PART II

TOLL EXPRESSWAY SYSTEM

CHAPTER 6

EXPRESSWAY NETWORK DEVELOPMENT

CHAPTER 6

EXPRESSWAY NETWORK DEVELOPMENT

6.1 EXPRESSWAYS IN OTHER MEROPOLITAN AREAS

6.1.1 Characteristics of Other Metropolitan Areas

To obtain a dynamic picture of the transport system in a large-sized metropolitan area such as Cairo Greater Region (CGR), the following section presents a comparative analysis on different metropolises in advanced countries from the viewpoints of socioeconomic characteristics and the transport system as well, especially the motorway networks. Here, motorways are defined as limited access roads without intersections. Such metropolises are: London, New York, Paris and Tokyo. It should be mentioned that a broad analysis on such aspects shows that efficiency of transport systems depends to a great extent on the integration of land-use and transport planning, and suggests that there are ways in which the cities can draw lessons from each other in order to improve their transport systems in ways that minimize negative environmental impact and economic cost.

Since the cities vary in the size and area, they are divided into four comparable zones sharing similar spatial and demographic characteristics in order to be certain of measuring the comparative parameters. The collected data are summarized in Table 6.1-1, in which it will be noted that Paris, as a denser and smaller metropolis, does not extend to Zone 4. Under this comparative analysis, zones as shown in Figure 6.1-1 are defined in the metropolises as follows:

Zone 1 – The Central Area: the central business area of the city, which accommodates between 180,000 and 600,000 inhabitants.
Zone 1 & 2 – The Metropolitan Area: the densely built-up areas of the city, which accommodates approximately 7 to 9 million inhabitants.
Zone 1, 2 & 3 – The Outer Metropolitan Area: a commuter hinterland, which accommodates approximately 10 to 13 million inhabitants.
Zone 1, 2, 3 & 4 – The Region: the entire region, with at least 17 million inhabitants.

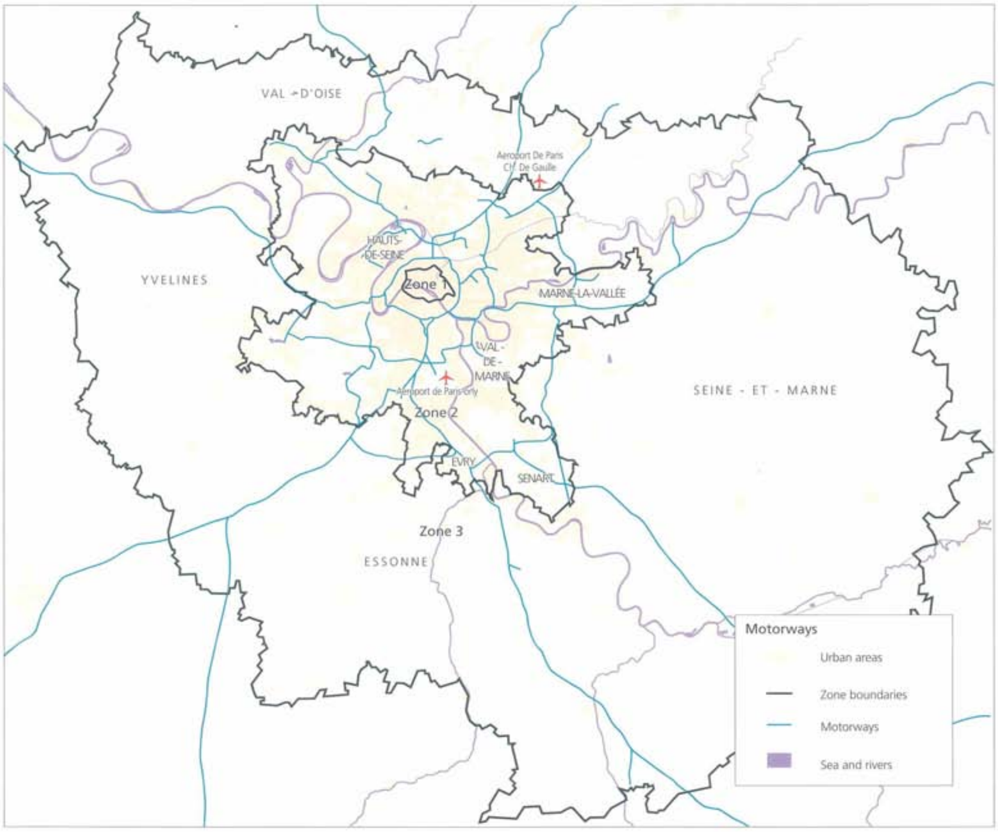
Table 6.1-1 Major Characteristics of Metropolitan Areas

	London	New York	Paris	Tokyo	Cairo
Population ('000)					
Zone 1	177	543	622	266	400
Zone 1 & 2	6,852	7,497	8,791	8,164	7,069
Zone 1, 2 & 3	11,606	13,526	10,661	11,856	14,391
Zone 1, 2, 3 & 4	17,549	19,843	-	31,797	-
Surface Area (Square kilometers)					
Zone 1	27	23	29	42	17
Zone 1 & 2	1,578	757	2,060	617	293
Zone 1, 2 & 3	10,385	5,793	12,011	1,777	1,885
Zone 1, 2, 3 & 4	27,224	33,165	-	13,143	-
Population Density (Persons per square kilometers)					
Zone 1	6,490	23,610	21,450	6,330	23,564
Zone 1 & 2	4,340	9,900	4,270	13,230	24,098
Zone 1, 2 & 3	1,120	2,330	890	6,670	7,636
Zone 1, 2, 3 & 4	640	600	-	2,420	-
Employment ('000)					
Zone 1	917	1,967	1,025	2,381	17
Zone 1 & 2	3,349	4,132	4,494	7,249	293
Zone 1, 2 & 3	5,279	7,444	5,075	8,628	1,885
Zone 1, 2, 3 & 4	7,775	10,674	-	16,441	-
Car Ownership (vehicle per household)					
Zone 1	0.54	0.22	0.49	-	-
Zone 2	0.83	0.63	0.91	0.47	-
Zone 3	1.22	1.65	1.33	0.74	0.34
Zone 4	1.08	1.83	-	0.96	-
Number of Metro and Rail Stations					
Zone 1	68	90	133	67	9
Zone 1 & 2	576	521	575	392	46
Zone 1, 2 & 3	845	742	732	532	91
Zone 1, 2, 3 & 4	1,018	888	-	1,306	-
Length of Motorways/Expressways in kilometers					
Zone 1	0	8	5	43	-
Zone 1 & 2	62	345	436	185	-
Zone 1, 2 & 3	n/a	1,343	782	224	-
Zone 1, 2, 3 & 4	6,643	2,996	-	911	-
Density in Motorways/Expressways kilometers per square kilometers of land area					
Zone 1	0.0	0.78	0.17	1.02	-
Zone 2	0.04	0.46	0.21	0.25	-
Zone 3	N/a	0.20	0.03	0.03	-
Zone 4	0.05	0.06	-	0.06	-

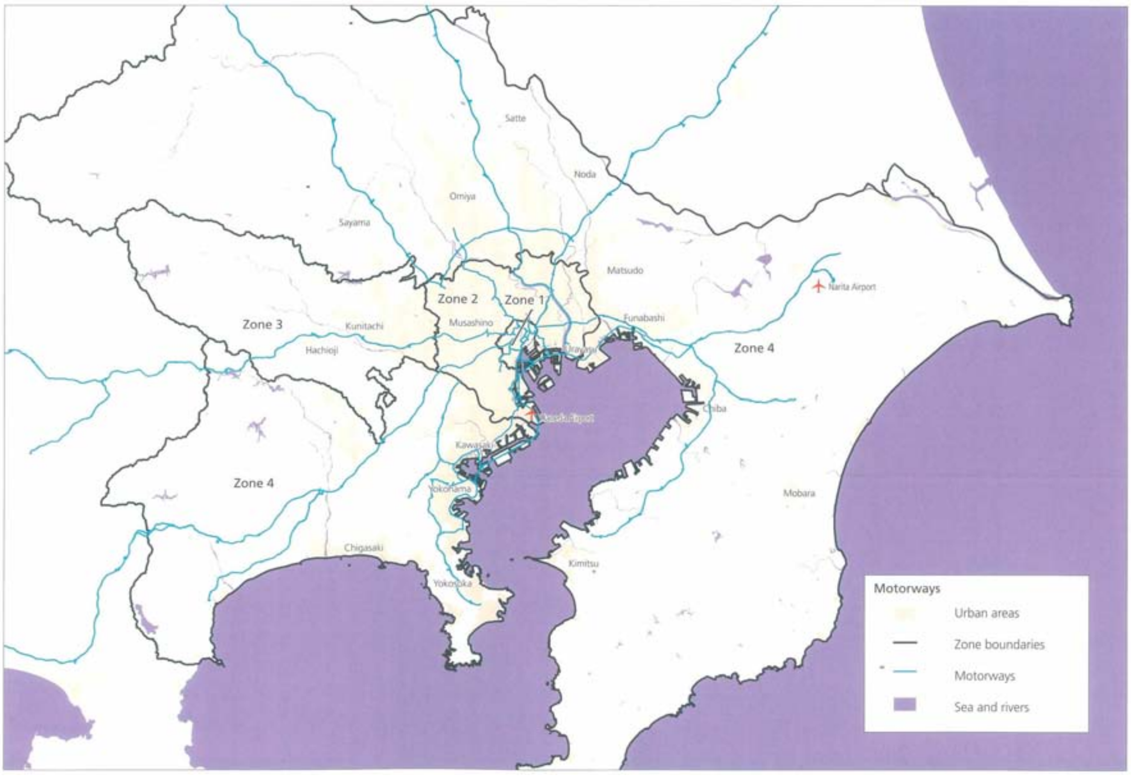
London

New York

Figure 6.1-1 Metropolitan Area Zoning System (1/3)

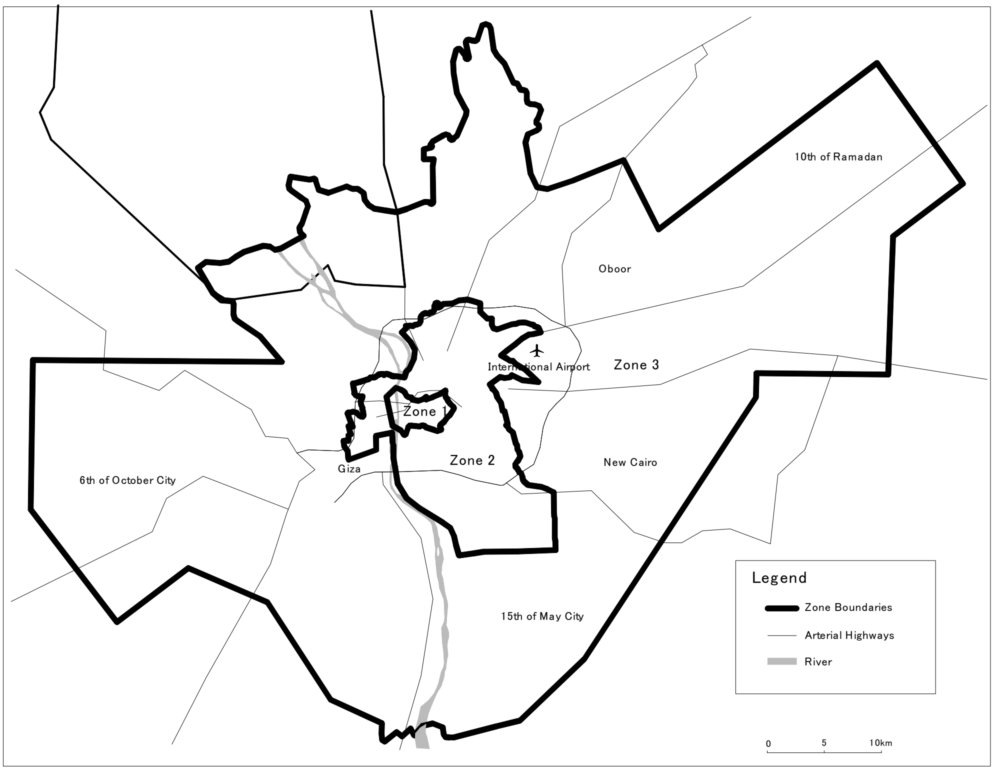


Paris



Tokyo

Figure 6.1-1 Metropolitan Area Zoning System (2/3)



Cairo

Figure 6.1-1 Metropolitan Area Zoning System (3/3)

6.1.2 Motorway Network

Whilst all the cities have a developed motorway/expressway network in their region, New York is the city with the largest and densest network. London has no motorways in the city center, which is under a pricing system at present. Tokyo has numerous toll motorways, most of which are elevated on multiple tiers. Paris and Tokyo are still continuing to build new motorways in their regions.

New York has by far the most motorway kilometers compared with other cities. Well over half are in Zone 4 and a third in Zone 3. Tokyo also has a substantial urban motorway network. What differentiates Tokyo is its urban expressways in Zone 1 with the length of 34 kilometers for a density of about 1.0 motorway kilometer per square kilometer of land area. Many of Tokyo's elevated urban expressways run through relatively narrow streets or on top of canals or railway commuting lines. New York has only 8 kilometers of motorways in Zone 1, Paris 5, and London none.

In Zone 2, both New York and Paris have more than twice the motorway length of other cities, but in Zone 2 Paris' motorway density is half that of New York's and about the same as Tokyo's. London has a low motorway density and, instead, facilitates vehicle movement from Zone 2 to Zone 1 by enforcing strict parking controls, optimizing signalization on nearly 500 kilometers of roads and introduced pricing system for access to Zone 1. In New York, Zone 2 motorways are generally radial, funneling much regional traffic through New York City, across a limited number of crossings of the waterways that separate all the boroughs of the city. Of the 20 river crossings into Manhattan, 6 crossings are tolled.

In Zone 3, New York and Paris have many more motorway kilometers than the other two cities, but when adjusted for area, New York has seven times the motorway density of Paris and Tokyo. Many of the 1,343 kilometers of motorways in New York's Zone 1, 2 & 3 experience recurring congestion in the morning peak. In Zone 4, New York again has by far the most motorway kilometers, but the density of New York's motorways is strikingly similar to that of London and Tokyo. Although London has a low density of motorways in Zones 3 and 4, it has a large number of dual carriageway roads.

Another significant difference among the four regions is that, while New York and London are not building any significant additions to the motorway system, both Paris and Tokyo are engaged in long-term programs to build significant new routes, either orbital as in Paris or central loops of the urban expressways in Tokyo.

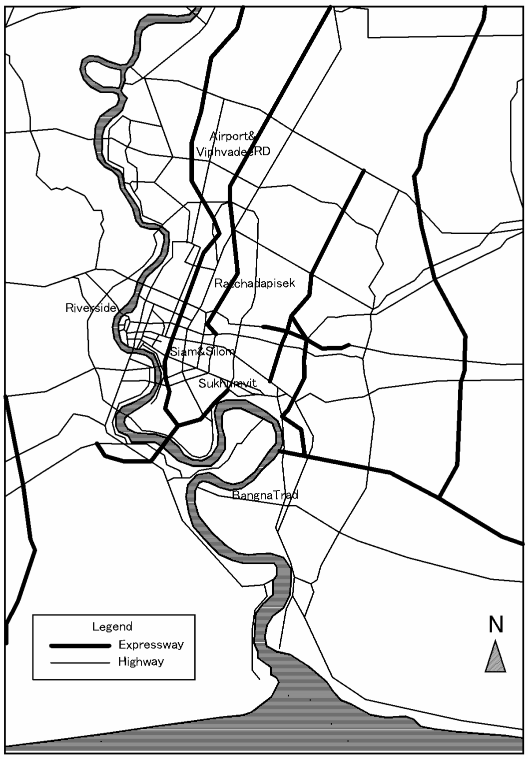
6.1.3 Urban Expressways in Asian Developing Countries

The governments of many developing countries in Asia have been keen to develop urban expressway network as well as nation-wide expressway network. Such countries include China, Thailand, Malaysia and Indonesia. These governments consider that well developed expressway network is indispensable for socioeconomic development of the nation. Values of GDP per capita of these countries, as indices of economic development, and total length of urban expressway networks are shown in Table 6.1-2, which actually do not show direct relationship. As an example, Figure 6.1-2 shows urban expressway network of Bangkok, Jakarta and Kuala Lumpur.

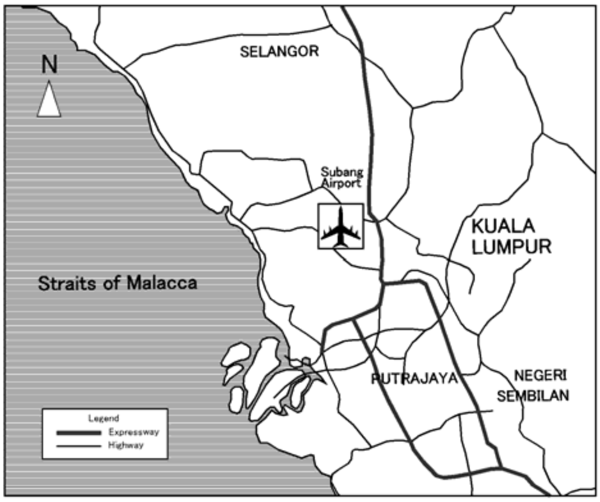
Table 6.1-2 GDP per Capita of Asia of Some Developing Countries and Urban Expressway Network

City, Country	Bangkok (Thailand)	Jakarta (Indonesia)	Kuala Lumpur (Malaysia)
GDP/Capita (US$) *	2,000	710	3,540
Length of Urban Expressway Network in Operation (km)**	108.1 (1998)	75 (2000)	51 (2000)

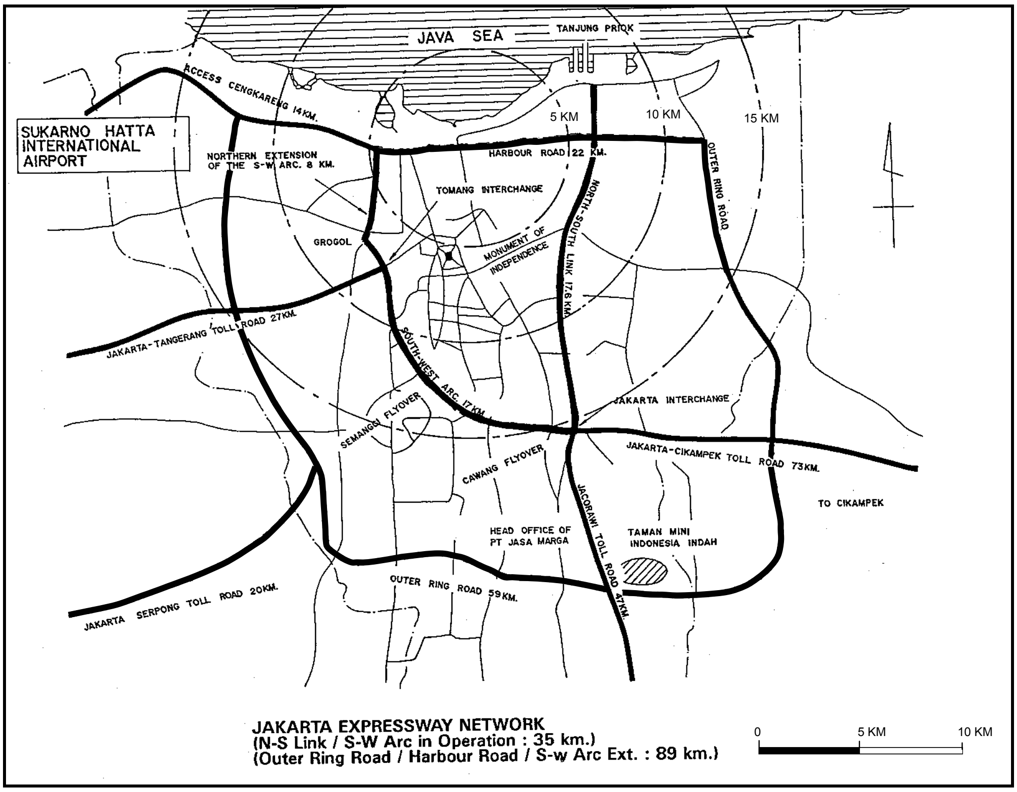
Source: *Key Indicators 2004, Asian Development Bank,
**Highways of the World, 1999 (Japanese), Express Highway Research Foundation of Japan



Bangkok



Kuala Lumpur



Jakarta

Figure 6.1-2 Urban Expressway Network of Bangkok, Jakarta and Kuala Lumpur

6.2 URBAN EXPRESSWAY PLAN

An urban expressway network proposed in CREATS consists of new construction of 7 lines with a total length of 78.3 km in addition to the existing ones. The total project cost for the new construction was preliminarily estimated at approximately EL 9 billion or US$ 1.3 billion.

The Cairo Urban Toll Expressway Network planned in CREATS Master Plan was subject first to comprehensive field survey and review in order to verify the engineering feasibility and to establish the basis for the preliminary cost estimates for the economic analysis and preparing the financial plan and other aspects for PPP schemes.

No detailed information, such as the configurations of interchanges, the necessity for acquisition of additional land (right-of-way) and road structure to traverse the difficult section, was presented. Information on the probable physical structures of the expressways is necessary in this Study from the following main points of view:

(i) To verify the engineering feasibility of the proposed urban expressway network.
(ii) To establish the basis for the preliminary cost estimates for preparing the financing plan and other aspects required in preparation of PPP plans.
(iii) To identify any environmental issues, especially the necessity for acquisition additional right-of-way (ROW) and associated social impacts.

Therefore, the probable physical structures of the expressways to enable actual construction of the expressways are discussed in the following sections.

Note: In the following discussions, the used terminologies are as defined as follows;

Interchange: *An entire structure of expressway section connecting one expressway with another.*

Ramp: *The word "ramp" is used to mean exit from, and entrance to, expressway to, or from, the adjacent at-grade street. A ramp for entrance to an expressway is referred to as "on-ramp" while a ramp for exiting from an expressway is referred to as "off-ramp" in this Chapter. The word "ramp" is also used to mean the part of an expressway which connects one expressway with other one at an interchange. However, in this case, the word "ramp of interchange" shall be used.*

6.2.1 Proposed Expressway Network

Some modifications in the expressway network were done to improve its function and links that omitted from "Do Maximum" were investigated in order to clarify their necessity in the network. Figure 6.2-1 shows the proposed overall plan subject to review and comprehensive evaluation techniques in order to conclude the optimum network required up to the target year 2022. Components of the network are presented in Table 6.2-1.

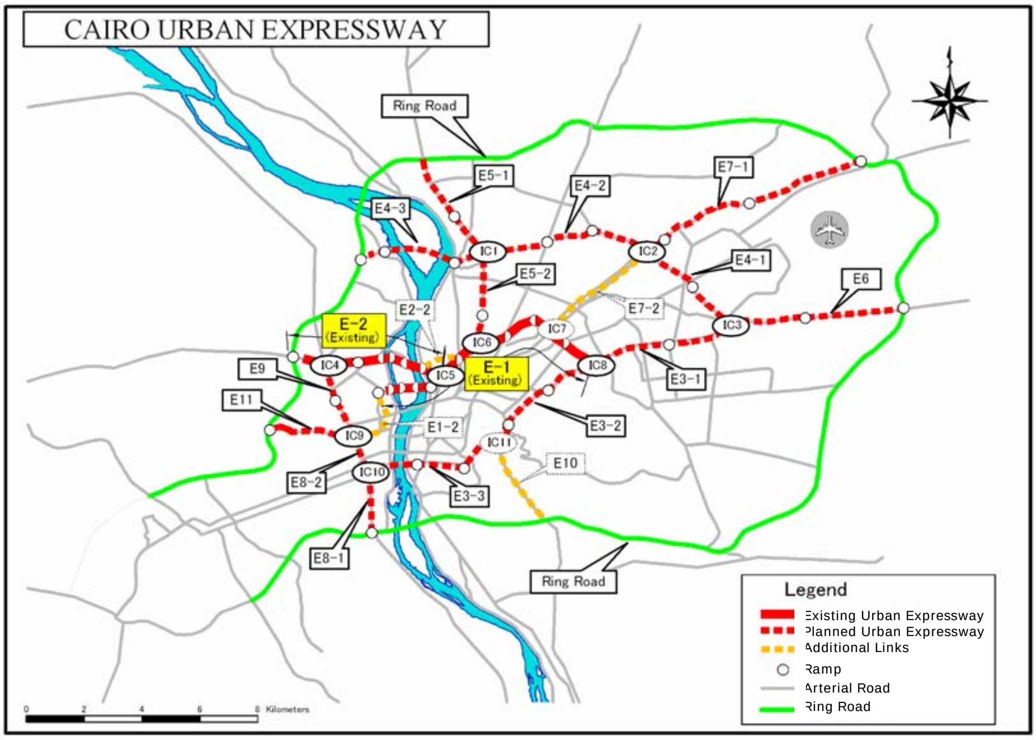


Figure 6.2-1 Proposed Cairo Urban Toll Expressway Network

Table 6.2-1 Components of Proposed Network

Route	Length km	Location	Remarks
E1-1	13.1	6th of October	Existing
E1-2	2.1	6th of October Extension	Newly Planned
E2-1	4.5	15th of May	Existing
E2-2	1.2	15th of May Extension	Newly Planned
E3-1	6.8	Autostrad El Nasr Street in Nasr City	
E3-2	5.8	Autostrad from Nasr City to Citadel	
E3-3	6.9	Salah Salem from Citadel to Giza Sq.	
E4-1	4.7	Abu Bakr El-Sedeeq	
E4-2	7.5	Ibn El hakam – El Matariyah	
E4-3	5.3	Tereat Ismailia – Al Warraq	
E5-1	5.7	Cairo-Alexandria Agriculture Road	
E5-2	5.3	Ahmad Helmi Street	
E6	7.5	Cairo-Suez Road	
E7-1	11.0	Gesr El Suez (Ismailia Desert)	
E7-2	5.3	Qubri El Kobbah	Omitted in CREATS
E8-1	3.0	Tereat El-Zumur South of King Faisal	
E8-2	1.7	Tereat El-Zumur North of King Faisal	
E9	4.0	Tereat El-Zumur in Bolaq el Dakroor	
E10	4.0	From Autostrad to Ring Road	Omitted in CREATS
E11	3.1	From Tereat El-Zumur to Ring Road	
Total	108.5		

Under this network, newly planned sections have the following justifications:

E1-2: To connect the existing E1 to E8, E9 and E11 providing an inner ring road function and east-west corridor that will alleviate heavy traffic on the at-grade network.

E2-2: To provide the opposite direction for the existing one-way section of E2 between E1 and the May 15 Bridge.

These two sections are necessary especially in the case of applying toll on the existing E1 and E2 to improve the function of the network as a whole and to generate revenue that can be used in the sustainable development of the network based on the results of the financial analysis and established cash flow.

6.2.2 Optimum Expressway Network

Several cases of traffic assignment were applied on the proposed expressway network to estimate the traffic demand on each section and to investigate the impact of implementing the elevated network on the at-grade street network. Based on the traffic assignment results of future demand, the two sections omitted in CREATS plan were separately investigated and the results are presented in Figure 6.2-2 for the section E7-2 and Figure 6.2-3 for the section E10.

Regarding the section E7-2, the two cases, of with and without this section, show great impact on the existing E1. It is clear that with this section, the existing E1 will face severe congestion with a V/C over 1.5 which means a low level of service. This result may show the necessity of constructing a second E-1 in a parallel corridor to the existing one in the future. In addition, it will affect the landscape and natural environment in the area. In the mean time, the traffic flow without this section does not show any large demand on other sections as it will be distributed on many sections instead of concentration on E7-2. It was concluded that this section may be constructed in later years after the target year of 2022.

As for the second omitted section of E10, it did not show any high demand due to the low development potential in the mountainous areas south-east of Cairo. This section also was omitted and may be constructed in later years after the target year of 2022. The optimum expressway network is concluded to be as presented in Figure 6.2-4 while the components of the optimum network are presented in Table 6.2-2.

6.2.3 Links for Later Years

The optimum network is planned to be implemented until the target year 2022. The two sections, E7-2 and E-11, which are omitted from the optimum plan are proposed to be considered for implementation in later years after 2022. Therefore, these two sections are included in the cost estimation process and other engineering aspects.

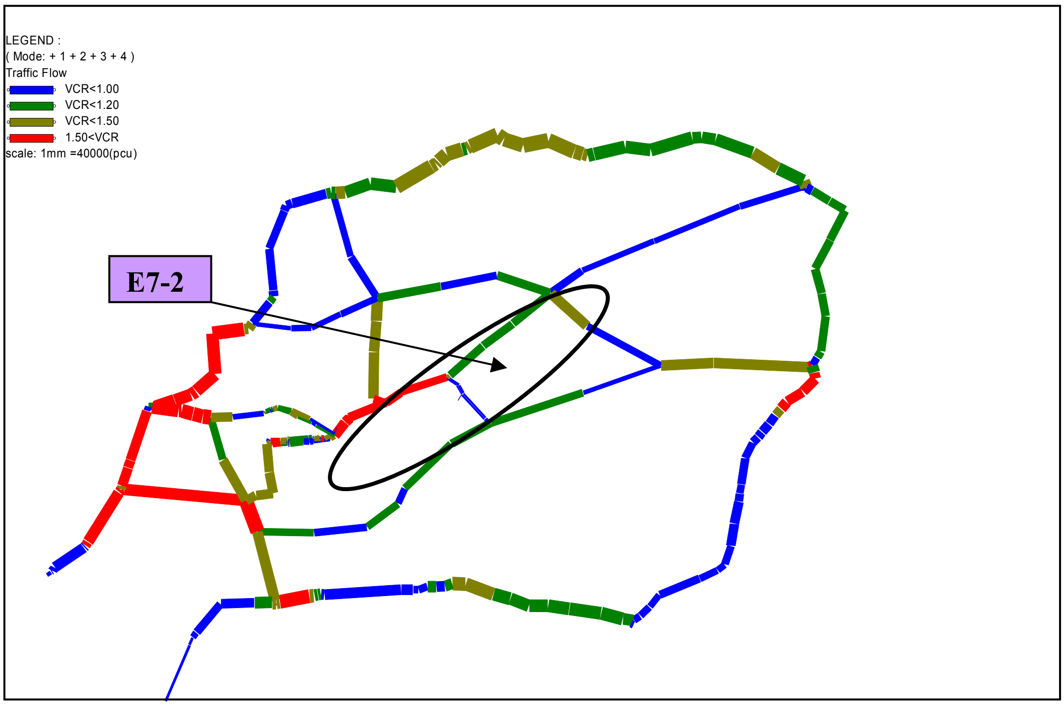


Figure 6.2-2 Assigned Traffic Volumes with E7-2 - 2022

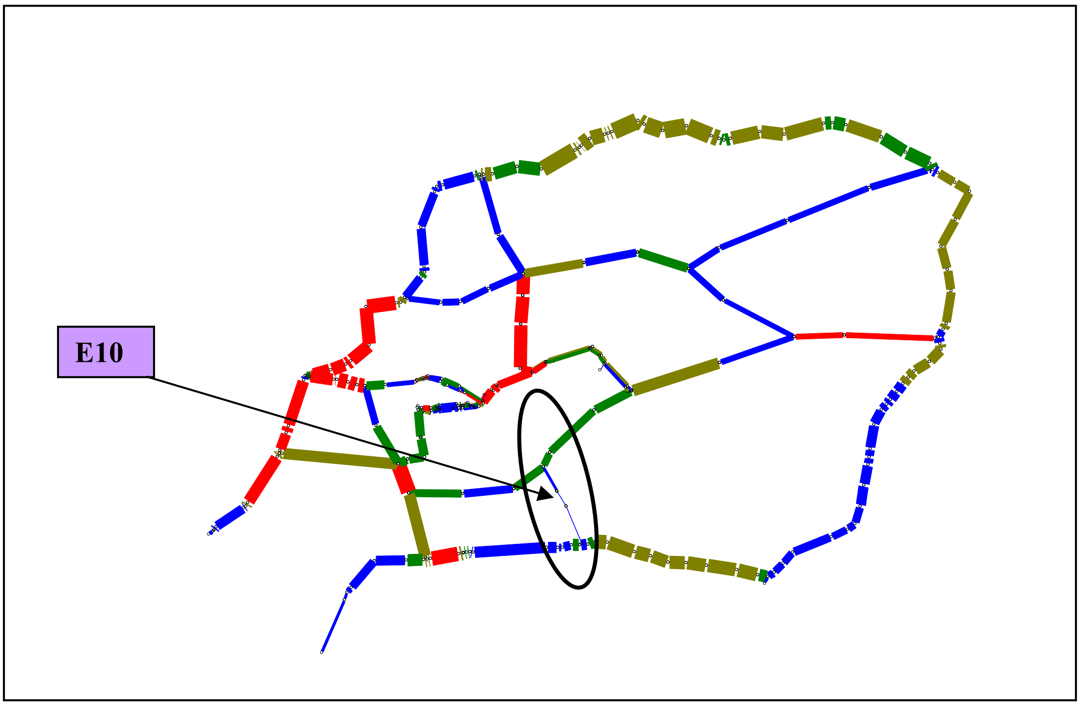


Figure 6.2-3 Assigned Traffic Volumes of E10 - 2022

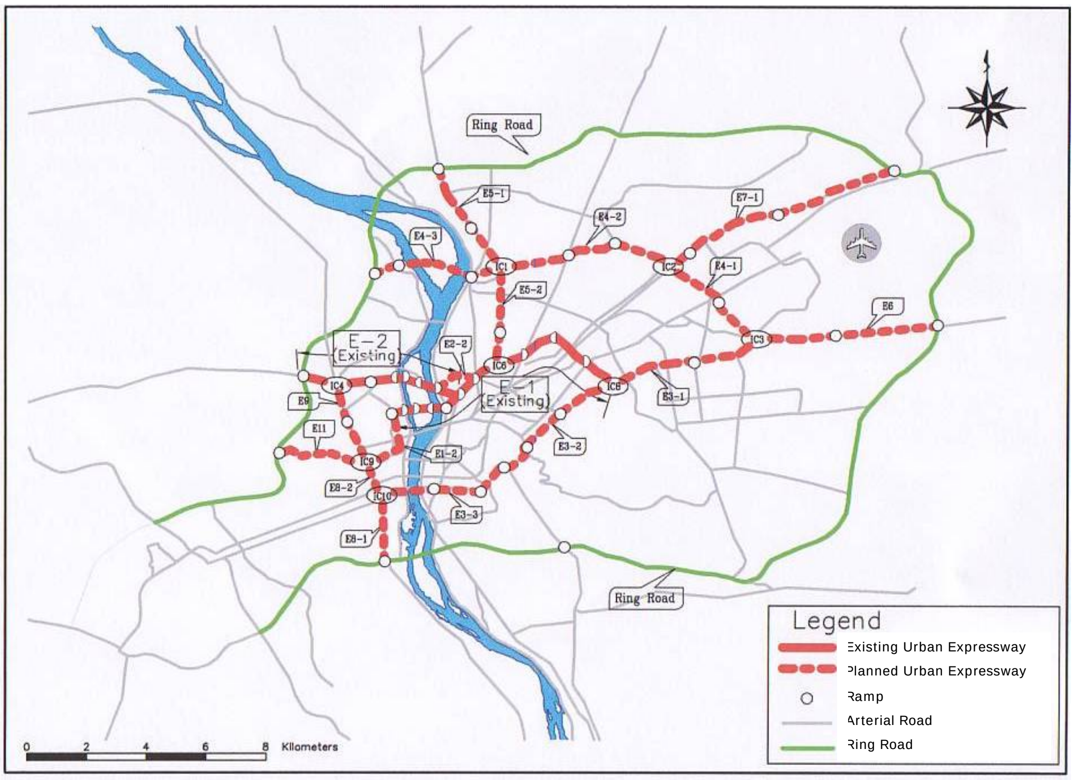


Figure 6.2-4 Optimum Expressway Network – 2022

Table 6.2-2 Components of Optimum Expressway Network – 2022

Route	Length km	Location	Remarks
E1-1	13.1	6th of October	Existing
E1-2	2.1	6th of October Extension	Newly Planned
E2-1	4.5	15th of May	Existing
E2-2	1.2	15th of May Extension	Newly Planned
E3-1	6.8	Autostrad El Nasr Street in Nasr City	CREATS Plan
E3-2	5.8	Autostrad from Nasr City to Citadel	CREATS Plan
E3-3	6.9	Salah Salem from Citadel to Giza Sq.	CREATS Plan
E4-1	4.7	Abu Bakr El-Sedeeq	CREATS Plan
E4-2	7.5	Ibn El hakam – El Matariyah	CREATS Plan
E4-3	5.3	Tereat Ismailia – Al Warraq	CREATS Plan
E5-1	5.7	Cairo-Alexandria Agriculture Road	CREATS Plan
E5-2	5.3	Ahmad Helmi Street	CREATS Plan
E6	7.5	Cairo-Suez Road	CREATS Plan
E7-1	11.0	Gesr El Suez (Ismailia Desert)	CREATS Plan
E8-1	3.0	Tereat El-Zumur South of King Faisal	CREATS Plan
E8-2	1.7	Tereat El-Zumur North of King Faisal	CREATS Plan
E9	4.0	Tereat El-Zumur in Bolaq el Dakroor	CREATS Plan
E11	3.1	From Tereat El-Zumur to Ring Road	CREATS Plan
Total	99.2		

Note: It should be noted that implementation of the 2 links of E7-1 and E10 are postponed to years after 2022.

6.3 CROSS-SECTIONS AND VIADUCT PLANS

6.3.1 Typical Cross-Section of Expressway

In preparing the above Typical Cross Sections, the following factors are taken into consideration:

(1) Number and Width of Lanes

Although 4-lane structure are proposed in CREATS, 6-lane cross-section are required for some sections in this Study. Traffic volumes on the expressways (year 2022) forecasted in Chapter 5 exceeds 50,000 pcu/day/direction, which is considered to be the capacity of a divided 4-lane freeway, on some sections of the expressway network. Accordingly, divided 6 lanes will be necessary to accommodate sections with high traffic volume.

Although 3.6 m is stipulated in the “Egyptian Code” as the standard lane width for urban highways, 3.25 m of lane width was proposed in CREATS. This Study supports the proposal of CREATS and adopts this value as the standard for the elevated expressway, to reduce the cost and necessity of land acquisition.

Figure 6.3-1 presents typical cross sections for the proposed basic viaduct on different levels of the road; elevated, submerged and at grade. Other typical cross sections for the case of 6 lanes viaduct are included in Appendix 6.1.

(2) Right-Of-Way (ROW) of Existing Street

All the proposed expressways traverse densely populated areas. Any acquisition of additional land may cause serious social impact. Therefore, the width of the expressway needs to be as narrow as possible when it is to be constructed along the existing street where the available space is limited. For this reason, double-deck type of structure may be adopted. (Appendix 6.1, Figures A6.1-6 and A6.1-7) Other measures to construct the expressways along the narrow streets include adoption of “gantry-type piers”. (Appendix 6.1, Figures A6.1-5 and A6.1-7)

(3) Preservation of Urban Amenities and Views

Many of the major streets in Cairo have beautifully maintained green belts at the median divisions and along the sidewalks. Of course, it is desirable to preserve these green belts. In such case, separated viaduct (Appendix 6.1, Figure 6.1-4) is often effective. In the cases where preservation of view is specially important, such as the case of the section of E3 Expressway in front of the Memorial Monument for the late President Naser, half-underground structure is effective to prevent the obstruction of view. Half under-ground structure is recommended to prevent concentration of exhaust gas of vehicles which occurs at the both end of tunnel. Therefore, where necessary, complete covered structure (tunnel) is technically feasible, as a matter of course.

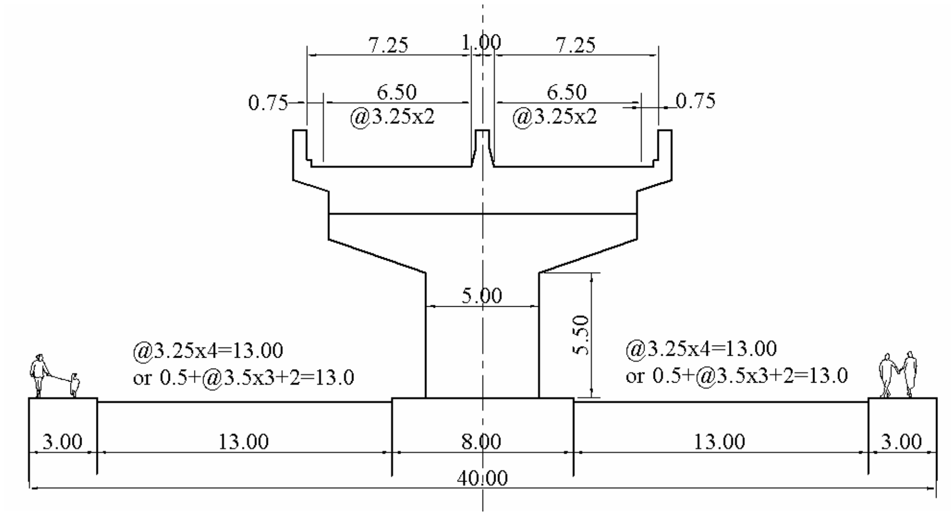
(4) Utilization of the Space Above City Tram

There are many lines of city trams in Cairo. The space above them can be used as the space for the proposed expressways. Gantry-pier type of structure (Appendix 6.1, Figure A6.1-5) fits in such occasion.

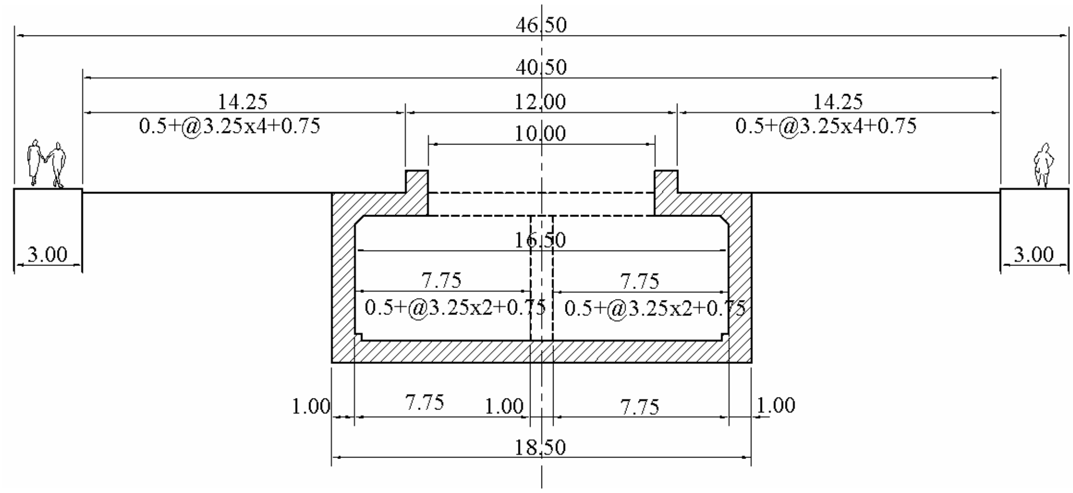
To cope with the various constraints of available space along the proposed routes and to fit the desired alignment within the available right-of-way, various types of typical cross-sections have been prepared in this Study as explained above and shown in Appendix 6.1. In principle, the expressways are to be constructed on viaducts. There are three main reasons for this:

(i) To cross the existing roads (intersections), railroads and other facilities with grade-separated structure.
(ii) To separate the traffic on the expressway and that on the adjacent street.
(iii) To secure sufficient space for the traffic on the street where the expressway is constructed.

Figures 6.3–1 show the typical cross-sections and Table 6.3-1 summarized their characteristics.

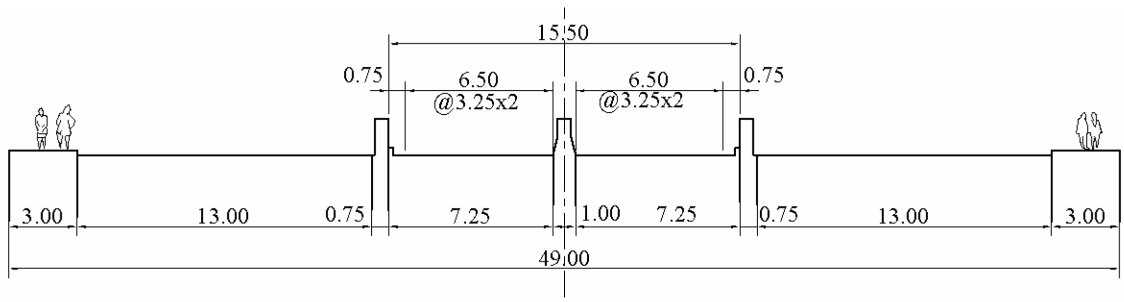


(a) Standard Viaduct Section

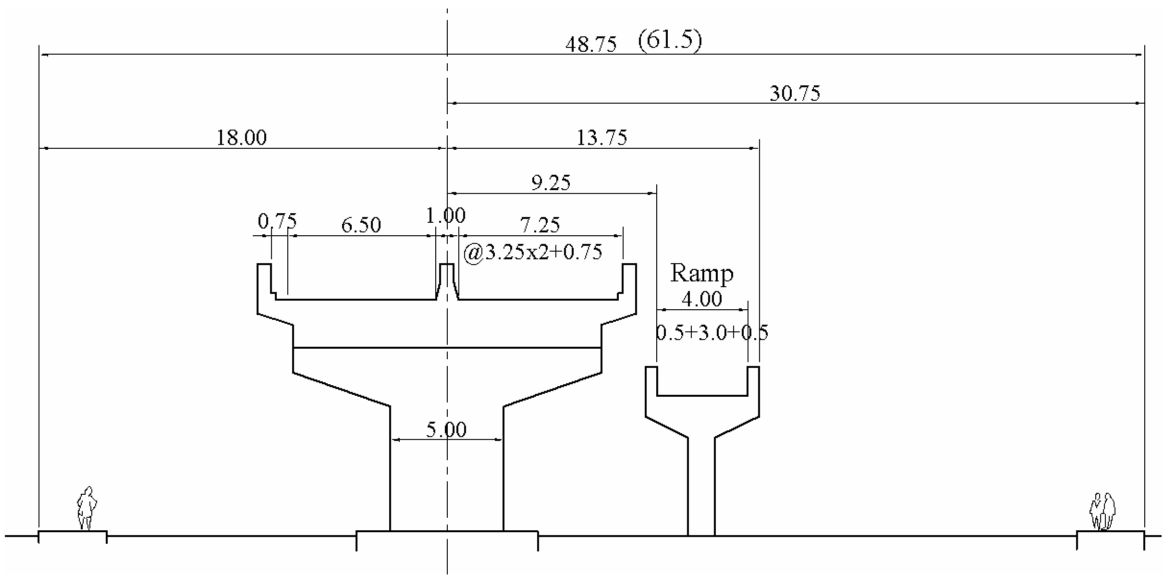


(b) Half-Underground Section

Figure 6.3-1 Typical Cross Sections (1/2)



(c) At-Grade Section



(Toll Gate is located under the nearby Viaduct. The width 4.0m is the minimum width allowed for ramps, however, wider widths are recommended based on available ROW)

(d) Section with On-/Off-Ramp

Figure 6.3-1 Typical Cross Sections (2/2)

Table 6.3-1 Summary Table of Advantages and Disadvantages of Different Types of Typical Cross Section

Type	Name	Advantage	Disadvantage	Example of Application
Type 1 (Figure 6.3-1 (a))	Standard Viaduct	- Relatively Low Cost - Lanes of opposing direction can be used in emergent cases such as accident or repair works. - The space between the piers can be used for turning lanes or parking space.	- Wide median division is necessary on the street below the expressway. - Carriageways of both directions needs to be adjacent with each other resulting in less degree of freedom in designing horizontal and vertical alignments.	- Section of E4 between Interchange with E6/E4 and A'Tayaran Street
Type 2 (Figure 6.3-1 (c))	At-Grade	- Low cost - No obstruction to view	- Wide ROW is necessary - Crossing of pedestrians becomes difficult (unless pedestrian crossing facility is provided).	- Transition section between Type 1 and Type 3
Type 3 (Figure 6.3-1 (b))	Half-Underground	- No obstruction to view - No concentration of exhaust gas at the both end (in comparison to tunnel structure). - The space above the covered part can be used as the lanes of the adjacent street.	- Closure of the street above the structure during the construction - Relatively high construction cost and maintenance cost (for lighting during daytime)	- E3 in front of Memorial Monument for the late President Sadat
Type 4 (Appendix 6.1, Figure A6.1-4)	Separated Viaduct	- Relatively high degree of freedom in designing of horizontal and vertical alignments - Space between piers can be used as the parking space or for commercial activities. - Sunlight can reach the median division allowing preservation of greenbelt at the median division.	- Relatively wide space is required under the viaduct on the outer sides of the piers.	- Almost entire section of E7
Type 5 (Appendix 6.1, Figure A6.1-5)	Gantry-Pier Viaduct	- The space below the expressway can be used efficiently. - The expressway can be constructed within the width of the gantry piers. - Space between piers can be used as the parking space or for commercial activities.	- May hinder the "openness" of, and sunlight to, the street below. - Piers are constructed close to the buildings along the street.	- Section of E4 along Husayn Kamil Silim Street (between STA 0+300 and 1+700)
Type 6 (Appendix 6.1, Figure A6.1-6)	Single-Pier Double-Deck	- Can be constructed where space is limited.	- High construction cost - Large height of the structure may be obstacle - The space below the expressway is largely occupied by the pier	- Section of E3 crossing Nile River beside the existing bridge
Type 7 (Appendix 6.1, Figure A6.1-7)	Gantry-Pier Double-Deck	- Can be constructed where space is limited. - The space below the expressway can be used efficiently	- High construction cost - Large height of the structure may be obstacle to view	- Section of E3 along A'Rawdah St. and A' Ahram St.

It should be noted that the dimensions of structures shown in the figures of typical cross sections are arbitrary and assumed on the conservative side (large size). Actual sizes of the structure may vary substantially depending on the site conditions.

The advantages and disadvantages of these typical cross sections are summarized in Table 6.3-2.

As described in Section 6.4, the widths and other physical conditions, and roadside land use of the existing streets along which the proposed expressways are to be constructed were surveyed by the local consultant employed by the JICA Study Tem. Based on the results of these surveys, as well as the site condition surveys conducted by the members of the JICA Study Team, one of the typical cross sections described above was selected for each section of the expressways. The types of typical cross sections selected for various sections of the proposed expressways are described in Section 6.4.

It should be noted that the typical cross sections shown in Figures 6.3-1 and Appendix 6.1 do not cover all the types of expressway structures assumed in the discussions in the subsequent sections. To cope with the actual site conditions, these typical cross sections are assumed to be modified, and sometimes combined with each other.

6.3.2 Transition Section

When the height of viaduct becomes lower and the clearance below the viaduct becomes smaller than the standard clearance as stipulated in the Egyptian Code (such as 6 m above the surface of street at the sofit of the viaduct), the space below the viaduct of expressway cannot be used as a part of the carriageway of the street. To maintain consistency of the number of lane of the street, the ROW of such section needs to be wider.

This situation occurs when the structure of the expressway changes from viaduct to at-grade. Similar transition occurs between at-grade section and half-underground (or underground) section.

The typical cross sections for transition sections between viaduct and at-grade and at-grade and half-underground, respectively, are presented in Appendix 6.1.

In planning profiles (vertical alignments) of the expressways, these transitions sections need to be planned at the locations where sufficient ROW can be secured.

6.3.3 On-Ramp and Off-Ramp

In case of an urban expressway constructed along a street, entrance and exit ramps (on-ramps and off-ramps) of the expressway are connected to the street along which the said expressway is constructed. Therefore, there is relatively high degree of freedom in selecting these exits and entrances (on-ramps and off-ramps).

On the other hand, the space under the ramps cannot be used as a part of the carriageway for the street running parallel to the expressway. Therefore, similarly to the cases of transition sections described in Subsection 6.3.2 above, ROW wider than the ordinary section is needed to construct on-ramps and off-ramps.

Appendix 6.1 illustrates examples of wider ROW required for constructing on-ramps and off-ramps at viaduct and at-grade sections, respectively. This necessity for wide ROW is taken into consideration when exit from, and entrance to, an expressway are planed.

6.4 ROUTE AND ALIGNMENT

6.4.1 Routes of Proposed Expressways

The routes of the expressways proposed in CREATS generally follow those of the existing streets, or the proposed expressways are to be constructed along the existing streets utilizing the ROW of these streets (Please refer to Figure 6.2-2).

These streets generally constitute main corridors of urban street network of the Greater Cairo and are considered to be appropriate routes for the urban expressway network. The preliminary topographic survey was conducted under this Study with employing a local survey company. The plan and cross sections of the said streets are shown in Appendix 6-2. It should be noticed that details of structures in relation to utilities are not considered at this early stage.

Owing to the generally preferable alignments of these streets, the horizontal alignments of the proposed expressways generally have relatively few problems. In examining the horizontal alignment, design speed of the expressways was assumed to be 80 km/h. When application of the typical cross sections as described in Suction 6.3 above, however, the cross sections with relatively high cost, such as “double-deck” type. Also, the vertical alignments often become considerably high to over-pass the existing fly-overs, viaducts and bridges.

Probable vertical alignments and typical cross sections of the proposed expressways (E3 to E9) are schematically shown in Appendix 6.3 (from 6.3.1 to 6.3.7). Typical cross sections applicable, probable vertical alignments and problems of these routes are described in the following subsections. It should be noted that some of these figures are drawn not starting from Station No. This is to make the direction of the drawing coincide with the direction of the streets shown on the ordinary street maps (with the north as upwards), while Station Nos. were set starting from Ring Road when the local surveyor surveyed. It also should be noted that Station Nos. in Plan and Profile sometimes differ from those shown in the topographic map in Appendix 6.2, due to convenience of survey practices at some locations where existing roads are interrupted along the expressway alignment.

6.5 INTERCHANGES, RAMPS AND PARKING

6.5.1 Interchanges

As stated in Section 6.2, the word "interchange" is used to refer the part of expressway connecting one expressway with the other. In the urban expressway network proposed in CREATS, a total of 11 interchanges were proposed (Figure 6.5-1). Table 6.5-1 lists these interchanges with the expressways connected at these interchanges.

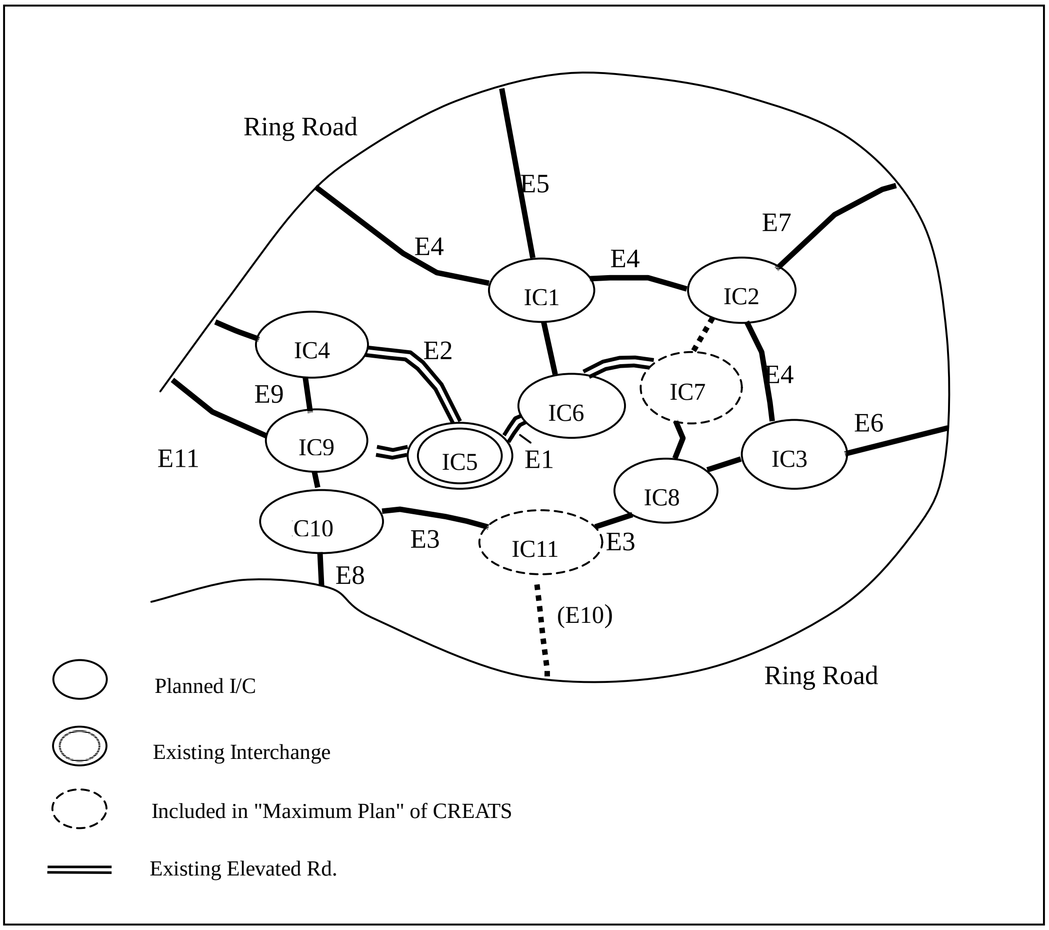


Figure 6.5-1 Schematic Illustration of Connection of Expressways and Interchanges

Table 6.5-1 List of Interchanges of Expressway Network

IC No.	Connected Expressway	Remarks
IC 1	E4 + E5	
IC 2	E4 +E7	
IC 3	E3 + E4 + E6	
IC 4	E2 + E9	
IC 5	E1 + E2	
IC 6	E1 + E5	Existing but in a incomplete form
IC 7	E1 + E7	Included in "Maximum Plan
IC 8	E1 + E3	
IC 9	E3 + E9	
IC 10	E3 + E8	
IC 11	E3 + E10	Included in "Maximum Plan

IC 7 and IC 11are the interchanges needed for the extension of E7 and connection of E10, respectively, which are included in the “Maximum Plan” of CREATS but not included in the “Optimum Plan”. Therefore, these interchanges are not discussed in detail.

IC 5 is the existing interchange connecting E1 (existing) and E2 (existing). However, the traffic can flow only from E1 to E2 and cannot come back from E2 to E1 at IC 5. In this sense, IC 5 is not in a complete form and needs improvement.

In this subsection, configurations of ICs 1, 2, 3, 4, 6, 8, 9 and 10 are discussed in detail in Appendix 6.4, while discussion on IC 5 mainly focuses on improvement measures.

Many of the interchanges are located at places with various physical constraints for spaces such as existence of fly-overs and bridges. Physical constraints at these locations are shown in the maps of interchanges included in Appendix 6-1.

In planning the configuration of interchanges, considerations were given to the following points:

(1) Conservation of existing fly-overs and bridges

In many cases, the location of interchange coincides with the intersection of the major streets along which the proposed expressways are to be constructed. Naturally, quite often, fly-overs, viaducts or bridges already exist at these intersections. These fly-overs and bridges are expected to play important role for maintaining smooth traffic at these locations even after completion of the expressways. Therefore, in planning of the configurations of the interchanges, due considerations are given to conservation of these fly-overs, viaducts and bridges.

(2) Minimizing the acquisition of additional land

Roadsides of the proposed interchanges are generally highly urbanized. Therefore, it is assumed that acquisition of additional land is very difficult. To avoid additional land acquisition, “absolute minimum” values for the geometric design of the interchanges are often adopted. Although the interchanges are planned to avoid additional land acquisition in principle, some interchanges are planned with assumption of additional land is to be acquired. This the case where the roadside land is not used or used by government agencies, large-scale companies or a similar institution with whom negotiation of land acquisition is possible.

(3) Omission of unnecessary ramp

In some cases where the traffic flow in particular direction(s) are supposed to be minimal and the ramp for this flow of traffic cannot be constructed within the existing ROW, the said ramp is omitted to avoid additional land acquisition.

The probable schemes for the proposed interchanges, planned with the above considerations, are shown in Appendix 6.4. To secure the required clearance between existing fly-overs, ramps and main carriageways, the structures of the interchanges often become 3-layer type. In these figures, the numbers in the small circles indicate the "level" of ramps and main carriageways.

It should be noted that the configurations of the interchanges shown in Appendix 6.4 are of arbitral nature drawn based on the results of very preliminary survey. Substantial change may occur when these configurations are reviewed based on more accurate survey results and more detailed design of alignment of the expressways.

6.5.2 On-Ramps and Off-Ramps

As explained in Section 6.2, the words "on-ramp" and "off-ramp" are used to mean entrance and exit of expressway, respectively. In the urban expressway network, CREATS, a total of 14 locations of [entrance + exits] are proposed on the newly constructed expressways (expressways excluding the existing E1 and E2) as shown in Table 6.5-2. This gives an average interval of about 5.6 km.

Table 6.5-2 Number of Ramps (Entrance + Exit counted as one)

Expressway	E3	E4	E5	E6	E7	E8	E9	Total
No. of Ramps	6	5	3	1	3	0	1	14

While longer interval of entrance/exit is desirable to secure smooth traffic flow, shorter interval is preferable from the road users' viewpoint. (To have more opportunities to exit from the expressway in case of traffic jam.) As reference, in case of the Metropolitan Expressway Network of Tokyo, intervals of entrances and exits are 3.2 km and 3.1 km, respectively. (Intervals of exits are shorter than that of entrances to give more chances of exiting from the expressway.) In the actual design of the proposed expressways, it is recommended to plan more entrances and exits (on-ramps and off-ramps) in addition to those proposed in CREATS.

As explained in Section 6.3, on-ramps and off-ramps connect the expressway with the street running parallel to the expressway. Accordingly, there is considerable degree of freedom in selecting the locations of on-ramps and off-ramps from viewpoint of traffic flow. On the other hand, construction ramps of requires ROW wider than required for the ordinary section (see Typical Cross Sections in Section 6.3). Therefore, the actual location of on-ramps and off-ramps should be determined in the process of the detailed designing of the expressways considering the availability of ROW.

Possibilities of constructing on-ramps and off-ramps proposed in CREATS are examined and most of them are considered to be possible to be constructed. Possible locations for on- and off-ramps are shown in the Plans presented in Section 6.4. As an exceptional case, the on- and off-ramps of E3 near the east bank of Nile River (Al Kumaysh St.) is difficult to be constructed because of the constraints in available ROW and densely built buildings along the proposed alignment of the expressway.

6.5.3 Location of On/Off Ramps

There is always demand to provide many access ramps to elevated expressways. While this meets the desires to local traffic in general, it carries many incidental dangers, such as ramps closely spaced which create congested weaving areas and interference. Adequate space between on/off ramps shall be provided as specified. Ramps may closely intervene streets, unless the ramps are carefully placed.

If land use underneath a viaduct is considered, ramp placement shall be carefully considered since ramps usually interfere with land use under a viaduct.

To maximize the functionality of expressway, location of the ramps shall be identified at the best location taking into account the following factors, viz;

- Available R.O.W. width for provision of the ramps
- Condition of connection roads in regard to No. of Lanes, distance from intersections, etc.
- Traffic condition and capacity of connecting roads
- Topographical condition
- Distance from adjacent ramp
- Constructability
- Cost
- Impact to the vicinity

6.5.4 Connection with Ring Road

The Ring Road (RR) is the outer boundary of the proposed urban expressway network. Although RR should be considered as integrated with the proposed urban expressway network with regard to traffic planning and management, the toll systems of RR and the proposed urban expressways should be planned separately. The major reasons for this is as the following:

(i) If the toll for RR is integrated to that of the urban expressways, such as E3, E4 and E5, the toll level becomes considerably higher than that for the urban expressways alone. This imposes unreasonable payment to those who use the urban expressways only.

(ii) Since the total length of RR is substantially long and a wide spectrum of trip lengths is expected for the traffic on RR, distance-dependent toll system is appropriate while uniform toll (open system) is appropriate for the urban expressways in view of simplifying the toll collection procedure.

Therefore, the urban expressway and RR should not be connected directly (without passing toll gate). Accordingly, the urban expressways are connected to RR via the access roads (ordinary streets) of the RR. This arrangement is preferable also in view of the following aspects:

(i) New construction of interchanges and ramps requires additional costs.

(ii) Construction of interchanges and ramps on RR in addition to the existing ones will result in closer intervals of interchanging on RR which is not preferable.

Based on the above consideration, it is recommended that the expressways be connected to RR via the access roads of RR.

6.5.5 Parking Area

Two types of parking areas; (1) emergency parking bay on the expressway and (2) parking area outside of the expressway for "park-and-ride" are considered.

(1) Emergency parking bay on the expressway

It is often observed that broken-down vehicle is the cause of traffic jam on the existing urban expressways (E1 and E2). Provision of emergency parking bays on urban expressways is one of the commonly adopted measures to avoid such traffic jam caused by broken-down vehicles. Figure 6.5-2 shows an example of layout of such emergency parking bay.

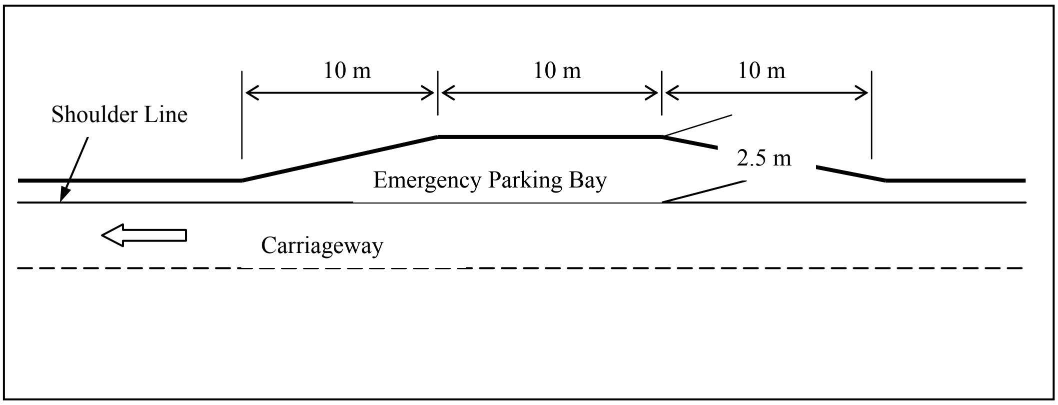


Figure 6.5-2 Example of Emergency Parking Bay

Such emergency parking bay can be constructed with appropriate intervals (such as 500 m) and at locations where the space is available. The cost for providing such emergency parking is usually not substantial.

However, there remains one problem: It is often observed in Cairo that a broken-down vehicle is left in the middle of carriageway or other places causing a serious hindrance to other vehicles. This is greatly attributed to the manner of the drivers. Unless such manners are improved, the contribution of emergency parking bays to reduction of traffic jam may remain minimal.

(2) Parking area for "park-and-ride"

The Study Team has been asked by the Technical Committee on the possibility of providing parking areas for "park-and-ride" drivers. This kind of parking area may be able to be provided at appropriate locations outside of the expressways but near to the entrances of expressways especially at the connecting points with the Ring Road. However, to identify appropriate locations for such parking areas, information of land owned by the three governments of Cairo, Giza and Qalyebeya at the required locations should be obtained. Because of the scarcity in the information on this matter including drivers' preference and spaces available for this parking, this task should be addressed in more details during the feasibility studies on each route. In addition, the demand of parking at each location should be identified based on the results of more detailed Park & Ride Studies.

6.5.6 Consideration on Bus Lane on the Expressway

Provision of exclusive bus lane on the urban expressways is discussed in Subsection 4.8.5 (pp 4-189 to 196) of Volume III, Phase I Final Report of CREATS. In this Study, provision of exclusive bus lane (busway) is not considered for the following reasons:

1. In planning the urban expressway, number of lanes, or the capacity, of particular section is to be determined to maintain "Level of Service (LOS) C" as defined in the Highway Capacity Manual (HCM) of USA. "LOS C" denotes the traffic condition where smooth flow (may not be free flow) is secured. Thus, buses can travel at desired speed, or at the speed close to it, without provision/usage of an exclusive bus lane.
2. CREATS report assumes an average interval of bus stops for the exclusive bus lane to be approximately 5 km for the required loading and unloading of passengers. The planned average interval of the exits and entrances of the proposed expressway network is also approximately 5.6 km (see Subsection 6.5.2 above). Therefore, buses operating on the expressway can use the planned entrances and exits.
3. In the CREATS plan, the costs for constructing exclusive bus lane and bus stop facilities are to be born by the entity(ies) of bus services. At present, bus operators do not seem to be ready to bear this cost. It is important that this issue should be investigated in the feasibility study of the priority expressways to see if buses will be allowed on the expressways and if so are we going to put bus lanes? And if so are there any untraditional financing that can be provided? And also who will pay the toll for the private operator if bus fare values cannot be increased?, etc.

As a conclusion, it is considered appropriate that provision of bus lanes be excluded in discussion of PPP schemes for construction of the proposed urban expressway network.

6.6 RIGHT-OF-WAY CONDITION

Except for the section of STA 14+000 – 17+300 of E4 Expressway which is to be completely new construction without at-grade street, most of the proposed expressway sections are to be constructed either on the existing streets or other public facilities such as railroad. Therefore, no large-scale acquisition of additional land is generally anticipated except for the above-mentioned section of E4 Expressway and the section of E3 which traverses the area of "City of the Dead" or ancient graveyard. The condition of existing right-of-way for the proposed expressways and salient problems are discussed below.

Section of E3 Expressway in front of Ancient Graveyard

Section of STA 8+500 – 11+000 of E3 Expressway, or existing An Nasr St runs adjacent to the ancient graveyard. The width of present An Nasr St is around 40 m and separated viaduct (Type 4) structure is proposed for this section to maintain the present condition of An Nasr St. Although the total width of An Nasr St is fairly wide, the width of sidewalks may not be sufficient for construction of piers. In such case, it is assumed that piers be constructed partly in the ancient graveyard (on the right side) and in the space left between An Nasr St and the railroad running parallel (on the left side) to the street. In case of constructing piers in the ancient graveyard, diligent consideration and consultation with the relevant parties will be required.

Section of STA 14+000 – 17+300 of E4 Expressway

This section is to be constructed as a completely new section. Although the Study Team could not visit the island in Nile River, it is observed from the bank that the land use of the area that the Expressway is to traverse is mainly agricultural land or unused land. The condition on the west bank of Nile River is similar to that of the island. Thus, no substantial relocation of residents is anticipated for this section.

Interchanges

The proposed configurations of the interchanges are designed considering the available space. However, in cases of IC 3 and IC 9, the loop ramps are planned in the land outside of the existing ROW. In case of IC 3, the loop ramp is planned on the unused land in the northwest corner of the existing intersection.

In case of IC 9, two loop ramps are to be constructed on the east side of the railroad, one in the premises of Cairo University and another in the premises of the seemingly residential building. The loop ramp planned in the premises of Cairo University may be able to span over the relatively low building located there. The other loop ramp is planned in front of the seemingly residential building located in the north of Cairo University, but probably can be constructed without affecting the building. In the both cases, further detailed survey and design is needed before any conclusion is reached.

Other Possibilities of Necessities for Land Acquisition

In addition to the above, there are several locations where there are **possibilities** of necessity for acquisition of additional right-of-way (ROW), in smaller scales than those described above at some locations depending on the final alignment of each expressway.

It should be noted that the locations and extends of necessities of land acquisition listed in Table 6.6-1 are estimated based on very preliminary survey and design, and, thus, it is very possible that land acquisition may not be actually necessary depending on the result of detailed design and survey. It should be also noted that there may arise necessities of land acquisition at other locations not listed in the table. Therefore, Table 6.6-1 ought to be interpreted as the indicators to illustrate the magnitude of necessary land acquisition involved.

Table 6.6-1 List of Locations Where Acquisition of Additional ROW may be Required

No.	Express-way No.	Location (STA)*	Exist. Width (m)	Proposed X-Section Type	Width for Proposed X-Section (m)**	Additional Width Required (m)	Type of Roadside Land Use
1	E3	13+850 – 14+100 (R)	38	4	26	***20	Company
2	E3	12+550 – 12+650 (L)	25	5	26	1	Company
3	E5	6+100 – 6+250 (L)	23	4	26	3	Railroad
4	E6	5+250 – 5+350 (B)	25	1	40	15	Military (L) Garden (R)
5	E7	3+000 – 3+100 (L)	25	4	32	7	Company
6	E7	8+200 – 8+300 (L)	25	4	32	7	El Shams Club

* R=Right, L=Left, B=Both sides of road, looking from smaller STA No.
** Width required for maintaining the existing No. of lanes except those used for parking.
*** Needed to enable minimum radius of curve: Land needed to construct piers.

At all the locations listed in the above table, any relocation of residents is not anticipated.

Land acquisition for on- and off-ramps

ROW wider than that for ordinary section is required for the section of on- and off-ramps. As explained in Section 6.5, on- and off-ramps can be planned at the locations where wide ROW is available. Also, required ROW may be reduced by shifting the centerline of the main carriageway of the expressway. As such, there are many uncertain factors involved in the estimation of necessity for additional ROW for on- and off-ramps (entrances and exits). However, it can be said that on- and off-ramps can be constructed without major relocation of roadside residents and/or shops although roadside land currently used as parking spaces or gardens may be acquired.

6.7 ENVIRONMENTAL ASSESSMENT

6.7.1 Environmental Consideration in CREATS

Chapter 12 of the Final Report of CREATS (November 2002) describes the environmental aspects of CREATS. The “Potential Significant Adverse Impacts from Proposed Road Projects; Scenario D (Master Plan)” presented in the report summarizes the anticipated potential adverse impacts of the expressways and other major road projects as shown in Table 6.7-1. Positive impact of the expressway network is discussed and evaluated in Sections 9.3.6 and 9.4.6 in regard to improvements in air quality.

Table 6.7-1 Potential Significant Adverse Impacts from Proposed Road Projects; Scenario D (Master Plan) Listed in CREATS Report

Proposed Road Projects	Potential significant impacts on socio-economic environment	Potentially significant impacts on physical/ biological environment
NEW ROADS NOT REQUIRING LAND ACQUSITION New Ring Road: Maryooteya Rd New Roads: 15th May Street Ext. Tereat Tirsa St. Khafra St. Expressways: E3 – E9	• Impact on historical and cultural sites • Increased fragmentation/split up of areas • Impact on land use • Effects of increased air pollution and noise/vibrations on health of affected persons (public health) • Risk of accidents (public health) • Impact on aesthetics/ modification of scenery • Temporary impact on health of workers during construction	• Increased fragmentation/ split up of areas • Impact on land use • Increased air pollution • Risks of contaminating drinking water sources and soil by spills of hazardous materials, caused by accidents. • Runoff

Source: Table 12.7.1, p 12-30, Phase I Final Report Vol. III, Nov. 2002

The same report also estimates the (total) emission of CO_2 as shown in Table 6.7-2. It is noted that estimation for “Do-Nothing Scenario” was not shown. The report states that; “CO_2 emissions were estimated for the different Scenarios of the proposed Transport Improvement Projects for Greater Cairo. Japanese standards were used for the estimation, because Egyptian standards are not available. Consequently, the absolute values are not relevant. ….. It is evident that CO_2 emissions are increasing, because of the enormous growth of the use of private cars in the coming years in Egypt. …..”

Table 6.7-2 Estimated CO_2 Emission for Different Scenarios (as Presented in CREATS Report)

	Base Year 2001	Scenario A Committed Projects 2022	Scenario B Do Maximum 2022	Scenario C Core Projects 2022	Scenario D Proposed 2022
CO_2 Emission (10^6 ton)	12.2	15.9	10.6	13.7	13.6

Source: Table 12.7.2, p 12-31, Phase I Final Report Vol. III, Nov. 2002

Then the CREATS Report recommends "EIA + Environmental Management Plan + Environmental Monitoring Plan" be prepared. The conclusion of CREATS that "EIA + Environmental Management Plan + Environmental Monitoring Plan" is recommended, is also supported by this Study but questions remains on the following points:

(i) Since the impact of expressway projects are discussed together with other (ordinary) road projects, some desirable impacts of expressway construction are not highlighted. For example, CREATS Report points out "risk of accidents" as one of the negative impacts. However, it is usually believed by highway engineers that accident rates (vehicle-kilometer basis) of expressways are usually lower than those of ordinary streets. For example, accident rate of the Metropolitan Expressway Network (MEX) of Tokyo is about 1/6 of that of average streets in Tokyo. (MEX: 169 Acc./100 million veh-km; Average Street: 1,055 Acc./100 million veh-km)

(ii) Similarly, construction of expressways are expected to reduce number of "stop-and-go", resulting in reduction of emission of some toxic gas from vehicles, while CREATS Report simply state that "increased air pollution".

(iii) Since no estimation on the total emission of CO2 for was made for "Do Nothing" case, it is difficult estimate the degree of reduction in the emission of CO2 by implementation of new roads. Projects compared to the case where these projects are not implemented. Also, it is difficult to interpret the figures since the methodology of the above estimation is not shown.

6.7.2 Major Adverse Environmental and Social Impacts Identified in This Study

At this stage, even preliminary designs of the expressways are not available. Accordingly, it is not realistic to estimate detailed environmental impacts of the expressway. Based on the result of the observations of the sites of proposed expressways, the followings are anticipated as adverse impacts of the proposed expressways.

(A) Social Impacts

(1) Impacts on the living environment/amenity

The following adverse impacts are anticipated:

(i) Obstruction to views and sunlight caused by construction of viaducts
Since the expressways are proposed to be basically constructed as viaducts, they will constitute obstructions to the views and sunlight. Ordinary sections of viaducts are expected to be about 8 m high from the surface of the streets. Since the existing viaducts such as E1 and E2 Expressways are accepted by the majority of the citizens, it may be reasonable to assume the ordinary structures of viaducts are acceptable to the majority of the citizens.

In the case where obstruction to the view needs to be kept minimum, such as in front of the Memorial Monument, the expressway can be constructed underground.

Some people may feel uncomfortable on the aesthetic view of the viaducts. This can be mitigated, at least partially, by adopting aesthetic design on the structure (such as piers and girders) of the viaducts.

(ii) Partial loss of green belts or roadside trees/plants due to construction of viaducts
The streets in Cairo often have beautifully vegetated areas (green belt) on the median division and/or on the sidewalks. Some portions of such green belts may have to be used as the spaces for the piers of viaducts.

This is particularly probable in case of the section of E4 Expressway, along Abu Bakar Siddiq St. The green belt between Aziz Al Masri St. and Al Urubah St. is used as the divider between the railroad and carriageway for the vehicles and 6 – 10 m wide. Major part of this green belt can be preserved by constructing the viaducts over the railroad. On the other hand, there is no space of railroad on the section of Abu Bakar Siddiq St between Al Urubah St and Husayn Kamil Silim St. Thus E4 Expressway has to be constructed in the form of separated viaduct to save the green belt at the median. Then this structure will reduce the sunlight to the trees on the roadside. Adoption of underground (tunnel) structure is difficult for this section confined by the physical constraints for the adjacent sections on both sides. This problem needs further considerations in the design in future.

Hindrance to sunlight caused by viaducts is anticipated also in other expressways such as E7 Expressway. Over substantial distance, there are green belts on Aziz Al Masri St. Although separate viaduct structure is basically recommended, further consideration should be given in the design in future to conservation of trees on the roadsides.

(iii) Increase of noise and vibration along the expressway

When expressways are constructed and opened to traffic, they naturally cater for large volume of traffic. As a result, there is strong possibility of increased noise and vibration occurring along the expressways.

Traffic noise from expressways can generally be mitigated to the reasonably acceptable level by constructing noise barrier (fence) along the parapet of the viaduct. The height of such noise barrier may be 1 to 3 m in ordinary cases and can be as high as 5 m in practice.

Noise barrier can also function as the "blind" to shut the view from the vehicles where necessary such as to protect privacy of roadside houses.

Vibration caused by viaducts is difficult to prevent. In case of Cairo, however, possibility of harmful vibration caused by viaducts seems to be relatively low owing to preferable foundation conditions. No serious problem of vibration has been caused by existing expressways (E1 and E2) has been reported to Study Team.

(2) Impact to cultural heritage and religious facilities

The following impacts are anticipated on the cultural heritages.

(i) Change of the scenery in the vicinity of the Citadel, due to construction of viaduct

E3 Expressway traverses the area in front of the Citadel. Construction of a new viaduct may affect the scenery of the area. However, the Study Team considers that the construction of a new viaduct is acceptable in view of the following:

(a) Already, there are viaducts (fly-overs) on An Nasr St in front of the Citadel.
(b) Two major streets (An Nasr St and Salah Salim St) and railroad are running in front of the Citadel.

(ii) Land Acquisition and change of environment of the ancient graveyard along An Nasr St for construction of viaduct

A section of E3 Expressway, runs along the southeastern periphery of the ancient graveyard. Although not in large scale, some necessity acquisition of land of graveyard may become necessary, depending on the result of detailed design. Also, the influence of construction of the viaduct on the view may need to be consulted with the relevant parties.

(iii) Construction of expressway along the ancient water channel in the southwest of the Citadel

There is an ancient water channel along Salah Salim St in the southwest of the Citadel. The viaduct of E3 Expressway for on this section can be constructed avoiding the channel. However, due attention needs to be paid during construction. For example, excavation of foundation needs to be diligently planned not to harm the channel.

(iv) Influence to mosques

There are two mosques located adjacent to the planned route of the expressways; one in the area of IC 10 and the other in the intersection of Al Kablat St and An Nadi St along E4 Expressway. It seems that the expressways can be constructed with no or very little physical influence on these mosques, but more detailed survey and designing are necessary to confirm this.

The magnitudes of these impacts can be estimated only after the basic designs of the expressways will be confirmed and locations and dimensions of the expressways will be fixed. It is generally perceived that the impacts described above can be mitigated to reasonably acceptable level by adjusting the design of the expressways. However, it is recommended that consultation be held at appropriate stages in the future as plan/design will become more concrete and specific.

(3) Relocation of roadside residents and shops

As described in Section 6.6, no substantial relocation of residents is anticipated. Although acquisition of some additional land may become necessary, these pieces of land are currently owned by governmental organizations or private firms with whom negotiation is considered to be possible.

(B) Impact on Natural Environment

Since the expressways are basically constructed along the existing streets, no precious or important fauna or flora is supposed to exist along the expressways. Only conceivable impact on the natural environment is the impact of the construction of new bridges across Nile River. This impact needs further study when the types and other features of the bridges are determined.

Table 6.7-3 summarized the objectives and strategic indicators for different expected environmental impacts.

Table 6.7-3 Objectives and Strategic Indicators of Environmental and Social Impact

Impact	Objective	Strategic Indicator
Noise and Vibration	Traffic noise levels in the vicinity of the urban expressway network are minimized	Length of the urban expressway with a change in noise/vibration levels
Air Quality	Total greenhouse gas emissions from transport are minimized	Change in CO_2 emissions in the regional transportation modal area
	To minimize any increase in the acidification loading due to transport	Change in NO_X emissions in the regional transportation modal area
	To minimize emissions from transport affecting local air quality	Percentage change in total emissions of NO_X within the network
Landscape	To minimize adverse change in designated or historic landscapes	Area of the urban expressway affecting designated or historic landscape
Nature Reservation	To minimize any adverse effects on the integrity of designated sites of national importance	Area of the urban expressway affecting designated sites
		Extent of direct or indirect risk to designated sites
	To minimize adverse effects upon locally designated sites of irreplaceable value	Area of sites of local ecological value directly or indirectly affected
Cultural Heritage	To minimize any adverse effects on the integrity of nationally designated sites of cultural heritage	Number of scheduled ancient monuments or conservation areas experiencing a change in their setting
Community Severance	To reduce community severance	Length of urban expressway with a change in severance
Land-use	To minimize the need for property demolition or land acquisition	Potential for property to be demolished or relocated
	Maximize support to transportation, land-use planning, environmental sustainability and health policies	Extent to which plans and policies are assisted or hindered
Construction	To minimize risk of extensive construction disturbance to sensitive features	Area of major construction works within 100m of properties or designated sites

6.8 SUMMARY AND CONCLUSIONS

The discussions stated in this section can be summarized as follows:

(i) The proposed expressways are considered to be feasible from engineering viewpoint.
(ii) No large-scale relocation of residents is anticipated to be caused by construction of the expressways.
(iii) Some adverse social impacts are anticipated. These impacts are supposed to be within “manageable level” at this stage but need further studies.

CHAPTER 7

ESTABLISHMENT OF EXPRESSWAY SYSTEM

CHAPTER 7

ESTABLISHMENT OF EXPRESSWAY SYSTEM

7.1 TOLL ROAD SYSTEM

7.1.1 Introduction

In many countries (probably all the countries in the world), it is widely accepted that the public roads are free of charge in principle. However, it is also the case in many countries that the road users are required to pay some form of charge, either directly or indirectly, for the usage of roads.

One of the typical and widely adopted systems of the indirect road user charge is taxation on the motor vehicle fuels (gasoline and diesel oil) and exclusive usage of whole amount, or certain portion, of this revenue on roads. This system is reasonable in the sense that the road users pay the charge in proportion to the distance of their travels, or the lengths of their road use, because the fuel consumption is proportional to the travel distance, in general. Although this system is reasonable and easy for the road users to accept, it is not necessarily adopted in the majority of the countries in the world. One of the possible main reason that designation of some portion, or whole amount, of certain revenue for the national account reduces the degree of freedom for drafting of annual national budget by the Financial Ministry and Parliament's authority to review and approve the draft budget.

Direct road user charges do not have the above problem. On the other hand, strong opposition by the road users is anticipated if it is to be introduced. Therefore, rationale for introduction of such system should be diligently discussed among the relevant government agencies and presented to the road users to minimize the social conflict.

Toll road system is one of the most clear-cut and straightforward systems of the direct road user charge system. Still, the consensus among the road users needs to be established before the successful introduction of the system. This section discusses the legal basis and basic policy for toll system.

7.1.2 Legal Basis

In many countries nowadays, public roads are regarded as one of the very basic public facilities constructed and maintained by the government and provided to the general public “free of charge”. Toll roads are seemingly against this widely granted principle. This subsection discusses the legal ground for collecting tolls on the public roads.

(1) Principle of Free of Charge for Usage of Public Roads

Historically, the public roads were not always free of charge. In the medieval age, many federal lords collected money from those who came into their territories. The basic idea for this practice was that those who came into the federal lords’ territories were to obtain some profit by doing some business and the lords are entitled to collect the “tax” for such business. Later, however, this kind of “taxation” was gradually abolished to encourage trade and commerce.

In modern days, the government takes the responsibility of constructing and maintaining the road network in view of that the road transport is a very important transport mode supporting the major part of the socio-economic activities of the country. The general public is usually allowed to use public roads without charge, but the expenses for construction and maintenance of public roads are financed by the general account of the government, either national or local government, which, in turn, financed by the tax paid by the general public. Thus, the public roads are not “free of charge” in reality.

(2) Road Fund

As stated in Subsection 7.1.1 above, taxes on automobile fuel are used for construction and/or maintenance of roads in many countries. Quite often this kind of fund, which is ring-fenced for exclusive usage for development of roads, is called the **Road Fund**. Where the revenue of fuel tax is not sufficient, other automobile-related revenue may be included. Many international aid agencies, including the World Bank have been recommending adoption of Road Fund to the governments of developing countries to promote road development. However, Road Fund has not been established yet in many countries.

Although toll road system is recommended to promote high-standard roads including expressways, establishment of Road Fund is also strongly recommended to promote development of ordinary (non-high-standard roads) as rural and local roads. Benefits of high-standard roads cannot be fully enjoyed by the road user if the access roads connected to high-standard roads are not in good condition.

Currently, tax for gasoline in Egypt is 0.7 % per litter which is far below the level of many other countries and evidently not sufficient to support sound development of the road network in the nation. In addition to fuel tax, currently automobile registration fee is collected from the owners. With increased fuel tax revenue and currently corrected automobile registration fee combined, it seems to be possible to establish Road Fund in Egypt.

(3) Beneficiary-Pay Principle

Although not always explicitly stated in the relevant laws in many countries, there is an very basic concept underpinning the toll road system:

"Those who get benefit by using a particular road should pay for the cost of construction and/or maintenance of the said road."

The above concept is often called **"Beneficiary-Pay Principle"** or **"Fee-for-Service Concept"**. This concept is easy to understand and recently being accepted in many countries.

(4) Justification for Toll Road

Although the basic principle in many countries is that public roads are free of charge to use, the urgency of, and the insufficiency in the fund for, road network development necessitate the governments to adopt toll road system. Usually, collections of toll on certain kinds of roads are regarded legally acceptable on the following reasons:

(i) The government needs some fund source(s), out of the existing sources of the government revenue to develop the planned road network within the planned time framework. The planned development of road network is essential for the socio-economic development of the nation which will give the benefit in the future.

(ii) The road users who use the toll road can get the benefit (time saving, reduction in damage of cargo, reduction in vehicle operation cost, etc.) which is larger than the toll in monetary value.

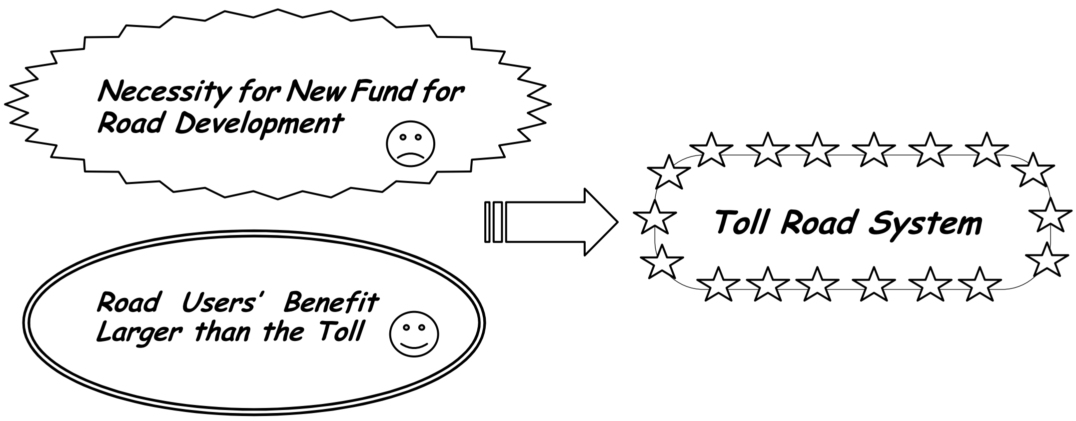


Figure 7.1-1 Justification for Toll Road System

Item (ii) is same with “Beneficiary-Pay Principle”. Although Beneficiary-Pay Principle is not commonly accepted or understood by the general public, the explanation as Item (ii) is easily understood and accepted in case of toll road. Figure 7.1-1 illustrates the justification for Toll Road System.

It should be noted that one of the prerequisites for toll road adopted in many countries is that there is an alternative road for those who do not want to pay the toll. This is one of the basic principles that justify the toll collection.

(5) Provisions for Toll Road System in the Existing Legislations of Egypt

Article 9 of the existing Road Law (Decree-Law of the President of the United Arab Republic No. 84 of the Year 1968: Article 9 was added in 1984 as Law No. 146.) stipulates the matters related to toll road system as summarized below:

(i) Condition for toll road
- The “fast traffic roads” (expressways)
- By a decree of the Prime Minister, and
- Where there are alternative roads

(ii) Toll rates

• Private cars and taxi cabs	LE 1.0
• Pickups and “half trucks” (station wagons)	LE 2.0
• Buses	LE 2.0
• Trucks and lorries	LE 3.0
• Heavy duty vehicles	LE 5.0

Note: It should be noted that 5 times of these toll rates are applied on the newly constructed Cairo - Sokhna Highway.

(iii) Toll is not applied to the armed forces and police vehicles and the ambulance cars.

(iv) Special toll rate may be applied in the following cases:
- Partial completion of the road
- Discount for frequent use (with decree of the Minister of Transport)

(v) The toll revenue is to be deposited in a public sector bank in the name of “General Authority for Roads and Bridges” (present GARBLT).
- The toll revenue shall be used for upgrading, maintenance and operation of the road.
- The remaining fund can be carried forward to the succeeding years.

(vi) Spending of the toll revenue is determined by the Minister of Transport upon proposal of the Board of the GARBLT.

(vii) The administrative expenses shall not exceed 10 % of the annual toll revenue.

As can be seen in the above, most of the basic matters of toll road system, such as (i) prerequisites for toll road, (ii) toll level and ratio among the vehicle types, (iii) special toll rate, and (iv) use of the toll revenue and forwarding the remaining balance. **With these stipulations, it is clear that the legal basis for toll road system have already been established since the above article of the law was promulgated.**

Further, Article 12 of the same law (added in 1996 as Law No. 229) stipulates the basic conditions for concession of (toll) roads as follows:

(i) Concessionaire shall be selected on the competition basis with public announcement.
(ii) Maximum concession period is 99 years.
(iii) The concessionaire shall be vested the powers, jurisdictions and rights of the road administrator.

According to these provisions, it is evident that the legal basis of PPP schemes for toll roads has also been established.

(6) Needed Revisions

Although the existing Road Law stipulates the necessary fundamental matters of toll road system, it needs some revisions and/or supplements to be applied on the planned urban toll expressway network. The matters which need revisions/supplements for the existing Road Law are as the followings:

(i) The provisions of toll road system as stipulated in the existing Law should be applied also to the proposed urban toll expressway network. (The proposed urban expressway network is in the jurisdictions of the three Governorates and out of the jurisdiction of the Minister of Transport.)
(ii) Higher toll rates should be allowed for the proposed urban toll expressway network: This is specifically necessary for the PPP entities to recover the construction cost, including the interest. Also, the procedure to revise (raise) toll rate to cope with the inflation in the future should be provided. For this purpose, the basic principle(s) for setting toll rate should be established. Such basic principles are discussed later.
(iii) The proposed organization, Metropolitan Expressway Authority (MEA), for the urban expressway network should be authorized to deposit the toll revenue of the proposed urban expressways in its own name (not in the name of GARBLT). The proposed toll expressway organization (MEA) should be authorized to appropriate the toll revenue with an approval of the Minster of Transport on the basic matters.
(iv) Vehicle categories different from those stipulated in the existing law may be used in urban toll road: Two or three vehicle-class system may be used.

7.1.3 Toll Level Policy and Toll Setting

Although the toll rates for the existing toll roads are stipulated in the existing Road Law, these rates are considered to be too low to recover the construction cost of the proposed urban toll expressway network. Accordingly, it is necessary to establish a new policy for setting the toll rate for the urban toll expressway network. In determining the level of toll, various factors need to be taken into account including the followings:

(i) Road users' benefit
(ii) Cost recovery
(iii) Willingness-to-Pay of the road users
(iv) Affordability of the road users
(v) Fare levels of other public transport modes
(vi) Examples of other countries
(vii) Ratio among the vehicle types
(viii) Toll system (Flat Toll or Distance-Dependent Toll)

This subsection discusses such factors.

(1) Basic Principle

In many countries where toll road system is adopted, the following basic principles are accepted, with or without explicit stipulations in the relevant legislations, before the actual toll levels are determined:

(i) Toll level should be equal to or less than the benefit enjoyed by the users of the toll road.
(ii) Toll level should be set to cover the cost for maintenance/operation and/or construction of the toll road.

Among the above two principles, Principle (i) is adopted in most of the countries while Principle (ii) is sometimes not adopted depending on the financial viability of toll roads or other reasons.

Principle (i) is straightforward and easy to understand. Unless the benefit of using toll road is larger than the non-toll alternative road, the road users do not have any reason to take the toll road.

This principle is sometimes called in Japan as "Justifiable Toll Level Principle". With this principle, the upper limit for the toll level is determined as the road users' benefit. (According to the results of the traffic forecast and economic analysis conducted in this

Study as shown later in Figure 7.1-14, the average benefit of a passenger car accruing from the usage of the proposed urban toll expressway network is about LE 7.3 and 10.3 per trip in year 2012 and 2022, respectively.)

While Principle (i) is widely adopted in many countries, Principle (ii) (sometimes called as "Cost Recovery Principle") is not adopted in some countries. Whether or not Principle (ii) can be adopted mainly depends on the financial viability of the toll road. If the toll road is used by many vehicles and yields a large amount of revenue which is sufficient to recover the construction cost, the toll revenue is, of course, used to pay the construction cost. However, this is quite often not the case. When the toll revenue is not sufficient to cover the construction cost, it is sought to cover the maintenance/operation cost, as the second choice. In either case, the lower limit of the toll level is determined as the necessary amount to cover the cost of construction or maintenance.

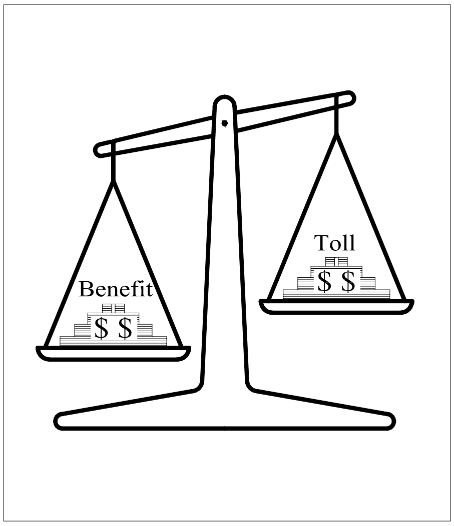


Figure 7.1-2 Benefit > Toll

Thus, the upper limit of toll level is confined by the road users' benefit while the lower limit of the toll level is confined by the construction cost and/or maintenance/operation cost. Figure 7.1-3 schematically illustrates this concept.

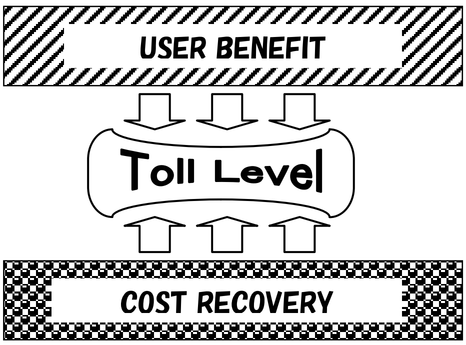


Figure 7.1-3 Concept of Upper and Lower Limit of Toll Level

Cost recovery

One of the few, very fundamental factors considered in toll level setting is cost recovery. Usually, the following three kinds of costs are considered:

(i) Maintenance and Operation Cost
(ii) Construction Cost (may or may not include the cost for land acquisition)
(iii) Capital Cost (Interest for the borrowed money and other expenses, occurs if the construction cost is borrowed from some fund source.)

Usually, the annual maintenance and operation cost is 2 % or less of the construction cost and can be easily covered by the toll revenue. On the other hand, the interest rates in many countries are often 10 % per year or more. Thus it is often difficult to cover the construction cost and the capital cost as clarified in Figure 7.1-4.

If the net income ([total toll revenue] – [maintenance & operation cost]) is less than the interest every year, the unpaid portion of the interest causes another interest. Thus, the total debt starts to increase exponentially.

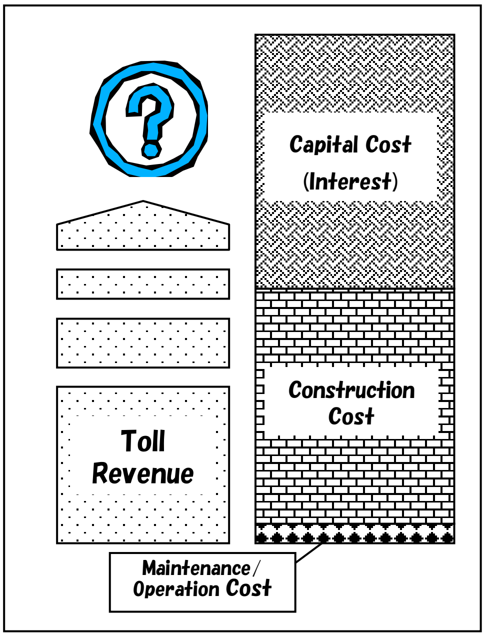


Figure 7.1-4 Cost Recovery

This problem of interest on the debt can be schematically illustrated by the four simplified examples shown below.

(i) Base Case: The initial debt (borrowed as the construction cost) of LE 1,000 million with an annual interest rate of 10 % (complex interest) is left without any payment of interest.
(ii) Scenario 1: The net income is assumed as 5 % of the construction cost (initial debt) and growth rate of income is assumed as 3 % per annum. (According to the experiences of Japan and other countries, the traffic volume on toll expressway network increases in proportion to the growth of the GDP.)
(iii) Scenario 2: Same with Scenario 1, except that the growth rate of toll revenue is 6 %.
(iv) Scenario 3: Same with Scenario 1, except that the interest rate is assumed as 7 % per annum.

Figures 7.1-5 to 7.1-8 show the increase/decrease of the remaining debt.

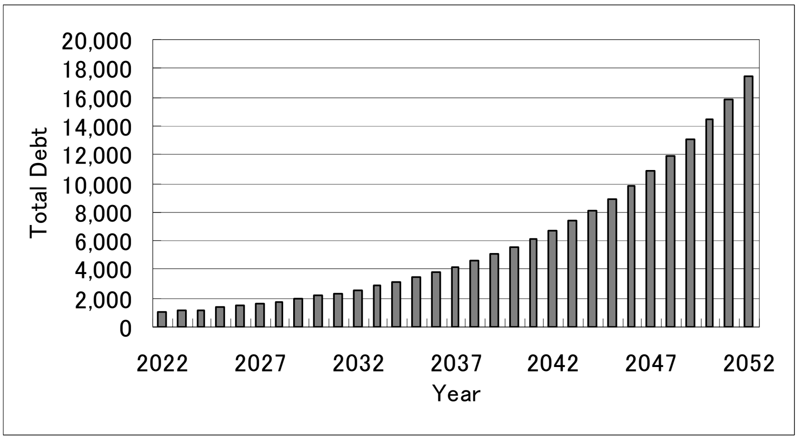


Figure 7.1-5 Base Case: A Debt of LE 1,000 Million Left Untouched for 30 Years

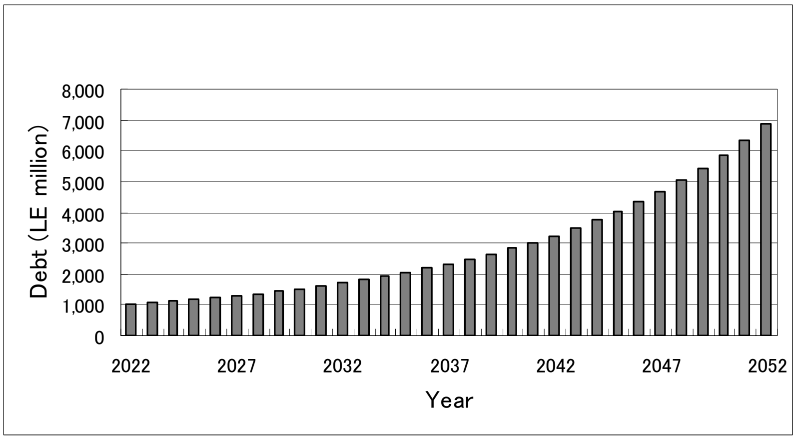


Figure 7.1-6 Scenario 1: With Net Income Amounting to 5 % of the Construction Cost

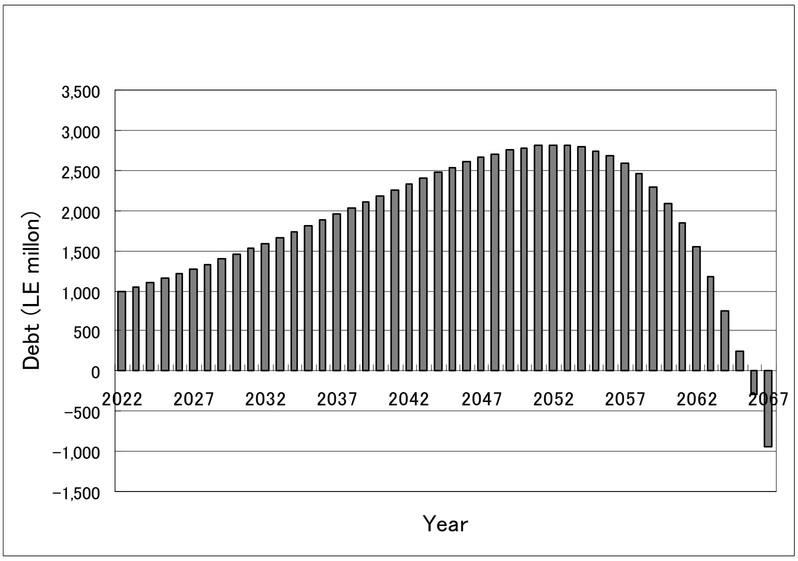


Figure 7.1-7 Scenario 2: With Growth Rate of Net Income as 6 % per Year

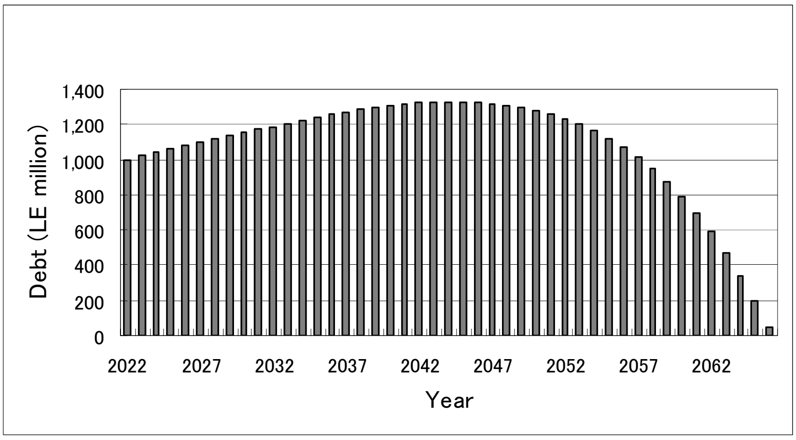


Figure 7.1-8 Scenario 3: Interest Rate 7 % per Year

From the above examples, the followings be concluded:

(i) If the debt is left without any payment for the interest for 30 years, the total debt increases to 18 times of the initial amount.
(ii) Even if the income amounting to 5 % of the initial debt, with annual growth rate of 3 %, is used to pay the interest, the total debt after 30 years increase to about 7 times of the initial debt.
(iii) Also in the case where the growth rate of the income is 6 % per year, the total debt increase in the first 30 years, but it decrease thereafter and becomes zero 45 years after the start of operation.
(iv) If the interest rate is 7 % per year, the total debt becomes zero about 45 years after the start of operation.

As can be seen in the above examples, **the toll revenue is used mainly to pay the interest** and financial viability of a toll road network depends on several factors including interest rate for the construction cost, annual net income of the network, growth rate of the revenue.

The preliminary financial analysis conducted in this Study shows that the annual total toll revenue is around 5 % of the construction cost. As it was shown in the above, this toll revenue is not sufficient to cover the construction cost of the expressway network. In this case, the Government needs to subsidize in some form including the followings:

(i) To provide some portion of the construction cost and reduce the amount of the initial debt.
(ii) To provide some portion of the interest every year

While Option (i) above require large amount of fund in a relative short period (about 15 years), Option (ii) requires the payment of relatively small amount for long period (such as 30 years or longer). Which option is more suitable depends on the characteristics of the fund available to the Government.

Where the toll level is planned to recover the construction cost, the longer is the cost recovery period (toll collection period), the lower is the toll level needed to recover the construction cost. Usually, 30 to 50 years is assumed as the toll collection (cost recovery) period. In very rare cases, the toll revenue is so large that the construction cost, including the interest, can be covered in a relatively short period such as 15 years. In such case, the toll rate should be lowered to allow more vehicles to enjoy the benefit of using the toll road. (Unfortunately, this is not expected to happen in case of the urban toll expressways in GCR due to high construction cost and low toll revenue.)

(2) Willingness-to-Pay

It is needless to say that the willingness or readiness of the road users to pay for better roads is an important factor in considering the toll level. The level of toll that the road users are willing to pay reflects the value or benefit that they percept for using the toll road. Such perception on the value of using toll road is considered to govern the road users' choice for using the toll road or opting for the alternative road.

Figure 7.1-9 shows the relation between the toll level and the percentage of road users who will pay the toll and use the toll road, obtained as the result of the "Willingness-to-Pay" Survey conducted in this Study.

This figure indicates, for example, that at the toll of LE 2.0, only 20 % of the surveyed road users want to use the toll road in year 2005. If the toll is raised to LE 4.0, the percentage of the road user who will use (divert to) the toll road decreases to 10 % and the remaining 90 % is to use the non-toll streets. The percentage of road users who will divert to the toll road is expected to increase in year 2022, but still the majority of the road users do not seem to be willing to pay more than LE 4.0. This is a very discouraging implication since the toll revenue calculated as the product of the estimate traffic volume multiplied by LE 4.0 is far below the estimated mount needed to cover the construction cost of the proposed expressway network.

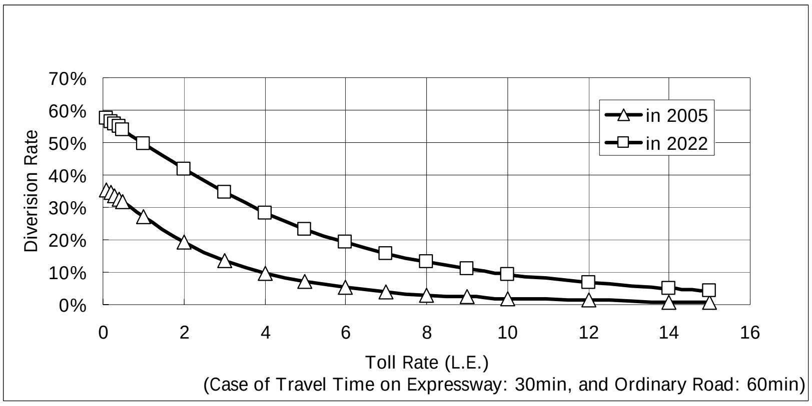


Figure 7.1-9 Relation between Toll Level and Percentage of Road Users who are Willing-to-Pay
(Based on the result of the "Willingness-to-Pay Survey" conducted under the Study)

It should be noted that the survey was conducted with regard to the road users in GCR whose concepts of "urban expressway" are assumed to be substantially influenced by the situation of the existing urban expressways (E-1 and E-2) which are always congested and no great benefit is felt for using them. Once the same road users will experience the smooth traffic flow on the proposed urban expressways, it is very probable that they find larger value/benefit in using the toll expressway.

(3) Affordability

(a) Affordability Based on the Average Household Income

Since the result of the "Willingness-to-Pay" Survey indicates the road users' perception/ evaluation for benefits of using the toll expressway, it reflects the subjective evaluation by the road users. Contrary, estimation of the road users' capacity or "affordability" to pay for the toll road may be objectively estimated from the level of average household income. Table 7.1-1 shows the shares of the average expenditure of urban household quoted from CAPMAS, "Income, Expenditures, Consumption Survey 1999/2000", July 2001. It is seen that the total monthly expenditure is about LE 1,000 and 7.62 % of the total expenditure is spent on "Transport and Communication".

Table 7.1-1 Shares of Average Expenditure of Urban Household

Item	Expenditure (LE)		%
	Annual	Monthly*	
Food & Drinks	4,500.0	375.0	38.84
Cigarettes & Tobaccos	326.4	27.2	2.82
Cloths and Cloth	1,214.2	101.2	10.48
House and Relevant Items	1,601.0	133.4	13.82
Furniture	320.8	26.7	2.77
Services and Medical Care	526.7	43.9	4.55
Transport & Communication**	882.3	73.5	7.62
Education	661.6	55.1	5.71
Culture, Sports & Entertainment	622.3	51.9	5.37
Restaurants, Café & Hotel	289.1	24.1	2.50
Others	641.5	53.5	5.54
Total	11,585.9	965.5	100.02

* Monthly expenditures are calculated from the annual expenditures.
Source: CAPMAS, "Income, Expenditures, Consumption Survey 1999/2000", July 2001

** There is no statistics for expenditure on transport in GCR only, as available statistics are for all urban areas in the country.

There are no other available data which more directly indicate the amount that average household can spend on road or car travel. Therefore, the followings are **arbitrarily assumed** to estimate the amount that average road users can afford to spend on toll roads:

(i) Total household expenditure increase by year 2012 to 1.3 times of that of year 2000. (According to the economic projection of CREATS, the average household income in year 2012 grows by 31 % compared with that in year 2001.)

(ii) The income level that owns a car is three times of the average household income shown in the table above: Thus, the monthly expenditure of the car-owner household is LE 3,000 in year 2000.

(iii) Two percent (2 %), or about one third of the expenditure on "Transport and Communication" can be spent on toll roads.

Based on the above **arbitrary assumptions**, the amount of average car-owner household can spend is estimated at LE 78 per month. If toll level is set at LE 2.0 per entry, LE 78 is equivalent to 39 entry or 20 times of "round trip" (go and come back).

(b) Theoretical Estimation of Benefit

Another method to examine the "affordability" is to compare the toll level with the benefit obtained by using the toll road. Theoretically, the benefit of using a toll road can be estimated by the following method. It is probably reasonable to assume that the benefit accruing from use of toll road is closely dependent on the income level of the road users and shows "normal distribution" type of distribution among the road users. Then, average value of the benefit of toll road user can be determined numerically form this curve.

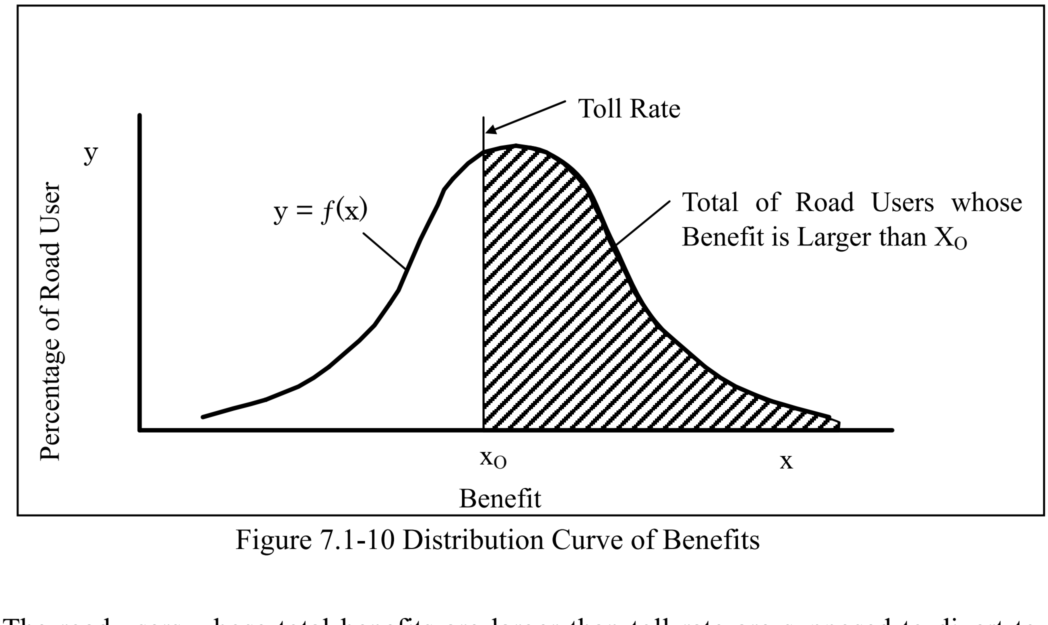


Figure 7.1-10 Distribution Curve of Benefits

The road users whose total benefits are larger than toll rate are supposed to divert to (use) the toll road. Thus the percentage of the road users who divert from the alternative road to the toll road (diversion rate) is estimated as the area below the curve on the right side of toll rate X0. Thus, the diversion rate, Pd, can be obtained by integrating the curve of distribution of benefit [$y = f(x)$]. Therefore,

$$Pd = \int_{X0}^{\infty} f(x)\,dx$$

The curve thus obtained generally look like Figure 7.1-11.

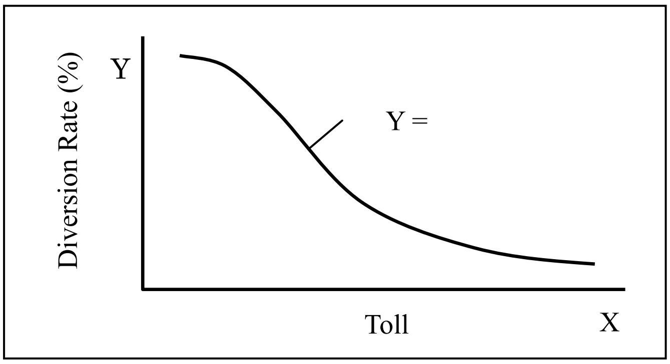


Figure 7.1-11 General Shape of Diversion Curve

Since the diversion curve as shown above is obtained by integrating the distribution curve of benefit, the distribution curve of benefit can be obtained by differentiating the curve of diversion rate. Then, the average benefit of users of the toll road can be obtained from the distribution curve thus obtained.

$$F(x) = \frac{dF(x)}{dx}$$

Therefore, if the diversion curve $Y = F(x)$, as shown in Figure7.1-11, can be determined based on the reliable observed data, the curve of the average benefit of toll road users $y = f(x)$ can be obtained by differentiating the diversion curve. This method is employed in Japan. However, in case of Egypt, such diversion curve is not available yet.

This method can be used to justify the value of time used in toll level setting in the future when sufficient data will be obtained.

(4) Comparison with the Fares of Other Public Transport Modes

Fares of other modes public transport such as buses, subways and ordinary railroads can be the references in considering the toll level of the expressway network. Table 7.1-2 shows the examples of fare levels of the public transport modes existing in and around GCR.

As seen in the table, the fare level per km of the train for Cairo-Giza is considerably higher than those of other sections/lines. This may be attributed to the fact that the income level of GCR is relatively higher than the other areas in the nation.

As discussed in Chapter 12, the toll of the planned urban expressways is proposed to be around LE 5.0 per entrance. This toll level is much higher than the fare level of the subway but comparable to that of the train (Class 1) between Cairo and Giza.

Table 7.1-2 Fare Levels of Public Transport Modes

Section	Type of Service	Fare (LE)	Travel Time (min.)	ΔF/ΔT (LE/min.)	Fare Rate (LE per km)
Inter-City Train					
Cairo-Alexandria (208 km)	Express, Class 1	34	150	-	0.163
	Ordinary, Class 1	28	240	-	0.135
	Difference (Δ)	ΔF=6	ΔT=90	0.067	-
Cairo-Tanta (86 km)	Express, Class 2	8	60	-	0.093
	Ordinary, Class 2	4.5	95	-	0.041
	Difference (Δ)	ΔF=3.5	ΔT=35	0.10	-
Subway (Metro)					
All Lines and Sections		0.75 (Uniform flat rate)			

It should be noted that these public transports are subsidized by the government. For example, the construction cost of the existing subway lines are not covered by the fare revenues. CTA bus services also receive considerable amount of subsidy from the government. Therefore, these public transports do not reflect the real financial costs for the services. (In view of this situation, it may be justified that the government subsidize the planned urban expressway as necessary.)

In the table, the ratios of ΔF/ΔT are shown. (ΔF and ΔT are the differences of fares and travel times between the express train and ordinary train, respectively.) ΔF/ΔT expressed in terms of LE/min is considered to represent the value of time of the passengers traveling by the trains. These time values are LE 0.1 or lower and much lower than that of vehicles used in the economic/financial analysis of the expressway network in this Study. This difference of time values between the train and motor vehicles on the expressway network may be explained, at least partly, by the following facts:

(i) The time value of train is calculated for one passenger while the time value of the vehicles is estimated for one unit of the vehicle which carries about 2 passengers on average.
(ii) The average income level of the owner and/or passengers traveling in motor vehicles is higher than that of the passengers traveling by train.
(iii) The fare levels of trains are not reflecting the real cost of operation of the trains because of the subsidy by the government.

(5) International Comparison

(a) Urban Toll Roads

In the countries where urban toll roads exist, “flat toll system” (the system where the same amount of toll is collected regardless of the distance of travel on the toll road[1]) is often adopted. Table 7.1-3 shows the toll levels (for passenger car) of urban toll roads (flat rate) in several countries.

1 See Item (7) “Flat Toll System and Distance-Dependent Toll System” of this Subsection for more detailed explanation.

Table 7.1-3 Toll Levels of Urban Roads in the World (Flat Rate per Entry)

Country	Name of Toll Road	Fare			Length (km)	Toll per km* (US Cent)	GDP/Cap[2] (US$)
		Local Currency	Exchange Rate	US $			
Japan	Metropolitan Expressway[3]	JPY 700	120	5.83	283	29.15	37,180
Indonesia	Jakarta Intra-Urban Toll Road	Rp 4,000	8,940	0.447	49	2.24	1,140
Philippines	Manila Skyway[4] Elevated Section	P. 75	56.04	1.34	9.3	14.4	1,170
	Manila Skyway Magallanes-Bicutan	P. 20	56.04	0.357	6.6	5.41	
Thailand	Bangkok Expres'wy Stage I & II	Bht. 40	40.22	0.995	75.6	4.98	2,540
	Don Muang Tollway	Bht. 20	40.22	0.497	15.5	3.21	

* Where the total length exceeds 20km, toll per entry was divided by 20 km, considering average trip length on urban expressway.

Source: "Expressways of the World", Express Highway Foundation of Japan, 1999 (in Japanese language) (Except Footnotes 1 and 2)

In the above table, the toll levels per km are calculated as [Toll / 20 km], assuming that the average trip length on the toll road network is 20 km.

Figure 7.1-12 shows the relation between the toll level of urban toll road and GDP/Capita. In this figure, it is seen that the toll level of urban toll road in these countries, except Japan, ranges between around US$ 0.5 and around US$ 1.5, regardless of GDP/Capita. (The data are available for the countries whose GDP/Capita are around US$ 1,000 – 2,000 level.)

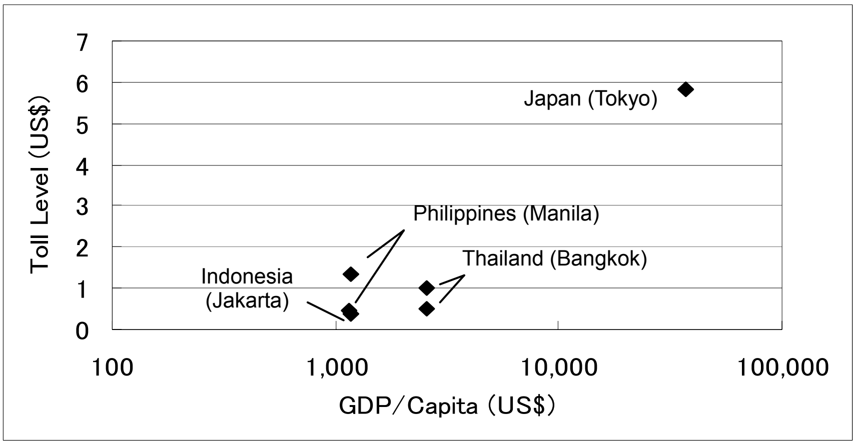


Figure 7.1-12 Relation between Toll Level of Urban Toll Road and GDP/Capita

2 Source: The World Bank, "World Development Indicators Database", 15 July 2005 (Figure for 2004)
3 Source: "Metropolitan Expressway Public Corporation Guide, 2004"
4 Source: "The Development of Public-private Partnership Technique for The Metro Manila Urban Expressway Network, Final Report, Vol. I: Main Text", March 2003

(b) Interurban Toll Roads

More data are available on interurban toll roads (expressways) than on urban toll roads. In this case, "distance-dependent toll system[5]" is widely adopted. Table 7.1-4 shows the toll level of interurban toll roads for passenger car in various countries.

Table 7.1-4 Toll Level of Interurban Toll Road

Country	Name of Toll Road	Toll Level (per km)			Remarks
		In Local Currency	Exchange Rate	In US ¢	
USA	New Jersey Turnpike	US ¢ 3.40	1.00	3.40	
France		EU ¢ 6.73	1.21	8.14	Ave. of ASF Rd. (Different line: Different toll level)
Italy	Autostrade	EU ¢ 5.2	1.21	6.29	Different toll level among the toll road operators
Japan	National Expressway	JPY 24.6	120	20.5	Uniform nationwide
Malaysia	North-South Expressway	MR ¢ 10.5	3.80	2.76	
Indonesia	Jakarta-Cikampek	Rp 90.3	8,940	1.01	Opened in 1988: 72km
	Padalarang-Cileunyi	Rp 85.8	8,940	0.960	Opened in 1991: 46.6 km
	(Semarang-Bawen)	(Rp 300)	8,940	3.36	Being planned as PPP project
Korea[6]	NA	NA	-	3.54	
Hungary[6]	NA	NA	-	4.50	
Brazil[6]	NA	NA	-	2.30	

In case of Indonesia, the toll rates of the roads in operation (Jakarta-Cikampek and Padalarang-Cileunyi) are relatively low (around 1.0 cent per km). On the other hand, that of the road under planning is about 3 times more expensive than those of the roads in operation, and is comparable to that of Korea and Malaysia. This substantial difference of toll levels in Indonesia may be attributed to large inflation which occurred after the roads currently in operation had been completed and the construction costs had been deflated.

Figure 7.1-13 shows the relation between the toll rate and GDP per Capita of the countries listed in Table 7.1-4.

5 See Item (7) of this Subsection for explanation of distance-dependent toll system

6 Source: Same as Footnote 4 in the previous page.

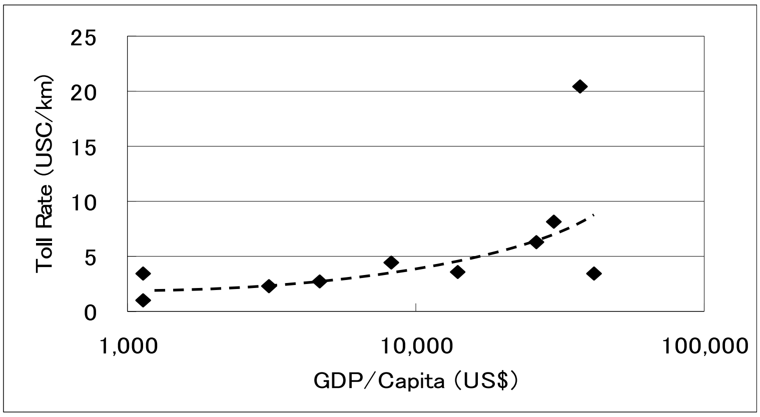


Figure7.1-13 Relation between Toll Rate and GDP/Capita

It is seen in the figure that the toll level increases in general as GDP per Capita increases. It is also observed that the toll level ranges between US ¢ 2 and 3 per km for the GDP per Capita of US$ 1,000 to 5,000. As shown in Table 7.1-4, the assumed toll rates per km of the urban toll roads in the countries with similar GDP per Capita levels ranges from US ¢ 2.2 to 14.4 and are considerably higher than those of the interurban toll roads.

(6) Examination of Toll Level Which Maximizes the Toll Revenue

Examination of the toll level which maximizes the total toll revenue is important to see the financial viability of the toll road project. Figure 7.1-14 shows the relation between the toll rate for passenger cars and the total toll revenue over the whole expressway network obtained through the traffic forecast and financial analysis conducted in this Study. (Detailed explanation on this figure is given in Chapter 5.)

It is observed in the figure that the maximum revenue is obtained at the toll rate of LE 4 to 5 for the year 2012 and LE 7 for the year 2022. These values are approximately two thirds (2/3) of the benefit of the road users in the respective years (LE 7.3 and 10.3).

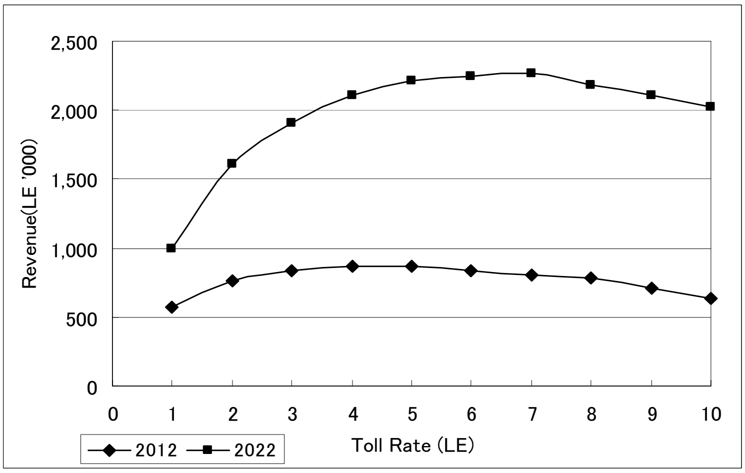


Figure 7.1-14 Relation between Toll Rate and Total Toll Revenue

(7) Ratio of Toll Level Among Vehicle Types

Usually, different toll is imposed on different types of vehicles. For this purpose, vehicles are categorized 3 to 6 types in many countries. (In case of urban toll roads, vehicles are sometimes classified into two types to reduce the time of identifying the vehicle classification and toll collection.) In Egypt, the existing Road Law adopts 5 vehicle types as described in Item (5) of Subsection 7.1 above. The ratio of the lowest toll (for passenger cars) and the highest (for "heavy duty vehicles") is 1 to 5.

The ratios of toll rate among the vehicle types are determined mainly considering the following factors:

(i) Impact on the maintenance/operation cost (the extent of damage of road facilities caused by each vehicle type)
(ii) Impact on the construction cost
(iii) Impact on traffic congestion
(iv) Magnitude of benefit accruing from usage of the toll road
(v) Other factors such as promotion of industry (The ratio for heavy vehicles are discounted.)

There is an opinion widely insisted in the world as summarized below:

"The damage of pavement caused by a vehicle is proportional to the 4^{th} power of the axle load. For example, a heavy truck with an axle load of 10 tons causes damage of pavement 10,000 times larger than that caused by a light vehicle with an axle load of 1 ton. Therefore, users of heavy vehicles should pay tolls (or any other form of road user charges) 10,000 time larger than that paid by the user of a passenger car."

Although it is widely accepted that the damage of pavement is proportional to the 4^{th} power of axle load, the above opinion is evidently focusing only one of the several factors related to the toll rate. The following facts need to be also considered.

(i) Construction cost is not proportional to the vehicle weight. For example, the largest portion of the weight supported by a bridge or viaduct is the "dead load" (the weight of the bridge/viaduct itself) and the weight the vehicles (called "live load") is smaller than the dead load. Thus the increment of the construction cost needed to let the heavy vehicles is not more than 50 % of the entire construction cost.
(ii) According to the Highway Capacity Manual (HCM) published by the Transport Research Board of USA (TRB) (considered as the standard textbook of traffic capacity of roads) the magnitude of impact of a heavy truck on traffic congestion is 3 to 5 time larger than that of a passenger car. (This ratio is called "Passenger Car Unit" or "pcu".)

Factors other than those describe above, such as promotion of industrial activities, are also considered, and the ratio of toll level between a passenger car and a heavy vehicle is usually 1:3 ~ 1:5 in many countries. The above stated ratios in Egypt are comparable to the international standard.

(8) Flat Toll System and Distance-Dependent Toll System

There are basically two types of toll rate system; Flat Toll System and Distance-Dependent Toll System. Flat Toll System and Distance-Dependent Toll System are commonly called "Open (Toll) System" and "Closed (Toll) System", respectively. The "Glossary" published by the International Bridge, Tunnel and Turnpike Association (IBTTA) defines these systems as follows:

Open Toll Section (System): Section (system) of a toll road where a fixed amount is paid, not depending on the distance traveled or on where the vehicle enters or exits the road.

Closed System: A system that monitors your entrance and exit and calculate the toll on the basis of distance traveled.

In this Study, the words "Flat Toll System" and "Distance-Dependent Toll System" are used to express the characteristics of these toll systems more explicitly.

The advantages and disadvantages of the two toll systems are compared in Table 7.1-5.

Table 7.1-5 Comparison of Flat Rate and Distant-Dependent Toll System

Toll System	Advantage	Disadvantage
Flat Toll	Shorter toll collection time than distant-dependent system.	Users with short travel lengths pay higher rate of toll (per km).
Distance-Dependent	Fair to the all toll road users.	Need complex toll calculation/ collection machine.

Usually flat toll rate is used in urban toll road networks and "turnpike" or "bypass" type of toll roads which are separated from regional or nation-wide toll road network for some reason. The main reasons that the flat toll rate is used in urban toll road network are as follows:

(i) There are no large variations of the travel distances on the toll road among the vehicles compared to interurban toll roads.

(ii) The time required to collect the toll is shorter than that of distance-dependent system and the area required to install toll booths can be smaller than in the distance-dependent system: This is important to minimize the necessity of land acquisition which is very difficult in the cities: Also longer toll collection time needs to be avoided since the total travel time is short and the ratio spend in toll collection becomes larger than in case of interurban toll road.

(iii) Since urban expressway tend to be congested because of high traffic demand and the expected function may not be fully exerted, it is appropriate to discourage the short-distance use of the toll road.

Contrary, distance-dependent toll system is used in interurban toll roads mainly for the reasons which are vice versa to the reasons (i) and (ii) above.

The rapid development of ETC (Electronic Toll Collection) technologies in the recent years has enabled the toll collection time much shorter than the conventional method such as manual toll collection or punch-card system. Also the advancement in ETC technologies has much shortened the time required to classify the vehicle types and calculate the toll amount, resulting in the shorter length of entrance lane to the tollbooth. Thus, it is possible to introduce distance-dependent toll system, or even toll system which allows discounted toll rates during non-peak hours, in the urban toll road network if ETC is adopted. It should be noted that the technologies of ETC is advancing very rapidly and the state-of-the-art technology of today may be outdated a few years later. The most suitable toll collection system needs to be determined in the detailed design stage or even later. (See Subsection 8.2.3 of Chapter 8 for more explanation of ETC.)

7.1.4 Toll Adjustment Mechanism

Toll is collected for a considerably long period, such as 30 years, after the toll road network is completed. It is highly possible that substantial inflation of the economy occurs during this period. This inflation is almost unavoidable because the expressway network accelerates the economic growth of the nation and economic growth is usually accompanied by inflation. (Inflation can occur even during the construction of the expressway network because of the large-scale investment for the expressways.)

To cope with the inflation, the toll rate is adjusted (usually raised). Toll adjustment becomes necessary also as the new sections are added to the existing expressway network to cover the construction costs of the newly added sections. Further, if a foreign currency is invested to finance the expressways and this investment is to be recovered by the toll revenue, toll level has to be adjusted to cope with the change in the exchange rate between the local currency and the invested foreign currency.[7]

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[7] The problems of toll rate adjustment to cope with the change in exchange rate is discussed in Subsection 13.7.2 of Chapter 13.

Figure 7.1-15 shows the change of toll rate and the price level with the increasing ratio in the case of the Metropolitan Expressway Network in Tokyo.

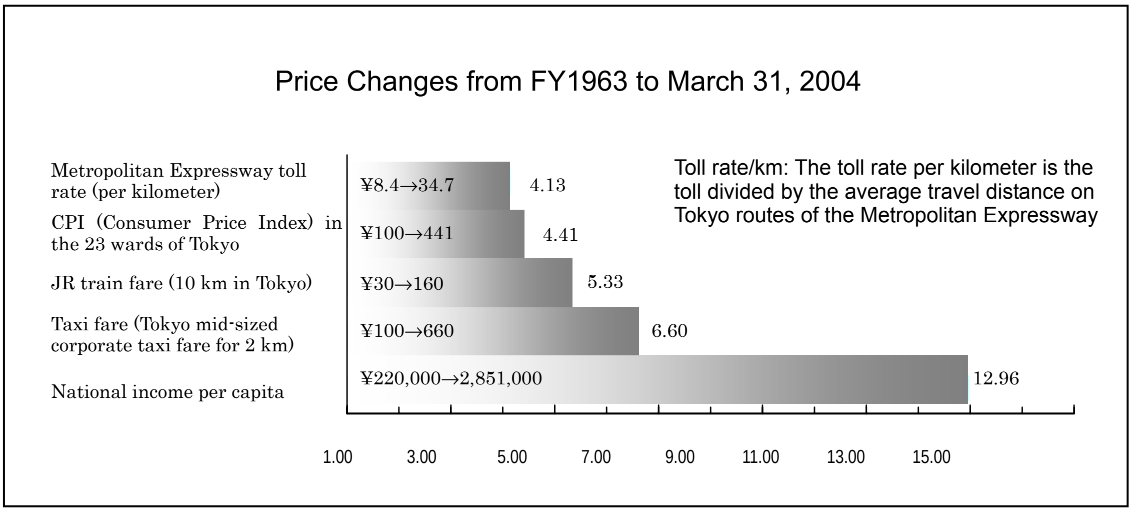

Figure 7.1-15 Change of Toll Rate of Tokyo Metropolitan Expressway Network

Figure 7.1-16 shows the historical change of toll rate (including adjustment for the change in price level as shown in the above) and the growth of the total length of the expressway network in case of the Metropolitan Expressway in Tokyo.

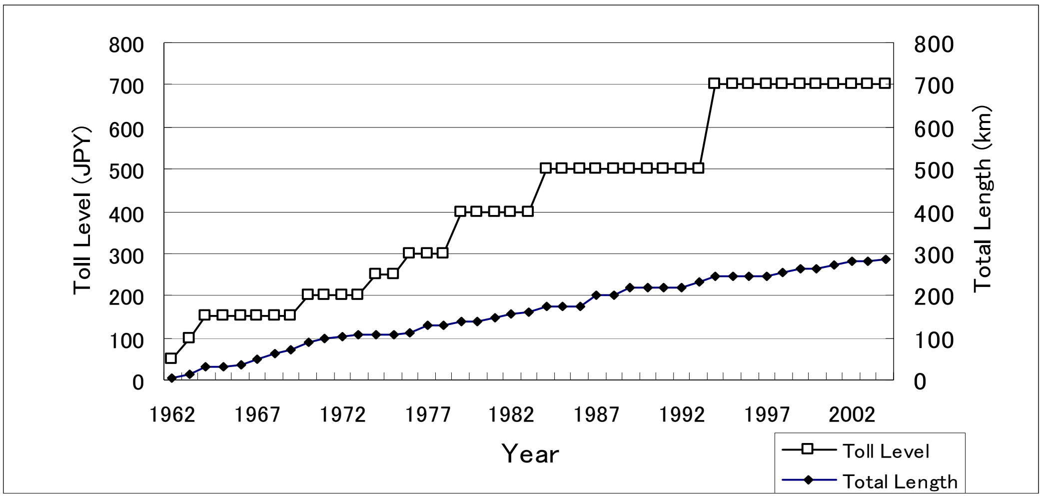

Figure 7.1-16 Change of Toll Level and Total Length of Tokyo Metropolitan Expressway

7.1.5 Cross Subsidy and Flat Toll System

Usually the unit construction costs (per km) of the expressways differ from one section/line to the other. On the other hand, same (flat) toll rate is applied over the entire network. Accordingly, some sections/lines are more profitable than others and some sections are less profitable than others. Therefore, there is a need to establish a mechanism whereby the surplus of profit from the very profitable sections/lines is used to subsidize the less profitable sections/lines. Thus, the operator (owner) of the newly connected section/line is entitled to claim some portion of the increased income of the existing section/line.

If different sections/lines are constructed and operated by different entities, this mechanism is indispensable. If the whole network is constructed and operated by a single entity, like MEA, this transfer of the surplus of the profit is done internally. In such case, this mechanism is called **"Cross Subsidy"** or **"Toll Revenue Pooling System"**.

This system is also necessary because of the differences of profitability among the sections/lines caused by such factors as; (i) the difference of the nominal unit construction cost (per km) due to the inflation occurring over the construction period of the entire network, and (ii) difference of traffic volume (toll revenue).

Still another reason for the necessity of cross subsidy among the lines/section of the toll road network is that the traffic volume (toll revenue) of the existing line/section increases as a new line/section is connected to it. In other words, the increase of toll revenue in such case is attributed to the connection of the new line/section.

7.2 INSTITUTIONAL SETUP

7.2.1 Introduction

One of the main tasks of this Study is to identify the public authority counterpart for traffic management and maintenance of the proposed expressway network as well as to design the organization for management and maintenance of the expressway network. This section discusses the institutional setup of such an organization.

7.2.2 Institutional Setup Proposed in CREATS

CREATS recommended establishing "the Ministerial Committee for Greater Cairo Region Transport" (MCGCRT) and "Cairo Metropolitan Transport Bureau" (CMTB) to promote integration and coordination of all transport-related activities in the Greater Cairo Region. (Section 9.6, Chapter 9, Phase I Final Report Volume III)

The proposed committee members of the MCGCRT are;

- Minister of Transport (MOT)
- Minister of Interior (MOI)
- Minister of Housing, Utilities and Urban Communities (MHUUC)
- Minister of Environment (MOE)
- Cairo Governor
- Giza Governor
- Qalyobeya Governor.

The functions of MCGCRT were proposed as the following:

(1) Approval and ownership of the Greater Cairo Transportation Master Plan. By ownership we (the CREATS Consultants) mean that the Committee will be in charge of the overall implementation of the Master Plan. It will seek the approval of the Master Plan by the cabinet. It will take active steps to include the projects components of the Master Plan into the successive five year plans and seek the required approval of the Ministry of Planning, Ministry of Finance and the People's Assembly.
(2) Take the necessary steps for the establishment of Cairo Metropolitan Transport Bureau (CMTB) and the local traffic management bureaus.
(3) Charting the policies for the operation of CMTB and local traffic management bureaus.
(4) Supervise and monitoring of the functions of CMTB.
(5) Approval of the recommendations of CMTB.
(6) Coordination and integration between the related ministries and governorates.
(7) Budget allocation for the related organization in coordination with the Ministry of Planning and the Ministry of Finance.

CMTB was proposed to be "the main player" in integrating and coordinating of all transport-related activities in the Greater Cairo Region. Figure 7.2-1 shows the organization chart of CMTB proposed in CREATS.

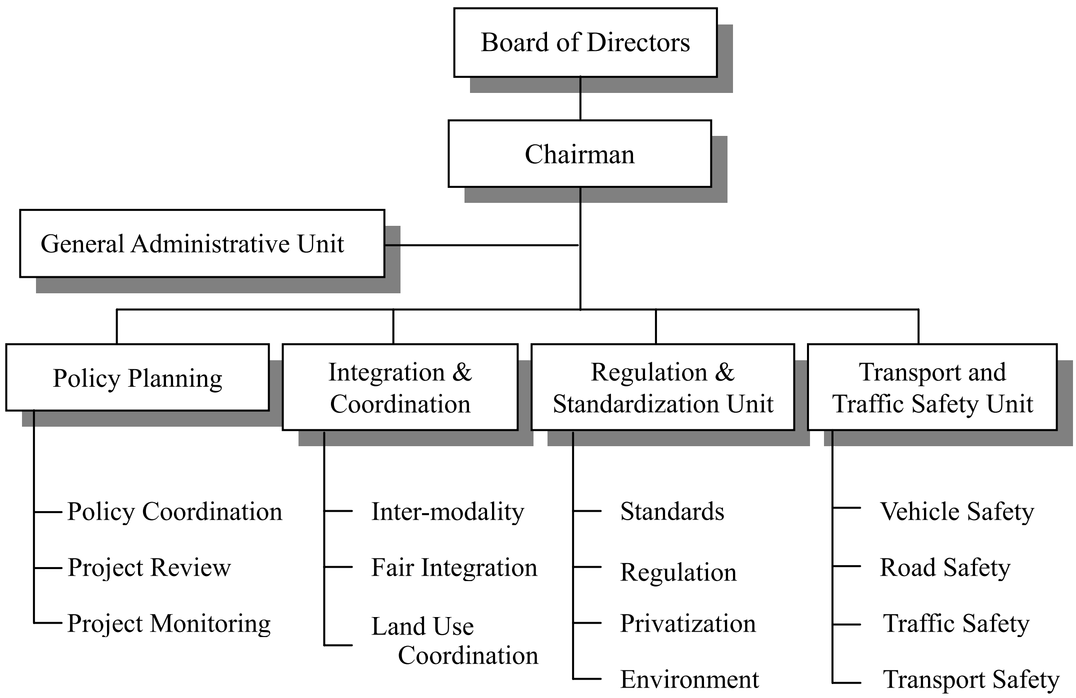

Figure 7.2-1 Organization Chart of CMTB (Phase I, CREATS)

It is interpreted that the basic functions of MCGCRT and CMTB are coordination of the activities related to the urban transport system in GCR and not direct planning or implementation of practical construction or operation of the transport facilities.

Chapter 5 (Urban Road System) of the same report recommends to establish a new organization, “hypothetically named as Metropolitan Expressway Authority” (MEA), to be exclusively responsible for the implementation of the proposed urban expressways. (No detailed discussion on this organization was given in the report.) It is also interpreted that such organization be included in the framework of MCGCRT and operate with close coordination with MCGCRT.

As of November 2005, the Government of Egypt is processing the preparatory works for the further study of the process for establishment of MCGCRT.

7.2.3 Existing Organization for Toll Road

Among the existing organizations, Investment Roads Department of GARBLT is dealing with the matters related to the toll roads, including those constructed and operated by the organizations, such as the National Company under the Ministry of Defense, as well as those directly operated by GARBLT.

Investment Roads Department of GARBLT is currently operating four toll roads and one toll bridge. Accordingly, it has substantial experience in operation of interurban toll road, including toll collection. Figure 7.2-2 shows the organization chart of the Investment Roads Department of GARBLT.

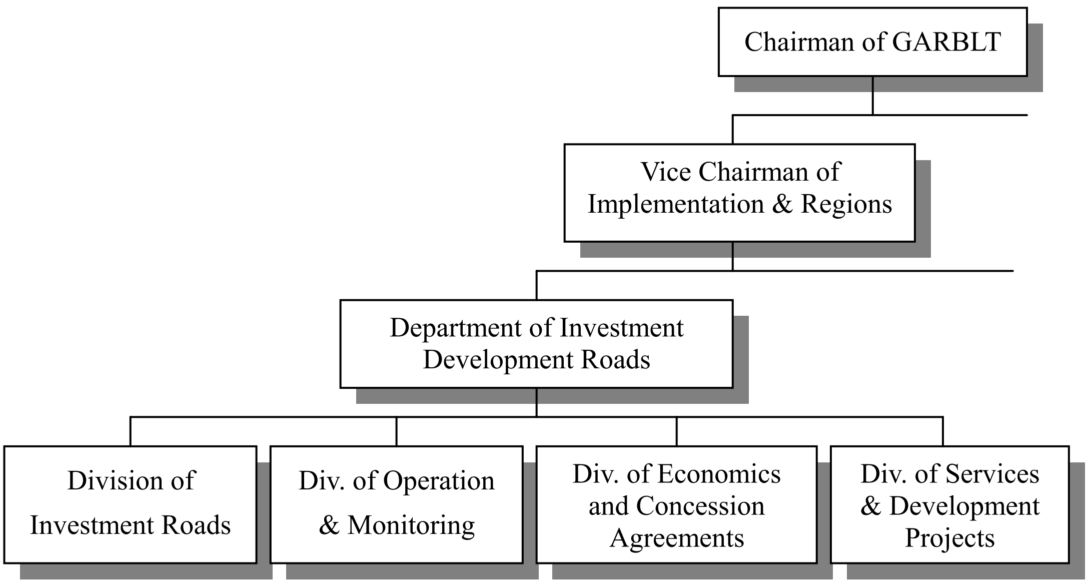

Figure 7.2-2 Organization Chart of Directorate General of Investment Roads

7.2.4 Necessity of New Organization for Urban Toll Expressway Network

To actually implement the projects for construction and operation of the proposed urban toll expressway network, some government agency need to deal with a vast volume of tasks to tackle a wide spectrum of problems. This is the case even if the entire network will be constructed and managed by the private entities, if the Government is to plan PPP packages, evaluate the proposals, negotiate with the proponents and monitor the implementation including management of the expressway. In addition to this, following facts necessitates a new organization:

(i) An urban toll expressway network is a novel transport infrastructure to Egypt, in a sense. Design, construction, maintenance and operation of this new transport infrastructure needs to be based on a new ideas not influenced by the precedent cases or old ideas.

(ii) The proposed urban expressway network is to cover three governorates of Cairo, Giza and Qalyobeya. No existing organization has such a jurisdiction.

In many countries where the toll road system is extensively used, organizations for construction/operation of toll expressways have been established. Table 7.2-1 shows some of the examples of such toll road organizations.

7.2.5 Alternatives of Institutional Setup

A few alternatives are possible for the institutional setup of the new organization as discussed in the following:

(1) Alternative 1

<u>Alternative 1</u>

Establish a new organization, such as "Metropolitan Expressway Authority" (MEA) and its governing mechanism. This governing mechanism may be such as "MEA Council" where representatives of MOT, the relevant governorates and other relevant agencies, or in the form of participation as the "shareholders", provided that the MEA is established as one of the "share-holding company" of the government under the existing legal framework.

MEA is to be responsible for implementation of the planned expressway network, including agreeing the contracts with the PPP entities. Figure 7.2-3 schematically illustrates the relation between the Government, MEA and PPP entities.

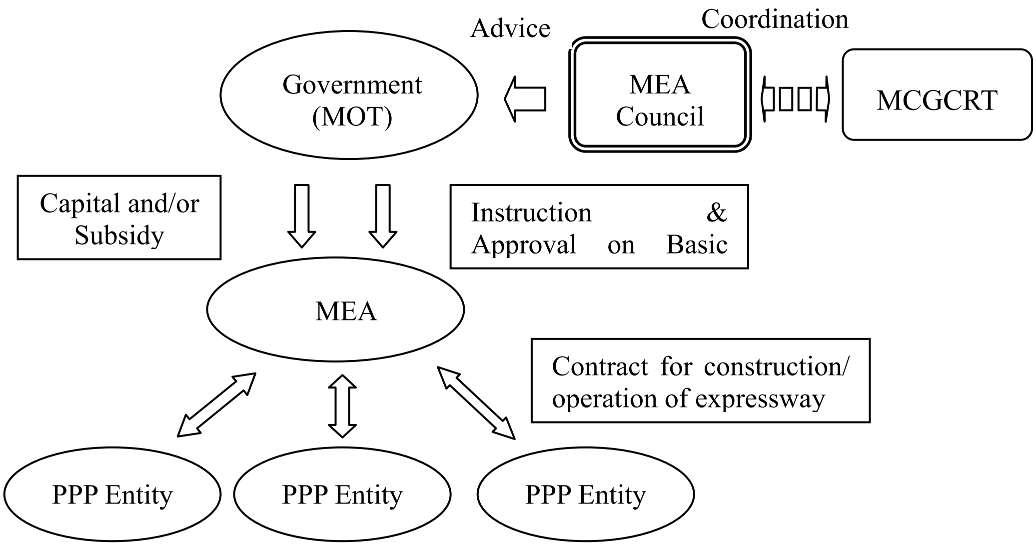

Figure 7.2-3 Fundamental Relation between Government, MEA and PPP Entities

The most important advantage is that this organization can be capable of directly constructing[1] a new expressway, if appropriate. As discussed in Chapter 11, one of the preferable scenario is that the newly established organization construct and manage some sections of the new expressway and accumulate know-how of construction, maintenance, toll collection, traffic management and other matters needed in construction through management of the toll expressways and utilize it in evaluation of the proposals, and negotiations with the proponents, of PPP projects for the expressway.

(2) Alternative 2

Alternative 2 A new division (or section) to deal with the necessary tasks for the implementation of the expressway is established within the Ministry of Transport.

Figure 7.2-4 illustrates the relation between the Government and PPP entities with Alternative 2.

[1] In this section, the word “construction of the expressway by MEA” is used to mean “construction management” (procurement and supervision of the relevant civil works).

Table 7.2-1 Toll Road Organizations of Various Countries (1/2)

Country	Name of Organization	Legal Status and Function	Remarks
Asia			
Japan	1. Japan Highway Public Corporation 2. Metropolitan Expressway Public Corporation 3. Hanshin Expressway Public Corporation 4. Honshu – Shikoku Bridge Authority 5. Toll Road Authorities owned by the local governments	1 & 4: 100 % owned and supervised by the central government. 2 & 3: Owned jointly by the central government and the relevant local governments. Mainly supervised by the Minister of Land, Infrastructure and Transport, but basic policy needs to be agreed by the Council where the governors of the local governments are the members. 1: Responsible for the construction & operation of the national expressway network system. 2 & 3: Responsible for the construction & operation of the urban expressway network in and around Tokyo and Osaka – Kyoto – Kobe Area, respectively. 4. Responsible for the construction and operation of bridges and highways connecting Honshu (the main island) and Shikoku Island.	Currently being privatized
China	Provincial Expressway Corporations or newly established Expressway Construction Headquarters in the Provincial Government	• 100 % owned by the Provincial Government or a part of the Provincial Government • Responsible for construction and operation of the part of the National Trunk Highway System (NTHS) in the Province	Central Govt. is responsible for NTHS planning
Korea	Korean Highway Corporation	• 100 % owned by the central government. • Responsible for inter-urban expressways	
Indonesia	Indonesian Highway Corporation (PT Jasa Marga)	• 100 % owned by the central government. The Ministry of Finance act as the shareholder. • Supervised by the Board of Commissioners, comprising Director General of Roads, Representative of the Ministry of Finance, Representative of National Traffic Police Dept. and others. • Operating large portion of the toll roads in the country • There are several toll roads constructed and operated by private investors.	
Malaysia	Malaysia Highway Authority (Lembaga Lefuhraya Malaysia)	• 100 % owned by the central government. • Supervised by the Minister of Public Works • Responsible for construction/operation of toll expressways	
Thailand	Expressway and Rapid Transit Authority (ETA)	• Responsible for construction/operation of urban expressways network and mass-transit (light rail) system in Bangkok Area	
Vietnam	Vietnam Expressway Corporation (VEC)	• Recently (April 2005) established to be responsible for construction/ operation of the national expressway network. • Details not yet decided	

Table 7.2-1 Toll Road Organizations of Various Countries (2/2)

Country	Name of Organization	Legal Status and Function	Remarks
Europe*			
Italy	1. ANAS 2. Autostrade S.p.A 3. Concessionaires invested mainly by the local governments	1: 100 % owned by the central government and is responsible for construction/operation of expressways (autostrade). 2 & 3: Implement construction/operation of expressways under the contracts with ANAS ● ANAS started construction of the expressways after the World War II	
France	1. SEM: Societes d'Economie Mixte Concessionnaires d'Autoroutes 2. Cofiroute (Private Company) 3. Others	1: Owned either (i) by a single local government, or (ii) jointly by multiple number of local governments, or (iii) jointly by local government and chamber of commerce. There are various SEMs which construct and operate expressways (autoroutes) by the concession with the central government. 2: 100 % private company. Function is same to SEMs. 3: Special companies established to be responsible for operation of particular facilities such as Mont Blanc Tunnel.	
Austria	AFINAG: Autobahnen und Schnellstrassen Finanzierung Aktiengesellschft	● AFINAG was established in 1982 to finance expressway projects and remodeled in 1997 to be responsible for toll collection of expressways.	

*Source: Express Highway Research Foundation of Japan, "Situation of Expressways in Foreign Countries", May 2005 (in Japanese language)

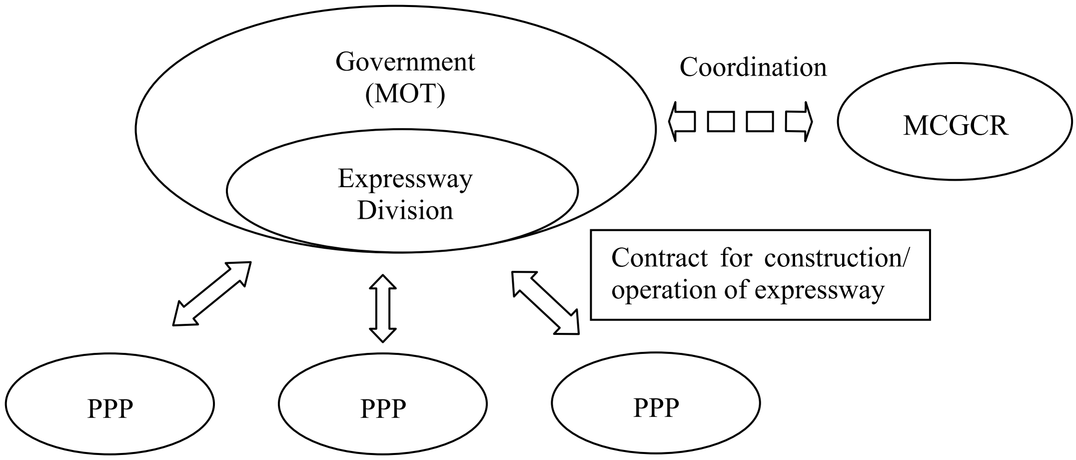

Figure 7.2-4 Relation between Government and PPP Entities

The largest advantage of this alternative is that the new organization can be established with relatively little preparatory works because it can be formed by strengthening an existing appropriate division of the ministry, such as the Investment Department of GARBLT.

The largest disadvantage of this alternative is that crucial decision may be influenced by the precedent cases relevant to ordinary (non-toll, low- standard) roads and may be inappropriate for the cases of expressways.

Another disadvantage may be that the salaries and other benefits for the personnel in the newly established organization needs to be same to other divisions of the Ministry, reducing the morale of the newly established division which is indispensable for accomplishing the demanding and challenging tasks required for implementation of the expressways, or the new type of road facilities. Further, other problems caused by the rigidities due to the regulations to the government agencies and/personnel may arise.

(3) Alternative 3

<u>Alternative 3</u>
A new organization is established with main initiatives of, and supervised by, the relevant governorates (Cairo, Giza and Qalyobeya).

The justification for this setup is that the planned urban expressways belong to the jurisdictions of these three governorates in the existing legal framework.[2] Figure 7.2-5 illustrate the relation between the three governorates, MEA and PPP entities.

[2] If the proposed urban expressway network is considered not to belong to the jurisdictions of the said governorates, this alternative becomes irrelevant.

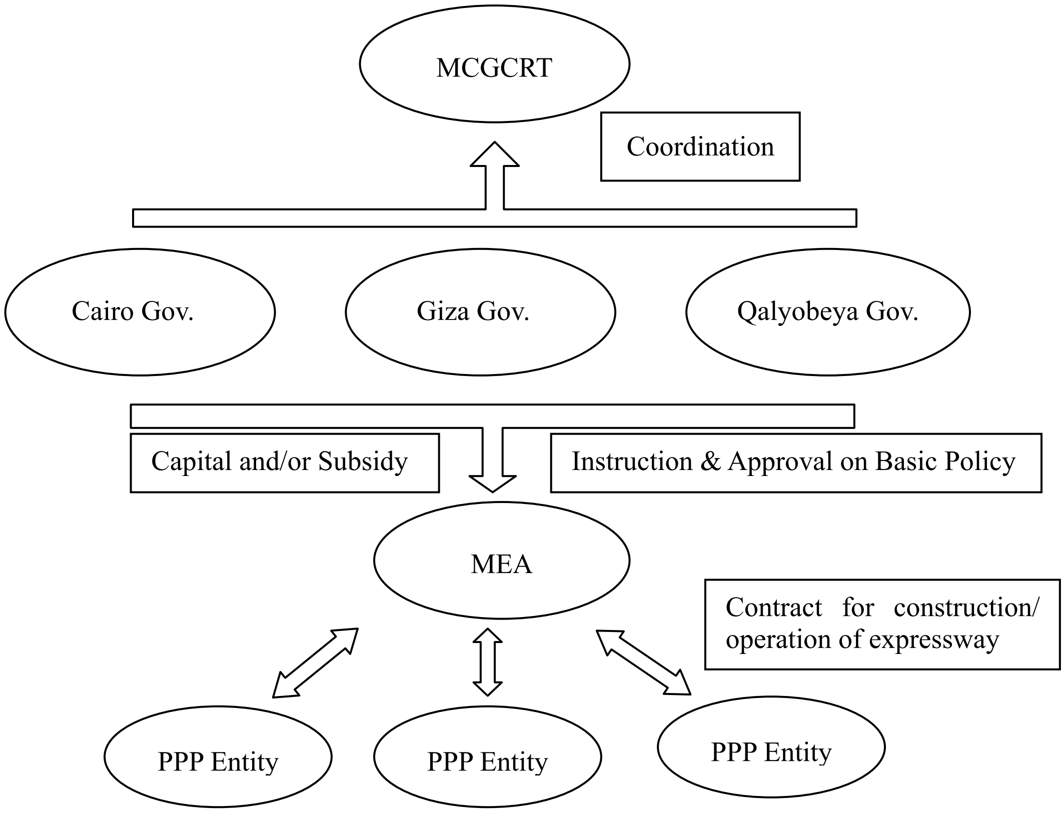

Figure 7.2-5 Relation between Three Govenorates, MEA and PPP Entities

One of the advantages of this alternative may be that Cairo Governorate has experiences of constructing and maintaining the existing urban expressways (E-1 and E-2).

On the other hand, the largest drawback of this scheme is that a conclusion may become difficult to reach in case where serious conflict among the concerned governorates arises, such as priority of construction. This problem may become very serious to hamper smooth implementation of the planned urban expressway network.

There is a ministerial committee for the coordination of the three governorate. This committee may function as one of the governing bodies for MEA. However, in this case, the role of the MEA Council has to be reviewed to avoid the duplication. Also, it is probable that the ministerial committee for the coordination of the three governorates needs considerable strengthening of the capacity in dealing with a novel task on planning, operation and coordination of the expressway network.

(4) Alternative 4

<u>Alternative 4</u> A new organization is established as a joint venture enterprise with investment by the Government and private investors.

In this alternative, a new organization is established as a joint venture enterprise with investments by the Government and private investors. This type of enterprise is often called "third sector enterprise". This kind of enterprise is expected to have good points of both Government (serve for "public interest") and private sector (efficiency). In reality, however, this type of enterprise tend to fail because both the management and employees tend to act as "government" (inefficient) and expected merits are not realized.

Table 7.2-2 compares "pros and cons" of the possible alternatives of the institutional setup. Considering these pros and cons, it is recommend that the Alternative 1 (establishing Metropolitan Expressway Authority "MEA" under the supervision of the Minister of Transport) as the most preferable plan of institutional setup. However, Alternatives 2 and 3 are also possible, and can be better options depending on the administrative, political and social background of the Greater Cairo Region. **Diligent discussions with the Government including the Higher Committee for this Study supports this recommendation.**

7.2.6 Governing Mechanism of Metropolitan Expressway Authority

Assuming that the establishment of a new organization like Metropolitan Expressway Authority (MEA) is opted, the mechanism to govern such a new organization need to be considered. This section discusses such a governing mechanism. For the purpose of discussion, it is assumed that MEA is responsible for the implementation of the planned expressway network exclusively and solely. In other words, it is assumed that (i) all the PPP projects for the planned urban expressway network are supervised by MEA, and (ii) MEA is allowed to directly construct[3], maintain and operate (collect toll) any section of the planned expressways. (The necessity for allowing the functions to directly construct and operate some sections of the planned expressways is discussed somewhere.) Here also, a few alternatives are possible:

(1) Alternative 1

Alternative 1
MEA is supervised by the Minister of Transport with advice or recommendation by the MEA Council consisting of the representatives from the relevant agencies including the concerned governorates.

[3] In this section, the word "construction of the expressway by MEA" is used to mean "construction management" (procurement and supervision of the relevant civil works), as explained in the footnote of Page 7-27.

Table 7.2-2 Comparison of Pros and Cons for Alternatives of Institutional Setup

Alternative	Description	Pros/Advantages	Cons/Disadvantages/Prerequisites	Evaluation
Alt-1	Newly Establish an independent organization, such as "Metro-politan Expressway Authority" (MEA) and its governing mechanism.	• Suitable for implementation of the expressway development which is a "novel task". • Can operate autonomously with minimum inputs by the government. • Can construct a new section of expressway, if necessary and appropriate.	• Needs consensus of the relevant parties including MOT and the governorates of Cairo, Giza and Qalyobeya.	○
Alt-2	Establish a new division in MOT (or other Ministry)	• Easy to start the actions	• Newly established division will become very large both in the staff size and the budget compared to other divisions. • May be influenced by the precedent cases relevant to ordinary (non-toll, low- standard) roads and may make inappropriate decision. • Salaries and other work conditions the personnel have to be same to other personnel of the Ministry even if much higher efficiency is required to cope with the private investors.	△
Alt-3	Establish a new organization to be jointly supervised by the Governorates of Cairo, Giza and Qalyobeya	• Cairo Governorate has experiences of construction of the existing urban expressway (E-1 & E-2).	• Difficult to reach conclusion in case of conflict of interests among the governorates. • Considerable strengthening of capacities of both the Govenorates and the ministerial committee is probably required to handle this novel, large-scale project.	×
Alt-4	Establish a new organization as a joint venture enterprise with investment by the Government and private investors (Third Sector Enterprise)	• Good points of government (serve to public interest) and private (efficiency) is expected	• In reality, the merit as described in the left tends not to be realized.	△

Figure 7.2-6 schematically illustrates the basic arrangement for the governing mechanism of Alternative 1.

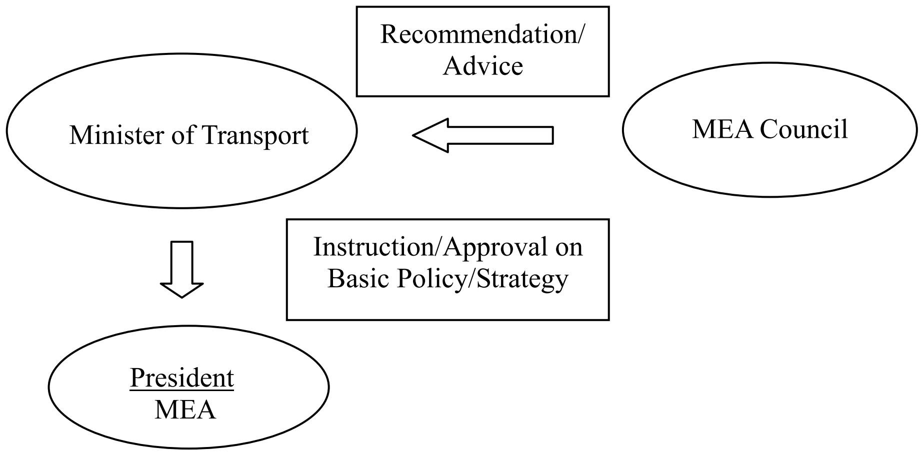

Figure 7.2-6 Basic Arrangement for Governing of MEA, Alternative 1

Table 7.2-3 describes the assumed functions of the governing bodies of MEA, and Table 7.2-4 lists the possible candidates for the MEA Council Members.

Table 7.2-3 Functions of Governing Bodies for Expressway Corporation

Minister of Transport • Act as the Chairperson of the Council • Act as the supervisor of the Expressway Corporation • Give order, instruction and approval to the President of MEA, based on his/her own decision or based on the recommendation/advise given by the MEA Council

MEA Council
• Represents the stakeholders
• Review the basic policy matters on the expressway network, including;
  ・ Priority of construction
  ・ Toll rate policy
  ・ Strategy for traffic safety
  ・ Environmental issues
  ・ Road user services
• Advise/recommend the Minister of Transport on the basic policy of expressway

President of the MEA
• Represent the MEA • Be responsible for overall operation of MEA • Act as a member of the Council and state the opinions from viewpoint of MEA as the implementing agency.

Table 7.2-4 List of Candidates as Members of MEA Council

No.	Position in the Council	Position in Mother Organization
1	Chairperson	Minister of Transport
2	Member	Chairperson of Parliament Transportation Committee
3	Member	Governor of Cairo
4	Member	Governor of Giza or Government of Qalyobeya
5	Member	Representative of Ministry of Planning
6	Member	Representative of Ministry of Finance
7	Member	Representative of Ministry of Housing
8	Member	Chairman of GARBLT
9	Member	Chairman of GOPP
10	Member	General Director of Central Traffic Police
11	Member	Chief of Traffic Police of Cairo Governorate
12	Member	Chief of Traffic Police of Giza Governorate
13	Member	Chief of Traffic Police of Qalyobeya Governorate
14	Member	Director of ENIT
15	Member	President of Expressway Corporation
16	Member	Representative of Public and Private Investors
17	Member	Expert of Road Transport Policy
18	Member	Expert of Road Transport Policy
19	Secretary (Non-Voting)	Executive Director of Expressway Corporation

The largest advantage of the governing mechanism as Alternative 1 is that the planned expressway network can be implemented effectively and efficiently owing to the consistent policy and strategy. The interests or opinions of stakeholders are reflected through the advice/recommendations presented by the MEA Council.

<u>Relation with MCGCRT</u>

The MEA Council needs to maintain close coordination with MCGCRT, if such committee will be established and functional. As of November 2005, MCGCRT has not been established. It is not certain whether or not MCGCRT will be established and functional in time for the operation of MEA. (MEA needs to be established in year 2007 according to the preliminary implementation plan being prepared by the Study Team.) If MCGCRT will not be functional in time for the operation of MEA, the MEA Council can tentatively act in place of MCGCRT. If MCGCRT will be functional in time, one of the possible arrangements for assuring close coordination between the MEA Council and MCGCRT may be that the MEA Council will be the subcommittee of MCGCRT.

It should be noted that the establishment of MCGCRT is very important for promotion/realization of the comprehensive transport plan of GCR as recommended by CREATS.

Other candidates of the MEA Council members

(i) Ministry of Environment (MOE)

It is necessary to maintain a close coordination with the Ministry of Environment in view of the anticipated environmental issues. (Since the expressways are to be constructed in densely populated area, diligent considerations on the environmental impacts and their mitigation measures are necessary.) Under the present legal framework, MEA or implementing institution is required to consult MEA and obtain approval on EIA and other documents. Such procedures are mandated by the present legal system concerning the environmental issues. Accordingly, MOE can review and demand necessary revisions on the plan and/or design of environmental measures. Therefore, it is not absolutely necessary that the Ministry of Environment is to be represented in the MEA Council. However, if it is expected that the participation of the representative of MOE in the MEA Council will expedite the process of the legal approval/concurrence by the Ministry, such representative should participate in the Council.

(ii) Number of experts of road transport policy

Number of the experts of road transport among the members of the MEA Council is tentatively proposed to be two in Table 7.2-4. Depending on the actual necessity, the number of such experts may be increased. Further, there may be necessity of inviting experts of other field. Considering these, it is recommended to include the following sentence in the rule of the MEA Council:

"If necessary and/or appropriate, the Chairman of the Council may call upon any expert(s), provided that the number of such expert(s) is within a reasonable range."

Semi-autonomous status of MEA

To maintain the consistency and efficiency, MEA should be allowed semi-autonomous status with supervision by the Minister of Transport on the basic policy matters only. Table 7.2-5 lists the recommended functions and powers given to MEA (or the President of the MEA).

Table 7.2-5 Power and Function of MEA

(i)	To borrow money needed for construction, maintenance and operation of the expressways.
(ii)	To use the entire, or any portion of, the toll revenue to maintain and operate the expressways and to amortize the loan that has been caused to obtain the funds for construction of the expressways.
(iii)	To directly construct, maintain[4] and operate any sections or lines constituting the proposed urban expressway network.
(iv)	To evaluate the proposals of PPP schemes for any sections or lines constituting the proposed urban expressway network and to enter contracts with appropriate proponents.
(v)	To regulate the traffic or stop the passage of vehicles on the proposed urban expressway network for the reason of protection or deficiency of road structure.

Item (i) above is necessary for MEA to obtain the necessary fund if MEA is to construct expressway. Even MEA will be responsible only for maintenance and operation, MEA may need to borrow money for short period in such case that serious damage of road facility occur and large-scale repair work becomes necessary. The amount of borrowed money should be limited so that it will not borrow excessively large amount of loan which MEA can not return by utilizing the toll revenue.

Item (ii) is necessary to allow MEA flexible and timely actions for maintenance and operation of the expressway since the problems occurring on the expressway have to be solved in a timely manner. For example, a pothole found on the pavement cannot be left for a long time with the reason of “unavailability of budget”.

Item (iii) is necessary because it is anticipated that some lines or sections have to be constructed by MEA, not PPP entities, for such reason of accumulating know-how, securing initial fund for subsidizing non-profitable lines/section and implementing the unprofitable lines/sections for which no PPP proposal is submitted.

Item (iv) is to let MEA handle all the matters of the urban expressway network and minimize the workload of the Ministry of Transport or any other relevant government institutions.

Item (v) is to secure the safety of traffic in hazardous situations which cannot be detected or handled by the traffic police.

[4] In this section, the word “construction and maintenance of the expressway by MEA” is used to mean “management of construction and maintenance” (procurement and supervision of the relevant civil works), as explained in the footnote of Page 7-27.

Although MEA is given semi-autonomous status, some important matter should be approved by the Minister. Table 7.2-6 lists the matters which need approval of the Minister.

Table 7.2-6 Matters which Need Approval by the Minister

(i)	Toll rate
(ii)	Annual budget (total expenditure, estimated revenue, plan of borrowing funds)
(iii)	Construction plan (Short-, Medium- and Long-Term Plans)
(iv)	Basic conditions of a concession contract for an expressway project to be agreed between MEA and the concessionaire (concession period, time of commencement and completion of construction, toll rate, if different from other sections, etc)

It is not preferable that the Minister or the Government strongly controls the toll rate because the toll rate needs to be decided based on the financial condition of MEA and the PPP entities. However, it is assumed that some form of control on the toll rate is needed since it is the price of the "public services" similar to the fares of bus, Metro (subway) and railroad. Therefore, Item (i) above is necessary.

Item (ii) is necessary to monitor the financial condition of MEA and take necessary actions to prevent "unhealthy" financial condition of MEA. Also, control of MEA's expenditure may become necessary to stimulate or cool down the macro economy of the nation since the relatively large-scale investment for the expressway network may substantially affect the national economy.

Item (iii) is necessary to coordinate the plan of the urban expressway network with the national road development plan.

Item (iv) is required to secure that PPP contracts are not prejudiced or unfair.

(2) Alternative 2

<u>Alternative 2</u>

MEA is supervised by the Prime Minister or a minister specially appointed by the President. The rest of the setup is same with Alternative 1.

In this case, the MEA Council is chaired by the Prime Minister (or the minister specially appointed by the President) and the Minister of Transport will participate as a member of the Council. Figure 7.2-7 shows the governing structure of Alternative 2.

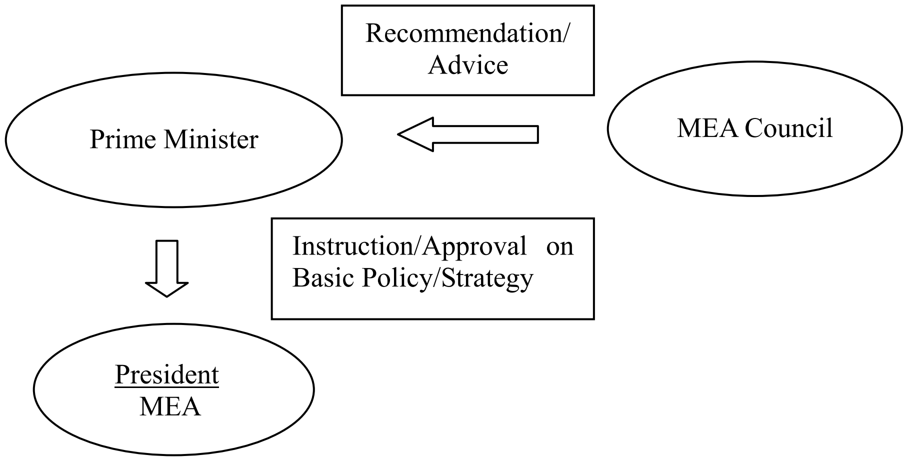

Figure 7.2-7 Governing Structure of MEA, Alternative 2

The largest advantage of this alternative is that the decision-making for politically difficult problems can be made quicker and implementation of the projects can be promoted more strongly than in Alternative 1.

(3) Alternative 3

Alternative 3

The stakeholders participate in governing MEA as the members of the General Assembly and/or the member of the Board as stipulated in the Public Business Sector Companies Law (Law No. 203 of the Year 1991) and its bylaw (Prime Minister's Decree No. 1590 of the Year 1991).

Figure 7.2-8 shows the governing structure of Alternative 3.

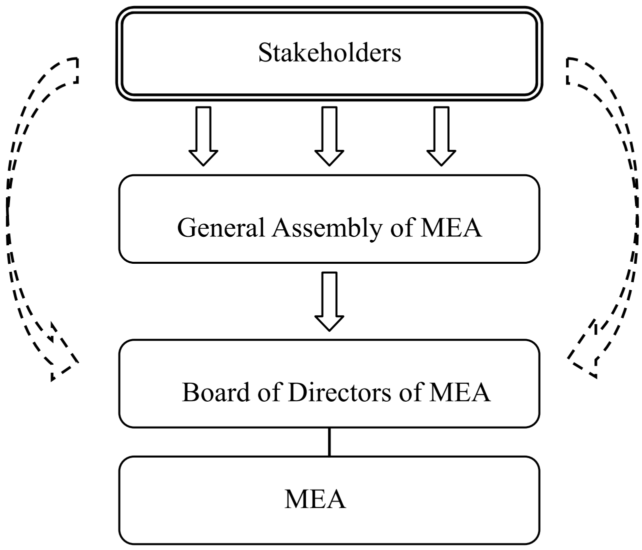

Figure 7.2-8 Governing Structure of MEA, Alternative 3

The advantage of this alternative is that this arrangement is in conformity with the stipulations of the existing legal system and easily implemented.

The pros and cons as described above are summarized and compared in Table 7.2-7.

Table 7.2-7 Comparison of Pros and Cons for Governing Mechanism of MEA

Alter-native	Description	Pros/Advantages	Cons/ Disadvantages	Remarks
Alt-1	• The Minister of Transport supervises MEA • The MEA Council gives advice/ recommendation to the Minister	• Consistency in the basic policy/strategy is maintained resulting in effectiveness & efficiency in the implementation. • In case of conflict of interest among the stakeholders, it is relatively easy to get consensus by strong leadership of the Minister of Transport.	Non in particular	
Alt-2	• The Prime Minister supervises MEA. • The rest is same with Alternative 1.	• Stronger political power to implement the projects (compared to Alt-1). • Thus, quicker in decision-making for difficult problems.	Too strong political power	
Alt-3	• The stakeholders participate as the member of the General Assembly and/or the member of the Board of MEA.	• Easy to implement under the existing legal framework.	Weak political power	

Considering the above, Alternative-1 is recommended.

7.3 ORGANIZATIONAL STRUCTURE DEVELOPMENT AND CAPACITY DEVELOPMENT OF METROPOLITAN EXPRESSWAY AUTHORITY

7.3.1 Organizational Structure of MEA

Figure 7.3-1 shows the proposed organizational structure of MEA. The main features of the proposed organization are as follows. This organizational structure should be further studied in the future as the establishment of MEA will materialize.

(i) To be always ready for emergent cases, such as serious traffic accident, Vice President should be appointed to be in charge if the President is absent for some reason.

(ii) The most important job of the Internal Auditor shall be prevention of misconduct concerning the toll collection. (Since cash is received at tollgates.) He/she shall directly report to the President and Vice President.

(iii) The function of the Board of Executive Directors is similar to that of Board of a private corporation. Each Executive Director shall supervise one or more Department(s). He/she should be delegated appropriate authority to represent MEA for the matters under his jurisdiction. For example, the authority of singing the contract of construction or large-scale rehabilitation should be given to the Executive Director in charge of construction or maintenance. This will allow the President to concentrate on the most important matters. (See Table 7.3-1: Job Description and Other Features of Major Organizational Units of MEA.)

(iv) Since the traffic on the expressways cannot be interrupted for 24 hours a day and 365 days a year, Maintenance Department should have Deputy Director who will take charge in the absence of the Director.

(v) One Division, preferably under Planning Department, should be responsible for the evaluation of proposals of, and negotiations with the proponents of, PPP projects.

(vi) Construction Department is needed only during the period of direct construction by MEA. It will be demolished after the sections/lines directly constructed by MEA will be completed.

For comparison and reference, Figure 7.3-2 shows the organization chart of Metropolitan Expressway Public Corporation of Tokyo. (Please note that this organization was privatized effective as of 1 October 2005.)

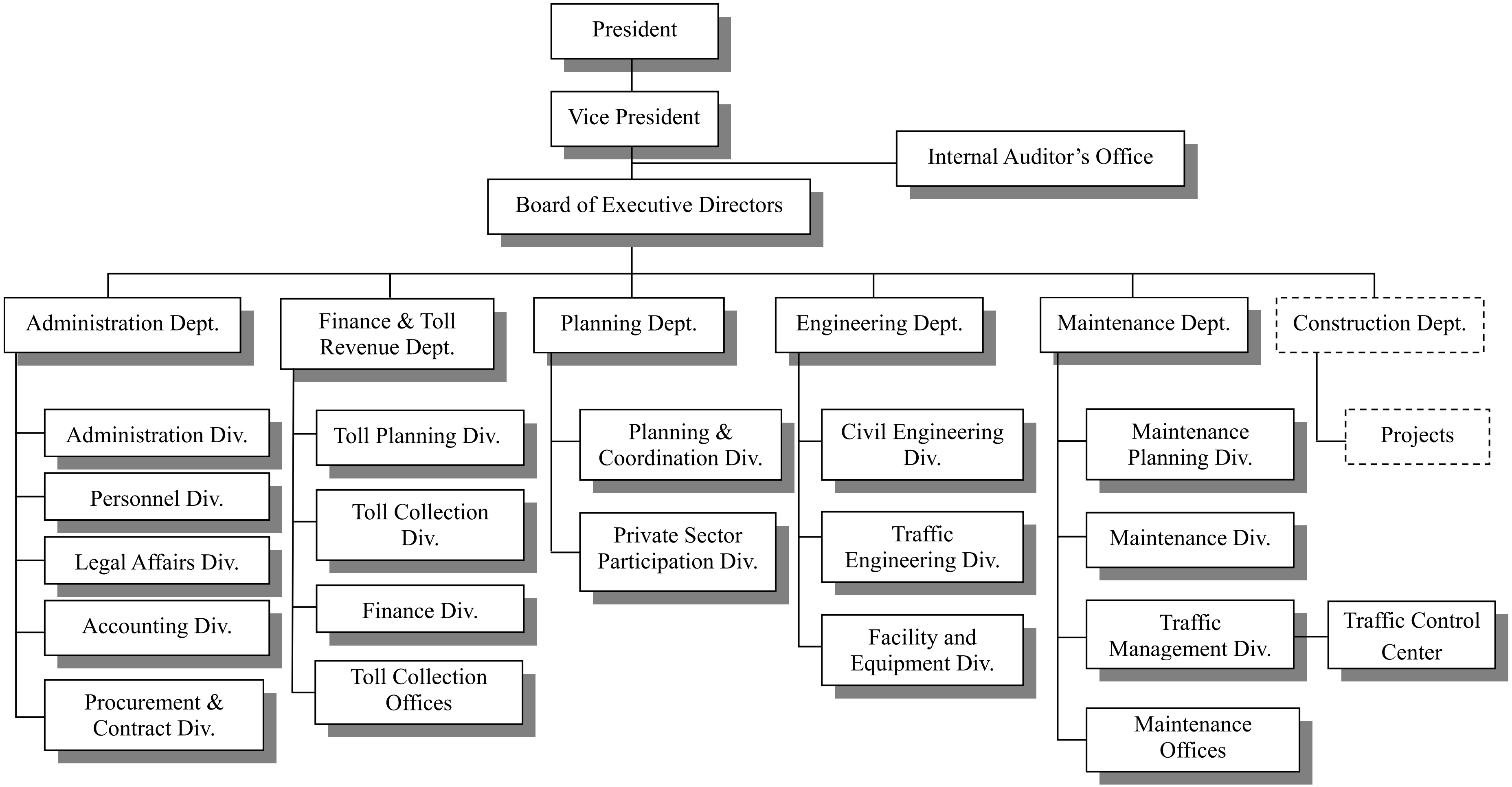

Figure 7.3-1 Preliminarily Designed Organizational Structure of Expressway Authority

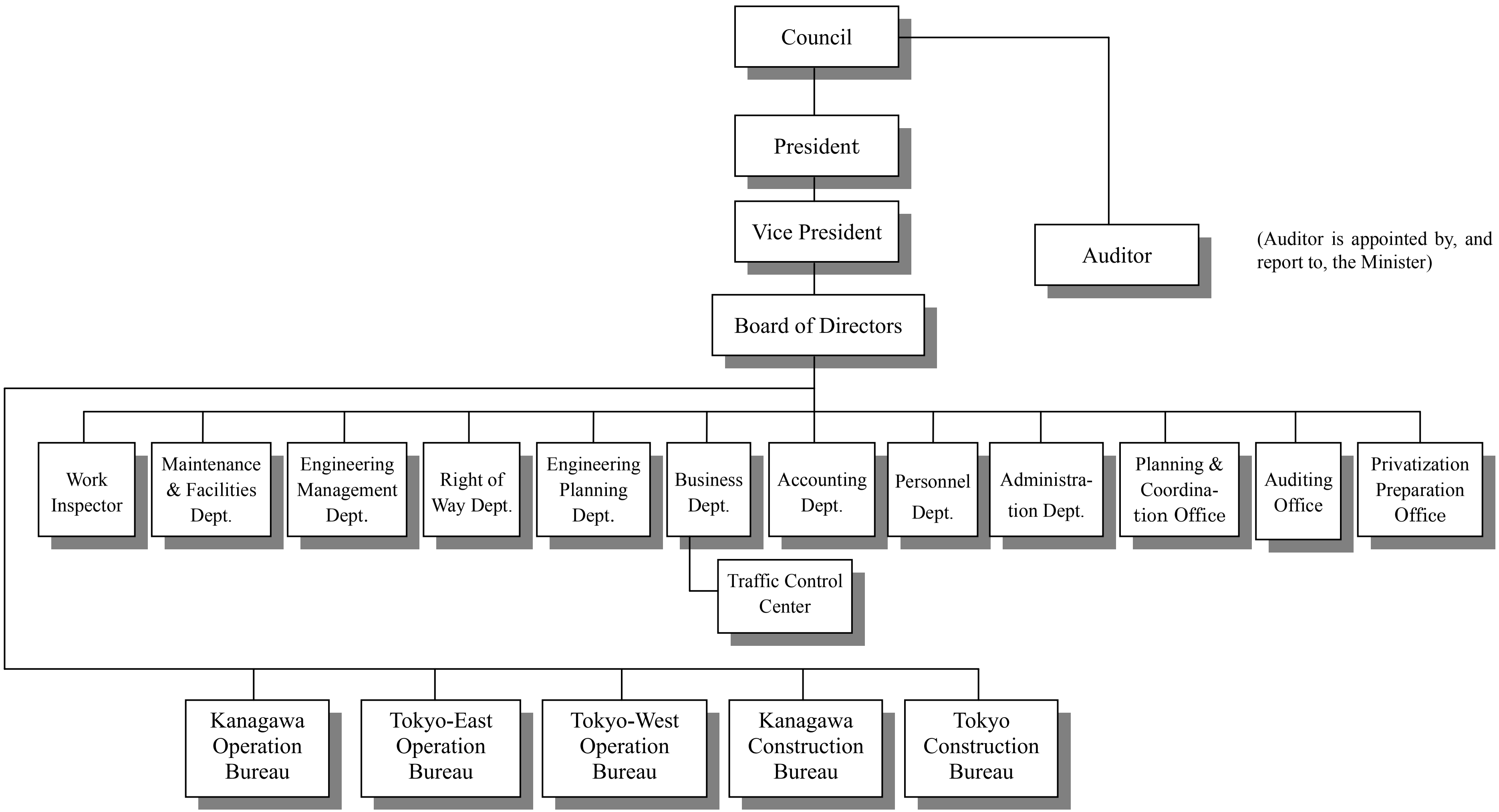

Figure 7.3-2 Organization Chart of Metropolitan Expressway Public Corporation, Tokyo

7.3.2 Job Description and Other Features of the Major Organizational Units of MEA

Table 7.3-1 shows the fundamental job descriptions and other features of the major units of MEA.

Table 7.3-1 Job Description and Features of Major MEA Organizational Units

President • Represent the Corporation. • Be responsible for overall management of the Corporation. • Report to the Minister of Transport. • Appointed by the Minster of Transport with an agreement of the Prime Minister
Vice President • Assist the President. • Be in charge of the function of the President in case of absence of the President. • Appointed by the President with an agreement of the Minister of Transport.
Executive Directors • Manage the Corporation under the overall supervision of the President an Vice President • Supervise one or more Departments. • Represent the Corporation for the matters related to his/her jurisdiction, such as signing a contract of civil works, signing an agreement with relevant parties. • Discuss the overall management of the Corporation • Appointed by the President
Internal Auditor • Audit toll revenue, expenditure and procedures of all works of the Corporation and report the irregular practices to the President and Vice President • Investigate misconduct of the staff members • Appointed by the President with an agreement of the Minister of Transport
Administration Department • General administrative matters • Public Relations • Personnel matters including recruitment, appointment, retirement policy, training, salaries and benefits, and staff welfare • Legal affairs and maintenance of official documents except those for contract and engineering matters • General accounting of the Corporation • Procurement and contract • Any other matters which does not belong to the jurisdictions of other departments
Finance and Toll Revenue Department • Preparation of plans for revision of toll rates to be approved by the Minister of Transport • Survey and study on transport economy • Preparation of forecast for the future traffic volume and toll revenue • Review and evaluation of the toll rates proposed by the private investors

• Supervision of the practices of toll collection by the Corporation and the PPP entities • Collection, analysis and storage of the data related to toll revenue, including traffic volume • Preparation of the financing plans and procurement of the funds required for the operation of the Corporation
Planning Department • Preparation of Short-, Medium- and Long-Term Plan of the Corporation • Coordination among the Departments • Evaluation of PPP proposals and negotiations with the proponents • Any other engineering matters which do not belong to other engineering-related departments
Engineering Department • Research and development on the engineering matters • Preparation of technical standards and manuals • Collection, analysis and maintenance of technical data, such as traffic accident, traffic congestion and axle loads
Maintenance Department • Maintenance of expressways which are under the direct jurisdiction of the Corporation • Planning and implementation of maintenance (of the expressways which are under the direct jurisdiction of the Corporation) • Traffic management, including road clearance after traffic accidents, rescue to the broken-down vehicles. • To be functional in a "semi-independent" manner to manage the traffic on the expressways which cannot be interrupted for 24 hours a day and 365 days a year.
Construction Department • Manage the construction of expressways • Necessary only when the Corporation directly manage the construction of an expressway

7.3.3 Staged Development of MEA

An organization cannot be established in its full-fledged form. It has to be developed in stages. Figure 7.3-3 schematically illustrates the process of development of organization of MEA.

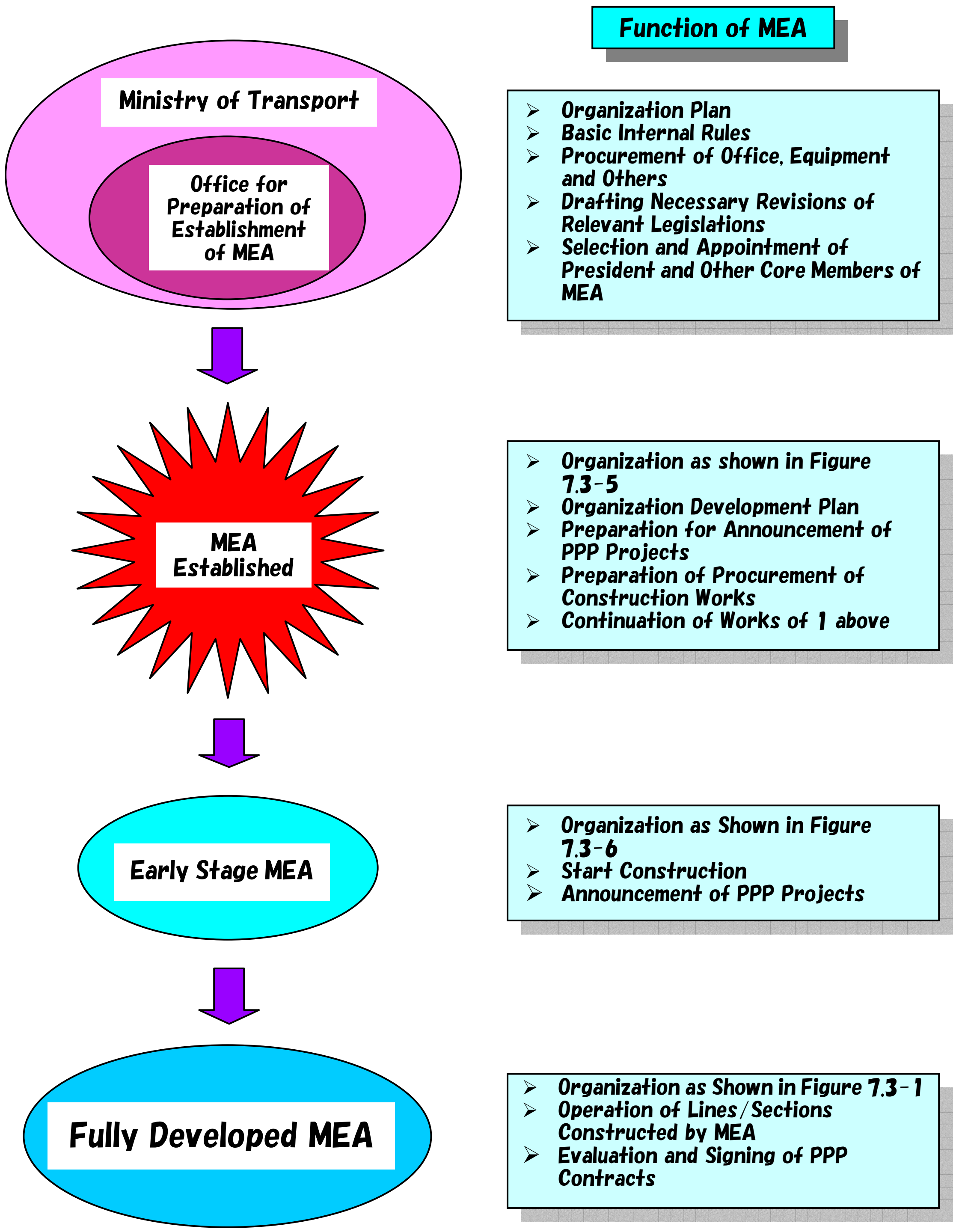

Figure 7.3-3 Process of MEA Organizational Development

(1) Organization for Preparatory Preparation of Establishment of MEA

Considerable volume of works is required to establish the organization of MEA. Therefore, it is recommended to establish a small organization which is to be exclusively responsible for the preparatory works to establish MEA. Such organization may be established in the Ministry of Transport such as in GARBLT, the secretariat of the Higher Committee, if practical, or ENIT. Figure 7.3-4 shows an example of organization for such preparatory works.

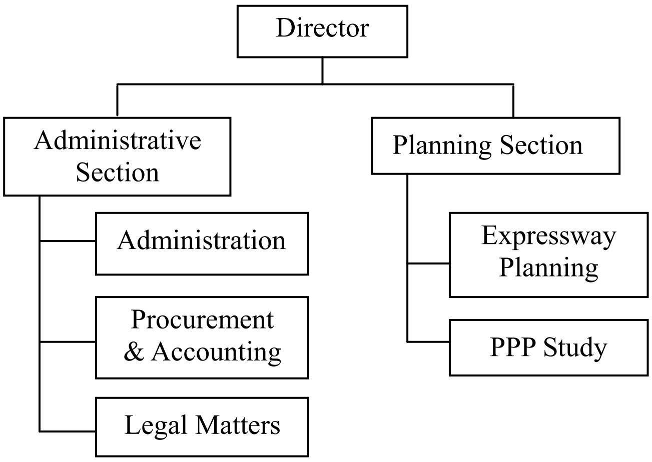

Figure 7.3-4 Organization of Preparation Office for MEA Establishment

(2) Organizational Structure of MEA Shortly After Its Establishment

At its start, the main tasks of MEA is assumed to be management of construction of the expressway(s) to be directly constructed by MEA and preparation of introduction of PPP schemes to other expressways. Thus, the main tasks required for MEA at this stage are supposed to be as follows:

(i) Supervision of design and construction of the priority line/section of the expressway network,

(ii) Securing the fund for (i) above,

(iii) Preparation of introduction of PPP schemes for the urban expressway network, including identification of the lines/sections to be constructed/operated under PPP scheme, announcement of candidate lines/sections, preparation of draft contract and preparation of evaluation criteria, and

(iv) Preparation of development plan of the urban expressway network and development plan of the organization and business of MEA.

The organizational structure should be as small as possible, but need to be functional for the above tasks. Figure 7.3-5 shows the organizational structure proposed for its initial stage shortly after the establishment.

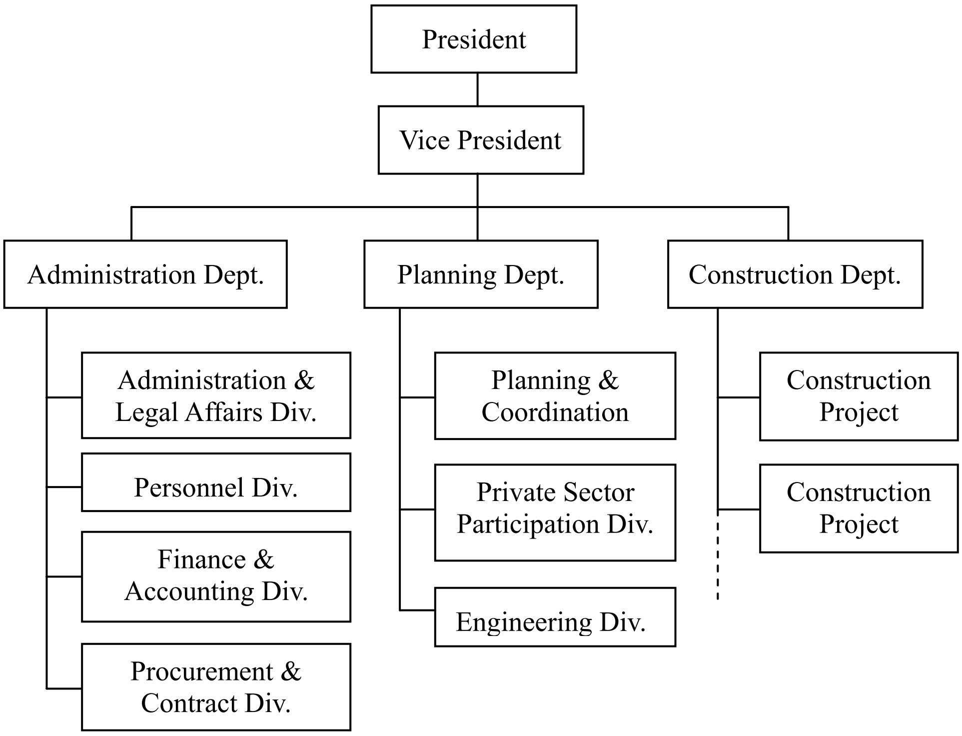

Figure 7.3-5 Organizational Structure of MEA Shortly After Its Establishment

(3) Organizational Structure of MEA in its Early Stage

The fully developed form of MEA cannot, and need not to, be established from the beginning. In the early stage when the length of expressways in operation is still relatively short and the expressway network is simple, the organization of MEA can be much simpler.

For the purpose of the discussions of the organization of MEA in its early stage, the followings are assumed:

(i) MEA constructs a few lines, such as E3 and/or E4, by preparing the funds through some channels, such as soft loans by the donor agencies.

(ii) Some of the existing high-standard roads such as the Ring Road and/or E1/E2 are converted to toll roads and the right to collect the tolls are given to MEA as a form of subsidy by the Government. MEA directly collects the tolls and does not lease this right to concessionaire.

(iii) MEA will be the main institution to promote PPP project for the development of the proposed urban expressway network.

Figure 7.3-6 shows the proposed simplified organizational structure of MEA in its early stage.

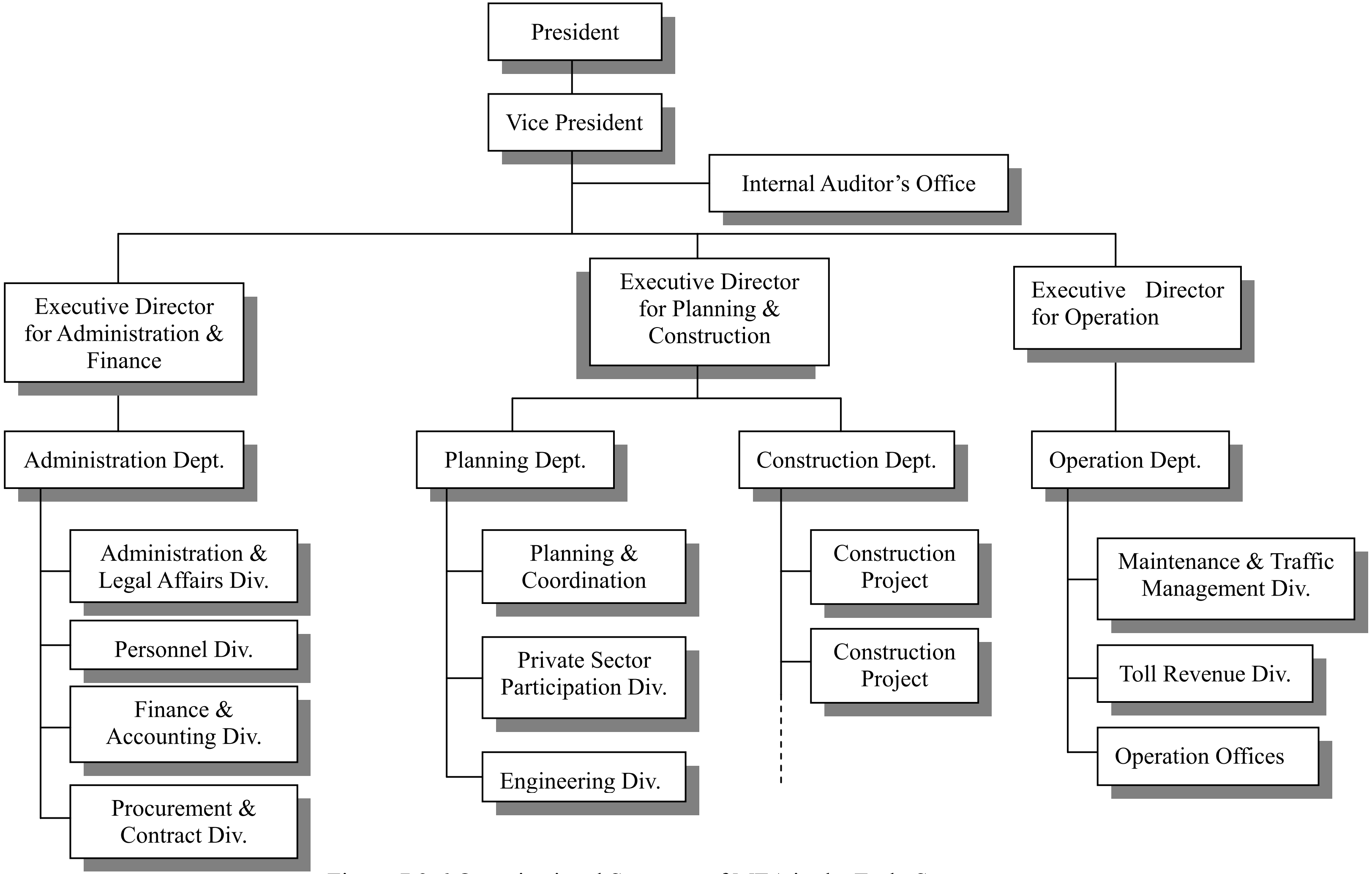

Figure 7.3-6 Organizational Structure of MEA in the Early Stage

7.3.4 Staff Size of MEA

For the purpose of the discussion of the staff size of MEA, the following jobs are assumed to be out-sourced to private enterprises.

(i) Toll collection
(ii) Routine maintenance works including road cleaning
(iii) Road patrol

All other maintenance works, periodic maintenance and emergent maintenance works, as well as design of these works and inspections, are also assumed to be contracted out to private contractors.

Table 7.3-2 shows the staff sizes at various Development stages of MEA as described in Subsection 7.3.3 above. The total number of staff members, including the management is estimated to be around 160 persons at the fully developed stage.

Table 7.3-2 Staff Size of MEA at Its Development Stages

Development Stage	Number of Staff Members
Shortly After Establishment	57
Early Stage	114
Fully Developed Stage	163

Tables 7.3-3 (a) to (c), 7.3-4 and 7.3-5 show the breakdown of the number of staff members of MEA at its development stages.

Table 7.3-3 (a) Breakdown of Number of Staff Members in MEA at Fully Developed Stage

	Staff Level				
	Manager & Above	Senior Professional	Professional/ Jr Prof/Technician	Supporting Staff	Total
Management					
President	1	0	0	0	1
V. President	1	0	0	0	1
Executive Director	4	0	0	0	4
Secretariat	1	6	2	3	12
Total	7	6	2	3	18
Internal Auditor's Office	1	2	2	1	6
Admin. & Account. Dept.					
Director	1				1
Admin. Div	1	2	2	1	6
Person. Div.	1	2	2	1	6
Legal Affairs Div.	1	1	1	1	4
Account. Div.	1	2	3	1	7
Procure. & Cont Div.	1	2	3	2	8
Subtotal	6	9	11	6	32
Finance & Toll Reven. Dept.					
Director	1				1
Toll Plan. Div.	1	1	1	1	4
Toll Collect. Div.	1	2	2	1	6
Finance Div.	1	2	2	1	6
Subtotal	4	5	5	3	17
Planning Dept.					
Director	1				1
Plan. & Coordinating Div.	1	2	2	1	6
PPP Div.	1	2	2	1	6
Total	3	4	4	2	13
Engineering Dept.					
Director	1				
Civil Engineering Div.	1	2	2	1	6
Traffic Eng. Div.	1	2	2	1	6
Facility & Equip. Div.	1	3	3	2	9
Subtotal	4	7	7	4	22
Maintenance Dept.					
Director	1				
Deputy Director	1				
Maintenance Planning Div.	1	1	1	1	4
Maintenance Div.	1	2	2	1	
Traffic Management Div.	1	2	2	1	6
Traffic Control Center	0	4	4	8	16
Maintenance Office I*	1	2	3	1	7
Maintenance Office II*	1	2	3	1	7
Maintenance Office III*	1	2	3	1	6
Subtotal	8	15	18	14	55
Grand Total	33	48	49	33	163

*2 Maintenance Office for Ring Road, 1 Maintenance Office for E1 - E3/E4

Table 7.3-3 (b) Breakdown of Number of Staff Members in Maintenance Office

Position	Staff Level				
	Manager	Sr. Professional	Professional/ Jr. Professional	Supporting Staff	Total
Chief of Office	1				1
Sr. Admin. Staff		1			
Admin. Staff/ Jr. Admin. Staff			1		
Secretary				1	
Admin Subtotal		1	1	1	3
Sr. Maint. Engineer		1			
Maint. Enginer			1		
Jr. Maint Engr./ Technician			1		
Maint. Subtotal		1	2	0	3
Total	1	2	3	1	7

Table 7.3-3 (c) Breakdown of Number of Staff Members in Traffic Control Center

Position	Staff Level			
	Sr. Professional	Professional/ Jr. Professional	Technician	Total
Supervisor	4			
Sr. Traffic Controller		4		
Traffic Controller			8	
Total	4	4	8	16

Above figures are for 3 shifts/day and one party is off after night shift

Table 7.3-4 Breakdown of Number of Staff Members in MEA at Early Stage

Position	Staff Level				
	Manager & Above	Senior Professional	Professional/ Jr Prof/ Technician	Supporting Staff	Total
Management					
President	1	0	0	0	1
V. President	1	0	0	0	1
Executive Director	3	0	0	0	3
Secretariat	1	4	0	3	8
Total	6	4	0	3	13
Internal Auditor's Office	1	1	1	1	4
Admin. & Account. Dept.					
Director	1				1
Admin. & Legal Div	1	2	2	1	6
Person. Div.	1	2	2	1	6
Finance & Account. Div.	1	2	3	1	7
Procure. & Cont Div.	1	2	2	2	7
Subtotal	5	8	9	5	27
Planning Dept.					
Director	1				1
Plan. & Coordinating Div.	1	2	2	1	6
PPP Div.	1	1	2	1	5
Engineering Div.	1	2	2	1	6
Total	4	5	6	3	18
Engineering Dept					
Director	1				1
Project Management Unit I	1	2	2	1	6
Project Management Unit II	1	2	2	1	6
Subtotal	3	4	4	2	13
Operation Dept.					
Director	1				1
Deputy Director	1				1
Maint. & Traffic Manage. Div.	1	1	1	1	4
Traffic Control Center		2	2	4	8
Toll Revenue Div.	1	1	1	1	4
Maintenance Office I*	1	2	3	1	7
Maintenance Office II*	1	2	3	1	7
Maintenance Office III*	1	2	3	1	7
Total	7	10	13	9	39
Grand Total	26	32	33	23	114

*2 Maintenance Office for Ring Road, 1 Maintenance Office for E1 - E3/E4

Table 7.3-5 Breakdown of Number of Staff Members in MEA Shortly After Its Establishment

Position	Staff Level				
	Manager & Above	Senior Professional	Professional/ Jr Prof/ Technician	Supporting Staff	Total
Management					
President	1	0	0	0	1
V. President	1	0	0	0	1
Secretariat	1	2	0	1	4
Total	3	2	0	1	6
Internal Auditor's Office	1	1	0	1	3
Admin. & Account. Dept.					
Director	1				1
Admin. & Legal Div	1	1	1	1	4
Person. Div.	1	1	2	1	5
Finance & Account. Div.	1	1	1	1	4
Procure. & Cont Div.	1	1	1	0	3
Subtotal	5	4	5	3	17
Planning Dept.					
Director	1				1
Plan. & Coordinating Div.	1	2	2	1	6
PPP Div.	1	1	2	1	5
Engineering Div.	1	2	2	1	6
Total	4	5	6	3	18
Construction Dept					
Director	1				1
Project Management Unit I	1	2	2	1	6
Project Management Unit II	1	2	2	1	6
Subtotal	3	4	4	2	13
Grand Total	16	16	15	10	57

7.3.5 Capacity Development

As soon as the new organization of MEA is established, it has to have sufficient capacity to operate the urban toll expressways. The areas where the capacities unique to MEA are required are as follows:

(i) Toll setting and revision
(ii) Toll collection
(iii) Financial management of toll road
(iv) Evaluation and negotiation of PPP schemes
(v) Traffic management including traffic information

In addition to above, the general capacity for planning, designing, construction management and maintenance of ordinary highway is required.

The above-mentioned capacity is "institutional capacity". A capacity of an institution usually consists of the components as shown in Figure 7.3-7.

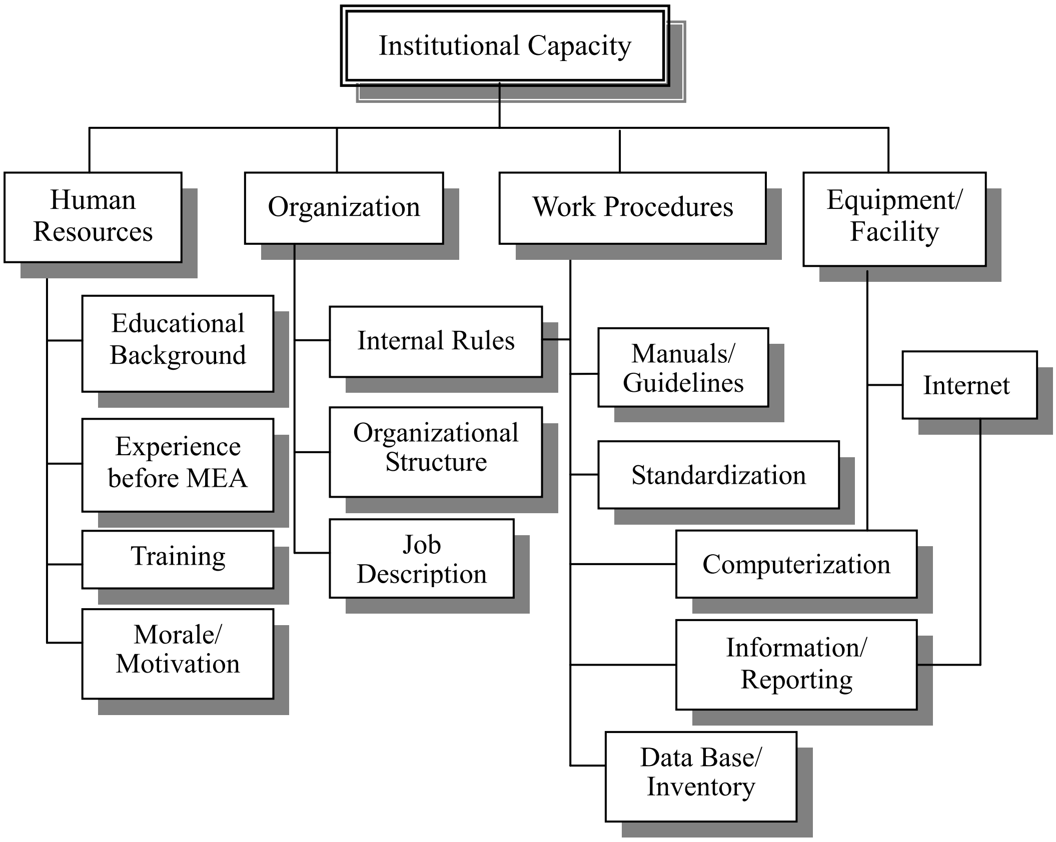

Figure 7.3-7 Components of Institutional Capacity

7.3.6 Capacity Development of Staff

(1) Training Methods

After the new organization is established, capacity development of the staff is most important and urgent matter, since other components are planned and constructed by the staff. Major Methods of training of the staff are given in Table 7.3-6. It should be noted that there are many subjects which are unique to the toll expressway in Cairo and cannot be taught by the outsiders. Therefore, the MEA has to accumulate its experience and establish its own methodologies in every aspects of its business, including the maintenance, traffic management and toll collection. As such, importance of self training through accomplishment of daily tasks of each staff member should be emphasized.

Table 7.3-6 Major Methods of Training and Their Features

Type of Training	Features
Self Training	• Very base of the all other training. • Can be done through daily practice of jobs. • Usually no substantial cost is required.
On-the-Job Training (OJT)	• Training through daily practices of jobs. • Usually very little cost is required, if any. • Trainer can be the trainee's supervisor or mentor.
Off-the-Job Training (Off-JT)	
Group Training	• This includes the training taught by the in-house trainers and external trainers. • Usually cost-effective since multiple number of trainees can be trained simultaneously. • The trainees have to leave their offices during the training period. • Costs for accommodation, travel, text and trainers are required.
Individual Training	• This includes sending the trainee abroad (to university, similar institution etc) or domestic institution (university or research institution etc). • Large cost is required and the number of trainee is limited. • Suitable for developing in-depth capacity.

(2) Training Subject and Trainee Group

In view of the required capacities as described in Subsection 7.3.1, the subjects of training, the trainee groups and the methods of training are proposed as summarized in Table 7.3-7.

Table 7.3-7 Training Subjects and Trainee Group

Trainee Group	Training Subject	Training Method*			
		OJT	Gp(I)	Gp(E)	Indv
Civil Engineer (Highway, Transport & Traffic Engineer)	Traffic Control/Management • Traffic engineering • Traffic control • Traffic safety measures	○	○	○	◎
Civil Engineer (Highway Engineer)	Expressway/Toll Road Maintenance • Pavement design & maintenance • Bridge/viaduct maintenance • Budget and schedule planning • Project management • Traffic regulation for maintenance works	◎	◎	◎	○
Toll Policy Expert	Transport Economics • Transport Economics	-	○	◎	◎
Toll Road Financing Expert	Toll Road Financing Project financing Public investment	-	○	◎	◎
PPP Expert	Evaluation & Negotiation of PPP Projects • Project financing • Public investment	-	◎	◎	○
	• Evaluation & Negotiation of PPP Projects	◎	◎	○	-

* OJT: On-the-Job Training, Gp(I): Group Training by In-house Trainer
Gp(E): Group Training by External Trainer, Indv: Individual Training
◎: Very Effective ○: Effective

(3) Training of Field Crew

The field crew who directly deal with the daily works need training. The type of crew and possible trainers are summarized in Table 7.3-8. In every case, the manual for each work should be prepared and used as the textbook. Exercise (maneuver) based on the manual is the essential part of the training.

Table 7.3-8 Training of Field Crew

Trainee Group	Possible Trainer
Toll Collector	• Experience toll collector of the existing toll roads
Patrol Crew	• Traffic engineer of MEA • Maintenance engineer of MEA • Staff of traffic control center • Traffic police
Road Cleaning Crew	• Maintenance engineer of MEA • Staff of traffic control center • Traffic police • Experienced foreman of contractor
Crew for Routine Maintenance Works	• Maintenance engineer of MEA • Staff of traffic control center • Traffic police • Experienced foreman of contractor
Staff of Traffic Control Center	• Traffic engineer of MEA • Traffic police • Engineers of makers of devices of traffic monitoring/information

7.3.7 Standardization and Manual

Standardization of the working procedures is necessary in almost all of the works of the MEA for efficiency. Standardization of the procedures of some types of works is necessary also for smooth implementation of maintenance and operation. For example, once a traffic accident occur, the judgments and actions of relevant personnel including traffic police officers in the traffic control center and at the accident site, the staff in the traffic control center and at the accident site and maintenance crew who clears the accident site need to work in unified and coordinated manner. For this reason also, work manuals/guidelines are needed. Table 7.3-9 lists the manuals/guidelines needed by MEA.

Table 7.3-9 Manuals Needed by Expressway Authority (1/2)

Name	Typical Subjects/Contents
Design Manual	Geometric Design ・ Highway class ・ Design speed ・ Typical cross section ・ Horizontal & vertical alignment ・ Ramps & interchanges
	Bridge/Viaduct Design ・ Foundation & substructure ・ Superstructure ・ Appurtenances (joints, bearings etc)
	Pavement Design, Road Marking & Traffic Signs, Traffic Safety Facilities
	Other Facilities/Devices ・ Traffic information ・ Traffic monitoring ・ Communication ・ Lighting ・ Toll Collection ・ Others
Maintenance Manual	Maintenance Planning and Management ・ Inspection & data collection ・ Budgeting ・ Implementation plan including scheduling
	Inspection ・ Daily inspection ・ Routine Inspection ・ Periodic inspection ・ Ad-hoc inspection & emergency inspection
	Design and Cost Estimation ・ Pavement ・ Bridge/Viaduct ・ Other Facilities
Manual for Evaluation (& Negotiation) of PPP Projects	Evaluation Method of PPP Projects ・ Theory of toll road financing ・ Risks and risk sharing ・ Relevant legislations ・ Precedent cases ・ Conditions of PPP concessions ・ Evaluation methods and criteria ・ Evaluation ・ Identification of items to be negotiated ・ Judgment in the negotiation ・ Concluding the negotiation ・ Approval procedures

Table 7.3-9 Manuals Needed by Expressway Authority (2/2)

Name	Typical Subjects/Contents
Traffic Management/ Control Manual	Traffic Management Procedures ・ Coordination with traffic police officers ・ Report to & instruction by the higher level staff ・ Actions when accident occurs ・ Job sharing by the relevant staff/parties ・ Rescue of /assistance to the road users ・ Basic manual for traffic information/ monitoring facilities/devices.
Toll Collection Manual	Toll Collection Procedures ・ Vehicle classification & toll level ・ Receiving toll & paying change ・ Treatment of coupons ・ Treatment of abnormal vehicles/drivers (overloaded vehicles, fraud coupon, drunken driver etc) ・ Treatment of complaint ・ Calculation of collected money and handing over to the supervisor ・ Consideration on security
Toll Expressway Patrol Manual	Patrol Procedures ・ Check list of equipment & material ・ Communication with traffic control center & patrol base ・ Cooperation with traffic police officers ・ Observation of road and traffic ・ Reporting ・ Emergent action for accident & others ・ Preventive actions including removal of obstacles on the road surface ・ Assistance & advice to road users in need ・ Log keeping
Road Cleaning Manual	Road Cleaning Procedure ・ Preparation of equipment and material ・ Operation speed ・ Shoulder & lane for cleaning ・ Attention to other vehicles ・ Removal of obstacles on the road surface ・ Handling/treatment of dangerous objects ・ Lost & found items ・ Log keeping
Daily/Routine Maintenance Manual	Work Procedures ・ Types of works and work methods ・ Crew ・ Equipment and material ・ Coordination with the traffic control center ・ Traffic regulation ・ Prevention of accident ・ Reporting in emergency ・ Handling/treatment of dangerous objects ・ Lost & found items

As for Design Manuals and Maintenance Manual, the existing, widely used manuals, guidelines and text books can be used until the Authority's own manuals are prepared, or they can be the basis for Authority's own manuals/guidelines. Table 7.3-10 provides examples of existing manual/guidelines widely used in the world.

Table 7.3-10 Examples of Existing Manuals/Guidelines

Name of Existing Manual/Guideline	Publisher
Highway Capacity Manual (HCM)	Transportation Research Board (TRB), USA
A Policy on Geometric Design of Highways and Streets	American Association of State Highway and Transport Officials (AASHTO)
Pavement Design Manual	AASHTO
Road Notes (Various volumes)	Transport Research Laboratory (TRL), UK
Asphalt Pavement Design Manual	Japan Road Association

It should be noted that there are various kinds of manuals and guidelines published in Japan but almost all of them are written in Japanese language and English versions are not available. The above listed Asphalt Pavement Design Manual published by the Japan Road Association is one of the few exceptional cases.

7.3.8 Other Way for Capacity Development

(1) Technical Assistance by the International Aid Agencies

Technical assistance programs extended by the international aid agencies such as JICA and World Bank can be very effective source for obtaining technology transfer. JICA has a program to dispatch experts of various fields to the governmental agencies, including the implementing agencies such as MEA, in many countries for such a long period as 2 to 3 years. JICA Experts have a comprehensive experience on toll expressway business.

(2) International Associations

Valuable information is obtained from international associations of highways and/or toll roads. Examples of such international associations are available in Table 7.3-11.

Table 7.3-11 International Associations of Road and Toll Road

International Association	Website or E-Mail Address
International Bridge, Tunnel and Turnpike Association (IBTTA)	http:/www.ibtta.org
International Road Federation (IRF)	
World Road Association (Association Mondiale de la Route: PIARC)	http:/www.piarc.org

CHAPTER 8

OPERATION
AND
MAINTENANCE

CHAPTER 8

OPERATION AND MAINTENANCE

Operation and Maintenance of urban toll expressway network is basically same to that of ordinary, non-toll highways. However, higher levels of works are required for the toll expressways because of the high travel speed of the vehicles and the expectation of the road users for the "return for the toll". Further, this Study focuses "introduction of PPP". Accordingly, this Chapter highlights the "maintenance and operation" of the "toll expressway network" with attention to the "introduction of PPP".

8.1 DEFINITION OF TERMINOLOGY AND BASIC CONCEPT

Various terminologies are used in the discussion of toll road system. There seems not to be clear boundaries between the terminologies of "management" and "operation". The relations between these terminologies are assumed in this Chapter as schematically illustrated in Figure 8.1-1. The definitions and concept of the terminologies shown in the above figure are described in Table 8.1-1.

As explained in Table 8.1-1, "Operation and Management" consists of "Toll Collection" and "Traffic Management" including surveillance and other actions. Sometimes the "Operation" is used to mean "toll collection" and "traffic management" combined. In this Chapter, the "Operation and Management" is used in view that this business of the two major components. The two components of Operation and Management, i.e. Toll Collection and Traffic Management Systems are discussed in the Subsections 8.2 and 8.3 while Maintenance is discussed in Subsections 8.4 and 8.5.

8.2 TOLL COLLECTION METHODS

8.2.1 Toll System

When the system of toll collection is considered or planned, the system or policy for toll setting has to be determined first. There are two types of toll systems which are usually adopted; "flat toll system" (or "open toll system") and "distance-dependent toll system" (or "closed toll system"). These two types of systems are described in Chapter 7.

If the “flat toll system” is adopted, manual collection can be used since there is no need for calculation of toll amount. On the other hand, if “distance-dependent system” is adopted, Electronic Toll Collection (ETC) needs to be introduced because of the complexity of the calculation of tolls.

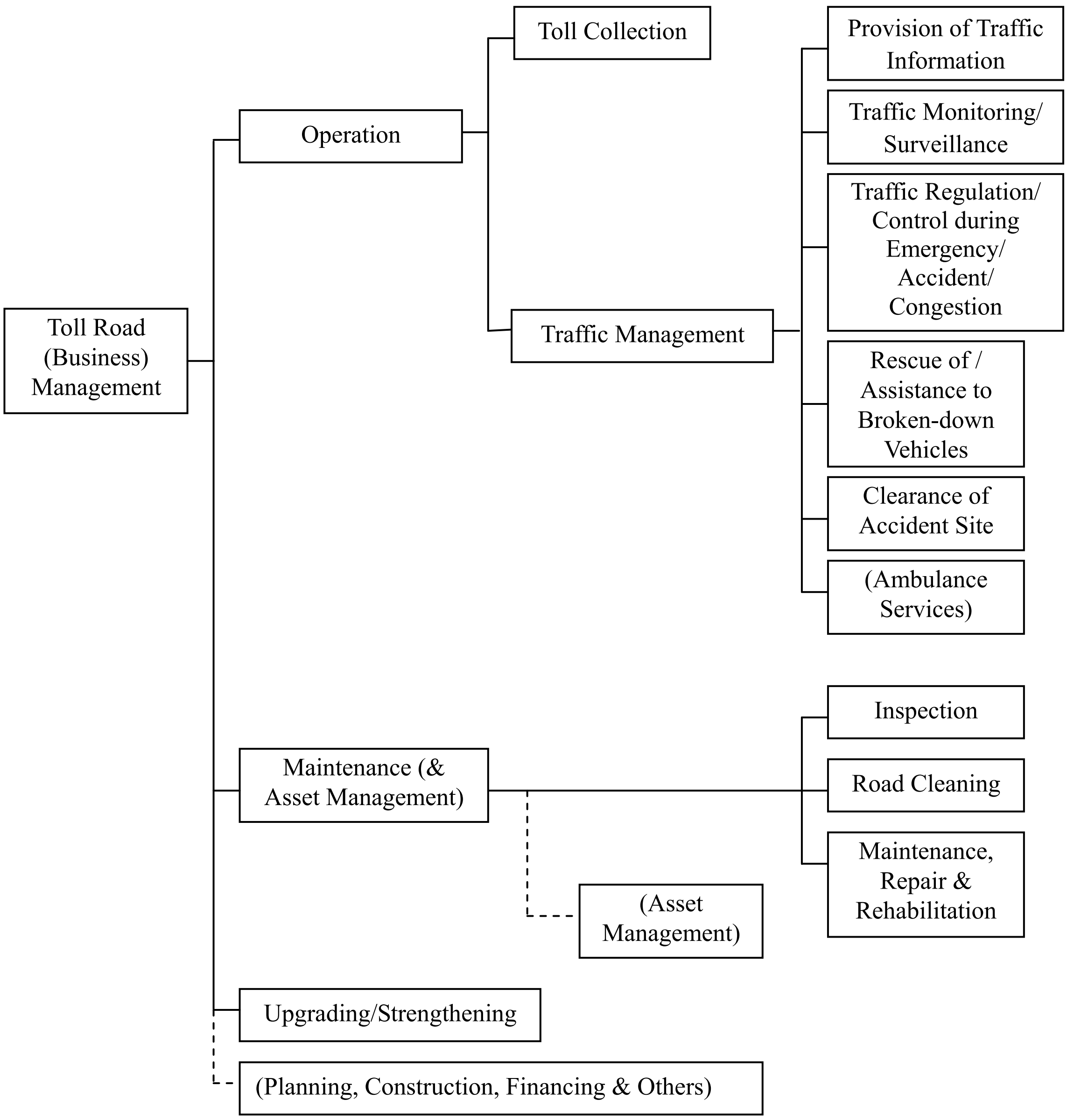

Figure 8.1-1 Relations between the Terminologies

Table 8.1-1 Definition and Concept of Terminology

Terminology	Definition/Concept
Toll Road (Business) Management	The management of whole business of toll roads. May or may not include the works other than maintenance, operation/management and upgrading/strengthening, such as construction, planning and financing. This word is not used frequently. Therefore, when it is used, clear definition shall be given.
Operation	This word is sometimes used to include maintenance, or used in combination with maintenance such as "operation and maintenance". In this chapter, this word is used to mean toll collection and traffic management.
Toll Collection	This is collection of toll, literally.
Traffic Management	This word is distinguished from the word "traffic control". "Traffic Control" in this chapter is used to mean regulation or control of traffic by police officers (or law enforcer), while the word "traffic management" is used to mean the works as listed below implemented by the road administrator: (i) Provision of traffic information (ii) Traffic monitoring/surveillance (iii) Traffic regulation/control during emergency/ accident/ congestion (iv) Rescue of / assistance to broken-down vehicles (v) Clearance of accident site
Maintenance	This refers to the works as inspection of the conditions, maintenance, repair and rehabilitation of the road and relevant facilities. Maintenance usually include road surface cleaning also. Asset management is being focused in the recent years. Maintenance is planned from the viewpoint of asset management.
Upgrading or Strengthening	Upgrading of the function of roads, including widening, improvement of functions of road (such as strengthening of bridges/viaducts to cope with the increase in vehicle weight, changing from ordinary AC surface to permeable AC surface) and installation of noise fence.

8.2.2 Manual Toll Collection

"Manual toll collection" is a system whereby the toll is calculated by the toll collector and the toll is paid to the toll collector. This system is often used for flat toll system where there is no necessity of calculation of toll. There are three stages of manual collection depending on the length of toll road network and, thus, the number of entrances and exits.

(1) Simple manual toll collection

Where flat toll system is adopted, toll is collected (usually at the entrance) based on the visual vehicle classification by the toll collectors. Toll can be paid in forms of cash or coupon (with discounted rate for frequent users).

The major advantages of this system are as follows:

(i) Little construction cost: This system needs little equipment, and initial (construction) cost on the side of the toll operator is minimal. Also, it requires no special device on the side of the road users.

(ii) Relatively small area needed for tollgate: Since no complicated facility is required, the tollgate can be installed in a relatively small area.

On the other hand, this system has the following disadvantages:

(i) Long time required for toll collection: Since this system fully relies on the manual works, relatively longer time is required for collection of the toll. The toll collection time becomes longer when the driver pays in a bill with a large amount and toll collector has to calculate and pay change.

(ii) Relatively large chances for toll collectors to commit misconduct: Although the vehicle and number of vehicles can be judged and recorded by various types of vehicle sensors and recording system and toll revenue can be estimated based on the recorded data, still it is possible for the toll collectors to illegally take some portion of the toll revenue before he/she submit it to the supervisor. In a extreme case, misconduct involving the supervisors can occur.

Where flat toll system is adopted, efforts to reduce or eliminate workload of toll collectors have been made in the past. These efforts resulted in the semi-automated or automated systems. One of these systems is described below:

Basket-type toll receiver: When the toll can be paid in a coin or combination of coins with fixed amount(s), the driver throws the coin(s) into a bucket-shaped container attached to the toll receiving machine. Within the toll receiving machine, there is a device to identify the coin (like those used in the various vending machines on the street) and the bar at the tollgate is lifted if the right amount is received.

(2) Manual toll collection with ticket

Manual toll collection can be used for distance-dependent system where the number of entrances and exits are not so many. In this case, some type of ticket is handed to the driver (or the driver take a ticket from a machine) at the entrance. The toll is calculated at the exit based on the distance from the entrance which is identified by the ticket that the driver got at the entrance.

(3) Manual toll collection with computerized toll calculation system

As the total length of the toll road network becomes long and number of entrances and exits becomes large, manual calculation of toll amount by the toll collector becomes practically impossible. Then computerized toll calculation system needs to be introduced. Ticket issuing machines at the entrances and ticket reading machines at the exits are often connected to the central computer which not only calculates the toll amount of each vehicle but also records such data as;

(i) traffic volume by vehicle type,
(ii) the time from entrance to exit (can be used to check illegal/abnormal travel of vehicles), and
(iii) toll revenue.

This system is transitional form to ETC which is explained in the next subsection.

Advantages and disadvantages of the manual toll collection with card and computerized toll calculation system as described in (2) and (3) above are same to those of simple manual toll collection as described in (1), but are so to less extent than in simple manual collection.

8.2.3 Electronic Toll Collection

"Electronic Toll Collection" system or "ETC" system usually refers to the system whereby the toll is calculated by the computer and paid in forms of prepaid card (contact or non-contact type) or deducted from the driver's bank account based on the agreement between the driver (user of the toll road) and the toll road operator. "Glossary" of International Bridge, Tunnel and Turnpike Association (IBTTA) defines ETC as follows:

Electronic Toll Collection: The collection of tolls based on the automatic identification and classification of vehicles using electronic systems.

Owing to the remarkable development in computer and peripherals, ETC has been, and is being, rapidly introduced in many countries in the last decade. There are basically two types of systems; "On-board unit" type and "Prepaid card" type. They are described below:

(1) "On-board unit" Type

"On-board unit" (OBU) is installed on each vehicle which communicates with the roadside station through very weak radio wave and inform the entrance of the vehicle. The signal of entrance is sent to the central computer and the vehicle's entrance is registered. At the same time, the gate of tollbooth is opened and the vehicle enters the toll road. At the exit, the OBU again communicates with the roadside station and the signal of exit is sent to the central computer. The computer calculates the amount of toll and transfers the corresponding amount from the driver's account to the toll road operator's account.

This system has the following major advantages:

(i) Reduction of the time to pass the entrance and exit gate, and increase of traffic capacity of the entrance and exit: In this system, vehicles do not need to stop at the entrance and exit although they have to slow down to allow the communication between OBU and the roadside station. This results in the large reduction of the time passing the entrance and exit gates and increase in the traffic capacities of entrance and exit.

(ii) The work of handling cash is eliminated: Since the toll is transferred from the bank account of the driver to that of the toll operator through computer, cash is not used. This results in reduction of chances of crime as well as works of calculating the toll revenue of each toll collector/toll office etc and transporting the cash.

(iii) The number of personnel at toll office is greatly reduced: Since the system is fully automated, toll collector is not required. However, toll collectors cannot be completely eliminated because some vehicles are not equipped with OBU for ETC and have to be manually handled. Even though the toll collectors cannot be completely eliminated, the number of toll collectors can be reduced resulting in the reduction in operating cost.

On the other hand, this system has the following disadvantage:

(i) High cost of OBU: The market price of OBU in Japan, for example, is in the order of US$ 150. Although the price is expected to become lower in the future as they will be manufactured in the larger number, it is a substantial expense for the average drivers at present. Due to this relatively high price, the increase of the number of vehicles equipped with OBU has been rather slow in Japan. However, the cost of OBU is not felt as a burden when a new car is purchased. Therefore, more than 80 % of the newly sold private cars are equipped with OBU these days (according to the explanation of a major car dealer in Tokyo).

(ii) Need for good banking system: Since the toll is paid using on-line banking system, existence of such banking system is essential

(iii) OBU for motorcycles need special device: Ordinary OBU is designed to be installed in the "covered" place. Accordingly, it cannot be used for motorcycles. Special equipment is necessary for motorcycles.

(2) Prepaid card type

In this system, the drivers (users of toll road) buy a prepaid card before entering the toll road. The prepaid card is inserted in the reading machine at the entrance and the exit. The toll amount is calculated at the exit and deducted from the prepaid card.

Currently, most of the types of prepaid card are **"contact"** type which are **inserted into the reading machine**. In this type card, the data are recorded on the magnetic elements coated on the card. Recently, **"non-contact"** type of prepaid card has been developed and being used in, for example, railroad network in Japan. In this case, an IC chip is embedded in the card. The card is placed on, or near, the surface of the reading machine for a very short time duration, such as a few seconds to be read by the reading machine. Thus, the time required for reading the data is very short. This type of card is expected be widely used in the future.

The advantages of prepaid card type are as the followings:

(i) No necessity for high-cost device on the side of the driver (road user): In prepaid card system, no special device is needed on the vehicle. The cost of conventional (contact type) prepaid card in Japan, for example, is in the order of US$ 1.

(ii) Can be used where on-line banking system is not available: Since this system does not involve on-line banking system, it can be used even if such banking system is not available

(iii) Prepaid card can be used in parallel to the manual toll collection: Especially in distance-dependent toll system where some type of card is used. The toll calculation facility used in distance-dependent toll system can be modified relatively easily so that prepaid card can be used. Thus, prepaid card system can be used in the transitional stage between the manual collection and full ETC. The time to pass the tollgate is reduced by adopting prepaid card compared to the full manual collection.

Prepaid car system has the following disadvantages:

(i) Vehicles have to stop at tollgate: To let the reading machine read the card and deduct the toll amount from the card, the vehicles necessarily have to stop at tollgates (entrance and exit). This results in less traffic capacity of tollgate than that of full ETC tollgate.

(ii) Danger of fraud prepaid card: Just like any prepaid card for other purposes, fraud prepaid can be produced and sold in the black market. This causes substantial loss of income for the toll road operator.

8.2.4 Comparison of Manual Toll Collection and ETC

The advantages and disadvantages described above are summarized and compared in Table 8.2-1.

Table 8.2-1 Comparison between Manual and ETC Systems

Type		Advantage	Disadvantage
Manual	Simple Manual	• No cost to the road users • Small construction cost • Small area needed for tollgate	• Long toll collection time and small traffic capacity at tollgate • Chance of misconduct by toll collectors • Vehicles have to stop at tollgate
	With Ticket	Same as above (to less extent)	Same as above (to less extent)
	Computerized	Same as above (to less extent)	Same as above (to less extent)
ETC	With OBU	• Non-stop operation at tollgate • Large traffic capacity of tollgate • No handling of cash • Low operation cost	• High cost of OBU to be imposed on road users • Cannot be used if on-line banking system is not available
	Prepaid Card (Non-contact)	• No device is required on the side of road users • Can be used when on-line banking system is not available	• Vehicles have to stop at toll gates • Smaller traffic capacity of toll gates than full ETC
	Prepaid card (Contact)	Same as above	Same as above

Since the state-of-the-art in this field is rapidly advancing, the system of toll collection should be further studied in the feasibility stage.

8.3 TRAFFIC MANAGEMENT SYSTEM

There are three terminologies which are similar with each other in the meaning; (i) Traffic Control, (ii) Traffic Management and (iii) Traffic Operation. As a matter of fact, these three words are considered to be used to express the matters slightly different with each other, but the differences are not fixed among the literatures and often ambiguous. In this Chapter, the words “Traffic Control” and “Traffic Management” are used in the manners as defined below. It should be noted that there are no internationally accepted definitions of “Traffic Control”, “Traffic Management” and “Traffic Operation” and the definitions described below are based on the usage of words in Japan.

Traffic Control

Traffic control is defined as the deeds of the police officers done mainly to enforce the legislations relevant to the road traffic. The deeds of traffic control usually include the followings:

(i) Regulation of speeds
(ii) Regulation of overtaking
(iii) Regulation of stopping/parking
(iv) Regulation for vehicles of certain categories (such as bicycles and animal-drawn carts) not to enter expressways

Among the actions of traffic control as listed above, speed regulation is most important in case of expressway. In any emergency, such as a traffic accident, regulated speed needs to be lowered to secure the safety and avoid the additional accident. Therefore, the police officers have to be always monitoring the hazards on the expressways and take necessary actions.

Traffic Management

Traffic management is defined as the actions done by the “road administrator” (such as MEA) to secure safe, smooth and comfortable traffic condition. There are two main reasons that the road administrator takes such actions:

(i) To satisfy the demand of the users of toll roads who naturally expect higher quality of “services” than on the ordinary (non-toll) roads.
(ii) To reduce the chances of accidents which result in decrease in the traffic volume the toll road and decrease in the toll revenue.

Traffic management usually consists of the following works:

(i) Provision of traffic information to the road users,

(ii) Monitoring/surveillance of the traffic conditions,
(iii) Regulation or control of traffic in case of emergency, accident and traffic congestion,
(iv) Rescue of, or assistance to, broken-down vehicles, and
(v) Clearance of the accident site

In addition to the above, **ambulance service is needed, but this usually belong to the responsibility of other institution.**

As can be seen in the above, there is no clear boundary between the traffic control implemented by the traffic police and the traffic management implemented by the road administrator. Actually there are many overlapping between the two. Accordingly, it is very natural that the traffic police and road administrator coordinate with each other. In Japan for instance, traffic officers are working together the staff of traffic control centers of the expressways.

8.3.1 Traffic Information System (TIS)

The word "Traffic Information System" usually refers to "Traffic Information Provision System". "Collection of Traffic Information" is done through "Traffic Monitoring and/or Surveillance" which is explained later. It is the system where the necessary/ desired information is provided to the toll road users via various methods.

(1) Objective

The main objectives of providing the traffic information to the users of the toll road are as listed below:

(i) Let the driver know the hazardous condition (accident, obstacle on the road, hazardous climate condition, etc) on the toll road ahead and let the driver take necessary caution.
(ii) Let the user of the toll road know the traffic congestion occurring on the road section ahead and let him/her decide to exit the toll road as he/she opts.
(iii) Let the road user know the congestion on the toll road before entering and let him/her choose to use or not to use the toll road.

(2) Kinds of Information Provided to Road Users

The following kinds of information are usually provided to the road users:
(i) Accident which has not been cleared.
(ii) Vehicle(s) stopping on the carriageway including shoulder.

(iii) Any hazardous obstacle on the carriageway.
(iv) Closure of the toll road.
(v) Maintenance works and other events occurring on the carriageway, shoulder or adjacent area of the toll road with or without traffic regulation.
(vi) Hazardous weather condition, such as heavy rain.

Most of the above items may not need explanation. In Item (ii), "vehicle(s) stopping on shoulder" (not only vehicles stopping on travel lane) is listed as one of the incidents for which the information used to be provided to the drivers.

This may need some explanation: Vehicles passing by the vehicle stopping on the shoulder tend to keep some distance from the vehicle(s) stopping on the shoulder. As a result, vehicles often change their lines of travel as they approach the vehicle(s) stopping on the shoulder or emergency parking bay. Thus, information on the vehicle(s) stopping on the shoulder/emergency parking bay is needed to give precaution to the drivers and minimize the chance of accident. Some thing can be said on the maintenance works and other events occurring on the shoulder or adjacent area of the toll road.

In many countries, information of hazardous weather conditions such as heavy rain, strong wind, thick fog, snow and ice is very important for safe driving. In Egypt, the climate is generally mild and chances of hazardous weather seem to be relatively rare. On the other hand, there may be other climate/weather condition(s) unique to Egypt, such as severe sand storm, which is hazardous to traveling vehicles. Therefore, diligent consideration should be given as to what kind of information be provided to drivers on weather.

(3) Methods/Devices for Traffic Information

The methods or devices commonly employed for provision of traffic information are listed in the table below:

Kinds and details of information desired by drivers may vary from one country to the other. Therefore, diligent consideration should be given on the details of traffic information at design stage and necessary modification should be made based on the observation of effectiveness of each method/device after being practically used.

Figure 8.3-1 shows different photos of some devices of traffic information.

(4) Main Points of Consideration in Planning/Designing Traffic Information

The following matters should be considered in planning/designing traffic information system:

Table 8.3-1 Methods/Devices for Traffic Information

Method/Device	Main Feature
Variable sign board (Word type)	• Message/information is expressed in words or numbers. • Various types of mechanism (scroll-film, flip-flop board, LED etc.) can be used. • Compact in size compared with "graphic" type. • Thus, less costly than "graphic" type.
Variable sign board (Graphic type)	• Message/information is expressed by combination of simplified picture and words. • Usually LED is used. • Easier and quicker for drivers to understand the message these "word" type. (Important for providing information to vehicles traveling at high speed.) • Larger in size compared with "word" type. • Thus, more costly than "word" type.
Highway radio (Exclusive)	• Message/information is disseminated through shorter-range (weak) radio wave which is broadcasted via antenna installed along the road and received by car radio. • Some type of sign board advising the drivers to turn on their car radios and tune to the frequency of the highway radio broadcast is necessary.
Information board at entrance	• Various types of message board (simple blackboard, scroll-film type etc.) can be used. • If placed at adequate position, easy for the drivers to read because the vehicles stop or slow down to pay the toll or get a ticket. • Drivers can get additional information, if necessary, from the personnel at the toll gate. • Effective for informing drivers of congestion on the toll road or other informatics and allows them to opt for not using the toll road.
General radio/ TV broadcast	• Traffic information is broadcasted via general radio or TV at fixed times every day. • The times of broad casting of traffic information are preferably fixed at easy-to-remember times, such as "every hour on the hour" or every 30 minutes. • Traffic information broadcasted is not limited to that of toll expressway but also includes that of ordinary streets. • Can be implemented with relatively small investment.

(i) Type of structure to support variable sign board

Traffic information needs to be exhibited overhead of vehicles so that it can be seen from all the drivers passing beneath even if large-size vehicles are blocking the side views. "Gantry-type" of structure is most suitable for this purpose although it is relatively costly.

(ii) Provision of information on traffic/road condition on toll road to the drivers on the street

Information on traffic congestion on the toll road needs to be given to the drivers on the streets accessing the entrance of the toll road to let them decide not to enter the toll road. For this reason, information board for traffic condition of toll road should be installed not only at the entrance but also some distances, such as 200 m and 500 m, before the entrance.

Source: http://www.nagoya-denki.co.jp/english/products_e.html

Travel Time Display Sign (top left)
This tricolor LED (red, green, and umber) sign displays route options (expressway and ordinary road) together with the travel time depending on route taken.

Variable Sign (top right)
This device is installed at a road side space for permitting time-limited parking, thus enabling to use the restricted road space of urban areas more efficiently. A parked vehicle is detected by the equipped laser and supersonic sensors, and warns of a time limit violation via blinking red lights.

VMS installed above urban expressways (bottom right)
This VMS displays the traffic and weather information of urban expressways and also the connected inter-urban expressways.

VMS installed above Toll Gates (bottom left)
This VMS displays the traffic and weather information of the expressway.

Figure 8.3-1 Examples of Traffic Information Devices in Japan

8.3.2 Traffic Monitoring/Surveillance System

(1) Objectives

The main objectives of traffic are two folds:

(i) To know abnormal or hazardous situation and take necessary actions
(ii) To obtain the sources of data/information to be provided to the road users

(2) Methods/Devices Commonly Employed and Kinds of Data/Information Collected

Table 8.3-2 lists the methods/devices commonly employed and kinds of data/information collected by the methods/devices as well as usage of the collected data/information (Basic mechanisms of the important devices are explained).

Table 8.3-2 Methods/Devices Commonly Employed and Kinds and Usage of Collected Data/Information

Method/Devices	Data/Information	Usage of Data/Information
CCTV (Closed-Circuit TV)	• General condition of traffic flow • Accident • Broken-down vehicles • Traffic congestion	• Actions for accident • Rescue for broken-down vehicles • Provision of traffic information to drivers
Traffic counter (loop-coil type, ultra-sonic type)	• Traffic volume • Vehicle speed (see explanation below the table) • Vehicle type (see explanation below the table)	• Judgment of traffic congestion • Record of traffic volume
Axle load-meter	• Axle loads of vehicles	• Enforcement of over-loading • Judgment of vehicle type
Patrol car (traffic police and toll road operator)	• Road surface condition • Obstacles on carriageway • Broken-down vehicles • Accident	• Rescue operation for accident/ broken-down vehicle • Warning to drivers on hazardous road condition • Actions to remove obstacles • Repair works of defects of road facilities
Emergency telephone (mobile phones of drivers)	• Accident • Broken-down vehicles • Obstacles on carriageway • Abnormal incidents on road	• Rescue actions for accident/ broken-down vehicle • Removal of obstacles • Warning to drivers
Devices for observing weather/climate condition	• Hazardous weather condition	• Warning to drivers • Regulation of travel speed

<u>Basic Mechanism of Devices/Methods</u>

(i) CCTV
CCTV provides on-time information on the traffic condition. Images taken by the TV cameras are sent to the traffic control center via cable or radio wave. Often, image of CCTV is the first information on accident and other incidents which require emergent actions. TV cameras are often installed on the tops of the building located along the expressway to watch certain length of section. TV cameras usually have zoom lens to take close-up image and rotary base to turn the camera into desired direction.

(ii) Traffic counter

There are some types of traffic counter but most commonly used one are; loop-coil type, ultrasonic wave type and light beam-photo-electronic diode type.

(a) Loop-coil type

A loop of electric wire is embedded in the surface course of the pavement. Weak electric currency is provided to the loop-coil creating magnetic field. When a vehicle passes over the loops coil, the magnetic field is affected and change occurs in the electric currency flowing in the loop-coil. The recorder connected to the loop-coil detects this change of electric currency and interpreters as the passage of the vehicle. Vehicle speeds can be measured by installing two loop-coils at certain distance, such as 10 m, and measure the time interval that a vehicle passes these two loop-coils.

(b) Ultrasonic wave type

The device is hung over the lane and continuously radiate ultrasonic wave towards the pavement surface directly below. The wave is reflected at the pavement surface and comeback to the device. The device measures the time between the radiation of wave and arrival of the reflected wave. When a vehicle passes below the device, the wave is reflected at the roof of the vehicle, and the time between the radiation of wave and arrival of the reflected wave becomes shorter. The magnitude of this shortening of time between radiation and reception of waves becomes larger as the roof of vehicle is higher. Thus, the type of vehicle can be judged.

(c) Light beam-photo-electronic diode type

Light beam is radiated across the road from either side of the road and received by the sensor located the other side of the road. The sensor is basically composed of photo-electronic diode which detect the light beam. When a vehicle passes between the light radiator and the sensor, the light is interrupted and the sensor detects it. By installing the combination of radiators and sensors at different heights from the road surface, height of the vehicle can be detected and the type of vehicle can be judged.

(iii) Patrol car

Two different organizations dispatch highway patrol; traffic police department and road administrator/operator. The patrol cars of traffic police are given two difference types at duties, one to observe traffic/road condition and report to the traffic control center and the other to enforce traffic regulations. The patrol cars of road administrator/operator, on the other hand, concentrate observation/report on traffic/road condition and rescue of vehicles/road users in need of assistance. Patrol crew of road administrator/operator is in charge of first-hand actions to prevent accident, such as placing warning signs, removing obstacles and signaling to coming vehicles.

(iv) Emergency telephone

Emergency telephone sets are installed on roadside. These telephones are directly connected to the traffic control center. Road users involved in, or witnessed, accident are to report to the traffic center. Emergency telephones are also used by road users who need any assistance. Each telephone set is numbered so that location of the accident or other trouble can be easily identified by the personnel in the traffic center. Owing to the common possession of mobile phones by road users, emergency telephone sets on roadside are becoming less important. If emergency telephones are not to be installed, signs indicating the location (such as “kilometer posts”) need to be installed on or along the edge of shoulder so that the road users in need of assistance can easily identify and report the location. Also, charge-free telephone number to be called for communication with the traffic control center should be shown along the road.

(v) Devices to observe weather/climate condition

Various types of devices/equipment are used in practice in many countries. These devices are readily available commercially.

8.3.3 Traffic Control/Regulation System

In this subsection, the terminology “Traffic Control” and “Traffic Regulation” is used to mean the actions done by the road administrator, such as MEA. The traffic control/regulation done by the road administrator includes the following:

(i) Regulation of traffic or closure of road needed for the reasons such as defects of the road,
(ii) Regulation of traffic to prevent an additional accident after an accident occur,
(iii) Regulation of traffic to execute the maintenance works,
(iv) Provision of traffic information as described in Subsection 8.3.1 above,
(v) Rescue of, or assistance to, the broken-down vehicles as described in Subsection 8.3.4 below, and
(vi) Clearance of the accident site as described in Subsection 8.3.4 below.

These actions are closely related to the traffic control implemented by the traffic office. Therefore, close coordination and consultation between the road administrator and traffic police should be maintained. Actually, it is preferable that traffic police officers are stationed in the traffic control center of the toll road administrator and work together. Figure 8.3-2 shows an example of a traffic control center in Japan.

Figure 8.3-2 Example of Traffic Control Center in Japan

A modern traffic control center exists in Cairo at the Al-Azhar Tunnel, which is shown in Figure 8.3-3. This is a good example for utilizing advanced systems for the traffic control center to be constructed for the proposed urban expressway network.

Figure 8.3-3 Traffic Control Center of Al-Azhar Tunnel

8.3.4 Other Activities

(1) Clearance of the Accident Site

When a severe accident occurs, the road often becomes impassable blocked by the vehicles involved in the accident or debris of the broken vehicles. Sometimes the cargo being transported by the vehicles involved in the accident are spread on the road surface. These obstacles need to be cleaned as soon as possible. (It has to be always borne in mind that the longer the time of road closure is, the more the loss of toll revenue.) This work is usually done in cooperation with the traffic police.

The works required for this job often need large number of manpower and experience. Therefore, specially trained crew should be prepared. Also, once a severe accident occurs and the traffic is stopped, the road section leading to the accident site is blocked by the stopped vehicles and it is often difficult for the vehicles and equipment required at the accident site to arrive at the site.

Some types of the cargo as listed below need special attention.

(i) Flammable objects such as gasoline and other oils
(ii) Poisonous material including various chemical agents and gases

It should be noted that gasoline, kerosene, motor oil and many other kinds of oil are harmful to asphalt pavement and have to be absorbed as soon as they are spread on the pavement surface. The material to absorb such oil can be commercially obtained, but if not available, powder of lime or even sawdust can be used.

(2) Rescue for Injured Persons in the Accident

When an accident occurs and some one is injured, rescue for the injured people is necessary. Usually, such rescue activities are the responsibility of the agency in charge of general rescue activities such as fire brigade or ministry of health. An agreement should be made between the rescue agency and the toll road operator so that ambulance vehicles can quickly enter the toll road when the toll road operator/traffic police informed about the injury.

(3) Rescue of Broken-Down Vehicles

When a vehicle stops on the carriageway, it hampers smooth flow of the traffic and often causes traffic jam. It is also hazardous to other vehicles. Thus, a broken-down vehicle stopping on a toll road needs to be towed away as soon as possible. Even if the broken-down vehicles is parked at the emergency parking bay provided along the expressway at certain intervals, it needs to be repaired at the spot or towed to a repair shop. Accordingly, towing service for such vehicles is needed.

A good example of this service already exists in the Al-Azhar Tunnel in Cairo. In this case, this service is provided by the authority in charge of the management of the tunnel. One towing trucks with crew is stationed at the entrance of the tunnel (one for each direction). When a vehicle stops in the tunnel, it is detected at the traffic control center of the tunnel through CCTV and the towing truck is mobilized.

In case of the Al-Azhar Tunnel, this service is currently provided without charge to the driver of the broken-down vehicle. However, the total length of the urban expressway network becomes longer, the cost of this service may become substantial and this service may need to be charged. There are three possible alternatives as for the provider of this service; (i) operator of the expressway (MEA), (ii) a non-profitable organization, such as "automobile associations", and (iii) private garages. To minimize the size of the expressway authority (MEA), it is recommended that either (ii) or (iii) above is adopted.

Since the proposed urban expressway network is to be toll roads, some arrangements for letting the towing truck enter the expressway will be necessary. Therefore, the arrangement of such services needs to be started with the initiatives of the toll road operator (MEA).

8.3.5 Relation of Parties Relevant to Traffic Management

Figure 8.3-4 shows relation of the following parties involved in the traffic management of the toll road:

- Toll Road Operator
- Traffic Police
- Rescue Agency, which is basically under the Ministry of Health
- Automobile Association for rescue services for break-down vehicle

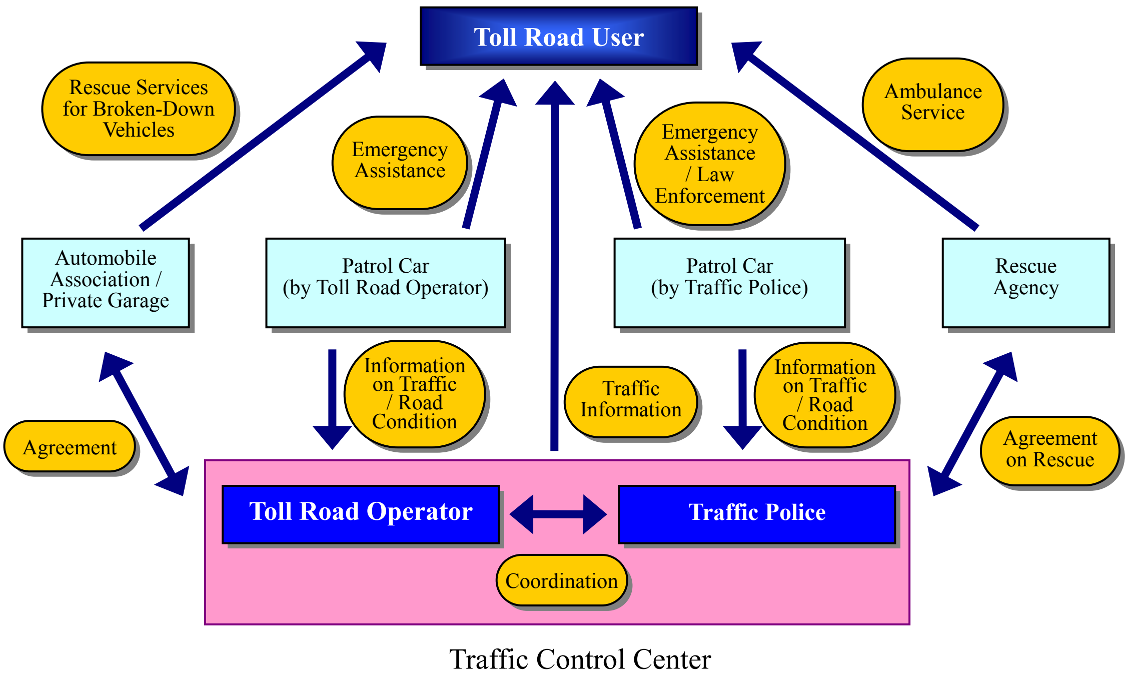

Figure 8.3-4 Relation Between Relevant Parties

8.3.6 Route Numbering System

It is strongly recommended, from viewpoint of traffic management, that each route (line) of the expressway network is given a route number such as E1, E2.

The route numbering system has in comparison with the system where the road names, such as “6 October”, the following advantages.

- Simple and easy-to-recognize on signboards
- Simple and easy-to-recognize on road maps

8.4 MAINTENANCE SYSTEM

The maintenance works for toll expressways are basically same to those for ordinary, non-toll highways. However, higher level of works is required because of the high travel speed of the vehicles and the expectation of the road users for the “return for the toll”.

Maintenance is very important to maintain the traffic safety of the expressways where heavy traffic is traveling at high speed. The traffic does not stop 24 hours a day and 365 days a year. Some of the drivers may not be experienced. Any defect of road surface/structure may result in severe accidents. The following subsections describe the works of maintenance.

8.4.1 Cycle of Procedures and Types of Maintenance Works

(1) Cycle of Procedures

The terminology “maintenance system” usually refers to a series of procedures which form a cycle as shown in Figure 8.4-1.

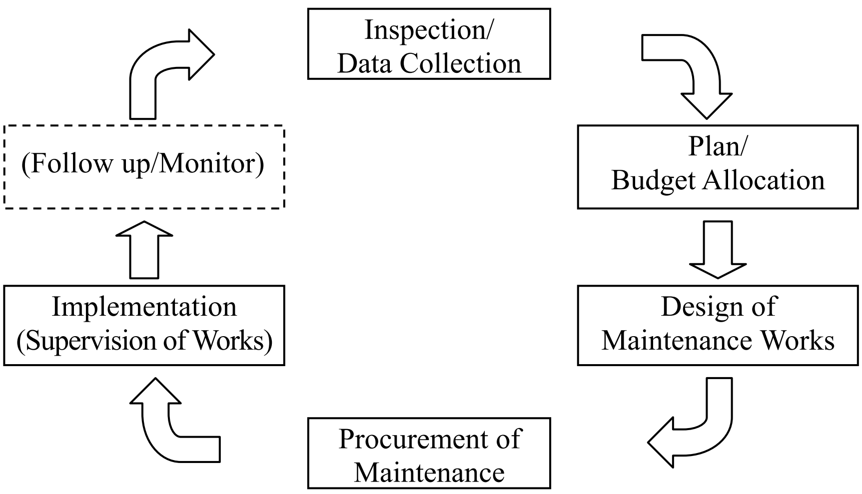

Figure 8.4-1 Cycle of Procedures of Maintenance System

In view of the objective of this Study (proposal for the scheme of the implementation of toll expressway network), the discussions in this section focus mainly on inspection/data collection and planning of maintenance. In Cairo consultants and contractors with satisfactory capacities to design/implement ordinary maintenance works are available, provided that adequate instruction/supervision by the road administrator/operator is given. Therefore, the capacities of consultants and contractors can be utilized in designing and implementation once proper maintenance plan is formulated.

(2) Types of Maintenance Works

Usually, road maintenance works are categorized into the following three types.

(i) Routine maintenance,
(ii) Periodic maintenance, and
(iii) Emergency maintenance.

"Routine maintenance" refers to the works with features as listed below.

(i) Need to be implemented more frequently than "periodic maintenance". Time interval or frequency may vary from more than once a day to once a year.
(ii) Relatively simple or small in scale.
(iii) Often interval of implementation is less dependent on the traffic volume than in case of periodic maintenance and is relatively regular compared with that of periodical maintenance.

In contrast to routine maintenance, periodical maintenance has the following features:

(i) Longer interval of implementation (once a year to once per 10 years),
(ii) Relatively large in scale: Often requires closure of lane(s) or even several sections of the expressway, and
(iii) Often, the interval of implementation is influenced by traffic volume, especially that of heavy vehicles.

Emergency maintenance mainly refers to the repair work for damages caused by natural disasters or large-scale accidents.

The following subsections describe these types of maintenance works.

8.4.2 Routine Maintenance

Actually, there is no clear logical boundary between routine maintenance and periodic maintenance. In practice, the work items as listed in Table 8.4-1 are usually categorized as routine maintenance.

Table 8.4-1 Work Items of Routine Maintenance

Work Item	Description	Typical Interval	Remarks
Road Cleaning	Removal of trash, debris, soil, stone, etc. on shoulders, usually using specially designed vehicles	1 – 2 times/day	Less frequent on left shoulder
Grass Cutting	Cutting of grasses on embankment slope, cut slope	1 – 4 times/year	Greatly dependent on climate condition
Cleaning of Drainage Facilities	Removal of trash and sediments in side ditch, catch basin, culverts, etc.	1 – 2 times/year	Before rainy season
Repair of Minor Defects of Pavement	Patching, sealing of cracks, etc.	As soon after the defect is found as possible.	
Maintenance of Appurtenant Facilities	Maintenance of lightings, guard rails, traffic signs, etc.	As soon after the defect is found as possible.	Interval depends on climate

8.4.3 Periodic Maintenance

Periodic maintenance usually includes the work items listed in Table 8.4-2.

Table 8.4-2 Work Items of Periodic Maintenance

Work Item	Description	Typical Interval	Remarks
Pavement Overlay	Laying 3 – 5 cm thick surface course material	Once/ 5 - 13 years	Interval depends on traffic volume
Pavement Resurfacing	Rehabilitation of surface course to rectify rutting, colligation, etc.	Once/ 5 – 13 years	Interval depends on traffic volume, climate & pavement characteristics
Pavement Rehabilitation	Removal of deteriorated pavement and laying new pavement	Once/10 – 20 years	Interval depends on traffic volume & pavement structure
Replacement of Expansion Joints of Bridges/Viaducts	Replacement of damaged expansion joints	Once/ 5 – 10 years	Interval depends on traffic volume of heavy vehicles
Replacement of Bearing Shoes of Bridges/Viaducts	Replacement of damaged bearing shoes	Once/10 – 30 years	Interval depends on climate
Repainting of Steel Bridges	Repainting of steel bridges	Once/ 3 – 10 years	Interval depends on climate, distance from sea & bridge structure

8.4.4 Emergency Maintenance

Emergency maintenance refers to the kinds of works to urgently rectify serious defects of road structure. Quite often the defects occur or are found unexpectedly. There are various forms of such defects and it is very difficult to anticipate what happens when. The followings are some examples of such defects:

(i) Failure of embankment/cut slope during/after heavy rain
(ii) Damage due to earthquake (Bridge/viaduct, cut/embankment slope, retaining wall, pavement, etc.)
(iii) Cracks in deck slab, beam or pier of bridge/viaduct (often caused by repeated loading of heavy vehicles)

As anticipated from the above examples, these types of defects are very hazardous to the traffic and closure of lane(s) or the section of expressway is often required, resulting in considerable confusion in the regional traffic. To minimize traffic confusion, repair works for these defects are often implemented in two stages; urgent temporary repair to secure traffic-ability and full-scale repair including some strengthening to prevent recurrence in future.

8.4.5 Inspection

Basic objective of inspection is to find out defects of road facilities and take necessary actions. This includes finding out the signs of future defects which are often found well before the actual defects occur.

Inspection is often categorized into the following three kinds:
(i) Routine inspection
(ii) Periodic inspection
(iii) Emergency inspection

Main features of these types of maintenance are compared in Table 8.4-3.

<u>Items to be inspected (major items)</u>

(i) Routine inspection
In routine inspection, inspection is made mainly in the patrol car traveling on the shoulder or right-most lane. Accordingly, items to be checked are concentrated on those what can be observed from the road surface. They include the following:
- Pavement condition, water-logging (drainage), condition of cut slope, appurtenant facilities (guard rail, lights, traffic information devices, etc.)

It should be emphasized that serious defects in the main structure of expressway, such as bridges, are often found through routine inspection.

Table 8.4-3 Main Features of Inspection

Type of Maintenance	Routine	Periodical	Emergency
Purpose	To find defects of facilities visible from vehicles	To check conditions of major facilities	To check safety of expressway
Frequency	Once/1 day – 1 week	1 – 4 times/year	Before/during/after abnormal incident such as heavy rain
Method	• Eye-inspection with simple tool such as binocular • Aboard patrol car, running at low speed: on-foot as necessary	• Close-up eye-inspection with simple tool such as test hammer • On-foot	• Eye-inspection with simple tool such as binocular • Aboard patrol car • Close-up inspection on-foot if abnormality is found
Typical place from where inspection is made	Road surface, aboard patrol car	Beneath bridges/ viaducts, cut slope, embankment slope, etc.	Various
Items to be inspected	See explanation below the table		
Typical format of record	Check list	Updating of data in inventories of individual bridges/ viaducts, culverts, cut slopes	Various
Problems to be detected	• Minor defects (patrol, crack of pavement, defects of lighting, message board, etc.) • Sign of serious incidents such as land slide	Defects of bridges/ viaducts, culverts drainage, slope protection, retaining wall, etc.	Damage due to natural disaster, etc.
Usage of data/ information obtained	• Repair of minor defects such as pothole, crack of pavement, damaged traffic signs, etc. • Urgent actions for unexpected serious incident	• Annual maintenance plan for next year • Revision (as necessary) of the maintenance plan for the current year	• Emergency actions including closure of the expressway

(ii) Periodic inspection

In periodic inspection, the items of inspection is determined first, and the methods and place of inspection are planned. The items commonly inspected include the following:

- Bridge: Cracks in deck slabs, piers, etc., bearing shoe, expansion joint, guard fence/ rail, drainage, paint
- Cut slope: Condition of slope protection works (shotcrete, retaining wall, etc.), drainage
- Embankment slope: Sign of slope failure, slope protection works, condition of vegetation
- Culverts: Physical condition, water flow

(iii) Emergency inspection

Emergency inspection is mainly conducted after, during or before natural disasters such as torrential rain or earthquake. (In case of earthquake, inspection can be conducted only after it happened.) The main purpose of emergency inspection is to check the safety of expressway. Accordingly, the inspection focuses on the following items:

- Soundness of bridge / viaducts
- Soundness of embankment and cut slopes
- Soundness of pavement

8.4.6 Procurement of Maintenance Works

Maintenance works for a toll expressway is usually contracted out. Force account is rarely adopted because it is not economically efficient. The following types of contract are often adopted.

(i) Routine maintenance
- Long-term contract with contract period 1 – 3 years
- Unit rate of each work item is agreed in the contract, and payment is made based on the quantities of the works actually implemented.

(ii) Periodic maintenance
- Ordinary contract of civil works
- Contract packages are designed considering types of works, location and traffic regulation

(iii) Emergency maintenance
- Special form of contract, such as direct appointment, to urgently start necessary works.
- It is often effective to establish a system where by equipment and labor force of private contractor can be mobilized quickly when emergency occurs.

In case of routine maintenance, long-term contract, such as with contract period of 3 years have the following advantages.

(i) Workload for tendering / contracting is greatly reduced resulting in reduction in the costs both on the side of the employer and on the side of contractor.
(ii) Maintenance crew can become familiar with the detailed conditions of the site, resulting in quick and adequate actions.
(iii) The contractor can make a plan for efficient usage of equipment and labor, resulting in cost reduction.

The largest drawback of long-term contract is that the contractor tends to loose the sense of “competitiveness”.

Performance based contract

In recent years, a new type of road maintenance contract called “performance based contract” (PBC) is being adopted in some countries. (In UK, PBC has been used for more than 10 years.) In this type of contract, only the results, or “the performance” of the maintenance works is stipulated and the methodologies involved are left to the option of the contractor.

The expected advantage of PBC is that the know-how possessed by the contractor is fully utilized resulting in the cost reduction.

8.4.7 Maintenance Planning

As discussed in the preceding sections, maintenance of the expressways involves road inspection, cleaning, and minor repairs as daily work for preserving road functions and periodic maintenance works such as painting and reinforcing bridges, repairing/ rehabilitating pavements. An efficient and systematic maintenance work plan can be drawn out based on the frequency of activities required because they are usually performed on a regular time cycle depending on the type of work item. Thus, the budget for the maintenance works needs to be incorporated in the business operation plan of the expressway.

Attention has to be paid to minimize the disturbance of the traffic since many of the works are carried out on the road shoulders or by restricting driving on a single or multiple numbers of lanes, influencing the flow of traffic. In some cases, the expressway has to be completely closed for some period. It has to be always born in mind that the traffic is supporting the socioeconomic activities of the nation and any disturbance of it may cause serious impact on these socioeconomic activities. In addition, a poorly prepared maintenance plan may increase the chances of traffic accidents.

Because of such impacts to the traffic, close coordination/consultation with relevant parties is required in maintenance planning. Such relevant parties include traffic police (including traffic police in charge of the alternative roads), affected roadside residents and frequent users such as trucking companies. In case of planned closure of the expressway for maintenance works, prior announcement through mass media and other channel is required to minimize the confusion.

To minimize the adverse impact to the traffic, it is often effective to plan to execute several maintenance works on same days by closing the expressway. This method is often adopted in Japan to minimize the number of days required for the maintenance works and thus, minimizing the disturbance of the traffic.

It is recommended that the administrator of the expressway network, such as MEA, to work out and prepare a maintenance manual, by which the regular maintenance works and periodical repair works including large scale rehabilitation can be conducted with optimum efficiency, minimum cost and minimum adverse impact to the traffic flow.

8.4.8 Traffic Regulation for Maintenance Works

As stated above, many of the maintenance works are executed on the carriageway and need some kind of traffic regulation. Such traffic regulation needs to be carefully designed to avoid any hazardous situation and to minimize the disturbance to the traffic. Figure 8.4-2 shows an example of traffic regulation on the “shoulder-side lane”. The fundamental points for planning/designing the traffic regulation for maintenance works are as follows:

(i) The planned traffic regulation needs to be agreed upon by the traffic police.
(ii) The traffic regulation should be removed as soon as it becomes unnecessary.
(iii) The location of the regulated area needs to be informed to the drivers well in advance. Exiting information boards can be used for this purpose. In addition, warning signs temporarily installed at such locations as 2 km, 1 km, 500 meters and 300 meters before the regulations starts are also effective. At the beginning point of the regulation, the lane or shoulder needs to be gradually narrowed, with tapering length of 20 ~ 30 meters to allow the final merging of the vehicles.

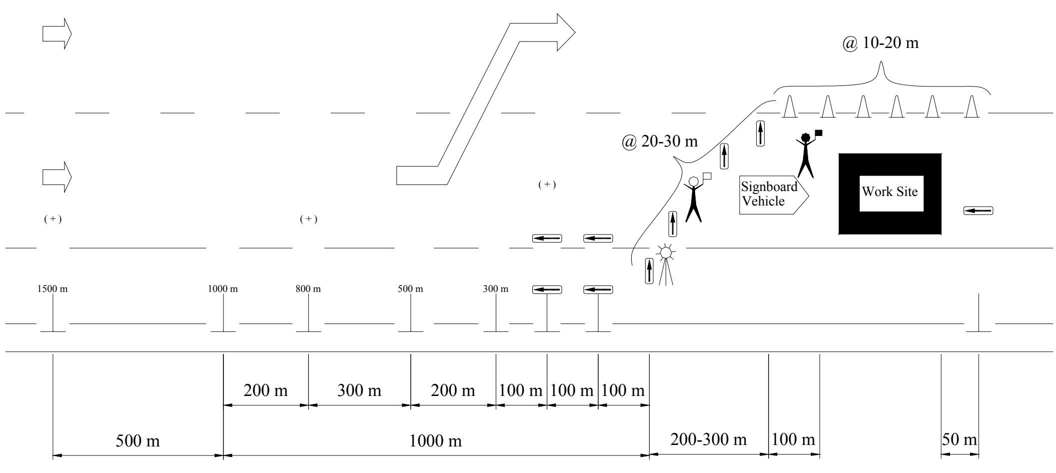

Figure 8.4-2 Example of Traffic Regulations

8.4.9 Strengthening and Upgrading

The works included in this category are to increase or improve the function(s) of the existing expressway to cope with the change in the environment of the expressway. These works are usually not foreseen at the time of planning or designing. The followings are some examples of such types of works:

(i) Strengthening of the structure to cope with the increase of vehicle weight (change in vehicle regulation).

(ii) Installation of noise barrier needed to cope with the change in the roadside land use.

(iii) Alteration from ordinary asphalt concrete (AC) surface to permeable, low-noise AC surface.

These works are similar with large-scale rehabilitation works from the viewpoint of the methodologies of planning, design and execution. Therefore, these works are usually planned together with the maintenance works. However, necessities for these works do not occur regularly or in a foreseeable manner, and thus, these works have to be planned on ad-hoc basis as the necessities arise. Accordingly, these works cannot be incorporated in the general program of toll road network development.

Although the works of strengthening and upgrading are similar to large-scale rehabilitation works from engineering point of view, they need to be distinguished from rehabilitation or other maintenance works from viewpoint of asset management and accounting. The maintenance and rehabilitation works are implemented to “maintain” or “recover” the function, or the value, that the road initially have. On the other hand, strengthening and upgrading works are to “add” a new function that the road does not initially has.

8.4.10 Asset Management

In the recent years, the viewpoint of “asset management” is emphasized in the maintenance planning of roads. As mentioned earlier, maintenance can be interpreted as the actions to preserve the functions or values of the road facilities. Construction of roads especially that of expressways needs huge amount of investment. On the other hand, little attention has been paid to the importance of maintenance and there are many cases where the road infrastructure suffered from deterioration caused by poor maintenance. Maintenance works implemented at appropriate timings allows the preservation of function/value of the road facilities with the minimum total expenditure.

To establish an adequate asset management system, the operator must have a sophisticated inventory system. Basic data such as road name, road sections, nodes and location reference points should be designed to allow importing of such database items as inventory elements, and condition survey data.

Inventory elements and attributes include number of traffic lanes, carriageway width, right of way, junctions, bridges, pavement type, pavement thickness, median, shoulder, sidewalk, drainage facility, side slope, signs, markings, hazards, gradient, lighting, etc. while condition survey data include surface condition, roughness, cracks, deterioration, etc.

Management of road assets should be properly undertaken based on an accurate periodically updated inventory surveys with relevant documentations.

The organization in charge of management of infrastructures (MEA) shall specify the following items to be included in the asset management plan.

(1) Determination of the Object of Structures

Asset managements plan will be arranged for each structure such as roads, bridges, tunnels for toll expressway network. Once the object of structures is determined, the organization shall design the asset management plan considering the characteristics of each structure. The characteristics will include type of demand, type of infrastructure (i.e. life cycle, critical safety), type of inspection (i.e. easy/difficult or simple/complex).

(2) Identification of Field Management

For example, the road management work includes the daily activities of cleanings, grass treatment, and patrols as well as structural maintenance, repairs, and rehabilitations of the road structures. In this example, the organization (MEA) shall determine which activities are included in the scope of their asset management. Once the coverage of the asset management work is determined, MEA shall implement the asset management plan for the determined field.

(3) Estimation Future Maintenance and Rehabilitation Costs

One of the main objectives of the asset management is to minimize the life cycle cost for infrastructure. Budget allocation will be different from the case of new construction, and therefore, future maintenance and rehabilitation costs shall be estimated deliberately, and shall be arranged in a proper manner.

(4) Building of Organization Structure

MEA shall decide the organizational structure for asset management, and put the relevant personnel to each section. Since asset management is a newly adopted concept for Egypt, it is recommended that a new sub-organization should be established in order to execute the asset management work under the special commitment. Since the asset management shall be applied for the assets of the toll expressway network, financial resources shall be arranged separately from the construction costs and the specific department for the asset management shall be responsible to carry out required tasks.

8.5 LEVEL OF MAINTENANCE AND STANDARDIZATION OF WORK PROCEDURES

It may not be necessary to explain that fulfilling the required level is essential in the practice of maintenance. In addition, securing a uniform level/manner of maintenance over the entire expressway network is very important for traffic safety. If there are unexpectedly hazardous situation, such as existence of a large obstacle on the carriageway, on an expressway network which is otherwise well-maintained creates very dangerous situation because the drivers do not anticipate such danger. For such reasons, the minimum level of maintenance has to be determined and the maintenance works need to be planned/designed in to fulfill the established maintenance level.

Setting the level of maintenance is also necessary as one of the items agreed upon between the PPP entity and MEA (or the Government) and clearly stipulated in the Contract of concession.

Better level of maintenance is preferable but may result in the increase in the cost. Since the maintenance cost is covered by the toll that the road users pay, the level of maintenance should not be set unreasonably high.

Further, some work procedures, such as the manner of traffic regulation for the maintenance works executed on the carriageway need to be standardized, regardless of who does it (MEA or PPP entity). Variation in such procedures possibly cause confusion on the side of drivers and may result in accident.

Standardization of work procedures is often discussed from the viewpoint of work efficiency. For this purpose, various guidelines and manual need to be prepared and disseminated. This topic is discussed in the part of “capacity building” in the section of “institutional set up” and not discussed here.

8.5.1 Level of Maintenance and Legal Aspects

(1) Legal Aspects

In many countries, it is assumed that the government, as the road administrator, is responsible for maintaining the public roads in the conditions not hazardous to the general traffic. This rule may or may not be explicitly written in the relevant legislation. Accordingly, the first priority criterion for considering the level of maintenance is this written or unwritten duty of the road administrator. This required level of maintenance is closely related to the drivers' expectation or behavior. Accordingly, it is often related also to cultural or social background. The following cases in Japan and USA may show the difference of social background of road maintenance.

Japan

[The law case for the accident on National Highway No. 41 along Hida River occurred in August 1968.]

In this accident, two sightseeing buses were washed away into the nearby river (Hida River) by a freshet and 104 people were killed. The families of those killed sued the Government (the Ministry of Construction at that time) for not taking necessary actions to prevent the accident (the Government should have closed the road). Both the decisions by Lower Court (Mach 1973) and Regional Higher Court (November 1974) judged that the road administrator (the Ministry of Construction; its road works office) did not practice the required task and was responsible for the accident. Since then, road administrators are obliged to close roads in their jurisdictions when natural disasters such as freshet or failure of cut slopes are possible.

USA

In the winter of 1976 – 1977, a severe cold front attacked the Mid-West Region of USA. The temperature did not go above 0 degree Fahrenheit (or about minus 17 degree Celsius) even in daytime. Harsh blizzard continued for 3 days (72 hours). The roads including the Interstate Highways became impassable because of snow on the road surface. In the State of Illinois alone, a total of 33 people were frozen to death on the highways stopped by the snow on the road surface. No voice was heard blaming the road maintenance (snow removal operations).

In both of the above cases, the first causes of the deaths of road users were "severe weather". But the evaluation on the responsibilities of the road administrators by the societies of the two countries differed completely.

Currently, Egyptian drivers seem to be used to see abnormal incidents such as bumps and holes on the road surface. However, as the road condition in Egypt will be improved, such anticipation/behavior of Egyptian drivers may change in future and higher level of maintenance may be required.

It should be also noted that it is usually the duty of the driver in the traffic law to be always cautious on the road and traffic condition and exert his/her best effort to secure the safety.

(2) Example of Level of Maintenance

As explained in the above, it is very difficult to assume the required level of maintenance. However, the required level of maintenance needs to be stipulated in the contract of concession with PPP entities. The criteria listed in Table 8.5-1 are tentatively proposed as examples of the maintenance level to be agreed upon between PPP entity and the Government.

Table 8.5-1 Examples of Criteria for Maintenance Works

Item	Criteria/Required Level	Remarks
Hazardous Obstacles	1. Definition: (i) Solid item with dimensions of 5 cm in width, 5 cm in height and 50 cm in length or larger, (ii) "Sheet-shaped" objects with size of 1 m x 1 m or larger. 2. Requirement: Shall be removed within 2 hours after being found or informed by the road user.	
Potholes	1. Definition: A depression on the pavement surface with dimensions of 10 cm x 10 cm and 3 cm in depth or larger 2. Requirement: Shall be repaired within 2 days after being found: An adequate warning sign shall be placed to draw the attention of drivers.	
Step-wise Unevenness of Road Surface	1. Definition the abrupt uneven surface occurring for example, but not limited to, at the abutment or expansion joints of bridges/viaducts. 2. Requirement: The depth/height of "step-wise unevenness" of road surface shall not exceed 4 cm.	
Roughness of Pavement	1. Definition: The roughness is expressed in terms of the International Roughness Index (IRI) 2. Requirement: IRI should not exceed XX.	Measure once a year.
Skid Resistance of Pavement Surface	1. Definition: Skid resistance measured by "British Portable Skid Meter" 2. Requirement: Coefficient of friction of the dry surface shall be 0.4 or large	Measured only when low skid resistance is suspected.
Road Cleaning	1. Definition: Cleaning of right and left shoulder of the carriageway using a vehicle specially constructed for this purpose (road sweeper). 2. Requirement: The interval of road cleaning shall not exceed 12 hours or twice a day.	
Repair of Damaged Traffic Safety/Control Facility	1. Definition: Damage of guard rails, traffic signs (except pavement markings), median divider and other similar facilities or devices. 2. Requirement: Shall be repaired within one month provided that adequate warning shall be placed until the damaged item is repaired.	(Should not be excessively demanding level)

It should be noted that these criteria are tentative proposal and need verification. It may be worth actually practicing these maintenance works on a trial basis and evaluate their practicability, social acceptability and cost affectivity. (This is one of the reasons that the establishment of MEA is recommended.) Considerable modification may become necessary after experience of maintenance and traffic management of urban toll expressway network is accumulated. It should be noted that the required level ever changes as the average level of road conditions in Egypt are improved.

8.5.2 Standardization of Work Procedures

The procedures of some types of maintenance works give considerable impact on the flow of traffic and the chances of traffic accidents. One of the typical examples of such work procedures is the manner of traffic regulation implemented for execution of maintenance works on the carriageway. An example of such traffic regulation was shown in Subsection 8.4.8 above. The warning signs should be installed well before the location of the maintenance work. The locations of these pre-warning signs should be designed following logically unified policy. The following factors are usually considered in designing the manner of traffic regulation.

(i) Traffic volume
(ii) Traffic characteristics (share of heavy vehicles etc)
(iii) Geometric elements of the location/section
(iv) Time of day (daytime or night)
(v) Structure of road (road section, bridge/viaduct or tunnel)

It should be noted that the example shown in Subsection 8.4.8 has been designed to be suitable for the traffic/drivers condition in Japan and can be excessively diligent. It is probable that simpler traffic regulations suffice in case of Egypt.

8.6 ENVIRONMENTAL PROTECTION MEASURES

8.6.1 Environmental Agencies and Laws

(1) Governmental Agency

MSEA - EEAA Institutional Framework

In June 1997, the responsibility of Egypt's first full time Minister of State for Environmental Affairs (MSEA) was assigned as stated in the Presidential Decree No. 275/1997. From thereon, the new ministry has focused, in close collaboration with the national and international development partners, on defining environmental policies, setting priorities and implementing initiatives within a context of sustainable development.

According to the Law 4/1994 for the Protection of the Environment, the Egyptian Environmental Affairs Agency (EEAA) was restructured with the new mandate to substitute the institution initially established in 1982. At the central level, EEAA represents the executive arm of the Ministry.

The Principal Functions of the EEAA

- Formulating environmental policies.
- Preparing the necessary plans for Environmental protection and Environmental development projects, following up their implementation, and undertaking Pilot Projects.
- The Agency is the National Authority in charge of promoting environmental relations between Egypt and other States, as well as Regional and International Organizations.

Tasks of the EEAA to Realize its Aims

- Preparing draft legislation and decrees related to the fulfillment of its objectives
- Preparing state of the environment studies and formulating the national plan for environmental protection and related projects.
- Setting the standards and conditions to which applicants for construction projects must adhere before working on the site and throughout operations
- Setting the rates and proportions required for the permissible limits of pollutants
- Periodically collecting national and international data on the actual state of the environment and recording possible changes.

- Setting the principles and procedures for mandatory Environmental Impact Assessment (EIA) of projects.
- Preparing Environmental Contingency Plans and supervising their implementation.
- Participating in the preparation and implementation of the national and international Environmental
- Monitoring Programs and employing data and information gained thereof.
- Establishing Public Environmental Education Programs and assisting in their implementation.
- Coordinating with other empowered authorities for the control and safe handling of dangerous substances.
- Managing and supervising the natural reserves of Specially Protected Areas.
- Following up the implementation stages of International Conventions concerned with the environment
- Suggesting an economic mechanism, which encourages the observation of pollution prevention procedures.
- Implementing pilot projects for the preservation of natural resources and the protection of the environment against pollution.
- Listing of national establishments and institutions, as well as experts qualified to participate in the preparation and implementation of environmental protection programs, and coordinating measures with the Ministry in charge of international Cooperation to ensure that projects funded by donor organizations and states are compatible with environmental safety.
- Participating in the preparation of an integrated national plan for the coastal zone management of the Mediterranean and the Red Sea areas.
- Participating in the preparation of a plan to prevent illegal entry into the country of dangerous and polluting substances and waste.
- Preparing an annual report on the state of the environment to be submitted to the President and the Cabinet of Ministers.

Council of the EEAA

The Administrative Council of the Agency is in accordance with the "Environment Act of 1994" composed of the Minister of Environmental Affairs as Chairman and the following as members:

- The Chief Executive Officer of the Agency, who also acts as Vice Chairman.
- Representatives from the ministries concerned with environmental experts, Non-Governmental Organizations (NGOs), the State Council, the Public Business Sector, the Universities and Scientific Research Centers.

Environmental Protection Fund

An Environmental Protection Fund will in accordance with the "Environment Act of 1994" be set up at the Agency. The Fund will receive the amount specifically allocated to it in the General State Budget by way of support, donations and grants presented by national and foreign organizations concerned with environmental protection, fines and compensation awarded by courts of law or via out-of-court settlements for damage caused to the environment, as well as revenues from the protectorates fund. The financial resources of the Fund shall be exclusively used for the purpose of realizing its objectives.

The Agency will offer incentives to institutions and individuals engaged in activities and projects directed to environmental protection purposes.

(2) Non-Governmental Agencies

A number of well-established NGOs is activate in Egypt like CEDARE and EQI. It is commendable to include the experience of these agencies into the future Studies once specific tasks are identified in line with the results obtained from the current Study.

Initiatives of NGOs, especially those with experience in environmental activities, are sponsored by a CIDA-program called “Community Environmental Initiatives Fund”. The fund primarily supports pilot projects aiming at environmental education, solid waste management, drinking water access, advocacy and landscape aesthetics.

(3) Laws for the Protection of the Environment

Major enacted presidential decrees on the protection of environment in Egypt include:

- The Presidential Decree No. 631 of 1982 for setting up an Environment Affairs Agency affiliated to the Cabinet.
- The Presidential Decree No. 54 of 1983 on the protocol for the protection of the Mediterranean Sea from pollution.
- The Presidential Decree No. 478 of 1988 on the Civil Obligation Agreement against Oil Spills signed in Brussels in 1969.

Enacted laws regulating the protection of natural resources and environmental quality are:

- Law No. 27 of 1981 for employing mine and quarry workers.
- Law No. 48 of 1982 for protecting the River Nile and waterways against pollution.

- Law No. 102 of 1983 for nature reserves.
- Law No. 3 of 1982 for urban planning.
- Law No. 116 of 1983 amended by Law No. 2 of 1985 for agricultural land scooping.
- Law No. 117 of 1983 for archaeological protection.

Law 4/1994 has a greater role with respect to all governmental sectors as a whole. The law has been designated as the highest coordinating body in the field of the environment that will formulate the general policy and prepare the necessary plans for the protection and promotion of the environment. It wills also, follow-up the implementation of such plans with competent administrative authorities.
The laws and regulations are covering the governmental sector that can be grouped according to the pollutant emissions from various activities.

The Environmental Protection Law has defined the responsibilities of the agency in terms of the following:

- Preparation of draft legislation and decrees pertinent to environmental management.
- Collection of data both nationally and internationally on the state of the environment.
- Preparation of periodical reports and studies on the state of the environment.
- Formulation of the national plan and its projects.
- Preparation of environmental profiles for new and urban areas, and setting of standards to be used in planning for their development.
- Preparation of an annual report on the state of the environment to be prepared to the President.

The original text of the Act is in Arabic, and it is the one authorized official version. The English translation can, therefore, only be considered as an aid to information dissemination.

The Executive Regulation was published in 1996. Law 4 and its Executive Regulation are available in the web site of MSEA and EEAA (http://www.eeaa.gov.eg).

CHAPTER 9

ECONOMIC ANALYSIS
AND
PRIORITY EXPRESSWAYS

CHAPTER 9

ECONOMIC ANALYSIS AND PRIORITY EXPRESSWAYS

9.1 COST ANALYSIS AND ESTIMATION

9.1.1 Analysis of Cost Estimation in Expressway

As shown in Table 9.1-1 of CREATS Phase 1, the unit construction cost of the urban expressway is estimated to be LE 93 mil/km. Analysis of this estimation shows that the construction cost of each section includes an additional cost of 0.4 - 0.5% of the amount for which the length of a section is multiplied by the unit cost. The costs are assumed as adjustment costs. Furthermore, on section E5, 7% of the amount is added. The cost equivalent to 7% “LE 72 mil” is considered to be the construction cost of two bridges over the River Nile. On section E6, around 60% of the amount is added. The cost equivalent to 60% “LE 420.5 mil” is regarded as the construction cost of a tunnel.

The standard unit cost “LE 93 mil/km” shown in Table 9.1-1 is assumed to be estimated under the following process, which is based on the cost of the latest section (Phase 9) of the existing elevated road E1. The standard unit cost “LE 93 mil/km” has been obtained by dividing the construction cost “LE 492.3 mil” for phase 9 of the existing E1, which was completed in 1999, by the construction length “5,300m”. This standard unit cost is the most expensive in unit costs of viaduct construction on all phases of existing E1 and E2. One reason is that cost for inflation was reflected in the cost of phase 9 of E1 since the viaduct highway was completed in 1999. Another reason is that there are many high piers (more than 20m) and two cable-stayed bridges. In addition, the cost of phase 9 includes the cost of 5 ramps with 2 lanes of which total length is 2,300m. Although the River Nile Bridges are planned on section E5, this section does not actually include River Nile Bridge. Therefore the River Nile Bridges on section E5 used an adjustment that somewhat erroneous. Actually the section E4 includes two bridges that are going to span over the River Nile north of Cairo.

Table 9.1-2 shows an analysis of the unit cost in CREATS. The unit cost of bridges and tunnel were estimated as follows: On section E4, two bridges 500m and 700m long, are needed on both sides of the Warraq Island, for which it is estimated that another LE 72 million will be added. The total length of the two bridges is 1,200m which means the additional unit cost for a bridge is LE 60 mil/km. Therefore, the unit cost of a bridge is estimated at LE 153 mil/km, which has been obtained by adding the standard unit cost “LE 93 mil/km” to the additional unit cost “LE 60 mil/km” above.

On E6, the additional cost for a tunnel 3 km long in front of military areas is estimated to be around LE 420 mil. Therefore, the additional unit cost is LE 140 mil/km and the unit cost for a tunnel is estimated at LE 233 mil/km, which has been obtained by adding the standard unit cost “LE 93 mil/km” to the additional unit cost “LE 140 mil/km”. It should be noted that all costs will be thoroughly revised, to provide more accuracy, during the feasibility study and detailed design stages

Table 9.1-1 Analysis of Construction Cost in Expressway

Section	Length (km)	Unit Cost (LE mil/km)	Cost by Unit Cost (LE mil)	Estimate Cost in Expressway (LE mil)	Addition Cost (LE mil)	Increase Ratio (%)	Remarks
	A	B	C=A*B	D	E=D-C	100*E/C	
E3	24.3	93	2,259.9	2,270.0	10.1	0.4	
E4	17.5	93	1,627.5	1,635.0	7.5	0.5	
E5	11.0	93	1,023.0	1,095.0	72.0	7.0	Nile Bridge*
E6	7.5	93	697.5	1,118.0	420.5	60.3	Tunnel
E7	11.0	93	1,023.0	1,027.0	4.0	0.4	
E8	3.0	93	279.0	280.0	1.0	0.4	
E9	4.0	93	372.0	374.0	2.0	0.5	
TOTAL	78.3			7,799.0			

Source: CREATS-Phase1, Vol. 3
*Note: *on section E4*

Table 9.1-2 Analysis of Expressway Unit Cost

Item	Standard Unit Cost	Additional Unit Cost	Unit Cost		Width of Road
	(LE mil/km)	(LE mil/km)	(LE mil/km)	(LE/m^2)*	(m)*
Viaduct	93	0	93	5,813	16
Bridge	93	60	153	6,955	22
Tunnel	93	140	233	14,563	16

Source: CREATS-Phase1, Vol. 3
*Note: *Estimation by Study Team*

As shown in Table 9.1-2, the unit cost is categorized into three items: viaduct, bridge and tunnel. The unit cost of viaduct “LE 93 mil/km” is not different, according to structures of cross-section. Also the cost of each section includes the construction cost of interchanges. However, from the economic and financial viewpoint, it might be necessary to figure out construction cost of ICs and sub-sections between interchanges individually. In this study, this cost shall be estimated, according to unit costs of each structure of cross-section. The cost of sub-sections includes the construction cost of ramps, which is estimated by necessary quantity. By the same token, the cost of ICs shall be estimated, according to unit costs of each structure of cross-section.

Figure 9.1-1 shows a Route Map with sub-sections and ICs. In this study, the sub-section E3-4 in Expressway is renamed as E8-2 so that subsections can be easier to recognize. By the same token, the sub-section E3-5 is renamed as E11.

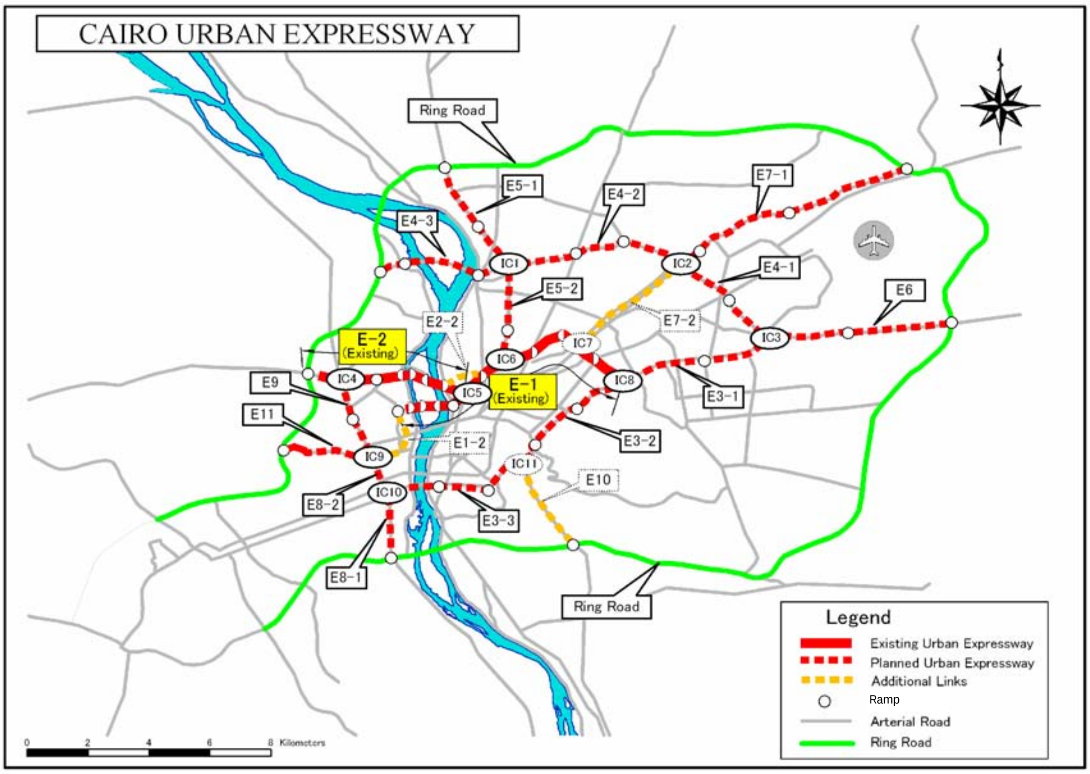

Figure 9.1-1 Cairo Urban Expressway Network

9.1.2 Estimation of Construction Cost

(1) Unit Cost

Reliable detailed data on unit costs for road construction are very little. The reason is that in Egypt, prices increase 2-10% every year under the influence of inflation, which makes it difficult to fix unit cost steadily. Existing expressways "E1 and E2" are the only two cases of the construction of urban expressway with viaduct in Cairo. Therefore, in this study, the unit costs are figured out, based on the actual construction costs of section E1 and E2. Since the actual costs consist of the construction costs of viaducts and ramps 8-34m wide, the unit costs are figured out, employing square meter (m^2) instead of length (km). These actual costs and unit costs of section E1 and E2 are shown in Table 9.1-3. Also, the unit costs are estimated in construction phases from 1969 to 2002. It will be necessary for them to be converted into unit costs in 2005, according to annual inflation rates. Averages of the converted unit costs are also shown in Table 9.1-3.

The converted average unit cost of section E1 is LE 5,892 mil/km. The converted average unit cost of section E2 is LE 4,927 mil/km. The average of these unit costs is about LE 5,400 mil/km. The structure of cross-section in large part of E1 and E2 is separated viaduct type. Depending on these results, the unit cost for cross section of separated viaduct is assumed to be LE 5,400 mil/km.

Table 9.1-3 Actual Construction Cost of E1 and E2 and Conversion of Cost into those of 2005

Section			Actual Cost					Conversion Cost to 2005		
			Length (m)	Width (m)	Area (m2)	Cost (LE mil)	Unit Cost (LE/m2)	Average of Inflation Rate	Unit Cost (LE/m2)	Cost (LE mil)
E1	1969-2002	Viaduct*	12,273	18～34	324,234	—	—	—	—	—
		Ramp	9,820	8	78,560	—	—	—	—	—
		Sub-Total	—	—	402,794	605	1,502	3.92	5,892	2,373
E2	1980-2002	Viaduct*	3,280	18～34	66,720					
		Ramp	3,750	8	30,000					
		Sub-Total	—	—	96,720	105	1,086	4.54	4,927	477

Source: CREATS-Phase1, Vol. 3
*Note: *Viaduct and Bridges*

After consideration for changes in unit costs deriving from differences in structures of cross-section types, the unit costs of each cross-section type have been estimated as shown in Table 9.1-4. For type 2 "At-Grade", type 3 "Half-Underground" and Bridge unit costs are estimated, employing the latest actual unit costs in Cairo Governorate and inflation rate. The actual unit cost of At-Grade is LE 100 mil/km in 2004. The inflation rate from 2004 to 2005 is 110%. Then, the unit cost of At-Grade is estimated to be LE 110 mil/km. The actual unit cost of Half-Underground is LE 1,390 mil/km in 1984. The inflation rate from 1984 to 2005 is 854%. Then, the unit cost of Half-Underground is estimated to be LE 11,870 mil/km. The actual unit cost of Bridge is LE 3,500 mil/km in 1992. The inflation rate from 1992 to 2005 is 227%. Then, the unit cost of Bridge is estimated to be LE 7,945 mil/km. Regarding the bridge which is less or equal to 200m, the unit cost assumed to be 90% of the unit cost of Bridge "LE 7,945 mil/km".

Table 9.1-4 Unit Costs depending on Cross Sections

Cross Section Type	1 Standard Viaduct	2 At – Grade	3 Half – Underground	4 Separated Viaduct	5 Gantry – Pier Viaduct	6 Double Deck, Single Pier	7 Double Deck, Gantry Pier	Bridge 1 L≦200m	Bridge 2 L>200m
Unit Cost (LE/m^2)	4,590	110	11,870	5,400	5,670	5,940	6,210	7,150	7,945

(2) Construction cost

Based on the unit costs shown in Table 9.1-4, construction cost of each sub-section and IC had been estimated as in Table 9.1-5. The total cost includes engineering costs for detailed design and supervising, and costs for contingency. Table 9.1-6 shows estimates of construction costs with the maximum network in Expressway Plan.

The breakdown of the construction cost is broadly divided into three items; (1) Labor Coat, (2) Material and Facilities Cost, (3) Construction Equipment Cost. According to the actual examples of viaduct and bridge constructions for expressway, the approximate proportions of each item are assumed as follows: (1) Labor Cost is 15% of the total cost, (2) Material and Facilities Cost is 35% of the total cost, (3) Construction Equipment Cost is 50% of the total cost.

Table 9.1-5 Estimates of Construction Cost of Expressway Depending on Sections and ICs

Section, IC		Length* (km)	Construction Cost (LE mil)	Engineering Cost (LE mil)	Contingency (LE mil)	Total Cost (LE mil)	Local Currency (LE mil)	Foreign Currency (LE mil)	Cross-Section Type	Remarks
			A	B=A×4%	C=(A+B)×10%	D=A+B+C				
Section	E3-1	6.8	586.5	23.5	61.0	671.0	600.0	71.0	1,2,3,4	Tunnel: 1400m
	E3-2	5.8	473.6	18.9	49.3	541.8	490.0	51.8	4,5	
	E3-3	6.9	668.1	26.7	69.5	764.3	690.0	74.3	4,5,7	Nile Br.: 200,400m
	E4-1	4.7	391.3	15.7	40.7	447.6	400.0	47.6	4,5	
	E4-2	7.5	769.9	30.8	80.1	880.8	790.0	90.8	4,5,7	
	E4-3	5.3	497.8	19.9	51.8	569.5	510.0	59.5	1,4,5	Nile Br.: 500,700m
	E5-1	5.7	394.9	15.8	41.1	451.8	410.0	41.8	4	
	E5-2	5.3	394.3	15.8	41.0	451.1	410.0	41.1	4	
	E6	7.5	472.7	18.9	49.2	540.8	490.0	50.8	1,4	
	E7-1	11.0	879.5	35.2	91.5	1006.1	910.0	96.1	4	
	E8-1	3.0	424.2	17.0	44.1	485.3	440.0	45.3	4	
	E8-2	1.7	69.9	2.8	7.3	80.0	70.0	10.0	5	
	E9	4.0	285.1	11.4	29.7	326.2	290.0	36.2	4	
	E11	3.1	236.7	9.5	24.6	270.8	240.0	30.8	4,7	
Interchange	IC1	—	274.7	11.0	28.6	314.3	280.0	34.3	4,5	E4～E5
	IC2	—	252.0	10.1	26.2	288.3	260.0	28.3	4,5	E4～E7
	IC3	—	163.8	6.6	17.0	187.4	170.0	17.4	4,5	E3～E4～E6
	IC4	—	47.5	1.9	4.9	54.3	50.0	4.3	4	E2～E9
	IC6	—	120.7	4.8	12.6	138.1	120.0	18.1	4	E1～E5
	IC8	—	134.8	5.4	14.0	154.2	140.0	14.2	4,5	E1～E3
	IC9	—	152.9	6.1	15.9	174.9	160.0	14.9	4,5	E1～E8～E11
	IC10	—	184.8	7.4	19.2	211.4	190.0	21.4	4	E3～E8
	E8-1-R.R.	—	54.9	2.2	5.7	62.8	60.0	2.8	4	E8～Ring Road
TOTAL		78.3	7930.6	317.2	824.8	9072.8	8170.0	902.8		

Table 9.1-6 Estimates of Construction Costs of Expressway for Maximum Plan in Expressway

Section, IC		Length (km)	Construction Cost (LE mil)	Engineering Cost (LE mil)	Contingency (LE mil)	Total Cost (LE mil)	Local Currency (LE mil)	Foreign Currency (LE mil)	Cross-Section Type	Remarks
			A	B=A×4%	C=(A+B)×10%	D=A+B+C				
Section	E1-2	2.1	298.2	11.9	31.0	341.1	310.0	31.1	4,5	Viaduct
	E2-2	1.2	82.4	3.3	8.6	94.3	80.0	14.3	4,5	Viaduct
	E7-2	5.3	615.8	24.6	64.0	704.5	630.0	74.5	4,5,7	Viaduct
	E10	4.0	327.6	13.1	34.1	374.8	340.0	34.8	1,4,5	Viaduct
IC	IC7	—	89.9	3.6	9.3	102.8	90.0	12.8	4	E1～E7
	IC11	—	89.9	3.6	9.3	102.8	90.0	12.8	4	E3～E10
	Connection to R.R	—	629.3	25.2	65.4	719.9	650.0	69.9	4	E2,3,4,5,6,7,10～R.R.
TOTAL		12.6	2133.1	85.3	221.8	2440.3	2200.0	240.3		

9.1.3 Estimation of Traffic Information System Cost

The traffic information system is an integrated system consisting of several subsystems with different functions. In this regard, the functions of the system vary from basic and simple to the most advanced and sophisticated ones. In this study, for rough estimation, the cost for traffic information system shall be estimated, taking the basic and simple system. Table 9.1-7 shows the unit costs of the traffic information system. Based on the unit costs, costs of the traffic information system for each section are estimated and shown in Table 9.1-8.

Table 9.1-7 Unit Costs of the Traffic Information System (per km)

Item	Quantity (per km)	Unit Cost (LE/pcs.)	Unit Cost (LE mil/km)	Local Currency	Foreign Currency	Remarks
Vehicle Detector	2 pcs.	25,000	0.050	0.010	0.040	1 pc./1 lane
Monitoring System	1 pc.	120,000	0.120	0.024	0.096	1 pc./2 lanes
Emergency Telephone System	2 pcs.	12,000	0.024	0.005	0.019	1 pc./1 lane
Variable Message Sign System	0.4 pcs.	180,000	0.072	0.014	0.058	1 pc./1 lane
Cost for Control Center System	1 set	20,000,000	0.200	0.040	0.200	1 set/100km
TOTAL			0.466	0.093	0.200	

Table 9.1-8 Costs of Traffic Information System

Section		Length (km)	Unit Cost (LE mil/km)	Cost (LE mil)	Contingency 5%(LE mil)	Total Cost (LE mil)	Local Currency	Foreign Currency
Existing	E1-1	11.3	1.0	11.8	0.6	12.4	2.7	9.7
	E2-1	2.8	1.0	2.9	0.1	3.1	0.7	2.4
	Ring Road	95.0	1.0	99.0	4.9	103.9	22.5	81.4
	Sub-Total	109.1		113.6	5.7	119.3	25.9	93.4
Expressway Plan	E3-1,2,3	19.5	1.0	20.3	1.0	21.3	4.6	16.7
	E4-1,2,3	17.5	1.0	18.2	0.9	19.1	4.1	15.0
	E5-1,2	11.0	1.0	11.5	0.6	12.0	2.6	9.4
	E6	7.5	1.0	7.8	0.4	8.2	1.8	6.4
	E7-1	11.0	1.0	11.5	0.6	12.0	2.6	9.4
	E8-1,2	4.7	1.0	4.9	0.2	5.1	1.1	4.0
	E9	4.0	1.0	4.2	0.2	4.4	0.9	3.5
	E11	3.1	1.0	3.2	0.2	3.4	0.7	2.7
	Sub-Total	78.3		81.6	4.1	85.6	18.4	67.2
Maximum Plan	E1-2	2.1	1.0	2.2	0.1	2.3	0.5	1.8
	E2-2	1.2	1.0	1.2	0.1	1.3	0.3	1.0
	E7-2	5.3	1.0	5.5	0.3	5.8	1.3	4.5
	E10	4.0	1.0	4.2	0.2	4.4	0.9	3.5
	Sub-Total	12.6		13.1	0.7	13.8	3.0	10.8
TOTAL		200.0		208.3	10.4	218.7	47.3	171.4

9.1.4 Estimation of Maintenance and Operation Costs

The operation of an expressway and the maintenance work are mainly divided into two items; (1) Expressway Maintenance, and (2) Traffic Management.

(1) Expressway Maintenance

The actual unit cost for maintenance of existing E1 and E2 is “LE 0.05 mil/km/year”, which is used by Cairo Governorate. The new urban expressways should provide high quality facility and service to users. Therefore it is thought that the cost for maintenance needs an amount more than actual maintenance cost of existing E1 and E2. And then, the unit cost for maintenance is assumed to be LE 0.1 mil/km/year. In addition, a cost is necessary to handle accidents. The unit cost is assumed to be LE 0.1 mil/km/year. Total unit cost for expressway maintenance is estimated to be LE 0.2 mil/km/year. The annual maintenance costs of each section are shown in Table 9.1-9. They include the following costs:

a) Cleaning of pavement
b) Cleaning of ditches and culverts
c) Repair of pavement as patching and resurfacing
d) Repair of expansion joints of bridges and viaducts
e) Repair of facilities damaged by traffic accidents, etc.
f) Repair of pavement overlay, road thermoplastic markings and curb stone
g) Handling an accident

(2) Traffic Management

The objective of traffic management is to control traffic and provide users with expressway and traffic information. Highway patrol will be carried out to detect damage to road facilities and abnormal conditions, prevent traffic accidents and deal with disabled cars, and crack down on illegal parking, all of which threaten safety in traffic. The cost of annual traffic management in Table 9.1-10 includes the following costs:

a) Personnel cost for a traffic control office
b) Purchase and maintenance cost for office building, equipment, cars, supplies, utilities, etc.
c) Maintenance cost of Traffic Information System
d) Overhead (20%)

(3) Toll Collection Management

Toll collection should be operated by toll collection administration office. Table 9.1-11 shows the annual cost of toll collection administration office. The office manages each tollgate on approach ramps. Table 9.1-12 shows the annual cost of toll collector. The necessary number of tollgates will generally depend on traffic amount, and then the number of tollgates for estimation is assumption. The condition for estimation is that two toll gates are placed at one ramp and 4 collectors work 8-hour shift at a tollgate.

Table 9.1-9 Annual Costs for Urban Expressway Maintenance

	Section	Length (km)	Unit Cost (LE mil/km)	Cost (LE mil)	Contingency 5%(LE mil)	Total Cost (LE mil)	Local Currency	Foreign Currency
Existing	E1-1	11.3	0.05	0.57	0.03	0.59	0.47	0.12
	E2-1	2.8	0.05	0.14	0.01	0.15	0.12	0.03
	Ring Road	95.0	0.05	4.75	0.24	4.99	3.99	1.00
	Sub-Total	109.1		5.46	0.27	5.73	4.58	1.15
Expressway Plan	E3-1,2,3	19.5	0.05	0.98	0.05	1.02	0.82	0.20
	E4-1,2,3	17.5	0.05	0.88	0.04	0.92	0.74	0.18
	E5-1,2	11.0	0.05	0.55	0.03	0.58	0.46	0.12
	E6	7.5	0.05	0.38	0.02	0.39	0.32	0.07
	E7-1	11.0	0.05	0.55	0.03	0.58	0.46	0.12
	E8-1,2	4.7	0.05	0.24	0.01	0.25	0.20	0.05
	E9	4.0	0.05	0.20	0.01	0.21	0.17	0.04
	E11	3.1	0.05	0.16	0.01	0.16	0.13	0.03
	Sub-Total	78.3		3.92	0.20	4.11	3.30	0.81
Maximum Plan	E1-2	2.1	0.05	0.11	0.01	0.11	0.09	0.02
	E2-2	1.2	0.05	0.06	0.00	0.06	0.05	0.01
	E7-2	5.3	0.05	0.27	0.01	0.28	0.22	0.06
	E10	4.0	0.05	0.20	0.01	0.21	0.17	0.04
	Sub-Total	12.6		0.63	0.03	0.66	0.53	0.13
TOTAL		200.0		10.00	0.50	10.50	8.41	2.09

Table 9.1-10 Annual Cost for Traffic Management

Item		Qty.	Unit Cost (LE/year)	Cost (LE mil/year)	Local Currency	Foreign Currency
Personnel for Traffic Management Office	General Manager	1	60,000	0.06	0.06	0.00
	Deputy General Manager	2	42,000	0.08	0.08	0.00
	Supervisor	6	30,000	0.18	0.18	0.00
	Operator	15	21,600	0.32	0.32	0.00
	Clerk	3	18,000	0.05	0.05	0.00
	Secretary	3	18,000	0.05	0.05	0.00
	Driver	9	12,000	0.11	0.11	0.00
	Janitor	4	8,400	0.03	0.03	0.00
	Sub-Total			0.90	0.90	0.00
Purchase & Maintenance for supply, utility, housing, machinery, car, etc.		1	1,000,000	1.00	0.30	0.70
Traffic Information System 5% of Maximum System Cost		1	1,094,000	1.09	0.11	0.98
Sub-Total				2.99	1.31	1.68
Overhead 20%				0.60	0.26	0.34
TOTAL				3.59	1.57	2.02

Table 9.1-11 Annual Cost for Toll Collection Management Office

Item		Qty.	Unit Cost (LE/year)	Cost (LE mil/year)	Local Currency	Foreign Currency
Personnel for Toll Collection Management Office	General Manager	1	60,000	0.06	0.06	0.00
	Deputy General Manager	1	42,000	0.04	0.04	0.00
	Supervisor	3	30,000	0.09	0.09	0.00
	Accountant	2	21,600	0.04	0.04	0.00
	Clerk	3	18,000	0.05	0.05	0.00
	Secretary	2	18,000	0.04	0.04	0.00
	Driver	3	12,000	0.04	0.04	0.00
	Janitor	2	8,400	0.02	0.02	0.00
	Sub-Total			0.38	0.38	0.00
Purchase & Maintenance for supply, utility, housing, machinery, car, etc.		1	500,000	0.50	0.15	0.35
Sub-Total				0.88	0.53	0.35
Overhead 20%				0.18	0.11	0.07
TOTAL				1.05	0.63	0.42

Table 9.1-12 Annual Cost for Toll Collector

	Section	Approach Ramp	Qty.	Unit Cost (LE/year)	Sub-Cost (LE mil/year)	Overhead 20% (LE mil/year)	Cost (LE mil/year)	Local Currency	Foreign Currency
Existing	E1-1	15	120	12,000	1.44	0.072	1.51	1.51	0.00
	E2-1	9	72	12,000	0.86	0.043	0.91	0.91	0.00
	Ring Road	42	336	12,000	4.03	0.202	4.23	4.23	0.00
	Sub-Total		528		6.34	0.317	6.65	6.65	0.00
Expressway Plan	E3-1,2,3	7	56	12,000	0.67	0.034	0.71	0.71	0.00
	E4-1,2,3	9	72	12,000	0.86	0.043	0.91	0.91	0.00
	E5-1,2	5	40	12,000	0.48	0.024	0.50	0.50	0.00
	E6	3	24	12,000	0.29	0.014	0.30	0.30	0.00
	E7-1	6	48	12,000	0.58	0.029	0.60	0.60	0.00
	E8-1,2	1	8	12,000	0.10	0.005	0.10	0.10	0.00
	E9	1	8	12,000	0.10	0.005	0.10	0.10	0.00
	E11	1	8	12,000	0.10	0.005	0.10	0.10	0.00
	Sub-Total		264		3.17	0.158	3.33	3.33	0.00
Maximum Plan	E1-2	2	16	12,000	0.19	0.010	0.20	0.20	0.00
	E2-2	0	0	12,000	0.00	0.000	0.00	0.00	0.00
	E7-2	2	16	12,000	0.19	0.010	0.20	0.20	0.00
	E10	1	8	12,000	0.10	0.005	0.10	0.10	0.00
	Sub-Total		40		0.48	0.024	0.50	0.50	0.00
TOTAL			832		9.98	0.499	10.48	10.48	0.00

9.1.5 Land Acquisition Cost

As a result of field study, it is thought that some land areas will be essential to the right-of-way. Table 9.1-13 shows land acquisition cost required for the construction of new expressways. The unit land values are estimated by the Land Management Department of Cairo Governorate.

Table 9.1-13 Land Acquisition Cost

Section	Location (Station No.)	Length (m)	Width (m)	Area (m2)	Unit Value (LE/m^2)	Cost (LE mil)	Remarks
E3-3	12+550－12+650 (L)	100	1	100	3,000	0.30	Company
E3-3	13+850－14+100 (R)	125	12	1,500	1,500	2.25	Company
E5-2	6+100－6+250 (L)	150	3	450	4,000	1.80	Railroad
E6	5+250－5+350 (R･L)	100	15	1,500	2,000	3.00	Garden (R), Military (L)
E7-1	3+000－3+100 (L)	100	7	700	4,000	2.80	Company
E7-1	8+200－8+300 (L)	100	7	700	4,000	2.80	El Shams Club
TOTAL				4,950		12.95	

9.1.5 Summary of Project Cost

The project cost is summarized as shown in Table 9.1-14. The project cost is divided into two parts. One is primary cost which includes construction cost, land acquisition cost and installation coat of traffic information system. The other is annual cost which includes maintenance cost, traffic management cost and toll collection cost.

Table 9.1-14 Summary of Project Cost

	Section	Primary Cost: Construction (LE mil)	Primary Cost: Land Acquisition (LE mil)	Primary Cost: Traffic Information System (LE mil)	Primary Cost: Total (LE mil)	Annual Cost: Maintenance Cost (LE mil/year)	Annual Cost: Traffic Management (LE mil/year)	Annual Cost: Toll Collection (LE mil/year)	Annual Cost: Total (LE mil/year)
New Construction	**E3**	1,977	2.6	21.3	2,001	1.02	0.00	0.71	1.73
	E3-1,2,3	L/C 1,780 F/C 197	L/C 2.6 F/C 0.0	L/C 4.6 F/C 16.7	L/C 1,787 F/C 214	L/C 0.82 F/C 0.20	L/C 0.00 F/C 0.00	L/C 0.71 F/C 0.00	L/C 1.53 F/C 0.20
	E4	1,898	0.0	19.1	1,917	0.92	0.00	0.91	1.83
	E4-1,2,3	L/C 1,700 F/C 198	L/C 0.0 F/C 0.0	L/C 4.1 F/C 15.0	L/C 1,704 F/C 213	L/C 0.74 F/C 0.18	L/C 0.00 F/C 0.00	L/C 0.91 F/C 0.00	L/C 1.65 F/C 0.18
	E5	903	1.8	12.0	917	0.58	0.00	0.50	1.08
	E5-1,2	L/C 820 F/C 83	L/C 1.8 F/C 0.0	L/C 2.6 F/C 9.4	L/C 824 F/C 92	L/C 0.46 F/C 0.12	L/C 0.00 F/C 0.00	L/C 0.50 F/C 0.00	L/C 0.96 F/C 0.12
	E6	541	3.0	8.2	552	0.39	0.00	0.30	0.70
		L/C 490 F/C 51	L/C 3.0 F/C 0.0	L/C 1.8 F/C 6.4	L/C 495 F/C 57	L/C 0.32 F/C 0.07	L/C 0.00 F/C 0.00	L/C 0.30 F/C 0.00	L/C 0.62 F/C 0.07
	E7	1,711	5.6	17.8	1,734	0.86	0.00	0.81	1.66
	E7-1,2	L/C 1,540 F/C 171	L/C 5.6 F/C 0.0	L/C 3.9 F/C 13.9	L/C 1,550 F/C 185	L/C 0.68 F/C 0.18	L/C 0.00 F/C 0.00	L/C 0.81 F/C 0.00	L/C 1.49 F/C 0.18
	E8	565	0.0	5.1	570	0.25	0.00	0.10	0.35
	E8-1,2	L/C 510 F/C 55	L/C 0.0 F/C 0.0	L/C 1.1 F/C 4.0	L/C 511 F/C 59	L/C 0.20 F/C 0.05	L/C 0.00 F/C 0.00	L/C 0.10 F/C 0.00	L/C 0.30 F/C 0.05
	E9	326	0.0	4.4	331	0.21	0.00	0.10	0.31
		L/C 290 F/C 36	L/C 0.0 F/C 0.0	L/C 0.9 F/C 3.5	L/C 291 F/C 40	L/C 0.17 F/C 0.04	L/C 0.00 F/C 0.00	L/C 0.10 F/C 0.00	L/C 0.27 F/C 0.04
	E10	375	0.0	4.4	379	0.21	0.00	0.10	0.31
		L/C 340 F/C 35	L/C 0.0 F/C 0.0	L/C 0.9 F/C 3.5	L/C 341 F/C 38	L/C 0.17 F/C 0.04	L/C 0.00 F/C 0.00	L/C 0.10 F/C 0.00	L/C 0.27 F/C 0.04
	E11	271	0.0	3.4	274	0.16	0.00	0.10	0.26
		L/C 240 F/C 31	L/C 0.0 F/C 0.0	L/C 0.7 F/C 2.7	L/C 241 F/C 33	L/C 0.13 F/C 0.03	L/C 0.00 F/C 0.00	L/C 0.10 F/C 0.00	L/C 0.23 F/C 0.03
	IC	1,729	0.0	0.0 *	1,729	0.00 *	0.00	0.00	0.00
	IC1,2,3,4,6,7,8,9,10,11	L/C 1,550 F/C 179	L/C 0.0 F/C 0.0	L/C 0.0 F/C 0.0	L/C 1,550 F/C 179	L/C 0.00 F/C 0.00	L/C 0.00 F/C 0.00	L/C 0.00 F/C 0.00	L/C 0.00 F/C 0.00
	Sub-Total	10,295	13.0	95.8	10,404	4.60	0.00	3.63	8.23
		L/C 9,260 F/C 1,035	L/C 13.0 F/C 0.0	L/C 20.6 F/C 75.2	L/C 9,294 F/C 1,110	L/C 3.69 F/C 0.91	L/C 0.00 F/C 0.00	L/C 3.63 F/C 0.00	L/C 7.32 F/C 0.91
Existing Elevated E1&E2	**E1**	341	0.0	14.7	356	0.70	0.00	1.71	2.42
	E1-1,2	L/C 310 F/C 31	L/C 0.0 F/C 0.0	L/C 3.2 F/C 11.5	L/C 313 F/C 43	L/C 0.56 F/C 0.14	L/C 0.00 F/C 0.00	L/C 1.71 F/C 0.00	L/C 2.27 F/C 0.14
	E2	94	0.0	4.4	99	0.21	0.00	0.91	1.12
	E2-1,2	L/C 80 F/C 14	L/C 0.0 F/C 0.0	L/C 1.0 F/C 3.4	L/C 81 F/C 18	L/C 0.17 F/C 0.04	L/C 0.00 F/C 0.00	L/C 0.91 F/C 0.00	L/C 1.08 F/C 0.04
	Sub-Total	435	0.0	19.0	454	0.91	0.00	2.62	3.53
		L/C 390 F/C 45	L/C 0.0 F/C 0.0	L/C 4.2 F/C 14.8	L/C 394 F/C 60	L/C 0.73 F/C 0.18	L/C 0.00 F/C 0.00	L/C 2.62 F/C 0.00	L/C 3.35 F/C 0.18
Ring Road	**Ring Road**	0	0.0	103.9	104	4.99	0.00	4.23	9.22
	Main Line of Ring Road	L/C 0 F/C 0	L/C 0.0 F/C 0.0	L/C 22.5 F/C 81.4	L/C 23 F/C 81	L/C 3.99 F/C 1.00	L/C 0.00 F/C 0.00	L/C 4.23 F/C 0.00	L/C 8.22 F/C 1.00
	IC	783	0.0	0.0 *	783	0.00 *	0.00	0.00	0.00
	IC between R.R. to Highway	L/C 710 F/C 73	L/C 0.0 F/C 0.0	L/C 0.0 F/C 0.0	L/C 710 F/C 73	L/C 0.00 F/C 0.00	L/C 0.00 F/C 0.00	L/C 0.00 F/C 0.00	L/C 0.00 F/C 0.00
	Sub-Total	783	0.0	103.9	887	4.99	0.00	4.23	9.22
		L/C 710 F/C 73	L/C 0.0 F/C 0.0	L/C 22.5 F/C 81.4	L/C 733 F/C 154	L/C 3.99 F/C 1.00	L/C 0.00 F/C 0.00	L/C 4.23 F/C 0.00	L/C 8.22 F/C 1.00
Maintenance & Operation	**Traffic Management**	0	0.0	0.0	0	0.00	3.59	0.00	3.59
		L/C 0 F/C 0	L/C 0.0 F/C 0.0	L/C 0.0 F/C 0.0	L/C 0 F/C 0	L/C 0.00 F/C 0.00	L/C 1.57 F/C 2.02	L/C 0.00 F/C 0.00	L/C 1.57 F/C 2.02
	Toll collection Management Office	0	0.0	0.0	0	0.00	0.00	1.05	1.05
		L/C 0 F/C 0	L/C 0.0 F/C 0.0	L/C 0.0 F/C 0.0	L/C 0 F/C 0	L/C 0.00 F/C 0.00	L/C 0.00 F/C 0.00	L/C 0.63 F/C 0.42	L/C 0.63 F/C 0.42
	Sub-Total	0	0.0	0.0	0	0.00	3.59	1.05	4.64
		L/C 0 F/C 0	L/C 0.0 F/C 0.0	L/C 0.0 F/C 0.0	L/C 0 F/C 0	L/C 0.00 F/C 0.00	L/C 1.57 F/C 2.02	L/C 0.63 F/C 0.42	L/C 2.20 F/C 2.44
	TOTAL	11,513	13.0	218.7	11,745	10.50	3.59	11.54	25.63
		L/C 10,360 F/C 1,153	L/C 13.0 F/C 0.0	L/C 47.3 F/C 171.4	L/C 10,420 F/C 1,325	L/C 8.41 F/C 2.09	L/C 1.57 F/C 2.02	L/C 11.12 F/C 0.42	L/C 21.10 F/C 4.53

*Notice: *To be included in main line*

9.2 PRIORITY OF EXPRESSWAYS

9.2.1 Basic Policy and Prioritization Procedure

(1) Objectives of the Expressway Development Plan

The objectives of the Cairo Urban Toll Expressway development plan are the followings;

Expressway Development Objectives

- To reduce traffic congestion and to increase traffic efficiency on the road network in the Greater Cairo Region (GCR)
- To provide alternative high-grade service of expressway network to the road users
- To contribute to the provision of preferable social and urban environmental conditions
- To contribute to the national and regional economic development
- To promote the planned urban development and new communities

(2) Procedure for Prioritization

The procedure for prioritization of the expressway sections is shown in Figure 9.2-1. Under this procedure, the indicators of each factor were established and given scores based on importance of each factor. Indicators for each individual road project were measured and scored following the procedure illustrated in Figure 9.2-1.
It is noted that E-10 route is not included in the prioritization.

(3) Prioritization Factors

The following prioritization factors are set up in line with the objectives of the Urban Expressway Network Development;

a) Urban development

b) Traffic aspect
   - Magnitude and growth rate of traffic volume (in vehicles)
   - Traffic congestion both on at-grade road network and on expressway network
   - Travel speed both on at-grade road network and on expressway network
   - Alleviation of traffic congestion on existing expressway E1 and E2 (using traffic assignment).

c) Economic and Financial Aspect
   - Economic viability
   - Financial viability

d) Environmental Impact
   - Land acquisition
   - Air pollution

e) Other Factors

- Urgency for expressway sections
- Maturity for expressway sections

The factors, indicators and scores are set out as presented in Table 9.2-1.

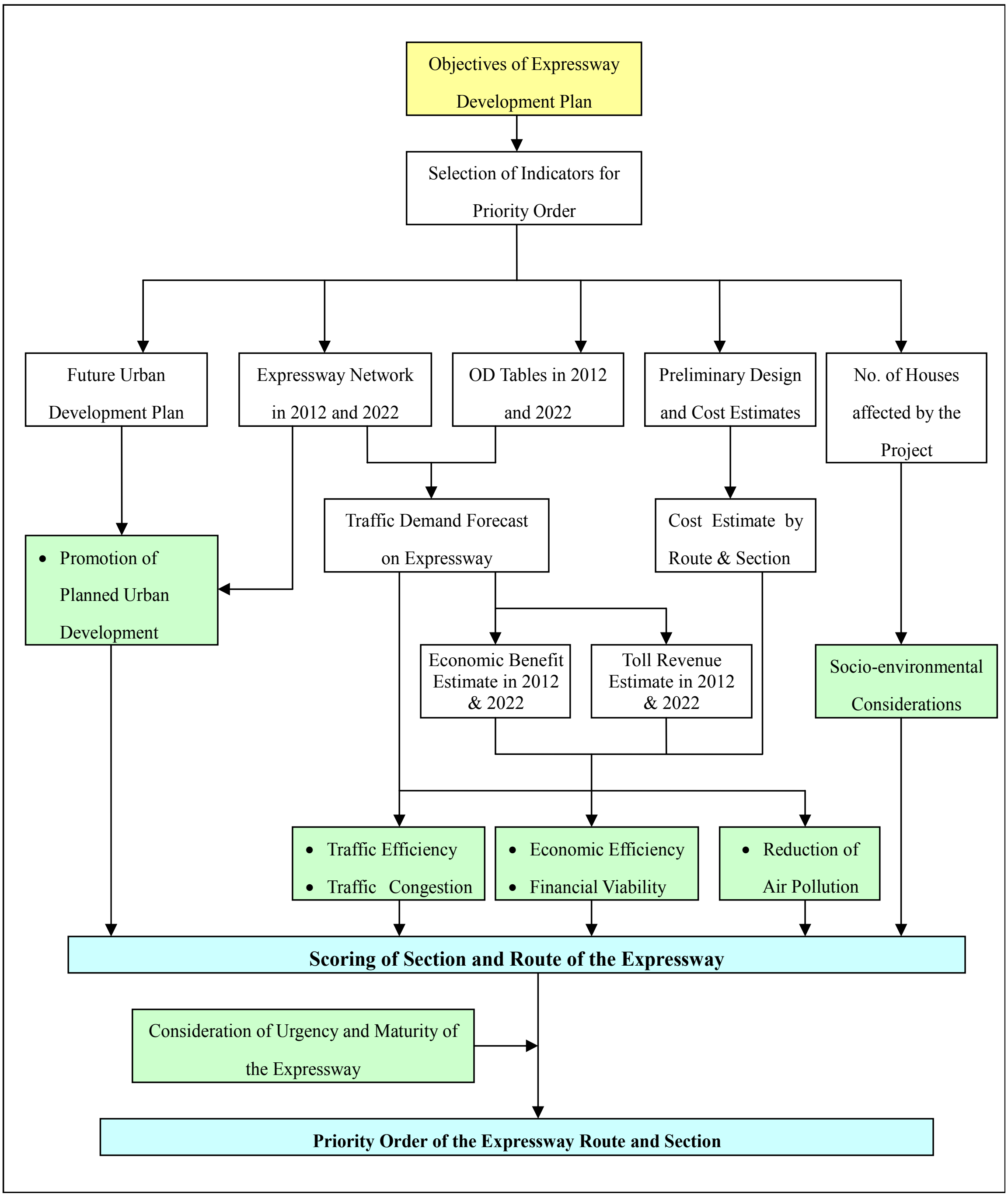

Figure 9.2-1 Procedure for Prioritization of Cairo Urban Expressway

Legends: **Objective** **Factor** **Output**

Table 9.2-1 Factors, Indicators and Scores of the Prioritization

Factor	Indicator	Score
1. Urban Development	1. Within direct influence corridor of Expressway 2. Within partial influence corridor of Expressway 3. A little influence of Expressway	10 5 0
2. Traffic Aspects		
2.1 Magnitude of Expressway Vehicle Use (Traffic Volume (TV))	1. TV> 100,000 PCU/Km 2. 100,000 > TV > 75,000 PCU/Km 3. 75,000 > TV > 50,000 PCU/Km 4. 50,000 > TV > 25,000 PCU/Km 5. 25,000 > TV	5 4 3 2 1
2.2 Growth Rate of Expressway Vehicle Use	1. GR > 20 % 2. 20 % > GR > 10 % 3. 10 % >AGR	5 3 1
2.3 Traffic Congestion (VCR) on at-grade Road network	1. VCR < 1.00 2. 1.00 < VCR < 1.99 3. 2.00 < VCR	5 3 0
2.4 Traffic Congestion (VCR) on Expressway	1. VCR < 1.00 2. 1.00 < VCR < 1.50 3. 1.50 < VCR	5 3 0
2.5 Travel Speed on Expressway Network during Peak Hour	1 TS > 50 km/h 2. 50 km/h > TS > 45 km/h 3. 45 km/h > TS	5 3 1
2.6 Reduction Rate (RR) of VCR on Existing Expressways of E1 and E2 on Section 1	1. RR < -30 % 2. -30 % < RR < -20 % 3. -20 % < RR < -10 % 4. -10 % < RR	5 3 1 0
3. Economic and Financial Aspects		
3.1 Economic Viability (Economic Internal Rate of Return (EIRR))	1. EIRR > 40 % 2. 40 % > EIRR > 30 % 3. 30 % > EIRR > 20 % 4. 20 % > EIRR > 12 % 5. 12 % > EIRR > 0 % 6. 0 % > EIRR	20 16 12 8 4 0
3.2 Financial Viability (Financial Internal Rate of Return (FIRR))	1. FIRR > 40 % 2. 40 % > FIRR > 30 % 3. 30 % > FIRR > 20 % 4. 20 % > FIRR > 12 % 5. 12 % > FIRR > 0 % 6. 0 % > FIRR	20 16 12 8 4 0
4. Environmental Impact		
4.1 Land Acquisition	1. Not necessary 2. < 500 3. 500 to 1,000 4. 1,000 to 1,500 5. 1,500 <	5 4 3 2 1
4.2 .1 Reduction of Air Pollution	1. HC, NOx >30 ton 2. 30 ton>HC, NOx>20 ton 3. 20 ton>HC, NOx>10 ton 4. 10 ton> HC, NOx 5 ton 5. 5 ton> HC, NOx	2.5 2 1.5 1 0.5
4.2 .2 Reduction of Air Pollution	1. CO > 200 ton 2. 200 ton>CO>150 ton 3. 150 ton>CO>100 ton 4. 100 ton >CO>50 ton 5. 50 ton>CO	2.5 2 1.5 1 0.5
5. Urgency and Maturity		
5.1 Urgency	1. Urgently needs 2. Moderate needs 3. Needs in future	5 3 1
5.2 Maturity	1. Maturity to construct 2. Moderate maturity 3 Less maturity	5 3 1

9.2.2 Urban Development

Nine new urban communities are identified within the Study Area. Of these, Sheikh Zayed City and New Community No. 7 are at very early stages of development and have been included within 6th of October. The 15th of May City is considered as an established city and has been undertaken with this community. The location of the six new communities that have been investigated in CREATS are shown in Figure 9.2-2.

The expressway routes to the west and east corridors should be given higher priority than the others. This is because large scale urban developments are located at these corridors.

Table 9.2-2 Score from Viewpoint of New Urban Development

Score from view point of New Urban Development	Expressway
10	E6 and E3-1 E11 and E1-2
5	E3 E7
0	Others

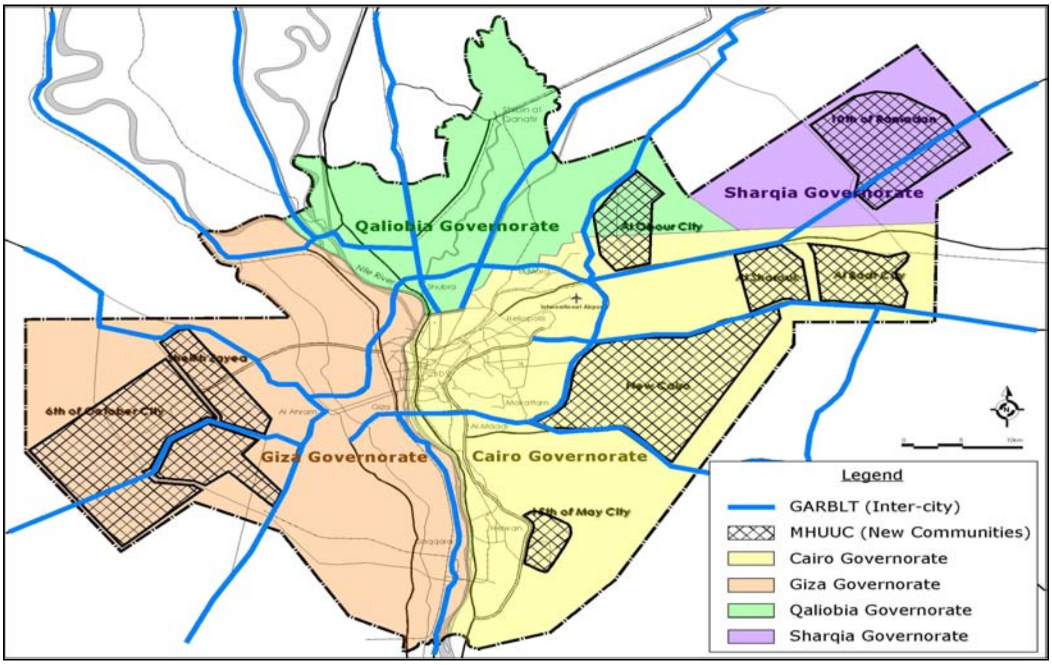

Figure 9.2-2 New Communities in the Study Area

9.2.3 Traffic Analysis

(1) Magnitude of Expressway Vehicle Use and Its Growth

Traffic demand for each route of the expressway network is forecasted by applying diversion rate model in the traffic assignment process in order to analyze route prioritization from the viewpoint of traffic efficiency.

Table 9.2-3 (1 and 2) shows the estimated daily users of Cairo Urban Toll Expressway while Table 9.2-4 and Figure 9.2-3 show the traffic volume per kilometer by route.

Table 9.2-3 (1) Expressway Vehicle Traffic Volume by Route (Individual Route Plan)

(Vehicle/Day)

	Route	Length (Km)	2012	2022	AAGR(%)
1	E1+E2	20.9	107,662	222,217	7.5
2	E3	19.5	35,145	149,172	15.6
3	E4	17.5	17,585	82,208	16.7
4	E5	11.0	34,910	196,447	18.9
5	E6	7.5	5,075	95,901	34.2
6	E7	11.0	12,439	44,873	13.7
7	E8	4.7	1,070	3,966	14.0
8	E9	4.0	9,626	30,895	12.4
9	E11	3.1	3,640	33,324	24.8

Notes: 1) Route E1+E2 includes newly constructed section of E1-2 and E2-2.
2) Users on the other routes exclude those on route E1 and E2.
3) AAGR: Average Annual Growth Rate (%)

Table 9.2-3 (2) Expressway Vehicle Traffic Volume by Route (Combined Route Plan)

(Vehicles/Day)

	Route	Length (Km)	2012	2022	AAGR (%)
1	E1+E2	20.9	107,662	222,217	7.5
2	E1+E2+E3	40.4	142,807	371,389	10.0
3	E1+E2+E4	38.4	125,247	304,425	9.3
4	E1+E2+E5	31.9	142,572	418,664	11.4
5	E1+E2+E6	35.2	112,737	318,118	10.9
6	E1+E2+E7	31.9	120,101	267,090	8.3
7	E1+E2+E8	25.6	108,732	226,183	7.6
8	E1+E2+E9	24.9	117,288	253,112	8.0
9	E1+E2+E11	24.0	111,302	255,541	8.7

Table 9.2-4 Expressway Vehicle Traffic Density by Route (Individual Route Plan)

(PCU km/km)

	Route	Length (Km)	2012	2022	AAGR (%)
1	E1+E2	20.9	82,900	173,329	7.7
2	E3	19.5	32,333	137,238	15.6
3	E4	17.5	16,178	75,631	16.7
4	E5	11.0	32,117	153,229	16.9
5	E6	7.5	4,669	88,229	34.2
6	E7	11.0	11,444	41,283	13.7
7	E8	4.7	1,070	3,966	14.0
8	E9	4.0	9,626	30,895	12.4
9	E11	3.1	3,640	33,324	24.8

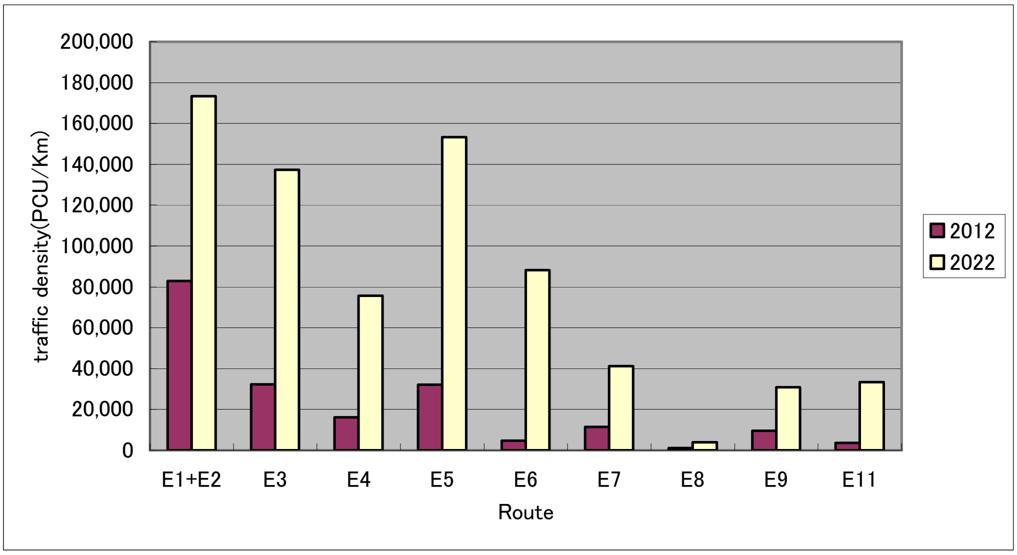

Figure 9.2-3 Expressway Vehicle Traffic Density by Route in 2022 (Individual Route)

(2) Traffic Congestion and Travel Speed on At-Grade Road Network and Expressway Network

Table 9.2-5 shows the traffic congestion in VCR form and travel speed on both the at-grade road network and expressway network in the years 2012 and 2020. Further, the travel speed on the same road networks is depicted in Figure 9.2-4 (1 and 2).

Table 9.2-5(1) Traffic Congestion and Travel Time by Route (Combined Plan)

Route		Length (Km)	2012				2022			
			Road Network		Expressway Network		Road Network		Expressway Network	
			VCR	Travel Speed (Km/h)	VCR	Travel Speed (Km/h)	VCR	Travel Speed (Km/h)	VCR	Travel Speed (Km/h)
1	E1+E2	20.9	1.22	40.5	0.73	53.0	1.87	31.1	1.53	44.8
2	E1+E2+E3	40.4	1.20	40.8	0.60	57.1	1.84	31.4	1.35	50.6
3	E1+E2+E4	38.4	1.20	40.5	0.43	53.3	1.83	31.3	1.02	47.9
4	E1+E2+E5	31.9	1.21	40.8	0.84	52.9	1.86	31.2	1.39	45.3
5	E1+E2+E3-1+E6	35.2	1.21	40.7	0.65	54.9	1.85	31.3	1.42	46.1
6	E1+E2+E7	31.9	1.21	40.5	0.61	53.1	1.80	31.2	1.47	46.5
7	E1+E2+E8	25.6	1.22	40.5	0.68	53.5	1.86	31.1	1.41	45.1
8	E1+E2+E9	24.9	1.22	40.7	0.89	56.8	1.87	31.1	1.48	45.8
9	E1+E2+E11	24.0	1.22	40.7	0.77	57.2	1.86	31.2	1.50	44.5

Table 9.2-5(2) Traffic Congestion and Travel Time by Route (Individual Plan)

Route		Length (Km)	2012				2022			
			Road Network		Expressway Network		Road Network		Expressway Network	
			VCR	Travel Speed (Km/h)	VCR	Travel Speed (Km/h)	VCR	Travel Speed (Km/h)	VCR	Travel Speed (Km/h)
1	E1+E2	20.9	1.22	40.5	0.73	53.0	1.87	31.1	1.53	44.8
2	E3	40.4	1.20	40.8	0.33	72.9	1.84	31.4	0.98	50.6
3	E4	38.4	1.20	40.5	0.16	78.3	1.83	31.3	0.76	52.0
4	E5	31.9	1.21	40.8	0.32	72.0	1.86	31.2	1.27	45.0
5	E3-1+E6	35.2	1.21	40.7	0.05	80.0	1.85	31.3	0.88	52.0
6	E7	31.9	1.21	40.5	0.11	78.1	1.80	31.2	0.41	70.5
7	E8	25.6	1.22	40.5	0.01	80.0	1.86	31.1	0.04	80.0
8	E9	24.9	1.22	40.7	0.09	80.0	1.87	31.1	0.30	73.2
9	E11	24.0	1.22	40.7	0.04	80.0	1.86	31.2	0.33	72.9

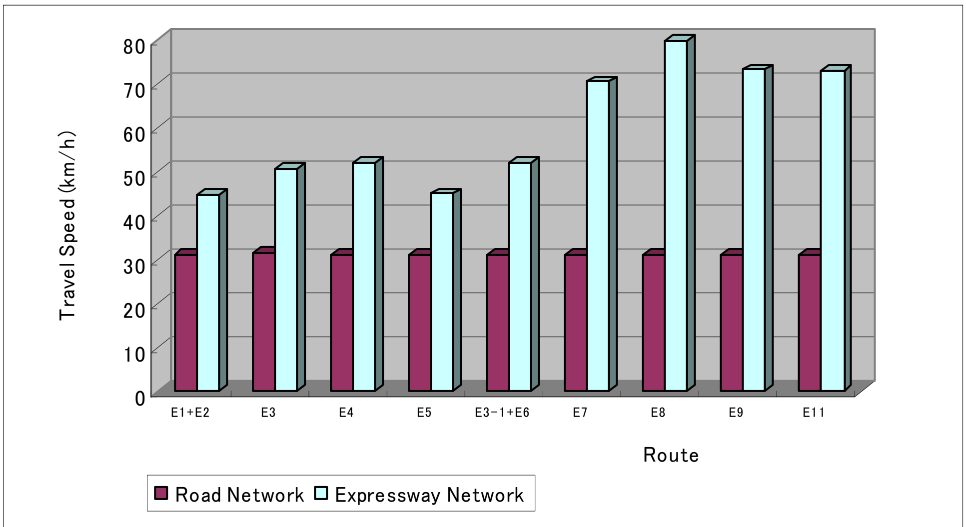

Figure 9.2.4 Travel Speed on Road Network and Expressway Network in 2022
(Individual Route Plan)

(3) Alleviation of Traffic Congestion on Existing Expressway Section

Table 9.2-6 shows the traffic volume on the existing expressway route called 6th October Road. From the table, the following sections are selected:

- Section 1: 6th October elevated road section
- Section 2: 26 July bridge on River Nile
- Section 3: 6th October bridge on River Nile

From the same table, the following findings are noted:

a) If parallel routes such as Route E3 or E4 will be constructed, the traffic flow in the existing expressway route, which is currently heavily congested, is expected to significantly improve.

b) If the existing expressway is extended to E5, E6, E9 or E11, the traffic congestion on the existing expressway is not expected to be improved.

Table 9.2-6 Daily Traffic Volume on Existing Expressway (Combined Route Plan)

Route		Section 1		Section 2		Section 3	
		Traffic Volume (PCU)	Comparison with Base Case (%)	Traffic Volume (PCU)	Comparison with Base Case (%)	Traffic Volume (PCU)	Comparison with Base Case (%)
Do Nothing (Base Case)		150,500	0.0	73,500	0.0	345,700	0.0
Do Something							
1	E1+E2	157,400	4.6	71,100	-3.3	247,800	-28.3
2	E1+E2+E3	105,000	-30.2	56,400	-23.3	203,700	-41.1
3	E1+E2+E4	109,800	-27.0	56,200	-23.5	207,900	-39.9
4	E1+E2+E5	146,200	-2.9	61,400	-16.5	211,000	-39.0
5	E1+E2+E3-1+E6	127,800	-15.1	60,600	-17.6	210,500	-39.1
6	E1+E2+E7	122,300	-18.7	60,800	-17.3	219,400	-36.5
7	E1+E2+E8	118,500	-21.3	60,200	-18.1	215,100	-37.8
8	E1+E2+E9	120,600	-19.9	60,300	-18.0	213,200	-38.3
9	E1+E2+E11	124,100	-17.5	60,800	-17.3	223,800	-35.3

Notes: 1) Comparison is calculated by following formula:
Rate = (TV under Do Something –TV under Do Nothing)/TV under Do Nothing) X 100
2) E1 and E2 includes newly construction section of E1-2 and E2-2.

(4) Overall Evaluation

Table 9.2-7 shows the score of each route plan from traffic viewpoint. The following findings are noted:

a) Route 3 has the highest score among the proposed routes. This is largely due to large number of traffic demand on this route and travel speed being comparatively high.

b) Route 4 has the second highest score. This is due to comparative large number of traffic demand while comparative low VCR on this section.

c) Route E1+E2 is the lowest score among others. Although this route has the lowest score, magnitude of traffic demand on this route is very much higher the other routes.

Table 9.2-7 Score of Each Route Plan from Traffic Viewpoint

	Route	Length (Km)	Magnitude of Expressway Vehicle Use	Growth Rate of Expressway Vehicle Use	VCR on Road Network	VCR on Expressway Network	Travel Speed on Expressway	Reduction Rate of VCR of Existing Expressway	Total Score
1	E1+E2	20.9	5	1	1	1	1	1	10
2	E3	19.5	5	3	1	3	5	5	22
3	E4	17.5	4	3	1	5	3	3	19
4	E5	11	5	3	1	3	3	1	16
5	E6	14.3	4	5	1	3	3	2	18
6	E7	11	2	3	1	3	3	2	14
7	E8	4.7	2	5	1	3	3	3	17
8	E9	4	1	3	1	3	3	2	13
9	E11	3.1	2	5	1	1	1	2	12

9.2.4 Financial Aspects

(1) Presumption

For the purpose of prioritization and in order to carry out financial analysis, the following presumptions are made:

1) Implementation schedule is assumed as follows:
   - 2008: Detailed design
   - 2009 -2011: Construction
   - 2012: Open to public
2) Evaluation period: 30 years after opening to public
3) Toll fee is set up at LE 5.00 for light vehicle and LE 10.00 for heavy vehicle
4) Vehicle composition of light vehicle to total vehicle is 87 % while that of the heavy vehicle is 13 % based on the traffic demand forecast.

5) Inflation is not considered in the financial analysis for both toll revenue and construction and maintenance costs.
6) Only individual route plan is subject to the financial analysis due to great influence of Route E1 +E2.
7) In order to evaluate the expressway from the financial view point, the following financial indicators are estimated:
   - Financial internal rate of return (FIRR)
   - Revenue-cost ratio
8) Only toll revenues which levy from Expressway Vehicle Use are taken into account.

(2) Estimation of Toll Revenue

Based on the assumed toll rate and the projected Expressway Vehicle Use, the toll revenue in case of individual route plan is estimated and presented in Table 9.2-8.

Table 9.2-8 Estimation of Annual Toll Revenue (Individual Route Plan)

Unit: (LE Million)

	Route	Length (Km)	2012	2022	AAGR (%)
1	E1+E2	20.9	200.74	414.32	7.5
2	E3	19.5	65.53	278.13	15.6
3	E4	17.5	32.79	153.28	16.7
4	E5	11.0	65.09	366.28	18.9
5	E6	14.3	9.46	178.81	34.2
6	E7	11.0	23.19	83.67	13.7
7	E8	4.7	2.00	7.39	14.0
8	E9	4.0	17.95	57.60	12.4
9	E11	3.1	6.79	62.13	24.8

(3) Financial Indicators

Using the annual toll revenue and financial cost estimated, the financial analysis is carried out. The results of the financial analysis are shown in Table 9.2-9 and Figure 9.2-5.

Route E1+E2 has the highest economic indicator, due to lesser construction cost while toll revenue being comparatively large, followed by Route E5 and Route E3.

Table 9.2-9 Financial Indicator of Cairo Urban Expressway by Route (Individual Route Plan)

	Route	Length (Km)	Construction Cost (LE Million)	Revenue 2012-2041	Revenue / Const. Cost	FIRR (%)
1	E1+E2	20.9	452.1	14,874.0	32.9	35.9
1	E3	19.5	2,055.0	31,794.9	15.5	12.2
2	E4	17.5	1,985.1	6,949.9	3.5	5.1
3	E5	11.0	937.7	17,988.9	19.2	16.9
4	E6	7.5	1,389.8	17,966.3	12.9	8.0
5	E7	11.0	1,689.1	20,317.1	12.0	5.3
6	E8	4.7	587.3	496.6	0.8	-2.8
7	E9	4.0	1,039.4	14,393.7	13.8	9.3
8	E11	3.1	281.2	1,545.8	5.5	10.8

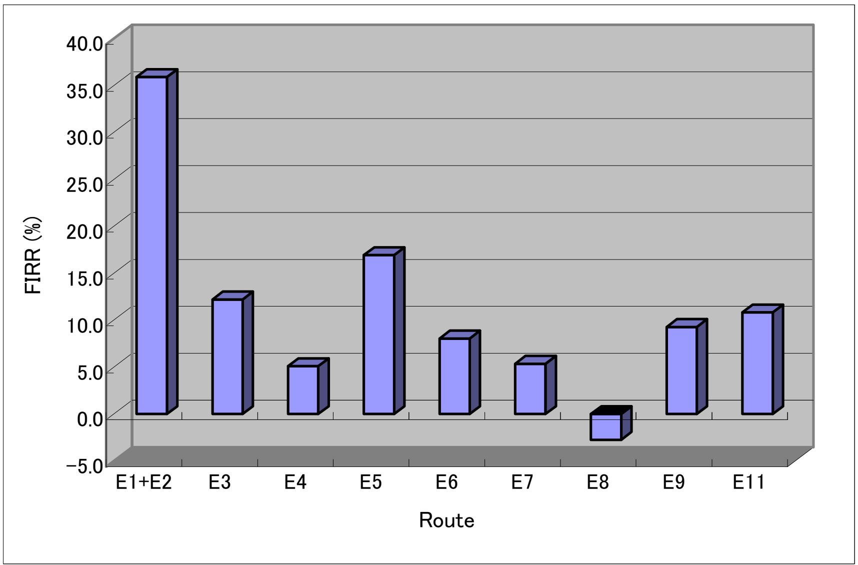

Figure 9.2-5 Financial Indicator of Cairo Urban Toll Expressway by Route

9.2.5 Economic Analysis

(1) Presumption

The following presumptions are made to calculate financial analysis.

1) Implementation schedule is assumed as follows:

- 2008: Detailed design
- 2009 -2011: Construction
- 2012: Open to public

2) Evaluation period: 30 years after opening to public

3) A discount rate of 10% is assumed taking into account the opportunity rate of capital of Egypt.

4) Only individual route plan is subject to the economic analysis.

5) In order to evaluate the expressway from the economic view point, the following economic indicators are estimated:

- Economic internal rate of return (EIRR)
- Benefit-cost ratio (B/C Ratio)
- Net Present Value (NPV)

6) The following benefits are estimated

- Saving in vehicle operating cost (VOC)
- Saving in travel time cost (TTC)

(2) Vehicle Operating Cost (VOC) and Time Cost (TC)

The vehicle operating cost (VOC) and travel time cost (TTC) as of 2005 prices are estimated on the basis of the estimated VOC and TTC in CREATS (2002). The VOC and TTC by vehicle type are estimated using inflation rate pf an consumer price index (CPI) between 2002 and 2005, that is 16.4 %. Average values of the VOC and TTC are estimated using weighed traffic composition in this study and are presented in Table 9.2-10.

Table 9.2-10 Basic Vehicle Operating Costs (at 2005 Prices)

	VOC (LE/km)	TTC (LE/Hr)		
		2005	2012	2022
Car	0.466	6.5	8.6	11.5
Taxi	0.585	8.6	11.3	12.9
Bus	2.262	41.8	54.6	73.2
Truck	0.929	9.8	12.9	17.3
Average	0.671	7.8	10.3	13.4

Note: VOC and TTC are estimated based on VOC and TTC in CREATS,

(3) Estimation of Benefits

The project cost, which is already estimated in the previous section, is expressed as the financial cost. It is therefore merely converted from financial cost to economic cost. In this study, the economic cost is estimated by deducting government taxes and shadow costs from the financial cost. CREATS study estimated the conversion factors and for economic cost estimation in this study, the following same rate are used:

- Foreign currency: 0.84
- Local currency: 0.81

Based on the VOC mentioned above and the PCU–km and PCU-hour (‘with’ and ‘without’ toll expressway plan), the benefits in case of individual route plan are estimated and presented in Table 9.2-11.

Table 9.2-11 Estimation of Benefits (LE '000)

	Route	Length (Km)	2012			2012		
			VOC	TTC	Total	VOC	TTC	Total
1	E1+E2	20.9	18.4	163.7	182.2	82.4	1,152.7	1235.1
2	E3	19.5	6.7	59.6	66.3	60.9	851.5	912.4
3	E4	17.5	3.0	26.8	29.8	30.1	421.1	451.3
4	E5	11.0	3.8	33.4	37.2	45.2	632.6	677.8
5	E6	14.3	0.7	6.3	7.0	28.7	401.5	430.2
6	E7	11.0	1.3	11.9	13.2	10.3	144.5	154.8
7	E8	4.7	0.1	0.5	0.5	0.4	5.9	6.4
8	E9	4.0	0.4	3.6	4.0	2.8	39.3	42.1
9	E11	3.1	0.1	1.1	1.2	2.4	32.9	35.2
	Total	106.0	34.6	306.9	341.4	263.3	3,682.0	3,945.3

(4) Estimation of Economic Costs

The project cost, which was already calculated in the previous section, is expressed as the financial cost. It is therefore to convert from financial cost to economic cost. In this study the economic cost was estimated to deduct from financial cost to government taxes and import duty is shown in Tables 9.2-12 (1) and (2).

Table 9.2-12 (1) Economic Cost Estimate (Combined Route Plan) (as of 2005 Prices)

Case	Route	Length (Km)	Financial Cost (LE '000)	Economic Cost (LE' 000)
1	E1+E2	20.9	452.1	368.4
2	E1+E2+E3	40.4	2,507.1	2,039.1
3	E1+E2+E4	38.4	2,437.2	1,982.6
4	E1+E2+E5	31.9	1,389.8	1,130.4
5	E1+E2+E3-1+E6	35.2	1,703.9	1,386.1
6	E1+E2+E7	31.9	1,497.0	1,217.6
7	E1+E2+E8	25.6	1,039.4	845.6
8	E1+E2+E9	24.9	790.7	643.5
9	E1+E2+E11	24.0	733.3	596.8
10	All Routes	99.2	9,824.8	7,991.3

Table 9.2-12 (2) Economic Cost Estimate (Individual Route Plan) (as of 2005 Prices)

Case	Route	Length (Km)	Financial Cost (LE '000)	Economic Cost (LE' 000)
1	E1+E2	20.9	452.1	368.4
2	E3	40.4	2,055.0	1,670.7
3	E4	38.4	1,985.1	1,614.2
4	E5	31.9	937.7	762.0
5	E6 with E3-1	35.2	1,251.8	1,017.7
6	E7	31.9	1,044.9	849.2
7	E8	25.6	587.3	477.2
8	E9	24.9	338.6	275.1
9	E11	24.0	281.1	228.4
10	All Routes	99.2	9,824.8	7,991.3

(5) Economic Analysis

Based on the above mentioned benefits and costs estimation, the economic analysis of the individual route plan is carried out. Table 9.2-13 shows the benefit – cost analysis of the individual route plan during project life period of 30 years and Table 9.2-14 presents the results of the economic analysis. The results are shown graphically in Figure 9.2-6.

From the table, it is observed that Route E1+E2 has the highest EIRR followed by Route E5 and Route E3.

Table 9.2-13 Economic Indicators of Cairo Urban Expressway by Route (Individual Route Plan)

	Route	Net Present Value (LE Million)	BC Ratio	EIRR
1	E1+E2	7,575.9	11.56	48.90
2	E3	5,977.2	3.73	20.61
3	E4	1,793.6	2.07	15.24
4	E5	3,378.5	4.15	22.73
5	E3-1+E6	4,597.1	3.58	18.70
6	E7	280.6	1.35	12.06
7	E8	-192.3	0.54	6.19
8	E9	30.6	1.12	10.57
9	E11	135.0	1.60	12.94

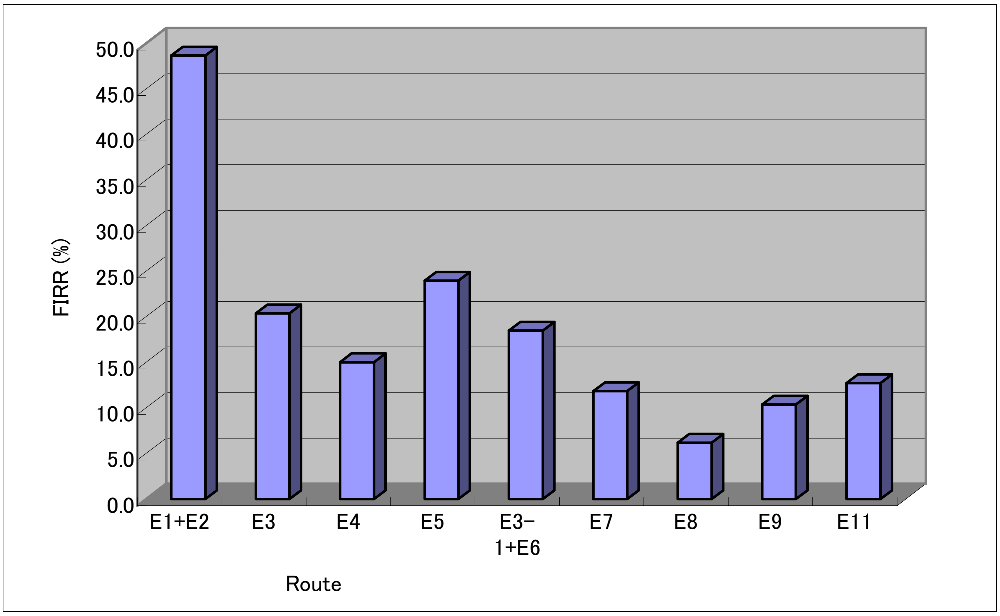

Figure 9.2-6 EIRR of Cairo Urban Expressway by Route (Individual Route Plan)

(6) Overall Evaluation

Table 9.2-14 shows the overall evaluation of the each route of the Toll Expressway Plan from financial and economic viewpoints.

Table 9.2-14 Score of Each Route Plan from Financial and Economic Viewpoint

Route		Financial Viability	Economic Viability	Total Score from Financial & Economic Viewpoint
1	E1+E2	16	20	36
2	E3	8	16	24
3	E4	4	12	16
4	E5	8	16	24
5	E3-1+E6	4	8	12
6	E7	4	4	8
7	E8	0	4	4
8	E9	4	8	12
9	E11	4	8	12

9.2.6 Environmental Aspect

(1) Land Acquisition Aspect

The proposed expressway is within the existing right-of-way (ROW) of major roads and therefore land acquisition problem is expected to be minimal. According to the preliminary design made in the previous section, the following land acquisition is required to construct the expressway project (Table 9.2-15).

Table 9.2-15 Required Area for ROW

Section	Location (Station No.)	Length (m)	Width (m)	Area (m^2)
E3-3	12+550－12+650(L)	100	1	100
E3-3	13+850－14+100(R)	125	12	1,500
E5-2	6+100－6+250(L)	150	3	450
E6	5+250－5+350(R･L)	100	15	1,500
E7	3+000－3+100(L)	100	7	700
E7	8+200－8+300(L)	100	7	700
TOTAL				4,950

(2) Air Pollution

One of external effects of transport projects is air quality impacts. Among these impacts, the following air quality elements are the most significant:

- HC (Hydro-Carbon)
- CO (Carbon monoxide)
- NOx (Nitrogen Oxide)

In this study, discharged volume of these air pollutions are estimated based on the discharge rate per PCU-kilometer and the estimated PCU-kilometers. Table 9.2-16 shows the estimated air pollution components of HC, CO and NOx produced by the Expressway Plans.

Table 9.2-16 Reduction of Daily Air Pollution per Route Unit: (Kg)

Route		2022			2022		
		HC	CO	NOx	HC	CO	NOx
1	E1+E2	7.0	57.8	6.8	31.2	258.0	30.5
2	E3	2.5	21.0	2.5	23.1	190.6	22.5
3	E4	1.1	9.4	1.1	11.4	94.3	11.1
4	E5	1.4	11.8	1.4	17.1	141.6	16.7
5	E3-1+E6	0.3	2.2	0.3	10.9	89.9	10.6
6	E7	0.5	4.2	0.5	3.9	32.3	3.8
7	E8	0.0	0.2	0.0	0.2	1.3	0.2
8	E9	0.2	1.3	0.2	1.1	8.8	1.0
9	E11	0.0	0.4	0.0	0.9	7.4	0.9

Notes: Discharge rate is assumed on the basis of values by Ministry of Environmental of Japan as follows: HC: 0.254 g / PCU-km, CO: 2.10 g / PCU-km, NO x: 0.248 g / PCU-km

(3) Overall Evaluation from Air Pollution

Table 9.2-17 shows the overall evaluation of the each route of the Toll Expressway Plan from environmental viewpoint.

Table 9.2-17 Score of Each Route Plan from Environmental Viewpoint

Route		Land Acquisition	Reduction in Air Pollution	Total Score from Environmental Viewpoint
1	E1+E2	5	5	10
2	E3	1	4	5
3	E4	5	2	7
4	E5	4	4	8
5	E3-1+E6	1	2	3
6	E7	2	1	3
7	E8	5	1	6
8	E9	5	1	6
9	E11	5	1	6

9.2.7 Priority Ranking of Cairo Urban Expressway

Based on the series of examinations, the priority ranking is identified as shown in Table 9.2-18. The detailed score of each route is shown in Table 9.2-19. In this table, if some other agencies have plans to construct the expressway, it is given high score such as E1 and E2, E3 or E4.

Table 9.2-18 Priority Ranking

Priority Ranking	Route
Top Priority	E1 and E2
Second Priority	E3 E4 E5
Third Priority	E6 E11
Fourth Priority	E7 E8 E9

Table 9.2-19 Total Score and Priority Ranking

Route	Urban Development	Traffic Aspect	Economic Viability	Financial Viability	Environ-mental Aspect	S-Total	Urgency & Mutuality	Total
	10	30	20	20	10	90	10	100
E1+E2	5	10	16	20	10	61	10	71
E3	5	22	8	16	5	56	8	64
E4	0	19	4	12	7	42	8	50
E5	0	16	8	16	8	48	6	54
E3-1+E6	10	18	4	8	3	43	4	47
E7	5	14	4	4	3	30	2	32
E8	0	17	0	4	6	27	2	29
E9	0	13	4	8	6	31	2	33
E11	10	12	4	8	6	40	4	44

9.3 EVALUATION AND SELECTION OF ALTERNATIVE NETWORK DEVELOPMENT SCENARIOS

9.3.1 Alternative Network Development Scenarios

The major issue to complete the Urban Toll Expressway Network in Cairo is the construction cost. A huge construction cost is required to complete the whole Expressway Network (preliminary estimate is around LE 9.8 billion). Although the initial investment cost will be borne by either Government, private entity or PPP scheme, it is necessary to repay these investment costs. To ease repayment for these costs, the following measures can be considered:

- Users on existing expressway route E1 and E2 will be levied the toll charge
- Users on Ring Road will be levied the toll charge

The combination of these toll charge schemes is shown in Table 9.3-1. Figure 9.3-1 shows the four scenarios established for the toll expressway network. These scenarios are established based of the characteristics and functions of the different components of the expressway network. With existing outer ring road and elevated roads, which are already constructed by public funds and will be connected to the newly constructed expressways, the concept of applying toll on such roads is considered here as governmental participation toward the sustainable development of the urban toll expressway network.

Table 9.3-1 Conditions of Each Scenario

	Existing Route E-1 and E-2 to be levied toll rate	Ring Road to be levied toll rate	New construction routes to be levied toll rate
Scenario 1	No	No	Yes
Scenario 2	Yes	No	Yes
Scenario 3	No	Yes	Yes
Scenario 4	Yes	Yes	Yes

Scenarios in Table 9.3-1 are elaborated below.

Do Nothing: This is the base case to evaluate the alternative scenarios.

Scenario 1: This case assumes that users on the existing routes E1 and E2 and Ring Road will not be levied the toll charge. Only users on new proposed routes of the expressway will be levied the toll charge.

Scenario 2: This case assumes that users on the new proposed routes and the existing routes E1 and E2 will be levied the toll charge, but Ring Road users will not be levied the toll charge.

Scenario 3: This case assumes that users on the new proposed routes and Ring Road will be levied the toll charge, but users of the existing routes E1 and E2 users will not be levied the toll charge.

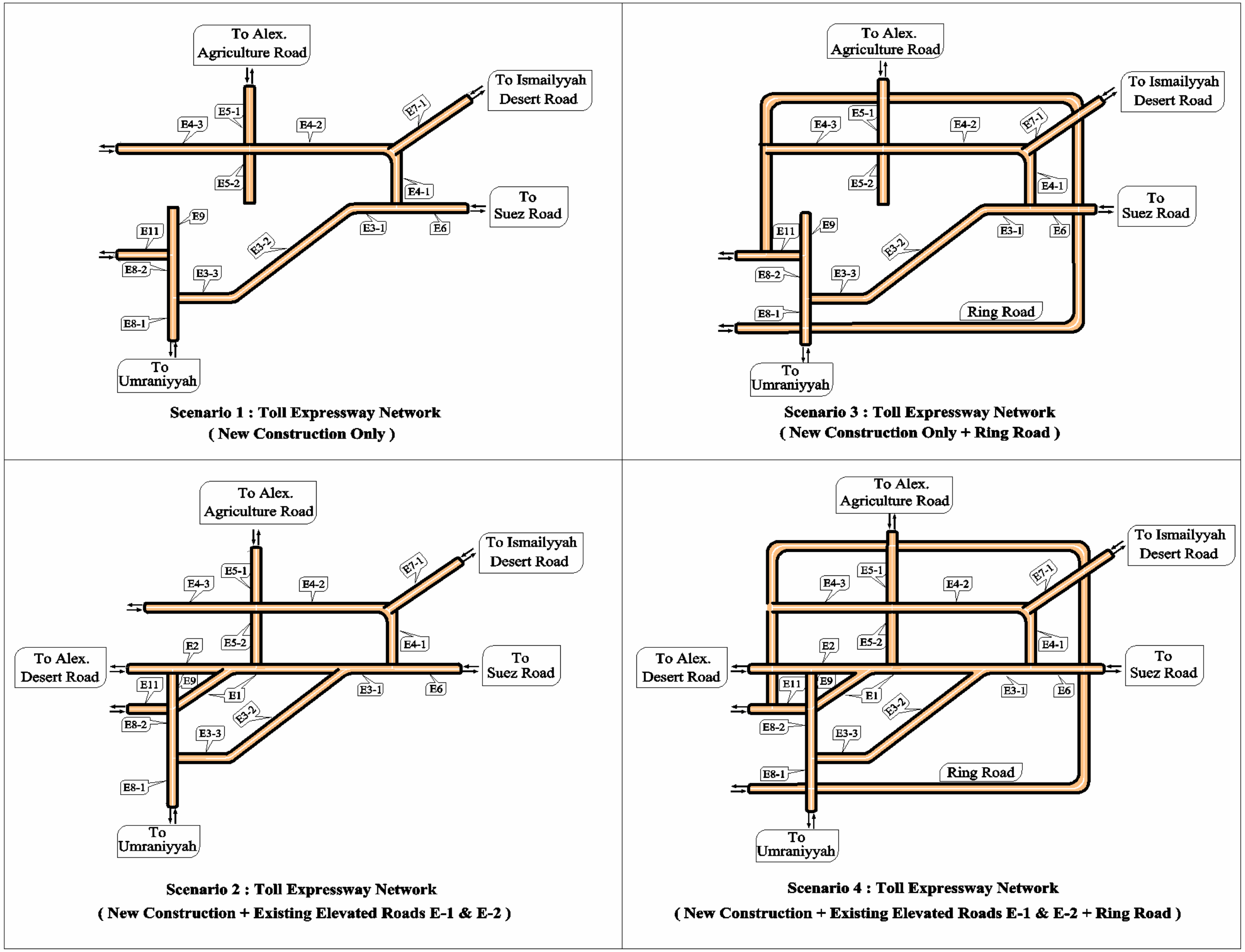

Figure 9.3-1 Scenarios of Toll Expressway Network

Scenario 4: This case assumes that users of the new proposed routes, the existing routes E1 and E2 and Ring Road will be levied the toll charge.

Under Scenarios 3 and 4, cost of upgrading the ring road is not included, as it is under another study at present. Here, it is assumed that toll will be collected at intermediate locations on the following sections:

1 – between Alexandria (Agriculture) and Ismailyyah Road
2 – between Suez Road and Umraniyyah Road
3 – between Alexandria Desert Road and Alexandria Agriculture Road

9.3.2 Presumptions of Comparative Analysis

(1) Proposed Implementation Program

In Section 9.2, the priority ranking of the network is established. Based on this ranking, the implementation program for each Scenario is established and presented in Tables 9.3-2 and 9.3-3.

Table 9.3-2 Implementation Schedule under Scenarios 1 and 3

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Route/ Section														
E3-1		28.0	331.1	331.1										
E3-2		19.7	135.7	271.5	135.7									
E3-3			28.0	193.6	387.1	193.6								
E4-1					16.3	112.1	224.3	112.1						
E4-2					32.0	220.7	441.4	220.7						
E4-3						21.2	146.1	292.2	146.1					
E5-1							16.4	113.2	226.4	113.2				
E5-2								16.4	113.0	226.1	113.0			
E6								19.6	135.5	271.0	135.5			
E7-1										36.5	252.1	504.2	252.1	
E8-1											17.6	121.7	243.3	121.7
E8-2											29.0	13.5	27.1	13.5
E9											11.8	81.7	163.4	81.7
E11											9.8	67.9	135.7	67.9
Interchange														
IC1								11.4	157.5	157.5				
IC2										10.5	144.5	144.5		
IC3						6.8	93.9	93.9						
IC4												2.0	27.2	27.2
IC6									5.0	69.1	69.1			
IC8				5.6	77.3	77.3								
IC9												6.3	87.7	87.7
IC10												7.7	105.9	105.9
Implemenation Schedule	0	47.7	494.8	801.7	648.4	631.7	922.0	879.5	783.5	883.9	782.4	949.4	1,042.3	505.4

Design / Construction

Table 9.3-3 Implementation Schedule under Scenarios 2 and 4

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Section														
E1-2		12.4	188.0	153.9										
E2-2		3.4	51.9	42.5										
E3-1		28.0	165.6	331.1	165.6									
E3-2			19.7	135.7	271.5	135.7								
E3-3			28.0	193.6	387.1	193.6								
E4-1					16.3	112.1	224.3	112.1						
E4-2					32.0	220.7	441.4	220.7						
E4-3						21.2	146.1	292.2	146.1					
E5-1							16.4	113.2	226.4	113.2				
E5-2								16.4	113.0	226.1	113.0			
E6								19.6	135.5	271.0	135.5			
E7-1										36.5	252.1	504.2	252.1	
E8-1											17.6	121.7	243.3	121.7
E8-2											29.0	13.5	27.1	13.5
E9											11.8	81.7	163.4	81.7
E11											9.8	67.9	135.7	67.9
Interchange														
IC1								11.4	157.5	157.5				
IC2										10.5	144.5	144.5		
IC3						6.8	93.9	93.9						
IC4												2.0	27.2	27.2
IC6									5.0	69.1	69.1			
IC8				5.6	77.3	77.3								
IC9												6.3	87.7	87.7
IC10												7.7	105.9	105.9
Implemenation Schedule	0	43.8	453.2	862.3	949.7	767.4	922.0	879.5	783.5	883.9	782.4	949.4	1,042.3	505.4

Design Construction

(2) Evaluation Method

1) Traffic Condition

- Average Travel Speed

  Travel speed obtained from each scenario is compared. Alternative with highest travel speed is the best.

- Average V/C Ratio

  V/C ratio obtained from each scenario is compared. Alternative with lowest V/C ratio is the best.

2) System Efficiency

- PCU-km

  PCU-km of each alternative is compared. Alternative with the least PCU-km is the best alternative.

- PCU-hr

  PCU-Hr of each alternative is compared. Alternative with the least time is the best alternative.

- Travel Cost

  Travel cost of each alternative is compared. Alternative with the least cost is the best alternative.

3) Financial Viability

- FIRR (Financial Internal Rate of Return)

  FIRR of each alternative is compared. Alternative with the highest FIRR is the best alternative.

- Net Present Value (NPV)

  NPV of each alternative is compared. Alternative with the highest NPV is the best alternative.

- Revenue/Cost Ratio
  Revenue/Cost Ratio of each alternative is compared. Alternative with the highest ratio is the best alternative.

4) Economic Viability
- EIRR (Economic Internal Rate of Return)
  EIRR of each alternative is compared. Alternative with highest EIRR is the best alternative.
- Net Present Value (NPV)
  NPV of each alternative is compared. Alternative with highest NPV is the best alternative.
- Benefit/Cost Ratio
  Benefit/Cost Ratio of each alternative is compared. Alternative with the highest ratio is the best alternative.

5) Environmental impact
- Amount of pollutants from each alternative is compared. Alternative with the least discharged amount of air pollutant is the best alternative.

9.3.3 Traffic Efficiency and System Efficiency

(1) Traffic Assignment Analysis

The traffic assignment analysis of four (4) alternative scenarios is carried out on the proposed expressway network in the Year 2022. The results are graphically shown in Figures 9.3-2 to 9.3-5. Number of vehicles and VCR on each link is indicated in these figures.

(2) Comparison of Traffic Efficiency Results

The result of each scenario concerning traffic efficiency is shown in Table 9.3-4. From the table, the followings are noted:

<u>Whole network</u>

- In terms of trip length, all scenarios have superior value over the ‘Do Noting’ case (i.e. having shorter trip length).
- All scenarios performed better than the ‘Do nothing’ case in terms of travel time although Scenario 3 is particularly notable.
- All scenarios outperformed the ‘Do Nothing’ case in terms of travel speed with Scenario 1 and 2 having the best performance.
- All scenarios have better record over the ‘Do Nothing’ case in terms of V/C ratio. Moreover, there is no observed notable difference among the scenario results.

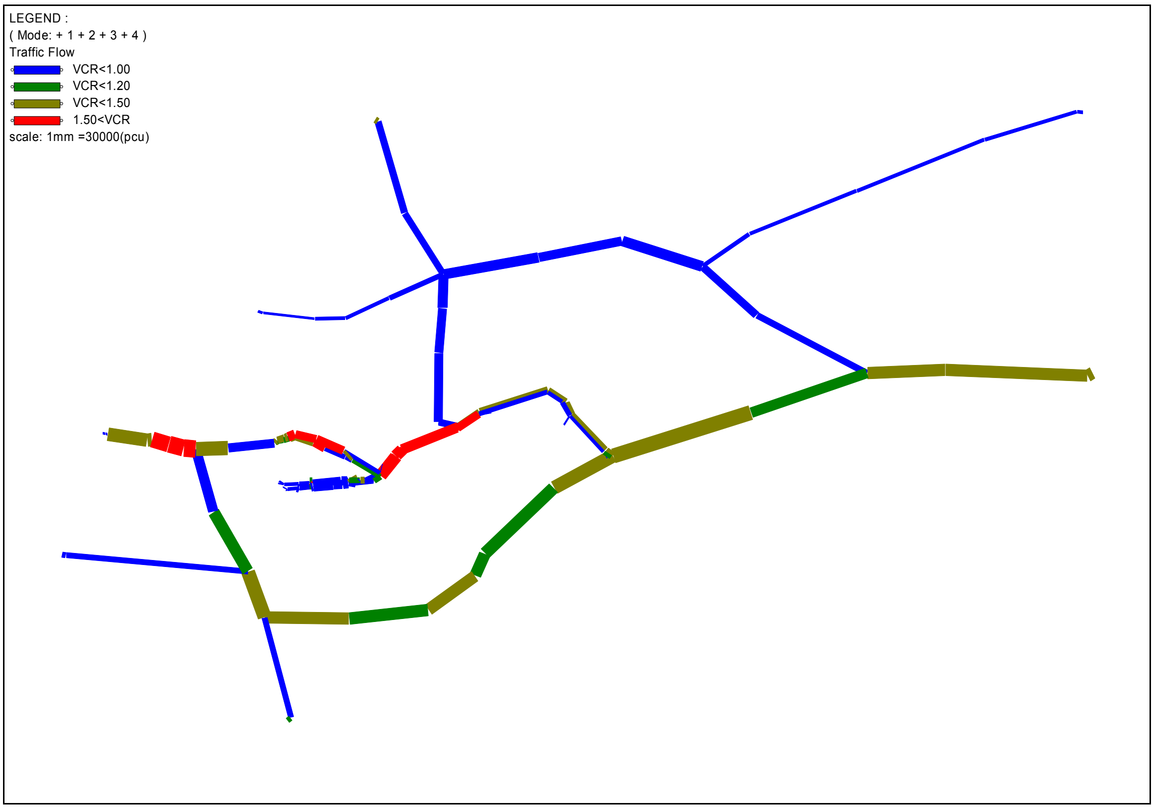

Figure 9.3-2 Assigned Traffic Volumes on Toll Expressway Network in 2022 – Scenario 1

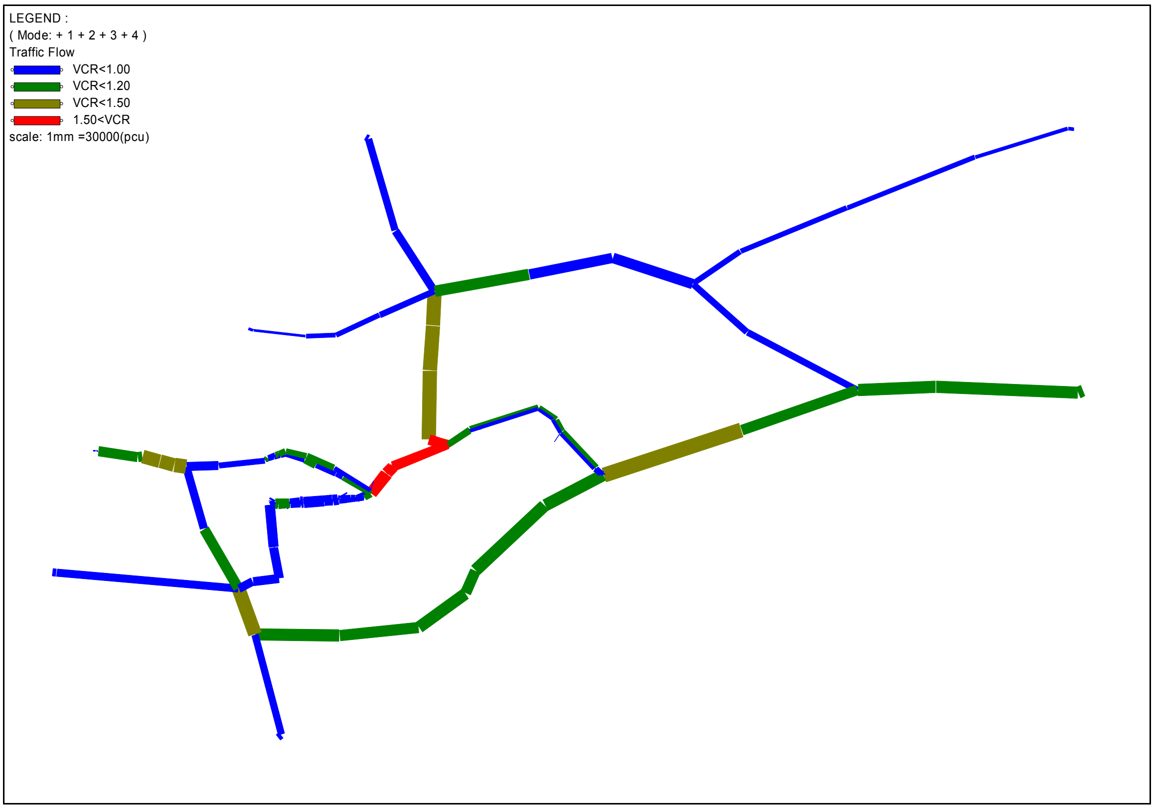

Figure 9.3-3 Assigned Traffic Volumes on Toll Expressway Network in 2022 – Scenario 2

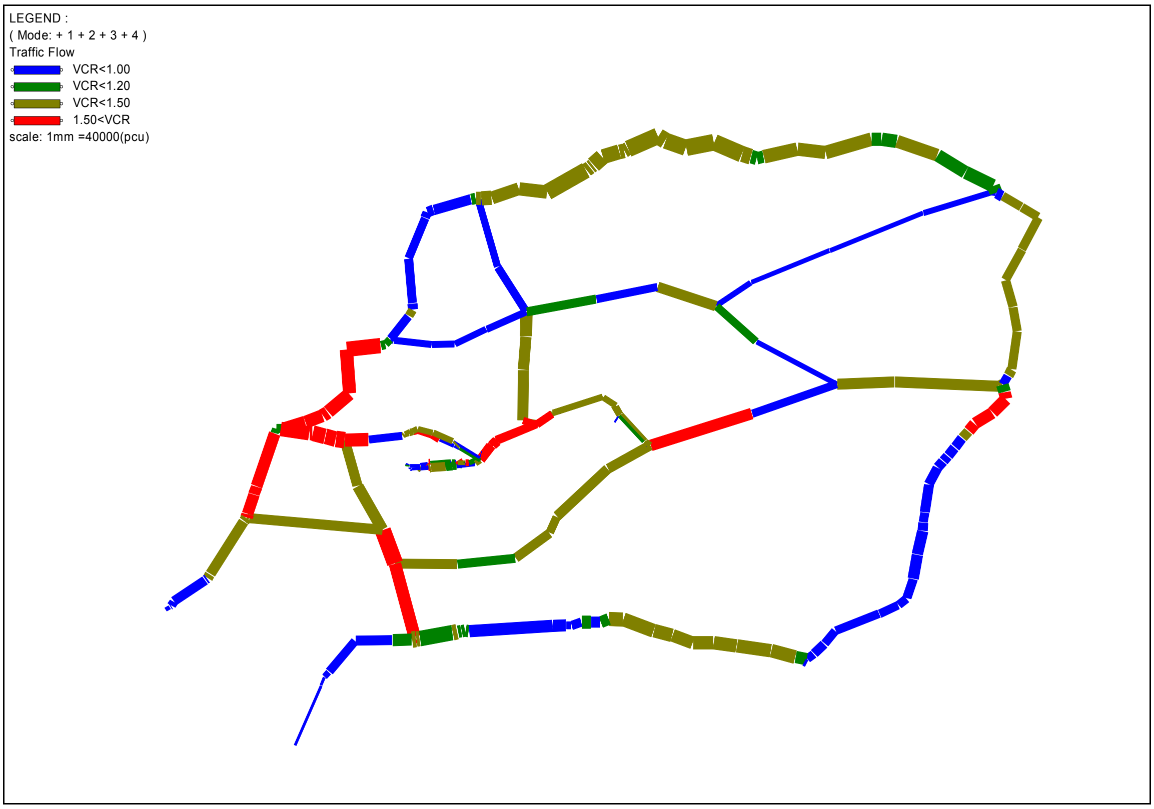

Figure 9.3-4 Assigned Traffic Volumes on Toll Expressway Network in 2022 – Scenario 3

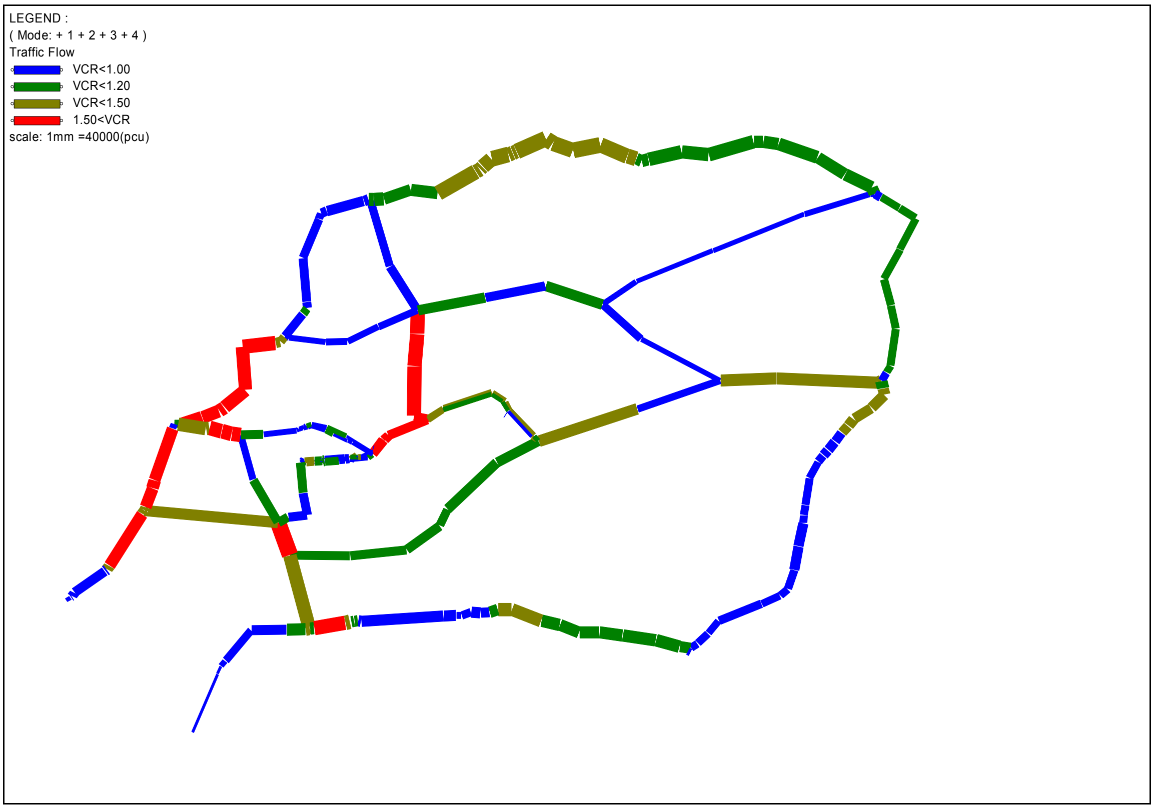

Figure 9.3-5 Assigned Traffic Volumes on Toll Expressway Network in 2022 – Scenario 4

Expressway network

- All scenarios have outperformed the 'Do Nothing' case in terms of travel speed with Scenario 4 being the best alternative.
- Regarding congestion, in terms of V/C ratio, only Scenario 1 and 2 have better record over the 'Do Nothing' case. Both Scenario 3 and 4 have inferior value compared to that of 'Do Nothing' case.

Generally, all the scenarios have better performed over the 'Do Nothing' case although there is no observed significance difference among the scenario results.

Table 9.3-4 Traffic Indicators of Alternatives (2022)

Scenario	Whole Road Network				Expressway Network	
	Trip Length (Km)	Travel Time (Min)	Average Travel Speed (Km/h)	Average VCR	Average Travel Speed (Km/h)	Average VCR
Without New Expressways (Do Nothing)	12.2	59.8	12.2	1.53	21.5	1.08
With New Expressways						
Scenario 1	11.9	55.8	13.2	1.47	24.1	1.05
Scenario 2	11.9	56.1	13.1	1.47	22.8	1.07
Scenario 3	11.9	54.0	12.8	1.48	24.0	1.22
Scenario 4	11.9	54.4	12.7	1.47	25.2	1.17

(3) Comparison based on System Efficiency Indicators

Table 9.3-5 shows the road network system efficiency indicators. Compared to 'Do Nothing' case, each alternative scenario has preferable result in PCU-km, PCU-hr and Travel Cost.

As for the PCU-km, Scenario 4 has the most desirable forecast result, followed by Scenario 3. As for PCU-hr, Scenario 4 has the best performance among the scenarios followed by Scenario 3.

Taking into account the estimated performance results of each scenario, it can be said that the differences between scenarios are very marginal. However, it can be pointed out that Scenario 4 has the best performance among the Scenarios from the view point of system efficiency point.

Table 9.3-5 System Efficiency Indicators of Scenarios (2022)

Scenario	Total Network				
	Total PCU-Km ('000)	Total PCU-Hr ('000)	Running Cost	Travel Time Cost	Vehicle Operating Cost
W/O Expressway Project	151,007	12,357	101,291	165,999	267,290
W/ Expressway Project					
Scenario 1	147,727	11,536	99,091	154,970	254,061
Scenario 2	147,635	11,593	99,029	155,736	254,765
Scenario 3	147,291	11,242	98,798	151,021	249,819
Scenario 4	147,122	11,157	98,685	149,879	248,564

9.3.4 Financial Analysis

(1) Presumptions for Financial Analysis

1) Evaluation period: 30 years after the year 2016 which is the weighted average of the construction cost of the expressway. This means that the evaluation year is from 2016 to 2045.
2) Following the implementation program of the expressway, the toll fee assumptions are in the table below. In this table, it is noted that the first phase (2012-2015) is set up the cheaper fee and incrementally increase of the toll fee depending upon the service length of the expressway.

	Light Vehicle	Heavy Vehicle
2012 – 2015	2	4
2016 – 2018	3	6
2019 – 2022	5	10
2023 -	5	10

3) Inflation is not considered in the financial analysis for both toll revenue and construction and maintenance costs.
4) In order to evaluate the expressway from financial view point, the following financial indicators are calculated:
    - Financial internal rate of return (FIRR)
    - Revenue Cost Ratio
    - Net Present Value (NPV)
5) Only toll revenues which levy from expressway vehicle use are taken into account.
6) Annualized factor to daily users is assumed to be 330 days.

(2) Estimation of Expressway vehicle use and Revenue

The Expressway vehicle use and Cairo Ring Road vehicle uses are forecasted by applying the same diversion model mentioned in Section 1.3.1. The results of these forecasts following the implementation schedule are shown in Tables 9.3-2 and 9.3-3. Using the unit toll rate and number of vehicles, annual revenues from the Expressway and Cairo Ring Road are estimated and shown in Tables 9.3-6 and 9.3-7.

Table 9.3-6 Estimation of Daily Expressway and Ring Road Users (vehicles/day)

	Scenario 1	Scenario 2	Scenario 3			Scenario 4		
			Express-way	Ring Road	Total	Express-way	Ring Road	Total
2012	74,795	131,263	139,453	148,860	288,313	183,096	162,853	345,949
2022	366,738	443,656	658,771	253,089	911,860	784,302	247,623	1,031,925
2032	669,270	809,639	994,058	440,578	1,434,636	1,277,545	435,159	1,712,704
2042	908,213	1,098,698	1,223,683	586,377	1,810,060	1,635,366	579,164	2,214,530

Table 9.3-7 Estimation of Annual Revenue (LE Million)

	Scenario 1	Scenario 2	Scenario 3			Scenario 4		
			Express-way	Ring Road	Total	Express-way	Ring Road	Total
2012	55.8	97.9	104.0	111.0	215.0	136.6	121.5	258.0
2022	683.8	827.2	1,228.3	471.9	1,700.2	1,462.3	461.7	1,924.0
2032	1,247.9	1,509.6	1,853.4	821.5	2,674.9	2,382.0	811.4	3,193.3
2042	1,693.4	2,048.5	2,281.6	1,093.3	3,374.9	3,049.1	1,079.9	4,129.0

(3) Financial Analysis

Based on the above mentioned input data, the financial analysis of each scenario is calculated and presented in Table 9.3-8. From the table, it is seen that the Scenario 4 is superior than the other plans followed by Scenario 3 from the viewpoint of financial viability.

Table 9.3-8 Result of Financial Analysis

Scenario	Toll Expressways	Construction Cost (LE Million)	Revenue 2012-2045 (LE Million)	Revenue / Const. Cost	FIRR (%)
Scenario 1	New Construction only	9,372.8	32,833.95	3.5	6.3
Scenario 2	New Construction + Existing Elevated Roads E1 & E2	9,824.8	40,269.63	4.1	7.7
Scenario 3	New Construction only + Ring Road	9,372.8	72,286.06	7.7	16.3
Scenario 4	New Construction + Existing Elevated Roads E1 & E2 + Ring Road	9,824.8	86,195.11	8.8	17.2

Note: Evaluation period is assumed to be 30 years.

9.3.5 Economic Analysis

(1) Presumptions for Economic Analysis

1) Evaluation Period
Evaluation period is assumed to be 30 years from 2016 and 2045 which is the same period of that in the financial analysis.

2) Implementation Schedule
The implementation schedule of the Expressway is also assumed to be the same of that in the financial analysis.

3) 'With' and 'Without' Project and Evaluation Cases
The economic benefits and costs derived from the project can be defined principally as those with and without project.

- Without Project Case (Do Nothing Case)：Without construction of Urban Toll Expressway
- With Project Case (Do Something Case): With construction of Urban Toll Expressway under Scenarios 1 to 4

4) Economic Indicators
The economic evaluation method employed benefit cost analysis which evaluated investment efficiency through comparison of benefit and cost derived from 'Do Nothing' case.

In the benefit cost analysis, the economic indicators used are as follows:

- Net Present Value (NPV)
- Benefit Cost Ratio, (BCR)
- Economic Internal Rate of Return (EIRR)

5) Economic Benefit derived from the Expressway Project
The economic benefit and cost derived from the project can be defined as follows:

- Saving in vehicle operating cost (VOC)
- Saving in travel time cost (TTC)

It should be noted that toll revenues are not defined as benefits due to transfer payment from Expressway vehicle use to Expressway operating company.

6) A discount rate of 10 % is applied taking into account the opportunity rate of capital of Egypt.

7) Annualized factor to daily users is assumed to be 330 days.

(2) Estimation of Traffic Demand

Traffic demand forecast of each route of the expressway network is forecasted by applying the expressway diversion model in the traffic assignment process in order to estimate the economic benefits.

(3) Vehicle Operating Cost (VOC) and Travel Time Cost (TTC)

As explained in paragraph 9.2.5, the vehicle operative cost (VOC) and travel time cost (TTC) as of 2005 prices are estimated and are presented in Table 9.3-9.

Table 9.3-9 Basic Vehicle Operating Costs (As of 2005 Prices)

	VOC (LE/km)	TTC (LE/Hr)		
		2005	2012	2022
Car	0.466	6.5	8.6	11.5
Taxi	0.585	8.6	11.3	12.9
Bus	2.262	41.8	54.6	73.2
Truck	0.929	9.8	12.9	17.3
Average	0.671	7.8	10.3	13.4

Note: VOC and TTC are estimated based on VOC and TTC estimated in CREATS

(4) Estimation of Benefit

The savings in vehicle operating cost and travel time cost are estimated as presented in Table 9.3-10.

Table 9.3-10 Estimation of Annual Benefit (LE Million)

	2012			2022		
	Saving in VOC	Saving in TTC	Total	Saving in VOC	Saving in TTC	Total
Scenario 1	228.8	235.4	464.1	726.0	1,452.2	2,178.2
Scenario 2	244.8	233.3	478.0	746.4	1,351.4	2,097.8
Scenario 3	334.5	335.9	670.4	822.6	1,973.0	2,795.6
Scenario 4	329.0	525.7	854.7	860.0	2,122.6	2,982.5

(5) Economic Cost

The project cost, which was already calculated in the previous section, is expressed as the financial cost. It is therefore to convert from financial cost to economic cost as shown in Table 9.3-11. In this study, the economic cost is estimated to deduct from financial cost to government taxes and shadow costs. Since CREATS study had already estimated the conversion factors, economic cost in this study is used for the same rate.

- Conversion factor for foreign currency: 0.84
- Conversion factor for local currency: 0.81

Table 9.3-11 Economic Cost Estimate (as a sample at 2005 Prices)

Route	Length (Km)	Financial Cost (LE '000)	Economic Cost (LE' 000)
E1+E2	20.9	452.1	368.4
E1+E2+E3	40.4	2,507.1	2,039.1
E1+E2+E4	38.4	2,437.2	1,982.6
All Routes	99.2	9,824.8	7,991.3

(6) Economic Analysis

Based on the above mentioned input data, the economic analysis of each scenario is calculated as presented in Table 9.3-12. From this table, it can be said that all cases are economically feasible.

Table 9.3-12 Results of Economic Analysis

Case	Scenario	Net Present Value (LE million)	B/C Ratio	EIRR (%)
1	Scenario 1	7,705	2.75	26.67
2	Scenario 2	6,873	2.46	24.14
3	Scenario 3	10,958	3.48	36.28
4	Scenario 4	11,508	3.44	38.78

9.3.6 Air Pollution of Alternative Plans

Air pollutants such as HC, CO and NOx produced by each alternative plan are estimated and shown in Table 9.3-13. And to appreciate environmental impact of all the alternatives, difference of each alternative and 'Do Nothing' case is obtained. It is seen from the same table that Scenario 4 has outperformed all other scenarios by having the highest reduction volume.

Table 9.3-13 Air Pollution of Alternative Scenarios (Kg)

		Do Nothing	Scenario 1	Scenario 2	Scenario 3	Scenario 4
HC	Amount	38,356	37,523	37,499	37,412	37,369
	Reduction from Do-Nothing Case	0	833	856	944	987
CO	Amount	317,115	310,227	310,034	309,311	308,956
	Reduction from Do-Nothing Case	0	6,888	7,081	7,804	8,159
NOx	Amount	37,450	36,636	36,613	36,528	36,486
	Reduction from Do-Nothing Case	0	813	836	922	963

Note: Discharge rates are assumed on the basis of data by Ministry of Environment of Japan as follows: HC is 0.254 g/pcu-km, CO is 2.10 g/pcu-km, NOx is 0.248 g/pcu-km.

9.3.7 Overall Evaluation

As presented in Table 9.3-14, the results of overall evaluation show that Scenario 4 is the most preferable Scenario for Cairo Urban Toll Expressway Network. The following comments are noted:

Scenario 4, in which toll is applied on an integrated urban expressway network, is superior from all aspects, compared with other scenarios. So it is selected as the optimum scenario in this stage of the Study. To implement this scenario, however, efforts may be required to be done to obtain social and political acceptance.

Table 9.3-14 Overall Evaluation of Alternative Scenarios

		Scenario 1	Scenario 2	Scenario 3	Scenario 4
1	Traffic Efficiency	4	4	4	4
2	System Efficiency	1	2	3	4
3	Financial Viability	1	2	3	4
4	Economic Viability	1	2	3	4
5	Air Pollution	1	2	3	4
Total Score		8	12	16	20

9.4 EVALUATION OF PROPOSED TOLL EXPRESSWAY PLAN

9.4.1 Introduction

(1) Evaluation Procedure

Based on the optimal Expressway Network Plan selected among the alternative scenarios in Section 9.3 which is Scenario 4, and priority of the expressway network plan, the selected Toll Expressway Network Development Plan by target years is established. This Section is to evaluate the proposed Expressway Plan from various view points. The procedure of the evaluation of the proposed Expressway Plan is illustrated in Figure 9.4-1.

9.4.2 Selected Expressway Development Plan

(1) Selected Plan

The Scenario 4 is recommended as the Toll Expressway Plan for future development in the Greater Cairo Area. The detailed component of the plan integrates the toll charges to the existing expressway E1 and E2 and Ring Road and newly proposed roads of the urban expressway network.

(2) Investment Cost and Schedule

A summary of the investment plan of the proposed expressway project is presented in Table 9.4-1 while Table 9.4-2 presents the investment cost estimation.

Table 9.4-1 Investment Schedule

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Route/Section														
E1-2		12.4	188.0	153.9										
E2-2		3.4	51.9	42.5										
E3-1		28.0	165.6	331.1	165.6									
E3-2			19.7	135.7	271.5	135.7								
E3-3			28.0	193.6	387.1	193.6								
E4-1					16.3	112.1	224.3	112.1						
E4-2					32.0	220.7	441.4	220.7						
E4-3						21.2	146.1	292.2	146.1					
E5-1							16.4	113.2	226.4	113.2				
E5-2								16.4	113.0	226.1	113.0			
E6								19.6	135.5	271.0	135.5			
E7-1										36.5	252.1	504.2	252.1	
E8-1											17.6	121.7	243.3	121.7
E8-2											29.0	13.5	27.1	13.5
E9											11.8	81.7	163.4	81.7
E11											9.8	67.9	135.7	67.9
Interchange														
IC1								11.4	157.5	157.5				
IC2										10.5	144.5	144.5		
IC3						6.8	93.9	93.9						
IC4												2.0	27.2	27.2
IC6									5.0	69.1	69.1			
IC8				5.6	77.3	77.3								
IC9												6.3	87.7	87.7
IC10												7.7	105.9	105.9
Implementation Schedule	0	43.8	453.2	862.3	949.7	767.4	922.0	879.5	783.5	883.9	782.4	949.4	1,042.3	505.4

Design Construction

Table 9.4-2 Investment Cost Estimation (LE Million)

	Length (Km)	Detailed Design	Land Acquisition	Construction	Total
Urban Expressway					
E1 & E2	20.9	15.8	0.0	436.3	452.1
E3	19.5	75.7	2.6	1,976.7	2,055.0
E4	17.5	69.5	0.0	1,915.6	1,985.1
E5	11.0	32.8	1.8	903.1	937.7
E6	14.3	19.6	3.0	539.0	561.6
E7	1.0	36.5	5.6	1,002.8	1,044.9
E8	4.7	46.6	0.0	540.7	587.3
E9	4.0	11.9	0.0	326.7	338.6
E11	3.1	9.8	3.4	268.0	281.2
Interchanges	0	55.3	0.0	1,526.0	1,581.3
Total	99.2	373.5	16.4	9,434.9	9,824.8

Note: Length of E1 and E2 includes the existing expressway sections

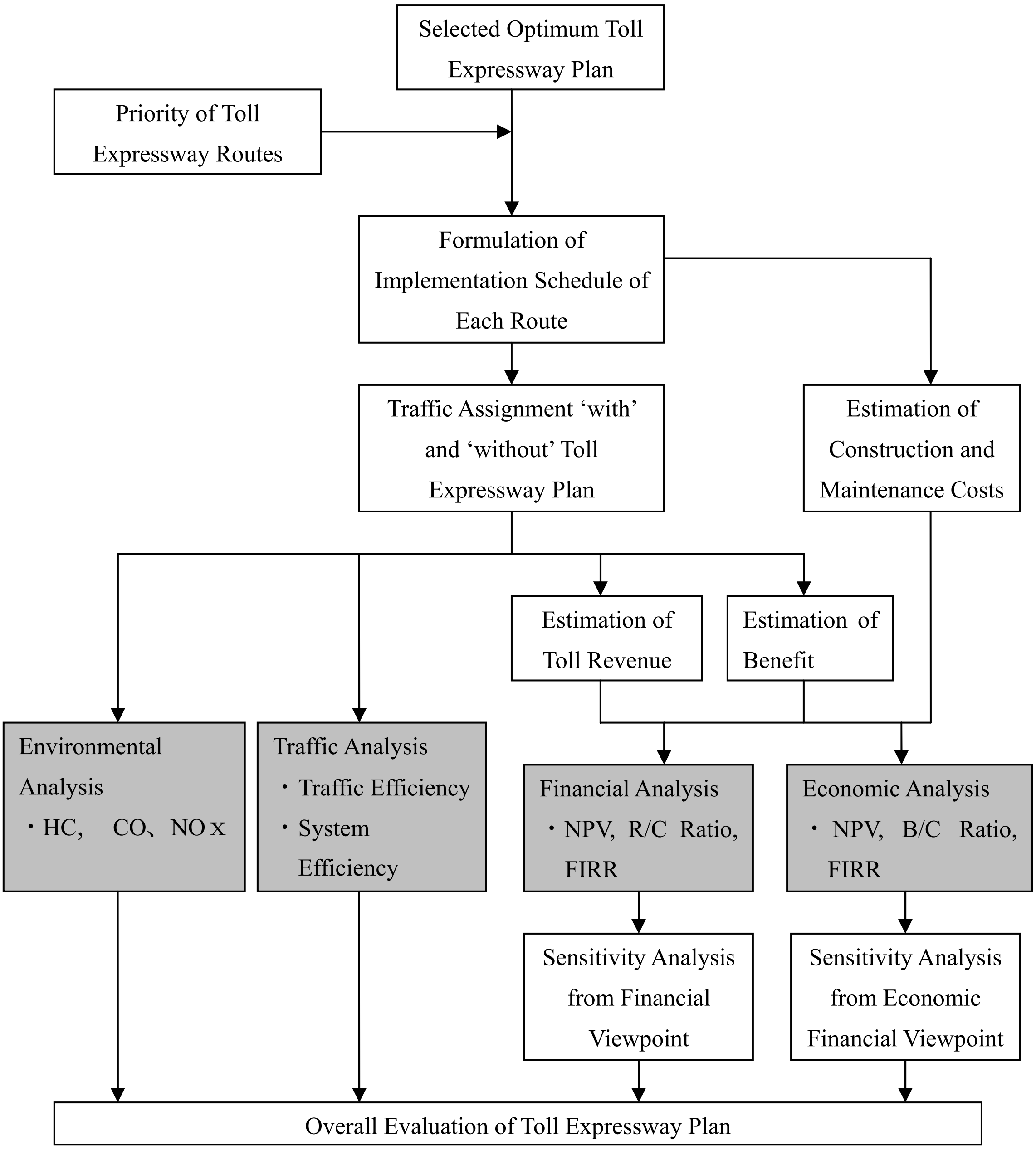

Figure 9.4-1 Procedure for Plan Evaluation

(3) Evaluation Factors

The Cairo Toll Expressway Network Development Plan is evaluated based on the following factors;

1) Improvement of traffic efficiency
   - Average Travel Speed

- Average VCR
2) Improvement of system efficiency
   - Total PCU-km
   - Total PCU-hour
3) Financial Viability
   - Toll Revenue
   - NPV, Revenue/Cost Ratio, and FIRR
4) Economic viability
   - Vehicle Operating Cost (VOC) including Travel Time Cost
   - NPV, B/C Ratio, and EIRR
5) Environmental impacts in terms of air pollution
   - Air pollution of HC, CO and NOx

9.4.3 Traffic Analysis

(1) Traffic Demand Forecast

Traffic assignment is again carried out for the target year 2022 and its results are presented in Figures 9.4-2.

(2) Traffic Efficiency

The traffic system performance of the Expressway Plan is assessed as shown in Table 9.4-3. From that table, the following is noted:

a) Through the Expressway Plan, average travel speed in the whole network in 2012 will increase by about 1% and will further increase to 4% in 2022. On the same manner, average travel speed on the Expressway Network in 2012 and 2022 will increase by about 23% and 17% respectively. These figures demonstrate that the Expressway Plan will bring improved travel speed both on the whole network of Cairo as well as on the expressway.

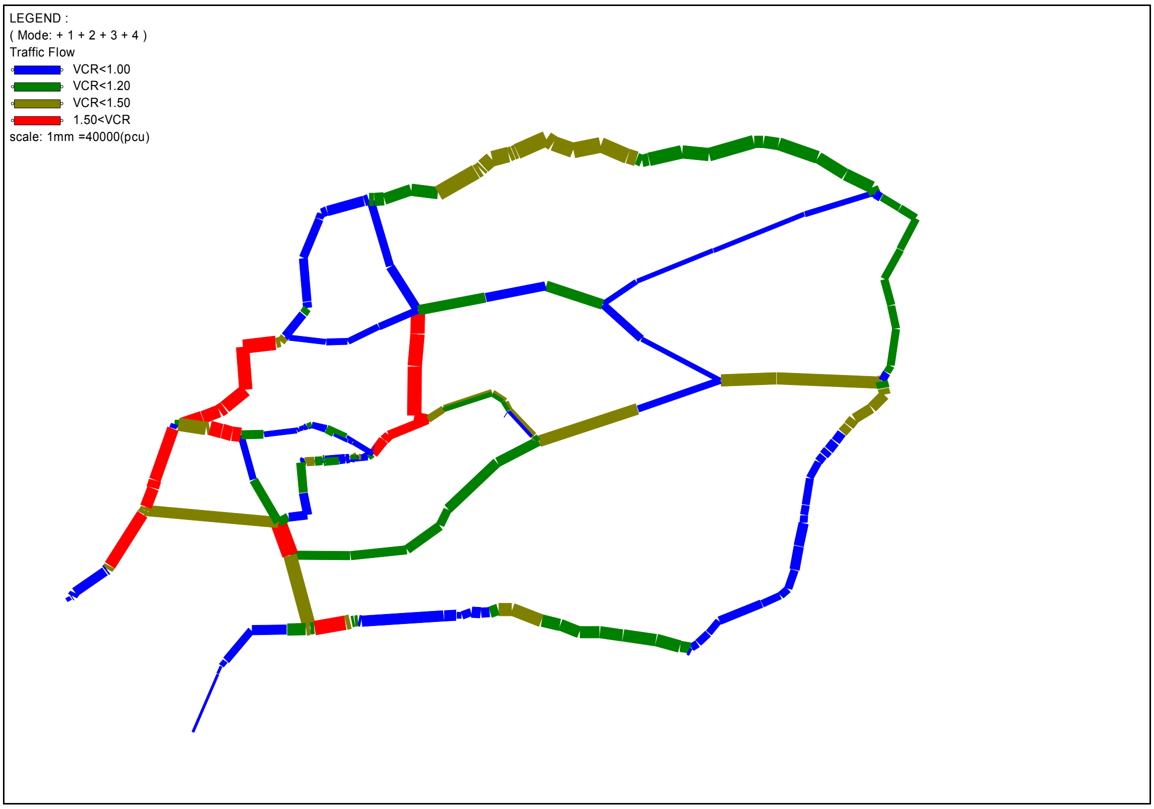

Figure 9.4-2 Assigned Traffic Volumes on Toll Expressway Network in 2022 – Scenario 4

b) Average congestion degree (VCR) of the whole road network in the Study Area is expected to decrease about 3% in 2012 and 15% in 2020 through the Expressway Plan. On the other hand, VCR of the expressway is expected to decrease about 14% in 2012 and 8% in 2020. These numbers show that the Expressway Plan will also contribute to decrease traffic congestion on the whole network of Cairo as well as on the expressway.

Table 9.4-3 Travel Speed and Traffic Congestion with and without Expressway Plan

			2005	2012	2022
Whole Road Network	Average Travel Speed (km/hour)	W/O Expressway (A)	17.7	15.3	12.2
		With Expressway (B)	17.7	15.4	12.7
		B/A	1.00	1.01	1.04
	Average V/C Ratio	W/O Expressway (A)	0.89	0.99	1.53
		With Expressway (B)	0.89	0.96	1.46
		B/A	1.00	0.97	0.95
Expressway Network	Average Travel Speed (km/hour)	W/O Expressway (A)	19.9	39.7	21.5
		With Expressway (B)	19.9	48.7	25.2
		B/A	1.00	1.23	1.17
	Average V/C Ratio	W/O Expressway (A)	1.25	0.66	1.17
		With Expressway (B)	1.25	0.57	1.08
		B/A	1.00	0.86	0.92

Another method to assess the efficiency of the road network is through the measurement of change of the PCU-km and PCU-hr of vehicles. Values of these two indicators are shown in Table 9.4-4 and the following observations are made:

a) The PCU-km in the Study Area will decrease by 0.2% in 2012 and by 2.2% in 2020. Decrease of PCU-km is more drastic on the expressway that recorded at 9% in 2012 and 16.2% in 2020. These records show that the Expressway Plan will contribute to decrease the vehicle-km on the road network of Cairo as well as that on expressway.

b) The PCU-hour in the Study Area will decrease by 1% in 2012 and by 6% in 2020. On the other hand, decrease of PCU-km on the expressway is higher that was observed at 9% in 2012 and 16% in 2020. These figures show that the Expressway Plan will contribute to decrease the vehicle-hour on the road network of Cairo as well as that on expressway.

Table 9.4-4 PCU-Kilometer and PCU-Hour with and without Expressway Plan

			2005 (Base Year)	2012	2022
Road Network	PCU –Kilometer ('000)	W/O Expressway (A)	70,689	97,438	151,007
		With Expressway (B)	70,689	96,675	147,635
		B/A	1.00	0.992	0.978
	PCU –Hour ('000)	W/O Expressway (A)	3,996	6,328	12,357
		With Expressway (B)	3,996	6,267	11,592
		B/A	1.00	0.990	0.94
Expressway Network	PCU –Kilometer ('000)	W/O Expressway (A)	2,262	11,159	18,104
		With Expressway (B)	2,262	10,188	21,031
		B/A	1.00	0.913	1.162
	PCU –Hour ('000)	W/O Expressway (A)	114	281	842
		With Expressway (B)	114	209	836
		B/A	1.00	0.744	0.993

9.4.4 Financial Analysis

(1) Estimation of Users and Revenue

The Expressway and Cairo Ring Road users are forecasted by applying the same diversion model mentioned in Section 9.2.3. The results are shown in Figures 9.4-3 and 9.4-4. Using the unit toll rate and number of vehicles, annual revenues from the Expressway and Cairo Ring Road are estimated and shown in Table 9.4-5.

Table 9.4-5 Estimation of Annual Revenue

	Daily Users			Annual Revenue (LE Million)		
	Expressway	Ring Road	Total	Expressway	Ring Road	Total
2012	136.6	121.5	258.1	183,096	162,853	345,949
2022	1,462.3	461.7	1,924.0	784,302	247,623	1,031,925
2032	2,382.0	811.4	3,193.4	1,277,545	435,159	1,712,704
2042	3,049.1	1,079.9	4,129.0	1,635,366	579,164	2,214,530

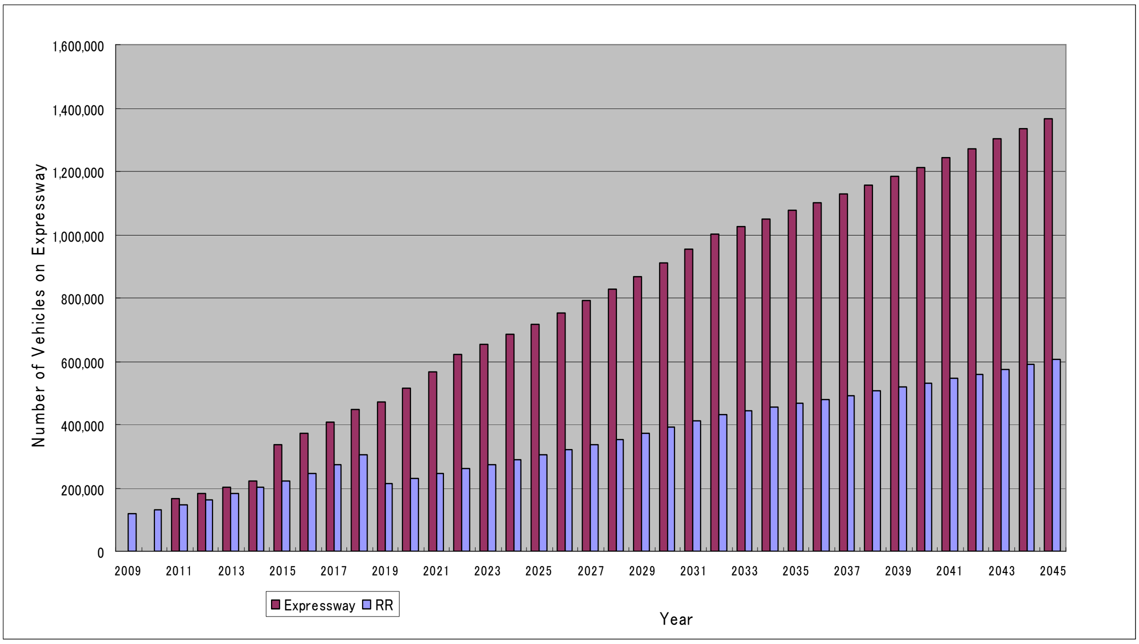

Figure 9.4-3 Forecast Number of Daily Users of Expressway per Year

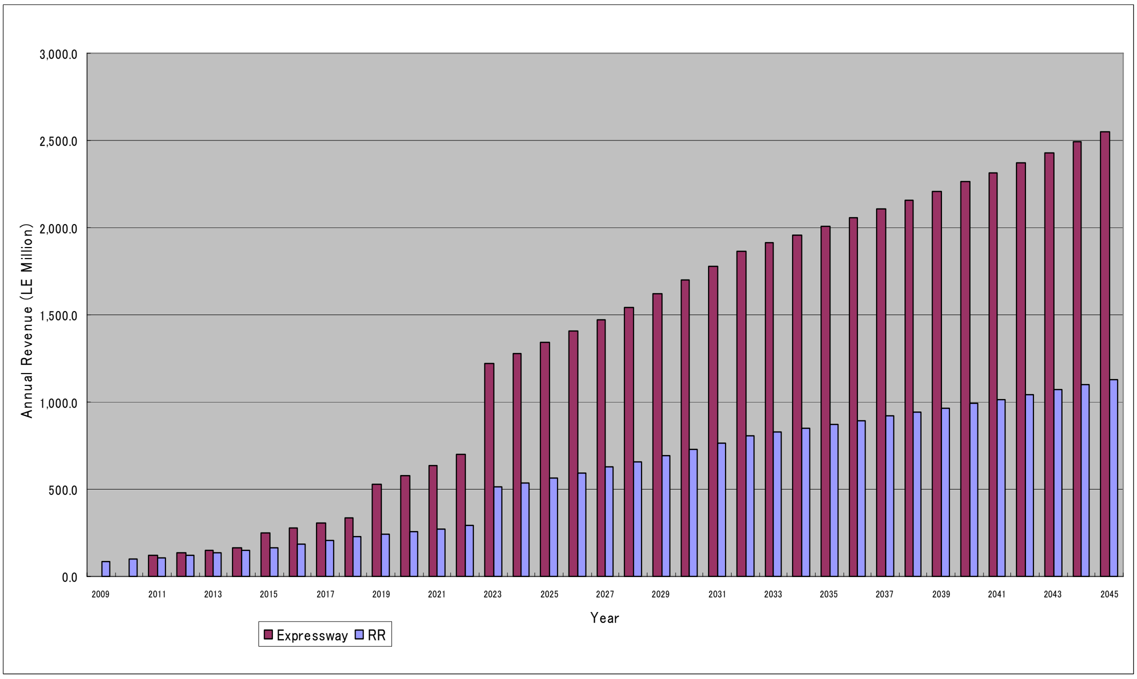

Figure 9.4-4 Forecast Annul Revenue of Expressway per Year

(2) Financial Analysis

Based on the above mentioned input data, the financial analysis of Scenario 4 is calculated and presented in Table 9.4-6. From the table, it is seen that the Scenario 4 is financially viable.

Table 9.4-6 Result of Financial Analysis

Indicators	Value
Construction Cost (LE Million)	9,825.0
Revenue 2012-2045 (LE Million)	86,195.0
Revenue / Const. Cost	8.8
FIRR (%)	17.2

Note: Evaluation period is assumed to be 30 years.

(4) Sensitivity Analysis

The sensitivity analysis is carried out taking into account various factors that influenced the financial viability. The factors considered are:

- Toll revenue from expressway
- Construction cost
- Construction period
- Traffic growth rate after 2022
- Applied toll rate

The sensitivity result of each factor is described below.

1) Changes in Toll Revenue and Construction Cost

One of the sensitivity analyses is conducted under a worse case scenario incorporating increase and/or decrease of the estimation of costs and revenue. Table 5.4-7 shows the results of the sensitivity analysis.

Table 9.4-7 Result of Sensitivity Analysis of Costs and Revenues

		Indicators	Revenue		
			0.8	1.0	1.2
Cost	0.8	Revenue-Cost Ratio	1.41	1.77	2.12
		FIRR (%)	17.20	21.40	26.00
	1.0	Revenue-Cost Ratio	1.13	1.41	1.70
		FIRR (%)	13.70	17.20	21.70
	1.2	Revenue-Cost Ratio	0.94	1.18	1.41
		FIRR (%)	11.20	14.30	17.20

Notes: Evaluation period is 30 years

Figure 9.4-5 shows also the results of sensitivity analysis of the project costs and revenues. It is observed that the marginal revenue is at 83% of the original revenue in case of 20 % increase in the original project cost. On the other hand, marginal revenue is at 55% of the original revenue in case of 20% decrease in the original cost.

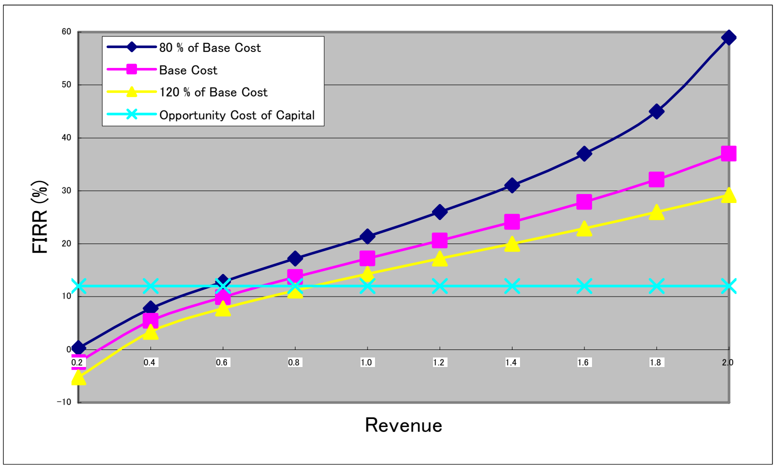

Figure 9.4-5 Relationship between Project Cost and Revenue

2) Completion Period of Expressway Network

In the financial analysis, it was presumed that all Expressway networks will be completed by the year 2022 which principally followed the recommendations made by the CREATS Report. However, realization of this presumption, that is completion of all routes of Expressway in the year 2022, might be difficult. This is due to required huge amount of construction cost and financial burden to the Egyptian Government although the Expressway project will be implemented by the PPP scheme. One of the measures to mitigate this problem is to extend the completion period from the year 2022 to the year 2032. This means the project has to be extended for 10 more years.

The results of the sensitivity analysis are shown in Table 9.4-8. Based on the results, it can be said extending the completion of the project to 10 years is more viable than the original plan. This means that extending the implementation period of the Expressway project is suggested from financial viewpoint.

Table 9.4-8 Result of Sensitivity Analysis of Financial Viability by Completion Period

Case	Scenario	Description	Construction Cost (LE Million)	Revenue 2012-2045 (LE Million)	Revenue/ Const. Cost	FIRR (%)
1	Scenario 4 (Original)	E1&E2, RR included for Toll, **all routes completed in 2022**	4,936	6,979	1.41	17.2
2	Scenario 4 (Alt. Case)	E1&E2, RR included for Toll, **all routes completed in 2032**	3,124	5,439	1.74	27.8

Notes: Evaluation period is 30 years

3) Changes in Growth Rate

The growth rate of the Expressway users is calculated and shown in Table 9.4-9. The AAGR between 2012 and 2022 is extremely high (22.3 %). This is due to the expansion of the Expressway network from 5.0 km to 90 km. When the growth rate is either increased or decreased as shown in Table 9.4-9, the corresponding results of the sensitivity analysis regarding to the growth rates are shown in Table 9.4-10. Figure 9.4-6 shows the relationship between FIRR and users' growth rate for Scenario 4.

Table 9.4-9 Alternative Average Annual Growth Rates (AAGR) of Traffic Volume

	2012-2022	2023-2032	2033-2045
80 % of Original Growth Rate	17.8%	4.2%	2.1%
Original Growth Rate	22.3%	5.2%	2.6%
120 % of Original Growth Rate	26.8%	6.2%	3.1%

Table 9.4-10 Results of Sensitivity Analysis for Alternative Traffic Volumes' AAGR

	NPV (LE Million)	Revenue-Cost Ratio	FIRR (%)
80 % of Original Growth Rate	175	1.04	12.5
Original Growth Rate	1,985	1.40	16.9
120 % of Original Growth Rate	4,416	1.85	21.1

Notes: Evaluation period is 30 years.

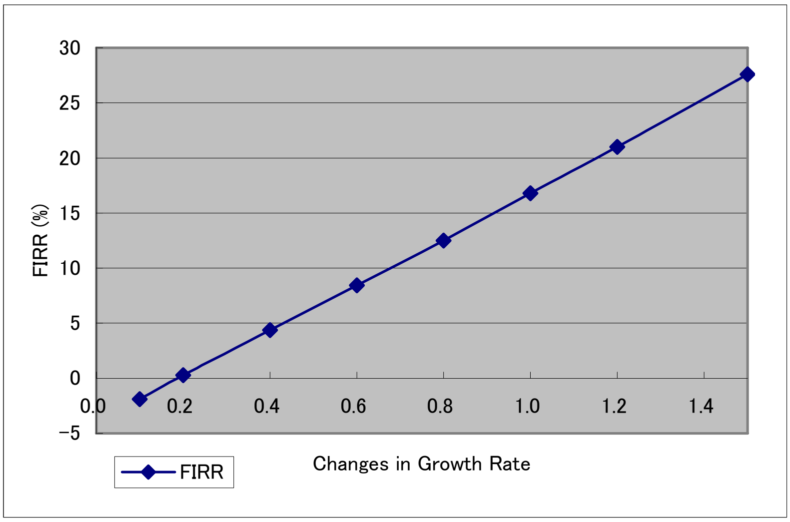

Figure 9.4-6 Relationship between Growth Rate and FIRR under Scenario 4

4) Change in Toll Rate

It is sometimes observed in some countries that the toll rate on the expressway is difficult to increase due to political and social considerations. In the sensitivity analysis, alternative toll rate is provided as shown in Table 9.4-11.

Table 9.4-11 Alternative Toll Rate

	Original Toll Rate		Alternative Toll Rate	
	Light Vehicle	Heavy Vehicle	Light Vehicle	Heavy Vehicle
2012 – 2015	2	4	2	4
2016 – 2018	3	6	2	4
2019 – 2022	5	10	2	4
2023 -	5	10	4	8

If the toll rate will not be changed as scheduled, NPV will decrease from LE 2,043 million in the original plan to LE 485 million in the alternative toll as observed in Table 9.4-12. This will largely affect the cash flow of the company.

Table 9.4-12 Results of Sensitivity Analysis of the Alternative Toll Rate

Case	Scenario	Description	Project Cost (LE Million)	Revenue 2012-2045 (LE Million)	Revenue/ Const. Cost	FIRR (%)
1	Scenario 4 (Original)	Original Toll Rate	4,936	6,979	1.41	17.2
2	Scenario 4 (Alt. Case)	Alternative Toll Rate	4,763	5,248	1.10	13.3

Notes: Evaluation period is 30 years.

9.4.5 Economic Analysis

(1) Economic Parameters

1) Estimation of Benefits

Using the unit vehicle operating cost and time cost presented in Chapter 9.3, and traffic assignment results, the vehicle operating cost consisting of the running cost and fixed cost and travel time cost is estimated and is shown in Table 9.4-13. The benefits are estimated as differences of these VOCs with and without Master Plan.

Table 9.4-13 Estimation of Benefits Unit: (LE‘000 /Day)

	2012			2022		
	Saving in VOC	Saving in TTC	Total	Saving in VOC	Saving in TTC	Total
E1+E2	329.0	525.7	854.7	596.8	1,247.6	1,844.4
E1+E2+E3	384.6	554.1	938.7	697.7	1,315.0	2,012.7
E1+E2+E3+E4	391.1	625.8	1,017.0	709.5	1,485.3	2,194.8
All Routes	474.1	894.4	1,368.4	860.0	2,122.6	2,982.5

2) Estimation of Economic Costs

The project cost, which was already calculated in the previous section, is expressed as the financial cost. It is therefore to convert from financial cost to economic cost. In this study the economic cost was estimated to deduct from financial cost to government taxes and import duty is shown in Table 9.4-14.

Table 9.4-14 Economic Cost Estimate

Case	Route	Length (Km)	Financial Cost (LE ‘000)	Economic Cost (LE’ 000)
1	E1+E2	20.9	452.1	368.4
2	E1+E2+E3	40.4	2,507.1	2,039.1
3	E1+E2+E3+E4	38.4	2,437.2	1,982.6
4	All Routes	99.2	9,824.8	7,991.3

(3) Maintenance Cost

The maintenance cost, which was already calculated in the previous section, is also expressed as the financial cost. It is therefore merely converted from financial maintenance cost to economic one.

(4) Economic Parameters

Based on the above mentioned benefits and costs estimation, the economic analysis of the Expressway Plan is made as presented in Table 9.4-15. Table 9.4-16 shows the benefit – cost analysis of the Expressway Plan during project life period of 30 years. The results of the economic analysis show that a Net Present Value (NPV) of LE 7,846 million and BCR of 2.96 over 30 years life of the Expressway Plan using a discount rate of 12.0 % which is designated by the Ministry of Planning of Egypt. The Economic Internal Rate of Return (EIRR) was compiled at 38.78 %.

(5) Sensitivity Analysis

The sensitivity analysis is conducted under a worse case scenario incorporating increase and/or decrease of the estimation of costs and benefits. Table 9.4-17 shows the results of the sensitivity analysis.

Table 9.4-15 Benefit Cost Stream of Cairo Toll Expressway Project

LE Million

SQ	Year	Construction Cost	Maintenance Cost	Operation Cost	S-Total	Benefit	Net Benefit Flow	Discount Cash Flow(at 10%)		
								Out-Flow	In-Flow	Net
1	2007	0.0			0.0		0.0	0.0	0.0	0.0
2	2008	0.0			0.0		0.0	0.0	0.0	0.0
3	2009	35.6			35.6		-35.6	29.4	0.0	-29.4
4	2010	368.5			368.5		-368.5	276.8	0.0	-276.8
5	2011	701.0			701.0		-701.0	478.8	0.0	-478.8
6	2012	772.1	11.1	22.1	805.3	854.7	49.4	500.0	530.7	30.7
7	2013	623.9	18.8	37.5	680.2	968.5	288.2	384.0	546.7	162.7
8	2014	749.6	25.0	50.0	824.6	1,097.4	272.8	423.2	563.1	140.0
9	2015	715.0	32.5	65.0	812.6	1,243.5	430.9	379.1	580.1	201.0
10	2016	637.0	39.7	79.3	756.0	1,409.0	653.0	320.6	597.6	277.0
11	2017	718.6	46.0	92.1	856.7	1,596.6	739.9	330.3	615.6	285.3
12	2018	636.1	53.2	106.4	795.7	1,809.1	1,013.4	278.9	634.1	355.2
13	2019	771.9	59.6	119.1	950.6	2,050.0	1,099.4	302.9	653.2	350.3
14	2020	847.4	67.3	134.6	1,049.3	2,322.9	1,273.6	303.9	672.9	368.9
15	2021	410.9	75.8	151.5	638.2	2,632.1	1,993.9	168.1	693.1	525.1
16	2022	0	79.9	159.8	239.6	2,982.5	2,742.9	57.4	714.0	656.6
17	2023	0	79.9	159.8	239.6	3,181.0	2,941.4	52.1	692.3	640.1
18	2024	0	79.9	159.8	239.6	3,392.8	3,153.2	47.4	671.2	623.8
19	2025	0	79.9	159.8	239.6	3,618.6	3,379.0	43.1	650.8	607.7
20	2026	0	79.9	159.8	239.6	3,859.5	3,619.9	39.2	631.1	591.9
21	2027	0	79.9	159.8	239.6	4,116.4	3,876.8	35.6	611.9	576.3
22	2028	0	79.9	159.8	239.6	4,390.4	4,150.8	32.4	593.3	560.9
23	2029	0	79.9	159.8	239.6	4,682.6	4,443.0	29.4	575.2	545.8
24	2030	0	79.9	159.8	239.6	4,994.3	4,754.7	26.8	557.8	531.0
25	2031	0	79.9	159.8	239.6	5,326.8	5,087.1	24.3	540.8	516.5
26	2032	0	79.9	159.8	239.6	5,504.0	5,264.4	22.1	508.0	485.9
27	2033	0	79.9	159.8	239.6	5,687.2	5,447.6	20.1	477.2	457.1
28	2034	0	79.9	159.8	239.6	5,876.5	5,636.9	18.3	448.2	430.0
29	2035	0	79.9	159.8	239.6	6,072.1	5,832.5	16.6	421.1	404.4
30	2036	0	79.9	159.8	239.6	6,274.2	6,034.5	15.1	395.5	380.4
31	2037	0	79.9	159.8	239.6	6,483.0	6,243.4	13.7	371.5	357.8
32	2038	0	79.9	159.8	239.6	6,698.8	6,459.1	12.5	349.0	336.5
33	2039	0	79.9	159.8	239.6	6,921.7	6,682.1	11.3	327.8	316.5
34	2040	0	79.9	159.8	239.6	7,152.1	6,912.4	10.3	307.9	297.6
35	2041	0	79.9	159.8	239.6	7,390.1	7,150.5	9.4	289.3	279.9
Total		7,987.6	2,026.4	4,052.8	14,066.7	120,588.3	106,521.5	4,713.2	16,220.9	11,507.7

EIRR(%)	38.78
B/C	3.44
NPV(Mill.LE	11,508

Table 9.4-16 Economic Parameters

Economic Parameter	Results
Net Present Value (LE Million)	11,508
BCR	3.44
EIRR (%)	38.78 %

Notes: 1) Project life is assumed to be 30 years
2) Discount rate is assumed to be 10.0%

Table 9.4-17 Sensitivity Analysis for Cost and Benefits of Expressway Network

Item			Benefits		
			20% down	Base Case	20% up
Costs	20% down	NPV (LE Million)	9,206	12,450	15,695
		BCR	3.44	4.30	5.16
		EIRR (%)	38.8%	50.3%	61.5%
	Base Case	NPV (LE Million)	8,264	11,508	14,752
		BCR	2.75	3.44	4.13
		EIRR (%)	30.4%	38.8%	47.7%
	20% up	NPV (LE Million)	7,321	10,565	13,809
		BCR	2.29	2.87	3.44
		EIRR (%)	24.9%	31.6%	38.8%

Notes: 1) Discount rate is assumed to be 10.0 % per annum.
2) Project life of the project is assumed to be 30 years.

(6) Summary of Economic Analysis

The implementation of the Expressway Development Plan can be justified from national economic viewpoint.

9.4.6 Environmental Factors

The environmental and social impact assessment was already carried out in previous sections of the report. Among the various environmental impacts, air pollution is taken into account in both (Do Nothing and Master Plan) cases. The air pollution components of HC, CO and NOx produced by the both cases are estimated and presented in Table 9.4-18.

Table 9.4-18 Air Pollution Unit: Kg / day

Year	Air Pollutants	Do Nothing	With Project	Difference
2012	HC	24,997	24,555	442
	CO	206,666	203,017	3,649
	NOx	24,406	23,975	431
2022	HC	38,356	37,369	987
	CO	317,115	308,956	8,159
	NOx	37,450	36,486	963

9.5 HIGH PRIORITY EXPRESSWAYS

Based on the results of the prioritization criteria developed in Section 9.2, high priority expressways that should be urgently constructed in the first stage of the implementation program are as presented in Table 9.5-1.

Table 9.5-1 High Priority Expressways

Section		Location	Length (km)	Cost (mLE)	Remarks
E1-2		6th October Extension	2.1	354	El-Tahrir Street
E2-2		15th May Extension	1.2	98	Boulaq 1-way section
E3	E3-1	Autostrad El Nasr – Nasr City	6.8	690	Underpass (1,400m)
E3	E3-2	Autostrad from Nasr City to Citadel	5.8	563	Elevated Viaduct
E3	E3-3	Salah Salem from Citadel to Giza	6.9	802	Nile River Bridge (600m)
Total			22.8	2,507	@ bJP￥50/mUS$440

Results of the economic evaluation for the high priority expressways show high economic viability, especially for E1+E2 with low construction cost for only extensions, while E3 includes a relatively high cost due to the bridge over the Nile River. Table 9.5-3 shows improvement in the air quality through the daily reduction in air pollution.

Table 9.5-2 Economic Parameters of High Priority Expressways

Expressway	NPV (m LE)	B/C	EIRR %
E1 + E2	4,945	9.84	48.7
E3	3,331	2.85	20.4

Table 9.5-3 Daily Reduction in Air Pollution (kg in Year 2022)

Expressway	Veh./day	HC	CO	NOx
E1 + E2	222,217	31.2	258.0	30.5
E3	149,172	23.1	190.6	22.5

Figure 9.5-1 clarifies a location map for the three stages of project implementation in the years 2011, 2013 and 2016 in which E4 is included. In order to implement the high priority expressways, and consequently other expressways for the sustainable development of the network, an action plan for all the required tasks are presented in Figure 9.5-1. Under this plan, the establishment of a secretariat for MEA is an important task. This secretariat will function as the core of MEA and will be responsible to handle all other tasks toward the realization of the expressways. This action plan is based on utilizing ODA finance for the design and construction of selected high priority expressways in order to reduce governmental burden and to put an attractive start for private sector participation in financing following stages. With the implementation of E1-2, E2-2 and E3-1 in 2011, toll will be applied on the whole length of expressways.

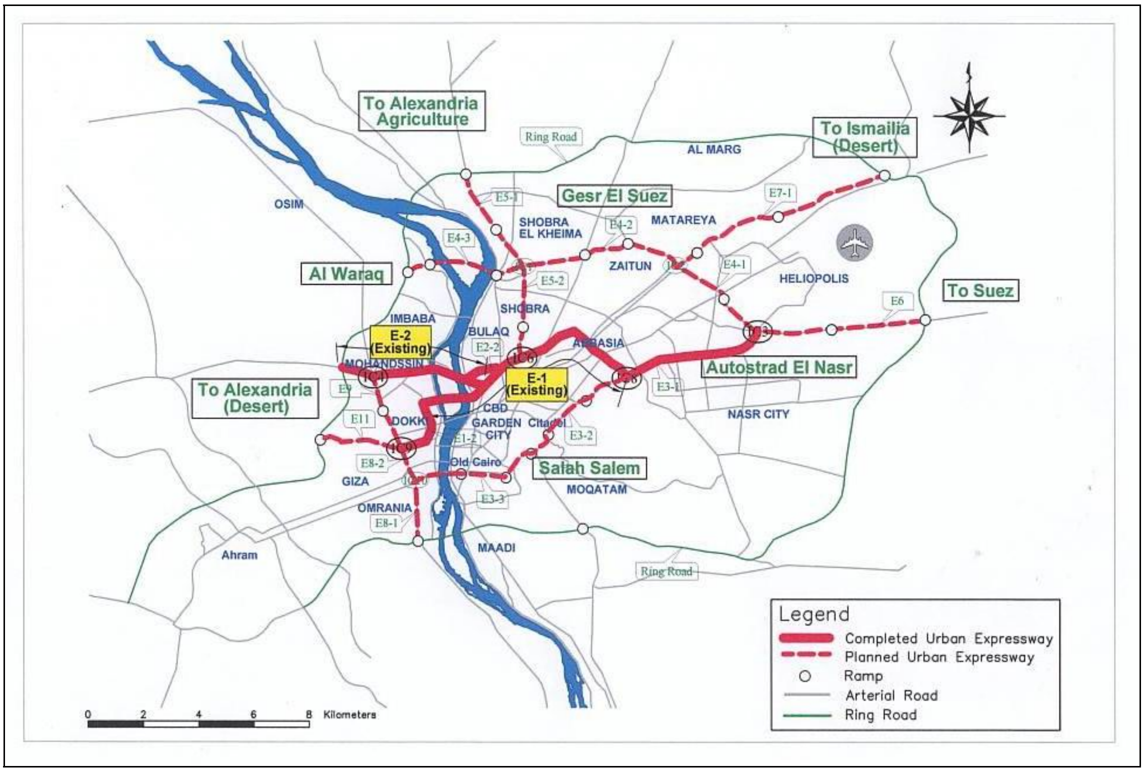

Figure 9.5-1 (1/3) Staging of High Priority Expressways - Year 2011

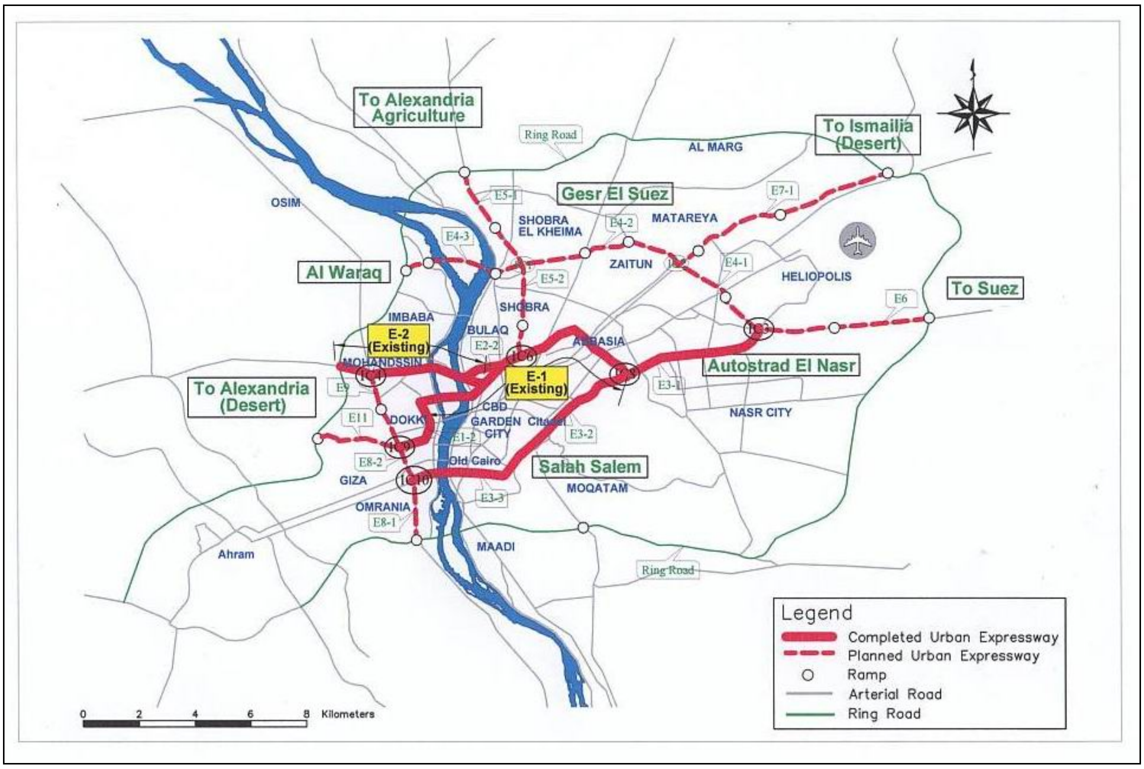

Figure 9.5-1 (2/3) Staging of High Priority Expressways - Year 2013

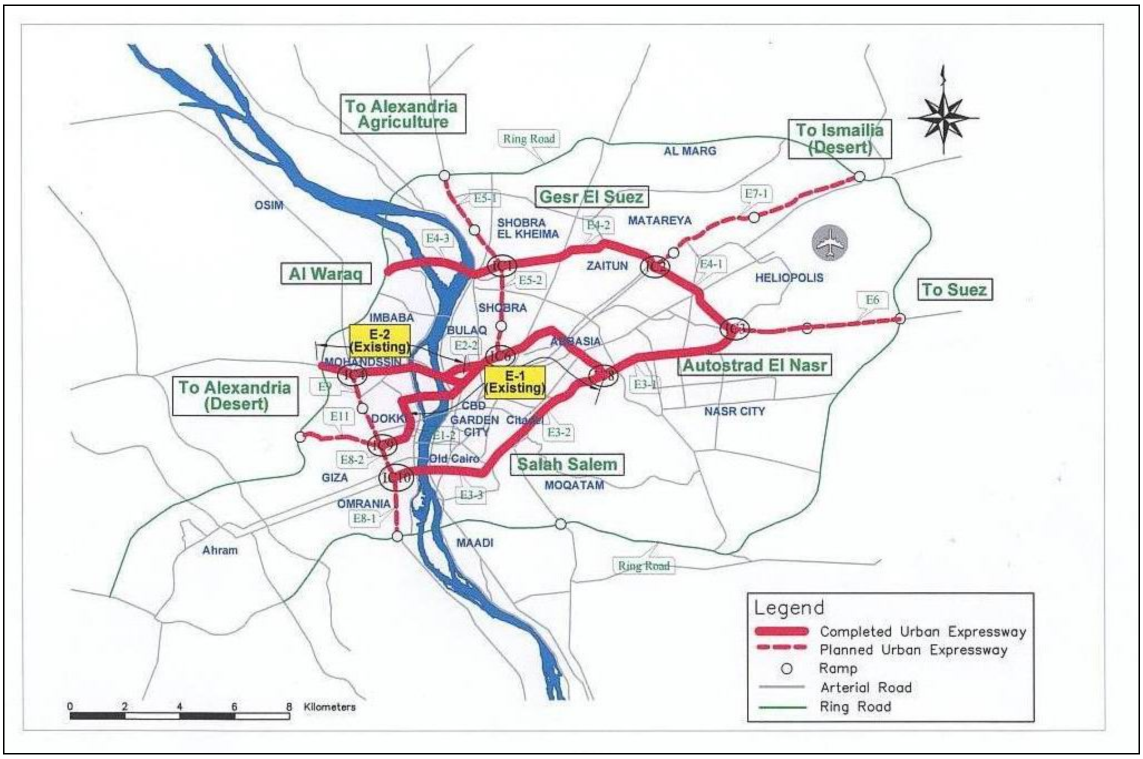

Figure 9.5-1 (3/3) Staging of High Priority Expressways - Year 2016

Table 9.5-4 Implementation Action Plan for High Priority Expressways

Major Tasks	2005				2006				2007				2008				2009				2010				Agency In-Charge
Cairo PPP Study		■	■	■	■																				JICA ST – ENIT
Route Prioritization - HPE					■																				JICA ST
MEA Secretariat						■																			MOT
Feasibility Study on HPE						■	■	■	■																MOT/ENIT/ODA
EIA on HPE							■	■	■																ENIT/GOPP/MOE
MOT Approval							■																		MOT
MEA Organization Set-up							■	■																	MOT
MOP / MOF Approval								■																	MOP/MOF
Parliament Committee Approval									■	■															MOT
Cabinet Approval											■	■													MOT
D/D Loan Preparation													■	■	■										MEA
D/D Loan Agreement																■									MEA
Consultant Selection																■									MEA
Detailed Design of HPE										■	■	■	■				■	■	■	■					ODA/MEA
Construction Loan																			■	■					MEA
Tendering																				■	■				MEA
Construction of HPE																						■	■	■	MEA/ODA
F/S on Next Routes										■	■	■	■												MEA

HPE: High Priority Expressways
JICA ST: Study Team
D/D: Detailed Design
F/S: Feasibility Study
EIA: Environmental Impact Study
MEA: Metropolitan Expressway Authority
CG: Cairo Governorate

MOT: Ministry of Transport
MOP: Ministry of Planning
MOF: Ministry of Finance
MOE: Ministry of Environment
ENIT: Egypt National Institute of Transport
GOPP: General Organization for Physical Planning
ODA: Official Development Assistance