16.4 Overall Evaluation and Possible Countermeasures

As a result of screening and scoping examination for the master plan, major negative impacts are predicted. Resettlement and cultural heritage may suffer major negative impacts in pre-construction stage on roads and intersections project. Other minor negative impacts are on landscape, waste, air pollution in both construction and operation stages. Evaluation and possible countermeasures by each transport category are discussed below.

(1) Roads Improvement

Major negative impact, which is resettlement, is identified. Especially some proposed projects are located in existing urbanized area, which include informal housing area and mixed land use, residential and commercial, before the construction stage, so that resettlement is necessary for project implementation. Other negative impacts before construction stage effect traffic, cultural property, waste, and landscape. In addition, air pollution, and noise and vibration are also identified for operation stage due to increase in traffic volumes.

For the smooth implementation of the projects, countermeasures such as resettlement system including compensation based on current value of housing, compensation housing in suitable locations and speedy implementation shall be considered. In addition, conservation system for cultural heritage properties for the currently 265 properties in the city are registered by the antiquities department and new sites to be identified in the future, shall be set up in order to enhance planning and construction.

Furthermore, in general, from the natural viewpoint in this region, ratio of green open spaces and roadside trees shall be conserved.

(2) Intersections Improvement

As in the case of road projects, resettlement and cultural heritage properties (above and under ground) may suffer major negative impacts in pre-construction stage. Those intersections have busy traffic so that some affects to traffic are identified during construction stage. Moreover, other negative impacts are identified such as waste, landscape, air pollution, noise and vibration, the same as road project.

Resettlement in pre-construction stage is also identified as a major negative impact due to high density mixed land use area. Other negative impacts are identified such as cultural property, waste, and landscape in each stage.

(3) Trunk Bus System

There is no major negative impact on this project because the proposed project utilizes existing roads, However, minor impact such as traffic is identified on construction and operation stages. In order to enhance the bus system, avoiding interruption from other traffic, shall be considered in operation stage.

(4) Signalization Improvement

There is no major negative impact from this project. Component of the project is signalization facility and central control center installation. Only a minor impact during the installation in intersections is traffic. Appropriate traffic control is required during the installation.

(5) Parking Control and Facilities Improvement

There is no major negative impact on both parking control and facility improvement in all stages of implementation. Enhanced parking control will improve traffic conditions and have hardly any negative aspects. Some of proposed parking facility areas are already used for the same function while others are open space or squares. Proposed improvement calls for constructing multi stories parking garages, ant it is not necessary to acquire land.

Appropriate announcement shall be required when the new parking control system is introduced. Traffic management system shall be required for surrounding area of new parking facilities in order to provide smooth access to the parking facilities.

Table 16.4.1 Summary of Scoping for Proposed Projects

No.	Environmental Items	Roads Improvement	Intersection Improvement	Trunk Bus System	Railway Improvement	Signalization	Parking Control and facility
	Social Environment						
1.	Resettlement	A	A	C	B	D	D
2.	Economic Activities	B	B	D	D	D	D
3.	Traffic and Public Facilities	B	B	C	D	D	D
4.	Split of Communities	D	D	D	C	D	D
5.	Cultural Property	A	A	C	C	D	D
6.	Water Rights and Rights of Common	D	D	D	D	D	D
7.	Public Health Condition	D	D	D	D	D	D
8.	Wastes	B	B	B	B	D	D
9.	Hazards (Risk)	D	D	D	D	D	D
	Natural Environment						
10.	Topography and Geology	D	D	D	D	D	D
11.	Soil Erosion	D	D	D	D	D	D
12.	Ground Water	D	D	D	D	D	D
13.	Hydrological Situation	D	D	D	D	D	D
14.	Coastal Zone	D	D	D	D	D	D
15.	Flora and Fauna	D	D	D	D	D	D
16.	Meteorology	D	D	D	D	D	D
17.	Landscape	B	B	B	B	D	D
	Pollution						
18.	Air Pollution	B	B	C	D	D	D
19.	Water Pollution	C	C	D	C	D	D
20.	Soil Contamination	D	D	D	D	D	D
21.	Noise and Vibration	B	B	C	C	D	D
22.	Land Subsidence	D	D	D	D	D	D
23.	Offensive Odor	D	D	D	D	D	D

Note 1: Evaluation categories
- A: Serious impact is predicted
- B: Some Impact is predicted
- C: Extent of impact is unknown (Examination is needed. Impact may become clear as study progresses)
- D: No impact is predicted. EIA is not necessary

Note 2: The evaluation should be made with reference to the Explanation of Item.

16.5 Study Items during the Environmental Impact Assessment (EIA) Study

Based on the IEE evaluation, for some projects it is necessary to conduct further detail environmental examination such as road improvement, intersection improvement, trunk bus

system and parking facility. While the other projects such as signalization, parking control and railway improvement do not require detail environmental examination due to less impact generated by these projects.

It is more effective to group similar projects together in order to prepare Terms of Reference for the EIA studies. Proposed projects are categorized by project type into three types, 1) Urban Roads and Intersections, 2) Trunk Bus system, and 3) Parking Facilities, as shown in Table 16.5.1.

Table 16.5.1 Study Items to be emphasized for EIA Study by Project Category

No.	Category Environmental Items	Roads and Intersections	Public Transport	Parking Facility
	Social Environment			
1.	Resettlement	A	D	D
2.	Economic Activities	B	D	C
3.	Traffic and Public Facilities	C	C	C
4.	Split of Communities	C	D	D
5.	Cultural Property	A	C	C
6.	Water Rights and Rights of Common	C	C	C
7.	Public Health Condition	D	D	D
8.	Wastes	C	C	C
9.	Hazards (Risk)	D	D	D
	Natural Environment			
10.	Topography and Geology	D	D	D
11.	Soil Erosion	D	D	D
12.	Ground Water	D	D	C
13.	Hydrological Situation	D	D	C
14.	Coastal Zone	D	D	D
15.	Flora and Fauna	D	D	D
16.	Meteorology	D	D	D
17.	Landscape	B	B	B
	Pollution			
18.	Air Pollution	B	C	C
19.	Water Pollution	C	D	C
20.	Soil Contamination	D	D	D
21.	Noise and Vibration	B	C	C
22.	Land Subsidence	D	D	D
23.	Offensive Odor	D	D	D

Note A: Serious impact is predicted
B: Some Impact is predicted
C: Extent of impact is unknown (Examination is needed. Impact may become clear as study progresses)
D: No impact is predicted. EIA is not necessary

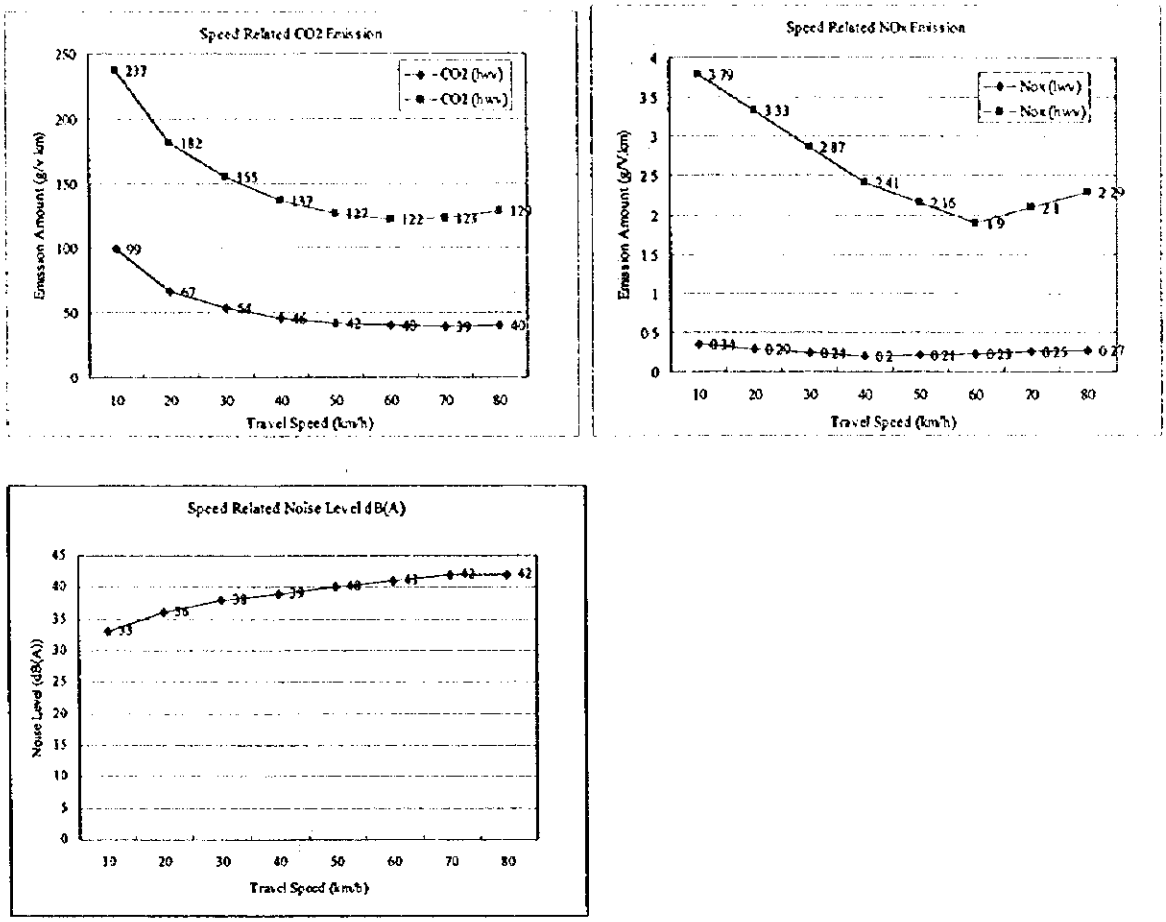
16.6 Environmental Improvement Benefit

The environmental improvement benefits by urban road improvement are estimated in comparison between Without and With Master Plan Projects. From the viewpoints of environmental impacts, air pollution (NOx), green house effects (CO_2) and noise level are considered in this evaluation.

16.6.1 Emission Factors and Noise Level in corresponding to Travel Speed

The environmental impacts are estimated utilizing speed related vehicle emissions factors in each environmental item shown in Table 16.6.1 and results of traffic demand forecast that includes traffic volume by vehicle type and travel speed in each link.

Recently, the emission factors have been researched in several institutions such as EU, EPA and in Japan. In this study, Japan's one is applied for the estimation, for compact calculation method in consideration of vehicle category of light and heavy weight vehicle.



Source: Guideline of Road Investment Evaluation (1998)

Figure 16.6.1 Speed Related Emission Factors NOx, CO_2 and dB(A)

16.6.2 Pollutants

As results of the estimation of environmental impact based on the speed related emission factors, daily total amount of NOx and CO_2 emissions in cases of without and with master plan projects are shown in Figure 16.6.2. Regarding noise from vehicle, noise level along the roads was estimated as a total length of roads that is more than 55 dB(A) shown in Figure 16.6.3.

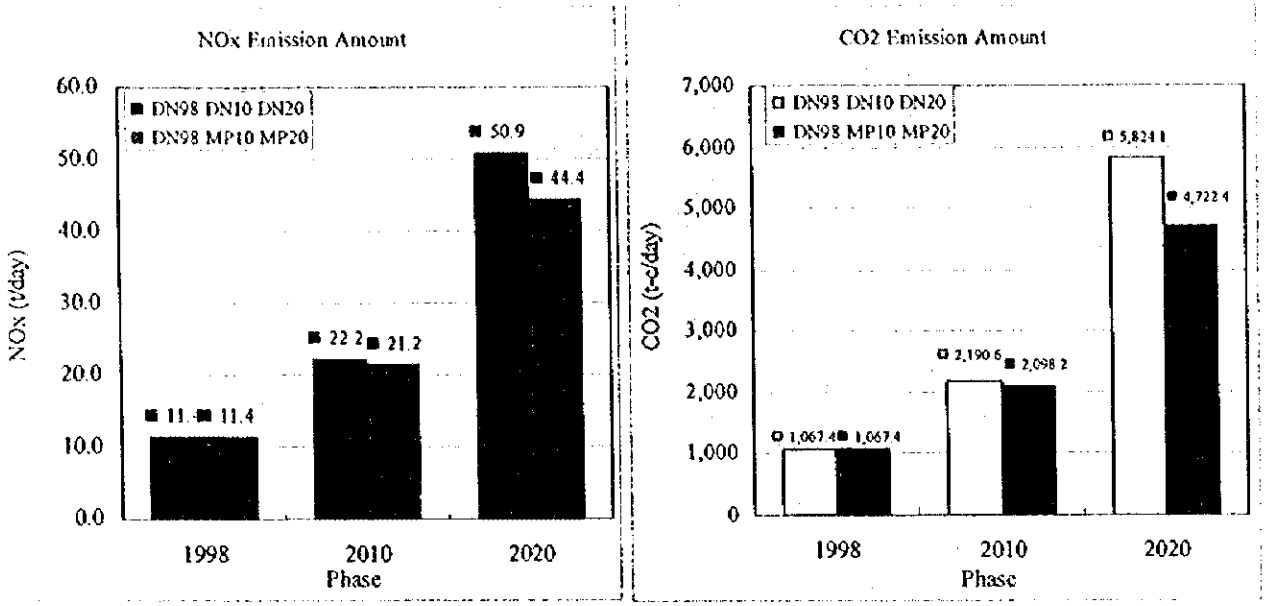


Figure 16.6.2 Estimation of NOx and CO_2 Emissions

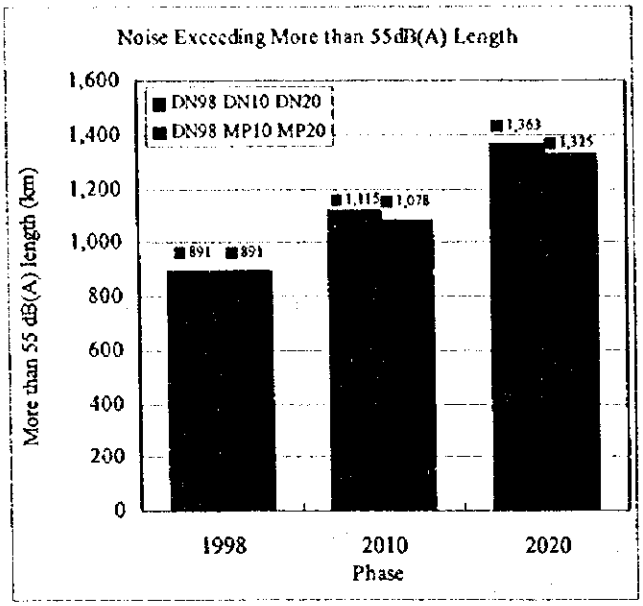


Figure 16.6.3 Total Length of Roads with more than 55dB Noise Level

Table 16.6.1 Estimation Results of Environmental Impacts

Phase	Without Master Plan			With Master Plan		
	Air Pollution	Green House Effects	Noise	Air Pollution	Green House Effects	Noise
	NOx (kg/V.km/day)	CO^2 (kg-c/V.km/day)	dB(A) (km)	NOx (kg/V.km/day)	CO^2 (kg-c/V.km/day)	dB(A) (km)
1998	11,437	1,067,368	891	11,437	1,067,368	891
2010	22,150	2,190,593	1,115	21,219	2,098,199	1,078
2020	50,858	5,824,145	1362	44,353	4,722,384	1,325

Source: JICA Study Team

Table 16.6.2 Improvement Ratios of Subject Items (MP/Do Nothing)

	NOx	CO2	dB(A)	NOx /Veh.km	CO2/Veh.km	Ave.speed
1998	1.000	1.000	1.000	1.000	1.000	1.000
2010	0.958	0.958	0.967	0.951	0.951	1.075
2020	0.872	0.811	0.972	0.877	0.815	1.634

Source: JICA Study Team

As results of estimation of emission amount, NOx and CO_2 emissions on With Master Plan case are reduced 12.8% and 18.9% respectively compared to Without Master Plan case in 2020.

Noise level that is total length of more than 55 dB(A) is also reduced 2.8% with Master Plan case in 2020.

Chapter 17. ECONOMIC AND FINANCIAL EVALUATION

17.1 Vehicle Operating Cost and Travel Time Cost

17.1.1 Characteristics of Representative Vehicles

(1) Import Permit and Taxes

A Syrian who has a right to buy a car goes to "Free Market" and buys one. Then, the Syrian pays import tax and the car is registered as Syrian nationality. The system is quite complicated and has many variations. Some common cases are explained below as an example.

1) Passenger Car

The definition of passenger car of Syrian Government is a car to have more than or equal to 4 seats (including driver's seat) but less than 9 seats. A person who has worked abroad for 10 years or more and has earned foreign currency more than the amount of car selling price has a right to import one unit of passenger car. This right is transferable to another person who wants to buy a car. It should be noted that nobody could buy a car without import permit though there are some exceptional cases.

Import tax rate has two categories by size of car such as;

- For the car of less than or equal to one ton of wet weight (empty car with full of gasoline), 185% of SAYYARAT price is charged.
- For the car of more than one ton of wet weight, 250% of SAYYARAT price is charged.

SAYYARAT price is determined under the process of

- An importer submits his proposal of a car import price to SAYYARAT.
- The proposal submitted is studied by SAYYARAT and when it is approved, it becomes subject to SAYYARAT price.
- An import tax is charged by the system mentioned above and has no connection to actual selling price at the free market.

After the car is imported, registration is required and the registration fee is 6,000 SP.

It is general that a real buyer buys the right to purchase a car from a holder of the right. In this case, the real buyer shall pay a transfer tax of 20% of sum of SAYYARAT price and import tax. SAYYARAT price is registered in US$, then import tax is also charged in US$. However, the transfer tax is charged in SP because the transfer tax is a Syrian local tax. The fixed changing rate of 23 SP/US$ is applied to SAYYARAT price portion but the rate of 11.25 SP/US$ is applied to the import tax portion.

The import tax exemption is authorized to companies aimed to receive privileges secured by the Investment Law No. 10. The Law ensures the right to import production input including cars in free of custom duty for projects with more than ten million SP of fixed assets.

2) Truck

The import tax of truck is 32% and no changes of tax rate by size of vehicle exist. A farmer who export his products and earns foreign currency more than the price of the pick-up has a right to import a pick-up with import tax of 32% of SAYYARAT price. When a farmer owner sells his pick-up to the third party, an additional registration fee of 35,000 SP is charged to the third party.

3) Microbus/Regular Size Bus

A license holder of the microbus service (public transport) has a right to import one microbus for his public transport service. Import duty is 132% of SAYYARAT price. On the contrary regular/large buses are imported, in general, under the beneficially of the Law No. 10 (no import duty). Import taxes of most common case by type of car are shown in Table 17.1.1.

Table 17.1.1 Import Tax of Vehicle

Tax Items/ Vehicle Type	Passenger Car (less 1 ton)	Passenger Car (more 1 ton)	Taxi	Microbus	Bus	Light Truck	Heavy Truck	Note
Import Tax (% of S. Price)	185	250	-	132	-	32	32	42 SP/US$
Transfer Tax (1)+(2)								
(1) % of S. Price	20	20	-	-	-	-	-	23
(2) % of Import Tax	20	20	-	-	-	-	-	11.25
Registration Fee for Transfer (SP)	-	-	-	-	-	35000	-	
Qualification	Syrian who has worked abroad more than 10 yrs			Licensed party	Companies under Law No.10	Licensed party	Licensed party	

(2) Representative Vehicles at present

Because of the strict import control, car fleet of Syria is mainly composed of old aged cars. Most of the passenger cars are small size as represented by Mazda 323 or Nissan Sunny. But large cars as Mercedes, Volvo or BMW imported by the Law No. 10 with tax exemption policy and temporary use of tax-free for authorized foreigners are also seen. The ratio of cars of tax-paid imported and of tax exempted is 15.5 tax-paid vs. 1 tax-free.

Most of the taxis running in Damascus are 1980s Lancer. Microbus fleet (4,317 units as of February 1998) are mainly composed of Asia Topic (1,481 units) and Mazda K2200 (1,147 units). Majority is Asia and more than half of Asia was imported before 1994.

Many types of light trucks and pick-ups are in Damascus. Number of large trucks and buses are not so large in Damascus. As for make Mercedes is majority of trucks and buses. Most of these vehicles are aged. There is no data to rely upon.

(3) Representative Vehicles selected and these characteristics

Considering the period between 2000 and 2020, such an old fleet mentioned above can not survive. Similar types of representative vehicles of 99 model are chosen as representative vehicles. Characteristics of representative vehicles chosen are summarized as shown in Table 17.1.2.

Table 17.1.2 Characteristics of Representative Vehicles

Type of Vehicles	Passenger car	Taxi	Microbus	Bus	Light truck	Heavy truck
Representative Model	Mazda 323	Mitsubishi Lancer	Mazda E2200	Man	Daihatsu	Mercedes
	99	99	99	99	99	99
Cost						
Financial Cost	806,513	761,192	627,480	4,168,410	565,488	2,851,200
Economic Cost	378,000	359,100	378,000	4,168,410	428,400	2,160,000
No. of Tires	4	4	4	6	4	10
Fuel Type	Gasoline	Gasoline	Diesel	Diesel	Gasoline	Diesel
Duties						
Import Duties	349,650	332,167	249,480	0	137,088	691,200
Transfer Fee	78,863	69,925	0	0	0	0

17.1.2 Fuel and Lubrication Costs

(1) Fuel and Lubrication Costs in 1998

Fuel and lubrication costs in 1998 are shown in Table 17.1.3. Using this information and composition of engine type by vehicle type based on the registration data of Damascus Governorate, average fuel cost and oil cost by vehicle type were calculated as shown in Table 17.1.4.

Table 17.1.3 Fuel Cost and Lubrication Oil Cost by Vehicle Type

1. Fuel		(unit: SP/Liter)
Type of Fuel	Gasoline*1	Diesel
Selling Price at Refinary	4.940	5.660
Selling Price to Gas Station	20.240	6.075
Selling Price to End Users	20.300	6.100
Government Share (Equivalent to Tax)	15.300	0.415
2. Lubrication Oil		
Type of Oil	Gasoline*2	Diesel*2
Selling Price at Refinary	37.850	37.850
Selling Price to Gas Station	40.910	40.910
Selling Price to End Users	45.000	45.000
Government Share (Equivalent to Tax)	7.150	7.150

Note: *1: No Lead Gasoline, *2: 40/High Viscosity
Source: Damascus Governorate.

Table 17.1.4 Fuel Composition, and Average Fuel and Oil Costs by Vehicle Type

Type of Cars	Fuel Composition (%)		Average Economic	
	Gasoline	Diesel	Fuel Cost	Oil Cost
Passenger Car	100	0	5.00	0.0
Taxi	100	0	5.00	0.0
Microbus	2.3	97.7	5.67	0.0
Bus	1.4	98.6	5.68	0.0
Light Truck	88.1	11.9	5.08	0.0
Heavy Truck	0	100	5.69	0.0

Source: Damascus Governorate

(2) Fuel Consumption by Vehicle Type and Speed

Fuel consumption is highly depending on running speed and vehicle type. There are some empirical studies to explore that relationship, known as the Kenyan study, the Brazilian study, the Caribbean study and the Indian study. The study team used formulas of Indian study. Indian experimental formulas are simplified to apply to flat and good surface conditioned road as follows;

Passenger car $F=10.31+1676/V+0.0133V^2$
Diesel jeep $F=30.83+2258/V+0.0242V^2$
Light truck $F=49.84+319/V+0.0035V^2$
Medium truck $F=85.07+3905/V+0.0206V^2$
where, F = Fuel consumption (litter/1000km)
V= Velocity (km/hr)

The estimated results were modified by field data collected in Damascus and are summarized in Table 17.1.5.

Table 17.1.5 Fuel Cost (Economic) by Vehicle Type and Speed (SP/km)

Type of Vehicles (unit: SP/km)	Pass. Car	Taxi	Microbus	Bus	Light Truck	Heavy Truck
Speed(km/hr) 5	2.13	1.83	1.75	3.31	1.85	4.15
10	1.10	0.95	0.94	1.89	1.00	2.37
20	0.61	0.53	0.57	1.14	0.60	1.42
30	0.48	0.42	0.47	0.92	0.50	1.16
40	0.45	0.39	0.47	0.86	0.49	1.08
50	0.48	0.41	0.50	0.86	0.53	1.08
60	0.53	0.46	0.58	0.90	0.61	1.13
70	0.61	0.53	0.67	0.97	0.71	1.21
80	0.72	0.62	0.78	1.07	0.83	1.34
90	0.85	0.73	0.92	1.17	0.97	1.46

(3) Oil Consumption by Vehicle Type

Strictly speaking an oil consumption rate is also dependent on vehicle speed. However, the team used a flat function on oil consumption to vehicle speed because no empirical study to clarify vehicle speed and lubrication oil consumption relationship is found out. Table 17.1.6 shows oil consumption by vehicle type.

Table 17.1.6 Oil Consumption by Vehicle Type

Type of Vehicles	Unit	Pass. car	Taxi	Microbus	Bus	Light truck	Heavy truck
Oil Change Cycle	per km	2,000	2,000	2,000	4,500	2,000	2,500
Engine Oil Quantity	liter	3.50	3.50	5.50	26.00	5.00	20.50
Oil Consumption	liter/1000km	1.75	1.75	2.75	5.78	2.50	8.20
Oil Consump. Cost (Economic)	SP/1000km	66.24	66.24	104.09	218.77	94.63	310.37
Oil Consump. Cost (Financial)	SP/1000km	78.75	78.75	123.75	260.10	112.50	369.00

17.1.3 Tire Cost

After Law No. 10 was introduced in 1991, it was available to import tires under the price control of SAYYARAT. SAYYARAT established the standard price list for Bridgestone Tires. Tires of other manufactures are indicated by the discount rates to Bridgestone such as;

Manufacturer	Max. discount rate (%)
Bridgestone	8
Toyo, Yokohama, Dunlop, Sumitomo	13
Nitto, Outsu	16
Bridgestone (Turkish or Indonesian made)	25
Michelin, Radial Tires	10 of Japanese Bridgestone

Importers of tires must pay 2% of SAYYARAT approved price as commission to SAYYARAT and 30% of it (for passenger car use) or 21% of it (for truck/bus use) as the import tax. In addition, importers have to buy the same amount of the same size tires made by AFAMIA (Governmental tire manufacturer). Table 17.1.7 shows tire costs when Bridgestone tires are installed with 8% discounted price.

Table 17.1.7 Tire Cost

Type of Vehicles	Pass. Car	Taxi	Microbus	Bus	Light Truck	Heavy Truck	Unit
Tire Size	175/13	165/13	185/13	1100/20	600/14	1200/24	
Import Price *	2135.7	1841.7	2241.12	7925.4	1765.68	9859.92	SP/unit
8% Discount Price	1964.8	1694.4	2061.8	7291.4	1624.4	9071.1	
Import Tax Rate	30	30	21	21	21	21	%
SAYARAT commission	2	2	2	2	2	2	%
Economic Tyre Cost	1964.8	1694.4	2061.8	7291.4	1624.4	9071.1	SP/unit
Financial Tire Cost	2648.3	2283.7	2779.0	9827.5	2189.4	12226.3	SP/unit
No. of Tires	4	4	4	6	4	10	
Tire Change Cycle	50,000	60,000	60,000	60,000	60,000	60,000	km
Tire Consump. Cost (E)	0.16	0.11	0.14	0.73	0.11	1.51	SP/(car*km)
Tire Consump. Cost (F)	0.21	0.15	0.19	0.98	0.15	2.04	SP/(car*km)

* Bridgestone Tire Price, Rate of 42SP/1US$ is applied

17.1.4 Repair/Maintenance Costs

Repair/maintenance costs are considered as 6% of the new car price per year based on experiences in Philippines and the repair/maintenance costs per km are induced for convenience of economic evaluation (Table 17.1.8). Average running distance by type of vehicle is estimated from operational data or empirically.

Table 17.1.8 Repair and Maintenance Costs by Vehicle Type

Type of Vehicle	unit	Passenger Car	Taxi	Microbus	Bus	Light Truck	Heavy Truck
Financial Vehicle Cost (New,CIF)	SP	378,000	359,100	378,000	4,168,410	428,400	2,160,000
Repair/Maintenance Costs	SP	22,680	21,546	22,680	250,104	25,704	129,600
Average Running a Year	km	14,600	115,000	53,000	19,000	31,000	47,000
Repair/Maintenance Costs/km	SP/km	1.55	0.19	0.43	13.16	0.83	2.76

17.1.5 Depreciation Costs and Capital Opportunity Cost

(1) Depreciation Costs

The rate of depreciation was assumed as 7.0% per annum, which comes from the assumption of 10 years depreciation period and 30% residual value. The results of calculation are shown in Table 17.1.9.

Table 17.1.9 Depreciation Cost by Vehicle Type

Type of Vehicle	unit	Passenger Car	Taxi	Microbus	Bus	Light Truck	Heavy Truck
Economic Vehicle Cost	SP	378,000	359,100	378,000	4,168,410	428,400	2,160,000
Economic Tire Cost	SP	7,859	6,777	8,247	43,748	6,498	90,711
Economic Vehicle Cost w/o Tire	SP	370,141	352,323	369,753	4,124,662	421,902	2,069,289
Depreciation	% p.a.	7.0	7.0	7.0	7.0	7.0	7.0
Depreciation Amount	SP	25,910	24,663	25,883	288,726	29,533	144,850
of which, subject to use	SP	12,955	17,264	18,118	202,108	20,673	101,395
subject to time	SP	12,955	7,399	7,765	86,618	8,860	43,455
Average Running km in a year	km	14,600	115,000	53,000	19,000	31,000	47,000
Depreciation Cost							
subject to use	SP/km	0.89	0.15	0.34	10.64	0.67	2.16
subject to time	SP/hr	0.43	0.25	0.26	2.88	0.30	1.45

(2) Capital Opportunity Cost

The capital opportunity costs were calculated assuming capital opportunity of 12% p.a. Breakdown of the capital opportunity cost is shown in Table 17.1.10.

Table 17.1.10 Capital Opportunity Cost

Type of Vehicle	Passenger Car	Taxi	Microbus	Bus	Light Truck	Heavy Truck
Economic Vehicle Cost (SP)	378,000	359,100	378,000	4,168,410	428,400	2,160,000
Capital Opportunity (% p.a.)	12	12	12	12	12	12
Capital Opportunity Cost (SP/hr)	6.3	6	6.3	69.5	7.1	36

17.1.6 Crew cost and Overhead Cost

Driver's income was interviewed by type of vehicle. Overhead cost was estimated at 50% of crew cost in cases of taxi, microbus and light truck, and 100% of crew cost for bus and truck. Because most passenger cars were driven by owner, crew cost and overhead cost of passenger car was considered as zero (0). Hourly costs are calculated assuming 25 days of 12 hours work. The results are shown in Table 17.1.11.

Table 17.1.11 Crew Cost and Overhead Cost

Type of Vehicle	Passenger Car	Taxi	Microbus	Bus	Light Truck	Heavy Truck
Annual Cost (SP/year)						
Crew Cost	0	91,250	91,250	109,500	91,250	182,500
Assistant Cost	0	0	0	36,500	0	0
Overhead Cost	0	45,625	45,625	146,000	45,625	182,500
Hourly Cost (SP/hr)						
Crew Cost	0.00	25.35	25.35	30.42	25.35	50.69
Assistant Cost	0.00	0.00	0.00	10.14	0.00	0.00
Overhead Cost	0.00	12.67	12.67	40.56	12.67	50.69
Total	0.00	38.02	38.02	81.11	38.02	101.39

17.1.7 Summary of VOC

The unit VOC is obtained as summary of cost items mentioned in the preceding sections in the two different categories of distance related cost and time related cost (Table 17.1.12).

Table 17.1.12 Summary of VOC

Type of Vehicle	Passenger Car	Taxi	Microbus	Bus	Light Truck	Heavy Truck
1. VOC subject to distance (SP/km)						
Speed (km/hr) 5	4.80	2.35	2.77	28.06	3.55	10.89
10	3.77	1.47	1.96	26.64	2.70	9.11
20	3.28	1.05	1.58	25.88	2.30	8.16
30	3.15	0.93	1.48	25.67	2.20	7.90
40	3.12	0.91	1.48	25.61	2.19	7.82
50	3.14	0.93	1.52	25.61	2.24	7.82
60	3.20	0.98	1.59	25.65	2.31	7.87
70	3.28	1.05	1.68	25.72	2.41	7.96
80	3.38	1.14	1.80	25.82	2.53	8.09
90	3.51	1.25	1.93	25.92	2.67	8.21
2. VOC subject to time (SP/hour)						
	6.73	44.27	44.58	153.49	45.42	138.84

17.1.8 Travel Time Cost

Travel time cost at present is estimated from household income data obtained by home interview survey applying 100% of overhead cost. It is obtained by car user/public transport user, and transferred to each vehicle type (Table 17.1.13).

Travel costs of 2000, 2005, 2010, 2015 and 2020 are projected in accordance with the forecast of per Capita GDP of the same years as mentioned above (Table 17.1.14).

Table 17.1.13 Present Hourly Income and Travel Time Value

Item	Car Owner (Car User)	Non Car Owner (Bus User)	Note
Family Income	12,620	8,321	SP/month
Number of Earners	1.89	1.7	Persons/household
Working Hours	8	8	Hours/Person
Working Days	21	21	
Hourly Income	39.7	29.1	SP/hour/person
Time Value			
Business Trip	39.7	29.1	
Other Trip	0	0	
Trip Composition			Based on PT Survey
Business Trip	7.3	7.3	
Other Trip	92.7	92.7	
Travel Time Value			
Person Base	2.90	2.13	SP/hour/person
Vehicle Base			
Car	4.27		Average Occupancy = 1.47
Taxi	5.03		Average Occupancy = 1
Microbus + Bus	24.22	Microbus(95.7%)	Average Occupancy = 9.83
		Bus (4.3%)	Average Occupancy = 22.78
Trucks/Others	3.81		Average Occupancy = 1.79

Note: Travel Time Value of Taxi and Micribus+Bus include travel cost of one driver

Table 17.1.14 Travel Time Cost (2000, 2005, 2010, 2015, 2020)

	1998	2000	2005	2010	2015	2020
GDP/Capita	45692	48484	55789	63668	72336	81868
Index	1.000	1.061	1.221	1.393	1.583	1.792
Travel Time Cost (person base)						
Car and Taxi User	2.900	3.077	3.541	4.041	4.591	5.196
Bus User	2.130	2.260	2.601	2.968	3.372	3.816
Travel Time Cost (vehicle base)						
Car	4.270	4.531	5.214	5.950	6.760	7.651
Taxi	5.030	5.337	6.142	7.009	7.963	9.012
Microbus+Bus	24.220	25.700	29.572	33.749	38.343	43.396
Truck	3.810	4.043	4.652	5.309	6.032	6.827

17.2 Benefit and Cost

17.2.1 Benefit

Benefit is calculated from difference of VOC of present road network with present traffic management system and present public transport network (hereinafter Do Nothing case) and Master Plan case assigned same OD volume. The study area, in where traffic volume is assigned, consists of the planning area (Damascus City) and outside area of Damascus City.

Improvements of road network and bus network in the outside area are projected based on the existing plan. From such a point of view, Do Nothing case has also improved in the outside area of Damascus City in some extent. Contribution of these improvements is, strictly speaking, not the same for the Do Nothing case and Master Plan case because roads in the network are closely related. In this study, it is considered that VOC savings are due to improvements of the network in the inside area of Damascus City.

As a term of benefits, VOC savings and TTC (Travel Time Cost) savings are generally examined. TTC savings are counted only for business trips. Because of small portion of business trip in the Damascus Home Interview Survey results (see Chapter 4), TTC savings are not counted in this study. VOC savings of 1998, 2005, 2010 and 2020 are summarized in Table 17.2.1.

Table 17.2.1 VOC Savings of 1998, 2005, 2010 and 2020

Year	Case (unit: million SP)	VOC km	VOC hr	VOC sum	VOC Savings
2020	Do Nothing	17,136	20,426	37,562	0
	Master Plan	12,771	4,367	17,138	20,423
2010	Do Nothing	5,869	8,102	13,971	0
	Master Plan	4,676	2,132	6,808	7,163
2005	Do Nothing	3,595	5,031	8,626	0
	Master Plan	2,912	1,213	4,125	4,501
1998	Do Nothing	2,455	3,476	5,931	0

17.2.2 Costs

Costs are divided broadly into two categories by money source, public and private. Costs burdened to public sector are divided also into two; Damascus Governorate budget or others.

New road development, road widening, intersection improvement and traffic control system improvements are public burden. Those in Damascus City are financed by Damascus Governorate and in the outside are financed by the Governorate of Countryside Damascus or the Syrian Government.

Acquisition of new buses, construction of bus terminals and construction of parking facilities are private burdened. The idea comes from that facilities utilized for all citizens are covered by tax and by user are charged to user.

Due to this concept, cost items for economic analyses are limited to new road developments, road widening, intersection improvements and traffic control system improvements in Damascus City.

17.3 Economic Analysis

Economic analysis done for the Master Plan shows high performance. In this analysis,

a. Residual values of Master Plan projects are calculated applying 2% linear depreciation method based on Syrian rule.
b. Maintenance costs of the projects are assumed 5% per annum based on study team experience.
c. Road improvements of the outside Damascus City are introduced to Master Plan Cases and DO Nothing Cases in the same manner.

Results are summarized in Table 17.3.1. EIRR is 52%, B/C is 3.6 and NPV is 19,386 million SP in the first 21 years. In this calculation 12% of discounted rate was assumed.

Table 17.3.1 EIRR, NPV, B/C of Master Plan

Year	Costs		Benefit	B-C	Discounted Values		
	Road/IS Investment	Repair/ Maint.			Cost	Benefit	B-C
2000	37	2	0	-39	39	0	-39
2001	657	35	0	-692	609	0	-609
2002	809	75	0	-884	685	0	-685
2003	982	124	900	-206	754	613	-140
2004	1167	183	900	-450	810	540	-270
2005	1155	240	2701	1306	736	1425	689
2006	991	290	3601	2320	595	1672	1077
2007	908	335	4501	3258	508	1839	1331
2008	863	378	5033	3792	446	1810	1364
2009	1030	430	5566	4106	462	1762	1299
2010	1044	482	6098	4572	425	1698	1273
2011	935	529	6631	5167	359	1625	1266
2012	1097	584	7163	5482	363	1545	1182
2013	1233	645	8489	6611	356	1611	1255
2014	1279	709	9815	7827	332	1639	1307
2015	1384	779	11141	8978	318	1637	1320
2016	1529	855	12467	10083	308	1612	1304
2017	1344	922	13793	11527	258	1570	1312
2018	1327	989	15119	12803	232	1514	1282
2019	1536	1065	16445	13844	229	1449	1220
2020	1536	1142	17771	34109	-1267	1378	2646
Residual Value = -19,016			IRR = 52% B/C = 3.6		Total = 7,556	Total = 26,942	NPV = 19,386

Sensitivity of the Master Plan (MP) was checked for increase of costs and/or decrease benefits. Results are summarized in Table 17.3.2. In case of cost increase but benefit is stable (Benefit= Standard) IRR shows MP is viable until 250% cost increase. In case of benefit decrease but cost is stable (Cost = Standard) IRR shows MP is viable until 60% of standard benefit.

Table 17.3.2 Sensitivity of Master Plan

Cost/Benefit	Standard	80%	60%	40%	20%
Standard	52	43	33	21	8
125%	43	35	26	16	3
167%	32	26	18	9	-
250%	20	14	7	-	-
500%	0	-	-	-	-

17.4 Financial Analysis

Projects with sales are bus and bus terminal operation, and parking services. Financial analysis of bus and bus terminal operation was done in Chapter 14. Results were

a) An operator can not survive under the fare system at present.
b) An operator can survive with small profit under the basically same fare system but adjusted by running km.

Parking services shows 18.1% of IRR on equity (see Chapter 19). Based on this figure, parking facilities developed by BOT system are recommended.

Chapter 18. MASTER PLAN IMPLEMENTATION SCHEDULE

18.1 Implementation Schedule

18.1.1 Independent Nature due to Fund Source

Damascus Governorate owes sole responsibility on road improvement/development in Damascus City. Budget of road improvement/development is solely used for those purposes. Road improvement/development project including traffic control projects are hence independent from other projects such as public transport improvement projects.

In correspond to the growth of Damascus Metropolitan Area, road network development outside Damascus City becomes very important for the integrated urban transport plan. Budgeting policy of these developments is, however, out of power of Damascus Governorate. Due to this, development schedule of projects outside Damascus City is assumptions only.

Damascus Governorate has budget for road network development but public transport improvement is highly depended on private sector investments. Some of off-road parking facilities are owned by the Governorate but rented to private sector enterprises. The Governorate expects to increase off-road parking facilities by BOT (Build, Operate and Transfer) system.

Due to development based on independent fund sources, implementation schedules are discussed one by one from road improvement, which is core development.

18.1.2 Staging of Planning Period

Planning period, 2000-2020 is divided by three stages, that is
a) Short Term Planning Period (2000-2005)
b) Middle Term Planning Period (2006-2010)
c) Long Term Planning Period (2011-2020)

18.1.3 Implementation Program of Road Network Development Projects

(1) Plan for Near Future

Figure 18.1.1 shows traffic condition in 1998. From the Figure, road sections shown heavy traffic congestion (colored in red) are scarcely seen at present but relatively congested road sections (colored in yellow) are seen along;

a) North-South Corridor (Al Aththawra St. – Uthman Bin Affan St.),
b) Eastern part of Inner Ring Rd.,
c) Roads connecting to Al Umawiyeen Sq.
d) Sixth October St.

Figure 18.1.2 shows what will be happened in 2005 if nothing is improved. From the Figure it is clear that traffic congestion of the said roads and intersections, especially a), b) and d), become severe.

Figure 18.1.1 Do Nothing Case(1998)

Figure 18.1.2 Do Nothing Case (2005)

To prevent these situations, projects as follows are programmed (Figure 18.1.3).

a) Improvement of Traffic Control Systems inside and along the Inner Ring Road.

It was planned to execute priority control to arterial traffics. It is expected to relieve traffic congestion along the North-South Corridor and the Inner Ring Road.

b) Extension of the North Bypass Road to connect to the Six October Road
It was planned to be Bypass of the Six October Road (north bound) and is expected to relieve traffic congestion along the Six October Road.

c) Extension of the South Bypass Road to connect to the Six October Road
It was planned to be Bypass of the Six October Road (south and west bound) and is expected to relieve traffic congestion along the Six October Road. In addition to this function, it is expected to relieve traffic congestion along the Inner Ring Road (eastern part) as a road in parallel to that road, especially traffics from outside to inside Damascus City and vice versa.

d) Construction of Underpass of Two Intersections along the Inner Ring Road
It is expected to relieve traffic congestion along the Inner Ring Road in coordinate to the Improvement Project of Traffic Control Systems along the Inner Ring Road. One of two intersections is Al Umawiyeen Sq. The underpass project at Al Umawiyeen Intersection is not only for improvement of the Inner Ring Road but more for improvement of the local congestion at that intersection and roads connecting to it (refer to congested road section c) stated above).

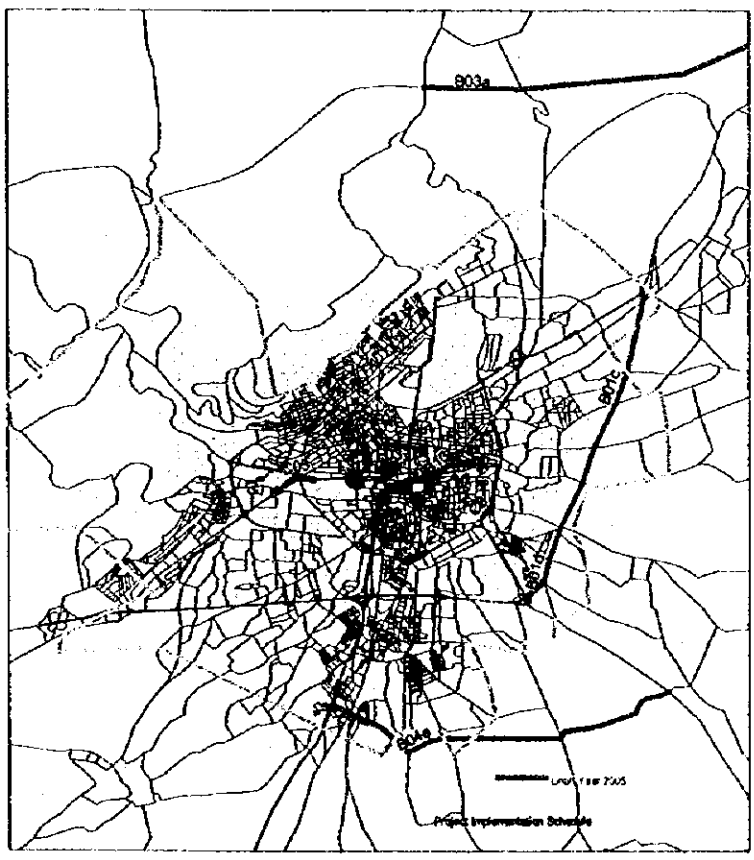


Figure 18.1.3 Master Plan Project, (2000-2005)

Due to these improvements, traffic issues are lesson in reasonable extent (Figure 18.1.4).

Figure 18.1.4 Master Plan Case (2005)

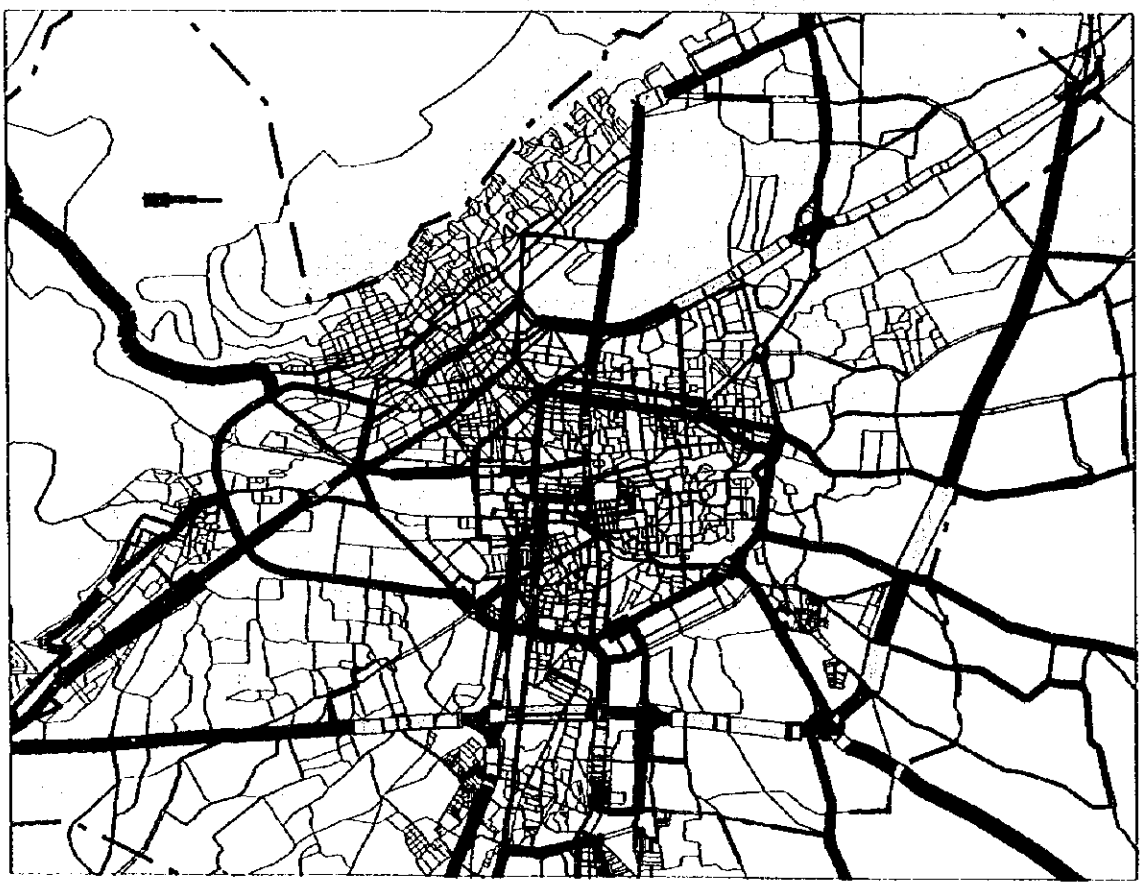


Figure 18.1.5 Do Nothing after 2006 with Demand of 2010

(2) Plan for Middle Term

Figure 18.1.5 shows traffic condition in 2010 when no improvement project are implemented between 2006 and 2010 after implementation of improvement projects until 2005. From the Figure, road sections having traffic congestion are seen again along;

a) Central Section of North-South Corridor (Al Aththawra St. – Uthman Bin Affan St.),
b) Eastern part of Inner Ring Rd.,
c) South Bypass and
d) Six October St.

A heavy traffic demand concentrates on these four road sections and widening of these roads is difficult excluding the South Bypass. Projects to ease traffic congestion on the identified road sections are classified into two types. The first type is to increase road capacity and the second is to diversify traffic demand. Projects a) and b) belong to the first type and project c) belongs to the second type.

a) Construction of the Outer Ring Road
   This project is expected to provide an additional bypass function to support the present sole South Bypass. It relieves traffic congestion along the Inner Ring Road, the South Bypass and the Six October Street.
b) Construction of a Tunnel in the congested area between Ath Thawra St. – Uthman Bin Affan Street
   It is planned to connect Ath Thawra St. and Uthman Bin Affan St. Grade separations are facilitated in most sections of both streets but only in the central area there are at grade intersections which cause severe congestion. The plan is to connect both areas by 2 km length tunnel.
c) Extension of the East-West Corridor to East
   It is planned to lessen the burden of the Inner Ring Road.
d) Other minor improvements
   These improvements are for balanced improvements of the road network of the City.

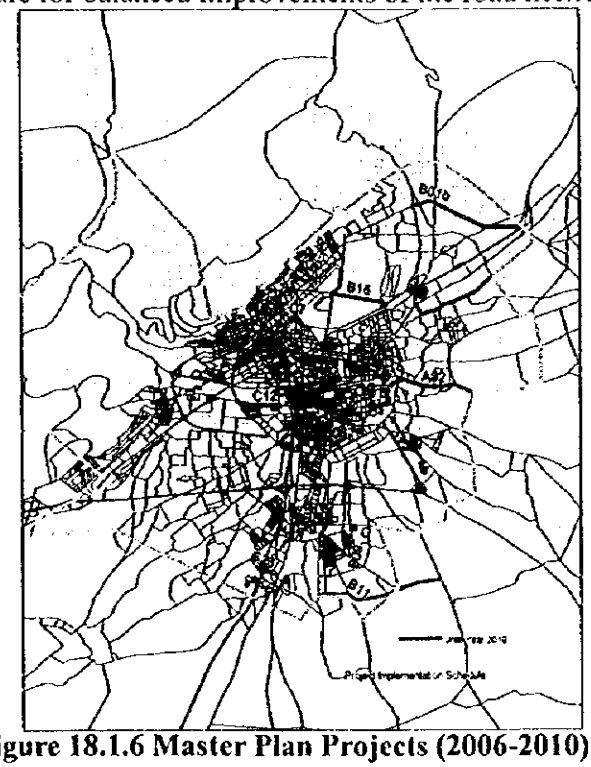


Figure 18.1.6 Master Plan Projects (2006-2010)

Due to these improvements, traffic issues are lesson in reasonable extent (Figure 18.1.7).

Figure 18.1.7 Master Plan Case (2010)

Figure 18.1.8 Do Nothing after 2011 with Demand of 2020

(3) Plan for Long Term

Figure 18.1.8 shows traffic condition in 2020 when no improvement project is implemented during 2011 and 2020 after implementation of improvement projects until 2010. From the Figure, road showing traffic congestion are as follows;

a) South Bypass,
b) Six October St.
c) Southern Section of North-South Corridor and
d) Eastern Section of East-West Corridor

Projects to ease traffic congestion at the four road sections mentioned above are as follows;

a) Construction of the Auxiliary Ring Road
   The new ring road between the Inner Ring Road and the Outer Ring Road utilized local roads is projected and developed to lessen burden of traffic to the South Bypass.
b) Construction of Quasyun Road
   It was planned to develop Quasyun Road to lessen traffic road to the Six October road.
c) Improvement of Intersections
   There are no sovereign remedies for congestion of Southern Section of North-South Corridor and Eastern Section of East-West Corridor. Only the way is to improve traffic condition inside the City with untiring perseverance.

Figure 18.1.9 shows master plan projects during 2011-2020 and Figure 18.1.10 shows traffic condition of the Damascus City in 2020. The heavy traffic sections (colored in red) are seen but only limited to local areas.

(4) Budget Allocation

Annual investment during the planning period was calculated and is shown in Table 18.1.1 in comparison of the amount of annual budget estimated as disbursal. The total investment is mostly equal to (slightly smaller than) the total of budget estimated. Annual investment exceeds the annual budget in the first seven years (start from 2001 until 2007) but annual budget exceeds annual investment in the rest 13 years (from 2008 till 2020).

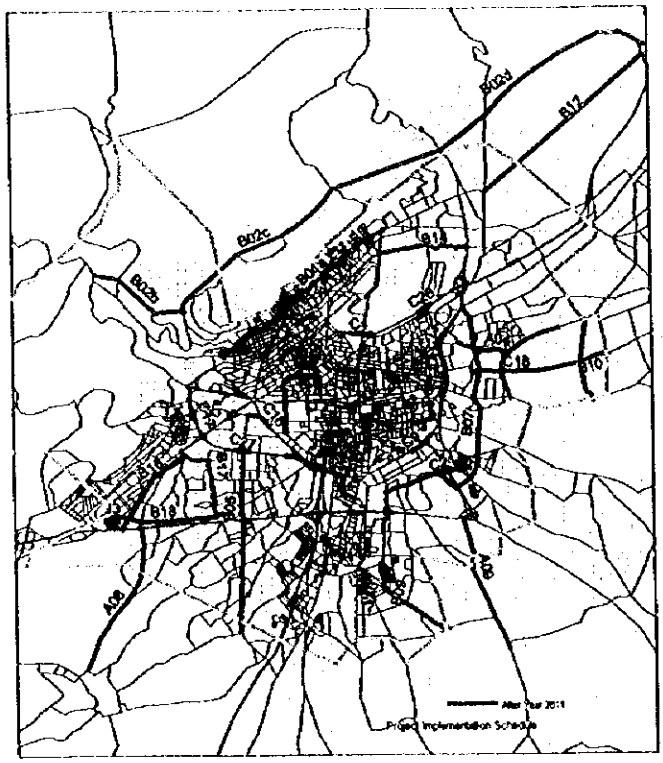


Figure 18.1.9 Master Plan Projects (2011-2020)

Figure 18.1.10 Master Plan (2020)

Table 18.1.1 Investment and Budget (Roads)

Project		Length (m)	Cost ('000)	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
A		Widening Projects																						
A02		1,700	45,578																					
A03		350	87,972																					
A04		1,900	92,009																					
A05		1,800	349,432																					
A06		3,000	345,392																					
A07		4,000	460,323																					
A09		2,000	266,374																					
A10		350	126,124																					
A11		1,000	26,811																					
B		New Road Construction Projects																						
B01	a	3,800	1,105,052																					
	b	4,200	1,052,679																					
	c	4,000	688,052																					
	d	3,000	908,128																					
B02	a	5,000	441,081																					
	b	2,000	280,216																					
	c	3,000	333,838																					
	d	4,000	387,439																					
B03	a	4,000	387,439																					
	b	5,000	268,108																					
B04	e	6,000	2,397,432																					
B05		4,000	2,338,652																					
B06		700	341,171																					
B07		6,400	2,092,068																					
B10		1,200	382,341																					
B11		3,400	636,491																					
B12		3,000	793,483																					
B13		1,500	960,066																					
B14		2,000	1,033,095																					
B15		1,100	568,202																					
B16		2,000	542,087																					
B17		1,100	298,148																					
B18		1,500	406,566																					
B19		1,400	307,160																					
C		Structure Projects																						
T01		2,120	1,247,400																					
C03		940	646,800																					
C04		250	184,800																					
C05		210	155,232																					
C06		210	77,616																					
C07		200	73,920																					
C08		300	110,880																					
C09		225	83,160																					
C10		300	110,880																					
C11		450	332,640																					
C12		200	73,920																					
C13		270	199,584																					
C14		600	337,501																					
C16		250	92,400																					
C17		300	221,760																					
C18		450	332,640																					
C19		400	147,840																					
C20		50	36,960																					
C21		150	110,880																					
C22		100	73,920																					
C23		300	110,880																					
C24		1,000	184,800																					
C26		200	147,840																					
C27		200	147,840																					
D		ATC-System																						
D01		28 int.	328,500																					
D02		39 int.	291,700																					
D03		63 int.	524,000																					
E		On Street Parking Facility																						
E01		1,500 m	64,000																					
F		Off Street Parking Facility																						
F01		500 lots	308,920																					
F02		200 lots	87,000																					
F03		200 lots	175,000																					
F04		320 lots	140,000																					
F05		240 lots	105,000																					
G		Pedestrian Exclusive Streets																						
G01		650 m	16,250																					
G02		400 m	10,000																					
G03		1,400 m	35,000																					
G04		200 m	5,000																					
G05		1,200m	30,000																					
H		Pedestrian Priority Streets																						
H06		3,000 m	30,000																					
H07		800 m	8,000																					
H08		500 m	5,000																					
H09		500 m	5,000																					
H10		2,800 m	28,000																					
H11		1,100 m	11,000																					
H12		750 m	7,500																					
I		Pedestrian Crossing Facilities																						
I01		5 sites	50,000																					
I02		85 sites	35,000																					
J		Bus Fleet Reinforcement																						
J01		Bus Fleet	28,104,000																					
J02		Aswad Brid	390,000																					
J03		Kaboun	134,000																					
J04		Mazzeh	204,000																					
Grand Total		(Million SP)	37,137	2,092	2,331	2,339	2,832	2,331	2,988	2,693	2,778	2,576	2,352	2,571	2,400	2,513	2,595	2,709	2,536	3,008	2,942	2,926	3,117	3,116

18.1.4 Implementation Program of Public Transport Network Development Projects

The leading policy is large sizing of bus fleet in coordination with the increase in demand. Due to the nature of the existing bus operators of small capital, that policy shall be realized step by step and year by year pursuing actualized increase of demand.

The big innovation of public transport network shall be the installment of 105 passengers size bus using bus exclusive way (Trunk Bus Service). This service is anticipated to start from 2011 on the route illustrated on Figure 14.3.1.

Large sizing and rerouting that occurs consequently for the said large sizing fleet requires transfer terminals. Due to the nature of this sector as private-oriented, construction costs and expenditures for operation are planned to be shouldered by operators. Initial cost, however, is so huge that soft loan through the Syrian Government is strongly requested. Construction schedule of transfer terminals is planned as seen in Table 18.1.2. Locations of the three bus terminals are illustrated on Figure 18.1.11.

a) Assad Bridge Terminal
New Assad Bridge Terminal absorbs Baramkeh Terminal and Abbas Terminal in addition to Old Assad Bridge Terminal. This terminal is planned as central terminal. Construction is expected in 2003 and 2004 (first phase), and 2012 and 2013 (second phase).

b) Kaboun Terminal
Kaboun Terminal accommodates passengers from eastern areas. This terminal is planned to be constructed in 2009 and 2010.

c) Mezzeh Terminal
Mezzeh Terminal accommodates passengers from western to southern areas. This terminal is planned to be constructed in 2015 and 2016.

Location of the three terminals is illustrated on Figure 18.1.11.

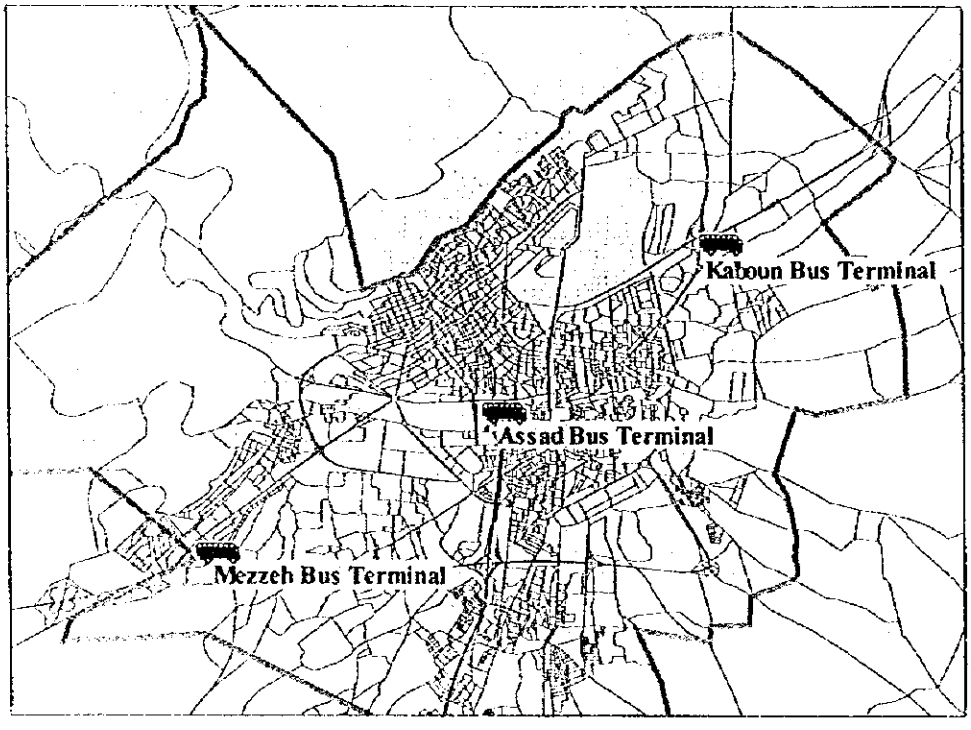


Figure 18.1.11 Location Map of Bus Terminal

(1) Railway

Construction shall start beyond the planning period. When new Qatana City, which is one million population scale, is developed on schedule as mentioned in the land use plan (Draft, studied by General Consultant Group), it is advisable to start the study of innovation of existing railway in the planning period.

(2) Taxi

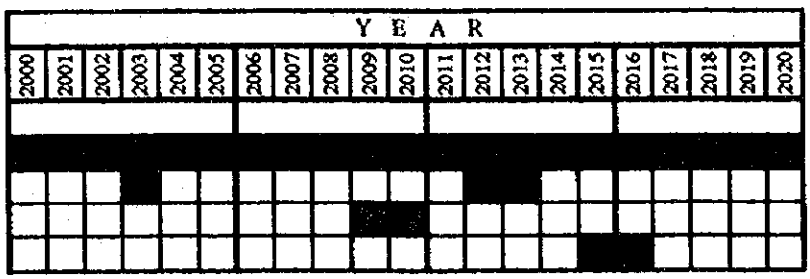
Operating body shall be private entities including private persons. The Governorate will only handle change of fare. Installment of higher fare taxi service is expected from 2005.

(3) Installment Schedule

Based on demand forecast installment schedule was formulated and is shown in Table 18.1.3.

Table 18.1.2 Investment and Budget –Public Transport

Project		Length (m)	Cost ('000)
F		Bus Fleet Implementation	
J01		Bus Fleet	28,104,000
J02		Assad Bridge	390,000
J03		Kaboun	134,000
J04		Mezzeh	204,000



18.1.5 Off-Road Parking Facilities

The Damascus Governorate contributes land and a private enterprise prepares construction cost. BOT system is introduced for construction of parking facilities. Sites that are possible for BOT are five at present (Figure 18.1.12). Construction projects are programmed in order of higher feasibility.

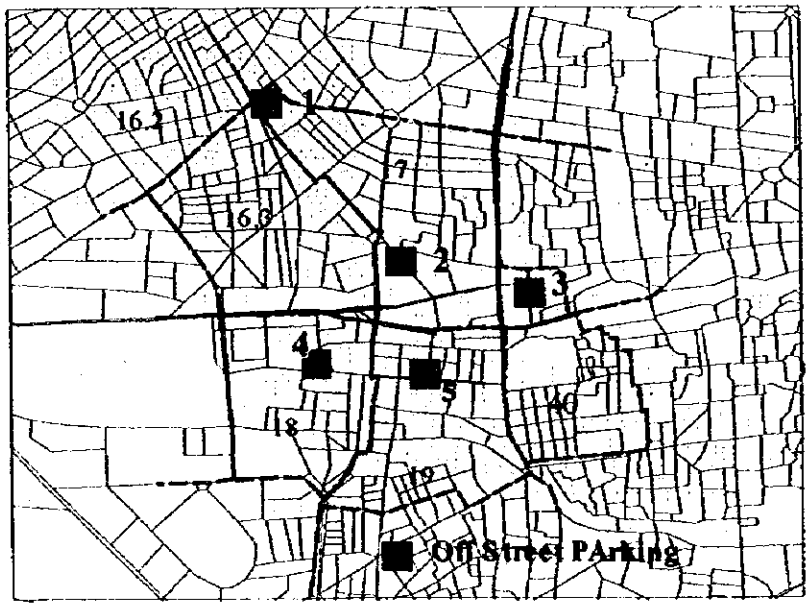


Figure 18.1.12 Location Map Off-Road Parking Facilities

Table 18.1.3 Investment and Budget – Off-Parking Facilities

Project	Length (m)	Cost ('000)
F	Off Street Parking Facility	
F01	500 lots	308,920
F02	200 lots	87,000
F03	200 lots	175,000
F04	320 lots	140,000
F05	240 lots	105,000

YEAR																				
2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020

18.2 FS Projects

18.2.1 Requirements on FS Projects

(1) Urgency

Traffic issues FS projects concern must be urgent. In another word FS project shall be selected from projects to start in 2000-2005.

(2) Project Scale

At the first five years investment to the road network development is larger than estimated budget schedule but total investment proposal is smaller than total budget estimated based on projection of the Study Team. From this fact the Study Team recommends the Damascus Gavernorate seeks possibility of loan for implementation of FS porjects.

(3) Execution Body

Road improvements are under the control of the Damascus Governorate, counterpart agency of the team, and investments in the public transport field came mostly from private sector. FS projects are selected from projects the Damascus Governorate is responsible for.

(4) Study Example Nature

There are many similar projects in each type of the construction of underpass at intersection, construction of off-street parking facilities by BOT, introduction of ATC, widening of road, construction of road, and construction and operation of bus terminal in this Master Plan. If one of such projects is studied in precise, impact to the traffic movement, way of designing, construction and operation, cost of project, and economic and financial viability, similar projects are easily estimated. Some of FS projects are selected from these project groups excluding widening of road and construction of a new road because the Governorate has enough experience in such fields.

(5) Feasibility

Relocation of residents including informal residents is difficult problem in general and needless to say difficult in Damascus City also. In addition that there are many antiquities in Damascus City, especially in the heart of the city. One of important nature of FS projects is early execution. Due to this point of view, FS projects shall avoid projects including relocation issue and/or antiquities issue.

(6) Substantial Project of the Master Plan

Selection of FS projects is a part of actualization effort of the Master Plan. FS projects are forming substantial projects of the Master Plan.

18.2.2 Selected FS Projects

The Master Plan projects planned to be introduced before 2005 are listed in Table 18.2.1 and evaluated from the above-mentioned points of view.

Table 18.2.1 Evaluation of Promising FS Projects

Project Name	Evaluation Item*						Result
	1	2	3	4	5	6	
B01c	Y	Y	Y	N	N	Y	N
B01d	Y	Y	Y	N	N	Y	N
B03a	Y	Y	Y	N	Y	Y	N
B03b	Y	Y	Y	N	Y	Y	N
B04e	Y	Y	Y	N	N	Y	N
B13	Y	Y	Y	N	N	Y	N
T01	Y	Y	Y	Y	Y	Y	Y
C03	Y	Y	Y	Y	Y	Y	Y
C08	Y	Y	Y	Y	Y	Y	Going
C14	Y	Y	Y	Y	Y	Y	Y
C24	Y	Y	Y	N	N	Y	N
Assad Bridge Bus Terminal	Y	Y	N	Y	Y	Y	N
Arnouse Square Parking Facility	Y	Y	N	Y	Y	Y	Y
Sq. near Azmeh St. Parking Facility	Y	Y	N	Y	Y	Y	N
Al Nasr St. Parking Facility	Y	Y	N	Y	Y	Y	Y
ATC inside Inner Ring Road	Y	Y	Y	Y	Y	Y	Y

Note: * 1: Urgency, 2: Project Scale, 3. Execution Body, 4. Study Example Nature, 5. Feasibility 6. Substantial Project of the Master Plan
** Y:Yes N:No (including Difficult)

Projects that satisfy all the evaluation items are T01, C03, C08, C14 and ATC. Four projects of five, excluding C08 (on-going project) are chosen as FS projects. Off-street parking facilities are planned to be constructed by BOT system, but Damascus Governorate has no experience in BOT schemes. In order to provide concrete idea to the Governorate, Arnous parking facility construction project is added to the above FS project set.

18.3 Comments and Recommendations

(1) Exact Implementation of Master Plan Projects

All of the Master Plan projects have reasons to be included in the plan. Due to this, exact implementation of the Master Plan projects on schedule is highly recommended.

As stated also above, North-South Corridor, Inner Ring Road (South Bypass after completion of eastern link) and Six October St. suffer regular congestion. Major concerns of the Master Plan are congestion of these roads and FS projects are the answer to solve these issues from the study. In the period until 2005, consequently, exact implementation of FS projects is very important.

As for the public transportation plan, it seems to be difficult to induce private investment on time of schedule. It is necessary to undertake some programs to promote private investments and guide them to proper way.

(2) Importance of Public Transport Development

Public transport improvement only by private operation is doubtful. However, it is a fact that trips by public transport based on Person Trip Survey result, 1998, excluding walk, dominates 74% of total trip in the study area. This aspect indicates that improvement of public transport is second to none in importance in road network improvement. In this regard, Damascus Governorate shall take positive measures to deal with public transport development

(3) Implementation of the Organization for Coordination to the Development Plan of the Damascus Countryside Governorate

The major development area in future of Damascus Capital Region is Damascus Countryside. This transport plan however is restricted inside of Damascus City. Major portion of workers living in newly developed areas commute to inside of Damascus City.

Development plan of Damascus Countryside is closely related to this Master Plan. Most of the Outer Ring Road, for example, belongs to Damascus Countryside Governorate and only one section belongs to Damascus Governorate. One million population city plan of Qatana is closely related to the trunk bus plan of the Master Plan.

It is easily understood that the necessity of coordination between the transport plan of Damascus Governorate and the transport plan of Damascus Countryside Governorate based on the above mentioned examples. Organizations in charge of these issues, however, have been established independently by both Governorates and are not well organized.

It is necessary to establish the organization responsible for road network development and public transport network development of the Damascus Capital Region.

(4) Rolling System of the Plan

Syrian economy is expecting big changes because of
a. Acceleration of Open Door Policy,
b. Exploitation of Oil. and
c. Final peace in the Middle East.

In addition, assumptions of this Study include some indefinite factors as follows;
a. The study team used the draft of land use plan of Damascus Countryside Governorate, but it is not complete and has rather large possibility to be changed. Especially the plan for a city of one million in Qatana is bold but faces many difficulties to realize.
b. The plan inherits the strict control on import of vehicles as it is. There is, however, the question of permanency of this control.
c. Delay or abandonment of execution of the Master Plan may happen due to shortage of budget, difficulties of relocation of residents or some other unforeseen reasons.

Due to these uncertainties, revision of this Master Plan shall be examined. Suitable time of revision highly depends on time of changes of conditions mentioned above. The study team suggests the Governorate to examine the necessity of revision after 10 years from the start of the Master Plan.

PART IV

FEASIBILITY STUDY ON SELECTED PROJECTS

Chapter 19. ECONOMIC AND FINAMCIAL EVALUATION OF FS PROJECTS

19.1 Method of Feasibility Studies

As described in 18.2, the following 5 projects are selected for feasibility studies:

a. Area traffic control (ATC) system installment project
b. Umawyeen Square underpass construction project (C03)
c. Al Yarmouk Square underpass construction project (C14+C15)
d. Ath Thawra – Al Hejaz traffic improvement project (Hejaz Tunnel alternatives: T01a or T01b)
e. Arnous Square underground parking area construction project

Among the above-mentioned projects, from b to d are physical improvement projects of the present road network structure. Each location is separated but they are connected and correlated to each other closely as parts of the network.

If benefit generated by each of these 3 improvement projects is measured separately, it would be offset by increased traffic congestion at adjacent intersections and road sections without improvement. Accordingly, it is considered that project packages should be made up for the Feasibility Study (FS) from 3 structure improvement projects and the Stage 1 of ATC system installment project.

From the viewpoint of investment type, the ATC system installment project and the structure improvement projects are subject to public investment. On the other hand, the parking area project will gain daily income and could be conducted by the private sector through BOT method on condition that it will make enough profits as a business.

Considering these facts, the FS is carried out as follows:

- Technical aspects
  For each of 5 projects separately
- Environmental aspects
  For each of 5 projects separately
- Economic and financial aspects
  (1) Economic evaluation
  -For packages of 4 projects (a. Stage 1 of ATC System, b. Umawyeen Square, c. Al Yarmouk Square and d. Hejaz Tunnel alternatives)
  (2) Financial evaluation
  -For Arnous Square underground parking area project

19.2 Project Packages for the FS

Two project packages, Package A and Package B, are prepared. Package A comprises Stage 1 of ATC system, Umawyeen Square, Al Yarmouk Square, and Hejaz Tunnel T01a. Package B is composed of Stage 1 of ATC system, Umawyeen Square, Al Yarmouk Square and Hejaz Tunnel T01b. The project packages cover the area shown in Figure 19.2.1.

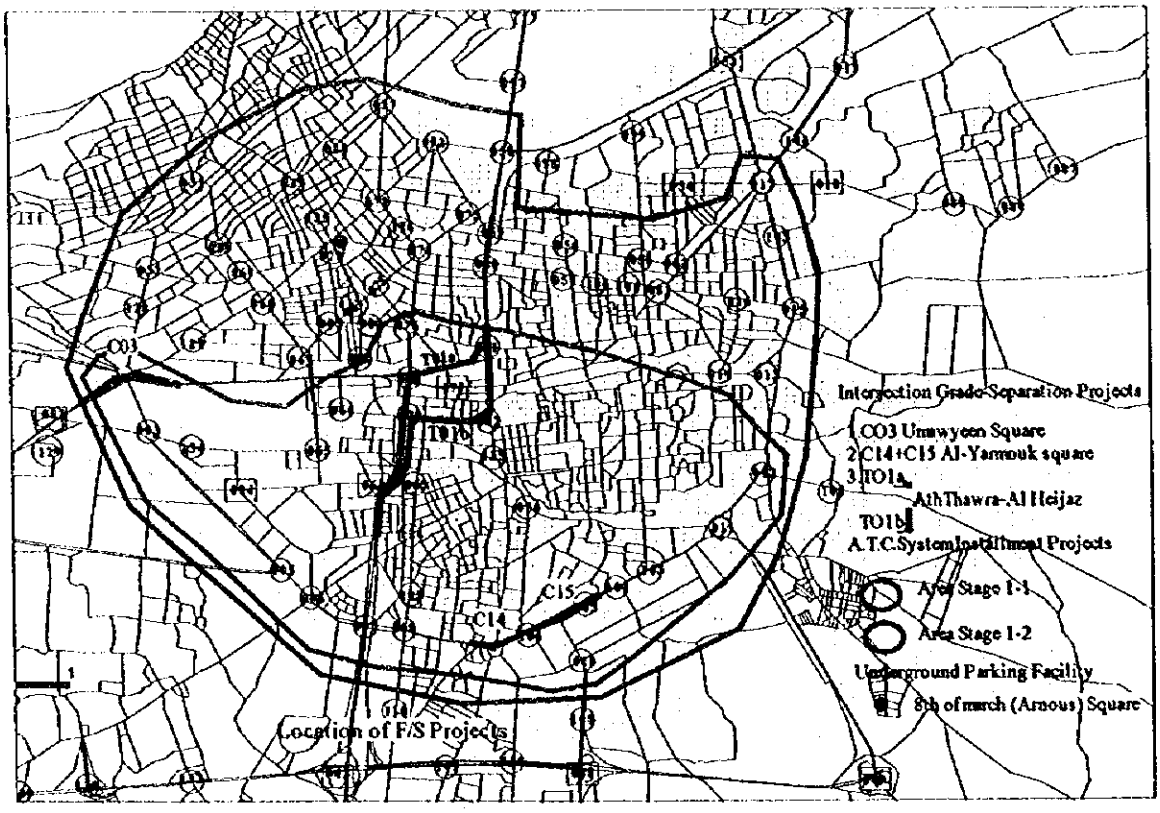


Figure 19.2.1 Locations of FS Projects

Table 19.2.1 shows estimated investment costs for the FS project packages. The total amounts are 2,850 million SP for Package A and 2,460 million SP for Package B, during the period from 2000 to 2009.

Table 19.2.1 Estimated Investment Costs for FS Project Packages

Project Name	Investment Amount (Financial Cost) (million SP)	Economic Cost (million SP)	Investment Period
1. Stage 1 of ATC	620.2	539.3	Y0, Y1, Y2
2. Umawyeen Sq.	646.8	531.3	Y1, Y2, Y3, Y4
3. Al Yarmouk Sq.	337.5	277.2	Y1, Y2, Y3, Y4
4-1. Tunnel T01a	1,247.4	1,024.7	Y5, Y6, Y7, Y8, Y9
4-2. Tunnel T01b	857.5	704.4	Y5, Y6, Y7, Y8, Y9
Package A Total	2,851.9	2,372.5	Y0-Y9
Package B Total	2,462.0	2,052.2	Y0-Y9

The investment cost of ATC system installment project does not include the construction cost of the control center, assuming that the center room will be provided within an existing building of the executing agency. Most of the investment cost of the project is for the imported soft- and hard-wares expressed at CIF prices.

The economic costs of the FS project packages for the economic evaluation are 2,372.5 million SP for Package A and 2,052.2 million SP for Package B, respectively.

19.3 Economic Evaluation of Project Packages

19.3.1 Investment Schedule and Annual Economic Costs

For the economic evaluation of the FS project packages, annual investment costs during the period between 2000 and 2009 are calculated based on the planned investment schedule (See Table 19.3.1).

Table 19.3.1 Annual Investment Costs (Economic Cost) of FS Project Packages

(million SP)

Year	Umawyeen Square	Al Yarmouk Square	Hejaz Tunnel T01a	Hejaz Tunnel T01b	ATC System	Package A Total	Package B Total
2000					36.7	36.7	36.7
2001	132.8	69.3			279.9	482.0	482.0
2002	132.8	69.3			222.7	424.8	424.8
2003	132.8	69.3				202.1	202.1
2004	132.8	69.3				202.1	202.1
2005			204.9	140.9		204.9	140.9
2006			204.9	140.9		204.9	140.9
2007			204.9	140.9		204.9	140.9
2008			204.9	140.9		204.9	140.9
2009			204.9	140.9		204.9	140.9
Total	531.3	277.2	1,024.7	704.4	539.3	2,372.5	2,052.2

19.3.2 Maintenance Costs

Annual maintenance costs of the project packages are assumed 4 % of the initial investment cost for the underpasses and 5 % for the tunnel. With regard to the ATC system, it is assumed that personnel for daily operation will be assigned from the existing staff and no additional personnel expenses are necessary. The annual maintenance and repair costs of the system are assumed to be 5 % of the initial investment cost.

19.3.3 Depreciation and Residual Values

Based on the present Syrian accounting system, the fixed amount method is adopted for depreciation and the lives and residual values of respective projects are determined as shown in Table 19.3.2.

Table 19.3.2 Project Life and Residual Value in 2020

(million SP)

	Umawyeen Square	Al Yarmouk Square	Hejaz Tunnel T01a	Hejaz Tunnel T01b	ATC System
Project Life	50 years	50 years	50 years	50 years	5 years
Residual Value in 2020	361.3	188.5	799.3	549.4	0

Source: Study Team estimates based on "Unified Account System and Accounts Guide" (Ministry of Finance, 25-1-1978)

19.3.4 Project Benefits

Project benefits are calculated as annual savings in "Vehicle Operating Costs" (VOC) brought about by the FS Project Packages. As shown in Table 19.3.3, VOC of the Study Area will increase from 8,385.1 million SP in 1998 to 54,697.6 million SP in 2020, if no improvement projects are implemented. When Project Package A is implemented as scheduled, annual savings in VOC will be 28.8 million SP in 2005, 288.8 million SP in 2010 and 2,275.6 million SP in 2020. In the case of Project Package B, estimated benefits will be 28.8 million in 2005, 270.9 million SP in 2010 and 2,106.3 million SP in 2020.

Table 19.3.3 Future Savings in VOC by the FS Project Packages

(Million SP)

Year	Case	VOC	Benefit (DN-FS)
1998		8,385.1	
2005	"Do nothing case" (DN)	12,221.9	
	"Package A case" (FS1)	12,193.1	28.8
	"Package B case" (FS2)	12,193.1	28.8
2010	"Do nothing case" (DN)	19,840.3	
	"Package A case" (FS1)	19,551.5	288.8
	"Package B case" (FS2)	19,569.4	270.9
2020	"Do nothing case" (DN)	54,697.6	
	"Package A case" (FS1)	52,422.0	2,275.6
	"Package B case" (FS2)	52,591.3	2,106.3

19.3.5 Evaluation Indicators of Project Packages

Table 19.3.4 and Table 19.3.5 show the results of economic evaluation for the project packages of A and B. No significant differences are recognized between two project packages. The package B is less expensive than the package A, but the project benefit will also be less.

NPV and B/C are 14.9 million SP and 1.01 respectively, calculated by using a discount rate of 12%, and IRR is 12.1% for the package A. As for the package B, NPV, B/C and IRR are 48.2 million SP, 1.03 and 12.3%, respectively. Both packages show IRRs a little higher than 12%.

Evaluation indicators are not very high. The project packages, however, are considered to be advisable for the implementation, in order to alleviate the present traffic congestion in the city.

Table 19.3.4 Results of Economic Evaluation of Project Package A

(million SP)

Year	Benefit (Savings in VOC)	Cost						Total	B-C
		Intersection Improvement Projects			ATC System Installment Projects				
		Invest.	Mainte.	Total	Invest.	Mainte.	Total		
2000	.0	.0	.0	.0	36.7	.0	36.7	36.7	-36.7
2001	5.8	202.1	.0	202.1	279.9	.0	279.9	482.0	-476.2
2002	11.5	202.1	.0	202.1	222.7	14.3	237.0	439.1	-427.6
2003	17.3	202.1	.0	202.1	.0	27.0	27.0	229.1	-211.8
2004	23.0	202.1	.0	202.1	.0	27.0	27.0	229.1	-206.1
2005	28.8	204.9	32.3	237.3	.0	27.0	27.0	264.2	-235.4
2006	36.0	204.9	32.3	237.3	.0	27.0	27.0	264.2	-228.3
2007	44.9	204.9	32.3	237.3	.0	27.0	27.0	264.2	-219.3
2008	56.1	204.9	32.3	237.3	.0	27.0	27.0	264.2	-208.2
2009	70.0	204.9	32.3	237.3	.0	27.0	27.0	264.2	-194.2
2010	288.8	.0	83.6	83.6	.0	27.0	27.0	110.5	178.3
2011	355.0	.0	83.6	83.6	.0	27.0	27.0	110.5	244.5
2012	436.4	.0	83.6	83.6	.0	27.0	27.0	110.5	325.9
2013	536.5	.0	83.6	83.6	.0	27.0	27.0	110.5	425.9
2014	659.5	.0	83.6	83.6	.0	27.0	27.0	110.5	548.9
2015	810.7	.0	83.6	83.6	.0	27.0	27.0	110.5	700.1
2016	996.5	.0	83.6	83.6	.0	27.0	27.0	110.5	886.0
2017	1,225.0	.0	83.6	83.6	.0	27.0	27.0	110.5	1,114.5
2018	1,505.9	.0	83.6	83.6	.0	27.0	27.0	110.5	1,395.4
2019	1,851.2	.0	83.6	83.6	.0	27.0	27.0	110.5	1,740.6
2020	2,275.6	-1,349.0	83.6	-1,265.5	.0	27.0	27.0	-1,238.5	3,514.1
B/C= 1.01				NPV=		14.9 million SP		IRR= 12.1%	

Table 19.3.5 Results of Economic Evaluation of Project Package B

(million SP)

Year	Benefit (Savings in VOC)	Cost						Total	B-C
		Intersection Improvement Project			ATC System Installment Project				
		Invest.	Mainte.	Total	Invest.	Mainte.	Total		
2000	.0	.0	.0	.0	36.7	.0	36.7	36.7	-36.7
2001	5.8	202.1	.0	202.1	279.9	.0	279.9	482.0	-476.2
2002	11.5	202.1	.0	202.1	222.7	14.3	237.0	439.1	-427.6
2003	17.3	202.1	.0	202.1	.0	27.0	27.0	229.1	-211.8
2004	23.0	202.1	.0	202.1	.0	27.0	27.0	229.1	-206.1
2005	28.8	140.9	32.3	173.2	.0	27.0	27.0	200.2	-171.4
2006	36.0	140.9	32.3	173.2	.0	27.0	27.0	200.2	-164.2
2007	44.9	140.9	32.3	173.2	.0	27.0	27.0	200.2	-155.3
2008	56.1	140.9	32.3	173.2	.0	27.0	27.0	200.2	-144.1
2009	70.0	140.9	32.3	173.2	.0	27.0	27.0	200.2	-130.2
2010	270.9	.0	67.6	67.6	.0	27.0	27.0	94.5	176.4
2011	332.6	.0	67.6	67.6	.0	27.0	27.0	94.5	238.0
2012	408.3	.0	67.6	67.6	.0	27.0	27.0	94.5	313.7
2013	501.2	.0	67.6	67.6	.0	27.0	27.0	94.5	406.7
2014	615.3	.0	67.6	67.6	.0	27.0	27.0	94.5	520.8
2015	755.4	.0	67.6	67.6	.0	27.0	27.0	94.5	660.9
2016	927.3	.0	67.6	67.6	.0	27.0	27.0	94.5	832.8
2017	1,138.4	.0	67.6	67.6	.0	27.0	27.0	94.5	1,043.9
2018	1,397.6	.0	67.6	67.6	.0	27.0	27.0	94.5	1,303.1
2019	1,715.7	.0	67.6	67.6	.0	27.0	27.0	94.5	1,621.2
2020	2,106.3	-1,099.2	67.6	-1,031.7	.0	27.0	27.0	-1,004.7	3,111.0
		B/C= 1.03			NPV=	48.2 million SP		IRR= 12.3%	

19.3.6 Sensitivity Analysis

A sensitivity analysis is carried out for three disadvantageous cases compared with the base case. The results are shown in Table 19.3.6.

Table 19.3.6 Results of Sensitivity Analysis

	Package A			Package B		
	B/C	NPV (million SP)	IRR (%)	B/C	NPV (million SP)	IRR (%)
Base Case	1.01	14.9	12.1	1.03	48.2	12.3
Cost 10% Up	0.92	-148.3	11.2	0.94	-100.3	11.4
Benefit 10% Down	0.91	-149.8	11.1	0.93	-106.0	11.3
Cost 10% Up & Benefit 10% Down	0.83	-313.0	10.2	0.85	-254.5	10.4

According to the table, when benefit is not changed and cost increases by 10%, each package shows an IRR lower than 12%, with a B/C of less than 1 and an NPV of negative value. When cost is not changed but benefit decreases by 10%, the result is almost the same as the first case. If cost increases by 10% and benefit decreases by 10%, the IRR of each package goes down to nearly 10%, B/C becomes around 0.85.

In conclusion, the project packages are recommendable to implement. It is required, however, that the estimated project cost should be severely as less as possible, for the estimation of project benefit is harder and more uncertain.

19.4 Financial Evaluation of Underground Parking Area Project

19.4.1 Outline of the Project

Arnous Square underground parking area project is intended to construct an off street parking facility under Arnous Square (8th of March Square) as the first project selected from the 5 parking areas proposed in the master plan. The planned number of parking lots is 500. There has been a plan to construct a new public facility building of Damascus City at Arnous Square. If the building is constructed on the underground parking area, its cost will be increased due to a required stronger structure.

Therefore, the study is made for the following two cases; Case 1: underground parking facility only, and Case 2: underground parking facility with a building on it.

A layout design of the Arnous underground parking area is shown in Figure 19.4.1.

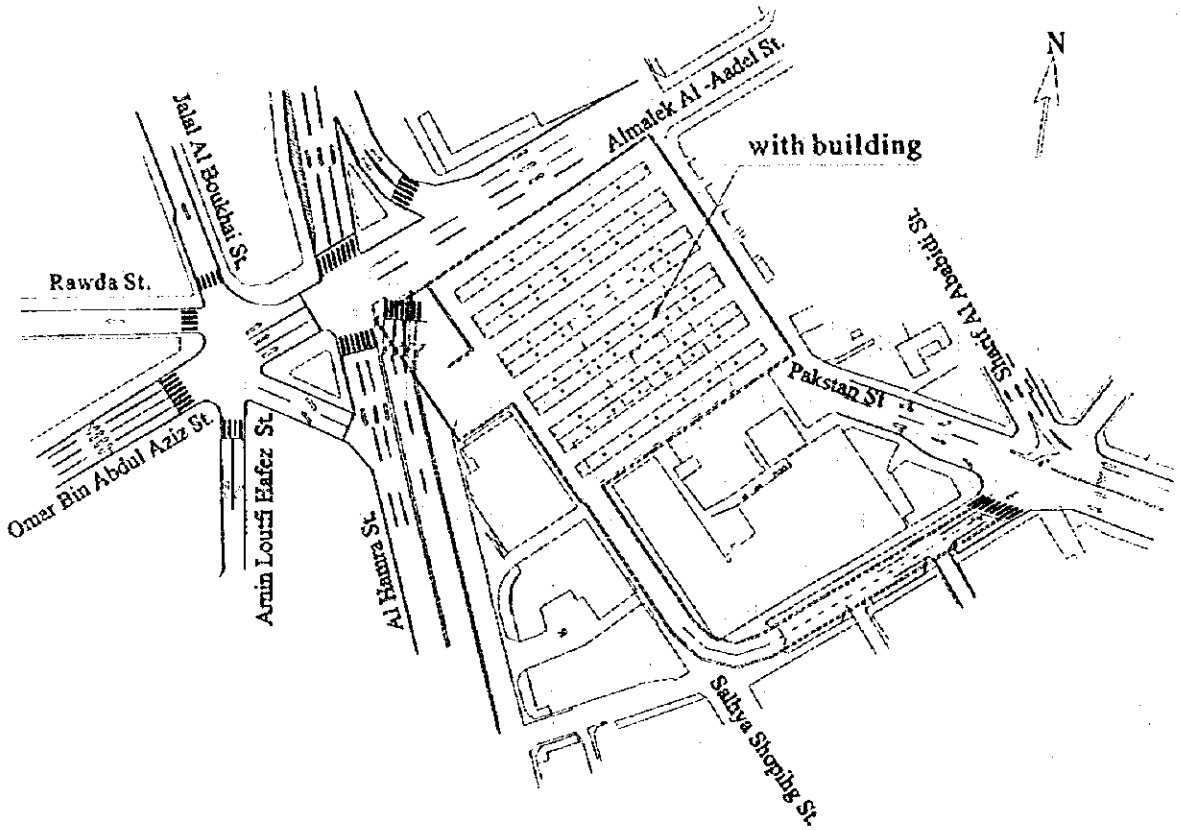


Figure 19.4.1 Arnous Underground Parking Area

19.4.2 Assumed Conditions for Financial Cash Flow Analysis of the Project

a. Implementation Schedule

- During the year 2000

b. Initial Investment Cost

- 308,920 thousand SP (Structure: 176,770 thousand SP, and Equipment: 132,150 thousand SP) for Case 1 (Parking facility only)
- 525,440 thousand SP (Structure: 393,290 thousand SP, and Equipment: 132,150 thousand SP) for Case 2 (Parking facility and building)

c. Operation and Maintenance Cost

- Salary and wages for O & M staff: 7,000 SP x 10 persons x 12 months = 840,000 SP
- Administration cost: O & M staff cost x 30% = 252,000 SP
- Total operation and maintenance cost: 1,092,000 SP per year

d. Depreciation (based on the present Syrian accounting system)

- Structure: annually 2% (50 years)
- Equipment: annually 10% (10 years)
- Depreciation of Case 1:
  Structure: 176,770 thousand x 0.02 = 3,535 thousand SP
  Equipment: 132,150 thousand x 0.1 = 13,215 thousand SP
  Total: 16,750 thousand SP (from 2001 to 2010) and 3,535 thousand SP (after 2011)
- Depreciation of Case 2:
  Structure: 393,290 thousand x 0.02 = 7,866 thousand SP
  Equipment: 132,150 thousand x 0.1 = 13,215 thousand SP
  Total: 21,081 thousand SP (from 2001 to 2010) and 7,866 thousand SP (after 2011)

e. Operating Revenue

- Parking lot allocation: 50 lots for permanent users and 450 lots for casual users
- Parking tariff: monthly 2,000 SP for permanent users and hourly 40 SP for casual users
- Operating days and hours: 294 days a year (excluding Fridays and holidays) and 12 hours a day (from 9:30 to 21:30)
- Occupation ratio: 60% as a weighted average for 12 hours
- Annual operating revenue:
  Permanent users: 50 lots x 2,000 SP x 12 months = 1,200 thousand SP
  Casual users: 450 lots x 40 SP x 12 hours x 60% x 294 days = 38,102 thousand SP
  Total: 39,302 thousand SP

19.4.3 Financial Cash Flow Analysis of the Project

Based on the assumed conditions, calculations of financial evaluation indicators for the two cases are carried out. Table 19.4.1 shows the result for Case 1 (parking facility only), while Table 19.4.2 for Case 2 (parking facility and building).

According to Table 19.4.1, Case 1 can be judged financially feasible as a public investment project, with FIRR of 11.4% (more than 11%), NPV of 7,671 thousand SP, B/C of 1.03 (more than 1), and pay back period of 19.2 years.

On the other hand, Case 2 is very difficult to implement because all evaluation indicators are negative and the pay back period will be more than 20 years. Therefore, it is necessary to adopt a measure for the alleviation of heavy cost burden caused by the building. It will be, for example, to make the investor to the building pay the additional cost.

Generally, it is considered that an underground parking area construction could be financially feasible as a public investment project on condition that its initial investment cost is held down to a reasonable level.

Table 19.4.1 Project Financial Cash Flow Analysis, Case 1 (Parking Facility Only)

Year	Cash Flow (1,000 SP)					Discounted Cash Flow at 11% (1,000 SP)				Number
	Cost			Revenue	Net	Cost	Revenue	Net	Accumulated	Of
	Construction	M. & O.	Total		Cash Flow			Cash Flow	Net CF	Years
2000	308,920		308,920		-308,920	278,306	0	-278,306	-278,306	1
2001		1,092	1,092	39,302	38,210	886	31,898	31,012	-247,294	2
2002		1,092	1,092	39,302	38,210	798	28,737	27,939	-219,355	3
2003		1,092	1,092	39,302	38,210	719	25,889	25,170	-194,185	4
2004		1,092	1,092	39,302	38,210	648	23,324	22,676	-171,510	5
2005		1,092	1,092	39,302	38,210	584	21,012	20,429	-151,081	6
2006		1,092	1,092	39,302	38,210	526	18,930	18,404	-132,677	7
2007		1,092	1,092	39,302	38,210	474	17,054	16,580	-116,096	8
2008		1,092	1,092	39,302	38,210	427	15,364	14,937	-101,159	9
2009		1,092	1,092	39,302	38,210	385	13,842	13,457	-87,702	10
2010		1,092	1,092	39,302	38,210	346	12,470	12,123	-75,579	11
2011		1,092	1,092	39,302	38,210	312	11,234	10,922	-64,657	12
2012		1,092	1,092	39,302	38,210	281	10,121	9,840	-54,817	13
2013		1,092	1,092	39,302	38,210	253	9,118	8,865	-45,953	14
2014		1,092	1,092	39,302	38,210	228	8,214	7,986	-37,967	15
2015		1,092	1,092	39,302	38,210	206	7,400	7,195	-30,772	16
2016		1,092	1,092	39,302	38,210	185	6,667	6,482	-24,290	17
2017		1,092	1,092	39,302	38,210	167	6,006	5,839	-18,451	18
2018		1,092	1,092	39,302	38,210	150	5,411	5,261	-13,190	19
2019		1,092	1,092	39,302	38,210	135	4,875	4,739	-8,451	20
2020		1,092	1,092	145,372	144,280	122	16,244	16,122	7,671	21
Total	308,920	21,840	330,760	892,110	561,350	286,140	293,812	7,671		

Internal Rate of Return (%)	11.4
Net Present Value (1,000 SP)	7,671
Benefit/Cost Ratio	1.03
Pay Back Period (Years)	19.2

Table 19.4.2 Project Financial Cash Flow Analysis, Case 2 (Parking Facility / Building)

Year	Cash Flow (1,000 SP)					Discounted Cash Flow at 11% (1,000 SP)				Number
	Cost			Revenue	Net	Cost	Revenue	Net	Accumulated	Of
	Construction	M. & O.	Total		Cash Flow			Cash Flow	Net CF	Years
2000	525,440		525,440		-525,440	473,369	0	-473,369	-473,369	1
2001		1,092	1,092	39,302	38,210	886	31,898	31,012	-442,357	2
2002		1,092	1,092	39,302	38,210	798	28,737	27,939	-414,418	3
2003		1,092	1,092	39,302	38,210	719	25,889	25,170	-389,248	4
2004		1,092	1,092	39,302	38,210	648	23,324	22,676	-366,573	5
2005		1,092	1,092	39,302	38,210	584	21,012	20,429	-346,144	6
2006		1,092	1,092	39,302	38,210	526	18,930	18,404	-327,740	7
2007		1,092	1,092	39,302	38,210	474	17,054	16,580	-311,159	8
2008		1,092	1,092	39,302	38,210	427	15,364	14,937	-296,222	9
2009		1,092	1,092	39,302	38,210	385	13,842	13,457	-282,765	10
2010		1,092	1,092	39,302	38,210	346	12,470	12,123	-270,642	11
2011		1,092	1,092	39,302	38,210	312	11,234	10,922	-259,720	12
2012		1,092	1,092	39,302	38,210	281	10,121	9,840	-249,880	13
2013		1,092	1,092	39,302	38,210	253	9,118	8,865	-241,016	14
2014		1,092	1,092	39,302	38,210	228	8,214	7,986	-233,030	15
2015		1,092	1,092	39,302	38,210	206	7,400	7,195	-225,835	16
2016		1,092	1,092	39,302	38,210	185	6,667	6,482	-219,353	17
2017		1,092	1,092	39,302	38,210	167	6,006	5,839	-213,514	18
2018		1,092	1,092	39,302	38,210	150	5,411	5,261	-208,253	19
2019		1,092	1,092	39,302	38,210	135	4,875	4,739	-203,514	20
2020		1,092	1,092	275,272	274,180	122	30,760	30,637	-172,877	21
Total	525,440	21,840	547,280	1,022,010	474,730	481,204	308,327	-172,877		

Internal Rate of Return (%)	5.7
Net Present Value (1,000 SP)	-172,877
Benefit/Cost Ratio	0.64
Pay Back Period (Years)	

19.4.4 Financing Plan and Financial Statement Analysis

Although an underground parking area construction can be financially feasible, the investment budget of Damascus Governorate is very limited. In this sense, possibility of the private sector involvement is studied. Recently, the "Build, Operate and Transfer" (BOT) system is widely adopted all over the world as a private sector involvement scheme to the infrastructure and public facility construction projects. Possibility of the application of this system to the underground parking area project is studied through financial statement analysis. In this system, the Governorate shall provide the land for the project, and the private sector shall construct and operate the facility by its own finance and hand it over to the Governorate after a contracted period.

In this section, the basic financial features of an assumed private entity (concessionaire) to be engaged in the construction and operation of the proposed underground parking area are discussed and some points for privatization are recommended.

As mentioned above, Case 2 (parking facility and building) is not financially feasible if the increased cost should be borne by the investor for the parking facility. If the increased cost can be excluded from the initial investment cost of the concessionaire (for example, through a sharing of the portion by the investor for the building), the case is almost same as Case 1. Therefore, only Case 1 is studied in the following.

(1) Financing plan

The assumed financing plan is as follows:

a. Fund Raising
- Syrian Bank's long term loan: 185,352 thousand SP (max. 60% of the capital cost)
- Funds on hand: 123,568 thousand SP (min. 40% of the capital cost)

b. Loan conditions
- Interest rate: 11% per annum
- Repayment: 10 years after the completion of construction

c. Tax payment
Based on the Syrian taxation system and the stipulation of Act No.10 of 1991, income tax payment is assumed as follows:
- Tax rate: 42% of "Net profits before tax"(Operating profits – Interest payment)
- Tax exemption: 7 years from the beginning of operation

d. Future escalation rate
Assuming that Syrian investors will apply for this BOT project, future escalation of prices is considered. According to the national account data, GDP at current prices increased by an annual average rate of 16.04% between 1990 and 1996, while GDP at 1985 fixed prices by 6.53%. It shows that there was a growth rate's gap of 8.93% per annum between GDP at current prices and that at fixed prices during that period. Considering the above-mentioned gap between the GDP at current prices and fixed prices, a future escalation rate is assumed as follows:
- 7% for operating revenue and operation & maintenance cost

e. Period for the preparation of financial statements
- 21 years from 2000 to 2020

(2) Financial statement analysis

Table 19.4.3 to Table 19.4.5 show financial statements of an assumed concessionaire entity. These tables are prepared for the evaluation of financial soundness of the entity, that is, to judge whether a profit oriented organization can reasonably implement this project.

Table 19.4.3 Income Statement shows that the entity will get net profits from the beginning year of operation of 2001 and the net profits will increase at a moderate pace. The debt service coverage ratio rise from 1.05 in 2000 to 2.50 in 2010, which means that the operating profits and depreciation will catch up the liabilities soundly, and that the project has a sufficient ability to pay the annual interest and repayment.

As shown in Table 19.4.4, the working capital in the assets and reserves in the capital will increase soundly. This means that the project is considerably profitable and will provide the concessionaire entity with opportunities for the development of its activities. "Return on equity" and "Return on net fixed assets" will gradually rise from the beginning year of operation of 2001 and reach 70.6% and 82.3% respectively in 2020. It shows an acceptable profitability of the entity.

According to Table 19.4.5, the internal rate of return on equity, net present value and pay back period in 2020 are estimated at 18.1%, 106,107 thousand SP (discount rate of 11%) and 12.3 years, respectively. These figures show that a private investor could have an interest to invest in the project on some conditions.

Table 19.4.3 Income Statement of Concessionaire Entity

Year	Operating Revenue (A)	Operating Expenses			Operating Profits (E)	Interest Payment (F)	Profits before Tax (G)	Income Tax (J=Ix0.42)	Net Profits After Tax (K)	Operating Ratio (D/A)	DSCR (C+F+K)/ (ADS*+F)
		M. & O. (B)	Depreciation (C)	Total (D)							
2000											
2001	44,997	1,250	17,923	19,173	25,824	21,816	4,008		4,008	0.43	1.05
2002	48,147	1,338	17,923	19,260	28,886	19,634	9,252		9,252	0.40	1.19
2003	51,517	1,431	17,923	19,354	32,163	17,453	14,710		14,710	0.38	1.34
2004	55,123	1,532	17,923	19,454	35,669	15,271	20,398		20,398	0.35	1.53
2005	58,982	1,639	17,923	19,561	39,420	13,090	26,331		26,331	0.33	1.74
2006	63,110	1,754	17,923	19,676	43,434	10,908	32,526		32,526	0.31	2.00
2007	67,528	1,876	17,923	19,799	47,729	8,726	39,003		39,003	0.29	2.30
2008	72,255	2,008	17,923	19,930	52,325	6,545	45,780	19,228	26,553	0.28	1.93
2009	77,313	2,148	17,923	20,071	57,242	4,363	52,879	22,209	30,670	0.26	2.19
2010	82,725	2,298	17,923	20,221	62,504	2,182	60,322	25,335	34,987	0.24	2.50
2011	88,516	2,459	3,782	6,242	82,274	0	82,274	34,555	47,719	0.07	
2012	94,712	2,632	3,782	6,414	88,298	0	88,298	37,085	51,213	0.07	
2013	101,342	2,816	3,782	6,598	94,743	0	94,743	39,792	54,951	0.07	
2014	108,435	3,013	3,782	6,795	101,640	0	101,640	42,689	58,951	0.06	
2015	116,026	3,224	3,782	7,006	109,020	0	109,020	45,788	63,231	0.06	
2016	124,148	3,449	3,782	7,232	116,916	0	116,916	49,105	67,811	0.06	
2017	132,838	3,691	3,782	7,473	125,365	0	125,365	52,653	72,712	0.06	
2018	142,137	3,949	3,782	7,732	134,405	0	134,405	56,450	77,955	0.05	
2019	152,086	4,226	3,782	8,008	144,078	0	144,078	60,513	83,565	0.05	
2020	162,732	4,521	3,782	8,304	154,428	0	154,428	64,860	89,568	0.05	

* ADS (Annual Debt Service) = 19,833 thousand SP

Table 19.4.4 Balance Sheet of Concessionaire Entity

Year	Assets			Capital				Return on Equity	Return on Net Fixed Assets
	Working Capital	Net Fixed Assets	Total Assets	Liabilities	Reserves	Equity	Total Capital		
2000	0	330,544	330,544	198,327	0	132,218	330,544	0	0
2001	2,098	312,622	314,720	178,491	4,008	132,218	314,720	0.166	0.070
2002	9,440	294,699	304,139	158,661	13,260	132,218	304,139	0.206	0.092
2003	22,240	276,777	299,017	138,829	27,971	132,218	299,017	0.247	0.118
2004	40,728	258,854	299,582	118,996	48,368	132,218	299,582	0.290	0.148
2005	65,148	240,932	306,080	99,163	74,699	132,218	306,080	0.335	0.184
2006	95,765	223,009	318,774	79,331	107,226	132,218	318,774	0.382	0.226
2007	132,858	205,087	337,944	59,498	146,229	132,218	337,944	0.431	0.278
2008	157,500	187,164	344,664	39,665	172,781	132,218	344,664	0.336	0.238
2009	186,260	169,242	355,502	19,833	203,451	132,218	355,502	0.368	0.287
2010	219,336	151,319	370,656	0	238,438	132,218	370,656	0.400	0.350
2011	270,838	147,537	418,375	0	286,157	132,218	418,375	0.390	0.349
2012	325,833	143,755	469,587	0	337,370	132,218	469,587	0.416	0.383
2013	384,566	139,972	524,538	0	392,321	132,218	524,538	0.444	0.420
2014	447,300	136,190	583,490	0	451,272	132,218	583,490	0.474	0.461
2015	514,314	132,407	646,721	0	514,503	132,218	646,721	0.507	0.506
2016	585,908	128,625	714,532	0	582,315	132,218	714,532	0.541	0.557
2017	662,402	124,842	787,244	0	655,026	132,218	787,244	0.579	0.613
2018	744,139	121,060	865,199	0	732,981	132,218	865,199	0.618	0.675
2019	831,487	117,277	948,764	0	816,546	132,218	948,764	0.661	0.745
2020	924,838	113,495	1,038,333	0	906,115	132,218	1,038,333	0.706	0.823

Table 19.4.5 Cash Flow Statement of Concessionaire Entity

Year	Cash Inflow					Cash Outflow			Net Cash Inflow	Equity Holders' Cash Flow	IRR on Equity
	Net Profits after Tax	Depreciation	Self Equity	Bank Loan	Total Fund Available	Construction	Debt Services	Total Fund Utilized			
2000	0	0	132,218	198,327	330,544	330,544		330,544	0	-132,218	
2001	4,008	17,923			21,931		19,833	19,833	2,098	2,098	
2002	9,252	17,923			27,175		19,833	19,833	7,342	7,342	
2003	14,710	17,923			32,633		19,833	19,833	12,800	12,800	
2004	20,398	17,923			38,320		19,833	19,833	18,488	18,488	
2005	26,331	17,923			44,253		19,833	19,833	24,421	24,421	
2006	32,526	17,923			50,449		19,833	19,833	30,616	30,616	-6.8%
2007	39,003	17,923			56,926		19,833	19,833	37,093	37,093	0.1%
2008	26,553	17,923			44,475		19,833	19,833	24,642	24,642	3.2%
2009	30,670	17,923			48,592		19,833	19,833	28,760	28,760	5.8%
2010	34,987	17,923			52,909		19,833	19,833	33,077	33,077	8.0%
2011	47,719	3,782			51,501			0	51,501	51,501	10.5%
2012	51,213	3,782			54,995			0	54,995	54,995	12.3%
2013	54,951	3,782			58,734			0	58,734	58,734	13.7%
2014	58,951	3,782			62,734			0	62,734	62,734	14.7%
2015	63,231	3,782			67,014			0	67,014	67,014	15.6%
2016	67,811	3,782			71,594			0	71,594	71,594	16.3%
2017	72,712	3,782			76,494			0	76,494	76,494	16.9%
2018	77,955	3,782			81,737			0	81,737	81,737	17.3%
2019	83,565	3,782			87,348			0	87,348	87,348	17.7%
2020	89,568	3,782			93,351			0	93,351	93,351	18.1%

IRR on Equity (%)	18.1
Net Present Value (1,000 SP)	106,107
Pay Back Period (Years)	12.3

19.4.5 Possibility of Implementation of the Project by BOT System

Generally, for attracting interest from private investors, a considerably high financial rate of return to the investors should be expected. The indicator of "IRR on Equity" expresses directly the degree of return to a private investor. The level of this indicator at which a private investor shows interest to a project is more than 20%.

It seems that the proposed financing plan has a considerable return on investment. But for the encouragement of the private sector involvement, it is required to study what level of IRR on equity attracts interest of the private sector, and, if necessary, to seek measures to raise it. For the raise of IRR on equity of the project, it is recommended to conduct a more detailed study about the followings in order:

a. Extension of the income tax exemption period (for example, if the income tax is not levied until 2020, the "IRR on Equity" will rise to 22.0%)
b. Conceding the right of on street parking business around the project area for the raise of operating revenue

19.5 Conclusion and Recommendations

19.5.1 Intersection Improvement Project Packages

The results of economic evaluation of the Project Packages A and B show no significant differences between the two packages. The construction cost of Package A is higher than Package B, but benefit generated by the former is expected to be larger than the latter.

From technical and environmental studies (see Chapters 21. 22 and 23), the following points are indicated:

- Hejaz Tunnel T01a (included in Package A) will avoid the high-possibility antique area in front of the Old City and its castle, and will attract more traffic from the city center to the south. With the historical background of the city, however, it may interfere with other antique areas in the city center.
- Hejaz Tunnel T01b (included in Package B) can facilitate two plans of pedestrianization of the square as well as an underground parking facility under An Nasr street. On the other hand, it will start with a curve at the high-possibility antique area in front of the Old City, and will require land acquisition to ensure an acceptable curve radius.

The ATC system installment project plays an important role of supporting the physical improvement of Umawyeen Square, Al Yarmouk Square and construction of Hejaz Tunnel. The installment cost is comparatively high but it will be economically recovered by the benefit of the project package including intersection improvement and construction of a tunnel.

In conclusion, the project package is recommended to implement according to the proposed schedule. For the selection of Package A or B, it is necessary to carry out a more detailed study on the possibility of interfering with antique and treatment of discovered materials as well as on the project cost and social influence. Considering the limited investment capacity of Damascus Governorate, however, it is recommended for the governorate to make efforts to introduce some foreign economic assistance for the implementation of the project package.

19.5.2 Arnous Underground Parking Area

It is judged that the underground parking facility construction can be financially implemented as a public investment project. The limited budget for investment of Damascus Governorate, however, requires a measure to introduce private funds to the project. BOT system is a recommendable measure for the utilization of private investment capacity.

According to the above-mentioned brief study, it is clarified that there is a possibility of implementing the project by domestic private investors through BOT system. It is necessary, however, to carry out a more detailed study on some preferential measures for the stimulation of investment mind of the private sector.

Considerable measures are as follows:

- Extension of the income tax exemption period
- Concession of the right to collect parking tariff from on street parking lots around the planned underground parking facility

Chapter 20. AREA TRAFFIC CONTROL SYSTEM

20.1 Objectives of the Project

Surveys on the existing road conditions and traffic flow show that traffic congestion is occurring in various places due to insufficient road/intersection improvements and non-systematized traffic signals.

In order to improve the present traffic conditions in Damascus City where traffic demand is increasing rapidly and a short-term countermeasure is required for it, an Area Traffic Control System Installment Project is expected to have an immediate effect on the situation. Objectives of the introduction of the ATC system are shown in Figure 20.1.1, corresponding to the existing traffic problems.

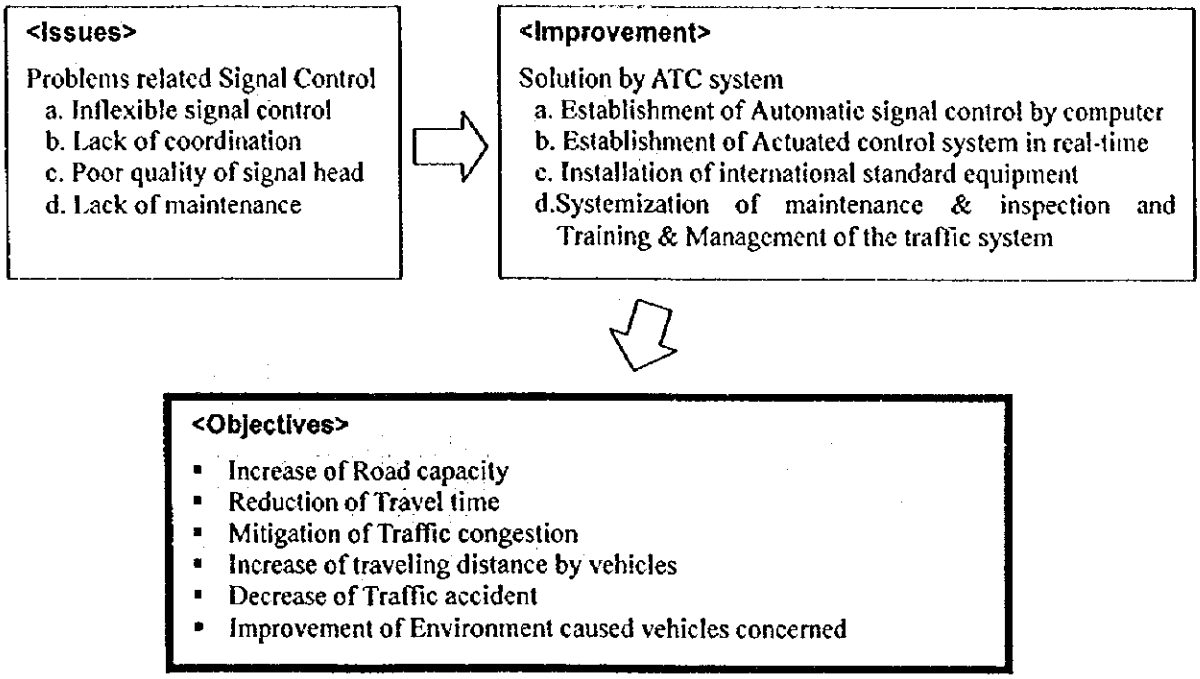


Figure 20.1.1 Issues and Objectives

20.2 Traffic Condition

Based on the "Traffic Count at Intersections" and the "Travel Time Survey", the present traffic condition of intersections and road sections are summarized in Figure 20.2.2. The figure shows intersections of which saturation degrees are more than 0.9 and road sections on which travel speeds are less than 15 km/hr, for the morning peak, the afternoon (daytime) and the evening peak, respectively.

The characteristics of traffic condition are as follows:

- On the radial roads toward the central part of the city, a concentration of inbound traffic to the center is found in the morning.
- Many of the intersections on the Ring Road and in the central area are at the saturation point all day long.
- In some parts of the central area the peak hour varies and some intersections have a different traffic fluctuation pattern from those of the adjoining ones.

- As road sections with travel speeds under 15 km/hr are mostly found in the daytime compared with the morning and evening, traffic congestion seems to be chronic in the city.
  Morning: 40 sections/total 152 sections
  Daytime: 49 sections/total 152 sections
  Evening: 20 sections/total 152 sections
  Morning: 40 sections/total 152 sections
  Daytime: 49 sections/total 152 sections
  Evening: 20 sections/total 152 sections

Variations in travel speed on road sections of the Ring Road are shown in Figure 20.2.1, for the east-west and west-east directions respectively. For the sections where difference in travel speed is extremely great between the directions or compared with the next section, a coordinated signal system should be adopted in order to level the difference and to secure a uniform travel speed.

Considering the above-mentioned present situation, it is necessary to install a coordinated traffic control system between the central area and the Ring Road.

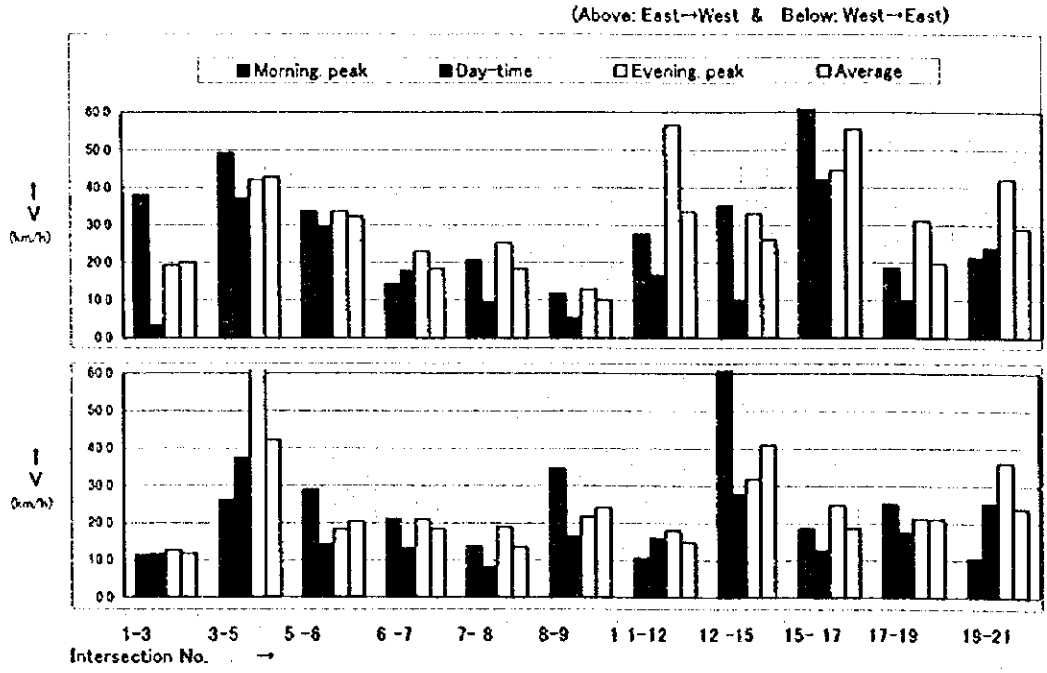


Figure 20.2.1 Comparison of Travel Time on Inner Ring Road

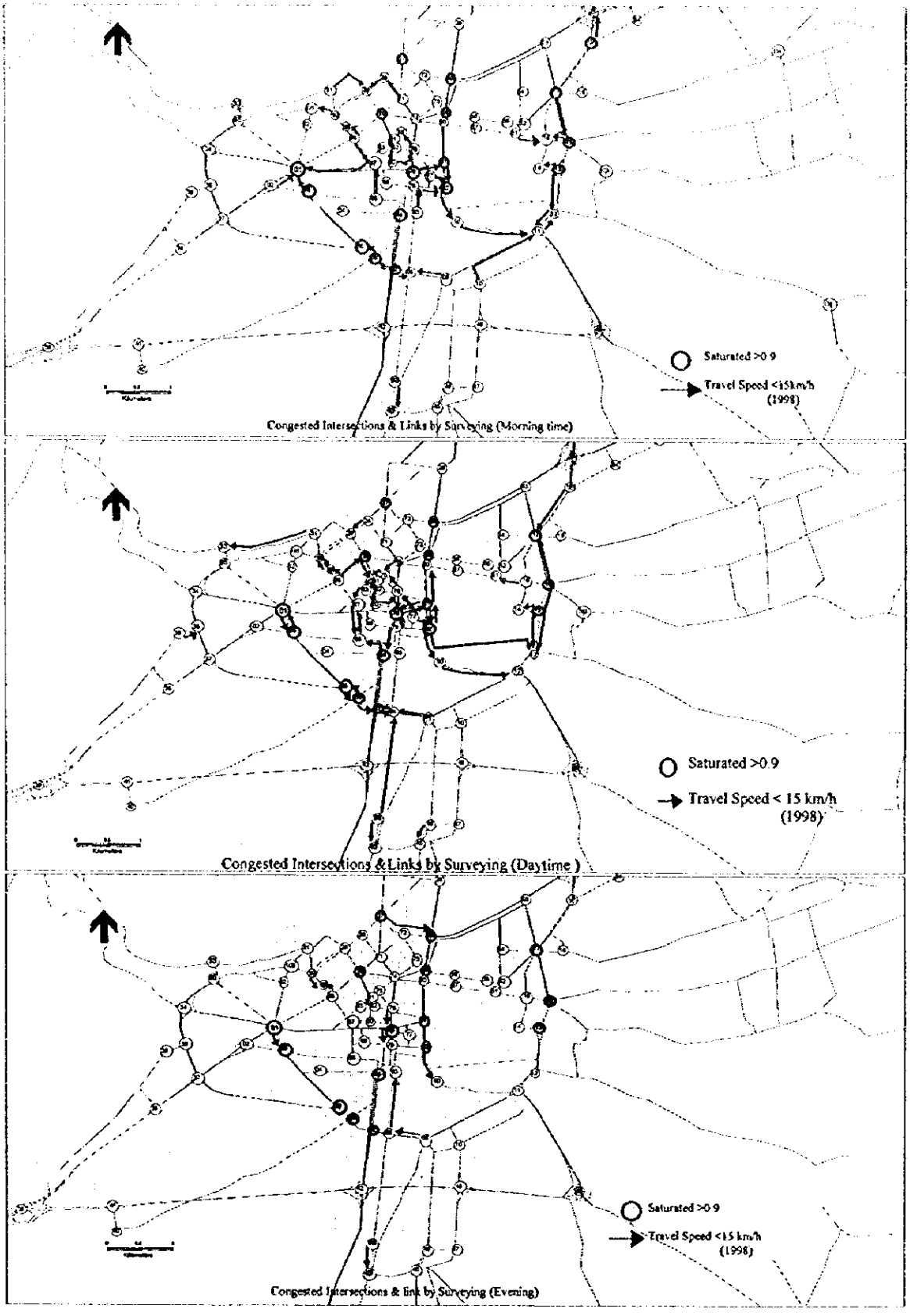


Figure 20.2.2 Congested Intersections and Link

20.3 System Design of ATL System

20.3.1 System Concept and Target Year

(1) System Concept

Outline of the system concept is as foltows:

- Coordinated traffic control system between the central area and the Ring Road.
- Staged expansion of the coverage area
- Flexible improvement of the system corresponding to technical innovation and annual changes of traffic flow
- Centralized traffic control by a Control Center

(2) Target Year

A study on the system installment will start in 2000, target years for the start of operation of each stage have been set as follows:(see Figure 20.4.1)

Stage 1-1: Year 2001
Stage 1-2: Year 2002

20.3.2 Road Networks and Intersections to be Covered by ATC System

Considering limited time and cost, and efficiency of the initial operation of the system, the installment is scheduled as shown below.

Stage 1: The Ring Road and areas within it
Stage 1-1: South part of the Ring Road and the central area
Stage 1-2: North part of the Ring Road and the rest of the areas within it

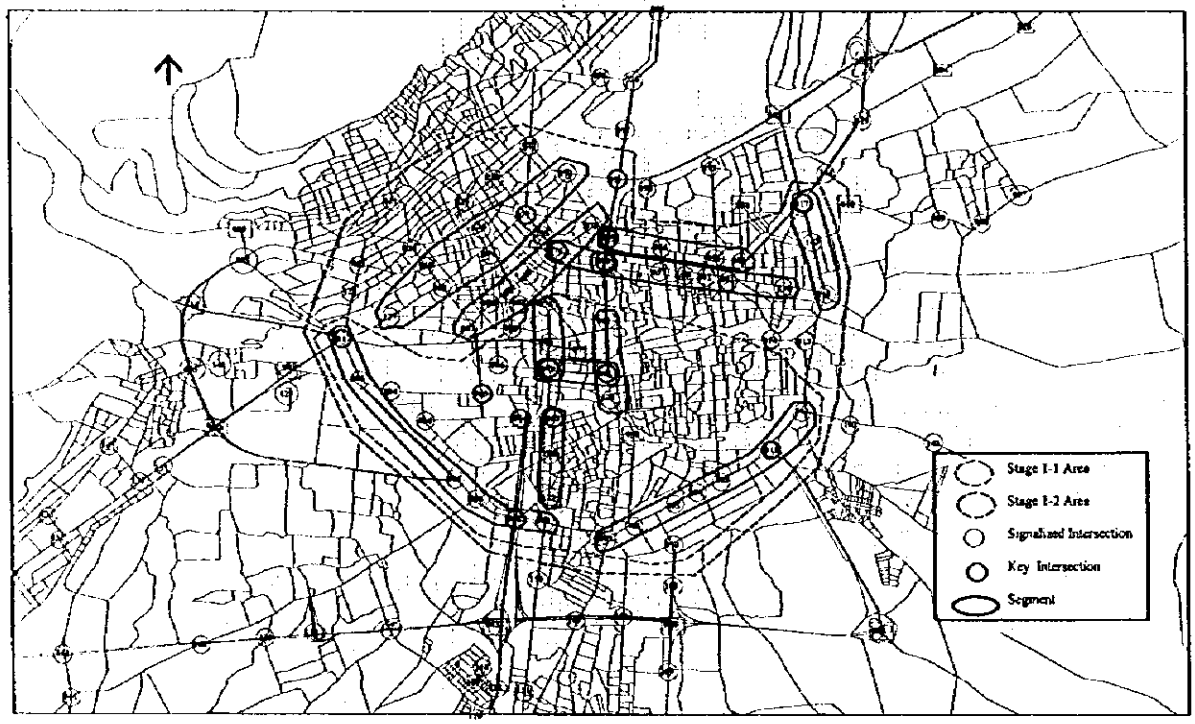


Figure 20.3.1 ATC Coverage Area and Control Segments

20.3.3 System Component of ATC System

(1) System Function

The system should have the following functions:

- Data collection
- Data processing
- Data display
- Signal control by man-machine interface
- Monitoring of terminal equipment
- Data base
- Information dissemination

Figure 20.3.2 show those functions.

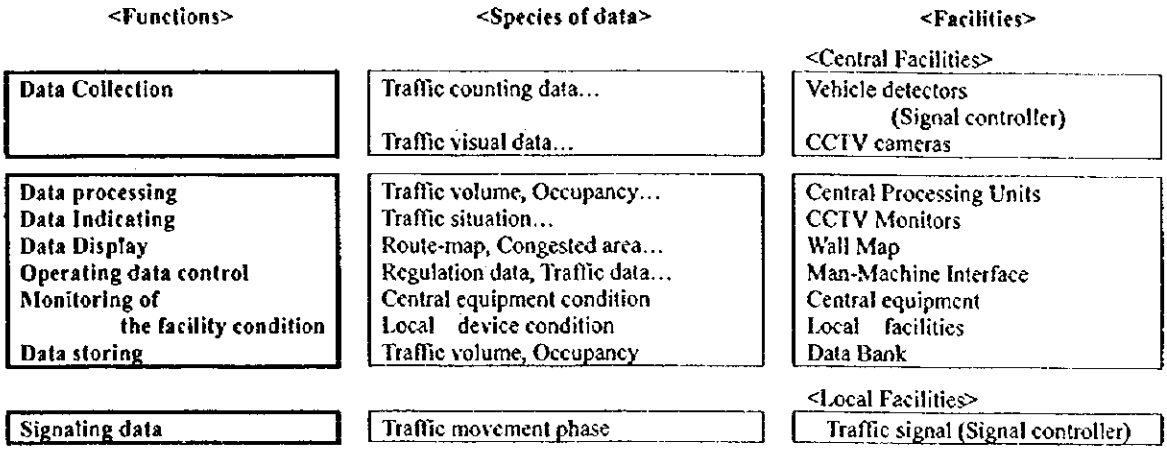


Figure 20.3.2 System Functions

(2) Software System

The software system should have the following capabilities.

- Grasp the traffic condition at the key intersections on the arterial road.
- Grasp the road situation in the traffic control area.
- Determine the suitable control parameters for the traffic signals.

1) Key Intersection and Control Segments

Key Intersections and Segments of the ATC-system are shown in Figure 20.3.1.
Basic installation of the vehicle detectors on Key intersection is shown in Figure .20.3.3.

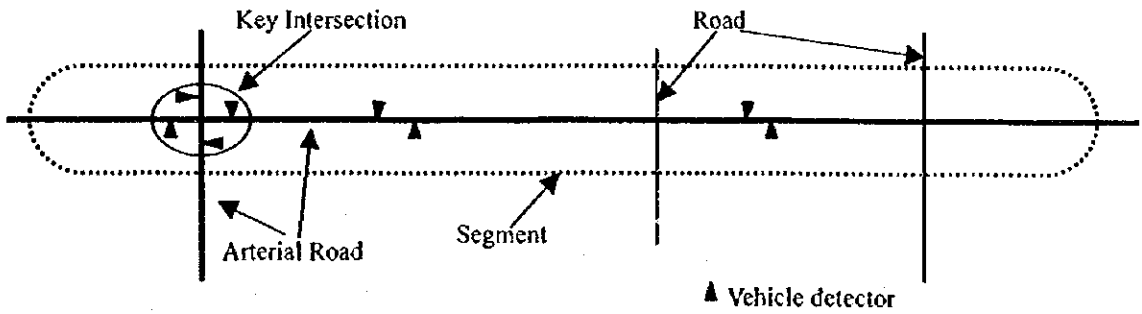


Figure 20.3.3 Key Intersection and Segment

2) ATC Control Parameters

Parameters necessary to control traffic signals include cycle length, split value, and offset pattern. The process of determining these parameters is basically as follows. This process requires identification of detailed traffic conditions at the time of system introduction. The, process must then be reexamined at the detail design stage by using the above information. In sum, the process requires:

1) Identification of traffic conditions at the mouths of key intersections by vehicle detectors.
2) Identification of traffic conditions of the entire segment including key intersections.
3) Identification and comparison of adjacent segments (key intersections).
4) Determination and arrangement of the priority at key intersections (and segments).
5) Determination of signal parameters at each intersection of the segment.

The above process can be used in areas inside the ring road. The same process is applicable to areas on the ring road. Figure 20.3.4 show this process.

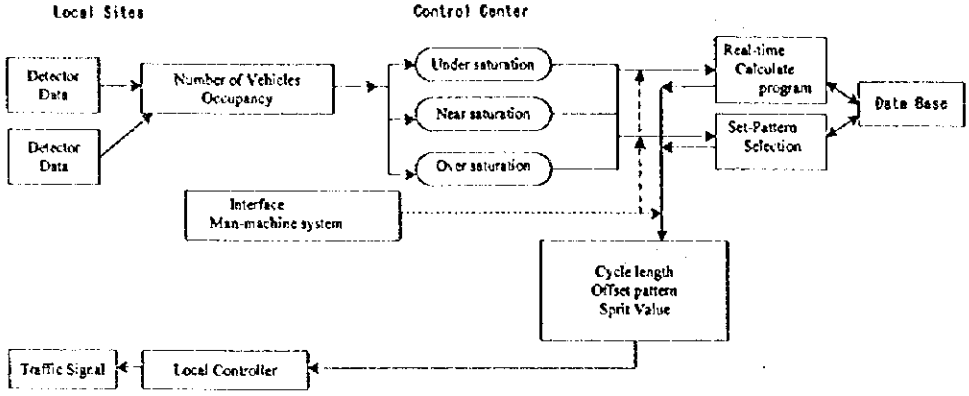


Figure 20.3.4 Determination of Signal parameter

(3) Hardware System Component

1) ATC System Equipment

Hardware equipment installation of the ATC System is required as follows:

- Vehicle Detector
- Signal Controller
- CCTV Camera
- Central Control Equipment
- Wall Map
- Console Desk
  - Man-Machine Interface Computer
  - Wireless Communication Equipment
- Others
  - Uninterrupted Power Supply System(UPS)
  - Instruction and Information Communication Equipment (Telephone, Radio, Facsimile, Video, etc)
  - Broadcasting Booth (For TV and Radio)
  - Public Relations Facilities (Observation Window for Visitors, Explanatory Video Equipment)

Total hardware equipment of configuration is shown in Figure 20.3.5. Standard design and installation of control system facilities: vehicle detectors, traffic signals are shown in Figure 20.3.6 and Figure 20.3.7.

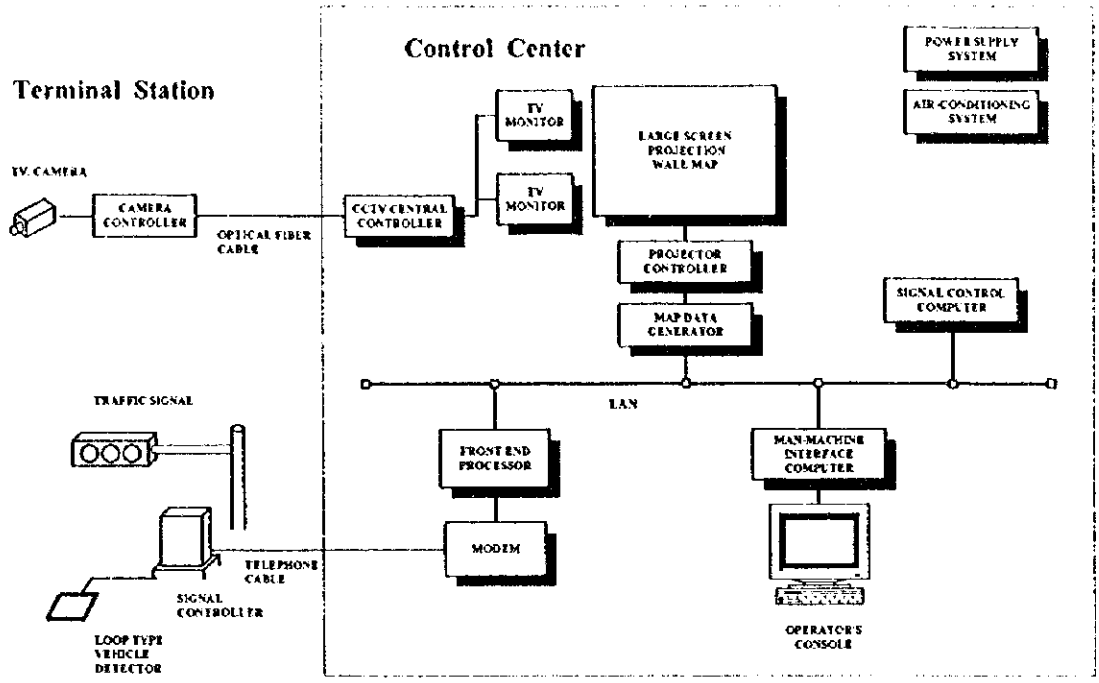


Figure 20.3.5 Conceptual Configuration of Area Traffic Control System

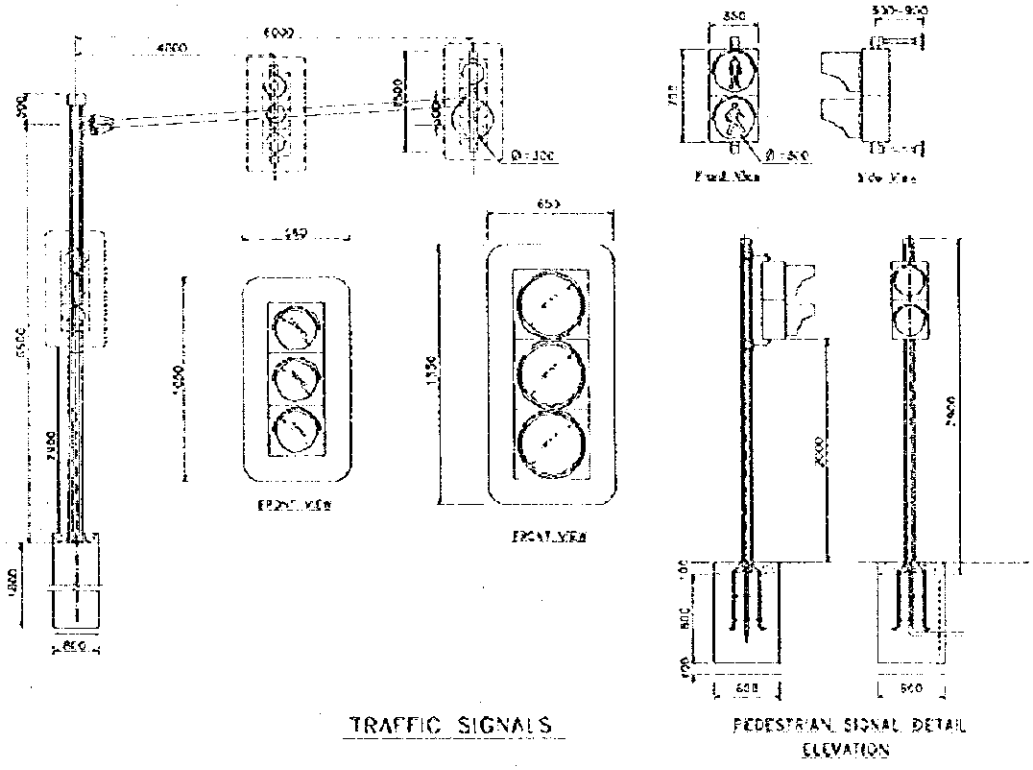


Figure 20.3.6 Traffic Signals

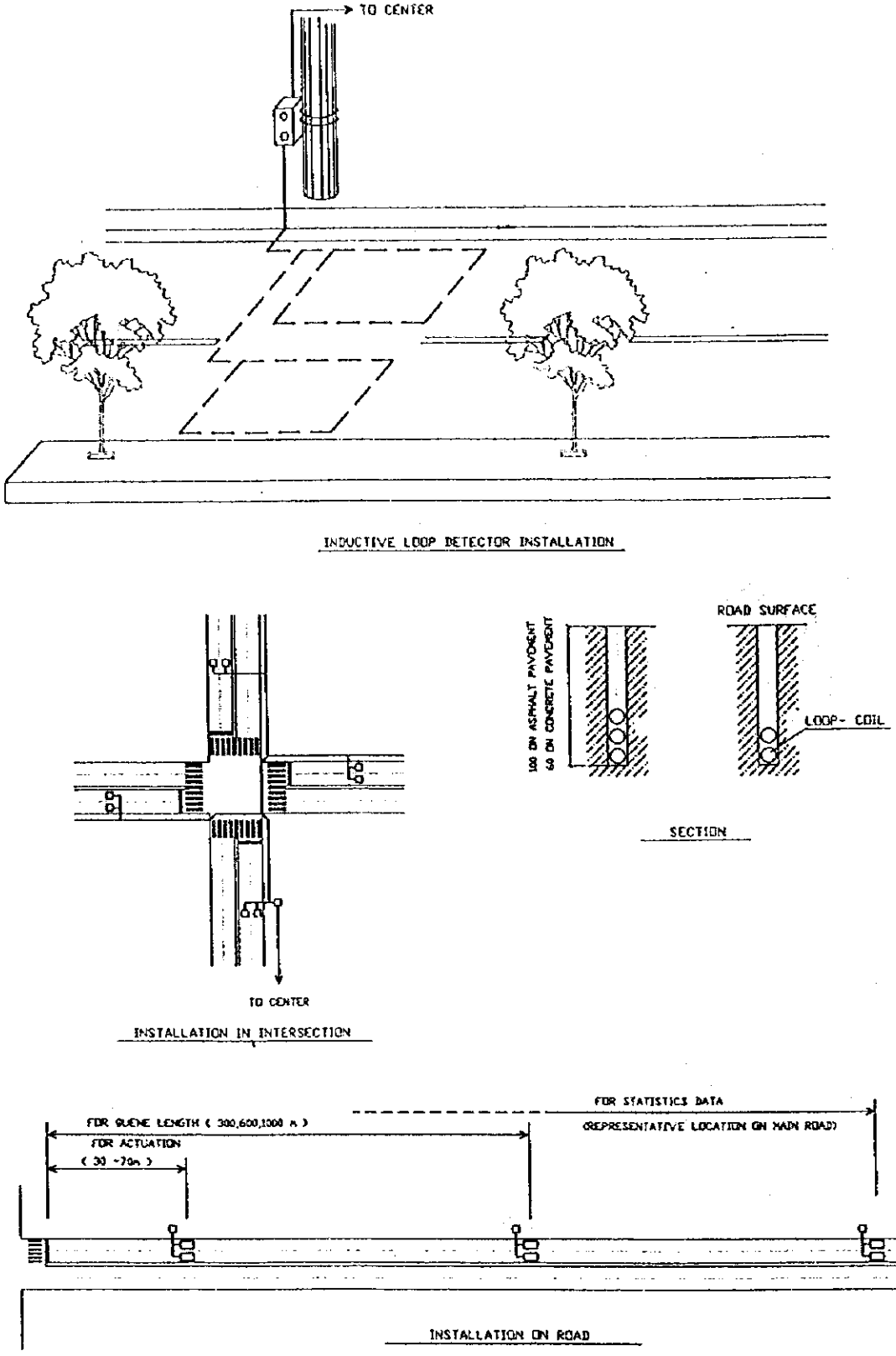


Figure 20.3.7 Vehicle Detector Installation Plan

2) Locations of CCTV cameras

The installed locations of CCTV camera are as follow. (See Figure 20.3.8).

Stage 1-1
No.1. Umawiyeen square
No.2. Intersection of Ath thawra St. with Al Etihad st.
No.3. Al Hijaz square

Stage 1-2
No.4. Abassiyeen square
No.5. Al Faiha'a intersection
No.6. Al Jihad intersection

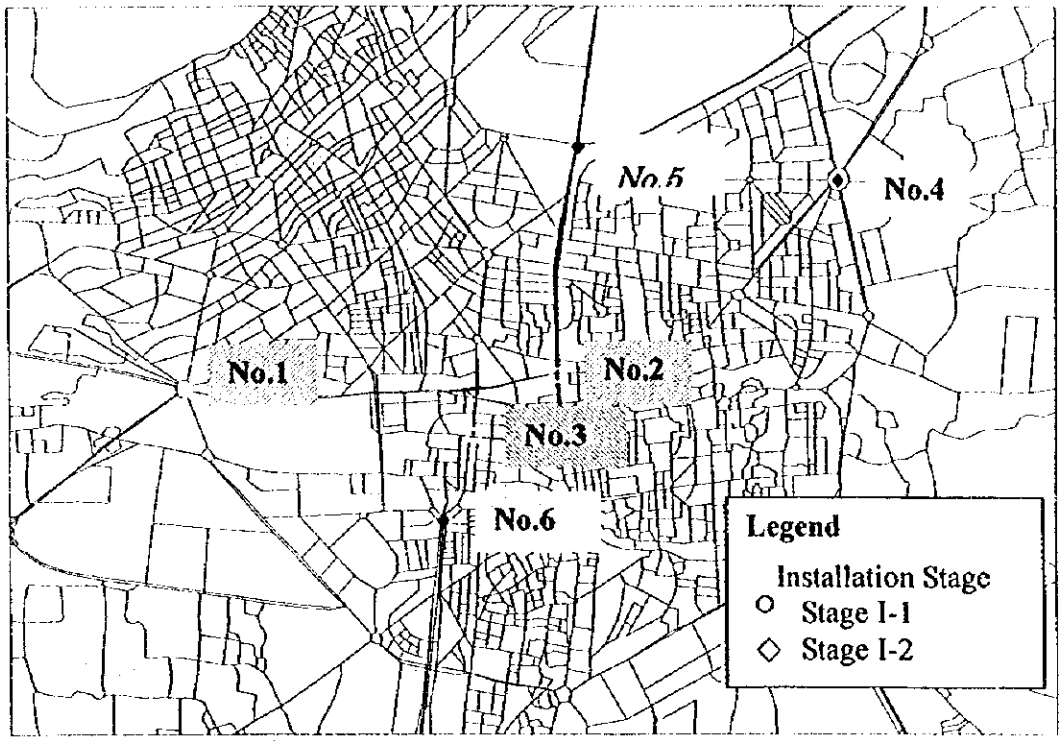


Figure 20.3.8 Location of TV Camera Installation

3) Layout of Control Center

The control center room would require two rooms.
Control room: 9m x 10.8m
Machine room: 9m x 10.8m

The System Operators will reside in the control room where all the interface devices such as terminals and wall map display will be placed. Other devices such as computers and communication equipment will be placed in the machine room.

A layout of the Control Center and its perspective are shown in Figure 20.3.9 and Figure 20.3.10.

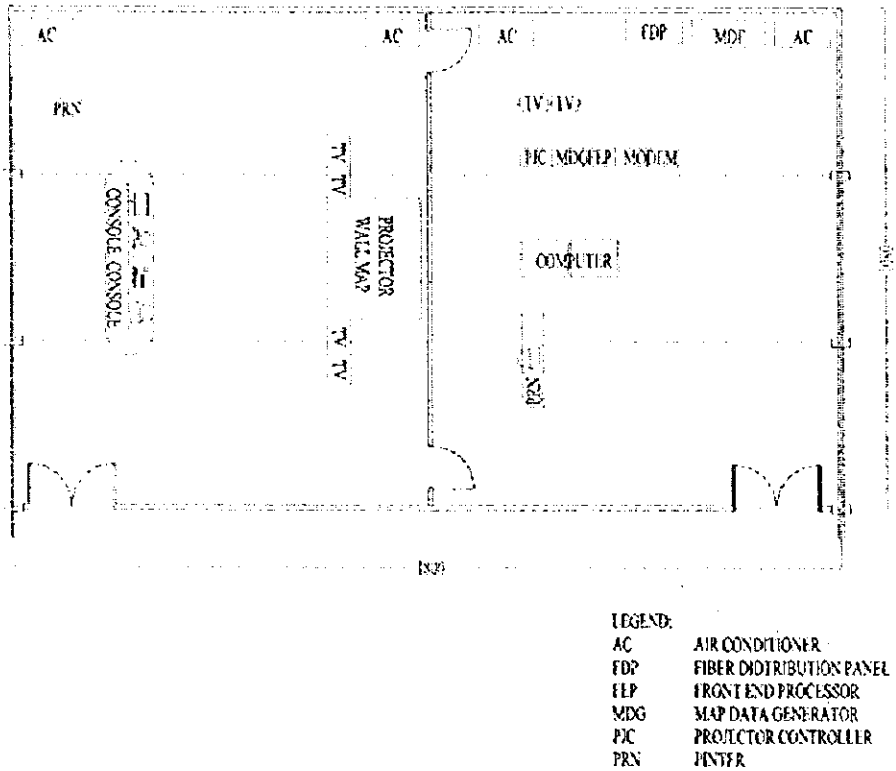


Figure 20.3.9 Control Center Room Layout

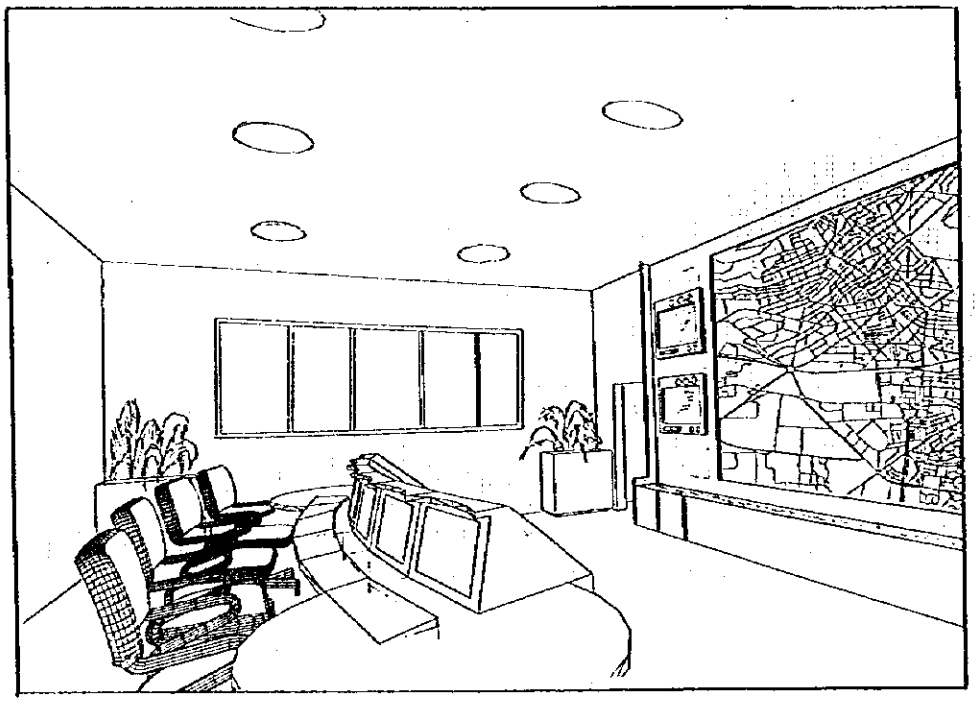


Figure 20.3.10 Perspective of Control Center Room

20.4 Implementation Plan

Considering the present traffic conditions of Damascus, in order to reduce traffic congestion, the ATC-system should be introduced promptly. The following tasks should be completed according to the implementation schedule as shown in Figure 20.4.1.

1) To use traffic signals that meet the world standards and taking into consideration the timing of their manufacturing orders.
2) To install five to six signal devices, controllers, and vehicle detectors a month. In so doing, include the installment of marking lines at intersections.
3) System Parameter, Testing, and Training System

In order for the system to operate properly, it must be a system which corresponds to traffic conditions of stages. It is necessary to set parameters essential for roads and intersections to be controlled and to have tests on the basis of those parameters.

In addition, it is also necessary to educate how to treat and maintain control devices and other equipment. Operation will start as follows.

Stage 1-1: the late 2001
Stage 1-2: the late 2002
Phasing of equipment installment is shown in Figure 20.4.1.

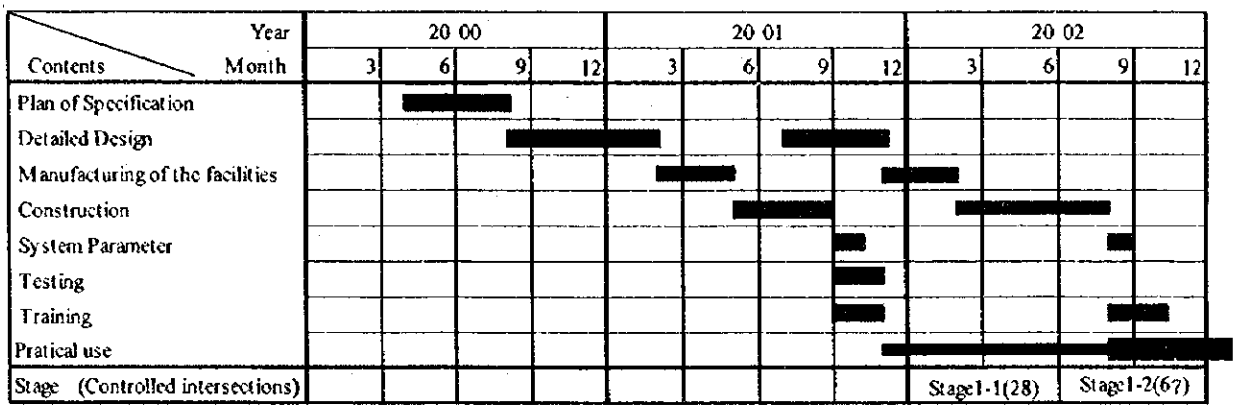


Figure 20.4.1 Construction Schedule of ATC Project

Table 20.4.1 Equipment Installation Component

Description	Stage 1-1	units	Stage 1-2	units	Total units	Remarks
Coverage Area & No. of Intersection	A	28 int.	B	39 int.	67 int.	Referred to Figure
Signal System	·Control center equipment - Center computer - Communication unit - Wall map display - Operator console - Control software - Database	1 set	·Control center equipment - Additional communication unit - Additional database	1 set	1 set	Fig. 20.3.5
	·Uninterruptible power supply system	1 set			1 set	Fig. 20.3.9
	·Air-conditioning system	1 set			1 set	Fig. 20.3.9
	·Terminal equipment - Signal and signal controller	28 sets	·Terminal equipment - Signal and signal controller	39 sets	67 sets	Fig. 20.3.6
	·Pavement markings	28 int.	·Pavement markings	39 sets	67 int.	
Closed circuit television system	·Control center equipment - Video receiver - Video switcher - Remote controller - TV monitor - Video cassette receiver	1 set (3 units)	·Control center equipment - Additional video receiver - Additional TV monitor	1 set (3 units)	1 set (6 units)	Fig. 20.3.5
	·Terminal equipment - TV camera - Camera controller - Video transmitter	3 sets	·Terminal equipment - TV camera - Camera controller - Video transmitter	3 sets	6 sets	Fig. 20.3.8
Training	·Training on system for system administrator ·Training on system and equipment for system operator		·Additional training on system for system administrator ·Additional training on system and equipment for system operator			
Spare parts	·Spare parts for signal and TV systems		·Spare parts for signal and TV systems			
Engineering service	·Detailed design of signal and TV systems ·Construction supervision		·Detailed design of signal and TV systems ·Construction supervision			

20.5 Cost Estimate

Costs of implementing the above plan are shown in Table 20.5.1. Costs have been estimated under the following assumptions:

1) One room in an existing building will be used as the control center.
2) Construction works that can be done domestically such as the interior of the center should depend on domestic resources to the maximum extent possible.
3) Although electronic equipment such as traffic signals will be imported, parts and materials should be procured domestically to the maximum extent possible.

Table 20.5.1 Cost Estimate of Traffic Control System

	Unity	Quantity		Amount		
		Stage 1-1	Stage 1-2	Pre-Stage 1 SP x 1,000	Stage 1-1 SP x 1,000	Stage 1-2 SP x 1,000
1. Signal system						
1.1 Control center					84,404	27,722
Central equipment	LS	1	1			
Software	LS	1	1			
Database	LS	1	1			
Timing parameter	LS	1	1			
Air-conditioning	LS	1				
UPS system	LS	1				
Control center interior	LS	1				
1.2 Intersection					167,126	196,258
Signal equipment	Intersects.	28	39			
Pavement marking	Intersects.	28	39			
1.3 Documentation	LS	1	1			
1.4 Training	LS	1	1			
1.5 Spare parts	LS	1	1			
2. TV system					16,100	13,081
2.1 Center equipment	LS	1	1			
2.2 Terminal equipment	Sites	3	3			
2.3 Optical fiber cable	Km	5.5	5.0			
3. Engineering service				42,178	35,578	
3.1 Detailed design	LS	1	1			
3.2 Construction supervision	LS	1	1			
Total Financial Cost (SP)				**42,178**	**321,901**	**256,119**

20.6 Estimation of the benefit of the ATC system

The travel time of the selected 12 routes shown in Figure 20.6.1 and Table 20.6.1 is calculated, 1st under the existing condition (without ATC) and 2nd after the installation of ATC system (with ATC) based on the result of the traffic survey.

The reduction in travel time by applying the ATC system is regarded as the benefit.
The calculation of the travel time was carried out for three different time periods:

Morning period between 7 and 10
Day-time period between 10 and 17
Evening period between 17 and 20

The sum of the travel time of all vehicles passing the route in those three periods were regarded as the one day total travel time, assuming the effect of the traffic during the rest of the day on the time saving is small. The traffic volume for the second case (with ATC) was assumed as the same as the first case for each route. The travel time for the second case was estimated under the following conditions.

a) The travel speed is constant along the whole length of each route, thanks to the control system.
b) On a route where the direction of the major flow changes from the morning to the evening, the offset was set individually for morning and evening.
c) On a route where the difference of the flow between morning and evening is not significant, equivalent offset was adopted.
d) For one way roads, travel speed is set on the basis of present traffic conditions.

The results of the calculation of total travel time for the 12 routes are shown in Table 20.6.1. The reduction of the travel time due to the ATC system ranges from 10 to 20 percent of total travel time.

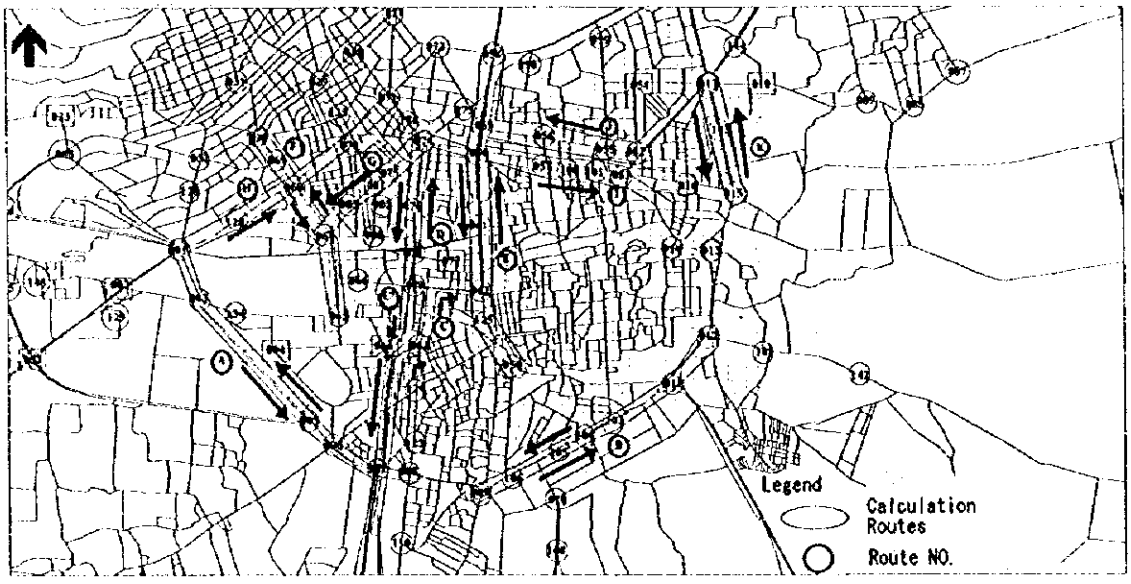


Figure 20.6.1 Calculation Routes

Table 20.6.1 Saving Time by ATC-System

Routes	Road Name	Distance m	Running time (A)	Estimated Running timeafter ATC installed (B)	Saving-Time (C)=(B)-(A)	Effect (C) / (A) %
A	Ring road (West)	2,219	4,964	4,426	-539	-10.9
B	Ring road (Cent.)	2,321	8,694	7,128	-1,566	-18.0
C	Naser & Ibn al Abbas	1,833	1,732	1,342	-390	-22.5
C'	Naser & Ibn al Abbas	1,890	2,360	2,125	-235	-10.0
D	29th May	1,227	2,453	2,120	-334	-13.6
E	Ath Thawra	1,990	6,731	6,227	-504	-7.5
F	Al Jalaa	1,205	2,142	1,884	-258	-12.0
G	M.ali Al Abed	1,283	1,387	1,279	-108	-7.8
H	Omar Ibn Abdjl	1,860	1,864	1,675	-190	-10.2
I	Baghdad	1,812	1,752	1,634	-118	-6.7
J	Morshed	1,179	1,343	1,203	-139	-10.4
K	Ring road (East)	683	1,663	1,340	-324	-19.5
Total	-	19,502	37,087	32,382	-4,705	-12.7

20.7 Conclusions

20.7.1 Conclusions

The area covered by the ATC system was selected along and within the ring road, based on the existing traffic congestion, such as intersections with a saturation degree of more than 0.9 or road sections with a travel speeds of less than 15 km/h.
In total 67 sets of signals and signal controllers, 6 sets of TV cameras, a control center with interface devices, computers and communication equipment etc. will be installed.

To assess the benefit of the ATC system. The travel time of the vehicles was calculated without and with the ATC system. The results of calculation show that the reduction of the travel time due to the ATC system is 13% of the total travel time on average. As further benefits of the ATC System, the following points can be mentioned.

a) The central control center can identify traffic conditions of all lines and can react efficiently to such emergency situations as traffic accidents or disasters by providing real time information.

b) The automated control system reduces the number of traffic officers on point duty and enables them to be placed in appropriate posts and to be used for other purposes.

The economic evaluation of the ATC system was carried out with other intersection improvement projects included in the feasibility study as one package. (See Chapter 19) The economic return of the package project shows feasible figures with a NPV of 2,770 Million SP and an EIRR of 13.6%.

20.7.2 Recommendations

1) The ATC project is economically feasible as mentioned in the preceding paragraph, and has an effect on the improvement of traffic congestion over a wide area with comparatively low investment. Thus, high priority should be given to this project and it is strongly recommended to start this project immediately with preparation of detail design and implementation plan and fund procurement.

   At-grade improvement of the intersections such as channelization has to be implemented simultaneously.

2) The ATC system requires the continuous support by capable staff in order to maintain its intended functions. Good traffic control cannot be realized by simply purchasing and installing the controllers. To benefit from the ATC system, the capability of the staff is essential. Training of the staff must cover both the theoretical aspects of traffic engineering and practical knowledge of traffic control and the devices used for it.

3) To use the ATC system effectively, exchanging information and cooperation between the traffic control organization and the road administration is essential. For example the data collected by the ATC system can be used for road planning or transport planning.

4) To improve the accuracy and reliability of the system, traffic data collected by the vehicle detectors must be accumulated and the database must be updated continuously. In future the installation of a system providing information to drivers such as on emergencies or traffic congestion is desirable.

5) To operated the ATC system effectively in Damascus, the improvement of the intersections, such as channelizations, or improvement of traffic regulations are indispensable. For this purpose inviting an adviser, who has a wide range of experience not only in the ATC system but also in traffic engineering generally, is recommended, before the implementation.