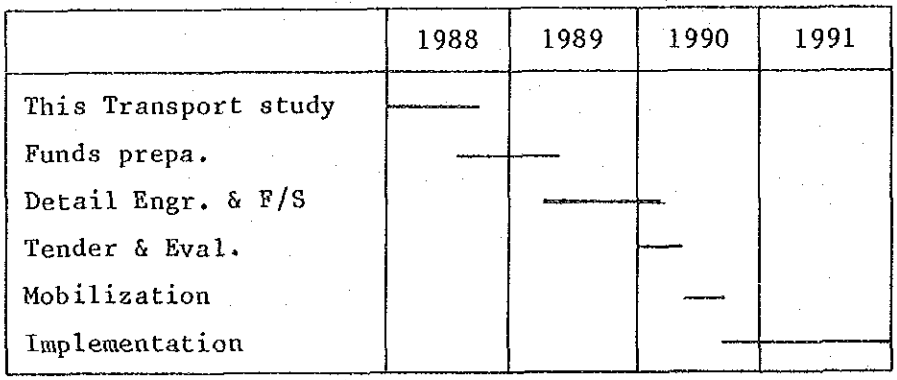
with Ped. Br & P.L.			
Project 1, 2, 4, 7	5.43 (52.94)	42.92	95.86
Project 5, 10	3.51 (34.22)	60.32	63.83
Project 13, 14	1.42 (13.85)	5.77	19.62
Project others	8.75 (85.31)	112.33	197.64
Project total	19.11 (186.32)	221.34	407.66

Improvement plans of each Project were shown in Appendix Fig. 10.2.1. They are summarized together with the total cost in Appendix 12.1.1 and Appendix 12.2.1.

12.3 Implementation Schedule

There are a number of minor plans included in the projects, spreading over the city of Sana'a. Periods for detailed engineering studies, calling for tender and evaluation, mobilization and implementation are proposed as under.

Fig. 12.3-1 Implementation Schedule



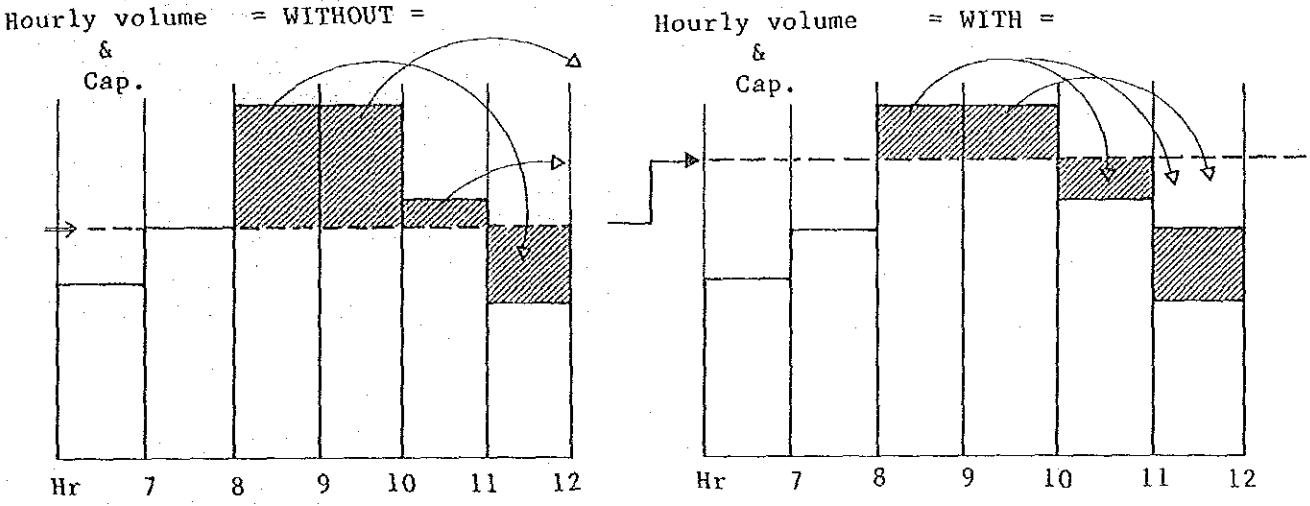
CHAPTER 13 ECONOMIC EVALUATION

CHAPTER 13 ECONOMIC EVALUATION

13.1 Approach

Benefits of those action plans are estimated through the following analysis. The basic understanding is that traffic congestion mostly in rush hours extends into the subsequent hours and chronic phenomenon of congestion tends to cover most of daytime hours. If the action plans increase the capacity of intersection, those prolonged congestion can be reduced. The reduction is measured as a part of economic savings. (Other part is reduced accidents)

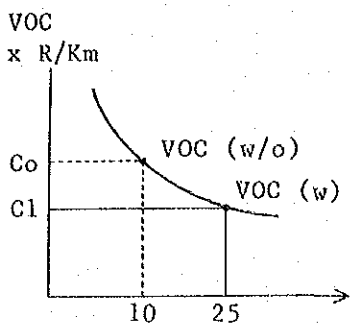
Hourly Volume and Capacity: with & without



The following can be found on each approach section of the intersection through traffic surveys in this study.

- Vehicles in pcu
- Average travel speed including speed changes
- Hourly distribution pattern of vehicles

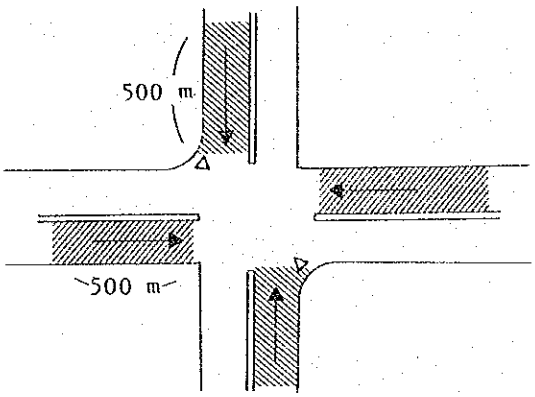
Measurement of savings in vehicle operation cost is set at approach sections of the intersection by comparing "with" and "without". The concept is shown as follows:



Co-C1: Savings per km
Travel speed means an average travel speed including stops and slowdowns.

Co : VOC without improvement

C1 : VOC with improvement



Improvement in capacity of each approach section in the intersection.

Intersection gives influence the travel speed in the approach section. Savings in VOC are calculated by using the 500 m of the approach section by finding the difference of average travel speed on the section. The difference with and without the action plans are measured by a model in Fig. 13.2.1. Saving in VOC (benefits) can be measured through different travel speeds.

When a project route is determined to include a few intersections, the benefits are calculated by summing up the difference of the VOC estimated in all approach sections of the route. The concept is shown below. The projects are shown in Figs. 10.2.5 - 10.2.7.

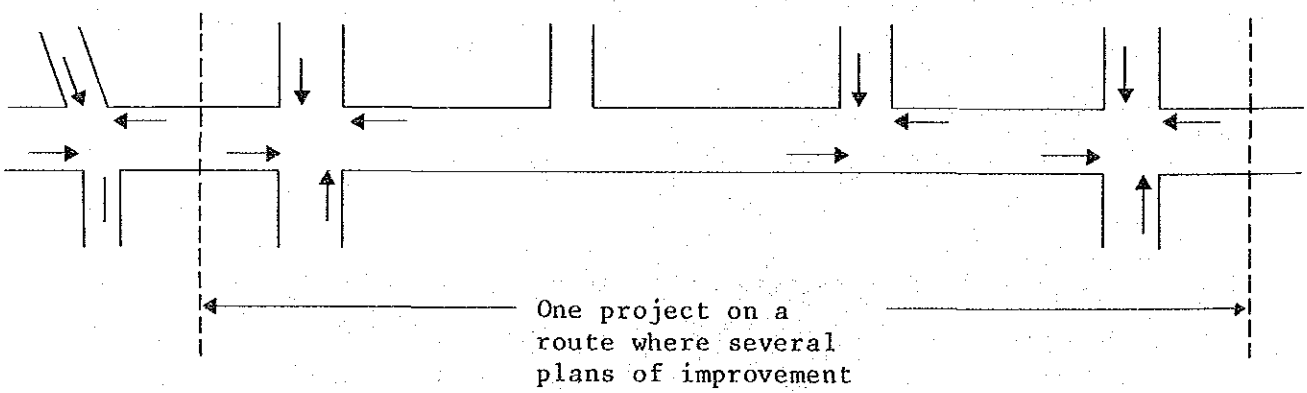
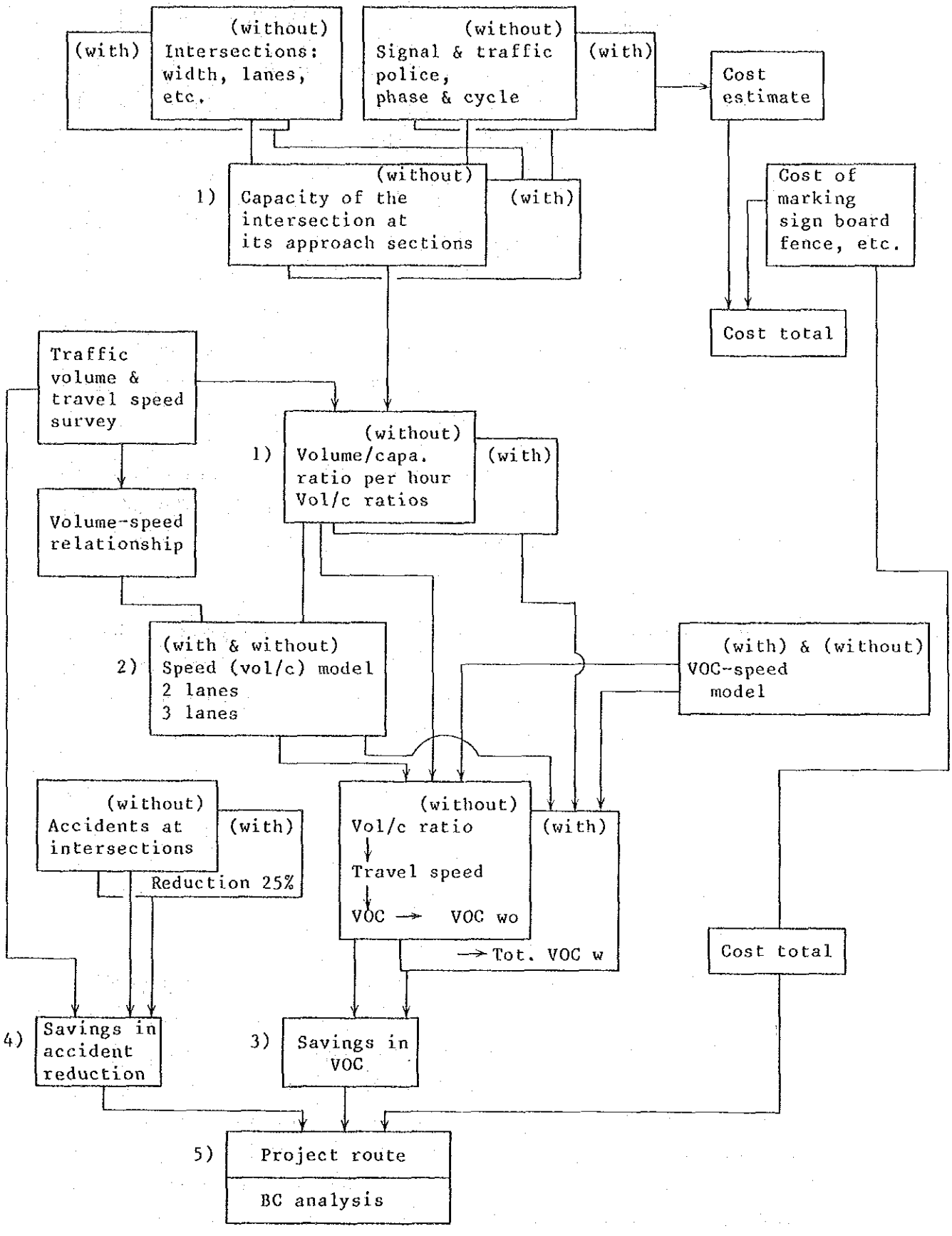


Fig. 13.1.1 Cost Benefit Analysis



13.2 Benefits

13.2.1 Benefit Estimate

Selected action plans are evaluated by cost-benefit analysis in economic terms. The analytical flows are shown in Fig. 13.1.1. The works for benefit estimate can be discussed as follows:

1) Capacity Analysis of Intersections

Capacity of each intersection is studied;

- whether it increases the number of lanes or not,
- whether the signal phase is altered or not.

Capacity per hour at each approach section is determined under the present status without improvement and the other with improvement.

The hourly volume in pcu is compared with the above capacities to find volume/capacity ratios for both cases of "with" and "without". The representative hourly traffic pattern is determined through analysis in Chapter 5.

The volume/capacity ratio of one approach section can show a saturation degree and the total in all approaches means the saturation degree of that intersection. Saturation degrees "with" and "without" of those intersections are in Table 13.2.1

The action plans can improve the capacity of intersections as in Table 13.2.1. However, it is found there remains some intersections with saturation degree more than 1.20. The degree 1.20 is a realistic saturation point and can be used for planning study instead of 1.00.

Intersections of Ali A Mughni Rd-Old Airport Rd - A Zubayri Rd, A Zubayri Rd - Hadda Rd, A Zubayri - Ring Rd have saturation point more than 1.60 even after improvement. It means these intersections or approach sections in inner city area need a large scale improvement such as the construction of fly-over passing or of bypasses. Or it may mean the reduction of vehicle use on those points. Those matters indicate a need of study on road development planning which is discussed in Chapter 10.

Table 13.2.1 Saturation Degrees at Intersections (with/without Project)

City	Project	Intersection	Saturation Degree: Without Project	Saturation Degree: With Project	Without - With
Sana'a	1	Air Port - Sadah	1.811	1.258	0.553
		Airport - No. 10, 19	1.549	1.375	0.174
	2	Airport - Ring Rd.	1.663	1.505	0.158
		Airport - No. 7, No. 9	1.743	0.979	0.764
		Airport - Shuub	1.515	1.022	0.493
		Ali Abdul Mughni - No. 30	1.713	1.265	0.448
		Ali Abdul Mughni - Bawn Lyah	0.778	0.856	-0.078
		Ali Abdul Mughni - Abdul Nasi	1.105	1.028	0.077
		Ali Abdul Mughni, Old Airport - Az Zubayri	2.160	1.942	0.218
	3	Old Airport - No. 33	0.574	0.574	0.0
		Old Airport - Ring Rd.	1.048	0.889	0.159
		Old Airport - 45 m Rd.	1.054	0.503	0.551
		Old Airport - 60 m Rd.	0.676	0.676	0.0
	4	Az Zubayri - Taiz	1.662	1.415	1.247
		Az Zubayri - No. 4	1.781	1.143	0.638
	5	Az Zubayri - Sayf Benthiyazin	0.994	0.994	0.0
		Az Zubayri - No. 30	0.767	0.767	0.0
		Az Zubayri - Hadda	1.800	1.569	0.231
		Az Zubayri - Ring Rd.	2.500	2.072	0.428
		Az Zubayri - Ad Dirasat	0.997	0.689	0.308
	6	Hadda - No. 15	0.961	0.520	0.441
		Hadda - Ring Rd.	1.356	1.267	0.089
		Hadda - 45 m Rd.	1.248	0.561	0.687
		Hadda - 60 m Rd.	1.510	0.554	0.956
	7	Taiz -	0.870	0.870	0.0
		Taiz - Ring Rd.	1.533	1.244	0.289
		Taiz - 45 m Rd.	1.741	0.735	1.006
		Taiz - 60 m Rd.	1.804	0.865	0.939
Sana'a	8	Mostasfa Al Thourah - Wadi Al Qasr	1.752	0.995	0.757
		Mostasfa Al Thourah -	0.624	0.624	0.0
		Mostasfa Al Thousah - Ring Rd.	1.002	0.859	0.143
	9	Wadi Dahr - No. 14	0.481	0.481	0.0
		Wadi Dahr -	0.888	0.770	0.118
		Wadi Dahr - No. 8	0.389	0.389	0.0
		Wadi Dahr - Ziraah	1.053	0.794	0.259
		Wadi Dahr - Ring Rd.	1.163	1.327	0.164
	10	Ring Rd. - No. 1	1.727	1.194	0.533
		Ring Rd. - No. 25	1.636	0.991	0.645
		Ring Rd. - No. 15	1.736	1.088	0.648
	11	Ziraah - No. 9	1.856	1.350	0.506
		Ziraah - Jamal Abdul Nasi	1.374	0.874	0.500
	12	Daddab - Shuub	1.273	0.955	0.318
		Daddab - Ring Rd.	1.457	1.398	0.059
		Sadda - Northeastern Boulevard	1.039	0.576	0.463
	13	Ring Rd. - Eastern Bl.	0.535	0.275	0.260
		Marib - Ring Rd.	1.022	0.924	0.098
	14	Ring Rd. - Ath Thaulathin	0.635	0.635	0.0
		Ring Rd. - No. 9	1.235	0.635	0.600
		Ring Rd. - No. 28	1.445	0.780	0.665
Taiz	15	Jamal - Al Jaynai	1.667	1.485	0.182
		Jamal - Ali Uthman	1.968	1.258	0.710
		Jamal - Tahrir	2.419	1.573	0.846
		Jamal - Central Bank	1.733	1.384	0.349
		Jamal - Central Blvd	1.479	1.169	0.310
		Jamal - (1)	1.047	0.788	0.259
		Jamal - (2)	1.073	0.854	0.219
		Jamal - Suq Ax Samil	1.744	1.199	0.545
		Al Jaynai - Ali Uthman	1.931	1.122	0.809
Hodeida	16	Sana'a - Zaid	—	1.671	—
		Sana'a - Shmsan	2.231	1.656	0.575
		Sana'a - Al Hukumi	—	1.375	—
		Sana'a - Al Moasla	—	1.386	—
		Sana'a - Al Matari	1.602	1.337	0.265
		Sana'a - Port	1.227	1.024	0.203
		Ziad - Shmsan	0.980	0.608	0.372
		Ring Rd - 26th Sep.	0.401	0.285	0.116

From Appendix Table 10.2.1. The calculation uses the estimated traffic in 1992

2) Speed and Vol./Cap. Models

Travel speed and volume relationship can be converted into travel speed - congestion ratio relationship, where the congestion ratio means the volume-capacity ratio per hour. Regression analysis is conducted and model formulas with parameters for 2 lane sections and 3 lane sections are found applicable. These formulas are shown in Fig. 13.2.1 and the result of regression analysis are shown in Appendix Table 13.2.2.

If an intersection is improved, new signals are placed and phasing pattern is changed, the capacity can be increased and the congestion ratio decreases. It means an increased travel speed on the approach section, the extent of increase can be measured by using the speed-congestion ratio relationship formula.

3) VOC Savings

When the improvement of intersection is completed, travel speed can be increased. The higher speed will realize savings in vehicle operation cost (VOC). The process of analysis in VOC is discussed in Appendix Note 13.1. The result in terms of shadow priced economic cost is shown in Table 13.2.2. and Fig. 13.2.2.

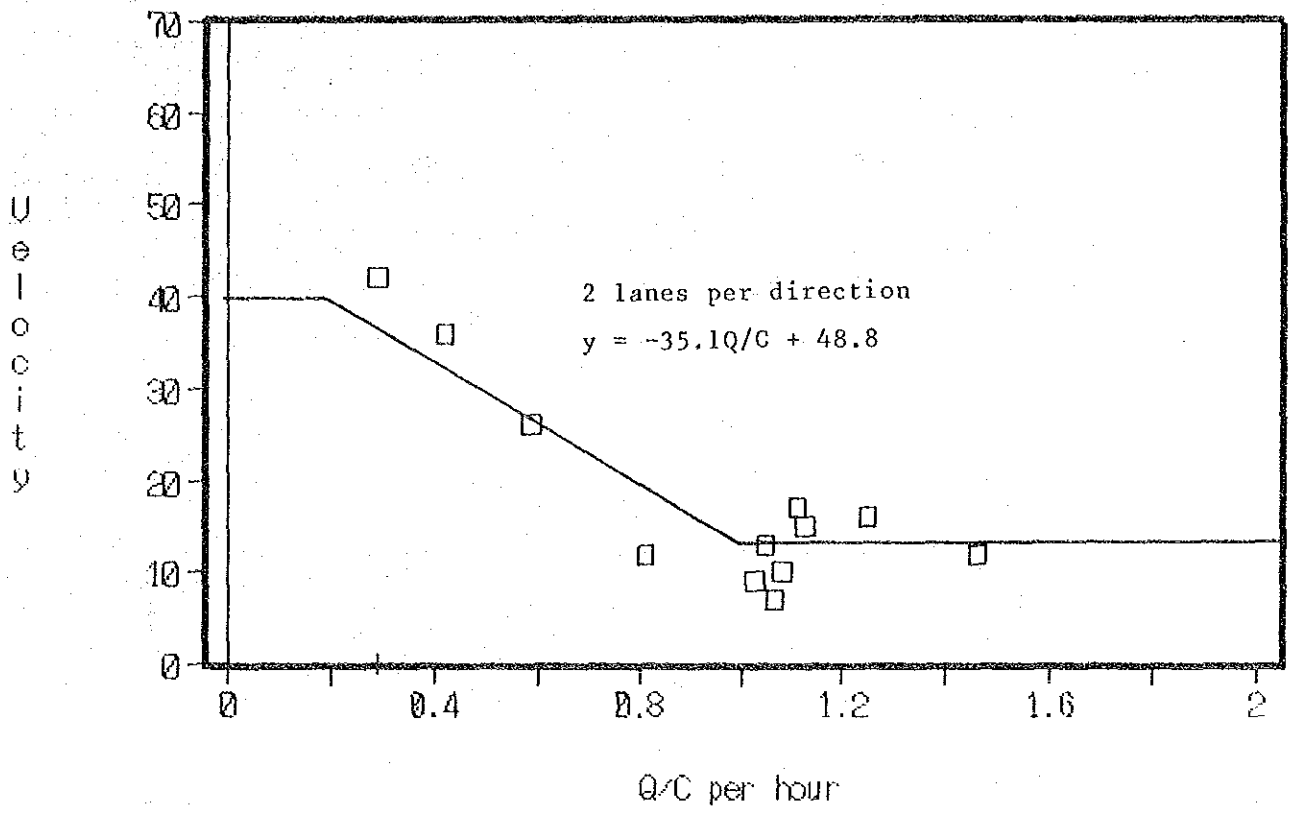
4) Time Value of Travellers

Time value of travellers in urban area is determined by allocating the representative income scale of passenger car users. In the case of public service vehicles, the average income, occupants, the percent of the work trips and other purpose trips are used.

Discussions are in Appendix Note 13.2 and the resultant are shown below:

Values per hour		
Passenger cars & taxis	-----	YR8.61/veh
Micro-buses	-----	YR4.31/veh
Medium-buses	-----	YR21.53/veh

Fig. 13.2.1 Congestion-Velocity Curves



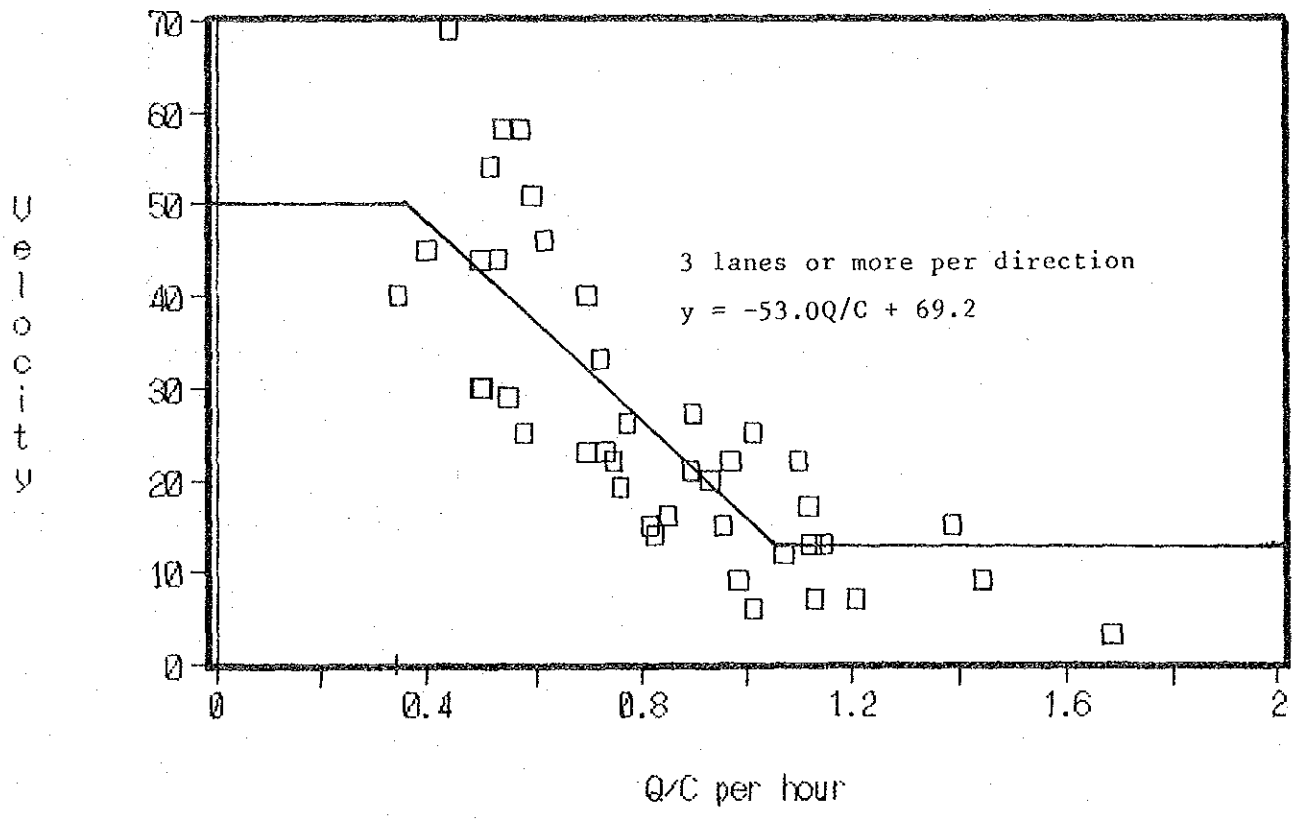


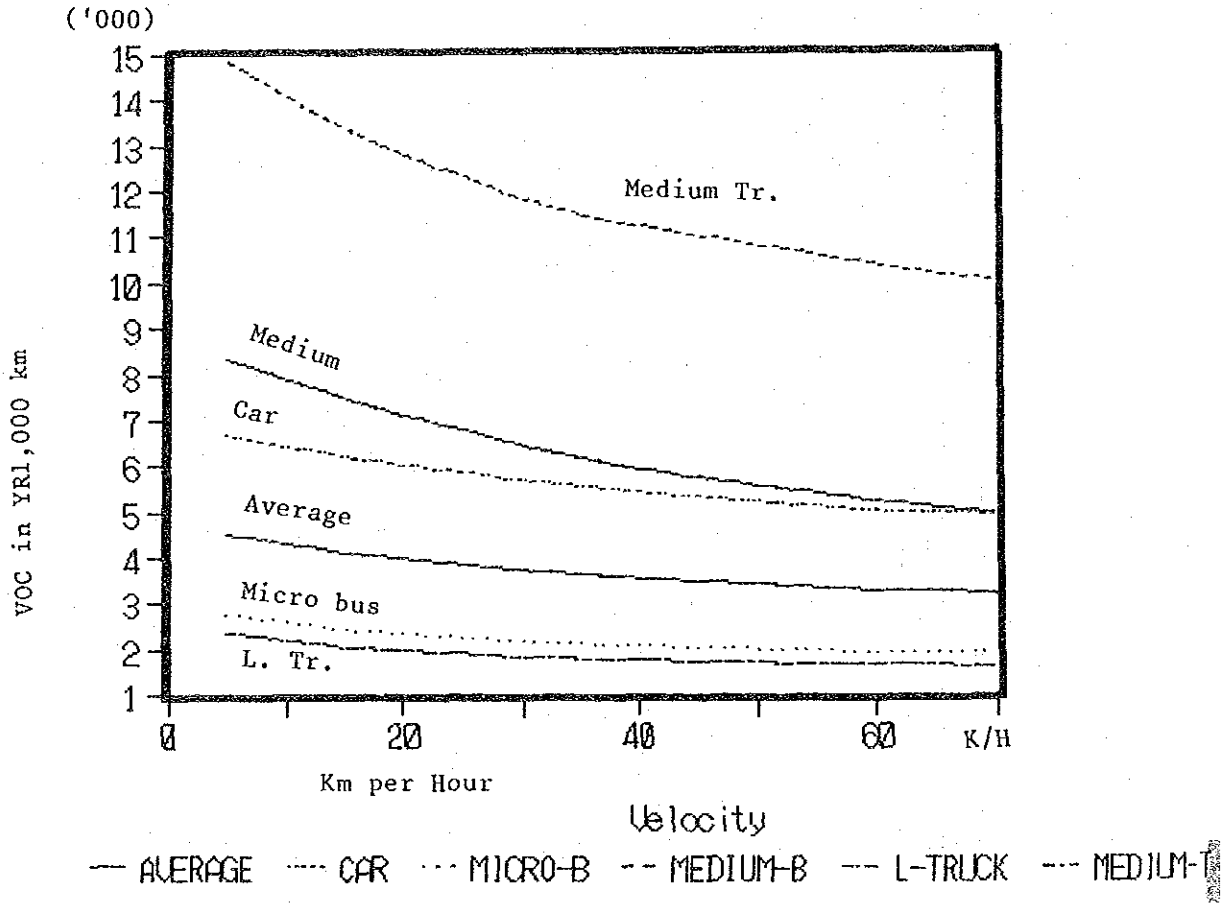
Table 13.2.2 VOC at Selected Speeds

(YR/1000km)

Travel Spped	Motor Cycle	Car	Taxi	Micro Bus	Medium Bus	Light Truck	Medium Truck	Average
5	1912.28	6676.55	4029.16	2776.51	8350.54	2365.42	14831.59	4524.87
20	1695.09	6024.51	3498.25	2331.84	7096.66	1972.07	12774.52	3970.57
40	1528.58	5421.70	3145.19	2075.25	5930.57	1761.43	11203.22	3549.83
60	1410.92	5009.76	2916.88	1927.05	5222.50	1648.28	10339.28	3280.89

Note ; Shadow priced VOC

Fig. 13.2.2 VOC and Velocity

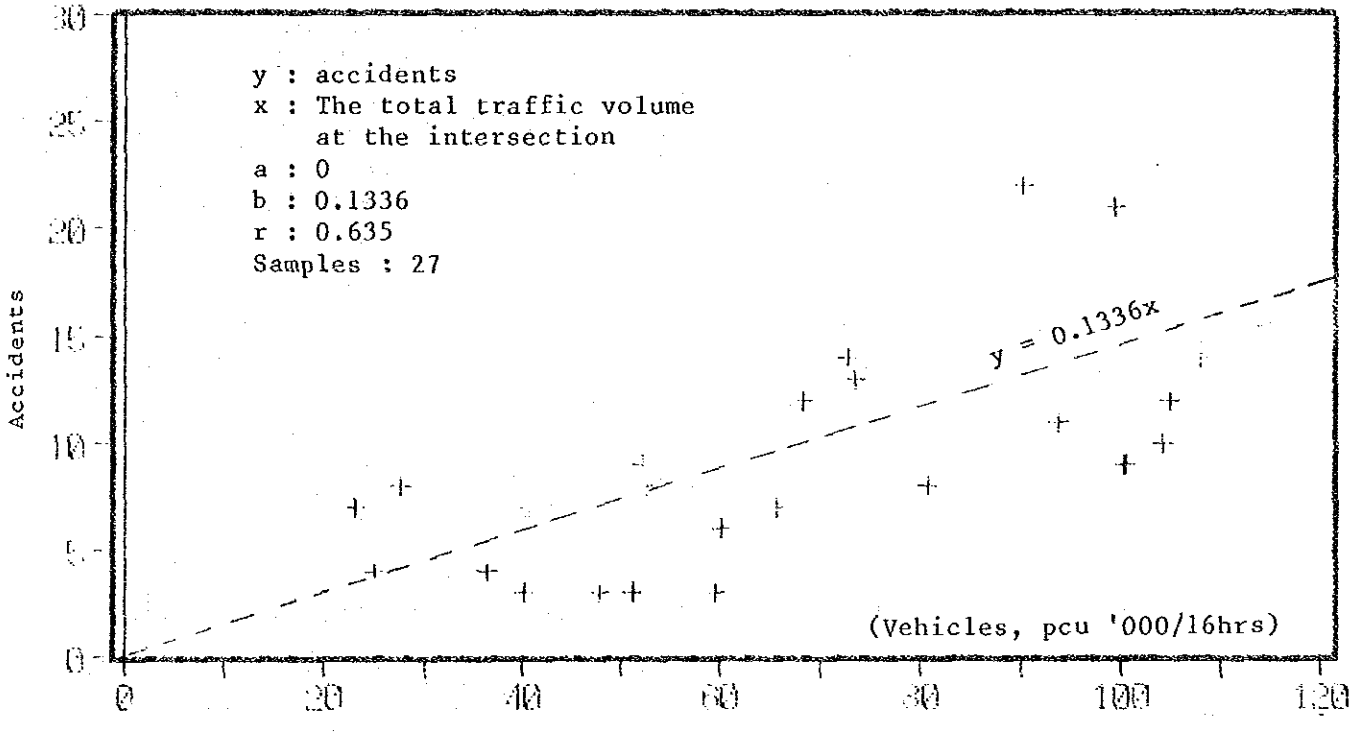


5) Accident Reduction

When an intersection is improved through various means including marking for pedestrians, accidents can be reduced. Data indicating the extent of accidents reduction "with" and "without" are hard to obtain in Yemen.

Numbers of accidents reported at Traffic Police in 1987 are studied as in Fig. 13.2.3, through which a linear relationship of accidents and traffic at the intersections can be found.

Fig. 13.2.3 Accidents-Volume Relationship at Intersections in Sana'a



The Total Traffic Volume of the Approach Sections into the Intersection

Accidents in Sana'a and Japan are compared as follow.

	Sana'a[1]	Japan[2]	
All accidents	21.3	11.5	per registered '000
Deaths	15.57	1.92	per registered '000
Injuries	172.5	141.2	per registered '000

1) Accidents in 1987 from Traffic Police in Sana'a and registered vehicles estimated.

2) Traffic Annual Book (Police Bureau, Japan 1986)

According to the Japanese statistical data in Traffic Annual Book (Police Bureau, Japan 1986), those equivalents to the above figures of Sana'a city are found as follows. Also it was found the years passed to achieve a 25% reduction in ratios.

In Japan	Year	25% less
All accidents	1973	after 3 years
Deaths	1965	after 3 years
Injuries	1977	after 6 years

(See Appendix Table 13.2.1)

It is assumed that the rate of accidents per 1,000 vehicles in PCU will be reduced by 25% when those action plans are realized in 1991.

Accident costs are determined through standardized calculations based on information supplied by the Traffic Police in Sana'a that a death is compensated at YR240,000 and a serious injury at YR70,000 in Traffic Court. Damages to vehicles are assumed at YR18,000. Registered accidents are studied as in the previous Chapter 5.

It is said there are a large number of accidents, two or three times, than those registered at Traffic Police. They are not registered at the Traffic Police probably because the extent of damage on vehicles may be small and negotiable at the site. Those data are not available, but are assumed at YR5,000 per accident and the number is also assumed at three times of the registered accidents.

13.3 Economic Cost

Net Cost excluding customs and taxes are computed in Chapter 12, which is also named "net economic cost". When shadow pricing factors are taken into account, it is named "shadow priced economic cost". Table 13.3.1 presents the net economic cost and the shadow priced economic cost. The shadow priced economic cost is used for economic benefit cost (BC) analysis.

Table 13.3.1 Economic Cost

(A) Economic Cost (A)

(Not Shadow Priced YR '000)

Project	Excluding Park & Bridge Foreign	Local	Total	F/T(%)	Excluding Park Foreign	Local	Total	F/T(%)	Including Park & Bridge Foreign	Local	Total	F/T(%)
1	5670.7	1149.0	6819.7	83.2	6444.2	2728.0	9172.2	70.3	6444.2	2728.0	9172.2	70.3
2	16167.5	3665.7	19833.2	81.5	18994.1	4944.2	23938.3	79.3	19903.8	31483.3	51387.1	38.7
3	9992.1	3025.1	13017.2	76.8	9992.1	3025.1	13017.2	76.8	9992.1	3025.1	13017.2	76.8
4	5573.4	1372.5	6945.9	80.2	8337.3	2725.9	11063.2	75.4	8337.3	2725.9	11063.2	75.4
5	11389.0	2554.5	13943.5	81.7	12741.1	4036.6	16777.7	75.9	15687.6	49095.1	64782.7	24.2
6	14818.8	5410.0	20228.8	73.3	15564.3	6975.1	22539.4	69.1	15564.3	6975.1	22539.4	69.1
7	17285.0	5511.3	22796.3	75.8	18251.9	5985.0	24236.9	75.3	18251.9	5985.0	24236.9	75.3
8	11287.2	3988.0	15275.2	73.9	11287.1	3987.9	15275.0	73.9	11287.1	3987.9	15275.0	73.9
9	7254.9	1440.9	8695.8	83.4	8001.6	1806.3	9807.9	81.6	8001.6	1806.3	9807.9	81.6
10	9168.8	3153.5	12322.3	74.4	10880.6	5907.6	16788.3	64.8	18507.1	11225.7	29732.8	62.2
11	6873.8	1301.1	8174.9	84.1	6873.8	1301.1	8174.9	84.1	6873.8	1301.1	8174.9	84.1
12	7687.4	1705.0	9392.4	81.8	7687.4	1705.0	9392.4	81.8	7687.4	1705.0	9392.4	81.8
13	2629.4	736.1	3365.5	78.1	4841.4	3018.7	7860.1	61.6	4841.4	3018.7	7860.1	61.6
14	8969.4	2751.0	11720.4	76.5	8967.8	2750.7	11718.5	76.5	8967.8	2750.7	11718.5	76.5
Total	134767.4	37763.7	172531.1	78.1	148864.8	50897.2	199762.0	74.5	160347.4	127812.9	288160.3	55.6
1,2,4,7	44696.6	11698.5	56395.1	79.3	52027.5	16383.1	68410.6	76.1	52937.2	42922.2	95859.4	55.2
5,10	20557.8	5708.0	26265.8	78.3	23621.8	9944.2	33566.0	70.4	34194.7	60320.8	94515.5	36.2
13,14	11598.8	3487.1	15085.9	76.9	13809.2	5769.4	19578.6	70.5	13809.2	5769.4	19578.6	70.5
Other	57914.2	16870.1	74784.3	77.4	59406.3	18800.5	78206.8	76.0	59406.3	18800.5	78206.8	76.0
Taiz P-15	11408.3	2336.1	13549.6	84.2	11408.3	2336.1	13549.6	84.2	14459.1	91384.3	105843.4	13.7
Hod P-16	11476.1	2143.3	13619.4	84.3	11476.1	2143.3	13619.4	84.3	11476.1	2143.3	13619.4	84.3
Total	157651.8	42243.1	199700.1	78.9	171749.2	55376.6	226931.0	75.7	186282.6	221340.5	407623.1	45.7

(B)

(Shadow Priced YR '000)

Project	Excluding Park & Bridge Foreign	Local	Total	F/T(%)	Excluding Park Foreign	Local	Total	F/T(%)	Including Park & Bridge Foreign	Local	Total	F/T(%)
1	7088.4	983.1	8071.5	87.8	8055.3	2507.4	10562.6	76.3	8055.3	2507.4	10562.6	76.3
2	20209.4	3202.4	23411.7	86.3	23742.7	4319.2	28061.9	84.6	24879.8	30790.2	55670.0	44.7
3	12490.1	2801.5	15291.7	81.7	12490.1	2801.5	15291.7	81.7	12490.1	2801.5	15291.7	81.7
4	6966.8	1258.4	8225.2	84.7	10421.6	2499.4	12921.0	80.7	10421.6	2499.4	12921.0	80.7
5	14236.3	2202.5	16438.7	86.6	15926.4	3645.8	19572.2	81.4	19609.5	48420.6	68030.1	28.8
6	18523.5	5097.3	23620.8	78.4	19455.4	6641.3	26096.7	74.6	19455.4	6641.3	26096.7	74.6
7	21606.3	5211.5	26817.7	80.6	22814.9	5659.4	28474.3	80.1	22814.9	5659.4	28474.3	80.1
8	14109.0	3819.3	17928.3	78.7	14108.9	3819.2	17928.1	78.7	14108.9	3819.2	17928.1	78.7
9	9068.6	1230.8	10299.4	88.0	10002.0	1542.9	11544.9	86.6	10002.0	1542.9	11544.9	86.6
10	11461.0	2735.3	14196.3	80.7	13600.8	5442.5	19043.3	71.4	23133.9	10055.4	33189.3	69.7
11	8592.3	1102.4	9694.7	88.6	8592.3	1102.4	9694.7	88.6	8592.3	1102.4	9694.7	88.6
12	9609.3	1538.4	11147.7	86.2	9609.3	1538.4	11147.7	86.2	9609.3	1538.4	11147.7	86.2
13	3286.8	632.5	3919.3	83.9	6051.8	2762.8	8814.6	68.7	6051.8	2762.8	8814.6	68.7
14	11211.8	2480.3	13692.1	81.9	11209.8	2480.0	13689.8	81.9	11209.8	2480.0	13689.8	81.9
Total	168459.3	34295.9	202755.1	83.1	186081.0	46762.3	232843.3	79.9	200434.3	122621.0	323055.3	62.0
1,2,4,7	55870.8	10655.4	66526.1	84.0	65034.4	14985.4	80019.8	81.3	66171.5	41456.4	107627.9	61.5
5,10	25697.3	4937.8	30635.1	83.9	29527.2	9088.3	38615.4	76.5	42743.4	58476.0	101219.3	42.2
13,14	14498.5	3112.8	17611.3	82.3	17261.5	5242.8	22504.3	76.7	17261.5	5242.8	22504.3	76.7
Other	72392.8	16589.8	87982.6	82.3	74257.9	17445.8	91703.7	81.0	74257.9	17445.8	91703.7	81.0
Taiz P-15	14260.4	2128.9	16389.3	87.0	14260.4	2128.9	16389.3	87.0	18073.9	91039.8	109113.6	16.6
Hod P-16	14345.1	1953.2	16298.3	88.0	14345.1	1953.2	16298.3	88.0	14345.1	1953.2	16298.3	88.0
Total	197064.8	38377.9	235442.7	83.7	214686.5	50844.4	265530.8	80.9	232853.3	215614.0	448467.2	51.9

13.4 Benefit Cost Analysis

13.4.1 Benefit Cost Analysis

Benefit cost analysis is conducted with the following conditions:

· Cost disbursement	1989	1990 1991
	5%	50% 45%
· Maintenance cost	:	(Total project cost - Land cost) x 5.9%
· Periodic maintenance	:	Marking cost in every 3 years
· Residual value	:	Land cost 100% at the end of the 5th year of benefit
	:	Others are assumed no residual value.
· Discount rate	:	11% p.a is used for B/C ratio.

Countermeasures to mitigate the problems on road traffic are grouped into Project 1 to 16. Benefit Cost Analysis are conducted on each of those 16 Projects. The results are shown in the following tables: Table 13.4.1 shows the first year benefits classified into savings in VOC, passenger time cost and accident cost. It is understood the percent shares of time cost and accident are relatively small when compared with savings of VOC. Table 13.4.2 shows benefit cost ratios and economic rate of return for the cases of standard (without pedestrian bridge and park lot), with pedestrian bridges, and with pedestrian bridges and parking lots. Fig. 13.4.1 - 13.4.3 are duplicated from Fig. 10.2.5 - 10.2.7 showing the routes of projects. Cost and benefit streams are filed in Appendix Table 13.4.1.

It seems all projects excluding pedestrian bridges and park lots are in the range of economic viability. IRR's are more than 15% in those projects. IRR of all projects in Sana'a is 32% and Taiz 33% and Hodeidah 26%. In Sana'a, Projects No. 1, 2, 4 and 7 will have a return of 28%, while those 10 and 5 will have IRR of 31%.

Table 13.4.1 Benefit (First year, 1992)

(A) (Shadow priced YR)

Project	VOC	(%)	TPC	(%)	ACC	(%)	Total
Sana'a P- 1	2256175	50.7	1501976	33.8	691689	15.5	4449840
2	5082805	48.5	3014663	28.8	2384106	22.7	10481574
3	6362847	64.1	3161073	31.8	408676	4.1	9932596
4	1768884	48.1	1147077	31.2	762328	20.7	3678289
5	3412834	49.8	1950600	28.4	1495903	21.8	6859337
6	10537287	66.5	4693169	29.6	620078	3.9	15850534
7	8312606	62.4	4120825	30.9	887991	6.7	13321422
8	4725199	61.5	2444560	31.8	508828	6.6	7678587
9	2620002	55.0	1291754	27.1	851384	17.9	4763140
10	5136336	56.1	3038408	33.2	986714	10.8	9161458
11	1799818	53.3	1071899	31.7	505601	15.0	3377318
12	4215746	59.1	2147715	30.1	767315	10.8	7130776
13	1755604	61.9	823132	29.0	256153	9.0	2834889
14	5129017	61.4	2721331	32.6	501861	6.0	8352209
1,2,4,7	17420470	54.6	9784541	30.6	4726114	14.8	31931125
5,10	8549170	53.4	4989008	31.1	2482617	15.5	16020795
13,14	6884621	61.5	3544463	31.7	758014	6.8	11187098
Other	30260899	62.1	14810170	30.4	3661882	7.5	48732951
Sana'a City	63115160	58.5	33128182	30.7	11628627	10.8	107871969
Taiz P-15	4389124	48.8	2701077	30.0	1906106	21.2	8996307
Hod P-16	3095681	54.8	1627004	28.8	922710	16.3	5645395
Total	70599965	57.6	37456263	30.6	14457443	11.8	122513671

Table 13.4.2 Benefit/Cost ratio and IRR

Project	Standard B/C	Standard IRR(%)	With P,B B/C	With P,B IRR(%)	With B B/C	With B IRR(%)
Sana'a -1	1.70	33.49	1.41	23.70	1.41	23.70
2	1.40	24.56	0.84	7.20	1.17	17.16
3	2.04	41.88	2.04	41.88	2.04	41.88
4	1.40	24.56	0.90	6.92	0.90	6.92
5	1.30	21.43	0.54	2.01	1.14	15.75
6	2.10	43.34	1.96	39.00	1.96	39.00
7	1.56	29.21	1.47	26.61	1.47	26.61
8	1.35	22.96	1.35	22.96	1.35	22.96
9	1.45	26.02	1.29	21.24	1.29	21.24
10	2.02	41.44	0.92	7.93	1.64	29.68
11	1.11	14.83	1.11	14.83	1.11	14.83
12	1.99	40.87	1.99	40.87	1.99	40.87
13	2.14	45.97	1.08	13.72	1.08	13.72
14	1.90	38.57	1.90	38.57	1.90	38.57
1,2,4,7	1.50	27.62	1.11	14.18	1.26	20.18
5,10	1.63	31.36	0.70	3.72	1.37	22.87
13,14	1.97	40.41	1.59	29.55	1.59	29.55
Other	1.74	34.14	1.68	32.42	1.68	32.42
S-Total	1.66	32.22	1.23	17.66	1.48	26.64
Taiz P-15	1.70	33.48	0.53	3.73	1.70	33.48
Hod P-16	1.42	25.71	1.42	25.71	1.42	25.71
Total	1.65	31.98	1.13	14.31	1.49	26.98

Note , Standard ; Excluding parking and bridge
With P,B ; Including parking and bridge
With B ; Including bridge

When pedestrian bridges are constructed it is certain to result in more reduced accidents and smoother traffic flow. However, its quantification cannot be done because data are not available. In this analysis, projects with pedestrian bridges have not changed the benefit stream while cost is added. It should be understood that results would be the same or higher although the calculated BC figures are slightly lower when the bridges are included.

As discussed in Chapters 11 and 12, parking lots construction is considered urgently needed. However, it has to purchase, occupy and clear the land for parking. It may compete with the alternative land use in the land market. Persuation of owners and legislative preparation are, in reality, necessary to develop public parking lots in busy areas. Development possibility is beyond economic justification.

13.4.2 Sensitivity Test

Sensitivity tests are conducted to see the effect on BC figures of the case without pedestrian bridges and park lots by changing the cost or benefit stream.

1) Cost + 10%
2) Cost + 20%
3) Time value x 0.5

The results are shown in Table 13.4.3. It is found among those figures that some projects indicates IRR values less than 10%, while the IRRs of the total projects (No. 1 - 16) are sufficiently large to support the economic viability.

Table 13.4.3 Sensitivity Test on the Standard Case

Project	Cost * 1.1 B/C	Cost * 1.1 IRR(%)	Cost * 1.2 B/C	Cost * 1.2 IRR(%)	TV/2 B/C	TV/2 IRR(%)
Sana'a -1	1.54	29.13	1.42	25.28	1.41	25.17
2	1.27	20.55	1.16	16.99	1.20	18.09
3	1.86	37.26	1.70	33.21	1.72	33.62
4	1.27	20.55	1.17	17.00	1.18	17.52
5	1.18	17.50	1.08	14.01	1.11	15.16
6	1.91	38.65	1.75	34.53	1.79	35.56
7	1.42	25.05	1.30	21.37	1.32	21.97
8	1.23	19.02	1.12	15.54	1.13	15.89
9	1.31	21.96	1.21	18.37	1.25	19.87
10	1.84	36.83	1.68	32.77	1.69	32.82
11	1.00	11.17	0.92	7.92	0.93	8.27
12	1.81	36.27	1.66	32.21	1.69	33.09
13	1.94	41.04	1.78	36.70	1.83	37.95
14	1.73	34.05	1.58	30.08	1.33	22.52
1,2,4,7	1.36	23.50	1.25	19.86	1.27	20.49
5,10	1.48	27.10	1.36	23.35	1.38	23.93
13,14	1.79	35.81	1.64	31.76	1.46	26.58
Other	1.58	29.80	1.45	25.98	1.47	26.73
S-Total	1.51	27.95	1.38	24.17	1.39	24.30
Taiz P-15	1.55	29.13	1.42	25.29	1.45	26.15
Hod P-16	1.29	21.57	1.19	17.90	1.22	19.02
Total	1.50	27.71	1.38	23.94	1.38	24.16

Note: TV means Time Value

Fig. 13.4.1 Location of Short Term Action Plan in Sana'a

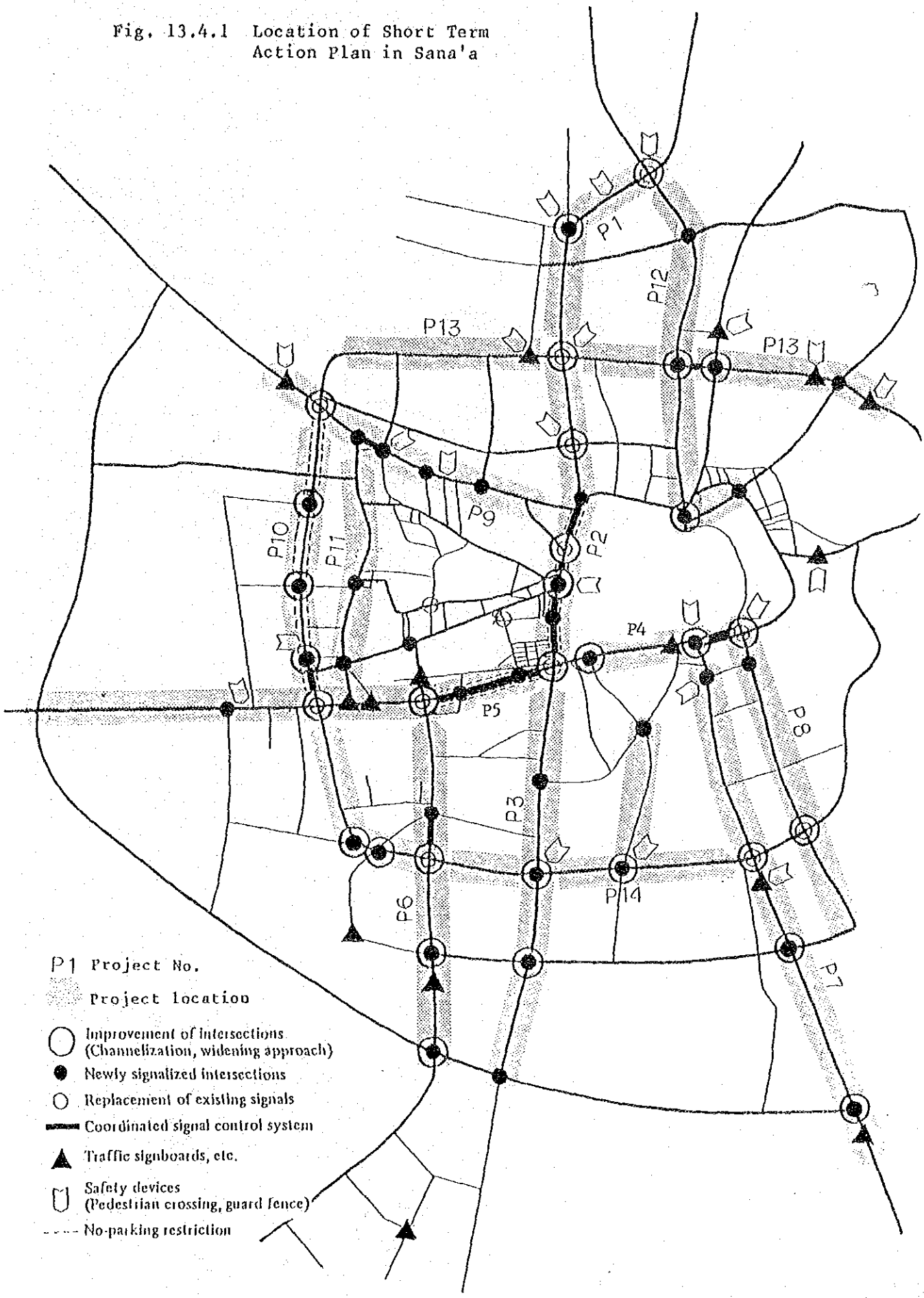


Fig. 13.4.2 Location of Short Term Action Plan in Taiz

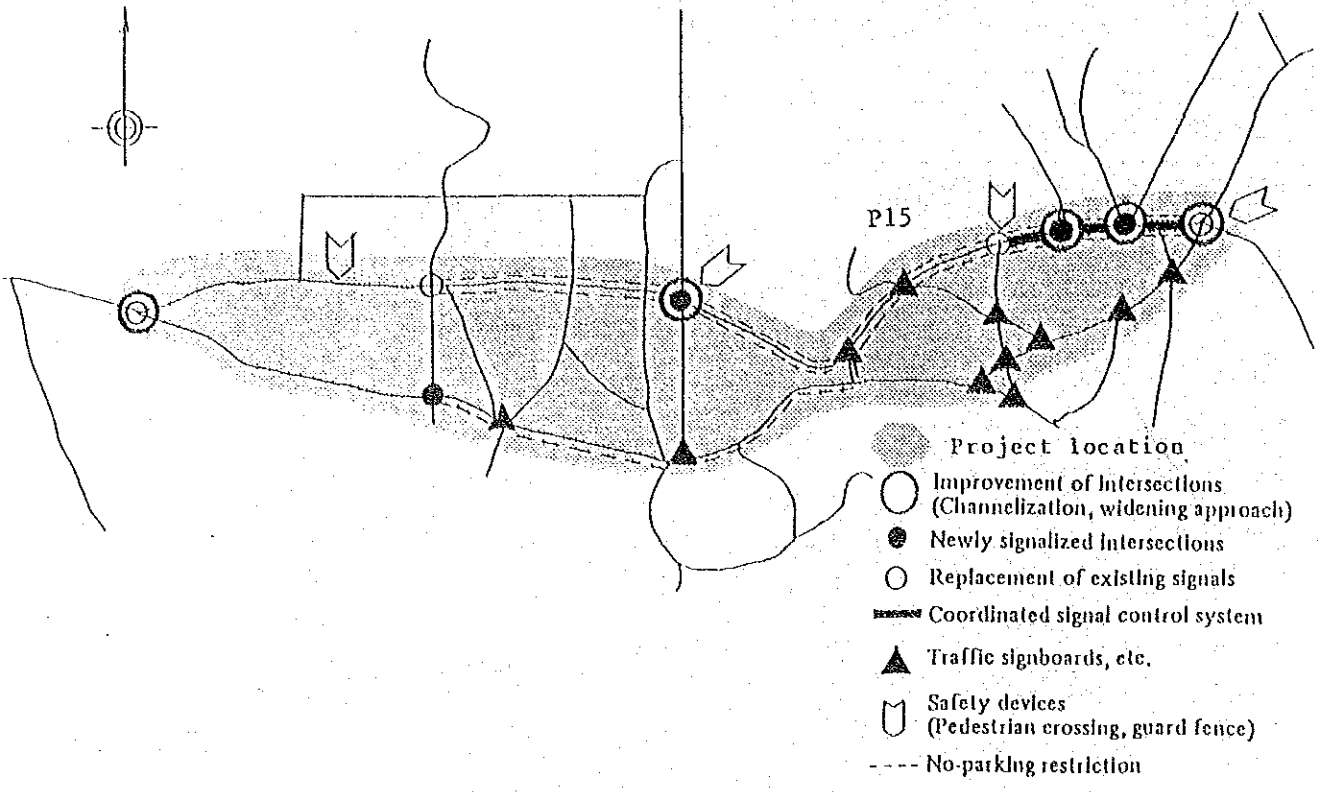
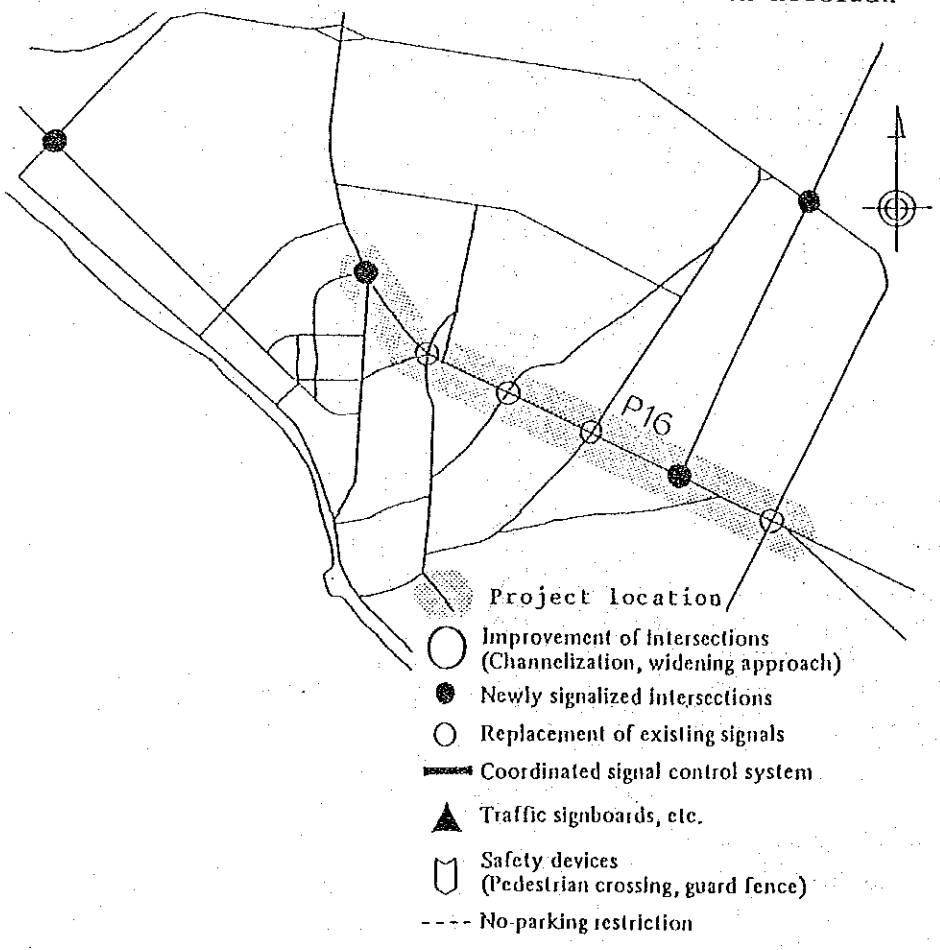


Fig. 13.4.3 Location of Short Term Action Plan in Hodeidah



CHAPTER 14 PUBLIC PASSENGER TRANSPORT SERVICE

CHAPTER 14 PUBLIC PASSENGER TRANSPORT SERVICE

14.1 General

Present public transport service and problems were discussed in Chapter 7. Problems are summarized below:

- Micro bus and taxi movement on roads increases conflicts in traffic flow and accidents.
- Public service is conducted by private owners/operators. They prefer running vehicles in the central area and congested routes while their operation in suburban areas are less, resulting in inconvenience in the areas.
- Medium buses have fixed routes, but micro buses are free to run any roads in request of passengers.
- Population and users of public buses are forecast to increase rapidly in Sana'a. Problems will be enlarged and remain unsolved if actions are not taken.

Under the circumstances, the use of large buses serving on determined routes in a scheduled time table is studied. Large buses can carry about 50 persons while micro-buses carry 6-7 persons. Large buses will serve in mitigating congestion when compared to the service by a large number of micro-medium buses.

In this chapter, development prospect of travel demand and improvement plans of bus service system are discussed. A plan of large bus operational network is proposed through which the priority route is selected for immediate action. Financial analysis is conducted to support the priority route in Sana'a operated by GLTC, a public bus corporation.

14.2 Development Prospects

14.2.1 Person trip volume

Rapid growth of population and economic activities in Sana'a City is expected to continue in the coming years. As in Chapter 9, it is expected that public transport person trips will increase from 207,000 in 1987 to 557,000 in 2000 and the share of public transport users in the total person trips will increase from 56% to 65% during the same period.

The forecast person trips using public transport service in Sana'a is shown in Table 14.2.1.

Table 14.2.1 Estimation of Public Person Trips in Sana'a

Unit: Person trips/day
(% to total)

Vehicle type	1987	1995	2000
Large bus	0 (0.0)	50,000 (12.6)	194,950 (35.0)
Medium bus	44,091 (21.3)	153,000 (38.5)	167,100 (30.0)
Micro bus	122,337 (59.1)	139,000 (35.0)	139,250 (25.0)
Taxi	40,572 (19.6)	55,000 (13.9)	55,700 (10.0)
Total	207,000 (100)	397,000 (100)	557,000 (100)

Source: Study Team, based on the public transport passenger survey in 1987.

14.2.2 Plan of Service

1) Bus types and their functions

Currently public passenger transport service is conducted by private owners/drivers with no administrative control in vehicle number, routes and operation license. Up until recently the system has worked well to meet the demand in the city.

However, the system is not expected to be able to serve in the same way further in the future due to increasing conflicts in traffic flows and accidents because of their frequent stops and lane-changes. Also the system does not serve well in newly developing outskirt areas.

Under the circumstances, public transport service should be restructured by allocating efficient service system onto appropriate roads and zones. The vehicles are divided into the three patterns as follows:

Micro buses : serving short distant trips on secondary and feeder roads. Currently, micro buses run and operate any roads they choose. Accordingly they prefer to run on busy central area or heavy traffic main roads to get a good return. They should be organized to operate in a certain zone and not free in inter-zonal movement. Their function should be mainly in feeder service.

Medium buses : serving short-medium distant trips on primary and secondary roads

Large buses : serving long-medium distant trips on primary roads Medium-buses and new coming large buses should be responsible for inter-zonal movement of passengers. Medium buses operate mainly for short-medium distance travelling and large buses for medium-long distance travelling. The former should come into inner areas off from main trunk roads, while the latter should be on main trunk roads.

Considering the forecast of rapid development of urban economy and population and a large job opportunity of the service, it is proposed that micro buses should not be deleted from the service, medium buses should increase their

fleet and that large buses should be introduced. Table 14.2.2 indicates the fleets in 1987, 1995, and 2000 in Sana'a.

Table 14.2.2 Estimation of Public Transport Fleets

(Unit: Number of vehicles)

	1987	1995	2000
Large bus	0	50	200
Medium bus	120*	250	350
Micro bus	2600	2600	2600
Taxi	3400	3400	3400
Total	6120	6300	6550

* Those only for the general public use
Source: Study Team

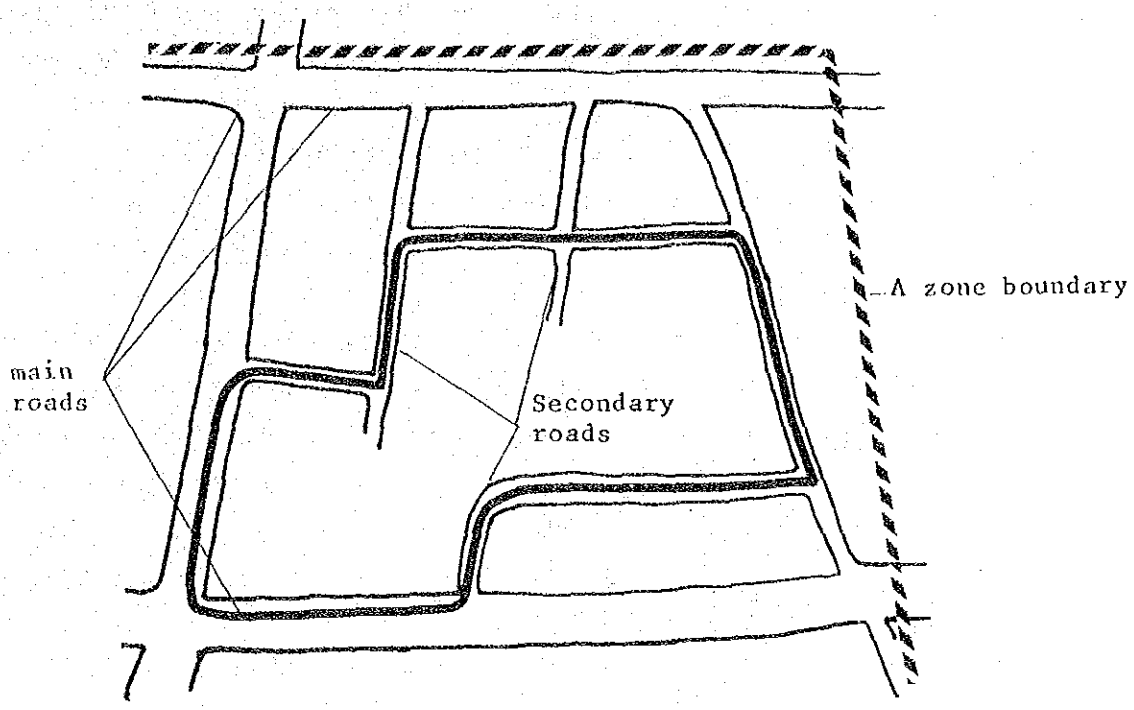
2) Network Development

The road network on which bus service should be operated can be decided for micro buses and medium-large buses.

a. Micro buses

The operational area should be defined as a zone in which routes should be decided in such manner as partly on the main roads, but mostly on inner roads. Thus they may compete partly with large-medium buses on the main road, however the main service should be on the inner feeder roads.

Fig. 14.2.1 Concept of Micro Bus Routes

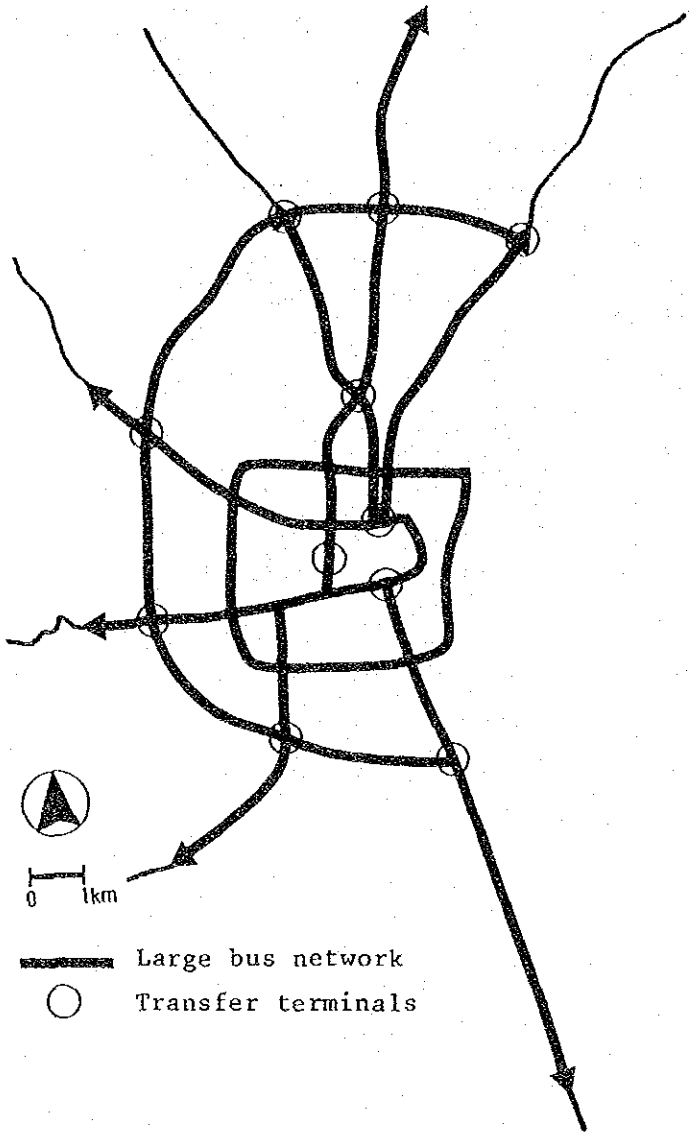


Micro bus routes.
They run part of the main roads,
but mostly on the roads of inside area.

b. Medium/Large buses

They should be assigned to operate on the main roads of the city. Their main bus stops would be gathering points of micro buses which serve in connecting work.

Fig. 14.2.2 Concept of Large Bus Network in 2000



Main road network is shown conceptually. Routing on those roads should be developed by stage in accordance with the urban development.

Medium buses owned by private operators and large buses by GLTC should run in cooperation on most of those routes regularly using the determined bus stops.

3) Organization

The Ministry of Public Works and Transport should be restructured to be responsible for supervising and co-ordination of planning, policy making and administration in the development of public transport sector. It is expected that organizations concerned with public transport such as Traffic Police, General Land Transport Corporation, private sector operators of public transport, etc. should be coordinated under the administration of the Ministry to realize an integrated public transport system. As a case of the restructuring, an idea is that individual drivers of medium buses, micro buses and taxis should organize cooprative associations.

At present GLTC is a public corporation with relevant experiences and assets to operate intercity regular service of large buses. It has been authorized to enter into intracity service, so it is reasonable the corporation is assumed to engage in the regular service by using large buses.

14.3 Large Bus Service

At present serious problems of the public transport are not caused by shortage of public transport means. On the contrary, an excessive number of public transport causes traffic congestion and accidents on certain streets.

However, in foreseeable future rapid population growth and urban expansion will take place which definitely need substantial development of quantity and quality of the public transport services.

The overall trunk network of large bus service in the year 2000 should be realized by stage development according to the priority and financial viability. It is better to start with a pilot case of one line operation by GLTC rather than a large scale network operation. Reasons are summarized below:

a. Financial cost burden is less in the case of one route operation.

b. There is possibility that operation of a few routes covering main roads in 1990 or 1991 would result in financial loss. It will require subsidies from the government.

c. It will be difficult to prepare sufficient operational and technical staff and facilities in the short preparatory period, which are necessary to have an efficient management.

d. Even when GLTC operation is established, the extent of the share of private operators is not decided. They should remain partly competitive on main roads and mostly supplementary on minor roads engaged in connecting service.

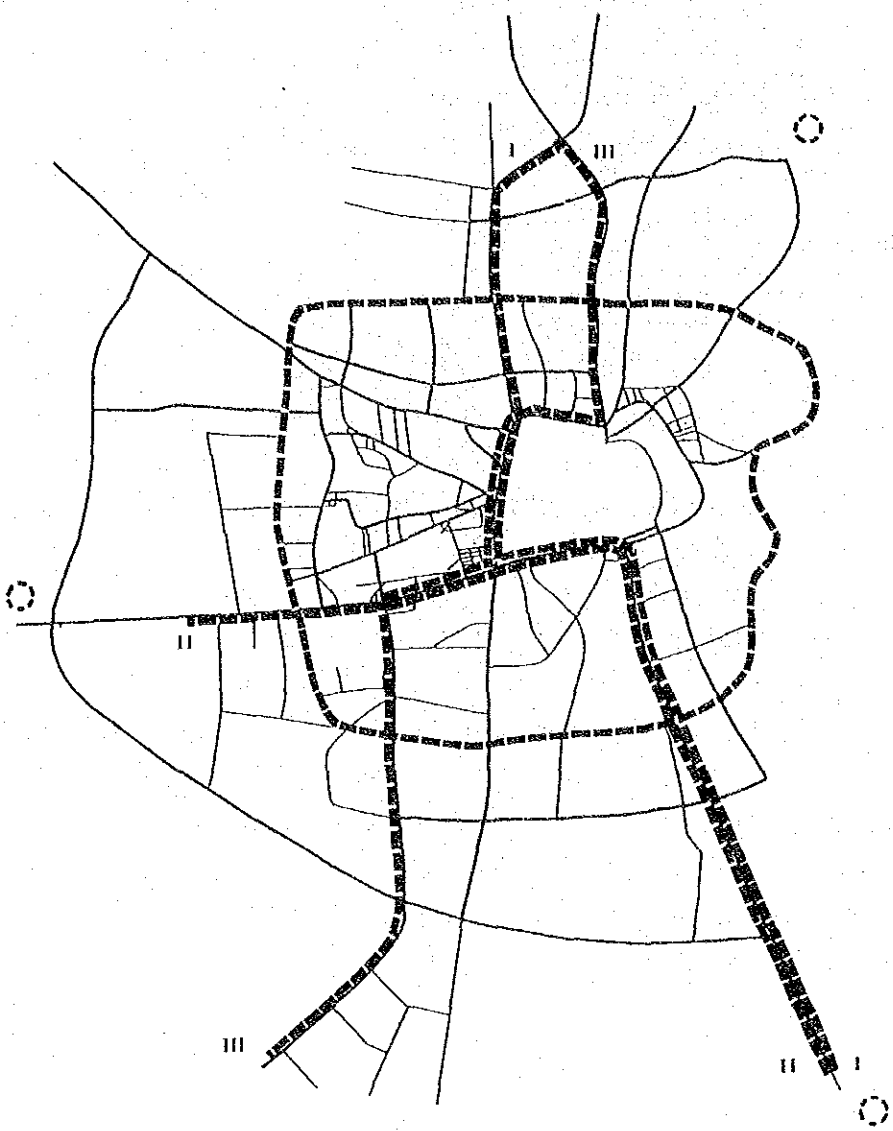
e. With the one line operation as recommended by this study, impacts on users and other buses can be reviewed together with the technical and financial performance of the GLTC operation. Necessary actions can be taken before starting the second route operation.

The new bus system is expected to be introduced along a route which should have multilanes and enough side-walkway to place stop posts. It should be the route of high potential demand for public transport. The route also performs an inter-zonal linkage without transfer.

Considering these conditions, 4 candidate routes can be identified as in Fig. 14.3.1. Based on the public transport passenger interview results and assuming a similar service level of each route, the numbers of passengers in 1990 are estimated as in Table 14.3.1, where it is assumed that the number of passengers increases by 10% per annum between 1987 and 1990.

The comparison of the number of the passengers shows that Route I is to be selected as the pilot route. It is recommendable that introduction of the new service by large buses should be to the route I first, route II second and the 3rd stage should be Route III and the Ring Road. After introduction of each bus route, evaluation and review have to be made for the next stage.

Fig. 14.3.1 Candidate Priority Routes



Route I : Hasaba Intersection - Airport Road - Al Qiyada Street -Ali Abdul Mughni Street - Az Zubayri Street - Taiz Road -Qat Market

Route II : Asser - Az Zubayri Street - Taiz Road - Qat Market

Route III : Hasaba Intersection - Saddah Road - Bab Shuub - Shuub Street - Ali Abdul Mughni Street - Az Zubayri Street - Haddah Road -Haddah at the foot of the hills

Ring Road Route: Ring Road

○ : Candidate large bus depot location

Table 14.3.1 Estimation of Passengers of Candidate Priority Routes in 1990

	Route length (km)	All day passenger demand* (passengers)
Route I	11	34,303
Route II	10	25,719
Route III	13	8,957
Ring Road Route	16	11,141

Regarding Routes I, II and III, numbers of trips which are along more than one route are allocated to each route equally. Trips along Ring Road Route are separately estimated irrespective of duplication to the 3 routes.

Source: Study Team

14.4 Study on the Priority Projects

1) Route I

a. Demand estimation

Future demand estimation and financial analysis are made based on the patterns of passenger trips using public transport service. The patterns and the methodology are in Appendix Fig. 14.4.1, Appendix Table 14.4.1 and Appendix Note 14.4.1.

Assumed conditions:

* Passengers on public transport service will grow 10% p.a. from 1987 to 1991 and 7% p.a. afterwards.
* The capacity of the new bus is 50 - 55 passengers/vehicle
* The operation hours are from 6 am to 10 pm, and the total daily frequency of the bus service is 120 per direction. (See Appendix Figure 14.4.2)
* 6 minute interval in peak hours and 10 or 15 minutes in other hours.
* New service buses will run on the roads together with other public service vehicles.
* The bus type is indicated as in Fig. 14.4.1 afterward.
* Bus stops are determined at a 400 m interval and the buses will not stop at other points.
* The fare is mostly the same level with micro-buses or medium buses.
* Passengers with trip origins and destinations along the route, who need 2 or mode rides for the trip, will divert to the new bus service provided that their waiting time is within 5 minutes in case of YR 2 flat fare. In case of YR 3 flat fare, the number of potential passengers is reduced by 1/3.
* The capacity of the service at a section is 10176 passengers per day, which is worked out as the

following calculation assuming 80% of the bus capacity is used.

53 passengers/bus x 120 frequencies x 2 ways x 80%

Estimated numbers of the passengers in 1990 and in 1995 in two fare levels are shown below.

Estimated Numbers of Passengers

(Unit: Passengers/day)

Case	1990	1995
YR 2	15900	18500
YR 3	14000	15700

The estimated numbers of the passengers at selected sections are shown in Table 14.4.1.

According to the table the shares of the new bus passengers to total passengers at selected sections are mostly greater than 10% in 1990 but smaller than 10% in 1995, because this analysis assumes no increase in bus fleet in the cycle years of 1990 - 1997.

It is also noted that in 1995 there will be a considerable number of passengers in excess of the capacity at some sections indicating necessity of additional services.

Table 14.4.1 Estimated Number of Passengers on the New Bus Route I
Case of YR3 Flat Fare

Unit: Passengers/day and (%)

Year	1990			1995		
Cross-section	Total public transport passenger flow	Passenger demand	Estimated number of passengers	Total Public transport passenger flow	Passenger demand	Estimated number of passengers
Northern section of Ring Road	32500	5082 (15.6)	4333 (13.3)(85.3)*	46900	7337 (15.6)	5526 (11.8)(75.3)*
Tahrir Area	71200	9370 (13.2)	7106 (10.0)(75.8)*	102600	13527 (13.2)	8060 (7.9)(59.6)*
Bab Al Yemen Area	81800	14825 (18.1)	10176 (12.4)(68.6)*	118,000	21401 (18.1)	10,176 (8.6)(47.5)*
Southern section of Ring Road	74800	12797 (17.1)	9043 (12.1)(70.7)*	107,800	18474 (17.1)	9,409 (8.7)(50.9)*
Total passengers along the route	-	18675	14026 (75.1)*	-	26,959	15,734 (58.4)*

( ): % to the total public passenger flow
( )*: % to the passenger demand
maximum occupancy of 80% is assumed
Source: Study Team

b. Facilities and Personnel for the Bus Service

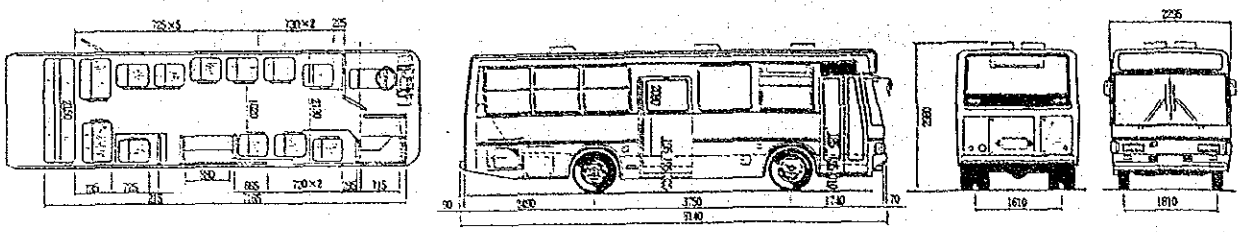
Following facilities are necessary for the operation, but some of which may not be necessary by using the existing facilities for the inter-city bus service of GLTC. It can be discussed when need arises.

(1) Bus vehicles for 50 - 55 passengers (18 vehicles including two buses standby). See Fig. 14.4.1.
(2) Spare parts of the buses (18 units)
(3) Office (1 place)
(4) Workshop (1 place)
(5) Garage or parking yard (one place for the space of 50 vehicles. This pilot case requires 18 vehicle space, but additional land area is included in preparation for the followed staged expansion.)
(6) Bus terminals (2 places) at both ends of the route
(7) Bus stops (50 - 60 locations)
(8) Other bus-related devices and means

The personnel required for the operation of new buses are shown in Fig. 14.4.2 Organization Chart. The total number of staff is 71 in case of operation without conductors and 111 in case of operation with conductors.

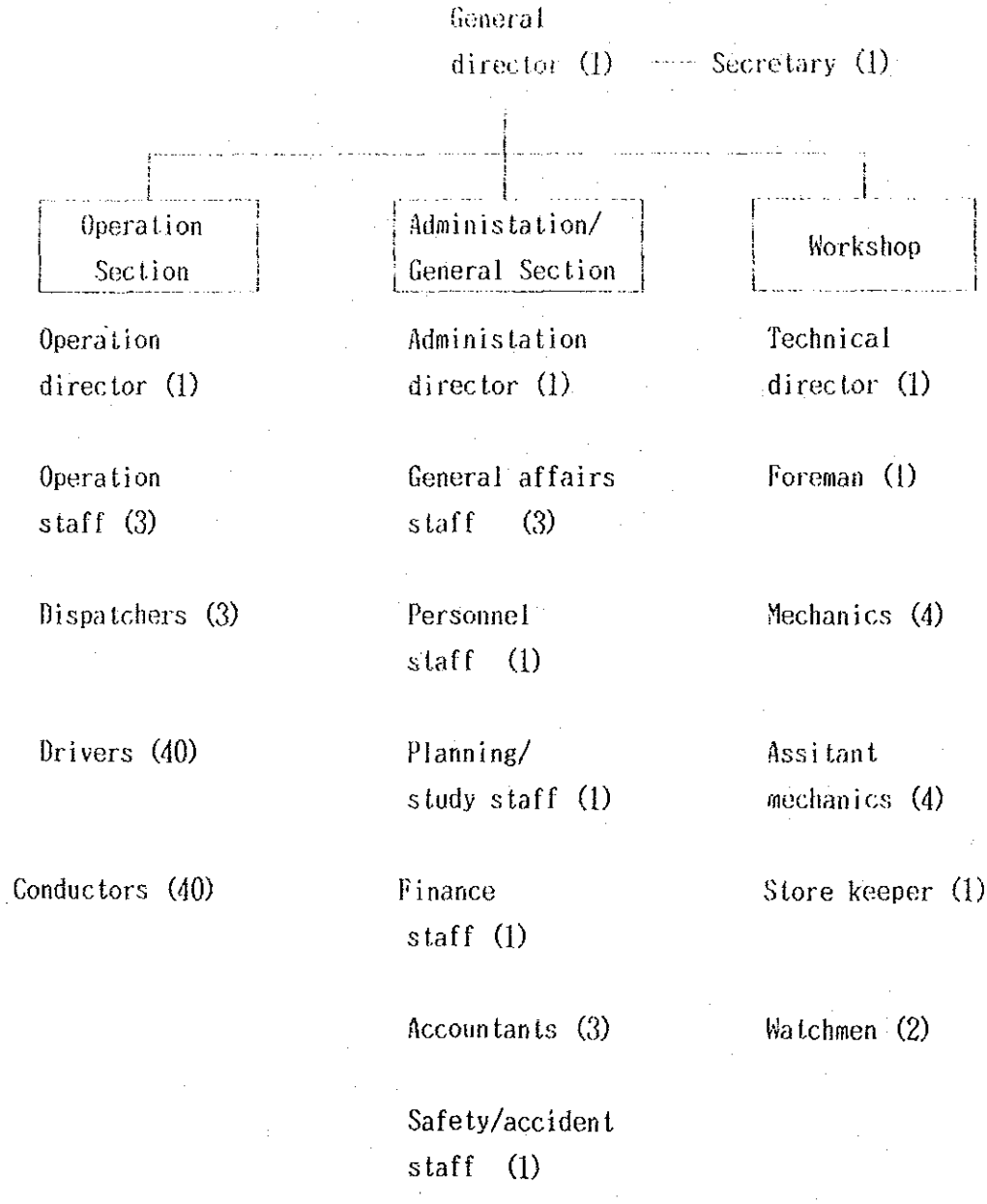
Currently GLTC operates large buses regularly on inter-city routes. It has staff experienced in operation, driving, maintenance and repair work of vehicles. Part of them can be available for in-city service with preparatory training.

Fig. 14.4.1 Examples of the Bus Type



Capacity: 53 passengers

Fig. 14.4.2 Organization Chart



c. Financial analysis of the project

-1 Assumptions

It is assumed that the new service is operated by a new organization under GLTC, and facilities of GLTC may be shared. The followings are assumptions on which the financial analysis is based.

(1) Number of passengers per year (an example for 1995)

YR2 fare case
18512 passengers/day x 290 working days
+ 18512 x 0.5 passengers/day x 75 holidays
= 6062700 passengers/year

YR3 fare case
15734 passengers/day x 290 working days
+ 15734 x 0.5 passengers/day x 75 holidays
= 5152900 passengers/year

(2) Yearly travel distance

(120 services x 22 km x 1.05 x 290 working days +
60 services x 22 km x 1.05 x 75 holidays)
= 907,830 km
= 908,000 km

(3) Office and workshop

Office	(approx. 40 employees at one time)	300m^2
Workshop	(approx. 13 employees)	400m_2
Total		700m^2

(4)

Land	(m^2)
Office	300
Workshop	400
Depot for 50 buses (including area for future use)	2400
Total	3100

-2 Estimation of earnings and expenses

(1) Earnings

The total annual revenue is calculated by multiplying the number of passengers per year by YR2 or YR3.

(2) Expenses

Initial investment, operating costs and depreciation are shown in Table 14.4.2, Appendix Table 14.4.2 and Appendix Table 14.4.3.

Route I: Hasaba - Ber Ubeid

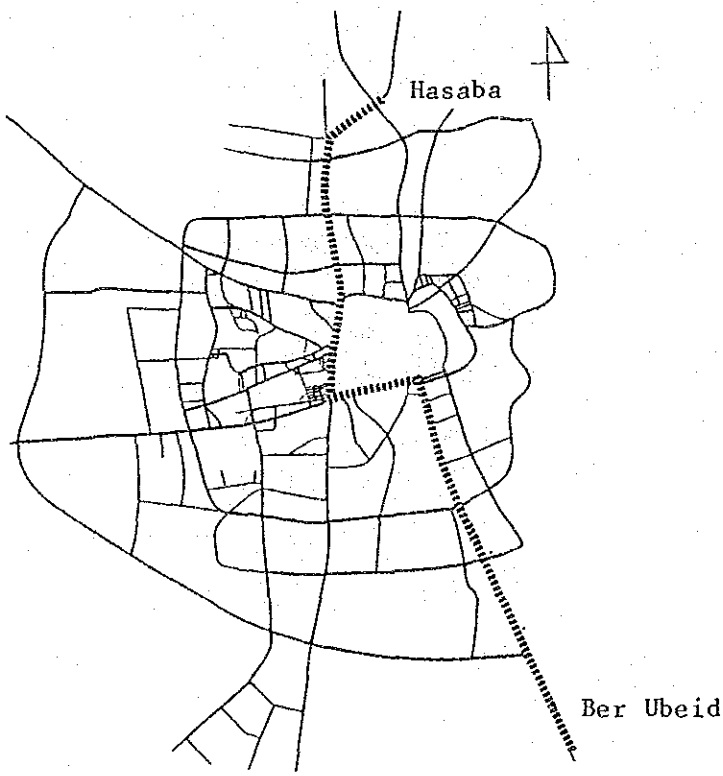


Table 14.4.2 Expenses and Unit Costs

Particulars	Amount (YR)	Remarks
(1) Initial investment	23,078,000	
Vehicles	11,232,000	YR 624,000 x 18 vehicles
Spare parts	1,123,200	YR 62,400 x 18 units
Workshop equipment	1,519,000	
Office and workshop	2,100,000	YR 3000 x 700 m^2
Bus stop posts	43,700	YR 780 x 56 posts
Land for office, workshop & depot	7,060,000	YR 100,000/44 m^2 x (700 m^2 for office & workshop + 2400 m^2 for 50 buses)
Training	1,000,000	Training in 0th year
(2) Operating Costs		
1st year	9,500,125	
2nd year	9,746,593	
3rd year	9,994,821	
4th year	10,244,961	
5th year	10,496,789	
6th year	10,750,458	
7th year	11,006,119	
8th year	11,226,053	
These are composed of:		
Personnel expenses	6,258,300	Amount for 1st year (Appendix Table 14.4.2) Annual growth rate = 1.5%
Fuel	558,400	YR 2.05 x 0.3 ℓ/km x 908,000 km

(continued)

Particulars	Amount (YR)	Remarks
Repair and maintenance		Oil, tires, spare parts and
1st year	753,900	batteries are included
2nd year	857,200	(See Appendix Table 14.4.3)
3rd year	960,500	
4th year	1,063,900	
5th year	1,167,200	
6th year	1,270,500	
7th year	1,373,900	
8th year	1,477,200	
Insurance	29,500	for 18 vehicles
General Cost	(See Remarks)	(Personnel cost + Fuel cost + Repair and maintenance + Insurance) x 25%
(3) Depreciation	1,878,645	
Vehicles	1,544,400	(YR 11,232,000 + YR 1,123,200)/8 years
Workshop equipment	189,875	YR 1,519,000/8 years
Office and workshop	140,000	YR 2,100,000/ 15 years
Bus stops	4,370	YR 43,700/10 years

-3 Financial analysis

Conditions for the financial analysis are as follows.

(1) The project cycle is assumed to be 8 years from 1990, with the year 1989 for preparation.

(2) The initial expenses should be financed by a loan which bears an annual interest rate of 13% and a repayment period of 7 years after a grace period of 2 years.

(3) The initial investment is composed of 18 vehicles and their spare parts, bus stop posts, the workshop equipment, the office, the workshop, and the land for the parking of 50 buses is also included.

(4) Repayment of the interest and amortization of the initial loan is made from the 2nd year to the 8th year.

(5) In the projected income statement, operation revenue is the fare revenue. Operating costs are increasing according to the annual increase of maintenance and repair costs. Operating income is the balance between operating revenue and costs. Depreciation is also set at the same amount every year. Net income is operating income minus depreciation and interest repayment.

(6) In the projected cash flow statement, the total sources are the sum of operating income and the loan. Capital expenditure is the initial investment except for training. Total debt service is the sum of repayment of the interest and amortization of the principal. Total applications are the sum of the capital expenditure and the total debt service. Net cash increase is the balance between the total sources and the total applications. Cumulative cash balance is shown at the bottom of the table.

Results of the cash flow analysis are shown in Table 14.4.3. Table 14.4.4 shows income statement and cash flow of a case with YR3 fare. The following are the summary of the results.

(i) YR2 fare case

8 year operation will result in a deficit approximately YR-28,000,000 in cumulative cash balance. This case is not financially feasible since the financial rate of return is below zero.

(ii) YR3 case

Only in the 0th year and 2nd year, net income is in negative values. (Table 14.4.4 is the case of YR3.00)

Although cumulative cash balance in the 8th year is in deficit, the amount is approximately 20% of the initial land cost, and this deficit is caused by purchasing of land for the future use of additional 32 bus depot. However, this case is considered financially feasible with the financial internal rate of return of 15.6%.

Table 14.4.3 Accumulated Income and Cash Balance of the Project in the 8th Year

	Income accumulated during 1989-1997 (YR)	Cash balance accumulated during 1989-1997 (YR)	Financial Internal Rate of Return (%)
Case			
YR2 flat fare	-20,360,000	-28,409,000	N.A.
YR3 flat fare	6,638,000	- 1,411,000	15.6
Sensitivity check YR3 flat fare 15% less revenue	-11,615,000	-19,664,000	3.3
YR3 flat fare 30% less revenue	-29,869,000	-37,918,000	N.A.

Table 14.4.4 Income Statement, Cash Flow Statement and Financial Internal Rate of Return

(Unit: Yemen Real)

LOAN OPERATION

YEAR	1989	1990	1991	1992	1993	1994	1995	1996	1997
LOAN	24078107								
TRAINING EXPENSES	1000000								
INITIAL INVESTMENT	23078107								
DEBT	24078107	27208261	30745335	23321367	19434473	15547578	11660684	7773789	3886895
INTEREST REPAYMENT			6667228	2682989	2235825	1788659	1341495	894329	447165
AMORTIZATION			3439730	3439730	3439730	3439730	3439730	3439730	3439730
BALANCE	24078107	27208261	20638377	17198648	13758918	10319189	6879459	3439730	0

PROJECTED INCOME STATEMENT

YEAR	1989	1990	1991	1992	1993	1994	1995	1996	1997
OPERATING REVENUE	0	13780545	15158599	15458655	15458655	15458655	15458655	15458655	15458655
OPERATING COSTS	1000000	9500125	9746593	9994821	10244961	10496789	10750458	11006119	11226053
OPERATING INCOME	-1000000	4280420	5412006	5463834	5213694	4961866	4708197	4452536	4232602
DEPRECIATION	0	1878643	1878643	1878643	1878643	1878643	1878643	1878643	1878643
INTEREST	0	0	6667228	2682989	2235825	1788659	1341495	894329	447165
NET INCOME	-1000000	2401777	-3133865	902202	1099226	1294564	1488059	1679564	1906794
ACCUMULATED INCOME	-1000000	1401777	-1732088	-829886	269340	1563904	3051963	4731527	6638321

PROJECTED CASH FLOW STATEMENT

YEAR	1989	1990	1991	1992	1993	1994	1995	1996	1997
OPERATING INCOME	-1000000	4280420	5412006	5463834	5213694	4961866	4708197	4452536	4232602
LOAN	24078107								
TOTAL SOURCES	23078107	4280420	5412006	5463834	5213694	4961866	4708197	4452536	4232602
CAPITAL EXPENDITURE	23078107								
INTEREST	0	0	6667228	2682989	2235825	1788659	1341495	894329	447165
AMORTIZATION	0	0	3439730	3439730	3439730	3439730	3439730	3439730	3439730
TOTAL DEBT SERVICE	0	0	10106958	6122719	5675555	5228389	4781225	4334059	3886895
TOTAL APPLICATIONS	23078107	0	10106958	6122719	5675555	5228389	4781225	4334059	3886895
NET CASH INCREASE	0	4280420	-4694952	-658885	-461861	-266523	-73028	118477	345707
CUMU CASH BALANCE	0	4280420	-414532	-1073417	-1535278	-1801801	-1874829	-1756352	-1410645

Financial Internal Rate of Return

year	cost	benefit	B-C
0	24078107	0	-24078107
1	9500125	13780545	4280420
2	9746593	15158599	5412006
3	9994821	15458655	5463834
4	10244961	15458655	5213694
5	10496789	15458655	4961866
6	10750458	15458655	4708197
7	11006119	15458655	4452536
8	11226053	23507618	12281565
total	107044026	129740037	22696011

FIRR = 0.1556841

Flat fare of YR3.-/passenger

2) Other Priority Routes

After two year operation on Route I and reviewing the performance, operation on Route II can follow it. Considering the growth trend of number of passengers, the operation on Route II with approximately 60 services per direction is expected to start in 1992.

In the same way as Route I, the number of passengers of Route II in the start year is estimated at 7398 in the YR2 fare case and 6628 in the YR3 fare case. Opening Route II operation requires the following facilities, personnel and initial costs.

Item	Cost (YR)
* 9 buses with spareparts	6,177,600
* Office and garage (350 m^2 floor area)	1,050,000
* 16 bus stop posts in addition to those shared by Route I	12,500
* Land for office, garage and depot for 25 buses	4,333,000
(Land space for the additional 16 buses is included.)	
* Staff training (50% of Route I)	500,000
Total*	12,073,000

* Workshop equipment is assumed to be shared with Route I, thus incurring no costs.

Required personnel expenses in the first operation year is to be approximately YR3129000 or 50% of those of Route I. Other operation costs such as fuel, maintenance, insurance and depreciation can be calculated as in the case of Route I.

Based on the above conditions, financial analysis results in the following flat YR3 fare case.

Income accumulated during 1992 - 1999 = YR-321,000
Cash balance accumulated during 1992 - 1999 = YR-5,146,000
Financial Internal Rate of Return = 10.6%

Therefore, operation of Route II in YR3 fare case is not financially feasible. However, when the land cost for additional 16 buses is not included in the cost of Route II, the rate of return will increase to 12% and becomes feasible marginally.

Analysis on the financial aspect of Route III and Ring Rd. Route is not conducted because they have smaller numbers of passengers and are considered not feasible to start operation in 1992 or so. They can be reviewed together with such factors as:-

- urban development along the routes
- policy to increase the passengers on GLTC by reducing private buses

These matters should be studied in detail when need arises.

14.5 Actions in the Traffic Management

Actions are necessary in traffic flow management in association with buses on roads. They are in the followings:

a. Bus stops

In order to keep smooth traffic flow, bus stops should be installed where the buses have priority over other vehicles. Such zones should be clearly marked to prohibit parking or stops of other vehicles. The passengers should not be allowed to get on or off in any other places.

Moreover, where there is enough space, forming bus bays should be considered.

b. No-stopping zone

No-stop zones should be delineated at crowded areas such as Tahrir Square, Bab Al Yemen and Bab shuub, etc. At the zones micro buses are not allowed to stop. Micro-buses can stop at specifically designated shoulder next to the zone. The shoulder may be equipped with bus bays and shelters.

Movement of taxis should also be controlled as in case of micro buses. At least in very congested areas such as the three terminals, taxi passengers should be allowed to get on and off at designated spots.

c. Bus terminals

Existing bus terminals in the center area should be improved in order to provide better service to passengers. Conceptual plans for improvement are shown in Appendix Fig. 14.5.1 -14.5.3.

14.6 Conclusion and Recommendations

The operation of one route by using 18 large buses between Hasaba and Ber Ubeid qat market (11 km) in 1990 is recommendable because it will be financially viable. The management of such a modest scale will be not difficult for GLTC.

Recommendations are summarized as follows:

- Large buses should be used for public service on a regular time table using pre-determined bus stops and terminals.
- In order to avoid risk in financial loss in the bus corporation, the step by step expansion strategy should be followed.
- Micro-buses should be grouped as partly competing with the regular serving large buses, but mostly serving as feeder service in designated routes/zones. Their vehicle fleet should not be increased from the present level.
- Medium buses should be increased and allocated to routes over the city. They serve for short/medium distance travellers on main roads together with large buses.
- Taxi vehicles also should not be increased for the time being.
- Urban development seems to continue and demand for public service will grow simultaneously. When a substantial growth is recognized, the fleet should be increased.

CHAPTER 15 SUMMARY AND RECOMMENDATIONS

Chapter 15 Summary and Recommendations

15.1 Projects

15.1.1 Improvement Plans

Studies on roads and traffic were conducted in Sana'a, Taiz and Hodeidah. Improvement plans were prepared in order to utilize fully the existing road facilities. Improvement plans grouped are shown in Figs. 15.1-15.3 being composed of the following elements:-

Signal system
Intersections
Guard fences
Marking on surface, reflectors, etc.
Traffic sign boards and direction guide boards
Pedestrian bridges
Parking spaces

Locations of those elements were determined by road conditions and traffic volume. Plans were studied and cost was estimated. The total cost, excluding customs duties and taxes, are summarized as in the following page:

15.1.2 Cost

The cost is estimated in 1988 prices excluding customs duties and taxes, but including engineering service, indirect cost and contingencies assuming a contract after tendering. It is summarized as follows:

Projects

(In YR million of 1988 prices)

	Sana'a	Taiz	Hodeidah	Total
1. Project				
-1. Engineering services	16.8	1.4	1.4	19.6 [10%]
-2. Construction				
a. Signals	59.9	6.3	7.4	73.6 (49%)
b. Intersections	45.2	0.9	-	46.1 (31%)
c. Guard fences	14.4	1.5	1.2	17.1 (11%)
d. Marking	5.1	0.7	0.8	6.6 (5%)
e. Traffic signboards	1.5	0.4	0.2	2.1 (1%)
f. Reflectors	3.0	0.5	0.5	4.0 (3%)
g. Total	129.1	10.3	10.1	149.5 (100%) [75%]
-3. Contingencies	26.4	2.1	2.1	30.6 [15%]
-4. Total	172.3 [86%]	13.8 [7%]	13.6 [7%]	199.7 [100%]
(YR1.00 = J.yen 13.80)	JY2,377.7	JY190.4	JY187.7	JY2,755.8
2. Ped. bridges	20.0	-	-	20.0
3. Park lots	19.4	4.8	-	24.2
4. Land for lots	76.9	86.8	-	163.7
G. Total	288.6 [71%]	105.4 [26%]	13.6 [3%]	407.6 [100%]

Currency components

(In million of 1988 prices)

Projects	Foreign	Local	Total
Construction	$12.4 (YR118.5) (79%)	YR31.0 (21%)	YR149.5 (100%)
Engineering	$1.6 (YR15.5) (79%)	YR4.1 (21%)	YR19.6 (100%)
Contingencies	$2.1 (YR23.5) (77%)	YR7.1 (23%)	YR30.6 (100%)
Total net cost	$16.1 (YR157.0) (79%)	YR42.2 (21%)	YR199.7 (100%)
(YR 1.00 = J Yen 13.80)	JY 2,173.5	JY 582.4	JY 2,755.9
.....			
Total Includ. Ped. Bri.	$17.5 (YR170.2) (77%)	YR49.7 (23%)	YR219.9 (100%)
Total Includ. Ped. Bri. and Park lots	$19.1 (YR186.2) (46%)	YR221.3 (54%)	YR407.6 (100%)

(US$ 1.00 = YR9.75)

15.1.3 Economic Evaluation

Economic benefits were studied through savings in vehicle operation cost, passenger time cost and accidents. Economic analysis has resulted in the following figures:

	Sana'a		Taiz		Hodeidah		Total	
	B/C	IRR	B/C	IRR	B/C	IRR	B/C	IRR
1) Projects without pedestrian bridges and parking lots.	1.66	32%	1.70	33%	1.42	26%	1.65	32%
2) Projects with pedestrian bridges but no parking lots	1.48	27%	1.70	33%	1.42	26%	1.49	27%
3) Projects with pedestrian bridges and parking lots	1.23	18%	0.53	4%	1.42	26%	1.13	14%

It is concluded that the above improvement plans are technically and economically feasible. Specifically 1) or 2) are worthy to be implemented as urgent action plans to be completed by 1991. (Fig. 15.1, Fig. 15.2 and Fig. 15.3) Implementation program is shown below:-

	1988	1989	1990	1991
This Transport study	———			
Funds prepa.	———	———		
Detail Engr. & F/S		———	———	
Tender & Eval.			———	
Mobilization			———	
Implementation			———	———

15.1.4 Public Passenger Transport Service

Public passenger transport service in Sana'a is operated by privalety owned taxis, micro-buses and medium-buses. Their frequent and free stops on roads increased conflicts and

Fig. 15.1 Location of Short Term Action Plan in Sana'a

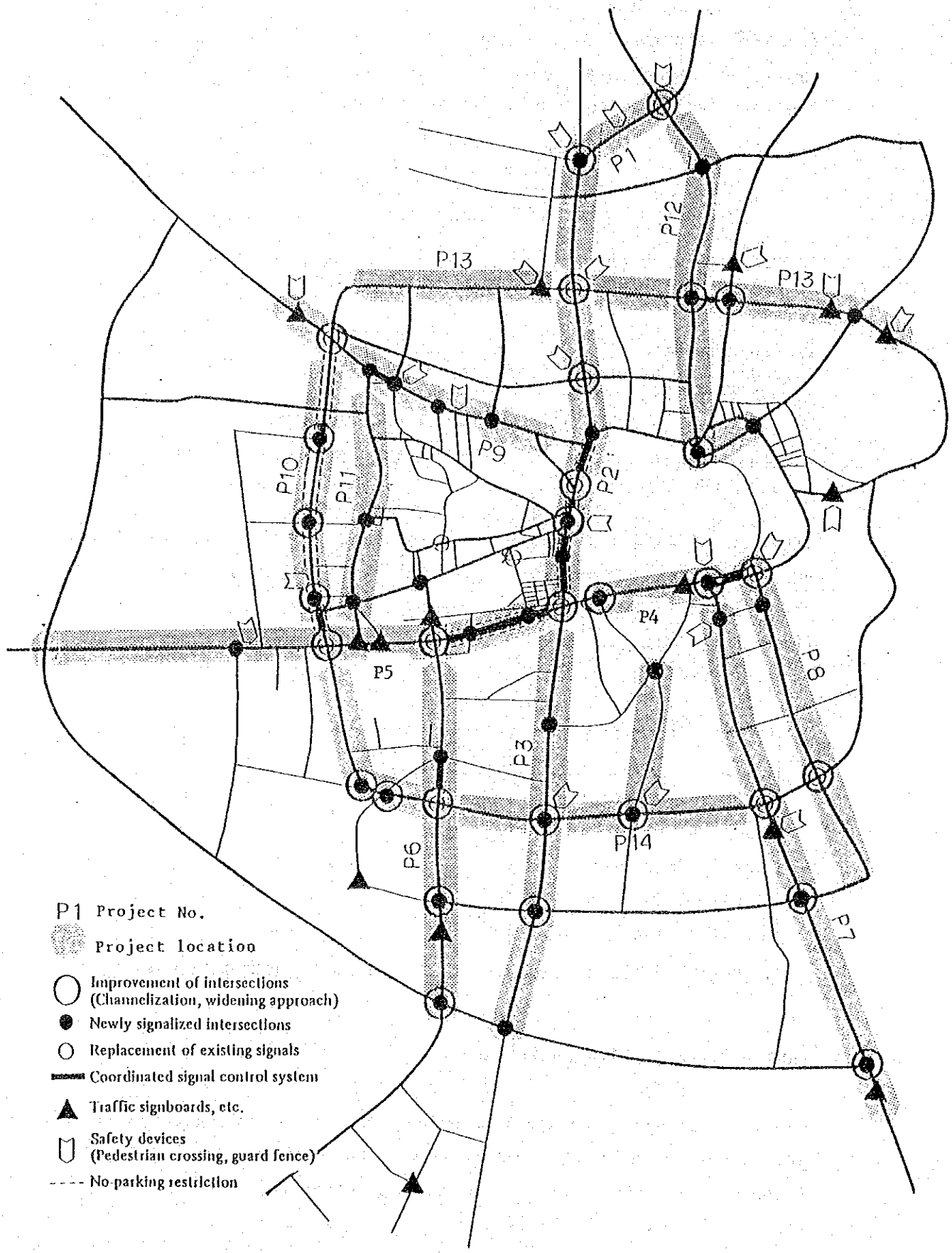


Fig. 15.2 Location of Short Term Action Plan in Taiz

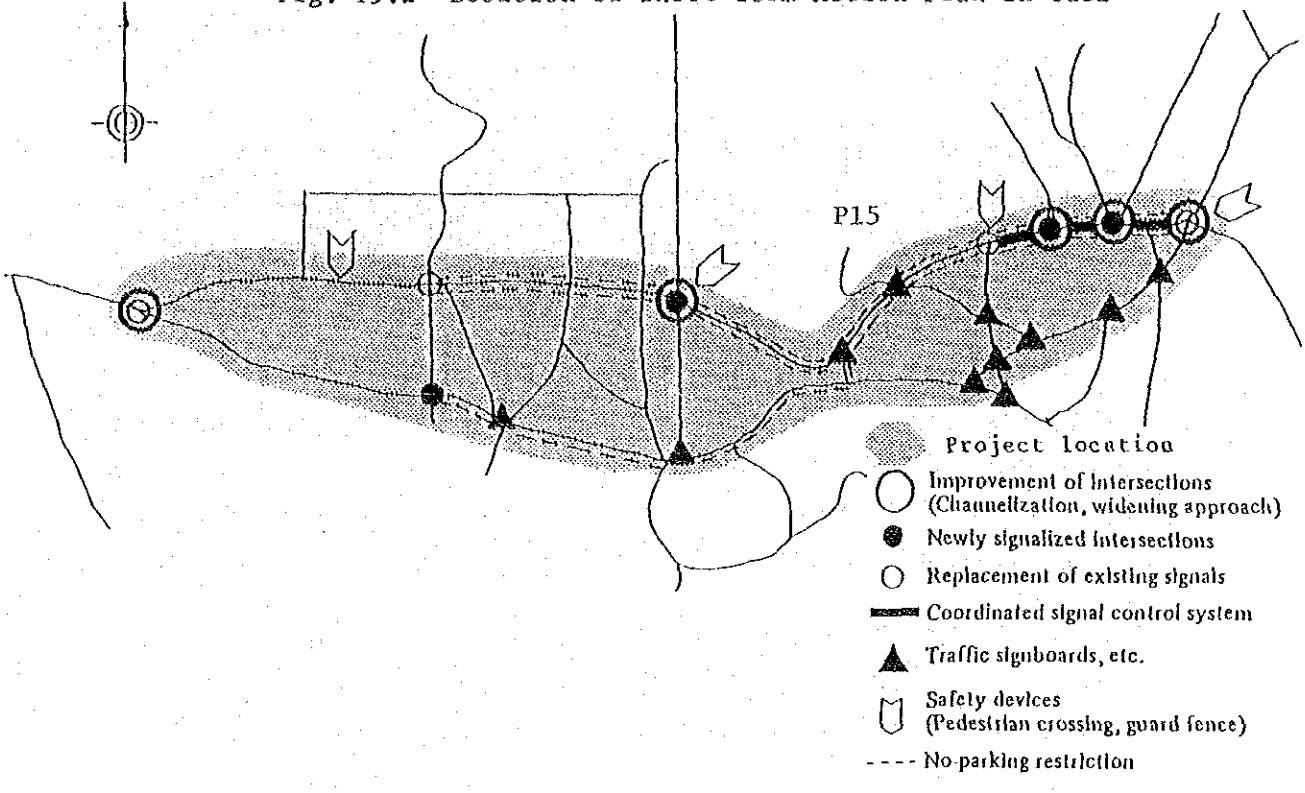
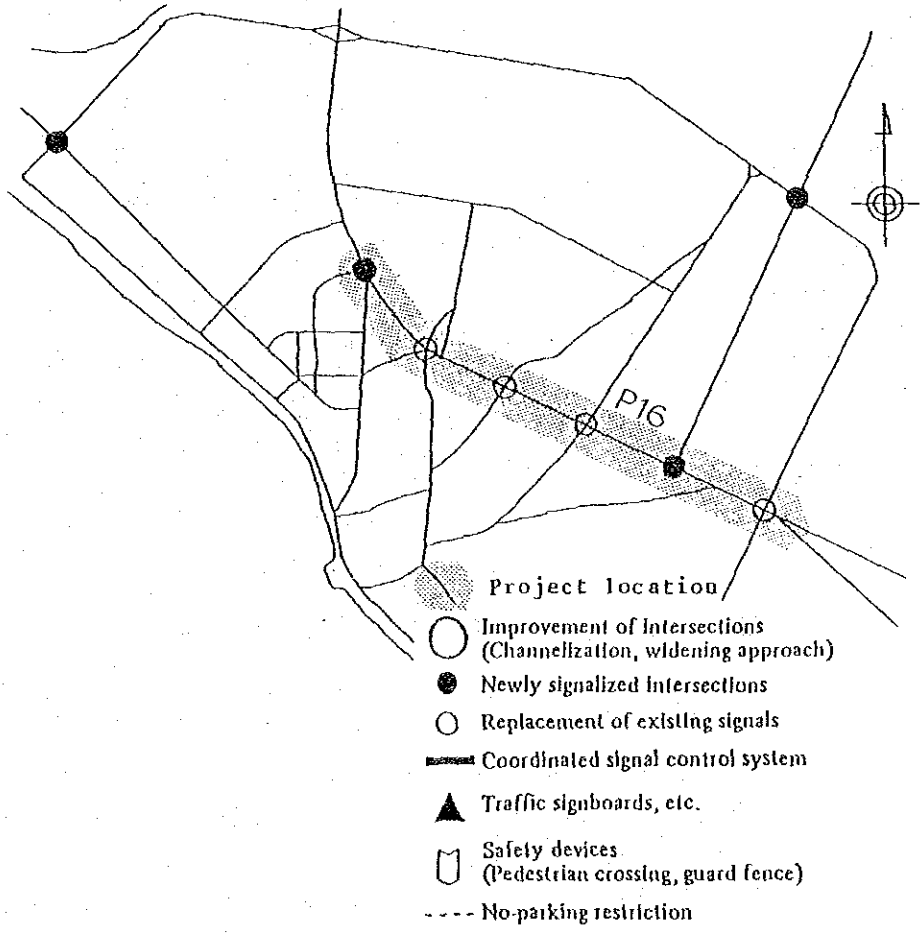


Fig. 15.3 Location of Short Term Action Plan in Hodeidah



accidents. This tendency is likely to increase under the expected urban development in the coming years.

A regular bus service is considered necessary on main routes using large buses. They are much efficient in carrying passengers than smaller buses and would mitigate traffic congestion.

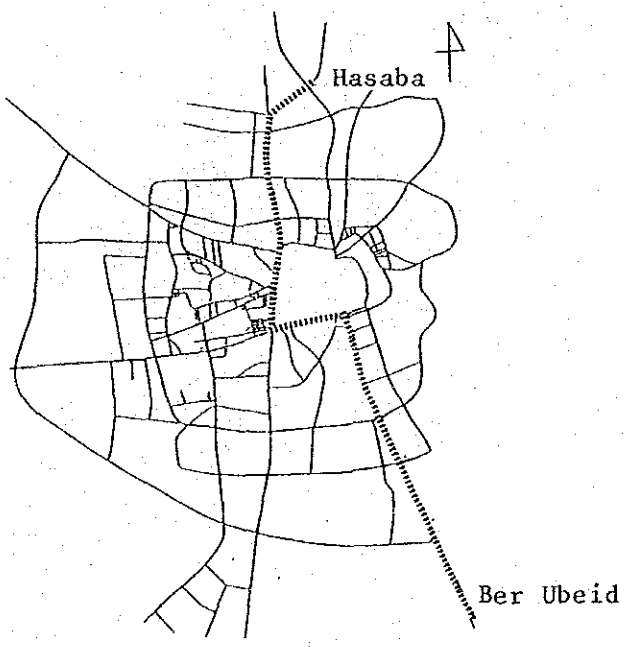
Development of regular bus service should be by stage and a pilot case of intracity service using large body buses is recommended to be operated by GLTC. Financial and managerial viabilities are identified in this study. the followings are the recommended operation .

Route	:	11 km between Hasaba and Ber Ubeid qat market
Buses	:	18 buses of a capacity of 53 persons
Operation	:	5 minutes - 15 minutes, 6 a.m. - 10 p.m.
Employment	:	111 persons including drivers and conductors
Fare	:	YR3 - per ride
Initial cost	:	YR23.1 million including the bus cost of YR11.2 million

Income
accumulated
1989-1997
YR6,638,000

Cash balance
accumulated
1989-1997
YR-1,411,000

Financial
IRR
15.6%



15.2 Recommendations

While this study proposes the implementation of urgent action plans on the existing road system, studies and staff strengthening are necessary in the following subjects in order to develop appropriate road and transport service in the rapidly growing urban areas.

15.2.1 Road Network Development Plan

The study should be closely related to the urban development master plan. And the study should present the following plans:

- Staged development of road network, including by-pass, grade-separated intersection, toll road, etc.
- Classification of roads in a hierarchical system in a block or a city
- Surfacing and betterment of service roads and community streets

15.2.2 Parking Facilities

Parking and restriction rules should be enforced on all streets of those cities. In addition the followings should be studied and implemented.

- The establishment and enforcement requiring parking space provision within a building or compound.
- Public parking space and buildings either by public fund and/or by private fund.

15.2.3 Public Passenger Transport Service

An administrative system responsible for the number and operation of taxis, buses (routes, frequencies), fares, etc. should be established in the Ministry of Public Works and Transport. It should determine the following matter by consulting with traffic police, MMH, GLTC and others.

- Routes and service of GLTC
- Routes and service of private operators
- Operation of micro-buses and medium-buses
- Operation of taxis
- Fares and service

15.2.4 Administrative Systems

Administrative systems should be established and work effectively in the following fields. Staff training in daily operation and in academic courses are necessary. Accepting experienced advisors from UNDP, World Bank, or other countries is also necessary for the initial years.

- Road maintenance and rehabilitation: organization, facilities, staffing and practice
- Traffic police: organization and staff training on vehicle registration and periodic mechanical checks, license issue, statistical filing of accidents
- Traffic & planning: organization & staff training on field surveys and analysis such as vehicle counting, travel speed survey, origin-destination survey, trend of increase/decrease of vehicles registered, traffic forecast and assignment on road network, ----- together with road inventory study and updated filing of road conditions

15.2.5 Traffic Management

Daily operations of traffic flow management by traffic police should be effectively enforced. Operations on roads should cover the followings:

- Check and enforce rules of parking and non-parking, one-way, stop at the stop-sign, no passing over, keep lane principle, priority rule at the intersection, etc.
- Ordered crossing by pedestrians
- Maintenance of traffic signals and other devices

15.2.6 Campaign and Training through mass-media, schools and tests of drive license.

- Safe and ordered manner in vehicle driving
- Safe and ordered crossing of the road by pedestrians and children.