these species are known to be growing. Guatemala City, however, preserves green areas of Barranco as a green belt from a viewpoint of environmental protection. Therefore, when the routes and projects are planned and designed, the preservation of the green areas shall be fully considered. Also the municipal authorities require that the contractors shall plant without delay in case of development of these green areas of Barranco.

About animals, it is known that a genus of rodent such as squirrel, rat, etc., and a genus of marsupial called "Tacuacin" live in the Study Area. This "Tacuacin" is partly eaten as food. Furthermore, two kinds of bat inhabit: "Artibeus Ssp Mormopidae Phyllostomidae" which eats fruits and "Pteronotus Ssp Mormopidae" which eats insects. This bat controls an increase of insects which are vectors of the pest N, etc. and keep an ecological balance. At the Point 6 near Naranjo on the planned route, a habitat of "Parabuteo Unicinctus" well known as harrishawk, a genus of bird, has been confirmed. This is listed as CITES in the Red Data List.

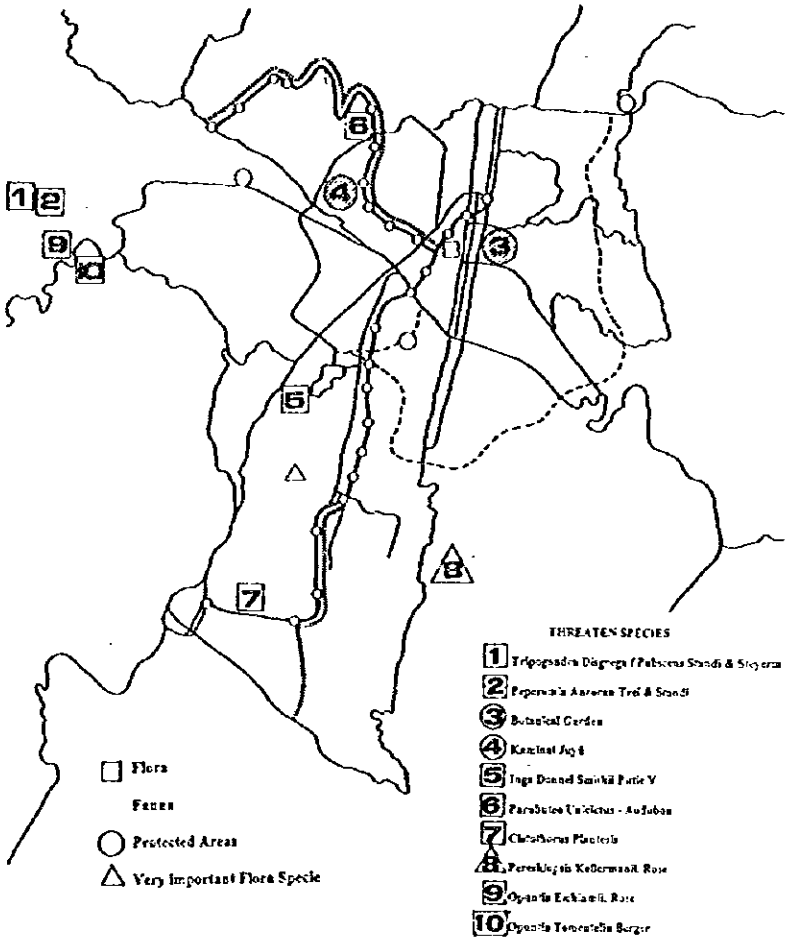

Figure 23.3 Threatened Species

(5) Air Pollution

The total traveling distance and traveling time according to the estimated results of the future traffic volume are shown in the Table 23.1.

Table 23.1 Vehicle Distance and Vehicle Time in 2010

Case	Type	Vehicle Distance (PCU·km)	Growth Rate	Vehicle Time (PCU·hour)	Growth Rate
Without	Bus	2,683,452	1.28	181,878	1.32
	Car	13,037,300	1.31	394,623	1.44
	Total	15,720,752	1.31	576,502	1.40
With	Bus	2,748,957	1.31	163,886	1.19
	Car	12,925,720	1.30	378,368	1.38
	Total	15,674,677	1.30	542,254	1.31
Present	Bus	2,103,477		138,273	
	Car	9,917,347		274,447	
	Total	12,020,824		412,720	

The total of vehicle distance will increase by 31% without the execution of the project and will increase by 30% with the project. The total vehicle traveling time will increase by 40% without the execution of the project, and will increase by 31% with the execution of the project. Especially for buses, the difference in the change of vehicle traveling time is obvious between the increment of 32% without the project and 19% with the project. From the above data it is obvious that the execution of the project will contribute to the increase of average traveling speed and efficiency of fuel consumption.

However, the exhaust coefficient of the traveling vehicles in the city is not known now. According to the actual study by Proeco, the level of maintenance is getting worse. On the other hand, considering the construction and operation of the inspection center, as well as the legislation such as a vehicle inspection system, the exhaust gas quantity per vehicle can be expected to considerably decrease.

Furthermore, it has been considered that by adequate maintenance of vehicle engines, the combustion ratio will be raised, the exhaust gas quantity will generally decrease, and as a result, the concentration of air pollution will be lowered. Anticipating the operation of the inspection center and the improvement of a vehicle inspection system, it is expected that the exhaust gas quantity caused by vehicles will not be above the present level, even if an increase of the total traveling distance is taken into consideration.

Presently 60-70 % of the air pollution is allegedly produced from transportation origin, such as automobiles, and this proportion is not expected to change largely in future. Moreover, it is considered that the quantity of air pollution materials in exhaust gas shall be able to decrease in future, and in any case shall not be higher than the present condition.

The above mentioned prediction, however, is premised on the rise of the proportion of well maintenaned vehicles by legislation of a vehicle inspection system, etc. If the number of vehicles increase in future without doing anything to control vehicle maintenance as in the present case, the air pollution will become much worse.

(6) Noise

To identify of noise level emitted by a vehicle, the power level (PWL) of the noise was measured on a road of relatively smaller traffic volume. The relation between the traveling velocity and the measured PWL of noise are shown in the Figure 23.4.

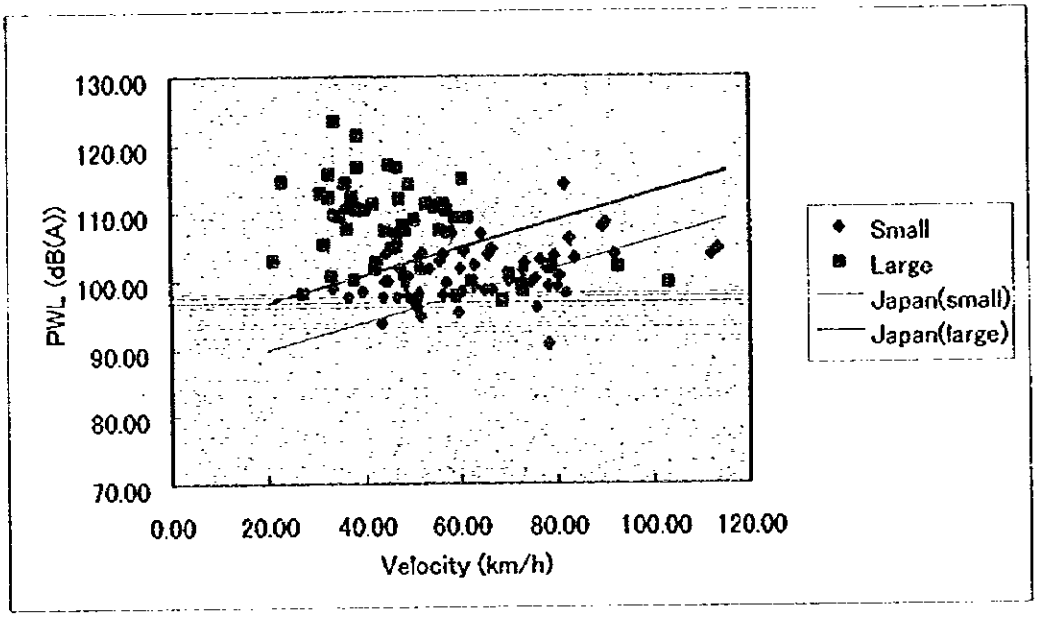

Figure 23.4 Comparison of PWL

According to above figure, the PWL is constant, having no proportional relationship to traveling velocity and no relation to vehicle velocity. In other words, it is considered that the power level depends on individual engine noise, or that may even reverse because new high speed vehicles, the vehicles traveling in the high speed zone, produce low noise. Furthermore about the tendency of large size vehicles, the more the velocity is increases, the lower the power level. This indicates the values of power level by engine have a wide range.

Outlines of the measuring results are shown in the Table 23.2

Table 23.2 The Average of Noise

Vehicle Type	No. of Samples	Average PWL (dB(A))	Average Velocity (Km/hour)	Average PWL in Japan (dB(A))
Small	67	101	64	99
Large	54	108	48	103

Concerning the actual noise level of the road traffic by traveling vehicles, inadequately maintained vehicles such as vehicles without mufflers are the main cause of rather high noise levels, and as a result, the noise level generally has a tendency to become higher. Therefore, the general noise level can be expected to delete lowered, enforcing complete maintenance of that part of vehicles which produce an extremely high noise level.

Taking the noise regulations of Japan and the U.S. into consideration, the power level per vehicle will be expected to decrease by about 5 dB (A) in case of large vehicles and by about 2 dB (A) in case of passenger vehicles in comparison to the present values.

Accordingly, the noise level increases by 3dB (A), even if the traffic volume becomes twice, and the traffic volume at peak hour is saturated even now. Consequently the future noise level from vehicle traffic can be expected to delete lower by some 5dB (A) against the present value on condition that vehicle maintenance rate shall be raised.

23.3 Countermeasures

(1) Resettlement

Facilitating smooth removal of the squatters along the FEGUA right of way shall be a prior condition for the implementation of the project. Consequently some important measures such as facilities for electricity and water supply will be desirable. These will determine the living conditions at the destination place, as will the employment conditions.

(2) Ruins and Cultural Heritage

It is necessary to carry out the following surveys before the implementation of the project, especially for East West Corridor near the Democracia Park.

* For large-scale projects, a cultural property survey is normally required, particularly in areas with known precious human occupation.
* Road projects can provide opportunities for the discovery, inventory, or development of preciously unknown sites.

Access to cultural heritage sites is often improved by road infrastructure. However, adequate measures should be taken to assure their proper protection, including preparation of a site management plan.

(3) Soil and Erosion

Among the planned road projects, there are earth work sections in and around Naranjo area of the East West Corridor, Villa Nueva of the Exclusive Busway-FEGUA Route and Petapa Road. Guatemala City is made up of a sedimentary formation of Puzzolana, so the geological structure is very weak against erosion.

Consequently for the road design of this section, the following measures shall be taken:

* To do everything possible to preserve existing plants
* To plant and replant in bare lands during construction and after the start to use without delay
* To make slope faces on an easier grade
* To establish adequate facilities for drainage

INGA SMITHI is recommended for planting, which is a native species, grows rapidly, and is effective as a countermeasure against soil erosion.

In the design of the Bus Inspection Center, it is indispensable to plan an adequate drainage for the precipitation and used water at the building site, because it is contiguous to a big Barranco.

(4) Air Pollution

Measures against the producing origin are effective as measures against air pollution. Therefore, the quantity of produced pollutants per vehicle shall be necessarily lowered. Since 1993 imported new vehicles are under the air pollution control of the manufacturing country, but the imported used vehicles are out of that control.

It is most desirable that all the used vehicles which are now being used shall be converted into controlled vehicles, but actually this takes a long time. Consequently, periodical vehicle inspection shall be carried out on used vehicles under a vehicle inspection system, and the vehicles shall be obligated to be driven under adequate maintenance conditions.

(5) Noise

Among countermeasures against the traffic noise , generally there are ones in the producing side of the noise, and the others in the receiving side, such as noise barriers. Considering the present high noise level, character of the planned project, as well as the situations in Guatemalan, the former measures to reduce the noise at origin shall be focused and promoted.

According to the results of the vehicle noise measurements in the Study, PWL per vehicle is about 5dB (A) higher than that in Japanese. This is due to the oldness of vehicles registered (the average age of sampled vehicles is 11.4-year-old for gasoline vehicles and 10.6-year-old for diesel vehicles as shown in the Figure 23.5). Another reason is the inadequate maintenance conditions of vehicles.

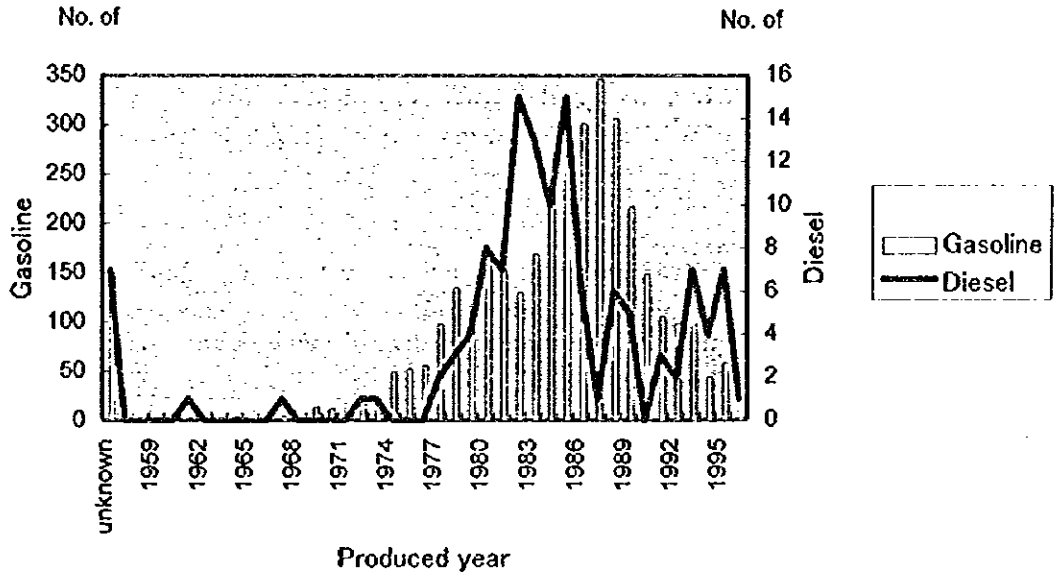

Figure 23.5 Production year of Vehicles

Consequently from now on, by enforcing periodical inspection, etc., adequate maintenance of engine and attachment of muffler shall be necessary.

Besides, for the surrounding areas of facilities requiring a calm environment such as hospitals and schools, the following measures shall be necessary, depending on cases: road traffic regulations such as speed control and vehicle class control; construction measures such as sound insulating barriers and arrangement of the road surface; and measures at the buildings, such as soundproof construction.

23.4 Environmental Evaluation

(1) Resettlement

By the continuous execution of the removal of the squatters along the FEGUA railway, which is now being carried on, the removal will be finished before the implementation of the project. Therefore, problems are not considered to be raised.

(2) Ruins and Cultural Heritage

In and around El Naranjo areas and La Democracia Park, it is known that archaeological ruins are exposed on the surface, and so regarding the East West Corridor plan, the planned route and the type of structure shall be changed to reduce influences on the district. Also some structural considerations shall be necessary so that the excavation quantity will be minimized and its influence will be reduced. In case a planned route change is impossible, a study of the archaeological ruins shall be executed prior to the construction. Moreover, if important ruins are found by this study, some measures such as change of plan or partial change, prolonging construction or its suspension shall be necessary according to the on-site study, with coordination with related organizations.

(3) Soil and Erosion

Cut section of the planned road have a probability of inducing soil erosion, but the influence of soil erosion from the execution of this project is considered to be small, and can be dealt with by some measures such as gentle slope gradients, installation of adequate facilities for drainage, and speedy implantation of existing species after construction.

(4) Flora Fauna

As the project planned area is out of the zones where rare species of flora or fauna grows and inhabits, the influence on those fauna and flora is considered to be little. Besides, the influence on these flora and fauna are judged to small, because of seeding and planting on the slopes of Barranco and rapid planting of existing species after construction, also on the slope of cuts of the newly constructed road.

(5) Air Pollution

When the present condition of the air pollution is compared with the U.S. Environmental Standards, the SPM is above the standard value. It is informed that some venders on the road side have diseases of the respiratory organs.

It is predicted that from now on the introduction of imported vehicles under exhaust gas regulations and complete control of the periodical inspection of existing vehicles, shall lower the present concentration level of air pollution. Consequently it is not considered the execution of the project will deteriorate the air pollution environment.

(6) Noise

The present noise level by vehicles is extremely high in Guatemala City because of vehicles without mufflers and inadequate maintenance of vehicles. In future by prohibiting the operation of poorly maintained vehicles, the general noise level is expected to be lowered. Accordingly, it is considered that the implementation of the planned project will not deteriorate the noise environment.