2.6 PLANNING OF THE SELECTED OPTION

2.6.1 Future Transport Demand

(1) East Wing Passengers

A further detailed demand forecast was conducted only for the railway option 1 (R1) selected through the preceding screening process in order to formulate a planning framework of technical, engineering and operational aspects, including design criteria for track layout, stations and facilities, train operation scheme and procurements of rolling stocks. The economic analysis is also based on the newly projected demand.

The outcomes of the demand forecast elaborated in this section are not identical to those discussed in the screening process as described in Section 2.5.2, because of setting of different assumptions for the above purpose. Major difference of the assumptions between both cases is tabulated below:

	For the Screening Process	**For Elaborated Forecast**
Number of Zones	503	525
Train Speed		
Total Number of Trips in the Study Area	25.14 million	25.65 million
Train Speed	- Ain Shams-Oboor: 60km/h - Oboor-Industrial Area: 80km/h - Industrial Area-Bus Terminal: 60km/h	- Ain Shams-Oboor: 60 km/h - Oboor-Industrial Area: 80km/h - Industrial Area-Bus Terminal: 50km/h
Fare System	2007: LE0.63 + 3 P/km 2012: LE0.74 + 4 P/km 2022: LE1.00 + 5 P/km	The same fare system after verifying the optimal fare level
Headway	Every 6 minutes	Every 6 minutes

In particular, the number of traffic zones was refined for this feasibility study to be increase from 503 to 525, because of needs of more accurate projections, focusing on the Project. Related to such an increase in the number of zones, the total number of trips eventually increased from 25.14 million to 25.65 million, because intra-zonal trips among additional zones were counted.

Table 2.6.1 and Figure 2.6.1 show the forecasted daily passenger flow of the East Wing. This forecast results are based on different assumptions as described above. Therefore, it should be noted that numbers of passengers are different from Table 2.5.1, which was projected for the screening purposes.

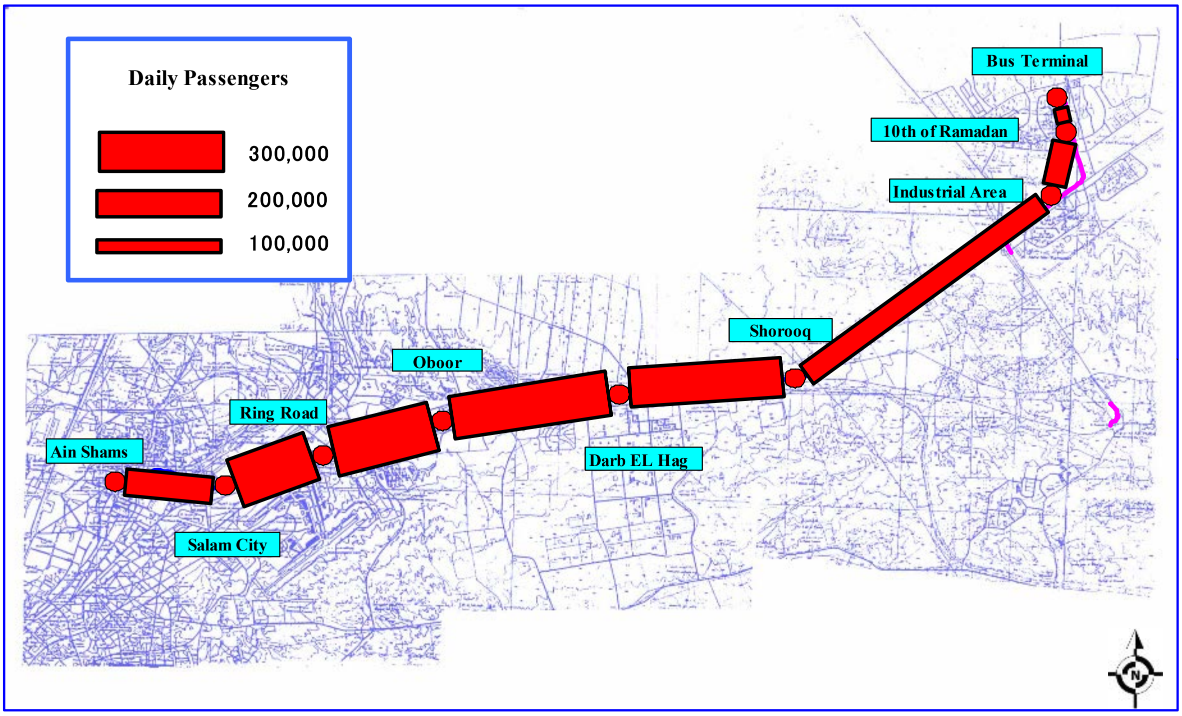
Looking into the distribution of daily passengers for both directions by section, the sections between Salam City and Shorooq shows a high passenger volume.

The highest volume is seen in the section between the Ring Road and Oboor, approximately 390,000 passengers per day for both directions. The passengers flow considerably reduces to be approximately 200,000 in the section between Salam City and Ain Shams, because passengers transfer at Salam City Station to Metro Line 3, to go to/from the central Cairo areas.

Table 2.6.1 Future Transport Demand Forecast Results (Number of Daily Passenger for Both Directions)

Section		2007	2012	2022
Ain Shams	Salam City	64,469	94,961	207,531
Salam City	Ring Road	64,469	94,961	386,796
Ring Road	Oboor	65,250	96,633	389,961
Oboor	Darb El Hag	50,903	71,802	331,107
Darb El Hag	Shorooq	47,526	67,977	300,068
Shorooq	Industrial Area	47,060	56,221	176,614
Industrial Area	10th of Ramadan	33,933	50,024	171,823
10th of Ramadan	Bus Terminal	25,851	37,496	110,685

Source: JICA Study Team



Source: JICA Study Team

Figure 2.6.1 Passenger Flow of the East Wing in 2022 (Both Directions)

Table 2.6.2 shows the projection of peak-hour passenger flow per hour and per direction between stations in 2007, 2012 and 2022. The peak ratio was assumed to be 10 % of daily traffic, based on Metro passenger information. Justification of the peak ratio is explained in Section 2.6.6.

Table 2.6.2 Peak-hour Transport Demand Forecast Results (Number of Peak-hour Passengers per Hour & per Direction)

Section		2007	2012	2022
Ain Shams	Salam City	3,223	4,748	10,377
Salam City	Ring Road	3,223	4,748	19,340
Ring Road	Oboor	3,263	4,832	19,498
Oboor	Darb El Hag	2,545	3,590	16,555
Darb El Hag	Shorooq	2,376	3,399	15,003
Shorooq	Industrial Area	2,353	2,811	8,831
Industrial Area	10th of Ramadan	1,697	2,501	8,591
10th of Ramadan	Bus Terminal	1,293	1,875	5,534

Source: JICA Study Team

(2) Metro Passenger

Metro Line 1 is even now carrying a large number of passengers. Therefore, it would be a concern if an additional large volume of passengers can be transferred to the Metro after the completion of the East Wing railway.

According to the CREATS Model, in the case of Metro Line 1, the maximum passenger flow was forecasted at 573,000 passengers per day per direction in the section between Demerdash and Ghamra in 2022. The hourly volume would be less than 60,000 per direction. This volume will be able to be carried by modern railway trains, given appropriate improvement measures for the capacity enhancement, for example, by increasing the number of cars per train.

As for Metro Line 3, it was confirmed that Metro Line 3 will take one third of passengers from the East Wing railway to the city center after the opening of the line. The maximum passenger flow per section was forecast as 537,000 per day and per direction in the section between Maspero and Naser. This volume is less than that of Metro Line 1, which means Metro Line 3 could accommodate passengers, given an appropriate measure.

2.6.2 Design Criteria

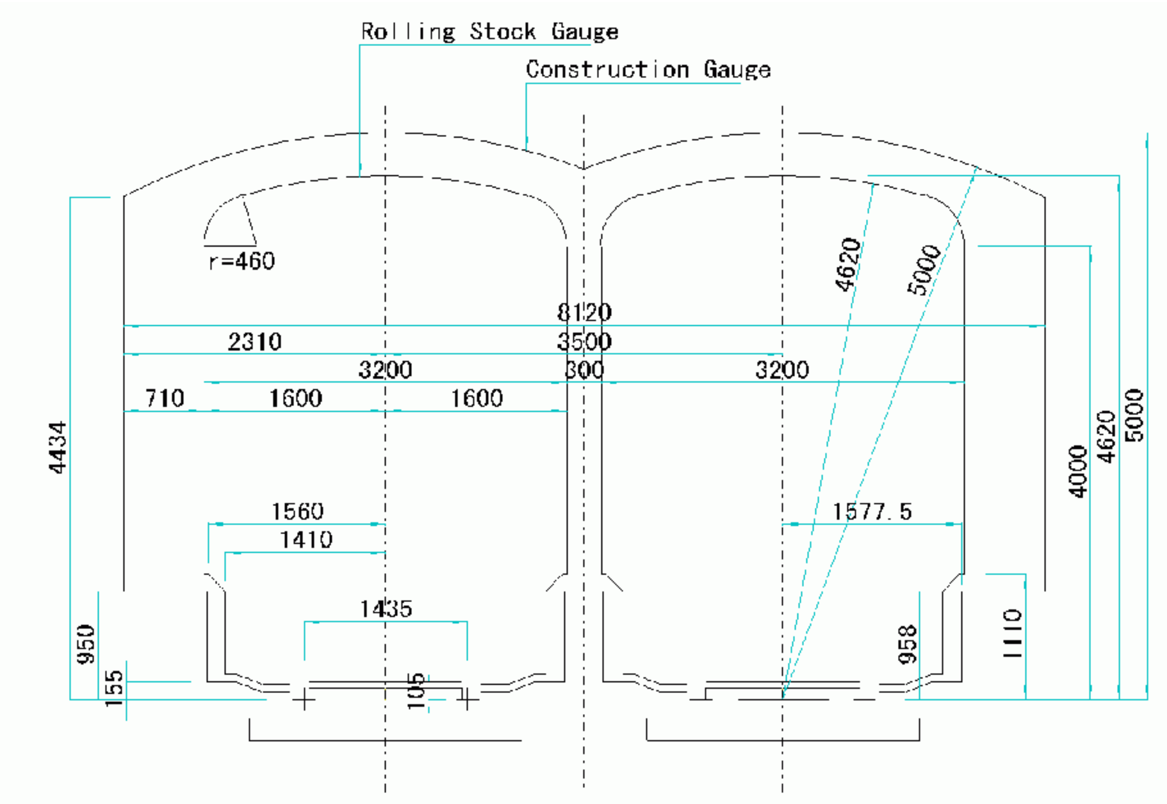
Since Option 1 (R1) was selected from the six options of the East Wing public transport development, the Study Team proceeds to the technical and engineering planning for Option 1, which is both the rehabilitation of the existing ENR Suez line and a new line construction to connect the 10^{th} of Ramadan City with the existing ENR line.

In this section, the design criteria for Option 1 are examined. Table 2.6.3 shows a summary of the proposed specifications of the Option 1 plan, and the proposed construction gauge and rolling stock gauge are as illustrated on Figure 2.6.2.

Table 2.6.3 Specification

Item	Project specifacation
Gauge	1435 mm
Horizontal Curvature Between Station On station platform Depot/Workshop connections	 Desirable 400m or more Minimum 300m Minimum 500m Minimum 200m or more
Gradient Maximum track gradient on Diesel car	 3% Compensated
Vertical Curves Radius	 Minimum 4000m
Rail size	UIC 54.0kg/m L=25m
Sleeper	PC Sleeper or Wood
Ballast depth (under the sleeper)	Crushed stone Minimum 250mm or more
Bank slope gradient	1:1.5
Formation width	10.65m
Ballast width	7.00m
Design Speed	Max. Speed 100 km/h
Power supply system	Diesel Electrical engine

Source: JICA Study Team



Source: JICA Study Team

Figure 2.6.2 Construction Gauge and Rolling Stock Gauge

(3) Track Gauge

ENR currently uses the standard gauge. The recommended standard track gauge is 1.435 mm the same as the existing gauge. The gauge is measured between running faces of rails at 14 mm below the top of the rails. At curved sections and turnout sections, no gauge widening is applied.

Curves will be designed with a curvature of at least 300 m in radius to meet the requirements of future train operating speed. The maximum rail gradient will be 30/1000.

(4) Rail

The rail shall be either of the UIC 60 (60 kg/m) or UIC 54 (54 kg/m) profile. Insulated joints shall be provided for the signaling system. The UIC standard rails are highly reliable and have been widely used in railways all over the world. The rails will be delivered in lengths of 25 m per unit as a maximum.

(5) Sleepers

Standard concrete pre-stressed mono-bloc sleepers are proposed. Alternatively post-tensioned concrete sleepers can be used subject to the preference of ENR. Special considerations should be given to the effective fixation of the guard rails.

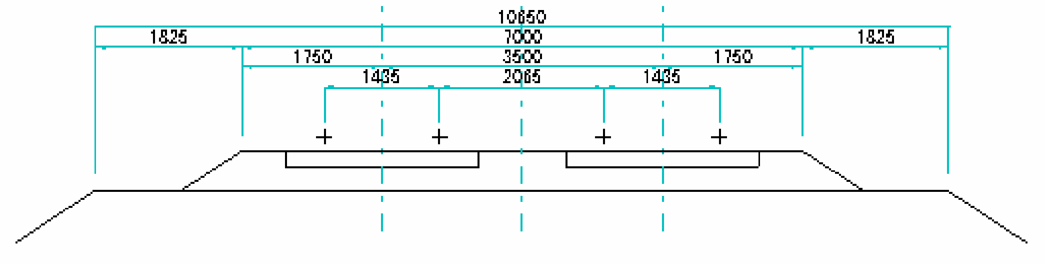
The length of sleepers is approximately 2,400 mm long. The width of the sleepers at the base is approximately 200 mm. The space between sleepers on the main line shall be 60 cm, while it shall be 70 cm in the depot.

Sleepers for turnouts and sections within 20 m of the turnouts (rail without inclination) shall be made from concrete or vacuum treated hard wood.

(6) Ballast

ENR currently use limestone and granite ballast. New ballast shall be crushed stone extracted from non-friable unweathered igneous or metamorphic rock, i.e., granite. It is desirable that the road bed ballast be replaced with crushed stone and that materials be screened if gravel from rivers is used. For the materials, the LA abrasion test should be applied with the internationally acknowledged criteria.

The design thickness of ballast will be 25 cm under the sleepers (Figure 2.6.3). The ballast shall be angular in shape with all dimensions nearly equal and free of dust and deleterious substances.



Source: JICA Study Team

Figure 2.6.3 Standard of Trackwork

2.6.3 Track Layout

The selected Option 1 starts from the existing the ENR Ain Shams Station and terminates at the Bus Terminal in the 10th of Ramadan City. The whole section between the terminals shall be double track because the Option 1 line is expected to be a commuter line for residents of Cairo and the new communities along the line.

The existing ENR Suez line should be utilized between Ain Shams Station and Shorooq Station, with a necessary rehabilitation for the commuter train operation. From Shorooq Station, the new line is separated from the Suez line and overpass the Ismailia Desert Road and reaches to the 10th of Ramadan City, passing new stations of "Industrial Area Station", "10th of Ramadan Station" and "Bus Terminal Station" along the north side of the road. This section between Shorooq and the Bus Terminal needs to be newly constructed with a total route length of about 49 km. The proposed outline track layout and the profile of Option 1 are shown in Figures 2.6.4 and 2.6.5 respectively. In this corridor five (5) stations be newly constructed and four (4) existing stations be rehabilitated/improved, which is further explained in the next section.

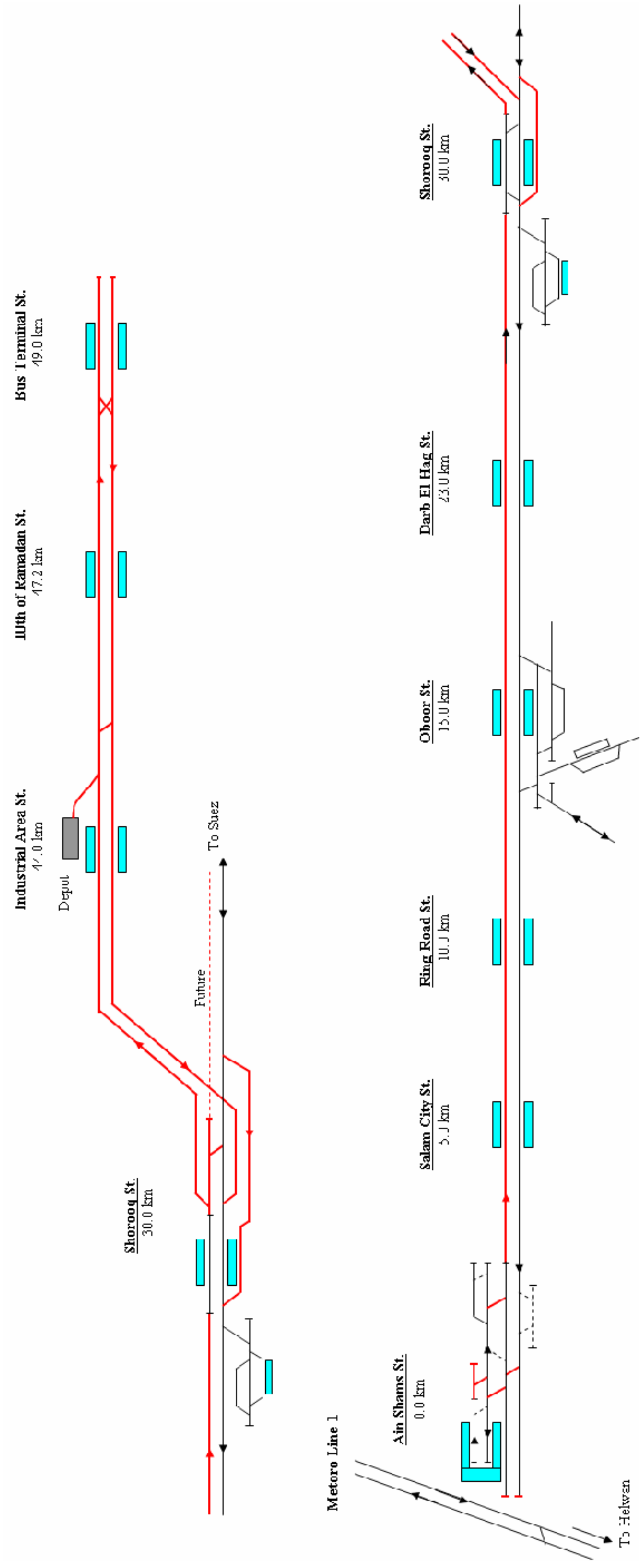


Figure 2.6.4 Outline of Track Layout

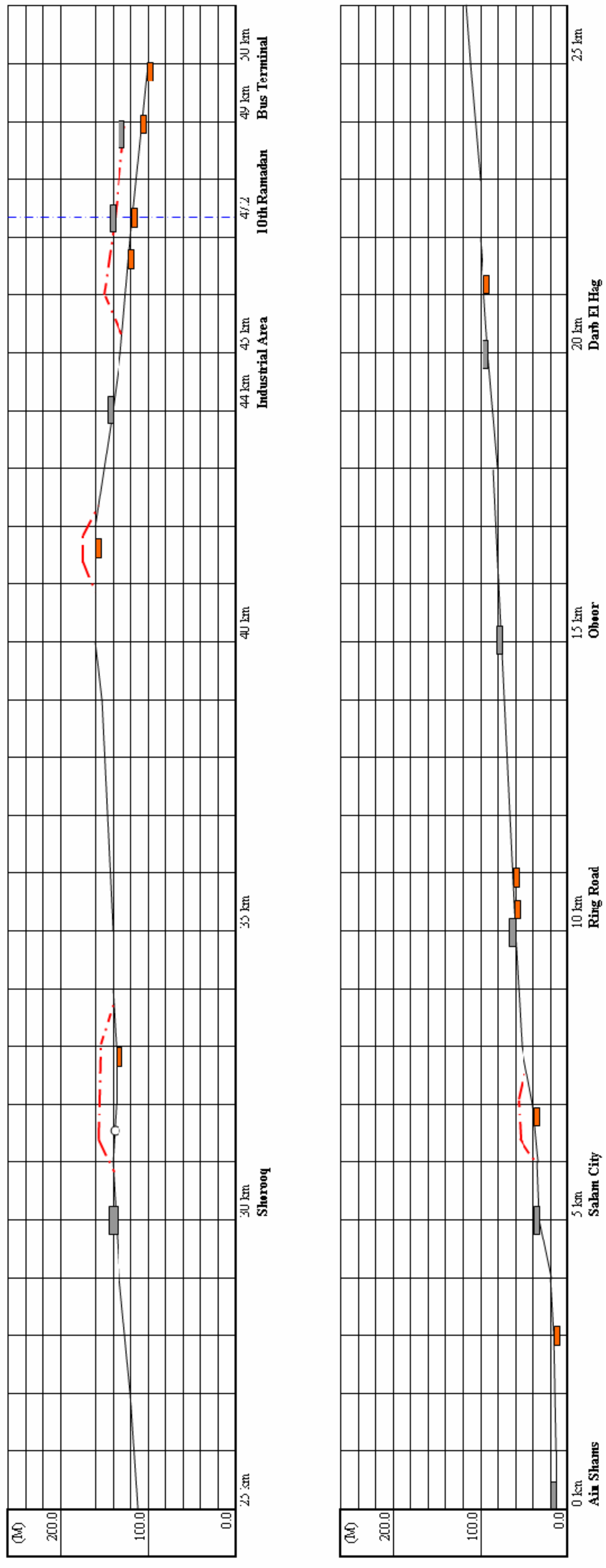


Figure 2.6.5 Outline of Track Profile

2.6.4 Stations and Facilities

(1) Station Location Planning

Locations of new stations in association with the new railway line construction project are determined, considering the convenience of passengers, the conditions of the surrounding areas along the line, the line alignment, etc. The major planning aspects to be considered are:

- Accessibility to commercial centers and work places;
- Convenience for transferring to/from other transport modes;
- Level ground at station areas;
- Possibility of straight alignment at station area;
- Drainage system;
- Minimization of civil works; and
- Availability of extra land area for future expansion.

(2) Station Scale Planning

One of the major elements to determine the scale of a station is the number of passengers at the station, in terms of the number of daily passengers for 10 and 20 years after opening. As commuters of work and school trips are the majority of railway passengers, the scale of the station is determined based on peak-hour (one hour) passenger volume. In the Study Area, it was assumed that 10 percent of daily passengers would be concentrated in the peak-hour.

In addition, the land use of the surrounding areas of the station, such as residential, commercial and recreational areas, should be taken into account for planning the station.

(3) Station Planning of the East Wing

The locations of stations on the existing Suez line were planned basically same as the existing stations. However, major stations need to be improved, considering the convenience of passengers, as described below. In the new line section between Shorooq and Bus Terminal Station, the transferability and accessibility were also considered to determine the locations.

As a common design criterion, the platform length was planned to be 110 m by assuming that future commuter trains consist of five cars, based on the following formula:

Platform length (L) = Maximum number of cars per train (5) x Length of car (20 m) + 10 m (reserved space)

The platform height was planned to 1,100 mm based on an expected new modern train specification. This height is almost the same as the existing platform.

1) Ain Shams Station Improvement Plan

The existing ENR Ain Shams Station is a terminal station to the Cairo urban center. Passengers transfer trains from ENR to Metro line 1 to travel to city centers. New station facilities such as a pedestrian deck and intermodal facilities should be functionally developed. The track layout of the station be improved by utilizing the existing ENR assets and land properties as shown in Figure 2.6.7.

Photo -1 Cairo side of ENR Line

Photo - 2 Front of Station

Photo - 3 For Suez side from Metro Station

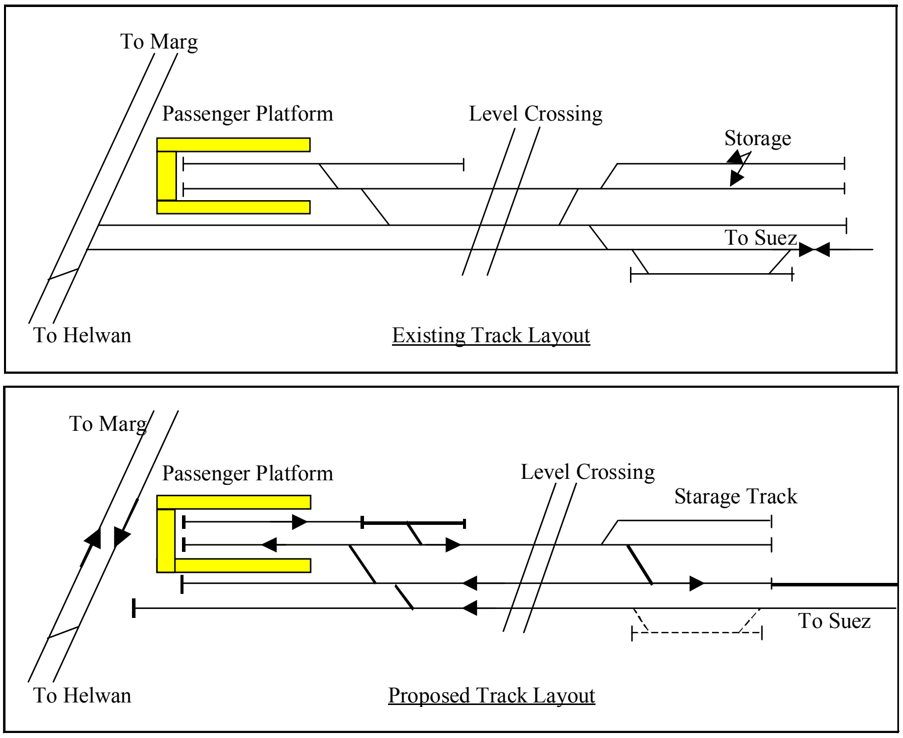
Photo - 4 Diesel Locomotive

Photo - 5 For Suez side

Photo - 6 Receiving Track

Source: JICA Study Team

Figure 2.6.6 Pictures: Existing Situation at Ain Shams Station



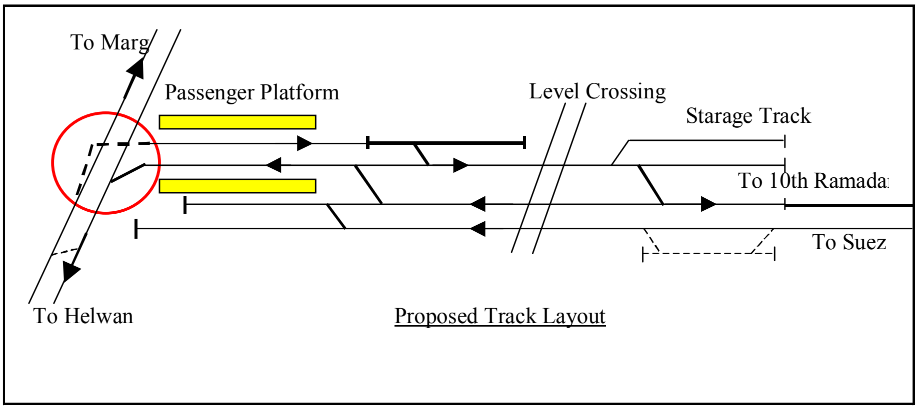
Source: JICA Study Team

Figure 2.6.7 Track Layout Improvement Plan for Ain Shams Station

In order to enable a "Through-Train Operation" to/from Metro Line 1 in the long-term, the following consideration should be taken:

- The East Wing Line should be double-track and electrified with overhead catenaries;
- Substantial station facility improvement, in particular platforms, is necessary to cope with the East Wing train operation. The station office shall be elevated to supply space for platforms;
- An idea to extend the exiting Suez line to connect to the Metro line is considered to be difficult because of insufficient space;
- Level crossing of the East Wing line and the Metro line should be avoided for safety reasons. Therefore, the track to the Suez should be elevated or underground with a sufficient length for grade separation; and
- The headway of Metro Line 1 is currently every 3.5 minutes. Therefore, a train operation plan should be coordinated properly between the Metro and the East Wing line.

A track layout plan to make a through-operation between the new East Wing line and Metro Line 1 is proposed as illustrated on Figure 2.6.8.



Source: JICA Study Team

Figure 2.6.8 Planning of Through Train Operation to Metro Line 1

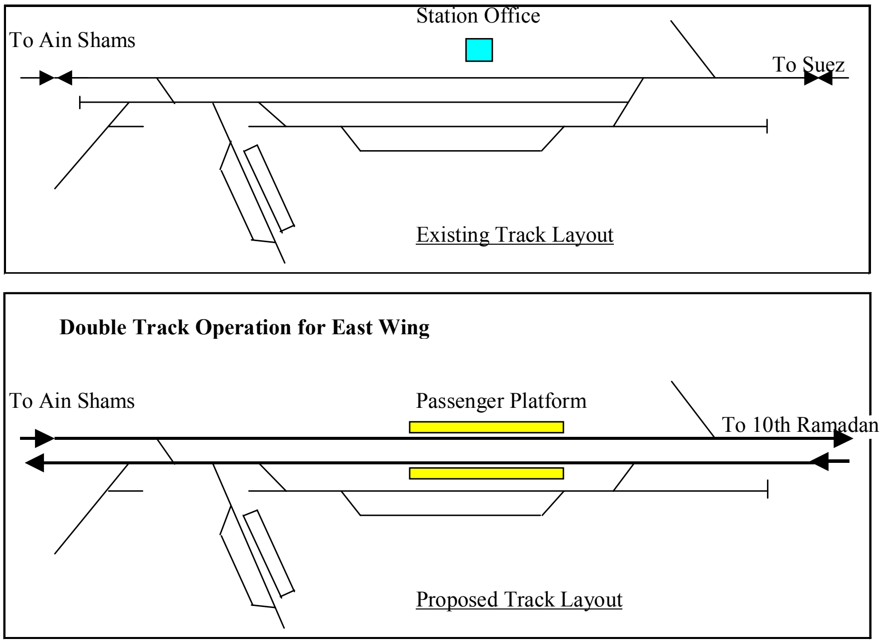
2) Ring Road Station Planning

There is a bus terminal at the intersection of the Ring Road and the Ismailia Desert Road. A considerable number of passengers make transfers to/from ordinary buses, air-conditioned buses, shared-taxis and normal taxis. Given the East Wing line, passengers to/from 10^{th} of Ramadan City and central Cairo areas would be able to transfer to the East Wing line. Those who go to the Cairo International Airport will use this station even before the opening of the planned Metro Line 3.

3) Oboor Station

A little number of passengers use Oboor Station at present. There is currently no platform and no facility for passengers. However, since this station is near to the huge Oboor Market, this station could be a gateway to the Oboor New Community. Therefore, along with the development of the adjacent new community, this station will play a significant role to provide a convenient public transport service for the residents as well as commuters.

Figure 2.6.9 shows an improvement plan for Oboor Station in a comparison with the existing ENR station. The track layout shall be improved for double tracks and for station facilities.



Source: JICA Study Team

Figure 2.6.9 Improvement Plan of Oboor Station Track Layout

4) Shorooq Station

Shorooq Station was built recently and has enough station functions. Although there are a few passengers at present, the future passenger demand is estimated to grow as the Shorooq New Community's development progresses. An over-pedestrian bridge will need to be equipped to secure the safety of passengers crossing the track. Figure 2.6.10 shows the existing Shorooq station.

Photo - 1 For Suez Side

Photo - 2 Signal System

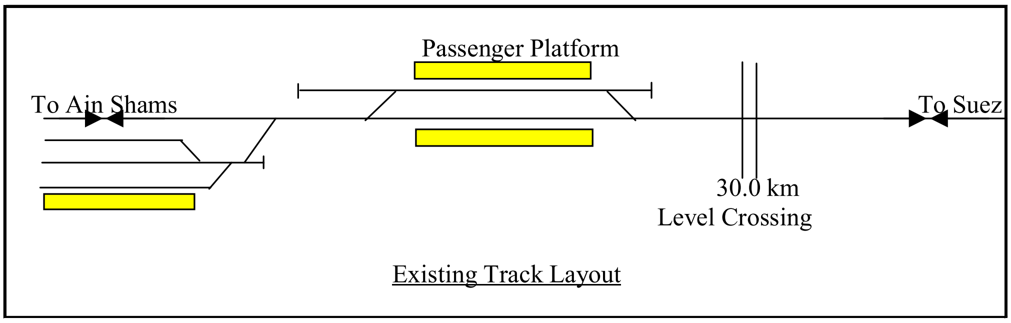
Photo - 3 Existing Station Plaza

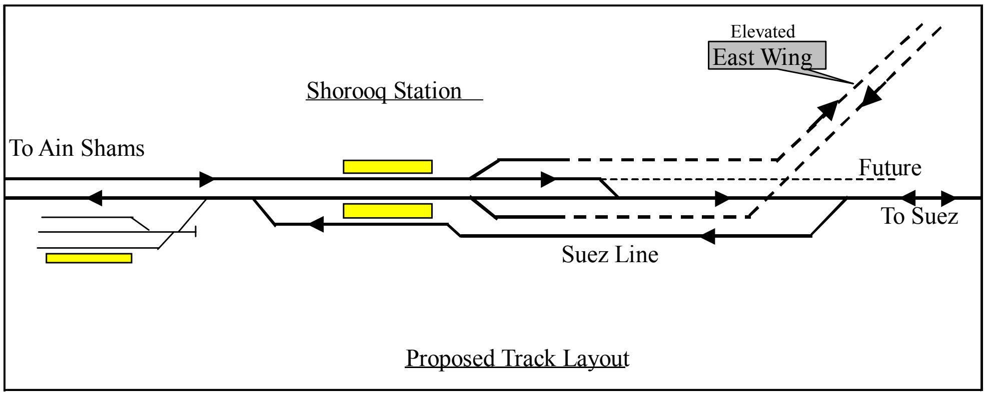
Photo - 5 Passenger Platform

Source: JICA Study Team

Figure 2.6.10 Pictures: ENR Shorooq Station

Option 1 (R1) of the East Wing line branches at Shorooq Station from the existing ENR Suez line in order to reach the 10th of Ramadan City along the Ismailia Desert Road. For this objective, the existing track system should be improved so as to functionally connect the new track to the 10th of Ramadan City, as proposed in Figure 2.6.11.





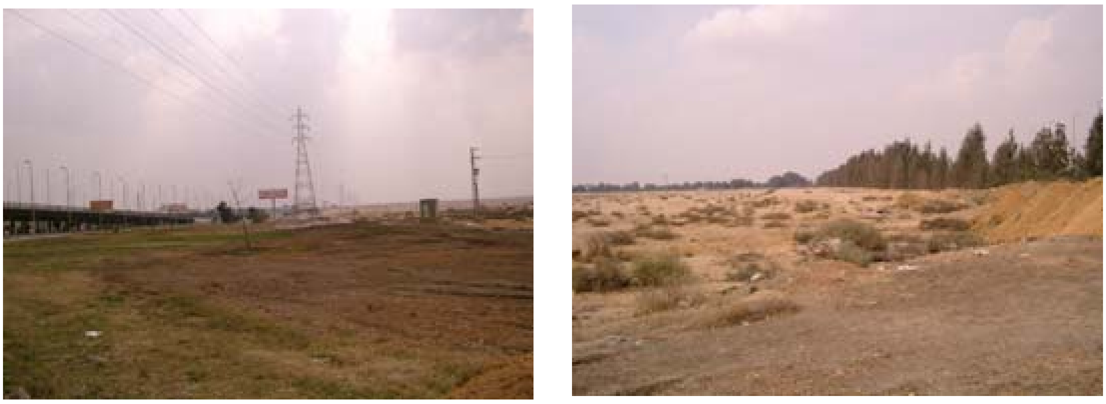
Source: JICA Study Team

Figure 2.6.11 Improvement Plan of Shorooq Station Track Layout

5) Industrial Area Station

The industrial area of the 10th of Ramdan has already fully been developed as an industrial center. In order to provide public transport services to commuters working at this industrial center, a new station is proposed be constructed on the vacant land area near the entrance of the 10th of Ramdan City. This station also serves passengers who wish to travel further in a north-east direction, as well as north-west and south, by using road-based public transport services at the station. Intermodal facilities shall be developed on the station plaza. Figure 2.6.12 shows the current conditions of the proposed site for the new station.

It is noted that a depot/work shop for the East Wing line is also proposed to be constructed in a vicinity of this station.



Source: JICA Study Team

Figure 2.6.12 Proposed " Industrial Area Station" Area

6) 10th of Ramadan Terminal Station

The development of the 10th of Ramadan City has been in progress, and the future population of the city is estimated to be 278,000 in 2007 and 576,000 in 2022. There exists a bus terminal for long distance services, as well as a shared-taxi service in the center of the city. However, the bus service would not be capable to cope with the future transport demand, when the City grows to be an urban agglomeration with a population of 576,000, as projected.

Two new stations are planned in the 10th of Ramadan City to cover the service area in the City. In addition, the alignment of the line within the City is planned to have a viaduct structure, because wide trunk roads run in all directions through the City. The viaduct shall be constructed in the median of the trunk road where the right of way for a mass transit system has already been reserved, as shown in Figure 2.6.14.

A proposed track layout of Bus Terminal Station of the 10th of Ramadan, which is a terminal of the East Wing line is as illustrated on Figure 2.6.15. Regarding the structure, a further explanation is provided in Section 2.6.8.

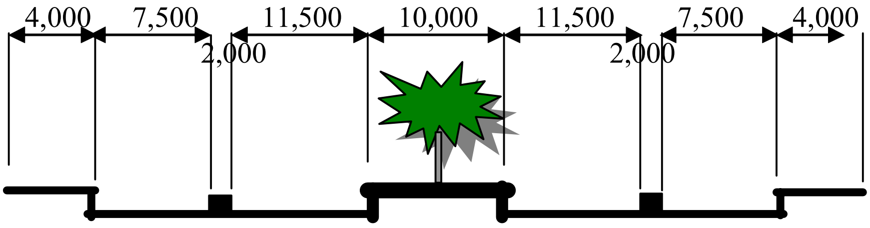
Photo - 1 Main Arterial Road

Photo - 2 Pavement Side

Photo - 3 Median

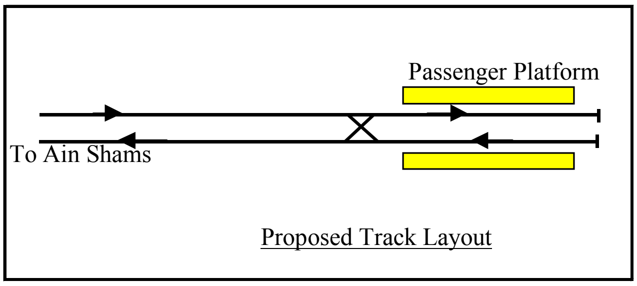
Source: JICA Study Team

Figure 2.6.13 Planned East Wing Route Site in the City



Source: JICA Study Team

Figure 2.6.14 Main Arterial Road in 10th of Ramadan City



Source: JICA Study Team

Figure 2.6.15 Proposed Track Layout of Terminal Station

2.6.5 Rolling Stock

(1) Type of Rolling Stock

All cars of a train are planned as diesel powered rolling stocks for the East Wing line. This type of decentralized power train has the advantage of high acceleration, high operation frequency and transport capacity compared to the locomotive hauling type of trains. Therefore, the decentralized power train is attractive to passengers and has the characteristics of high speed and a comfortable service. However, this type of train needs comparatively high investment as well as expensive maintenance facilities.

(2) Composition of Train

It is planned that one train consists of 3 cars in the beginning of operations of the East Wing line, considering the estimated transport demand and operation efficiency. The 3 cars composed train consists of 2 control cars and 1 intermediate car.

(3) Passenger Transport Capacity

The transport capacity of one car is calculated, as shown in Table 2.6.4. Based on these unit capacities, the transport capacity of one train (2 control cars plus one intermediate car) is 442 passengers, and the crush load capacity is 796 passengers.

Table 2.6.4 Transport Capacity

	Control Car	Intermediate Car
Seating Capacity	38	54
Standing Capacity	102	108
Total	140	162
Crush Load Capacity	252	292

Source: JICA Study Team

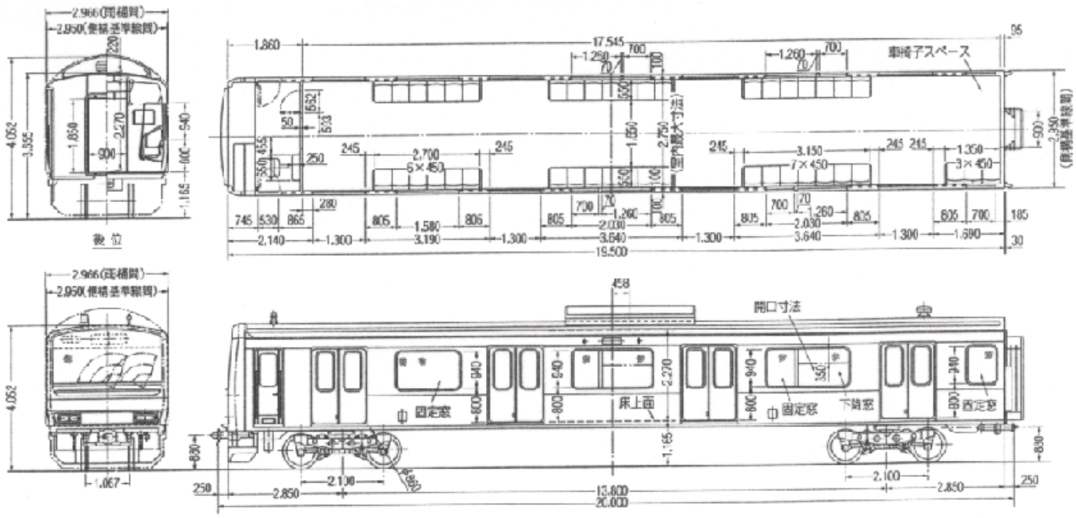
Note: The standing capacity was calculated by assuming 3 persons per square meter, and 8 persons per square meter in case of crush load capacity.

(4) Specification of East Wing Commuter Train Cars

Specification of the planned car is as follows.

- Gauge : 1,435 mm
- Coupling Length : 20.0 m
- Body Length : 19.5 m
- Body Width : 2,950 mm
- Weight Control car : 30.0 tons
- Intermediate car : 27.8 tons

A typical outline of the East Wing control car and a picture of a typical commuter train are shown in Figures 2.6.16 and 2.6.17.



Source: "Railway Journal", 2002, Railway Journal Publishing

Figure 2.6.16 Typical Outline of the East Wing Control Car

Source: "Railway Journal", 2002, Railway Journal Publishing

Figure 2.6.17 Typical Commuter Train

2.6.6 Train Operation

(1) Time-band Future Passenger Demand

The train operation plan of the East Wing line was planned based on the future passenger demand forecast from the CREATS model, which was shown in Table 2.6.1. This forecast was revised by considering detailed train operations and it is different from the preliminary forecasts which were used for screening the options and shown in section 2.5.

Train operations are planned to cope with the peak-hour passenger demand. Therefore, a rational peak-hour ratio needs to be projected. For this purpose, the Study Team reviewed the time-band traffic count data of passenger cars on Ismailia Desert Road at the inner cordon line, which was obtained during the Master Plan Study as shown in Table 2.6.5. Looking into the peak-hour traffic patterns from this table, it is clear that the outbound traffic volume is larger than inbound in morning peak hours. On the contrary, the inbound traffic is bigger than the outbound in the evening peak hours. The highest percentage was observed as 5 % of the total daily traffic volume during 8 to 9 a.m. to the outbound direction.[1]

This peak-hour ratio observed in Table 2.6.5, however, indicates the pattern of passenger cars traffic on Ismailia Desert Road, which includes longer distance passenger cars to/from the outside of the Study Area to some extent (even though those are not of a significant number). This means that another information source needs to be examined to determine a rational peak-hour ratio.

For this purpose, the Study Team reviewed the daily fluctuation of the number of passengers on Cairo Metro lines by time zone as well. It was found that the daily fluctuation of the Metro passengers was almost similar to the traffic count results in Table 2.6.5. Therefore, it was decided to utilize the time-band fluctuation patter of Metro passengers for the train operation planning.

Table 2.6.6 shows the result of the projected number of maximum passengers at sections between stations by time zone, which is defined as: morning peak hours from 7:30 a.m. to 9:30 a.m.; afternoon peak hours from 13:30 p.m. to 16:30 p.m.

Since big differences of traffic volume by direction were not observed in the defined time zones, the Study Team decided to use the same numbers for each direction. As shown in this table, the morning peak hours are much more congested than the afternoon peak hours.

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1 This pattern, which is characterized for the East Wing Corridor, is very unique, compared to other cities in the world. In a megalopolis, a higher ratio usually appears on inbound traffic than outbound traffic in the morning peak hours, while a higher ratio appears on outbound traffic in the evening peak hours. Such a unique traffic pattern is thought to be caused due to accumulations of work places in the Industrial Area in this corridor.

Table 2.6.5 Number of Passenger Cars on Ismailia Desert Road

Time of Day		Number of Cars		Percentage	
From	To	Outbound	Inbound	Outbound	Inbound
6:00	7:00	631	526	1.4	1.1
7:00	8:00	1,688	1,280	3.6	2.8
8:00	9:00	2,313	1,757	5.0	3.8
9:00	10:00	2,092	1,237	4.5	2.7
10:00	11:00	1,698	1,258	3.7	2.7
11:00	12:00	1,248	1,076	2.7	2.3
12:00	13:00	1,207	1,332	2.6	2.9
13:00	14:00	1,140	1,250	2.5	2.7
14:00	15:00	1,166	1,690	2.5	3.6
15:00	16:00	1,356	2,197	2.9	4.7
16:00	17:00	1,534	2,137	3.3	4.6
17:00	18:00	1,488	1,271	3.2	2.7
18:00	19:00	823	1,900	1.8	4.1
19:00	20:00	807	1,003	1.7	2.2
20:00	21:00	596	931	1.3	2.0
21:00	22:00	631	676	1.4	1.5
22:00	23:00	603	488	1.3	1.1
23:00	0:00	512	399	1.1	0.9
0:00	1:00	322	262	0.7	0.6
1:00	2:00	216	159	0.5	0.3
2:00	3:00	141	87	0.3	0.2
3:00	4:00	95	78	0.2	0.2
4:00	5:00	176	92	0.4	0.2
5:00	6:00	462	316	1.0	0.7
Total		22,945	23,402	49.5	50.5

Source: JICA Study Team

Notes: (1) Percentage shows numbers of total daily traffic of both directions.

(2) Number of passenger car includes sedan, taxi, minibus, bus and shared taxi. The survey was conducted on October 9, 2001. "Outbound" means a direction from Cairo to Ismailia, while "Inbound" means from Ismailia to Cairo.

Table 2.6.6 Estimated Maximum Hourly Passengers at Sections between Stations by Time Zone for One Direction (Number of Passengers per hour)

Time Zone	Percent (%)	Max. hourly passengers between stations for one direction		
		2007	2012	2022
5:30 - 7:30	6	979	1,077	5,849
7:30 - 9:30	20	3,263	3,590	19,498
9:30 - 13:30	20	1,631	1,795	9,749
13:30 - 16:30	21	2,284	2,513	13,649
16:30 - 21:30	27	1,762	1,939	10,529
21:30 - 23:00	6	1,305	1,436	7,799

Source: JICA Study Team

Note: Percent shows numbers of passengers for one direction.

(2) Train Formation

Optimal train formations were examined to meet the peak hour passenger demands. The directional number of passengers per hour range from around 1,000 to 20,000. Therefore, the Study Team planned two types of train formation, consisting of 3 cars and 5 cars, as follows:

- 3 cars-train formation: 1 control car + 1 intermediate car + 1 control car; and
- 5 cars-train formation: 1 control car + 3 intermediate cars + 1 control car.

Transport capacities by car type are assumed as shown in Table 2.6.4. Based on these capacities by car type, the transport capacities in the cases of 3 cars and 5 cars formation are estimated, as shown in Table 2.6.7. In the case of a 3 cars formation, the transport capacity of a train is calculated to be 442, while the crush load capacity is calculated as 796 by assuming that crush load would be 180 % of the capacity.

Table 2.6.7 Transport Capacity by Train Formation

Train Formation	**3-Cars Train**			**5-Cars Train**		
Type of Car	No. of Cars	Capacity	Crush Load	No. of Cars	Capacity	Crush Load
Control Car	1	140	252	1	140	252
Intermediate Car	1	162	292	3	486	875
Control Car	1	140	252	1	140	252
Total	3	442	796	5	766	1,379

Source: JICA Study Team

(3) Train Operation Planning

Based on the above future transport demand and the capacities of trains, a train operation scheme was examined. In addition to these factors, the following premises were adopted for the planning.

<u>Train Operation Route and Travel Speed</u>

The existing ENR Suez line is operated by trains consisting of one diesel locomotive and several coaches. The travel time between Ain-Shams and El Robeiky (45 km) is around 45 to 47 minutes. Therefore, the average operating speed between the two stations is about 60 km/h.

A general operation scheme of the new East Wing line is planned as shown in Figure 2.6.18, referring to the existing Suez line operation. The total length of the East Wing line is 49 km between Ain-Shams Station and Bus Terminal Station at 10^{th} of Ramadan City. Travel speeds of the train are planned to be 60 km/h on average between Ain-Shams and Oboor, 80 km/h between Oboor and Industrial Area and 50 km/h between the Industrial Area and the Bus Terminal.

The travel time between Ain-Shams and Bus Terminal, therefore, will be about 43 minutes, and the average operating speed of the East Wing line is expected to be 68 km/h. It should be noted that the "average speed" and the "commercial speed" are the same in this Study.

Station	Ain Shams, Salam, Ring Rd., Oboor, Darb El Hag, Shorooq, Indust. Area, 10th Ramadan, Bus Terminal							
Distance (km)	5	5	5	8	7	14	3.2	1.8
Average Speed	Av. Speed=60km/hr			Av. Speed=80km/hr			Av.Speed=50km/hr	
Sheduled Time	15min.			22min.			6min.	
Average Speed	68 km/hr							

Source: JICA Study Team

Figure 2.6.18 Train Operation Route and Travel Characteristics

<u>Number of Cars per Train</u>

The number of cars per train was assumed to be 3 in the initial years of operation, and was assumed to increase to 5 in some future year depending on future passenger demand volume. All cars are planned as powered rolling stock, as mentioned in Section 2.6.5.

<u>Transport Capacity of Trains</u>

Transport capacities by train formation were discussed in the previous section. It is assumed that crush load capacity is applied in the morning and afternoon pear hours and that normal transport capacity is applied in other time zones.

<u>Service Frequency</u>

As the East Wing line is a commuter railway service, headway in peak hours should be short enough to attract passengers to the new railway service. If the longer the headway is given, the more discouraged passengers would be to use the railway. On the other hand, given a too short headway such as 2 minutes, trains could not efficiently be operated due to the over-service, thereby resulting in an economical deficit for the East Wing operation. Therefore, the Study Team determined that headway during morning peak hours should be less than 15 minutes, by considering the future passenger demand, train transport capacities, and convenience of passengers.

<u>Head-end Operation Time</u>

The East Wing trains are operated from one terminal to another terminal. Therefore, trains should change their directions when arriving at the terminals. Necessary time to change direction of a train, which is called a "head-end operation time", is assumed to be five minutes at each terminal. Trains may stay at terminals for longer time than the head-end time in off-peak hours.

Taking into account this condition as well as future transport demands and the transport capacities as planned above, the necessary number of trains per hour per direction can be estimated as shown in Table 2.6.8, and then the required headways by time zone can be derived in two cases of the train formation types, as shown in Table 2.6.9.

Table 2.6.8 Necessary Number of Trains per Hour and Per Direction

Time Zone	2007		2012		2022	
Number of Cars/Train	3 Cars	5 Cars	3 Cars	5 Cars	3 Cars	5 Cars
5:30 - 7:30	2.2	1.3	2.4	1.4	13.2	7.6
7:30 - 9:30	**4.1**	**2.4**	**4.5**	**2.6**	**24.5**	**14.1**
9:30 - 13:30	3.7	2.1	4.1	2.3	22.1	12.7
13:30 - 16:30	**2.9**	**1.7**	**3.2**	**1.8**	**17.2**	**9.9**
16:30 - 21:30	4.0	2.3	4.4	2.5	23.8	13.7
21:30 - 23:00	3.0	1.7	3.2	1.9	17.6	10.2

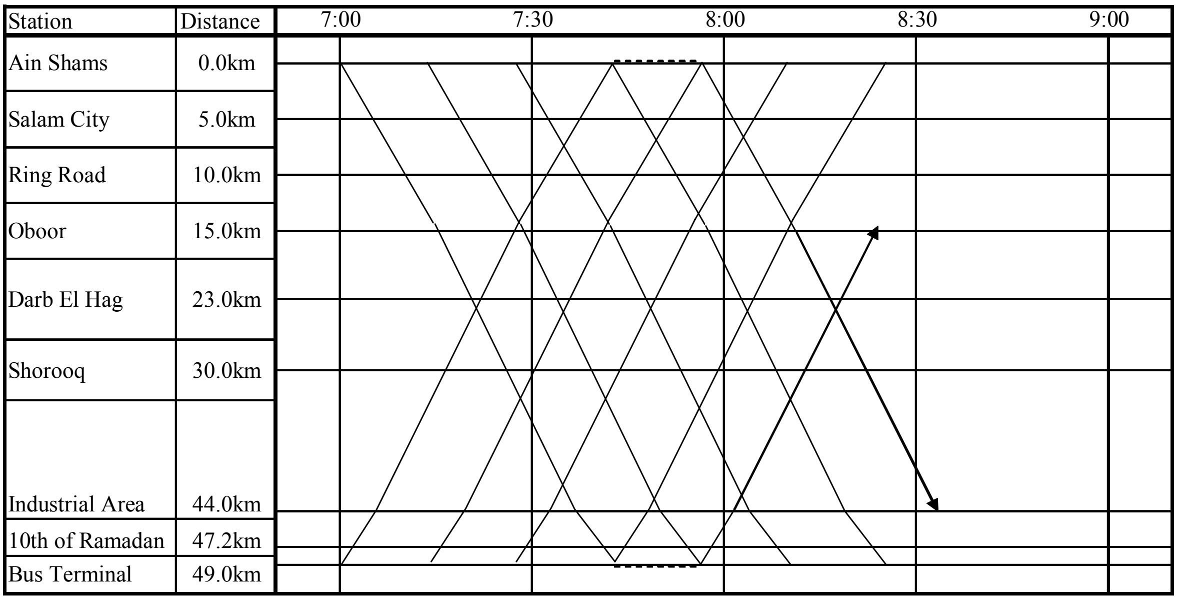
Source: JICA Study Team

Table 2.6.9 Headway of East Wing Line (Minutes)

Time Zone	2007		2012		2022	
Number of Cars/Train	3 Cars	5 Cars	3 Cars	5 Cars	3 Cars	5 Cars
5:30 - 7:30	27.1	47.0	24.6	42.7	4.5	7.9
7:30 - 9:30	**14.6**	**25.4**	**13.3**	**23.0**	**2.4**	**4.2**
9:30 - 13:30	16.3	28.2	14.8	25.6	2.7	4.7
13:30 - 16:30	**20.9**	**36.2**	**19.0**	**32.9**	**3.5**	**6.1**
16:30 - 21:30	15.1	26.1	13.7	23.7	2.5	4.4
21:30 - 23:00	20.3	35.2	18.5	32.0	3.4	5.9

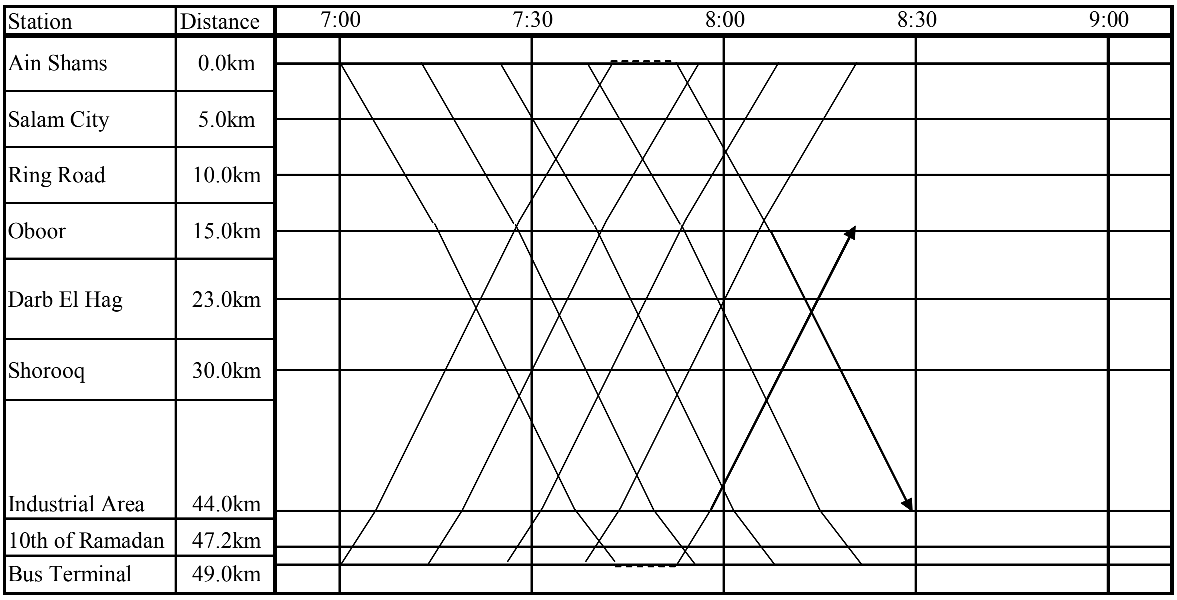
Source: JICA Study Team

Based on the above discussions, train operation diagrams are depicted for the operations in 2007, 2012 and 2022, as shown in Figures 2.6.19, 20 and 21 respectively. It can be suggested that in 2012, a 3 cars train be operated with a 13.3 minutes headway in the morning peak hours (7:30 – 9:30 a.m.), while a 5 cars trains be operated with a 4.2 minutes headway in 2022.



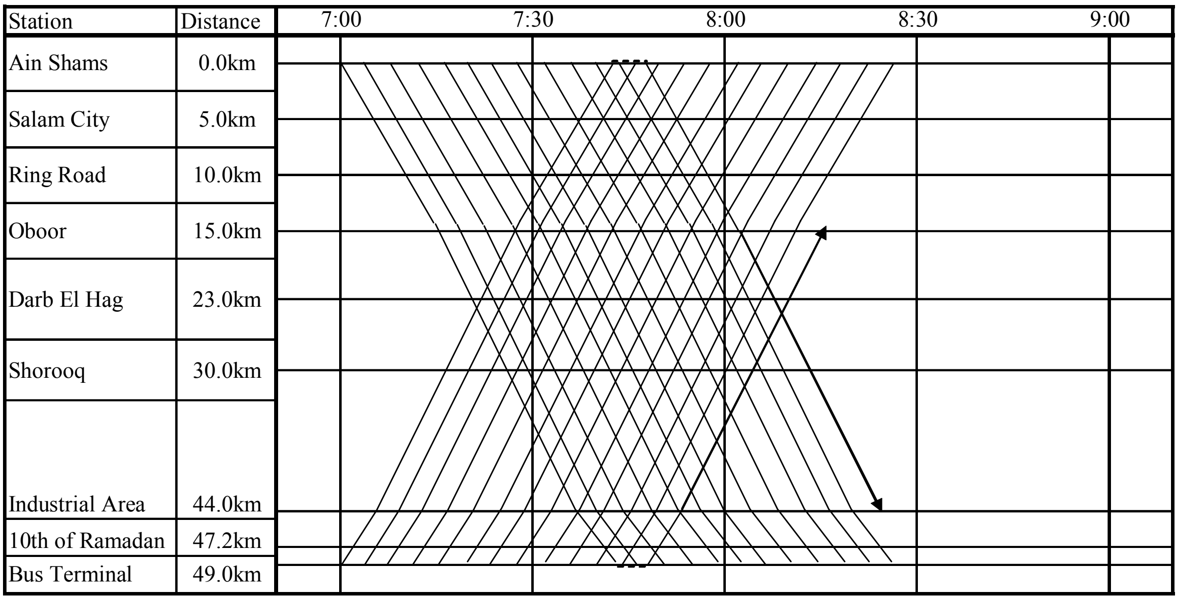
Source: JICA Study Team

Figure 2.6.19 East Wing Train Diagram in 2007 (3 cars train, 14 minutes headway)



Source: JICA Study Team

Figure 2.6.20 East Wing Train Diagram in 2012 (3 cars train, 13 minutes headway)



Source: JICA Study Team

Figure 2.6.21 East Wing Train Diagram in 2022 (5 cars train, 4 minutes headway)

(4) Necessary Numbers of Trains and Cars

The necessary number of trains and cars for the East Wing line was examined. Based on the train diagrams in future years as shown above, only 8 trains with 3 cars formation are necessary up to 2012. While, in order to respond to the 2022 passenger demand, 24 trains with 5 cars formation will be needed.

Table 2.6.9 shows the number of necessary trains and cars in both types of train formation, 3 cars and 5 cars. As seen in this table, the case of a 3 cars formation needs more control cars than the 5 car formation to cope with the same transport demand. Control cars have less transport capacity than intermediate cars. Therefore, it will be rational to begin the operation service with 5 cars train formation from 2017, based on the Table 2.6.10 analyses.

Table 2.6.10 Necessary Number of Trains and Cars

	2007		2012		2017		2022	
Number of Cars/Train	3 Cars	5 Cars	3 Cars	5 Cars	3 Cars	5 Cars	3 Cars	5 Cars
Number of Trains	8	6	8	6	23	15	38	24
Control Cars	16	12	16	12	46	30	76	48
Intermediate Cars	8	18	8	18	23	45	38	72

Source: JICA Study Team

As passenger demand increases, the number of trains increases. Table 2.6.11 shows the necessary number of additional trains in future years for the East Wing line. Table 2.6.12 shows the necessary number of additional cars including reserved cars, which are assumed to be 20 % of the necessary numbers.

This table implies a rational car procurement schedule, that is, the East Wing Service will be able to start with 19 control cars and 10 intermediate cars in the initial stage, 2017, and in order to provide the sufficient service in 2022, a total of 58 control cars and 86 intermediate cars will be needed, including 20% reserved cars.

Table 2.6.11 Necessary Number of Additional Trains and Cars

	2007	2013	2017	2022	Accum'd numbers
Train Formation	3 Cars	3 Cars	5 Cars	5 Cars	-
Control Cars	16	24	0	8	48
Intermediate Cars	8	12	36	16	72

Source: JICA Study Team

Table 2.6.12 Necessary Number of Additional Cars including Reserved Cars

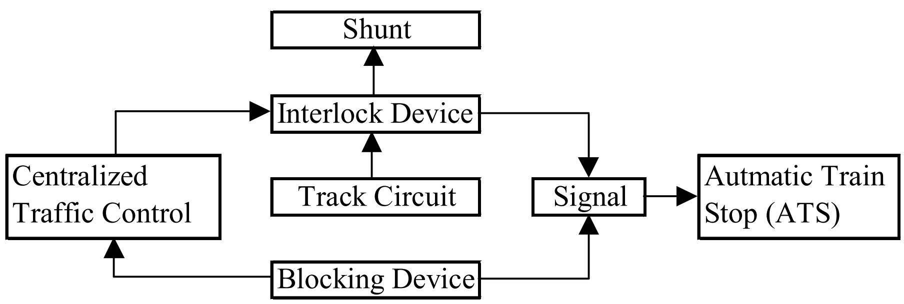
	2007	2013	2017	2022	Accum'd numbers
Control Cars	19	29	0	10	58
Intermediate Cars	10	14	43	19	86

Source: JICA Study Team

2.6.7 Signal and Telecommunication

(1) Signal System Planning

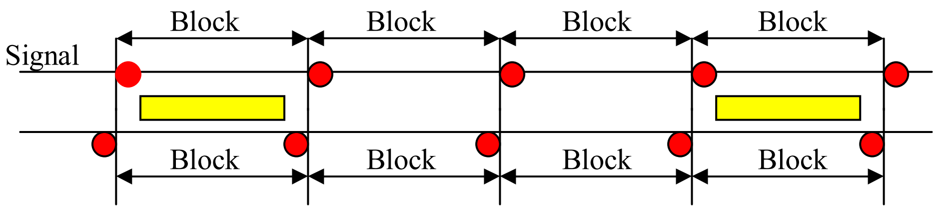
A signal system aims at safe and punctual train operation. A signal system usually consists of a signal device, interlocking device, blocking device, railway points, track circuit device, automatic train stop device (ATS), central traffic control device (CTC), level crossing protection device etc. Figure 2.6.22 summarizes the railway signal system.



Source: JICA Study Team

Figure 2.6.22 Block Chart of Signal System

A block system secures safe train operation. The system does not allow more than one train in a certain section of track in order to avoid train accidents, such as head-on collision and rear-end collision. Figure 2.6.23 shows a typical block system by separating track in to several blocks. An automatic block system consists of a block system, automatic signal and check in check out loop. The check in check our loop reports the existence of trains by receiving signals from a train. Therefore, the automatic signal system prevents other trains from going into an occupied block and thus protects against train accidents.



Source: JICA Study Team

Figure 2.6.23 Block System

A central traffic control device (CTC) controls many signal devices at remote areas on many lines and in a broad area from one particular point. The device also has a function of train dispatching. The locations of trains are automatically displayed on a central control board. Signal devices and points are also controlled by this device. An automatic signal system, an electrified interlocking system and a wireless communication system with trains are necessary to introduce CTC.

Most of the level crossings along the existing ENR Suez line are equipped with neither an alarm device nor a crossing gate. Existing level crossings are planned to be grade separated to secure safe train operation. Automatic crossing gates are planned at some level crossings.

(2) Telecommunication System Planning

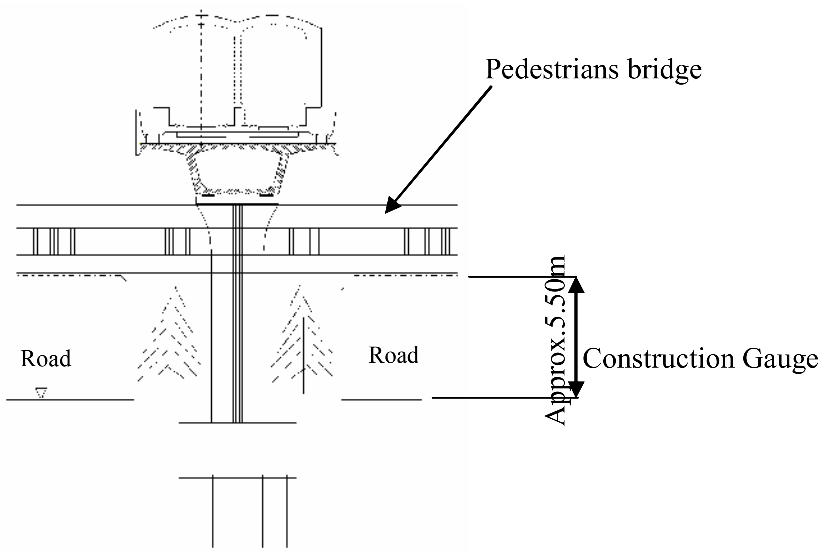
Railway facilities, such as stations and signals, are spread over a broad area along the track. A stable and exclusive use of a telecommunication system is a basic requirement for a railway system to connect these facilities systematically and to secure operation efficiency.

2.6.8 Structure

(1) Structure of Track

As shown in Figure 2.6.24, Main Arterial Road in 10th of Ramadan City, in Section 2.6.4, wide trunk roads run in all directions through the 10th of Ramadan City. Therefore, an elevated track structure is planned in the city, as shown in Figure 2.6.25.

An elevated section between stations is planned as a viaduct of PC box girder bridge structure. Space for pedestrian bridge is reserved above the road construction gauge under the structure for future installation.



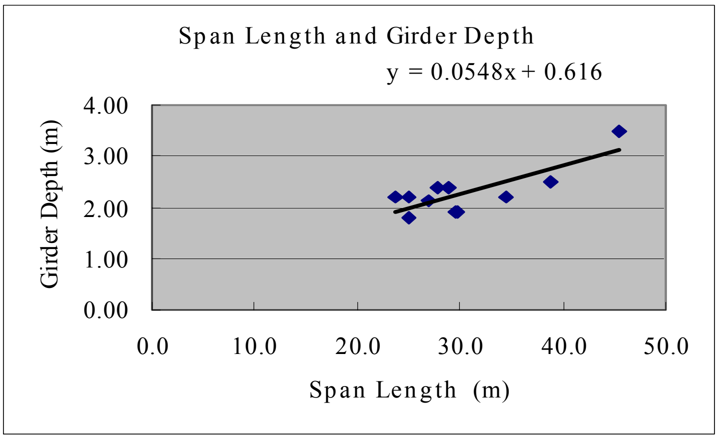
Source: JICA Study Team

Figure 2.6.24 Viaduct Structure between Stations in 10th of Ramadan

Source: JICA Study Team

Figure 2.6.25 Railway Viaduct Structure in Bangkok

The relationship between girder height and the span length of eleven pre-stressed concrete girders which support double tracks are plotted in Figure 2.6.26. This is derived from experiences in Japan, BKK, Jakarta, and India. The equation gives the depth of girder of 2.1 meters for 27 meter span length.



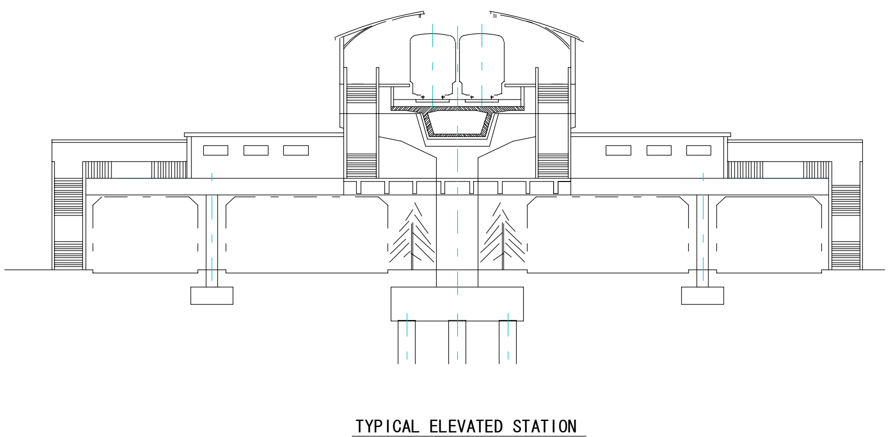
Source: "Basic Design Study Report, General Consultancy Services for DELHI Mass Rapid Transport System Project", October, 1998

Figure 2.6.26 Relation between Span Length and Girder Depth

(2) Structure of Elevated Station

All structures are elevated in the 10th of Ramadan City. Stations in the 10th of Ramadan area are planned as elevated stations. Figure 2.6.27 shows a typical elevated station structure.

In this plan, station facilities are concentrated on the concourse floor. Passengers are free to move from/to platforms in both directions from the concourse floor. In the case that station facilities are located at grade, more station staff are necessary because station facilities should be separated on both sides of the road under the viaduct.



Source: JICA Study Team

Figure 2.6.27 Typical Elevated Station

Following pictures show an example in case of Bangkok.

Photo-1 Commuter Train

Photo-2 Elevated Platform

Photo-3 Concourse

Photo-4 Concourse

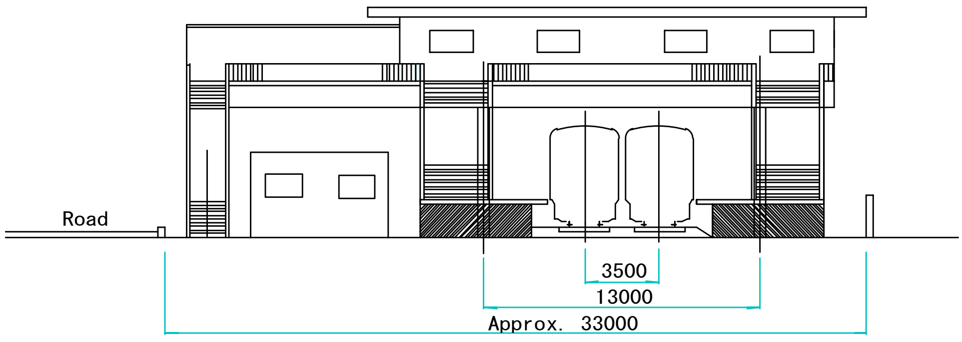
Source: JICA Study Team

Figure 2.6.28 Pictures: Elevated Station and Concourse

(3) Structure of At-Grade Station

Most of stations on the East Wing line are at grade stations. The main building of a station is planned as an elevated structure. All necessary station tasks are planned to concentrate on the main building.

It is possible to plan an at grade main station building to reduce construction cost. However, the number of trains in future is estimated to grow. Passengers would have to cross railway tracks safely on the elevated structure. Figure 2.6.29 shows a typical at grade station structure.



Source: JICA Study Team

Figure 2.6.29 Typical At-Grade Station

(4) Crossing Ismailia Desert Road

The East Wing line is planned to cross the Ismailia Desert Road to reach the 10th of Ramadan City from Shorooq station. Traffic volume on the road is very large and would also grow drastically in future. The Study Team, therefore, planned the viaduct structure to cross the road. Figure 2.6.30 shows the plan for crossing the road. The major components of the plan are summarized below:

- The existing Shorooq station is utilized for double track operation;
- A section between Ain-Shams and Shorooq stations is planned as double track;
- The track layout is planned carefully to avoid a level crossing between the East Wing line and the existing Suez line;
- New track is planned on the inbound direction of the Suez line, which serves inbound trains as well as passing track; and,
- The Suez line track is planned as double track for future development at Shorooq station.

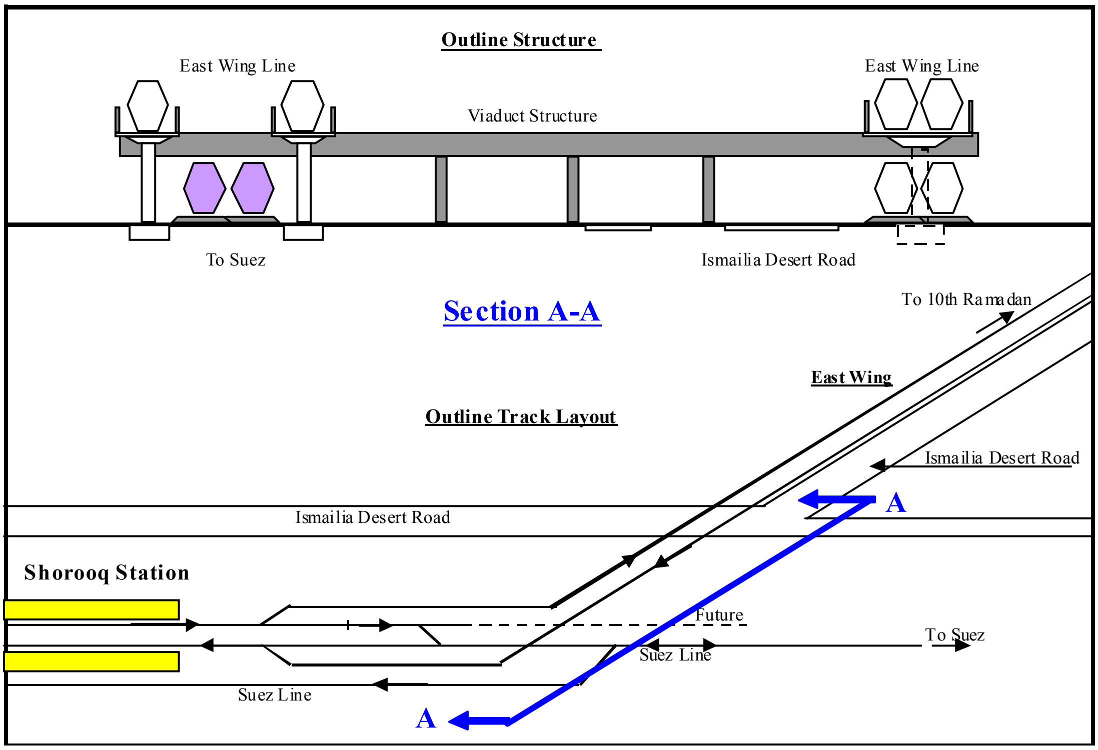


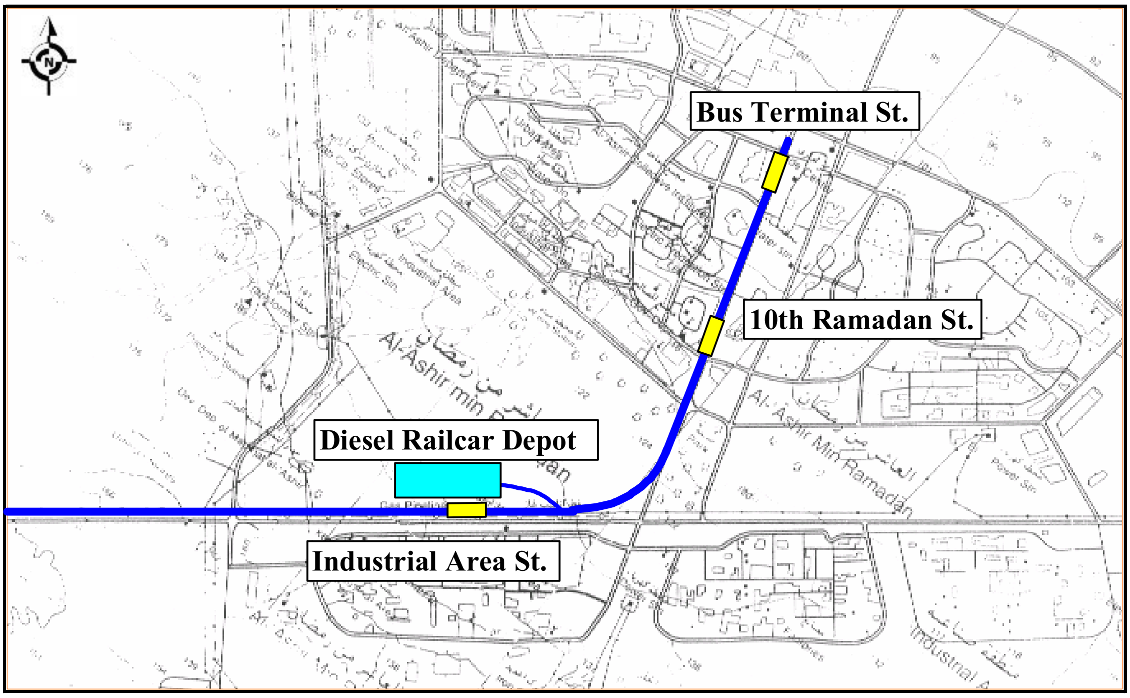
Figure 2.6.30 Outline Structure for Crossing Ismailia Desert Road

2.6.9 Depot/Workshop and Maintenance

(1) Location of Depot

The scale of depot should be planned based on the number of trains, cars and train formation. The depot should have functions for keeping trains as well as for inspection and repair. The scale of workshop is also determined by the number of train and cars.

The diesel car depot of the East Wing line is planned at a site near to the Industrial Area station as shown in Figure 2.6.31. The availability of land, proximity to a terminal and environmental conditions are considered in determining the depot location.



Source: JICA Study Team

Figure 2.6.31 Location of East Wing Depot

Source: JICA Study Team

Figure 2.6.32 Pictures: Existing Site of Planned Depot

(2) Functions of Depot

The functions of a depot are car storage, cleaning and inspection/repair.

Car storage

Trains are kept at a depot in principle, in some exceptions several trains are kept at stations.

Cleaning

Trains are cleaned, both the inside and outside of cars, every day after daily operations at car washing tracks and at storage tracks.

Inspection and repair

Daily and monthly inspections are carried out at an inspection shed, while two-year inspection and overhaul work are performed at a repair workshop.

(3) Maintenance of Train

Inspection and maintenance of trains/cars consists of daily inspection, monthly inspection, 2-year repair, overhaul and non-scheduled repair. This is summarized with a description of the inspection cycle and contents in Table 2.6.13.

Maintenance is planned so that storage and cleaning is carried out train by train, whilst the 2-year repair and overhaul is performed car by car.

Table 2.6.13 Inspection and Repair

Type of Inspection	Inspection Cycle	Contents of Inspection and Repair
Daily Inspection	Before operation	Observation of brake gear, bogie, running gear and etc.
Monthly Inspection	Every month	Inspection, repair and replacement of parts (if necessary) of running gear, engine, controller, battery, break gear, lamps, door lock device and etc.
Scheduled 2-year Repair	Every two years	Remove principal equipment and machine and overhaul
Overhaul	Every four years	Overhaul of all equipment, machine and parts
Non-scheduled Repair	Whenever necessary	Depending on necessity

Source: JICA Study Team

(4) Capacity of Depot

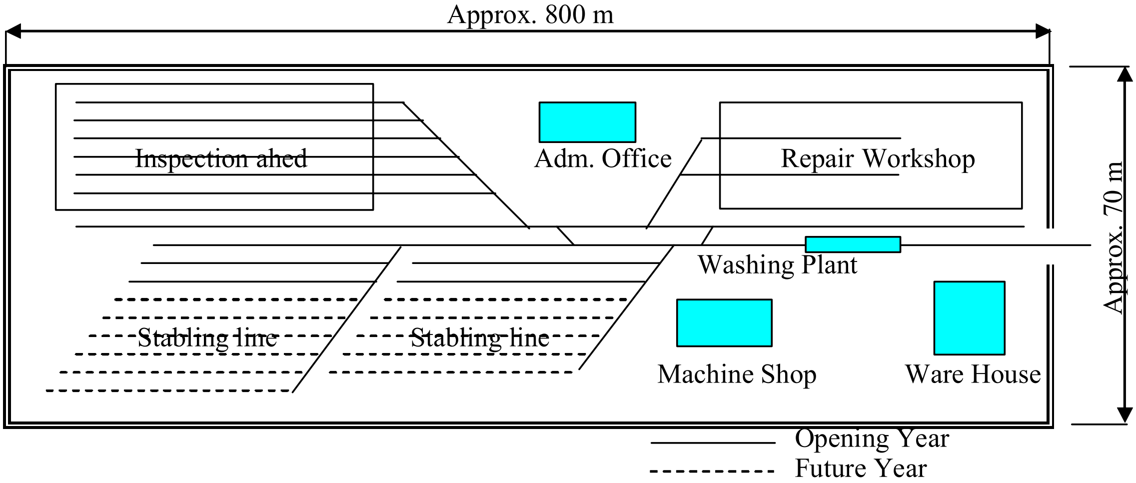
The capacity of the East Wing depot is planned as shown below, based on the necessary number of trains and cars, which were planned in previous sections.

- Stabling line :2 tracks
- Tracks for daily inspection :2 tracks
- Tracks for monthly inspection :2 tracks
- Tracks for 2-year repair :Necessary tracks for a 5-car train
- Tracks for overhaul :Necessary tracks for a 5-car train

- Tracks for non-scheduled repair :Tracks for overhaul and 2-year repair shall be utilized

Figure 2.6.33 shows an outline of the planned depot for the East Wing line.

Layout and Dimensions of Diesel Railcar Depot



Dimensions:

Area : 800m ×70 m
Stabling Yard : 5 cars ×34 train sets
Daily & Monthly : 5 cars ×6 train sets
Wash Line : 5 cars ×1 train sets
Heavy Maintenance Line : 5 cars ×1 train sets

Figure 2.6.33 Layout of Diesel Car Depot

2.7 AIN SHAMS INTERMODAL PLAN

2.7.1 Intermodal Facility Plan

(1) General

Ain Shams Station is located at the station of Metro line 1, between the northern part of Cairo and the CBD, which also will be a terminus of the East Wing for commuters from/ to 10th of Ramadan City.

The estimated population is approximately 88,000 persons in 2001, making it the high density of population in the catchments area of 800 m radius of Ain Shams Station. The area will have a population of 124,000 persons by 2022, based on the annual growth rate at 3.2 percent. In addition, Ain Shams station is used by students of Ain Shams University at 130,000 students per day and more than 6,000 employees per day.

In this context, it is necessary that a major intermodal facility at Ain Shams station must be developed to satisfy a variety transport needs. At present, the facilities at ENR station are not convenient for passengers, particularly passenger transfer from/to the Metro. Moreover, there is not a public transport terminal to provide feeder services in the surrounding area of the station. It has been observed that shared taxis run across the existing shopping arcade and make illegal terminals in the middle of the street in high-density residential areas.

In 2022, the daily passenger boarding demand per direction at Ain Shams station of Metro Line 1 is estimated at 212,000. Of which, 82,000 (40%) are transferred from the East Wing and another 100,000 (48%) are from public transport. The number of passengers by each mode is shown in Table 2.7.1

Table 2.7.1 Number of Passenger Demand of Metro Line 1 by Mode (1 direction) at Ain Shams Station in 2022

	Wing	Bus	Mini Bus	Shared Taxi	Taxi	Car	Walk	Total
No. of Passenger per day	82,000	20,250	4,750	63,000	12,000	5,000	25,000	212,000

Source: JICA Study Team

Based on the issues described above, the objectives are the following:

1. To improve or upgrade the intermodal facilities to provide for passenger and pedestrian-friendliness, and
2. To provide station plazas for feeder services, depending upon future passenger demand.

(2) Strategy

The intermodal facility plan that takes into account the following basic strategies based on the issues is envisioned for Ain Shams station. The strategies are shown as follows:

To improve the ENR station for the East Wing:
The current ENR station lacks the functions of a terminus station for the East Wing, in particular, platform capacity, a ticket controlled system and pedestrian-friendliness. It is essential that the station is rebuilt with vital intermodal functions. Especially, the construction of pedestrian deck linking to the Metro station should be planned, because, 38.6%[1] of the East Wing passengers are expected to transfer to Metro line 1 in 2022. Besides, the pedestrian deck would extend to the eastern side of the station to prevent the illegal crossing of the track and to secure pedestrian safety.

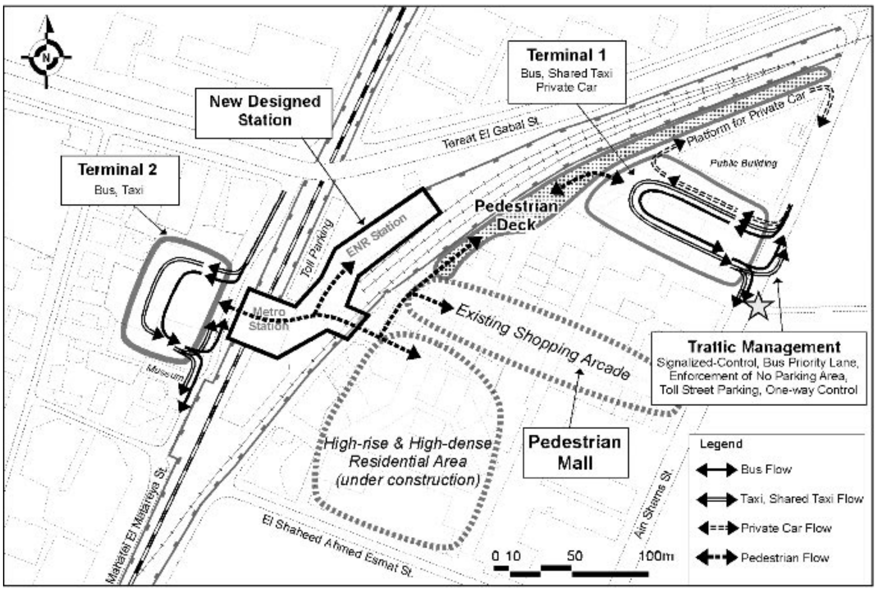
To develop bus terminals for providing feeder services:
According to the above table, 100,000 passengers expect to use public transport in 2022. Constructions of station plaza are necessary for providing feeder services, not only for the passenger but also for the large number of local residents. Taking account of the current status and traffic circulation, in particular, that the surrounding area of Ain Shams station is divided by the Metro line 1 alignment and the flyover on Tereat El Gabal St., a station plaza must be constructed for the linkage of east and west areas on each side of the station.

To formulate traffic management system:
A traffic management system is necessary that provides smooth traffic circulation, by introducing installation of signal light at non-signalized intersections, improvement of intersection, and on-street parking system.

To specify the current shopping arcade as a pedestrian mall:
It is necessary that current shared taxis and through traffic keep out from the current shopping arcade, in order to ensure a safe and comfortable pedestrian environment.

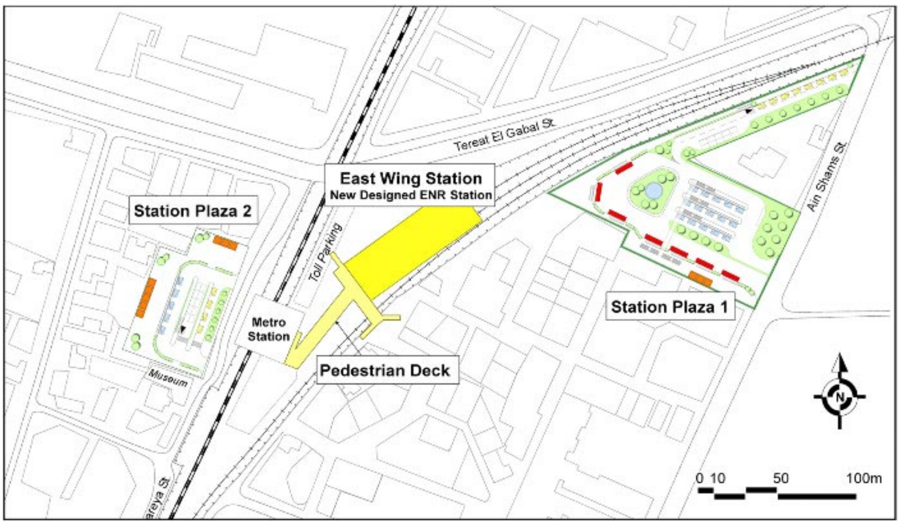
The concept of intermodal facility plan and locations are shown in Figures 2.7.1 and 2.7.2.

[1] The value was calculated based on the CREATS Model.



Source: JICA Study Team

Figure 2.7.1 Concept Map of the Ain Shams Station

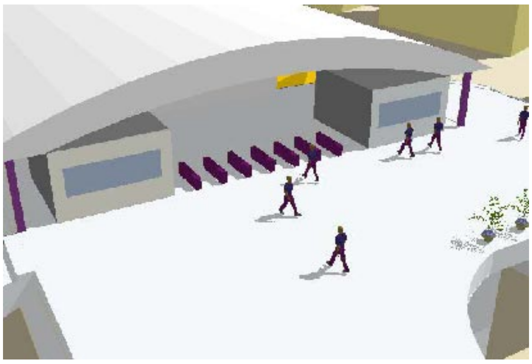


Source: JICA Study Team

Figure 2.7.2 Location Map of the Intermodal Facilities

1) East Wing Station

The new East Wing station should be designed with a 5 meter wide and 120 meters long platform, a ticketing controlled entrance and a ticket booth. The pedestrian deck links to the East Wing station and the Metro station, as well as linking to the area of the east side station. Figures 2.7.3 and 2.7.4 show images of plan.

Source: JICA Study Team

Figure 2.7.3 Images of the Platform and Entrance of the East Wing Station


Source: JICA Study Team

Figure 2.7.4 Images of the Pedestrian Deck

2) Station Plaza

The station plazas will be constructed at the east and west side of Metro Line station, in order to transfer from the railway station to feeder services for surrounding area. In terms of the capacity of each of the station plazas, the east side should be larger than the west side based on the analysis of traffic circulation and access roads.

The development needs of station plazas were determined according to the railway passenger demand and public space in relation to number of passengers. The required number of bus berths and land area are shown in Tables 2.7.2 and 2.7.3. The station plazas should be planned to include small-scaled public service facilities such as kiosks, cafés, and small restaurants.

The number of berths was calculated based on the estimate of passenger boarding demand by mode, boarding/alighting time per passenger, average dispatching interval by mode and the dispatching turnover per peak hour by mode. The calculation method is as follows:

- During peak hour, average occupancy per one Mini bus and Bus at station plaza of intermediate bus station is assumed at 100%.

- Based on the result of HIS survey, average passenger occupancy of car and taxi is as follows: Car at 1.5 passengers, and Taxi at 2.0 passengers.
- In accordance with the railway frequency including boarding/alighting time per passenger, average dispatching interval by mode is defined as follows: Bus at 8.0 min and Minibus at 8.0 min based on total boarding/alighting time, Shared taxi, taxi, and car at 2.0 min based on the arrival schedule of railway.
- Based on the above, the dispatching turnover per peak hour by mode is expected as follows: Bus and Mini bus at 7.5 times based on the dwell time of 8.0 min, Shared taxi, taxi, and car at 30 times based on the dwell time of 2.0 min.

Table 2.7.2 Maximum Number of Berth Required for Station Plazas at Ain Shams Station

Number of Berth Required in 2022					
Location	Car for Kiss & Ride	Shared Taxi	Bus	Minibus	Taxi
Station Plaza 1	8	15	5	2	10
Station Plaza 2	4	5	0	0	10
Total	12	20	5	2	20

Source: JICA Study Team

<u>Station Plaza 1 (East side)</u>

At the present, within the area between Ain Shams St. and the Metro Line station that constitute densely built-up area, it is very difficult to construct a station plaza at the east side of the station. Therefore, the plan of station plaza should be considered by using a method of moving out the dwellers and demolishing their buildings in front of the existing Metro Line 1 station. In addition, Cairo Traffic Engineering Bureau (CTEB) of Cairo Governorate proposed to construct an alternative of elevated station plaza on the East Wing railway track. Accordingly, the type of at-grade station plaza 1 is proposed at low-height and old building area, in consideration of the land constraints and accessibility of major roads. The proposed design of Station Plaza 1 is shown in Figures 2.7.5, 2.7.6, and 2.7.7.

Source: JICA Study Team

Figure 2.7.5 Proposed Plan of Station Plaza 1

Source: JICA Study Team

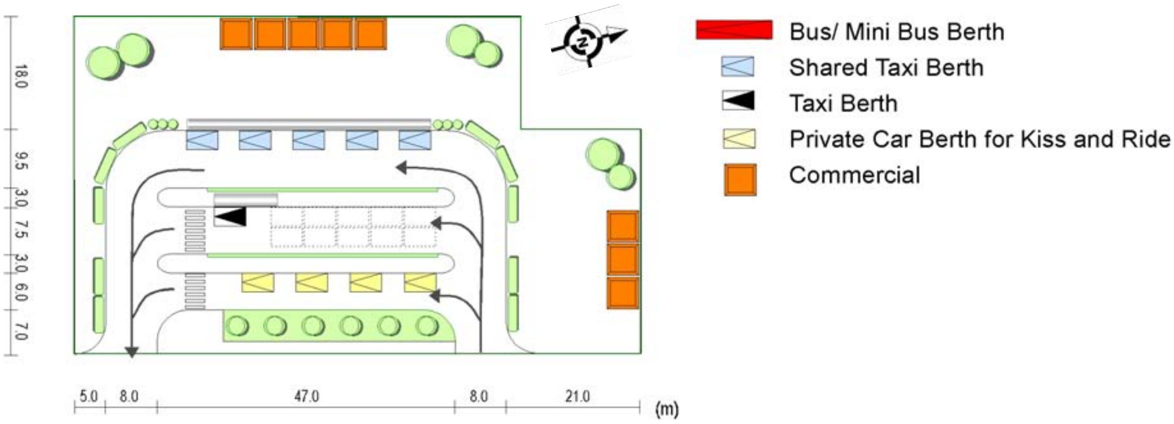
Figure 2.7.6 Image of the Proposed Plan of Station Plaza 1 (1)

Source: JICA Study Team

Figure 2.7.7 Image of the Proposed Plan of Station Plaza 1 (2)

Station Plaza 2 (West side)

On the other hand, there is suitable land for development of station plaza at the west side of the station. The proposed plan of Station Plaza 2 is shown in Figures 2.7.8 and 2.7.9.



Source: JICA Study Team

Figure 2.7.8 Proposed Plan of Station Plaza 2

Source: JICA Study Team

Figure 2.7.9 Image of Station Plaza 2

The required land area of each station plaza is shown in Table 2.7.3.

Table 2.7.3 Required Land Area for Station Plazas at Ain Shams Station

	Vehicle Way (sq.m)	Foot Path (sq.m)	Green Area (sq.m)	Total Area (sq.m)	Pedestrian Deck (3m width)
Station Plaza 1	5,600	3,000	2,400	11,000	54 m
Station Plaza 2	1,600	2,700	200	4,500	0m
Total	7,200	5,700	2,600	15,500	54m

Source; JICA Study Team

2.7.2 Traffic Management Program

This section discusses the traffic management program by introducing a traffic signal control system, a public transport priority system, based on the proposed intermodal facility plan.

(1) General

Figure 2.7.10 shows the road network in the intermodal area in Ain Shams. The intermodal area is traversed from east to west by Tereat El Gabal St., and from north to south by Ain Shams St., which serve as corridor for the area. Several streets serve as linkages to these corridors for feeder services in the area However, the ENR railway and Metro Line 1 intercept these feeder streets. The existing secondary street network in the study area is, on average, 6m and 10m wide. In this context, in peak periods, substantial traffic concentrates at the key intersections accessing the corridor. Based on the current street network and the plan of the intermodal facility, a traffic management program should be considered. In addition, the plan must consider how to create an attractive urban environment that is amenable to pedestrians as well for public transport.

(2) Planning Approach

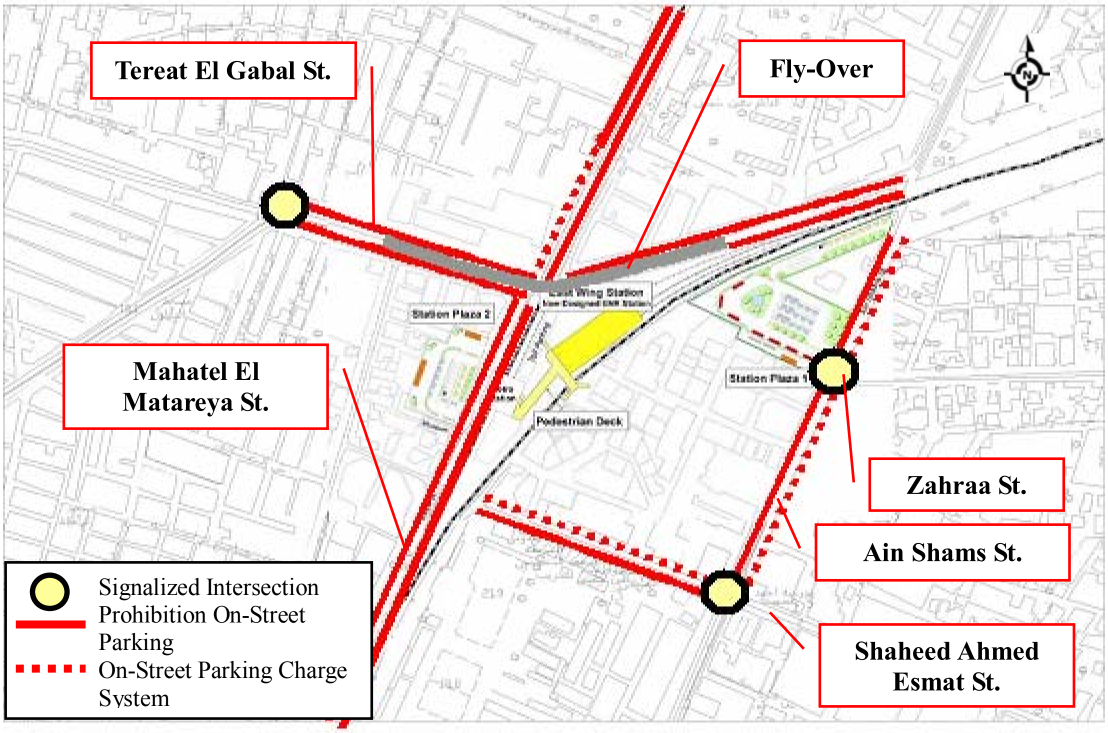
The traffic management program that takes into account the following basic strategies, based on these issues, is envisioned for the intermodal area in Ain Shams. The strategies are as follows:

- In order to control both motor vehicles and pedestrian traffic, traffic signal lights should be installed at non-signalized intersections on major corridor. In addition, the signal control system can be effectively operated for the smooth accessing of public transport near the bus terminal at railway station.
- In accordance with the installation of traffic signal lights at the above-mentioned intersections, it is necessary that intersection improvement should be planned by introducing the traffic channelization system, in order to reduce traffic accidents and for smooth turning vehicle movements.
- Since there is no space in the built-up area, for the short term, it is very difficult to construct new roads. In order to enlarge the road capacity around the intermodal area in Ain Shams, on-street parking should be restricted. Two

kinds of parking measures are recommended, the prohibition of on-street parking and an on-street parking charge system by introducing a parking ticket system.

(3) Plan Location

Based on the above-mentioned basic strategy, the plan of traffic management programs in the study area is shown in Figure 2.7.10. The locations for traffic management programs in the study area were based on the following analysis of the current situation.



Source: JICA Study Team

Figure 2.7.10 Plan of Traffic Management Programs in Intermodal Area

1) Installation of Signal Light

a. Locations for Installation of Traffic Signal Light

According to the traffic analysis of the vehicle traffic flow data and the site observation survey, substantial number of vehicles are observed traveling from/to the study area during peak periods, located at major gateways such as Ain Shams St. and Tereat El Gabal St. The no-signalized intersections on these gateways linking to intermodal area will be considered for the installation of signal lights, in order to control both motor vehicles and pedestrian traffic. The locations for the installation of traffic signal lights are as follows:

- Ain Shams St.- Zahraa St. intersection

- Ain Shams St.- Shaheed Ahmed Esmat St. intersection
- Tereat El Gabal St.- Trolley St. intersection

b. System Function and Control Concept

In order to control both motor vehicles and pedestrian traffic, based on the calculated capacity, the signal phases and splits will be designed. The plan includes the channelization system.

Control Concept

In order to reduce crossing time for pedestrians by minimizing the carriageway crossing distance, and contribute to pedestrian safety, an exclusive signal phase for pedestrian crossing at signalized intersection should be proposed. For Ain Shams St.- Zahraa St. Ain Shams St.- Shaheed Ahmed Esmat St. intersection and Tereat El Gabal St.- Trolley St. intersection, the signal of 3 phases with scramble crossings for pedestrian-friendly will be installed.

c. Design of Signal Cycle Time an Split Time

The calculation of the saturation flow rate and the saturation degree of the intersection was carried out in order to formulate adequate signal splits. The saturation flow rate of each intersection is shown in Tables 2.7.4 (1)(2)(3). Figures 2.7.11 (1)(2)(3) show the plan of signal cycle time and splits. The cycle length with all-red indication is determined from the degree of saturation of the intersection and time for pedestrian crossing.

Table 2.7.4 (1) Saturation Flow Rate and Phase Ratio Required at Ain Shams St.- Zahraa St. Intersection

Approach		N-S			S-N			E-W			W-E (Bus Terminal)				
		S+R	S	S+L	S+R	S	S+L	S+R	S	S+L	S+R	S	S+L		
1) No. of lanes		1	0	1	1	0	1	0	0	1	1	0	1		
2) Basic value of saturation flow rate (PCU)		2,000	-	2,000	2,000	-	2,000	-	-	2,000	2,000	-	2,000		
3) Adjustment factor lane width		1.000	-	1.000	1.000	-	1.000	-	-	1.000	1.000	-	1.000		
4) Adjustment factor for heavy vehicles		1.000	-	1.000	1.000	-	1.000	-	-	1.000	1.000	-	1.000		
5) Adjustment factor for left-turns		1.000	-	0.850	1.000	-	0.850	-	-	0.850	1.000	-	0.850		
6) Adjustment factor for right-turns		0.850	-	1.000	0.850	-	1.000	-	-	0.850	0.850	-	1.000		
7) Saturation flow rate (PCU)		1,700	-	1,700	1,700	-	1,700	-	-	1,445	1,700	-	1,700	S.D of phase	Total S.D
8) Flow rate		0.441			0.441			0.346			0.147				
9) Necessary phase ratio	1Φ				0.441									0.441	0.787
	2Φ							0.346						0.346	
	3Φ	(Scramble Crossing for Pedestrians)													

Source: JICA Study Team. Note: R=Right-turn, S=Straight, L= Left-turn, S.D=Saturation Degree

Table 2.7.4 (2) Saturation Flow Rate and Phase Ratio Required at Ain Shams St.- Shaheed Ahmed Esmat St. Intersection

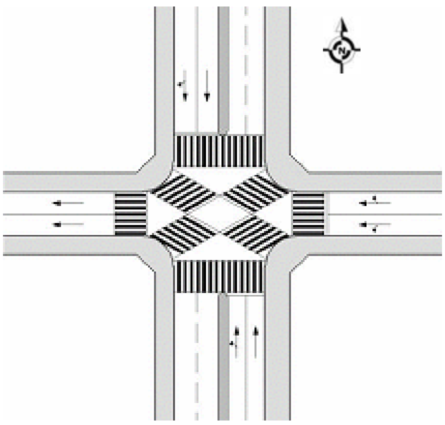
Approach		N-S			S-N			E-W							
		S+R	S	S+L	S+R	S	S+L	S+R	S	S+L					
1) No. of lanes		1	1	0	0	1	1	1	-	1					
2) Basic value of saturation flow rate (PCU)		2,000	2,000	-	-	2,000	2,000	2,000	-	2,000					
3) Adjustment factor lane width		1.000	1.000	-	-	1.000	1.000	0.950	-	0.950					
4) Adjustment factor for heavy vehicles		1.000	1.000	-	-	1.000	1.000	1.000	-	1.000					
5) Adjustment factor for left-turns		1.000	1.000	-	-	1.000	0.850	1.000	-	0.850					
6) Adjustment factor for right-turns		0.850	1.000	-	-	1.000	1.000	0.850	-	1.000					
7) Saturation flow rate (PCU)		1,700	2,000	-	-	2,000	1,700	1,615	-	1,615				S.D of phase	Total S.D
8) Flow rate		0.405			0.405			0.310							
9) Necessary phase ratio	1Φ	0.405												0.405	0.715
	2Φ							0.310						0.310	
	3Φ	(Scramble Crossing for Pedestrians)													

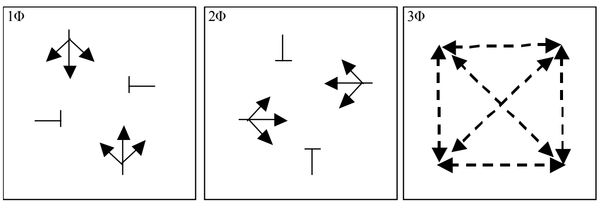
Source: JICA Study Team. Note: R=Right-turn, S=Straight, L= Left-turn, S.D=Saturation Degree

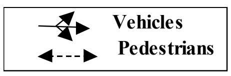
Table 2.7.4 (3) Saturation Flow Rate and Phase Ratio Required at Tereat El Gabal St.- Trolley St. Intersection

Approach		N-S			S-N			E-W			W-E				
		S+R	S	S+L	S+R+L	S	S+L	S+R	S	S+L	S+R+L	S	S+L		
1) No. of lanes		1	0	0	1	0	0	0	0	1	1	-	-		
2) Basic value of saturation flow rate (PCU)		2,000	-	-	2,000	-	-	-	-	2,000	2,000	-	-		
3) Adjustment factor lane width		1.000	-	-	1.000	-	-	-	-	1.000	1.000	-	-		
4) Adjustment factor for heavy vehicles		1.000	-	-	1.000	-	-	-	-	1.000	1.000	-	-		
5) Adjustment factor for left-turns		1.000	-	-	0.850	-	-	-	-	0.850	0.850	-	-		
6) Adjustment factor for right-turns		0.850	-	-	0.850	-	-	-	-	1.000	0.850	-	-		
7) Saturation flow rate (PCU)		1,700	-	-	1,445	-	-	-	-	1,700	1,445	-	-	S.D of phase	Total S.D
8) Flow rate		0.118			0.415			0.353			0.138				
9) Necessary phase ratio	1Φ				0.415									0.415	0.768
	2Φ							0.353						0.353	
	3Φ	(Scramble Crossing for Pedestrians)													

Source: JICA Study Team. Note: R=Right-turn, S=Straight, L= Left-turn, S.D=Saturation Degree







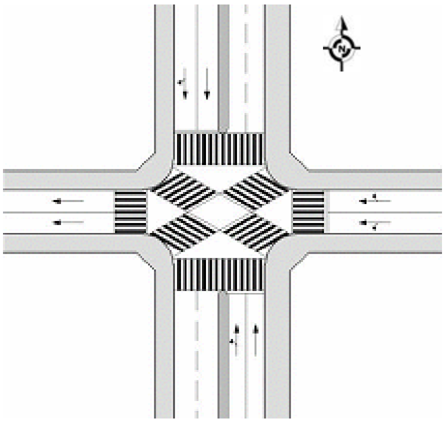
Proposed Signal Step: Cycle Length = 120 sec

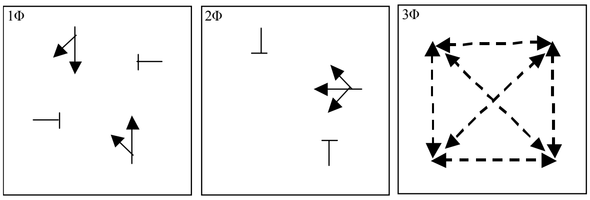
Phase	Time (sec) (20 / 40 / 60 / 80 / 100 / 120)				
1Φ	G (53)	Y	R (45)		AR
2Φ	R (57)		G (41)	Y	AR
3Φ	R (102)				AR

Note: G=Green time, R=Red time,
AR=All-red time, Y=Yellow time : 4 sec

Source: JICA Study Team

Figure 2.7.11 (1) Plan of Signal Cycle Time and Splits at Ain Shams St.- Zahraa St. Intersection



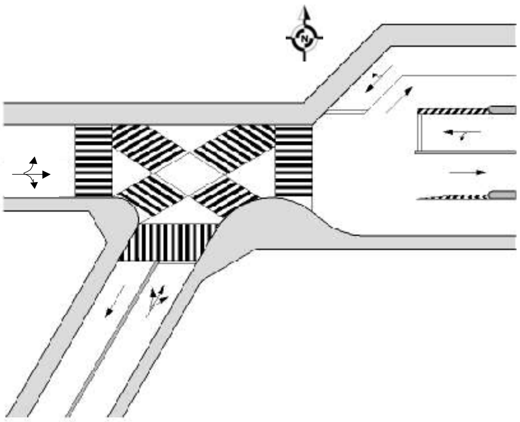


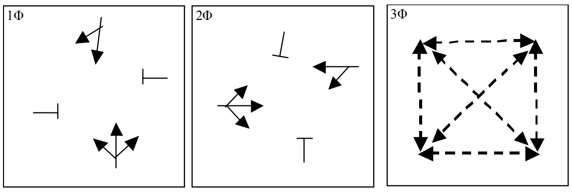
Proposed Signal Step: Cycle Length = 100 sec				
Phase	Time (sec) 20 40 60 80 100			
1Φ	G (43)	Y	R (35)	AR
2Φ	R (47)	G (31)	Y	AR
3Φ	R (82)			AR

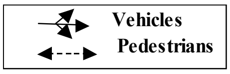
Note: G=Green time, R=Red time,
AR=All-red time, Y=Yellow time : 4 sec

Source: JICA Study Team

Figure 2.7.11 (2) Plan of Signal Cycle Time and Splits at Ain Shams St.- Shaheed Ahmed Esmat St. Intersection







Proposed Signal Step: Cycle Length = 110 sec				
Phase	Time (sec) 20 40 60 80 100			
1Φ	G (46)	Y	R (42)	AR
2Φ	R (50)	G (38)	Y	AR
3Φ	R (92)			AR

Note: G=Green time, R=Red time,
AR=All-red time, Y=Yellow time : 4 sec

Source: JICA Study Team

Figure 2.7.11 (3) Plan of Signal Cycle Time and Splits at Tereat El Gabal St.- Trolley St. Intersection

2) Intersection Improvement

a. Locations for Installation of Intersection Improvement

Based on the plan for signalized intersections, the intersections at Ain Shams St.- Zahraa St., Ain Shams St.- Shaheed Ahmed Esmat St., and Tereat El Gabal St.- Trolley St. will be improved by channelization, including pavement marking for lanes, pedestrian crossings and stop lines, in order to control traffic flow on major and minor approaches and to ensure the safety of pedestrians.

b. Improvement Items

A channelization plan for proposed signalized intersections was proposed, based on the installation plan of traffic signal lights at non-signalized intersections. These improvements are listed in Table 2.7.5.

Table 2.7.5 Improvement Measures for Signalized Intersection

Improvement Measures	Ain Shams St.- Zahraa St. Intersection	Ain Shams St.- Shaheed Ahmed Esmat St. Intersection	Ain Shams St.- Zahraa St. Intersection
1. Improvement of pavement markings where lane operation to be altered	○	○	○
2. Addition of exclusive left-turn lanes	–	–	–
3. Installation of pedestrian crossings	○	○	○
4. Improvement of channelizing island	–	–	–
5. Improvement of corner cut	○	○	○

Source: JICA Study Team

3) Parking System

On-street parking will be prohibited from 8:00 AM to 8:00 PM along the main gateway to the intermodal area of Ain Shams. The prohibition of on-street parking will be adopted at sections which have high parking occupancy. They are: Ain Shams St, Shaheed Ahmed Esmat St., Tereat El Gabal St., and Mahatel El Matareya St.. In addition, parking spaces should be made along Ain Shams St., Shaheed Ahmed Esmat St., and Mahatel El Matareya St. by introducing an on-street parking charge system.

a. Locations for On-Street Parking System

The on-street parking will be prohibited on the following section along major gateways in the area. Long-term parking will be controlled by a parking charge system. This parking charge system is referred to in Chapter 4, Traffic Management Program along Metro 4 Corridor. These two forms ought to be applied at the same time within one system. Figure 2.7.10 shows the location plan for parking system in study area. The plan location coverage is stated below.

- Section between railway crossing and El Shaheed Ahmed Esmat St. on Ain Shams St.: The section is 17.0m wide and composed of 4-lanes. The one side of section will be prohibited, on the other side an on-street parking charge system will be introduced (270m).

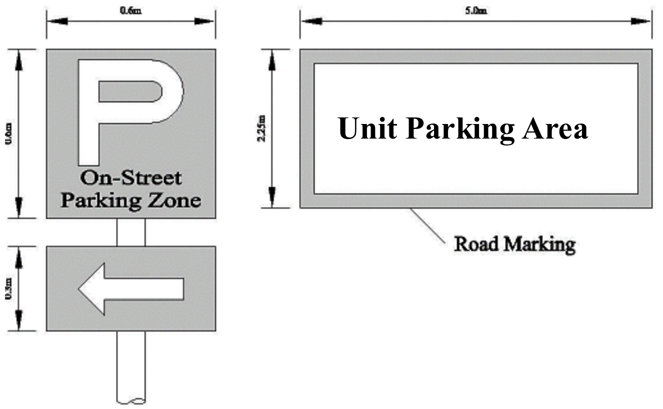
- Section between Ain Shams St. and railway station on El Shaheed Ahmed Esmat St.: The section is one-way 7.0m wide and composed of 2-lanes. One side of the section will be prohibited, on the other side an on-street parking charge system will be introduced (250m).

- Section between Trolley St.and railway crossing on Tereat El Gabal St.: The section is 23.0m wide and is composed of 4-lanes and 5-lanes. On both sides of the section, parking will be prohibited.
- Section between Rabbat St.and and Tereat El Gabal St on Mahatel El Matareya St.: The section is 7.0m wide and is composed of 2-lanes. On both sides of the section, parking will be prohibited.
- Section between Tereat El Gabal St and Moutafawiqin school on Mahatel El Matareya St.: The section is 8.5m wide and is composed of 2-lanes. On one side of the section, parking will be prohibited; on the other side an on-street parking charge system will be introduced (100m).

b. Plan Description of Parking Charge System

The parking charge system is: when parking on the designated street, he/she has to put a ticket on the dashboard where it can be seen from the outside. An inspector shall be responsible for the sale of tickets, and for patrolling to check for violators, the inspector shall stick a traffic violation ticket on the car to inform the driver of his/her offence.

Facilities for parking spaces and guide signs shall be installed so that the drivers can clearly identify them and easily follow the guided information. These facilities are provided for parking vehicles on parking-designated streets. The standard design of parking spaces and guide signs for on-street parking charge system are shown in Figure 2.7.12.



Source: JICA Study Team

Figure 2.7.12 Standard Design of Unit Parking Area and Guide Sign

2.8 COST ESTIMATION

(1) Initial Investment Cost Estimation of East Wing Railway Development Plan

Based on the East Wing Railway development plan, initial investment cost was estimated as shown in Table 2.8.1.

Table 2.8.1 Estimated Initial Investment Cost of the East Wing

(Unit: LE Million)

Investment Item	Unit	Unit Cost LE	Number of Units	Total Cost LE	Local %	Foreign %	Local Amount	Foreign Amount
Running Track								
Elevated	km	52	9	444.5	70	30	311.1	133.3
At-Grade (new line)	km	20	12	237.3	70	30	166.1	71.2
At-Grade (rehabilitation)	km	12	29	346.3	70	30	242.4	103.9
Sub-Total				**1,028.2**			**719.7**	**308.4**
System Works								
Track Work (new line)	km	9	19	168.1	35	65	58.8	109.3
Track Work (rehabilitation)	km	6	30	185.8	35	65	65.0	120.8
Signal & Communications	km	6	49	275.9	35	65	96.6	179.4
Sub-Total				**629.9**			**220.5**	**409.5**
Station								
Elevated	Sta.	14	2	29.0	60	40	17.4	11.6
At-Grade	Sta.	8	7	56.3	70	30	39.4	16.9
Sub-Total				**85.3**			**56.8**	**28.5**
Depot & Workshop	Uint	24	1	24.1	50	50	12.1	12.1
Sub-Total				**24.1**			**12.1**	**12.1**
Rolling stock	Unit	5	30	152.9	3	97	4.6	148.3
Sub-Total				**152.9**			**4.6**	**148.3**
Land Acquisition								
Depot and Station	10,000 m²	0.5	7	**3.3**	95	5	3.2	0.2
New line	10,000 m²	0.5	14	**7.0**	95	5	6.7	0.4
Sub-Total				**10.3**			**9.8**	**0.5**
Total				**1,930.7**			**1,023.4**	**907.2**
Engineering and Construction Management (8%)				154.5	10	90	**15.4**	**139.0**
Local Administration (5%)				96.5	100	0	96.5	0.0
Sub-Total				**2,181.7**	52	48	**1,135.4**	**1,046.2**
Contingency (10%)				218.2			113.5	104.6
Total				**2,399.8**			**1,249.0**	**1,150.9**

Source: JICA Study Team based on "Greater Cairo Public Transport Study Stage-1 Phase 3", February 2001, SYSTRA and others
Note: Year mid-2003 price

Assumptions for the cost estimation are summarized as below.

- Civil work includes embankments, cuttings, viaduct structures, realignment of streets and highways. Cost for relocations of utilities and sanitary services are taken into account in contingencies.
- Stations are assumed as relatively simple and economical in function and design.
- System and equipment include double track work, signalling, communication, and ticketing. Track work includes ballast, sub ballast and other track materials.
- The Depot and Workshop include capital cost of tracks and equipment cost for maintenance and repair.
- Land acquisition includes land for new line construction and the depot.
- The Rolling Stock includes cost for initial operation in year 2007. Additional investment cost for the rolling stock is shown in next section.

Engineering and construction management fee was calculated by assuming as 8% of the investment cost, while local administration cost was assumed as 5%. Contingency was assumed as 10% of a total cost of the initial investment cost, the engineering/construction management fee and cost of the local administration.

(2) Additional Investment Cost Estimation

As shown in the future transport demand forecast of the East Wing, number of passengers grows year by year. Therefore, additional investment is necessary to cope with the increased passengers. The train operation planning in section 2.6.5 clarified necessary number of trains in future. Based on the train operation plan, the Study Team estimated necessary additional investment schedule for rolling stocks as shown in Table 2.8.2.

Total additional investment reaches to LE722.7 million for the project period.

Table 2.8.2 Additional Investment Schedule

(Unit: LE Million)

Investment Item	Total Investment	Local Amount	Foreign Amount	2013		2017		2020	
				Local	Foreign	Local	Foreign	Local	Foreign
Rolling stock	581.4	17.4	564.0	6.4	207.8	6.6	212.7	4.4	143.5
Sub-Total	**581.4**	**17.4**	**564.0**	**6.4**	**207.8**	**6.6**	**212.7**	**4.4**	**143.5**
Engineering and Construction Management (8%)	46.5	4.7	41.9	1.7	15.4	1.8	15.8	1.2	10.6
Local Administration (5%)	29.1	29.1	0.0	10.7	0.0	11.0	0.0	7.4	0.0
Sub-Total	**75.6**	**33.7**	**41.9**	**12.4**	**15.4**	**12.7**	**15.8**	**8.6**	**10.6**
Contingency (10%)	65.7	5.1	60.6	1.9	22.3	1.9	22.9	1.3	15.4
Total	**722.7**	**56.3**	**666.4**	**20.7**	**245.5**	**21.2**	**251.4**	**14.3**	**169.5**

Source: JICA Study Team

(3) Operating and Maintenance Cost Estimation

Operation and maintenance cost of the East Wing railway was estimated based on Japanese experiences on diesel car operation by considering specific Egyptian conditions in terms of costs, such as labor cost and fuel cost.

Estimation of the cost was made on labor costs and material costs such as fuel cost, parts and other materials.

The labor costs were estimated based on necessary number of employees by three sections of the operating organization.

The necessary number of employees was calculated based on estimated future train-km for operating section, while car-km was used for maintenance section. Necessary number of employees for the administrative section was estimated based on total number of employees of the operating and maintenance section. Estimated number of employees was increased by 20% considering local conditions. Table 2.8.3 shows future passenger-km, train-km and car-km, while Table 2.8.4 shows necessary number of employees by section and by year.

Table 2.8.3 Future Passenger-km, Train-km and Car-km

(Unit: km)

Year	2007	2012	2022
Passenger-km/day	2,582,000	3,593,000	12,933,000
Train-km/day	5,939	6,527	20,355
Car-km/day	17,817	19,581	101,775

Source: JICA Study Team

Table 2.8.4 Necessary Number of Employees by Section

(Unit: person)

Year	2007	2012	2022
Administration	22	24	99
Operation	114	126	391
Maintenance	118	129	673
Total	254	279	1,163

Source: JICA Study Team

The material cost was estimated by separating it into four categories of track maintenance, electric circuit maintenance, rolling stock maintenance and fuel/others. These costs were estimated based on future car-km estimates. The material costs were finally converted into local costs by considering local factors such as fuel cost.

Table 2.8.5 shows the resulting operation and maintenance cost of the East Wing railway by year.

Table 2.8.5 Operation and Maintenance Cost of the East Wing Railway

(Unit: LE Million)

Year	2007	2012	2022
Labor Cost	3.8	4.2	17.4
Material Cost	39.7	43.7	201.8
Total	43.5	47.8	219.3

Source: JICA Study Team

The Study Team compared the estimated operation and maintenance cost with the costs of Egyptian National Railway and Cairo Metro Organization in terms of the cost per passenger-km. The estimated cost of the East Wing railway was LE0.046 in 2007, while the costs of ENR and CMO were 0.038 and 0.012 respectively (source: estimated by CREATS Master Plan, excluding interest payment and depreciation). Considering the current maintenance performances for the ENR and CMO, the cost of the East Wing railway is considered sufficient.

(4) Operating Revenue Estimation

As shown in the future transport demand forecast section, the fare system of the East Wing railway was assumed as a distance based system. Future fare revenue of the railway is calculated as in Table 2.8.6 according to the future passenger-km and future number of passengers.

Table 2.8.6 Future Fare Revenue of East Wing Railway

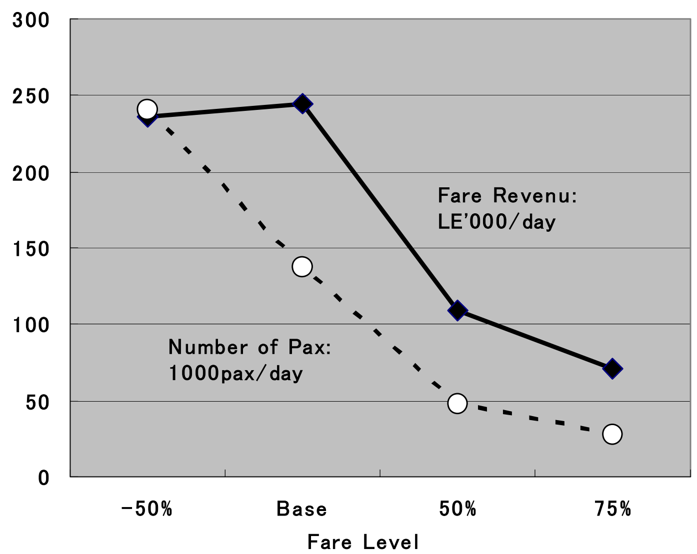
(Unit: person)

Year	2007	2012	2022
Daily Passenger (Million)	0.095	0.138	0.472
Revenue per Day (LE Million)	0.137	0.246	1.119
Revenue per Year (LE Million, 365 days)	50.0	89.8	408.4

Source: JICA Study Team

By comparing the fare revenue in future years with the operation and maintenance cost, it is clear that the railway revenue covers the cost from the first year of operation in terms of operation and maintenance. Operating and maintenance cost ratios to the fare revenue are 0.87, 0.52 and 0.54 in 2007, 2012 and 2022 respectively. The ratio in 2012 is better than other years, because number of passengers ideally fits with the train operation plan.

Figure 2.8.1 shows a sensitivity test of number of passengers and fare revenue of the East Wing railway against fare level changes. It should be noted that the analysis was done on year 2012. At the assumed "Base Case" fare level would produce maximum revenue, while number of passengers would decrease considerably compared to the 50% fare reduction case. Detailed financial analyses clarify overall financial feasibility including impacts of depreciation and interest payment in the later section.



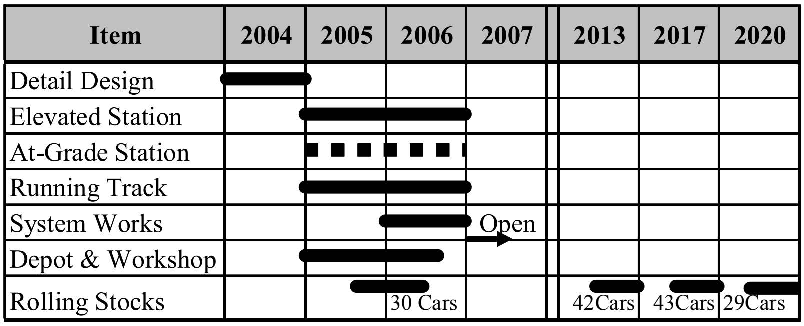
Source: JICA Study Team

Figure 2.8.1 Sensitivity of Revenue and Passengers against Fare Level Changes

(5) Construction Plan

As shown in the Table 2.8.7, the Study Team made a construction plan of the railway. Detailed design work is considered to take one year, followed by construction works, which shall be two years. In the beginning of 2007, the East Wing Railway shall be open according to the schedule. Additional rolling stocks shall be purchased to increase transport capacity in future years.

Table 2.8.7 Construction Plan of the East Wing Railway



Source: JICA Study Team

Table 2.8.8 shows an estimated initial investment cost distribution by year.

Among the total initial investment cost of approximately LE2.4 billion, two thirds are expected in 2006. With regard to the additional investment of rolling stocks, refer to Table 2.8.2 Additional Investment Schedule in this section.

Table 2.8.8 Construction Cost Estimation by Year

(Unit: LE Million)

Investment Item	Total Investment	Local Amount	Foreign Amount	2004		2005		2006	
				Local	Foreign	Local	Foreign	Local	Foreign
Running Track									
Elevated	444.5	311.1	133.3			124.5	53.3	186.7	80.0
At-Grade (new line)	237.3	166.1	71.2			66.5	28.5	99.7	42.7
At-Grade (rehabilitation)	346.3	242.4	103.9			97.0	41.6	145.5	62.3
Sub-Total	**1,028.2**	**719.7**	**308.4**			**287.9**	**123.4**	**431.8**	**185.1**
System Works									
Track Work (new line)	168.1	58.8	109.3					58.8	109.3
Track Work (rehabilitation)	185.8	65.0	120.8					65.0	120.8
Signal & Communications	275.9	96.6	179.4					96.6	179.4
Sub-Total	**629.9**	**220.5**	**409.5**					**220.5**	**409.5**
Station									
Elevated	29.0	17.4	11.6			7.0	4.6	10.4	7.0
At-Grade	56.3	39.4	16.9			15.8	6.8	23.7	10.1
Sub-Total	**85.3**	**56.8**	**28.5**			**22.7**	**11.4**	**34.1**	**17.1**
Depot & Workshop	24.1	12.1	12.1			8.4	8.4	3.6	3.6
Sub-Total	**24.1**	**12.1**	**12.1**			**8.4**	**8.4**	**3.6**	**3.6**
Rolling stock	152.9	4.6	148.3			1.8	59.3	2.8	89.0
Sub-Total	**152.9**	**4.6**	**148.3**			**1.8**	**59.3**	**2.8**	**89.0**
Land Acquisition									
Depot and Station	3.3	3.2	0.2			3.2	0.2		
New line	7.0	6.7	0.4			6.7	0.4		
Sub-Total	**10.3**	**9.8**	**0.5**			**9.8**	**0.5**		
Total	**1,930.7**	**1,023.4**	**907.2**			**330.7**	**203.0**	**692.8**	**704.2**
Engineering and Construction Management (8%)	154.5	15.4	139.0	4.6	41.7	4.6	41.7	6.2	55.6
Local Administration (5%)	96.5	96.5	0.0	29.0	0.0	29.0	0.0	38.6	0.0
Sub-Total	**2,181.7**	**1,135.4**	**1,046.2**	**33.6**	**41.7**	**33.6**	**41.7**	**44.8**	**55.6**
Contingency (10%)	218.2	113.5	104.6	3.4	4.2	36.4	24.5	73.8	76.0
Total	**2,399.8**	**1,249.0**	**1,150.9**	**37.0**	**45.9**	**400.7**	**269.2**	**811.3**	**835.8**

Source: JICA Study Team

2.9 ENVIRONMENTAL IMPACT ASSESSMENT

2.9.1 Introduction

Transport improvement projects are implemented to improve the mobility of goods and persons, which should result in improved economic development. Consequently, it will improve the social environment of the people involved. However, almost every project has also negative impacts on the environment, being slight or severe.

Environmental Impact Assessment (EIA) is an integral part of the process of project selection, design and implementation. It should be a tool for decision makers to consider the impacts of proposed activities on the (physical and social) environment, in order to seek for alternatives, to prepare steps to mitigate the negative impacts and to enhance the positive impacts. If necessary a proposed activity should be rejected.

To ensure sustainability for the Railway Project, one of the selected transport improvement projects for Greater Cairo (CREATS 2), a **scoped** Environmental Impact Assessment (EIA) has been carried out as part of the feasibility study. The EIA indicates the potential negative as well as the positive environmental impacts to be expected from the selected transport development project. Also mitigation measures, required to alleviate the identified adverse environmental impacts, are provided. The EIA has been carried out by Egyptian consultants (MB Consultants) under the supervision of the Study Team, according to the Egyptian, JICA, and international guidelines and regulations.

For a full description and characteristics of the Railway Project, refer to the relevant chapters in the current report.

Environmental Surveys were part of the Environmental Impact Assessment. An Air Quality and Noise Level Survey, and a Social Survey (Social Impact Assessment), were carried out. Their results revealed the present environmental condition of the Project Area, as well as the opinion of the residents on the proposed project.

2.9.3 Egyptian Guidelines and Legislation related to Environmental Impact Assessment

(1) Governmental Agencies

Environmental guidelines to be followed in the Study are in principle the guidelines and regulations of Egypt, as well as JICA and other international environmental guidelines. In general, it can be stated that Egyptian environmental regulations, as well as other international guidelines (like World Bank and EC guidelines), prescribe that transport development projects should be designed and constructed along environmentally sound principles to ensure sustainability.

The State Ministry of Environmental Affairs, established in 1982, is the final body in Egypt for all matters relating to national environmental policy and regulatory actions. Apart from overseeing the activities of the implementing agency, the Egyptian Environmental Affairs Agency (EEAA), the ministry has major inputs in the setting of the environmental policy and public investment projects. The EEAA has a broad mandate and regulatory power for enforcing Law No 4 for Environment (1994) and various environmental regulations. The EEAA is also responsible for environmental guidelines and setting of standards for industries, surveillance of environmental quality and sampling, and stipulation of corrective measures for polluters. It reviews EIA's for development projects and provides environmental clearance. The Agency has the mandate to develop public awareness, environmental training and undertake research on environmental resource management.

Through its regional branch offices, the EEAA oversees all activities in the field of environment in Egypt. In undertaking its duties, the EEAA cooperates with several multilateral and bilateral donors, as well as a large number of Egyptian bodies. The latter include research institutes, universities, and central and local government agencies. As far back as 1992, Egypt developed a National Environmental Action Plan (Environmental Action Plan of Egypt), which addressed all major issues related to Egypt's environment. The Plan provides the basis for environmental action and the framework for foreign funding of environmental projects in Egypt.

(2) Environmental Laws and Regulations in Egypt

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 / Law No. 2 of 1985 for agricultural land scooping.
- Law No. 117 of 1983 for archaeological protection.

The most important legal framework with reference to environmental protection is the "Law No. 4 of 1994". This law explains the objectives and policies advocated by the EEAA, and their means of realization. The Law called upon the formation of an Environmental Protection Fund to support environmental protection projects and studies. The law also outlines the legal requirements and procedures for Environmental Impact Assessment for different categories of development projects, including the construction of infrastructure for the transport sector.

The EEAA published in 1996 the "Guidelines for Environmental Impact Assessment". These guidelines complement the above mentioned rules and protective measures stipulated in the Environmental Law 4/1994. For the CREATS Study, the sections dealing with the categories of projects and the sector guidelines are of special relevance.

Similar EIA guidelines have been developed in the Ministry of Housing and Ministry of Transport, reflected in the "Egyptian Code for Urban and Rural Highway Works". A special circulation letter has been circulated by the EEAA which regulates the Implementation of Infrastructure Development Projects in the Transport Sector.

It can be concluded that the Egyptian Environmental laws and regulations are well developed and do not lack behind, for the major environmental problems, compared to international environmental laws, regulations and guidelines.

2.9.4 Environmental Impact Assessment for the East Wing Railway Project

(1) Introduction

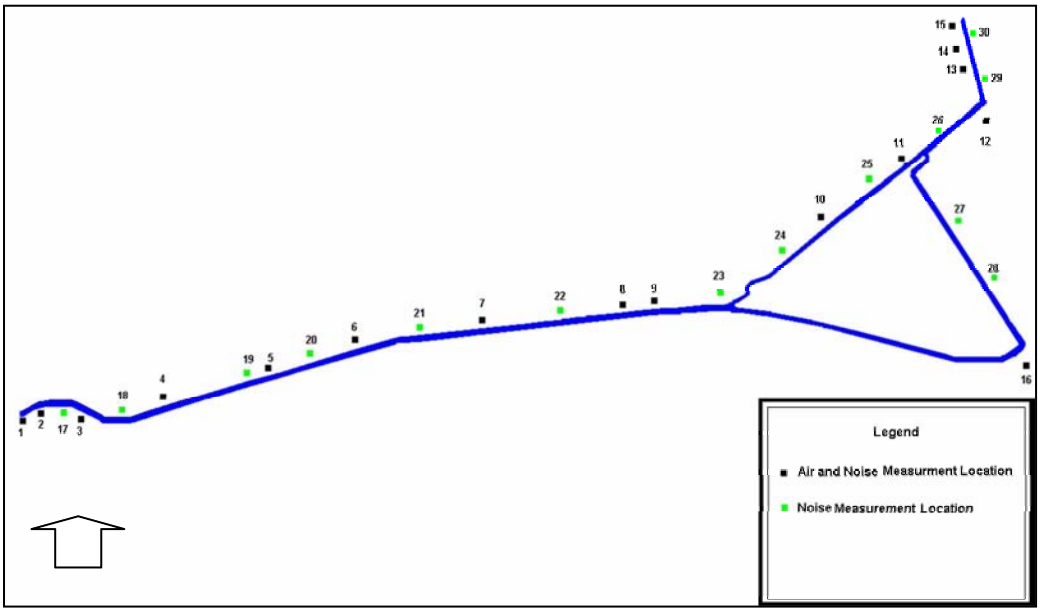
Potential adverse and positive environmental impacts have been identified for the proposed Option of the East Wing Railway Project. Also, the existing situation in the Project Area has been evaluated for its environmental condition. Major results of the Air Quality Survey, the Noise Level Survey and the Social Survey are presented in this section. The measurement locations for the Air Quality and Noise level Surveys are presented in Table 2.9.1 and Figure 2.9.1.

Table 2.9.1 Description of Measurement Locations, Rail Way Project

Location	Code	Location Name and Description
1.	01EW7 Noise & air	In front of Ain Shams Telecom Center, near Ain Shams Train Station Crossing of 6th October St with Ain-Shams St (next to rail crossing)
2.	02EW1 Noise & air	Crossing of 6th October St with Al Eshreen St (next to rail crossing)
3.	03EW7 Noise & air	Ain Shams Entrance from Gesser El-Suez Road in front of Garag Station
4.	04EW7 Noise & air	Gesser El-Suez Road in front of Qanal Market (at rail crossing)
5.	05EW7 Noise & air	Microbus Station in front of Salam City Entrance on Ismailia Desert Road (on the ring road)
6.	06EW7 Noise & air	Oboor Market (next to the Mosque)
7.	07EW1 Noise & air	Entrance of Hykstep Military Officers City Next to rail crossing

Location	Code	Location Name and Description
8.	08EW7 Noise & air	Shorooq City Entrance 1 next to rail crossing
9.	09EW1 Noise & air	Shorooq City Entrance 2 next to rail crossing
10.	10EW1 Noise & air	In front of Arab Contractors ConSt.uction Services Administration on Ismailia Desert Road
11.	11EW7 Noise & air	First Entrance of 10th of Ramadan City at the crossing of Robeiky Road (to Suez) with Bilbeis Road and Ismailia Desert Road (in front of KFC)
12.	12EW1 Noise & air	Second Entrance of 10th of Ramadan City below the bridge (KM 51) (Dr. Greiche)
13.	13EW1 Noise & air	El Rowad Club on the road to the city center (10th of Ramadan city) from the second entrance
14.	14EW7 Noise & air	10th of Ramadan Microbus Station next to Ordoneya Commercial Market
15.	15EW1 Noise & air	Residential Area next to 10th of Ramadan Microbus Station next to Ordoneya Commercial Market
16.	16EW1 Noise & air	Rail Crossing on Robeiky Road
17.	17EWN	At Ain Shams between location 2 and 3
18.	18EWN	Near the garage between location 3 and 4
19.	19EWN	Between location 4 and 5 but closer to location 5
20.	20EWN	Between location 5 and 6 but closer to location 6
21.	21EWN	Between location 6 and 7
22.	22EWN	Between location 7 and 8
23.	23EWN	Between location 9 and 10 but closer to location 9
24.	24EWN	Between location 9 and 10 but closer to location 10
25.	25EWN	Between location 10 and 11
26.	26EWN	Between location 10 and 11
27.	27EWN	Between location 11 and 16 but closer to location 11
28.	28EWN	Between location 11 and 16 but closer to location 16
29.	29EWN	Between location 12 and 13
30.	30EWN	Between location 14 and 15

Note: *Key for Location ID; example 06 EW 7/N:*
06: location number, EW: East Wing, 7: measuring days, N: if used, only noise measurement
Source: JICA Study Team



Source: JICA Study Team

Figure 2.9.1 Measurement Locations for the East Wing Railway Project

(2) Air Quality Survey

At the Survey Locations in the Project Area, the following parameters were measured:

- NO, NO_2, NOx, SO_2, CO, O_3, CH_4, NMHC, THC, TSP;
- PM_{10} and $PM_{2.5}$
- Ambient air temperature;
- Relative humidity;
- Barometric pressure;
- Bind direction;
- Wind speed; and
- Net radiation.

The measured concentrations of air pollutants have been compared with the Air Quality Standards of Egypt (Executive Regulations to Environmental Law No.4 of 1994), and the WHO standards (1999) for air quality as shown in Table 2.9.2. Wednesdays are (with Tuesdays) the busiest days in Cairo, and consquently have the heaviest air pollution during the week.

The following conclusions can be drawn from all the air quality measurements in the Project Area for the Railway Project:

- Fine dust (PM_{10}) levels heavily exceed the Egyptian standard (70 µg/m3) at most measuring locations almost continuously;

- The Carbon Monoxide (CO) levels regularly exceeded the Egyptian and WHO standards at several locations;
- Sulphur Dioxide (SO_2) is at considerable level at some places, however, below Egyptian and WHO standards; and
- Nitrogen Dioxide (NO_2) is at considerable level at some places, however, below Egyptian standards.

It can be generally said that the overall air quality in the East Wing Project Area is better than in the West Wing Project Area.

As seen above, the measured concentrations of PM_{10} appeared to be high. Generally, this type of very fine suspended particles consist of: coal and oil fly ash; metals and metal oxides; tire wear debris; street dust; and Carbon, Sulphate and Nitrate particles. The sources of particles of 10 μm or less (PM_{10}) are generally:

- Combustion of oil, diesel, gasoline, coal, and wood;
- Traffic, and industrial and agricultural operations;
- Construction and demolition operations; and
- Transformations from NO_x and SO_2.

Table 2.9.2 Summary Results Air Quality for Rail Way Project

Location/ Time Surveyed	NO_2 Nitrogen Dioxide		SO_2 Sulphur Dioxide			CO Carbon Monoxide			PM_{10} Particulate Matter 10 µm		O_3 Ozone	
	Measured	Egypt Standard	Measured	Egypt Standard	WHO Standard	Measured	Egypt Standard	WHO Standard	Measured	Egypt Standard	Measured	Egypt & WHO Standard
	(µg/m³)		(µg/m³)			(mg/m³)			(µg/m³)		(µg/m³)	
01EW7 7/May/03	53.8	150	15.0	150	125	5.7	10	10	112.9	70	93.1	120
03EW7 14/May/03	78.2	150	60.3	150	125	6.0	10	10	213.7	70	60.8	120
04EW7 14/May/03	35.0	150	68.0	150	125	14.3	10	10	189.9	70	90.2	120
06EW7 21/May/03	30.0	150	14.0	150	125	4.0	10	10	120.8	70	99.9	120
05EW7 21/May/03	30.4	150	68.8	150	125	4.1	10	10	94.1	70	65.8	120
11EW7 28/May/03	21.5	150	17.1	150	12	5.6	10	10	86.4	70	102.3	120
14EW7 28/May/03	15.3	150	20.2	150	125	3.6	10	10	37.8	70	81.9	120
8EW7 4/Jun/03	14.7	150	12.8	150	125	4.4	10	10	62	70	93.0	120
16EW7 4/Jun/03	33.0	150	9.0	150	125	2.6	10	10	97	70	80.3	120

Notes: 24-hour average concentrations of air pollutants at survey locations; (Except CO, and O3 is 8-Hour Averages)

(3) Noise Level Survey

The following results came from the Survey of Noise Level Measurements at 30 locations as shown in Table 2.9.1 in the Project Area for the Railway Project. The surveyed measurements are tabulated in Table 2.9.3.

The Noise Levels stipulated by the Egyptian standards are:

- During the day (>55 dB);
- During the evening (>50 dB);
- During the night (>45 dB);

Compared to these standards, the results are all exceed the standards, which also confirms the outcome of earlier Noise Level measurements, which were carried out during Phase I of CREATS.

Traffic produces noise that can cause considerable annoyance. It can interfere with daily life, like: work, sleep, study, communication and recreation. Long term exposure to noise can generate undesirable physical and psychological effects. In calm environments, generally sound levels of 30 - 50 dB(A) are measured. Disruptive sounds have noise levels higher than about 70 dB(A).

Generally, the following negative impacts on health are attributed to high noise levels: fatigue, headaches, lack of concentration, sleep disturbances, delayed reactions, mood and behavioural changes, high blood pressure, hearing impairment, and neurological ailments.

Table 2.9.3 Summary of Noise Levels for All Sites, the East Wing Railway Project

Egyptian Standard (Environment Law 4 , 1994) Maximum Permissible Noise Level (dB) in Residential Areas	Day	Evening	Night
	7 am – 6 pm	6 pm – 10 pm	10 pm – 7 am
	45 – 55	40 – 50	35 - 45
Survey Locations	Measured Noise Level (dB)		
Location 1	76.9	76.8	73.5
Location 2	73.8	72.0	67.9
Location 3	76.0	75.5	72.9
Location 4	72.8	72.6	70.6
Location 5	75.7	74.9	72.8
Location 6	77.4	76.5	73.3
Location 7	72.4	74.6	70.8
Location 8	78.5	77.9	73.3
Location 9	60.6	60.6	62.1
Location 10	67.0	73.2	66.0
Location 11	66.4	63.0	60.8
Location 12	73.5	72.0	68.1
Location 13	67.6	65.2	58.2
Location 14	70.3	69.1	63.4
Location 15	58.3	61.5	58.1
Location 16	60.7	63.0	61.3
Location 17	74.7	73.3	68.1
Location 18	76.4	75.2	72.1
Location 19	76.4	74.3	72.9
Location 20	75.6	74.3	73.4
Location 21	77.4	75.6	73.7
Location 22	73.0	74.5	71.2
Location 23	78.7	78.1	73.1
Location 24	68.1	73.5	65.5
Location 25	65.5	61.3	60.2
Location 26	65.9	62.0	61.4
Location 27	65.9	62.1	60.5
Location 28	65.7	62.5	60.8
Location 29	67.3	66.4	58.3
Location 30	70.2	72.6	63.5

Source: JICA Study Team

(4) Social Survey

The objective of the Social Survey was to assess the opinion of the residents in the Project Areas to the proposed and selected transport development projects..[1]

A total of 291 respondents were asked to fill in a questionnaire form especially prepared for the CREATS (Phase 2) Feasibility Studies. The division of the numbers of sampled respondents over the Projects was: West Wing 139, East

[1] Full details of the Social Impact Assessment are referred to the "Social Opinion Survey, CREATS 2, Cairo October 2003" which was carried out by MB Consultants under a subcontract with JICA Study Team.

Wing 119, and Supertram 33. The respondents were picked randomly in the following areas:

- Ard El Lewaa; Barageel; and 6th October for the West Wing Project
- Giza; 10th of Ramadan City; and Ain Shams for the West Wing Project
- Heliopolis; and Madinet Nasr for the Supertram Line 1 Project

The sample was semi-structured, that is, comprising, in spite of its limited amount, the various age groups, genders, and diversity of professions. Simultaneously it was divided to represent the density of the population; for example, a higher number of respondents was chosen within the highly populated areas such as Barageel, Ard El Lewaa, and Ain Shams. Attributes of the respondents are summarized as shown in Table 2.9.4.

Table 2.9.4 Attributes of Sample Respondents for Social Survey

Question	Answer	Share
Work Place	(1) Same suburb as residence	38%
	(2) Other Suburb	27%
	(3) Other town/city	11%
	(4) Others	24%
Distance between Residence and Work Place	(1) Less than 1.0 km	30%
	(2) 1 – 5 km	16%
	(3) More than 5 km	28%
	(4) N.A.	25%
Type of Residence	(1) Apartment	80%
	(2) House	20%
	(3) Others	0%
Residence Status	(1) Own	54%
	(2) Rent	32%
	(3) Fringe Benefit	2%
	(4) Others	4%

Source: JICA Study Team

Major questions and answers from the Social Survey are listed below for the total of 291 respondents. For several questions the answers are provided as a specific break down for the East Wing Railway Project, as shown in Table 2.9.5. The major conclusions of the Social Survey can be summarized as follows:

- There is evidently agreement with the Projects, inclusive of the East Wing Railway Project.
- Most of the residents concerned would use the new transport system.
- The residents concerned regard the selected projects as highly positive for the physical, as well as for the socio-cultural environment.

As for Question 1, it is not a surprising result that the basic perception level on the Project is significantly low among residents, as 41% of interviewees do not know the East Wing Project, because this project is a new idea proposed by the CREATS Master Plan. After this question, however, all interviewees were briefly informed of the Project, and then, next questions on their opinion were made. Therefore, their expectation and acceptance of the Project are based on their knowledge on the Project to some extent.

Table 2.9.5 Summary of Answers of Social Surveys Related to the Projects

Question	Answering Item	Supertram Project	West Wing Busway Project	East Wing Railway Project
1. Do you know about the planned Project ?	(1) Yes	27%	39%	**59%**
	(2) No	73%	61%	**41%**
2. What is your opinion about the Project ?	(1) Agree	97%	89%	**92%**
	(2) Not Agree	0%	6%	**4%**
	(3) Unknown	3%	4%	**3%**
3. Would you use the New Transport System?	(1) Frequently	42%	65%	**73%**
	(2) Not Frequently	9%	14%	**8%**
	(3) Occasionally	42%	17%	**15%**
	(4) No use	6%	4%	**3%**
4. How do you think about the Environmental Impact of the Project?	(1) Positive	97%	83%	**92%**
	(2) Negative	3%	16%	**6%**
	(3) Others	0%	1%	**2%**
5. How do you think about Scio-cultural Impact of the Project ?	(1) Positive	100%	93%	**95%**
	(2) Negative	0%	6%	**4%**
	(3) Others	0%	1%	**1%**

Source: JICA Study Team

(5) Expected Negative Environmental Impacts from the East Wing Railway Project

Activities and processes, related to transport development projects, may result in significant negative as well as positive impacts on the environment. Potential adverse impacts on the physical/biological as well as the socio-cultural, environment have been identified for the East Wing Railway Project. The impacts are presented in Table 2.9.6. Only potentially realistic impacts are presented for the proposed transport development project.

The core reasons why the environmental impacts of the proposed Railway Project are minor are:

- The Proposed Railway Project is a public transport project (versus projects promoting use of private cars);
- The train system with diesel locomotive is less energy consumption, compared to use of cars;
- The Project is situated in an urban environment where no impact will be on fragile ecology;

- The right of way is mainly owned by the government, and free of houses and other structures; and
- The impacts can be mitigated.

Table 2.9.6 Expected Adverse Environmental Impacts from the Rail Way Project in the Pre-Construction, Construction and O & M Phases

PROJECT ACTIVITIES	EXPECTED ADVERSE IMPACTS *Socio-economic and physical/biological aspects*
Pre-construction/Design Phase Survey and site investigations. Land acquisition: area to be acquired for the "right of way" (new section 140,000 m2; depot 70,000 m2).	**Pre-construction Phase** Fragmentation/split up of areas; increased physical barriers. Impact on aesthetics.
Construction Phase 1. Base camp establishment and operation 2. Earthworks/embankment fill: - haulage of fill and construction material - embankment spreading, levelling - compaction of embankment - shaping, finishing of embankment 3. Construction of 3 fly-overs and 2 elevated stations at 10th of Ramadan City: - excavation works - foundation works - construction of piers - construction of beams - erection of beams and casting deck slabs 4. Sign posting, traffic control	**Construction Phase** 1. Disposal of waste, waste spills (oil) 2, 3, 4: Interruption of water flows, erosion/ sedimentation, air pollution, spills of waste, vibrations, noise, safety risks for workers, damage to existing roads, traffic congestion, disposal of earth material / spoils, impact on aesthetics
Operation & Maintenance Phase Trains in operation Maintenance and repairs of rail tracks. Maintenance and repairs of signposts Cleaning up of debris Maintenance of planted trees, grass and berms	**Operation & Maintenance Phase** Noise and vibrations Risk of accidents (public health).

Source: JICA Study Team

(6) Expected Positive Impacts of the Rail Way Project

Table 2.9.7 presents anticipated adverse impacts on the socio-economic environment in the existing situation and the expected positive impacts after project implementation of the proposed Railway Project. Further positive impacts expected from the proposed Railway Project on the social and physical environment are:

- A number of car users will start using the train *(less emission, less energy consumption.)*
- There will be less air pollution compared to the situation of not carrying out the proposed public transport Project (*Zero Option*), especially when the trains will run on electricity after 2022 (*less emission, less energy consumption).* There will be no significant increase of noise levels.
- A more free flowing traffic pattern will be realized, resulting in a reduced number of accidents.

- Safety for pedestrians will be increased by the construction of pedestrian bridges and underpasses.
- There are new possibilities for planting of trees and landscaping.

Table 2.9.7 Adverse Environmental Impacts in Existing Situation and Expected Positive Impacts from the Rail Way Project

Proposed Project	Adverse socio-economic environmental impacts in existing situation	Expected positive socio-economic environmental impacts after project implementation
Rail Way Project	• Bad performance of existing facility • Long travel time for passengers • Nuisance • High operation costs • Poor accessibility.	• Reduction of travel time for passengers • Increased economic development • Improved mobility, facilitating the urban function of the city Increased safety

Source: JICA Study Team

(7) Recommended Mitigation Measures

The overall effect of the proposed Railway Project on the region of Greater Cairo is expected to be positive and should progress economic development.

Several negative impacts can be avoided or minimized when appropriate mitigation measures are incorporated in the Design, the Construction, and the Operation & Maintenance Phases of the Project.

It is emphasised that, particularly during the Pre-Construction/Design Phase, as many mitigation measures as possible (such as bridges for pedestrians) should be incorporated to minimise adverse environmental impacts in the next project phases.

Table 2.9.8 presents the expected adverse environmental impacts in the Pre-Construction/Design, the Construction and the Operation & Maintenance Phases of the Railway Project, with the possible mitigation measures to minimise the identified negative impacts.

Table 2.9.8 Mitigation Measures for the Rail Way Project in the Pre-Construction, Construction and O & M Phases

EXPECTED ADVERSE IMPACTS *Socio-economic and physical/biological aspects*	MITIGATION MEASURES
Pre-construction Phase - Fragmentation / split up of areas. - Impact on aesthetics.	**Pre-construction Phase** - Proper design of flyovers and stations. - Landscaping, planting trees. - Preparation of Environmental Management and Monitoring Plans and Transport Management Plan.
Construction Phase - Disposal of waste, waste spills (oil). - Interruption of water flows, erosion/ sedimentation, change in groundwater level, air pollution, spills of waste, vibrations, noise, safety risks for workers, damage to existing roads, traffic congestion, disposal of earth material/spoils. - Impact on aesthetics.	**Construction Phase** - Enforcement of laws and regulations. - Proper Environmental Management and Monitoring during all works. - Execution of Transport Management Plan. - Proper disposal of waste. - Proper drainage. - Safety precautions. - Planting of trees, landscaping, re-establishing situation.
Operation & Maintenance Phase - Risk of accidents (public health). - Noise and vibrations.	**Operation & Maintenance Phase**. - Landscaping, trees, plantations. - Proper Operation & Maintenance and repairs. - Proper Environmental Management and Monitoring. - Safety precautions. - Noise and engine control. - Strict enforcement of (environmental) laws and regulations. - Sound barriers if required (1km Ain Shams).

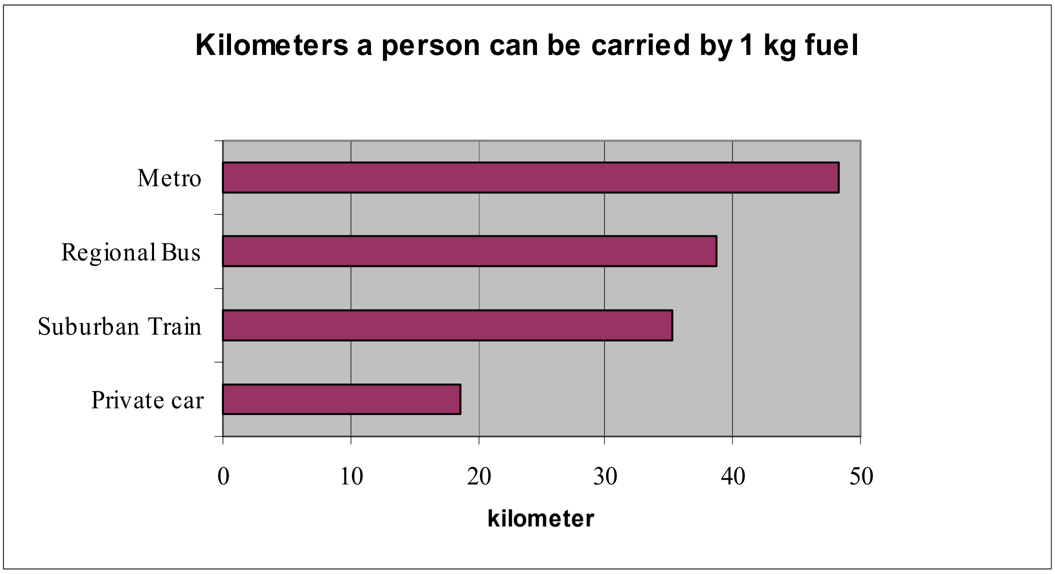
Source: JICA Study Team

2.9.5 Environmental Implications of Zero Option (No Projects Option)

(1) Mitigation of Environmental Burden by Public Transport Systems

It is important to indicate what the environmental situation would be, if the East Wing Project would not be carried out. If the East Wing Project would not materialize, as a consequence the growing traffic demand will be shifted (at least partly) to users of private cars, the fuel consumption as well as the emissions will be much larger than the case if the traffic demand is fulfilled by public transport facilities such as the enhanced railway system in the East Wing Corridor.

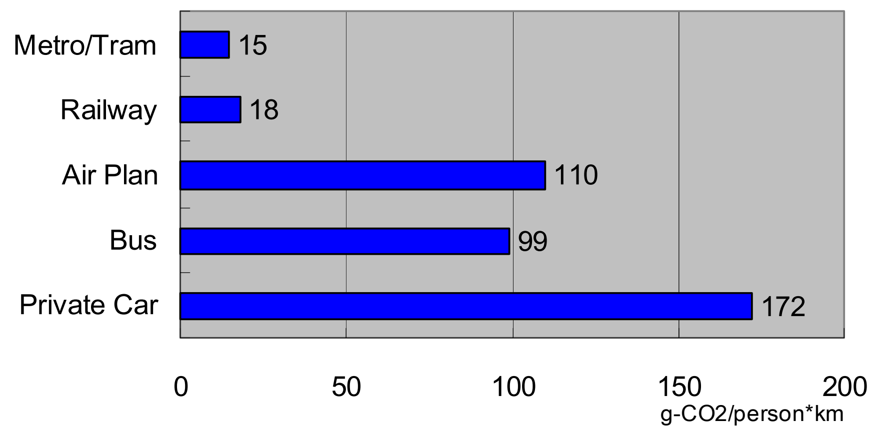
Figures 2.9.1 shows an evidently general form of fuel efficiency by transport mode in terms of kilometers a person can be carried by a 1 kg fuel. As seen in this figure, the Suburban Train is 2 times as fuel-efficient as private car.



Source: International Association of Public Transport, Brussels, May 2001

Figure 2.9.2 Fuel Efficiency of Different Modes

A general comparison of CO_2 emission by transport mode is as shown in Figure 2.9.3 quoted from a different source. This chart indicates CO2 emission (grams) per an unit transport load (passenger-km). The railway system generates only 10% of private car for a passenger-km.



Source: Annual Environmental Report, Japan (2000)

Figure 2.9.3 CO_2 Emission From Passenger-km by Transport Mode

Thus, the extension of public transport (metro, bus and train) is the best choice to meet growing traffic demand from an environmental point of view. This is certainly the case in an area like Greater Cairo, where the burden of air pollution and noise is already high.

(2) A Quantitative Impact on A Global Issue of CO_2 Mitigation

A quantitative environmental impact by the Project was examined in terms of deduction of CO_2 emission. Due to a lack of proven data for emission factors and meteorological conditions in Greater Cairo, the other quantitative and tangible environmental factors related to air quality other than CO_2 are difficult to be rationally projected,.

The analysis is based on the following assumptions:

- The total reduction of CO_2 Emission by the execution of the Project was projected in the Study Area as a whole, not in a limited service catchment area of the Project. This means that the analysis is based on a change in the transport pattern in the entire Study Area, given the Project. The traffic speeds and traffic volumes by vehicle type were computed by the CREATS Model in both "With" and "Without" cases.
- The analysis is also based on a CO_2 emission function with respect to the vehicle speed by vehicle type for the quantitative projection, as shown in Figure 2.9.4 which is a Japanese function developed in 1990, because of two reasons: a) neither reliable nor proven emission-speed functions exist for the local condition in Cairo; and b) this 1990 Japanese function seems close to the present Cairo condition.
- The impact on reduction of CO_2 is represented by annual volumes in 2022 when each project will fully be operated in service.

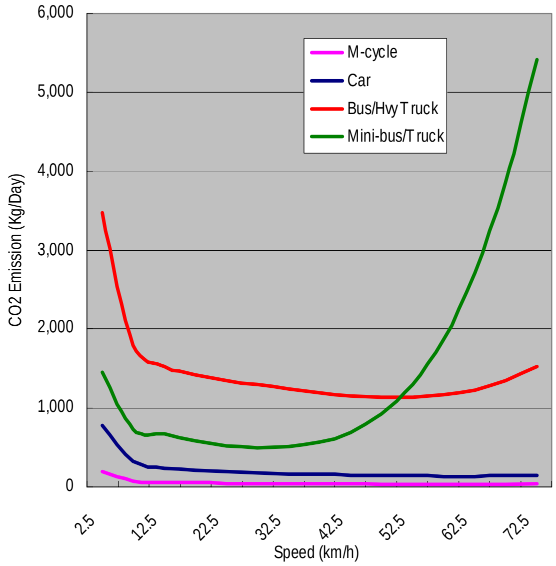


Figure 2.9.4 Relations between Vehicle's Speed and CO_2 Emission

- Since the Projects is the public transport improvement projects, the implementation of the Project will significantly affect road traffic conditions, which tends to induce the more vehicle traffic at higher speed. A special attention should be given to large vehicles such as trucks and buses which generate more CO_2 emission at higher speed over 30-40 km/h, as seen in Figure 2.9.4. The increased volume of CO_2 emission by such higher speed trucks are so large that all the reduction by the project could be offset. Therefore, an environmental control policy to enforce a speed limit of 30-40km/h to trucks is assumed to be applied.

A summary of the results is shown in Table 2.9.9, where environmental impacts of the other projects are compared.

As seen in this table, the total CO_2 emission in the "Without" case accounts for approximately **16,624 thousand** tons/year in the whole GCR in 2022. Given the East Wing Project, the total CO_2 emission will account for **16,582 thousand** tons/ year, therefore, the difference of **42,152 tons/year** can be regarded as a reduction of CO_2 brought by introduction of the East Wing Project.

For a comparison, the Supertram Project will reduce about 16,000 tons/year of CO2 in 2022, and the West Wing Project will provide with a remarkable reduction of CO_2 emission by around 632,000 tons/year in 2022, which is interestingly the most largest impact among the three projects.

Thus, the positive environmental impact by each project in terms of CO_2 emission is significantly great, and can be converted to the fuel energy consumption.[2] It is generally said that one as litter of gasoline generates **2.30 kg** of CO_2, the CO2 reduction of about 42,000 tons is equivalent to the reduction of about **18.3 million litters/year of gasoline**, or 108,000 bbl./year.

Table2.9.9 A Summary of Environmental Impact in CO_2 Emission

Case	CO_2 Emission in 2022 (tons/year)	Reduction of CO_2 Emission (tons/year)		
		East Wing	West Wing	Supertram 1
Without the Project (Committed Only)	16,623,904	-	-	-
With the East Wing	16,581,752	**42,152**	-	-
With the West Wing	15,992,197	-	631,706	-
With the Supertram Line 1	16,607,848	-	-	16,056

Source: JICA Study Team

2.9.6 Environmental Management and Monitoring

After assessing the environmental sensitivities, analyzing the potential impacts and their effects, and suggesting mitigation options, the following measures should be assured for the Environmental Management and Monitoring for the East Wing Railway Project. These measures should be considered as commitment actions to control the impacts on the environment and provide the framework for the future environmental management of the area in order to minimize the negative impacts of the project activities during the construction as well as the operation & maintenance phases.

Inform MHUUC, Cairo Governorate, local authorities and other operators in the region of the scheduled construction activities, the location and route of the project, the exact starting date of execution and the environmental measures taken to avoid damages. Beside being informed, they should be involved in case of emergencies.

[2] For another reference, it is said that one human being generates about 1.0kg CO2 per day, or approximately 0.36 ton per year.

Plan the excavation/construction programs to optimize the required equipment and site installations. A base camp should be at least 200m from any residential areas. Reinstate used land to its original state by the end of the activities.

Optimize the layout of access roads.

Detailed design and layout of (3) flyovers and (2) elevated stations will be discussed and consulted with the concerned authorities and affected people. All materials will be chosen in such a way as to provide the greatest chance of operational success, and have the lowest practicable impact on the environment.

Make available on-site temporary waste disposal facilities and dispose of wastes from the site as much as possible. Burial on site is not suggested. The operating contractor would be required to provide indication of how, where, and when waste will be disposed. Bills of quantities, times, and dates of disposal, should be kept.

Dispose of all scrap metal, plastic bottles, old drums, batteries and others in compliance with the EEAA guidelines.

Set up an emergency/contingency plan at least 30 days before the start of the project operations. This plan should include any spills. Keep pictorial and illustration records from before and after operations to monitor and control restoration of sites.

Prepare a checklist as part of the Environmental Management Plan that will constitute Environmental Performance Indicators (EPI) to monitor the environmental performance of all parties involved in the project activities.

The following authorities should be responsible, each in it's own jurisdiction area, for the Environmental Monitoring of the project performance during the construction phase and the operation and maintenance Phase of the Project:

- Ministry of Transportation and Communication;
- Ministry of Housing, Utilities and Urban Communities;
- Cairo Governorate;
- Giza Governorate; and
- Egyptian Environmental Agency Affairs (EEAA).

2.9.7 Conclusions

The negative environmental impacts to be expected from the proposed Railway Project are:

- Division of neighbourhoods by rail tracks.
- Impact on aesthetics from 2 elevated stations and 3 flyovers, blocking the views for residents.

The negative environmental impacts can be mitigated by the following measures:

- Construction of bridges and underpasses, especially for pedestrians.
- Compensation by landscaping, planting of trees, and parks.
- Additional: sound barriers are required to improve the situation (1 km in Ain Shams).

The following positive impacts are expected from the proposed Railway Project on the economy:

- Improved mobility and access for the residents of Greater Cairo.
- Reduced travel time and costs.
- Improved conditions for economic development.
- Enhanced development of tourism.

Further positive impacts are expected from the proposed East Wing Railway Project on the social and physical environment:

- A number of car users will start using the train (less emission, less energy consumption.)
- There will be less air pollution compared to the situation of not carrying out the proposed public transport Project (Zero Option), especially when trains will run on electricity after 2022 (less emission, less energy consumption)
- There will be no significant increase in noise levels.
- A more free flowing traffic pattern will be realized, resulting in a reduced number of accidents.
- Safety for pedestrians will be increased by the construction of pedestrian bridges and underpasses.
- There are new possibilities for the planting of trees and landscaping.The overall conclusions of the environmental studies for the East Wing Railway Project are:

- Major positive environmental impacts are expected.
- Minor negative environmental impacts are expected, which can be mitigated.
- The Railway Project is sustainable and environmentally feasible.

2.10 ECONOMIC AND FINANCIAL ANALYSIS

2.10.1 Procedure of Economic and Financial Evaluation

An economic evaluation provides a useful criterion for the public sector to make a rational decision of allocation of its limited budget to a certain project from the viewpoint of the national economy as a whole. For an economic evaluation, various benefits which are expected to arise by the project and costs to be spent for the operation and maintenance as well as the implementation of the project are considered and calculated in an economic term on an annual basis within a project life to be defined (20~30 years), depending upon the nature of the project. The costs estimated at market prices are converted to the "economic costs" which denotes the project cost to the national economy, excluding transfer items and employing an opportunity cost concept for goods/services to be procured at a distorted market.

While, a financial evaluation shall provide useful implications for the project owner, including the public sector, to predict anticipated returns on the investment, thereby supporting him/her to make a rational decision on the investment of funds, or "do or not", compared to the "cost of money" at a financial market and the returns from other investment opportunities. Furthermore, the financial viability implies a vital indicator on how much the government sector needs to involve in the project through provision of government subsidies.

2.10.2 Major Premises

(1) A Conceptual Setting of "With and Without the Project"

The costs and benefits are calculated as differences between "with" and "without" the Project. The "with" case denotes a situation of how the transport conditions could be in the entire Study Area, given the Project. While, the "without" case does not stands for nothing happened on the current situation, but represents a situation of how the transport conditions would be in the entire Study Area, given only the committed projects completed as scheduled.

Table 2.10.1 shows a list of project components and their status to be considered in the transport network in the Study Area in the case of "without", while Table 2.10.2, in the case of "with the Project". It is noted that the time framework proposed hereby is based on the CREATS Master Plan.

Table 2.10.1 Project Components and Their States in the "Without" Case

Major Components	Without		
	2007	2012	2022
Transport System Improvement in the Master Plan			
Bus Restructuring	As existing	As existing	As existing
Shared Taxi Franchising	As existing	As existing	As existing
Metro 1	Existing+ Committed	Existing+ Committed	Existing+ Committed
Metro 2	Existing+ Committed	Existing+ Committed	Existing+ Committed
Metro 3	Committed	Committed	Committed
Metro 4	None	None	None
Toll Expressway System	None	None	None
Local Roads Improvement	Existing+ Committed	Existing+ Committed	Existing+ Committed
Other Trams Rehabilitation	As existing	As existing	As existing
Focused Projects			
The Supertram 1 Project	None	None	None
The East Wing Project	None	None	None
The West Wing Project	None	None	None

Source: JICA study team calculations

Table 2.10.2 Project Components and Their States in the "With" Case

Major Components	With the East Wing		
	2007	2012	2022
Transport System Improvement in the Master Plan			
Bus Restructuring	As existing	As existing	As existing
Shared Taxi Franchising	As existing	As existing	As existing
Metro 1	Existing+ Committed	Existing+ Committed	Existing+ Committed
Metro 2	Existing+ Committed	Existing+ Committed	Existing+ Committed
Metro 3	Committed	Committed	Committed
Metro 4	None	None	None
Toll Expressway System	None	None	None
Local Roads Improvement	Existing+ Committed	Existing+ Committed	Existing+ Committed
Other Trams Rehabilitation	As existing	As existing	As existing
Focused Projects			
The Supertram 1 Project	None	None	None
The East Wing Project	**As planned**	**As planned**	**As planned**
The West Wing Project	None	None	None

Source: JICA study team calculations

(2) Price Indices and Project Life

For the economic and financial evaluation, the following assumptions are held.

- Pricing data: as of mid-2003
- Foreign Exchanges: 1 US Dollar = 6.0 LE.
- Project Life: 27 years from 2004 through 2030.

(3) Investment Costs

The estimated project costs are sorted out herewith for the evaluation analysis. The Project requires a total of approximately 2.4 billion LE at 2003 prices for the initial investment cost. According to a planned construction schedule, this initial capital cost, including costs for running tracks, system works, stations, depot & workshop, rolling stocks, land acquisition and engineering and administration are allocated in a time framework, as shown in Table 2.10.3. The construction will take 3 years including engineering services.

Along with an anticipated increasing passenger demand, additional investment will be necessary for procurement of rolling stocks, which accounts for about 723 million LE at 2003 prices, as shown in Table 2.10.4. This additional investment will be needed in around 10 years after the commencement of the Project.

Table 2.10.3 Initial Financial Investment Costs for the East Wing Project

(LE Million, at 2003 price)

(Financial Cost)	2004		2005		2006		Total		
	Local	Foreign	Local	Foreign	Local	Foreign	Local	Foreign	Total
Running Track	-	-	287.9	123.4	431.8	185.1	719.7	308.5	1,028.2
System Works	-	-	-	-	220.5	409.5	220.5	409.5	630.0
Station	-	-	22.7	11.4	34.1	17.1	56.8	28.5	85.3
Depot & Workshop	-	-	8.4	8.4	3.6	3.6	12.0	12.0	24.0
Rolling Stock	-	-	1.8	59.3	2.8	89.0	4.6	148.3	152.9
Land	-	-	9.8	0.5	-	-	9.8	0.5	10.3
Engineering	4.6	41.7	4.6	41.7	6.2	55.6	15.4	139.0	154.4
Local Adm.	29.0	0.0	29.0	0.0	38.6	0.0	96.6	0.0	96.6
Contingency	3.4	4.2	36.4	24.5	73.8	76.0	113.5	104.6	218.2
Total Cost	**37.0**	**45.9**	**400.6**	**269.2**	**811.4**	**835.9**	**1,248.9**	**1,150.9**	**2,399.9**

Source: JICA study team calculations

Table 2.10.4 Additional Financial Investment for East Wing Project

(LE Million, at 2003 price)

(Financial Cost)	2013		2017		2020		Total		
	Local	Foreign	Local	Foreign	Local	Foreign	Local	Foreign	Total
Rolling Stock	6.4	207.8	6.6	212.7	4.4	143.5	17.4	564.0	581.4
Engineering	1.7	15.4	1.8	15.8	1.2	10.6	4.7	41.9	46.5
Local Adm.	10.7	0.0	11.0	0.0	7.4	0.0	29.1	0.0	29.1
Contingency	1.9	22.3	1.9	22.8	1.3	15.4	5.1	60.6	65.7
Total Cost	**20.7**	**245.5**	**21.3**	**251.3**	**14.3**	**169.6**	**56.2**	**666.4**	**722.7**

Source: JICA study team calculations

(4) Residual Value

Residual values are appropriated in the last year of the project life, as some investment items have longer useful lives than the project life. Assets invested for the Project still have value till its useful life expires (See Table 2.10.5).

Thus, the residual value is computed according to years left for the rest of useful life by each investment item, as shown in Table 2.10.6.

(5) Reinvestment Cost

Reinvestment costs are appropriated for betterment, replacement and/or improvement of the railway system as whole to keep the railway system in a proper condition. This reinvestment will take place in 20 years after the operation starts. Table 2.10.6 shows a summary of such reinvestment costs as well as residual value as discussed above.

Table 2.10.5 Useful Life of Depreciation Assets of the East Wing Project

Assets	Years
Running Track	50
System Works	20
Station	30
Depot & Workshop	30
Rolling Stock	25

Source: JICA study team

Table 2.10.6 Reinvestment and Residual Value for the East Wing Project

(LE Million, at 2003 price)

(Financial Cost)	2026		Residual Value	
	Local	Foreign	Local	Foreign
Running Track	-	-	374.2	160.4
System Works	220.5	409.5	176.4	327.6
Station	-	-	11.4	5.7
Depot & Workshop	-	-	2.4	2.4
Rolling Stock	-	-	8.0	260.6
Land	-	-	9.8	0.5
Engineering	5.0	45.4	10.7	96.4
Local Adm.	31.5	0.0	67.0	0.0
Contingency	25.7	45.5	66.0	85.4
Total Cost	**282.7**	**500.3**	**725.9**	**939.1**

Source: JICA study team

(6) Operation and Maintenance Cost

The operation and maintenance costs for the new railway service include two items: the labor cost and material cost. The labor cost was estimated as shown in Table 2.10.7, taking into account the proposed organization for the East Wing railway service as discussed in Section 2.11.4 in this volume.

Table 2.10.7 Operation and Maintenance Cost for the East Wing Project

(Unit: LE Million, at 2003 prices)

Year	2007	2012	2022
Labor Cost	3.8	4.2	17.4
Material Cost	39.7	43.7	201.8
Total	**43.5**	**47.8**	**219.3**

Source: JICA study team

2.10.3 Economic Evaluation

The economic evaluation is carried out from a view of whether or not the investment for the East Wing Railway Project will be feasible in terms of the national economy, employing a cost-benefit analysis.

(1) A Special Note of "With" and "Without" the Project

Economic benefits are calculated as differences between "With the Project" and "Without the Project". For the calculation of economic benefits, the situation of the "Without" case is defined identical to the "Do Nothing Scenario" as examined in the CREATS Master Plan. This scenario is not the same situation as the current condition, but depicts such a situation that all committed projects, including Metro Line 3, capacity enhancement of Metro Lines 1 and a number of flyover projects, have materialized in a planned time framework (see the CREATS Master Plan). ***Metro Line 3 is assumed to be operated in 2017. Thus, it should be noted that even the "Without the Project" case hold inclusion of the Metro Line 3 which is very influential to changes in the transport pattern.***

(2) Economic Costs

Economic costs of the Project includes the initial investment cost, additional investment cost, reinvestment cost and residual value cost. These economic costs were derived from the financial costs as described above, after adjusting transfer elements. In order to convert from financial costs to economic costs, conversion rates are assumed to be 81% for local currency items as well as 87% for foreign currency (or imported) items. taking into account the Egyptian taxation and labor market conditions (refer to Section 13.2.2, Volume 3, the CREATS Master Plan, for the details).

1) Economic Costs of Initial Investment

The converted economic costs for the initial investment are summarized in Table 2.10.8. The total economic cost is approximately 2.0 billion LE, half of which, 1.0 billion LE, is local and another half is of the foreign currency portion. It is noted that the land acquisition cost is valuated zero at the economic cost, because the land to be acquired is inherently desert land, of which the opportunity value is none.

Table 2.10.8 Economic Costs of Initial Investment for the East Wing Project

(LE Million, at 2003 price)

(Economic Cost)	2004		2005		2006		Total		
	Local	Foreign	Local	Foreign	Local	Foreign	Local	Foreign	Total
Running Track	0.0	0.0	233.2	107.4	349.8	161.0	583.0	268.4	851.4
System Works	0.0	0.0	0.0	0.0	178.6	356.3	178.6	356.3	534.9
Station	0.0	0.0	18.4	9.9	27.6	14.9	46.0	24.8	70.8
Depot & Workshop	0.0	0.0	6.8	7.3	2.9	3.1	9.7	10.4	20.2
Rolling Stock	0.0	0.0	1.5	51.6	2.3	77.4	3.7	129.0	132.7
Land	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Engineering	3.7	36.3	3.7	36.3	5.0	48.4	12.5	120.9	133.4
Local Adm.	23.5	0.0	23.5	0.0	31.3	0.0	78.2	0.0	78.2
Contingency	2.7	3.6	28.7	21.2	59.7	66.1	91.2	91.0	182.2
Total Cost	**29.9**	**39.9**	**315.8**	**233.7**	**657.2**	**727.2**	**1,002.9**	**1,000.8**	**2,003.7**

Notes: Land cost in economic prices is evaluated at zero. However, necessary costs for engineering, local administration and contingency are included.
Source: JICA study team calculations

2) Economic Cost of Additional Investments

Additional investment cost was converted in the same manner and the result is summarized in Table 2.10.9.

Table 2.10.9 Economic Cost of Additional Investment for the East Wing Project

(LE Million, at 2003 price)

(Economic Cost)	2013		2017		2020		Total		
	Local	Foreign	Local	Foreign	Local	Foreign	Local	Foreign	Total
Rolling Stock	5.2	180.8	5.3	185.0	3.6	124.8	14.1	490.7	504.8
Engineering	1.4	13.4	1.4	13.7	1.0	9.3	3.8	36.4	40.2
Local Adm.	8.7	0.0	8.9	0.0	6.0	0.0	23.5	0.0	23.5
Contingency	1.5	19.4	1.6	19.9	1.1	13.4	4.1	52.7	56.9
Total Cost	**16.8**	**213.6**	**17.2**	**218.7**	**11.6**	**147.5**	**45.5**	**579.8**	**625.4**

Source: JICA study team calculations

3) Economic Cost of Reinvestment and Residual Value

Reinvestment cost and residual value are also converted from the financial to the economic costs, the results of which are shown in Table 2.10.10. The economic residual value is appropriated in the last year of the project life as a negative investment.

Table 2.10.10 Economic Costs of Reinvestment and Residual Value

(LE Million, At 2003 price)

(Economic Cost)	Reinvestment in 2026		Residual Value	
	Local	**Foreign**	**Local**	**Foreign**
Running Track	0.0	0.0	303.1	139.6
System Works	178.6	356.3	142.9	285.0
Station	0.0	0.0	9.2	5.0
Depot & Workshop	0.0	0.0	1.9	2.1
Rolling Stock	0.0	0.0	6.5	226.7
Land	0.0	0.0	0.0	0.0
Engineering	4.1	39.5	8.7	83.9
Local Adm.	25.5	0.0	54.2	0.0
Contingency	20.8	39.6	52.7	74.2
Total Cost	**229.0**	**435.3**	**579.3**	**816.5**

Source: JICA study team calculations

(3) Economic Benefits

Economic benefits were estimated by comparing "*without the project*" in which the East Wing Project does not exist and "*with the project*" in which the East Wing Project exists and is utilized by residents in the Study area who select the new public transport service by diverting from their previous modes in the "*without the project*" case. Economic benefits by the implementation of the East Wing Project was estimated, based on this change in the residents' choice of transport modes.

Economic benefits in this economic analysis are assumed to be two: savings in time cost and maintenance & operation costs. Both benefits are considered as an additional surplus to the national economy to be accrued from the implementation of the Project. Time saving benefit is derived from the total travel time saving in the new transport network with the East Wing Project. Alike, the saving of operation and maintenance costs appear for the other transport modes in the new transport network with the East Wing Project, however, the operation and maintenance cost for the East Wing itself will newly be generated, and the increased costs are considered as "cost" to the national economy.

1) Time Saving Benefits

First, the time saving in the entire Study Area is estimated as difference between the "without project" and "with project" in terms of the total travel time which is spent to travel activities of residents in the Study Area. Then, the travel time saving is converted into the economic benefits in the national economy in monetary term, using unit economic time value by transport mode.

The Study Team adopted a conventional methodology for travel time saving estimation, based on a comprehensive transport network model approach, which is explained as follows:

Methodology of Time Saving Computation

For an explanation purpose, a simplified hypothetical setting is herein supposed, that is, two existing transport modes and one new mode, which be introduced in the Study Area. The existing modes are supposed to be the CTA bus service (denoted by CTA) and the Cairo Metro (Metro) service. The new mode is the new East Wing public transport service (NM). In the "***without***" case, only two modes of CTA and Metro exist, while NM will be available in the "***with***" case.

Under the above setting, six (6) types of public transport passengers are conceivable with the number of passengers (***Tij***) between *i*-origin and *j*-destination (*i-j* zone pairs) by mode and by case as follows:

In the "***without***" case (denoted by WO):

Tij_{WO}^{CTA} : Number of CTA passengers, and

Tij_{WO}^{Metro} : Number of Metro passengers..

In the "***with***" case (denoted by WT):

Tij_{NM}^{CTA} : Number of NM passengers diverted from CTA;

Tij_{NM}^{Metro} : Number of NM passengers diverted from Metro;

Tij_{WT}^{CTA} : Remaining number of CTA passengers; and,

Tij_{WT}^{Metro} : Remaining number of Metro passengers.

While, travel time between *i-j* zone pairs can be expressed as below:

tij_{WO}^{CTA} : Travel time by CTA in "without" case;

tij_{WO}^{Metro} : Travel time by Metro in "without" case;

tij_{NM}^{CTA} : Travel time by NM in "with" case;

tij_{NM}^{Metro} : Travel time by NM in "with" case (same as above)

tij_{WT}^{CTA} : Travel time by CTA in "with" case; and,

tij_{WT}^{METRO} : Travel time by Metro in "with" case.

Since the CREATS model assumed no newly induced demands in the "*with*" case, the total number of *i-j* trips in both "*with*" and "*without*" cases are the same. Therefore, the number of CTA passengers in "*without*" case is same as the sum of the diverted CTA passengers to the NM and the remaining CTA passengers, which can be expressed by:

$$Tij_{WO}^{CTA} = Tij_{NM}^{CTA} + Tij_{WT}^{CTA} \qquad (1)$$

While, since the number of NM passengers in the "*with*" case consists of two types of passengers diverted from CTA and Metro services, which can be expressed by:

$$Tij_{WT}^{NM} = Tij_{NM}^{CTA} + Tij_{NM}^{Metro} \qquad (2)$$

The time saving consists of two: time savings of diverted passengers and the remaining passengers. The savings are expressed as a total travel time in the "*without*" case minus a total travel time in the "*with*" case. Looking into CTA passengers for instance, these are expressed by the following two equations of (3) for diverted passengers and (4) for remaining passengers:

$$TSij_{NM}^{CTA} = (tij_{WO}^{CTA} - tij_{WT}^{CTA}) * Tij_{NM}^{CTA} \qquad (3)$$

$$TSij_{WT}^{CTA} = (tij_{WO}^{CTA} - tij_{WT}^{CTA}) * Tij_{WT}^{CTA} \qquad (4)$$

where, TSij: Time saving of passengers between *i-j* zone pairs

The time saving of diverted passengers is clear, because the NM service is usually faster than that by CTA. While, as for the remaining CTA passengers, they could get time saving only if the travel speed of CTA in the "*with*" case is faster than that in the "*without*" case. This may happen when the travel speed of CTA buses increases due to eased traffic congestion, affected by the introduction of the new mode in the "*with*" case.

The total time saving of CTA passengers, which means a total of the diverted and remaining passengers, are calculated by summing up the formula (3) and (4):

$$\begin{aligned} TSij_{NM+WT}^{CTA} &= TSij_{NM}^{CTA} + TSij_{WT}^{CTA} \\ &= (tij_{WO}^{CTA} - tij_{WT}^{CTA}) * Tij_{NM}^{CTA} + (tij_{WO}^{CTA} - tij_{WT}^{CTA}) * Tij_{WT}^{CTA} \\ &= tij_{WO}^{CTA} * (Tij_{NM}^{CTA} + Tij_{WT}^{CTA}) - tij_{WO}^{CTA} * Tij_{NM}^{CTA} - tij_{WT}^{CTA} * Tij_{WT}^{CTA} \qquad (5) \end{aligned}$$

The formula (5) can be converted into (6) due to the equation (1) as follows:

$$TSij_{NM+WT}^{CTA} = tij_{WO}^{CTA} * Tij_{WO}^{CTA} - tij_{WT}^{CTA} * Tij_{WT}^{CTA} - tij_{NM}^{CTA} * Tij_{NM}^{CTA} \qquad (6)$$

The first term of the right side of the formula (6) means the travel time of CTA passengers in the "*without*" case. The second term means the travel time of the remaining CTA passengers in the "*with*" case, and the third term, the travel time of the diverted passengers from CTA to NM in the "*with*" case.

Thus, the second and third terms show the total travel time of passengers by mode in the "with" case. It should be noted that the travel time of NM passengers, which is represented as the third term in (6), indicates a negative value in this time saving calculation.

The formula (6) as represented for CTA passengers is common for all other modes in the CREATS model. The summation of travel time saving of the total *i-j* zone-pairs traffic by all modes indicates the total travel time saving which is generated by the new mode.

Meanwhile, regarding time saving of the private modes such as car, motorcycle and taxi, the same methodology was employed. It is the basic logic that diverted private mode users have to spend travel time for the new mode, while no travel time be spent for their travels by the previous private mode under the "*with*" condition.

It is also noted that some public transport modes usually increase passengers in the "*with*" case, compared to the "without" case, when many passengers divert from the private modes to the new public mode. This is likely to happen because some public transport modes are used as access/egress modes of the new public transport mode. Given more passengers use the new modes, it would increase the access/egress modes, thus some public transport modes users would increase.

The result of the computation of the time saving by mode, which be generated by the introduction of the East Wing Project, is tabulated as shown in Table 2.10.11.

Table 2.10.11 Time Saving by Transport Mode Generated by the East Wing Project

	2007			2012			2022		
	With	Without	Saving	With	Without	Saving	With	Without	Saving
Travel Time of Passengers by Public Transport Mode (*Million Passenger-hour/day*)									
CTA Bus	0.902	0.906	0.003	0.598	0.604	0.006	0.691	0.699	0.008
GCBC Bus	0.194	0.194	0.000	0.215	0.216	0.001	0.077	0.077	0.000
A/C Bus	0.264	0.330	0.066	0.320	0.412	0.092	2.050	2.499	0.449
Ferry	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Tram	0.176	0.174	-0.002	0.121	0.121	0.000	0.250	0.249	−0.001
Metro	0.753	0.741	-0.012	1.136	1.122	-0.014	1.834	1.824	−0.010
ENR	0.104	0.104	-0.001	0.133	0.132	-0.001	0.182	0.180	−0.002
Shared-Taxi	1.928	1.942	0.013	2.856	2.891	0.035	4.085	4.231	0.146
Minibus CTA	0.237	0.243	0.006	0.154	0.153	-0.001	0.190	0.190	0.000
Mini Coop Bus	0.050	0.050	0.000	0.023	0.023	0.000	0.051	0.050	−0.001
East Wing	0.040	0.000	-0.040	0.059	0.000	-0.059	0.178	0.000	−0.178
Sub-total	**4.649**	**4.684**	**0.034**	**5.615**	**5.674**	**0.058**	**9.588**	**10.000**	**0.412**
Travel Time of Private Transport Modes (*Million Vehicle-hour/day*)									
Motorcycle	0.099	0.099	0.000	0.171	0.170	-0.001	0.608	0.609	0.001
Car	1.288	1.293	0.005	2.233	2.224	-0.009	7.942	7.957	0.015
Taxi	0.584	0.586	0.002	1.012	1.008	-0.004	3.599	3.605	0.006
Sub-total	**1.971**	**1.978**	**0.007**	**3.416**	**3.402**	**-0.014**	**12.149**	**12.171**	**0.022**
Total	**6.620**	**6.662**	**0.041**	**9.031**	**9.076**	**0.044**	**21.737**	**22.171**	**0.434**

Source: JICA Study Team

Assumptions on Time Value

The time value to convert the saved travel time into monetary term was estimated. Table 2.10.12 shows the estimated time value at the year 2003 prices by each mode, which was computed, based on the income levels of different transport users (refer to Section 13. 2, Volume 3, the CREATS Master Plan for the detailed methodology). The hourly time value for public transport users is computed at 2.40 LE per person, while that of car users, 3.88 LE per person. The car time value per vehicle can be computed to be 7.3 LE, by multiplying the average number of persons in one vehicle, 1.9, by this hourly time value for a car use. Along with the economic growth, the time value must inherently increase in the future. Hence, the future time values were estimated at a proportional rate to the GRDP per capita in Cairo.

Table 2.10.12 Time Value Estimates by Transport Mode

(1) Time Value of Public Transport Mode User (LE/hour/person)

Economic Prices	**2001**	**2007**	**2012**	**2022**
Time Value	2.4	2.6	3.1	4.1

(2) Time Value of Private Mode (LE per hour per vehicle)

Economic Prices	**2001**	**2007**	**2012**	**2022**
Motor Cycle (1.1)	4.3	4.8	5.6	7.4
Car (1.9)	7.3	8.3	9.7	12.9
Taxi (2.5)	9.7	10.9	12.7	17.0

Notes: The number in parentheses denotes the average number of persons in one vehicles, and that in taxi stands for the average passengers.
Source: JICA study team calculations

Time Saving Benefit

As mentioned earlier, the time saving benefit generated by the introduction of the new East Wing service was calculated in terms of reduced total travel time of all people in the Study Area as a whole, simply multiplying the total travel time saving of passengers in the Study Area by time value by mode. The result is summarized as shown in Table 2.10.13.

Looking into the time saving benefits of passengers by transport mode, a great amount of the time saving benefit is expected for bus passengers. In particular, those of "air-conditioned bus passengers" are significant, because the travel time of passengers who diverted from air-conditioned buses will reduce substantially. Alike, those passengers who divert from shared-taxi to the East Wing railway service will gain increasingly greater benefits.

It is noted that in this calculation as seen in this table, the time saving of the East Wing passengers was presented negative. This is the logical result derived from this approach, as discussed above. For understanding this logic, another explanation can be given by a simple example as follows:

Suppose that a CTA bus passenger from A-origin to B-destination takes 30 minuets in the "*without*" case. Given the Project, he/she would divert to the new transport mode and spend 15 minutes for it, and spend another 5 minutes for a CTA bus for his/her access/egress to the new mode. In this case, as he/she takes a total of 20 minutes for the new transport mode choice, his/her time saving will be 10 minuets (= 30–20), in comparison between both cases. However, this CREATS Model indicates a different manner of expressions of the time saving by mode in such a way that the time saving of the new transport mode accounts for a negative figure, - 15 minuets, in a comparison between the "*With*" and "*Without*" cases, because zero travel time would be taken in the "*without*" case. At the same time, the time saving of the CTA bus accounts for a positive figure, 25 minutes (=30-5) in comparison between both cases. Consequently, the time saving of the Project can be computed, summing up both the negative and positive numerical value, thereby resulting in 10 minutes (= 25-15). Thus, the result is the same.

In this way, the total time savings to be generated by the East Wing railway service was calculated by mode. The summation denotes the total economic time savings by the introduction of the new transport service.

Table 2.10.13 Time Saving Benefit by the East Wing Project

(Unit: Million LE, At 2003 prices)

Economic Prices	2007	2012	2022
Time Public Mode Passengers			
CTA bus Passengers	3.4	6.4	12.1
GCBC bus Passengers	0.5	0.7	-0.5
A/C bus Passengers	63.3	103.0	674.9
Ferry Passengers	0.0	0.0	0.0
Tram Passengers	-1.7	-0.2	-2.0
Metro Passengers	-11.9	-16.1	-15.0
ENR Passengers	-0.6	-1.2	-2.6
Shared Taxi Passengers	13.0	39.4	219.8
Minibus CTA Passengers	5.5	-1.1	0.3
Mini Coop Passengers	0.5	0.3	-0.9
East Wing Passengers	-38.8	-65.7	-267.2
Sub-total	***33.1***	***65.4***	***619.0***
Private Transport Mode			
Motorcycle	0.0	-2.1	2.7
Car	15.2	-31.8	70.9
Taxi	8.0	-18.6	37.2
Sub-total	***23.2***	***-52.4***	***110.8***
Total Time Saving Benefit	**56.2**	***13.0***	***729.8***

Source: JICA study team calculations

2) Cost Saving Benefit

Bus passengers and car users are likely to divert to the improved railway. It results in a benefit in saving of vehicle operation costs to the national economy.

The operating costs of the private transport modes are calculated on vehicle-km basis by using the estimated unit vehicle operating cost (VOC) per vehicle-km by speed range. While, as for public transport modes, the operating costs are calculated on passenger-km basis, by multiplying the estimated unit operating cost per passenger-km by the passenger-km obtained as the traffic assignment results in the process of transport demand forecast. The detailed methodologies for the calculation have been mentioned in Section 13.2.4, Volume 3, the CREATS Master Plan.

a. Vehicle Operating Cost Estimate

The unit vehicle operating cost (VOC) by vehicle type was estimated, based on an analysis on the actual performance indicators collected from different transport operators such as CTA and Shared-taxi companies as well as automobile dealers. The following considerations were given to the estimation of VOC.

Representative Vehicles: Table 2.10.14 shows selected vehicle types and their representative vehicles for the estimation of the VOC.

Table 2.10.14 Vehicle Types and Representative Vehicles

Vehicle Type	Representative Vehicle
Private car (Sedan type)	Mitsubishi, 1300cc
Shared Taxi	Toyota, minibus (14 seats)
Pick-up	Nissan
Motorcycle	Jawa
Large Bus	Nasr
Minibus	Nasr
Light Truck	Mercedes (with loading capacity of 8 tons)
Medium Truck	Mercedes (with loading capacity of 15 tons)
Heavy Truck	Mercedes (with loading capacity of 20-22 tons)

Source: JICA Study Team

Vehicle Prices: The market prices of vehicle are obtained by interview to car dealers, trucking companies and CTA Operational Department. For converting from financial (market) prices to economic prices, information about the import duties and the sales tax are incorporated, and the portion of taxes are deducted. While the rates of import duties for imported vehicles are; private car: 55%, motorcycle: 20%, and others: 40%, those for imported chassis fitted with engines (for buses) are 30%. The rates of sales tax are 15% and 10% for private car and others, respectively.

Vehicle Performance Data: The information on vehicle performance in terms of vehicle life (years), vehicle annual kilometers, and vehicle annual operating hours were obtained through interviews to car dealers, trucking companies and CTA.

Tire Prices: The information of the market prices of tire, the tire life and the number of tire per vehicle is obtained by interviews to car dealers, trucking companies and CTA. For converting from financial (market) prices to economic prices, information about the import duties and the sales tax is incorporated, and the portion of taxes are deducted. While the rates of import duties and the rates of sales tax are commonly 20% and 10%, respectively, for each type of tire.

Fuel and Lubricants: For converting from financial (market) prices to economic prices, transfer costs such as tax and subsidy are redacted. Although neither sales tax nor subsidy are imposed on gasoline, some subsidy is given to diesel. CTA has some advantage at the market price of fuel. As for lubricants oil, there are two types: local made and imported. While no sales tax is charged for the local made one, sales tax is charged for the imported one. Since local made one is popular among users, the economic prices is assumed to be the same as financial prices.

Maintenance Spares: The percentages to vehicle price for maintenance spare per 1,000 km are set up based on the data which have been applied in the road transport study regarding other developing countries.

Maintenance Labor Hours and Labor Cost: The information of the maintenance labor hours and the unit labor cost is obtained by interviews to car dealers, trucking companies and CTA. For conversion from the market labor cost to the economic cost, the following were considered: 1) maintenance work for private cars and shared-taxies in Egypt is mostly carried out in private workshops which are available all around; 2) people working in these workshops are almost unskilled, compared with those working in workshops and garages of specialized transport and bus companies; and 3) for this reason, the economic maintenance cost of private cars and shared-taxi are lower than the financial cost.

Crew Cost: The information of the crew cost and crew size is obtained by interview to car dealers, trucking companies and CTA. The economic crew cost is assumed to be the same to the financial cost.

Depreciation: The share percentages of depreciation related to distance and time are estimated, based on the data which have been applied for road transport studies in other developing countries, because no data is available for Egypt.

b. Unit VOC by Speed Range

The unit VOC was examined in accordance with speed ranges. For this purpose, any study of “Highway Design Manual – Vehicle Operation Costs” regarding the unit VOC index by speed range is not yet available for the economic analysis in Egypt. Therefore, “the Study of Urban Transport Study in Bangkok, Thailand” is reviewed and referred for this analysis. Table 2.10.15 summarizes the result in terms of economic prices.

Table 2.10.15 Unit VOC Indices by Speed Range for Private Transport Modes

(Unit: LE/Vehicle-km at 2003 Economic Prices)

Speed (km/h)	MC	Car	Taxi	Truck	Heavy TRK
S<5	0.2616	0.6498	0.6498	1.5505	2.4702
5<S<10	0.2616	0.6498	0.6498	1.5505	2.4702
10<S<15	0.2398	0.6306	0.6306	1.3955	2.3866
15<S<20	0.1962	0.5814	0.5814	1.1629	2.2101
20<S<25	0.1744	0.5301	0.5301	1.0466	2.0801
25<S<30	0.1744	0.4938	0.4938	0.9691	2.0058
30<S<35	0.1744	0.4638	0.4638	0.8916	1.9316
35<S<40	0.1744	0.4435	0.4435	0.8334	1.8851
40<S<45	0.1744	0.4329	0.4329	0.7947	1.8665
45<S	0.1744	0.4275	0.4275	0.7753	1.8573

Source: JICA study team's calculations

c. Unit Operation Cost of Public Transport Mode

Table 2.10.16 summarizes the result of the unit operating cost of public transport modes per passenger-kilometer. The detailed explanations of the methodology and the computation process have been described in Section 13.2.4, Volume 3, the CREATS Master Plan.

Table 2.10.16 Unit Operation Cost of Public Transport Mode

(Unit: LE/passenger-km at 2003 Economic Prices)

Transport Mode	2007	2012	2022
CTA bus Passengers	0.0518	0.0518	0.0518
GCBC bus *1	0.0518	0.0518	0.0518
A/C bus *1	0.0518	0.0518	0.0518
Ferry boat	0.2196	0.2196	0.2196
Tram	0.3342	0.3342	0.3342
Metro	0.0531	0.0531	0.0531
ENR	0.0474	0.0474	0.0474
Shared Taxi	0.0708	0.0708	0.0708
Minibus CTA *2	0.0708	0.0708	0.0708
Mini Coop *2	0.0708	0.0708	0.0708

*Notes: *1: CTA cost was used; and *2: Shared taxi cost was used*
Source: JICA study team's calculations

d. Estimated Cost Saving Benefits

Under an assumption that the East Wing public transport service starts in 2007, the total cost saving benefits in economic prices were computed in 2207, 2012 and 2022, including cost savings of public transport (at the passenger-km basis) and private transport modes (at the VOC basis). The result is as shown in Table 2.10.17.

It should be noted that although a considerable amount of cost saving benefits can be expected to accrue from the East Wing Project in the entire Study Area as a whole, no cost saving for East Wing passengers is counted as shown in this table. As mentioned earlier, the newly introduced transport mode itself requires its operation and maintenance costs, therefore, no savings appear on it. Such costs are regarded as the cost of the Project in terms of "Operation and Maintenance Cost" in the economic evaluation procedure.

Table 2.10.17 Cost Saving Benefit of the East Wing Project

(Unit: Million LE at 2003 Economic Prices)

	2007	2012	2022
Cost Saving Benefits: Public Transport			
CTA bus Passengers	3.8	2.4	1.8
GCBC bus Passengers	0.6	0.4	-0.2
A/C bus Passengers	47.6	56.7	151.7
Ferry Passengers	0.0	0.0	0.0
Tram Passengers	-2.6	-0.3	-1.9
Metro Passengers	-9.1	-10.6	-9.0
ENR Passengers	-0.4	-0.7	-1.2
Shared Taxi Passengers	8.3	28.5	74.8
Minibus CTA Passengers	1.6	-0.4	0.1
Mini Coop Passengers	0.3	0.3	-0.1
Sub-total	49.9	76.2	216.0
Cost Saving Benefit: Private Transport			
Motorcycle	0.4	0.0	2.0
Car	16.1	-2.0	61.1
Taxi	7.4	-0.8	27.8
Truck	5.1	-2.0	-48.2
Heavy Truck	0.0	-0.8	-10.6
Sub-total	29.0	-5.5	32.1
Total	**78.9**	**70.7**	**248.1**

Source: JICA study team calculations

(4) Cost-Benefit Analysis

A cost-benefit analysis was made, based on all properties derived from discussions above. For the sake of seeking for the most rational investment for the project, two options are examined in terms of timing of the operation:

Option 1: The East Wing Railway projects will be commenced from 2004 and the railway system is to be operated from 2007; and

Option 2: The East Wing Railway projects will be commenced from 2007 and the railway system is to be operated from 2010.

The difference between the two is that the full operation year in Option 2 is 3 years later than that in Option 1. Taking into account that the Project requires a massive initial investment, Option 2 is considered as one alternative to seek for a more demand-responsive investment schedule, although the priority is still kept high.

The analysis yields economic evaluation indicators such as EIRR (Economic Internal Rate of Return), NPV (Net Present Value) and B/C (Benefit-cost Ratio). It is assumed that the social discount rate in the Egyptian economy is 12% p.a. An economically feasible project should satisfy the following conditions:

EIRR > the social discount rate (12%)
NPV = positive
B/C > 1.0

A summary of the computed evaluation indices is shown in Table 2.10.18, and the annual balance sheets of economic costs and benefits for Option 1 and Option 2 are depicted in Tables 2.10.19 and 2.10.20 respectively.

Table 2.10.18 A Summary of Economic Evaluation of the East Wing Project

Indicators	Option 1	Option 2
Economic Internal Rate of Return (EIRR)	11.1%	13.1%
Net Present Value (NPV) * at mid-2003 prices	-157.6 million LE	143.8 million LE
Benefit/Cost (B/C) Ratio *	0.92	1.09

*Notes: * at 12% discount rate.*
Source: JICA study team calculations

As for Option 1, the EIRR accounts for 11.1%, which is slightly lower than the social discount rate of 12%. As the result, the NPV becomes negative, given a 12% discount rare, and the B/C ratio is 0.92, which means that the total cost will exceed the total benefit in the long-term. This evaluation result implies that as long as the investment schedule of Option 1 is adopted, the Project will be difficult to be feasible from the national economy point of view.

On the other hand, Option 2 yields a favorable value of EIRR, 13.1%. Since this rate is higher than the social discount rate of 12%. The Net Present Value (NPV) is 143.8 LE million at mid-2003 prices, and the Benefit/Cost ratio is 1.09, given a 12% discount rate. This result advocates that the Project will bring a considerable amount of economic benefits to the national economy as a whole. It can be assessed that the Project is economically feasible, or worth being implemented from the national economic point of view.

Table 2.10.19 Economic Analysis for East Wing Project: Option 1

EIRR=11.1% **NPV=-157.6** **B/C=0.92** (Unit: LE Million at 2003 Prices)

Year	Investment Cost	O&M Cost	Cost Total	Time Saving	Cost Saving	Benefit Total	Net Benefit	NPV *1)
	(a)	(b)	(c)=(a)+(b)	(d)	(e)	(f)=(d)+(e)	(g)=(f)-(c)	(h)
2004	69.8	-	69.8	-	-	0.0	-69.8	-62.4
2005	549.5	-	549.5	-	-	0.0	-549.5	-438.0
2006	1,384.4	-	1,384.4	-	-	0.0	-1,384.4	-985.4
2007	-	35.3	35.3	56.2	78.9	135.1	99.8	63.4
2008	-	38.1	38.1	47.6	77.3	124.8	86.8	49.2
2009	-	40.9	40.9	38.9	75.6	114.6	73.7	37.3
2010	-	43.6	43.6	30.3	74.0	104.3	60.6	27.4
2011	-	46.4	46.4	21.6	72.4	94.0	47.6	19.2
2012	-	49.2	49.2	13.0	70.7	83.7	34.5	12.5
2013	230.4	62.0	292.4	84.7	88.5	173.2	-119.2	-38.4
2014	-	74.8	74.8	156.4	106.2	262.6	187.8	54.0
2015	-	87.5	87.5	228.0	123.9	352.0	264.5	67.9
2016	-	100.3	100.3	299.7	141.7	441.4	341.1	78.2
2017	235.9	113.1	349.0	371.4	159.4	530.8	181.8	37.2
2018	-	125.9	125.9	443.1	177.1	620.2	494.4	90.3
2019	-	138.7	138.7	514.8	194.9	709.7	571.0	93.1
2020	159.1	151.4	310.5	586.5	212.6	799.1	488.6	71.2
2021	-	164.2	164.2	658.2	230.3	888.5	724.3	94.2
2022	-	177.0	177.0	729.8	248.1	977.9	800.9	93.0
2023	-	177.0	177.0	729.8	248.1	977.9	800.9	83.0
2024	-	177.0	177.0	729.8	248.1	977.9	800.9	74.1
2025	-	177.0	177.0	729.8	248.1	977.9	800.9	66.2
2026	664.3	177.0	841.3	729.8	248.1	977.9	136.6	10.1
2027	-	177.0	177.0	729.8	248.1	977.9	800.9	52.8
2028	-	177.0	177.0	729.8	248.1	977.9	800.9	47.1
2029	-	177.0	177.0	729.8	248.1	977.9	800.9	42.1
2030	-1,395.8	177.0	-1,218.8	729.8	248.1	977.9	2,196.7	103.0

*Note: *1) Discount rate: 12 % p.a.*
Source: JICA study team calculations

Table 2.10.20 Economic Analysis for East Wing Project : Option 2

EIRR=13.1% **NPV=143.8** **B/C=1.09** (Unit: LE Million at 2003 Prices)

Year	Investment Cost	O&M Cost	Cost Total	Time Saving	Cost Saving	Benefit Total	Net Benefit	NPV *1)
	(a)	(b)	(c)=(a)+(b)	(d)	(e)	(f)=(d)+(e)	(g)=(f)-(c)	(h)
2004	-	-	0.0	-	-	0.0	0.0	0.0
2005	-	-	0.0	-	-	0.0	0.0	0.0
2006	-	-	0.0	-	-	0.0	0.0	0.0
2007	69.8	-	69.8	-	-	0.0	-69.8	-44.4
2008	549.5	-	549.5	-	-	0.0	-549.5	-311.8
2009	1,384.4	-	1,384.4	-	-	0.0	-1,384.4	-701.4
2010	-	43.6	43.6	30.3	74.0	104.3	60.6	27.4
2011	-	46.4	46.4	21.6	72.4	94.0	47.6	19.2
2012	-	49.2	49.2	13.0	70.7	83.7	34.5	12.5
2013	230.4	62.0	292.4	84.7	88.5	173.2	-119.2	-38.4
2014	-	74.8	74.8	156.4	106.2	262.6	187.8	54.0
2015	-	87.5	87.5	228.0	123.9	352.0	264.5	67.9
2016	-	100.3	100.3	299.7	141.7	441.4	341.1	78.2
2017	235.9	113.1	349.0	371.4	159.4	530.8	181.8	37.2
2018	-	125.9	125.9	443.1	177.1	620.2	494.4	90.3
2019	-	138.7	138.7	514.8	194.9	709.7	571.0	93.1
2020	159.1	151.4	310.5	586.5	212.6	799.1	488.6	71.2
2021	-	164.2	164.2	658.2	230.3	888.5	724.3	94.2
2022	-	177.0	177.0	729.8	248.1	977.9	800.9	93.0
2023	-	177.0	177.0	729.8	248.1	977.9	800.9	83.0
2024	-	177.0	177.0	729.8	248.1	977.9	800.9	74.1
2025	-	177.0	177.0	729.8	248.1	977.9	800.9	66.2
2026	-	177.0	177.0	729.8	248.1	977.9	800.9	59.1
2027	-	177.0	177.0	729.8	248.1	977.9	800.9	52.8
2028	-	177.0	177.0	729.8	248.1	977.9	800.9	47.1
2029	664.3	177.0	841.3	729.8	248.1	977.9	136.6	7.2
2030	-1,590.1	177.0	-1,413.1	729.8	248.1	977.9	2,391.0	112.1

*Note: *1) Discount rate: 12 %p.a.*
Source: JICA study team calculations

(5) Overall Economic Evaluation

Based on the cost benefit analysis, it is concluded that the economic feasibility of the East Wing Project will be somewhat sensitive to the investment schedule. The railway service is expected to be available as soon as possible, because such an improved transport service will facilitate and accelerate the development of the new communities. However, the massive investment cost at the initial stage for the Project could hardly be recovered without a sizable amount of passenger demands sufficient enough to make it viable. Thus, there exists a sort of "contradiction" between the passenger demand and the investment.

The Project should seek for possibly feasible timing of the initial investment, responsive to the increasing passenger demand. As shown in the evaluation result of Option 2, the investment schedule with a target that the railway service will be available in 2010 may be a feasible solution.

2.10.4 Financial Evaluation

The East Wing Railway Project is evaluated from the financial viewpoint. The following are a summary of the findings.

(1) Assumptions

A number of assumptions are employed for the financial analysis as follows:

- The financial costs are estimated at mid-2003 constant prices, as shown in Section 2.10.2 in this volume;
- Regarding the investment schedule, "Option 1" is adopted for this financial analysis to identify its fundamental financial situation of the Project. Hence, the estimated financial capital costs are allocated in the scheduled time framework up to the year 2022 in such a way that the railway service will be operated in 2007 and will generate the operating revenues from 2007.
- The evaluation period is assumed to be a period between 2004 and 2030, and the depreciation of depreciable assets are appropriated with a straight line method under an assumed useful life by asset and the residual value of the invested capitals is considered in 2030 as a negative cost.
- For the operating revenue, a distance-based fare system (a base fare plus distance-based charge) is adopted, that is, a 0.63 LE base fare plus an additional 0.03 LE per distance in year 2007; a 0.74 LE base fare plus an additional 0.04 LE per distance in 2012; and a 1.00 LE base fare plus an additional 0.05 LE per distance in 2022, as shown in Table 2.10.21. For instance, the fare between Ain Shams Station and 10th of Ramadan Bus Terminal Station, of which the distance is 49km, is computed at 2.10 LE in the beginning year 2007, compared to the current bus fare for this distance, around 2.00 LE.

Table 2.10.21 Assumed Fare Level for the East Wing Railway Service

	2007	2012	2022
Base Fare (LE)	0.63	0.74	1.00
Distance-based (LE/km)	0.03	0.04	0.05
An Example Fare (LE) Ain Shams Station ~ 10th of Ramadan Bus Terminal Station (49km)	2.10	2.70	3.45

Source: JICA study team calculations

- Additional incomes accruing from ancillary sources related to the railway service operation, such as advertisement charges and commercial activities at stations, are considered to be 6% of the operating revenue, taking into account experiences being performed in other countries. Since this off-rail revenue rate is significant to the financial feasibility, a sensitivity test will examine the financial conditions with different rates in a range from 6% to 20%.

(2) Evaluation Indicators for Financial Feasibility

The Project will be financially evaluated in terms of the following three indices:

- FIRR (Financial Internal Rate of Return)
- The first year when the Project generates a positive annual operating profit;
- The first year when the annual net profit becomes positive (after reduction of interest and depreciation); and
- The year when the accumulated net profit becomes positive.

The FIRR is an indicator to judge the financial robustness of the Project. Given a higher FIRR than any interest rate of a commercial loan, the Project could be financially viable. In other words, the investment capital for the Project, which is procured through a commercial bank, will be able to yield a higher rate of return than the interest rate of the loan. A higher FIRR is favorable, however, it is not necessarily the case, depending upon the availability of loans with a lower interest rate. Thus, the FIRR implies a feasible level of financial costs of the investment capital to be procured through some financial institutions.

Another important judgment from this analysis is whether or not the Project will have a risk for the bankruptcy, or how much risky the investment for the Project is against a complete loss. This will be examined by identifying some indicators in projected financial statements, that is, 1) how many years will take for the Project to generate a positive profit at annual basis?; 2) how many years will take till the annual net profit becomes positive?; and 3) how many years will take till the accumulated net profit will be positive? Needless to say, the Project is expected to yield a positive net profit within an acceptable timeframe, even if some losses annually take place in the initial stage.

(3) Summary Result of the Financial Analysis

The results of the financial analysis are summarized in Table 2.10.22. The FIRR for the East Wing Railway Project is computed at 3.3%, which implies that the Project will hardly be viable from the financial point of view, or that the investment funds should be procured at a lower than 3.3% interest rate in order to make the Project financially feasible.

Although the FIRR seems hardly favorable, the Project will not be bankrupted. A positive operating profit will occur at an annual basis in the year 2014, or 7 years after the commencement of the operation; and in the next year, or 2015, the net profit after reduction of the interest payment and depreciation will be positive. In the accumulated balance, the Project will recover all the investments in the year 2022, or the accumulated net profit will be positive 15 years after the commencement of the operation.

Table 2.10.22 A Summary of Financial Analysis for the East Wing Project

Evaluation Indices	Result
FIRR (Financial Internal Rate of Return)	3.31%
The First Year of Positive Operation Profit at Annual Basis	Year 2014
The First Year of Positive Net Profit at Annual Basis (after Interest and Depreciation)	Year 2015
The First Year of Positive Accumulated Net Profit	Year 2022

Source: JICA study team calculations

(4) Sensitivity Tests

It was identified above that the Project would hardly be feasible in terms of the FIRR under the assumed conditions. This will make the project financing considerably difficult. Therefore, some financing measures to make the Project more viable need to be considered. The following results of "Sensitivity Tests" indicate useful implications for this purpose:

- Should only the depreciation of rolling stock be considered, the FIRR accounts for 21.2%. This means that if the capital investments for the infrastructure, other than rolling stocks, could be financed by a government subsidy, the Project would be financially feasible.
- Given additional revenues from off-rail business activities equivalent to 20% of the operation revenue, instead of 6%, the FIRR would be 4.5%, which shows an improvement of its financial feasibility by 1.2 points.
- Given a 20% reduction in the initial investment cost, the FIRR is improved to 4.7%.

(5) Financial Evaluation

Taking into account the above findings through the sensitivity tests, the East Wing Project could be financially feasible, given three (3) key conditions to be assured:

1. Positive involvement of the government sector;
2. Diversification of revenue sources other than railway service revenues; and
3. Establishment of an unique financing and operation mechanism.

1. Positive involvement of the government sector

Firstly, regarding the government sector's involvement, two functions of the government are expected: one is to provide its subsidy for the initial investment for the infrastructures; and the other is to procure international concession loans from international aid agencies. As for the former function, since it has been proven from the economic evaluation as discussed in the preceding Section 2.10.3 that the Project is economically feasible from the national economy standpoint, a certain amount of the government subsidy for the Project can be justified. The government, however, may be reluctant to be fully responsible for financing the whole investment cost. The sensitivity test reveals that given the subsidy only for the infrastructures (of which the ownership should be held by the government sector) other than rolling stock, the FIRR of the Project will be as high as 21.2%. This implies that the Project could be financially managed at a commercial basis under such a condition.

As per the latter function, the government is expected to arrange a softer loan from possible international aid agencies such as European Investment Bank (EUB), World Bank or Japan Bank for International Cooperation (JBIC). The current ordinal interest rate of a long-term commercial loan seems to be more or less 10 % as of 2003 in Egypt. As proven above, the Project can hardly be managed by commercial finance with such a condition, unless the government provides with its subsidy.

2. <u>Diversification of revenue sources other than railway service revenues</u>

The railway business may diversify its revenue sources from not only fare charges but also commercial business activities at stations and for passengers-related services such as advertisement, kiosk and exhibitions/events at station halls and/or plazas. As shown in the sensitivity test, these commercial revenues, are significant to make the Project more viable. This, however, claims the deregulation of the current legal restriction against any commercial business by the public transport operators.

3. <u>Establishment of an unique financing and operation mechanism</u>

As a result of the above two measures, an unique mechanism for financing, operating and managing the Project should be explored, involving the private as well as the government sector. ENR itself also needs to be re-organized to implement the Project. A proposed mechanism is discussed in Section 2.11 "Implementation Plan" in this volume.

2.10.5 Economic and Financial Analysis of An Alternative Investment Scheme (a Rail-Bus Joint System)

(1) Basic Concept

Through the economic evaluation analysis of the East Wing Project, it was concluded that its economic feasibility is somewhat sensitive to the investment schedule, and that a demand-responsive investment scheme should be explored for the implementation of the East Wing Project. For this argument, as one feasible option, Option 2 was examined, i.e., the investment is to be rendered in such a way that the East Wing railway service will commence in the year 2010, instead of the year 2007. This scheme of Option 2 yields a FIRR of 13.1%.

In this context, another alternative scheme can be conceivable. As the railway improvement requires a massive amount of investment cost in the initial stage for the functional operation and service, the investment is likely to be hardly justifiable from the economic and financial viewpoints. Therefore, the initial investment for the rail system is minimized, being supplemented by the improvement of a bus system to connect with the rail service.

This scheme, named "***a rail-bus joint system***", should consist of two project components to be integrated with each other:

1) Rehabilitation of the section of the between the Ain Shams Station and the Shorooq Station of the existing Suez Line for the urban railway service; and
2) Provision of a feeder service with **an exclusive busway system** between the Shorooq Station and new communities such as the 10^{th} of Ramadan.

It is noted that the new rail line construction between the Shorooq Station and the 10^{th} of Ramadan Bus Terminal Station is not initially considered in this scheme, but this section is to be served by an exclusive busway system which is equivalent to the railway service in terms of transport comfort and travel speed.

For such an exclusive busway system operation, the segregated structure be provided as planned in such a way that the busway can be easily replaced for the railway by layering a rail system on the structure in the time when the passenger demand will assure the feasibility of the investment on the railway system.

In this section, this integrated system is examined in terms of its economic feasibility. The basic premises and the methodology are the same as those employed for the previous economic evaluation analysis. It is assumed that the operation service will be available in the year 2007 and the economic benefits will be generated at the same year 2007.

(2) Costs Estimates

1) Investment Costs

The total investment costs and its allocation schedule for this scheme are projected as shown in Table 2.10.23 for the financial costs at mid-2003 prices. A total of about 2.01 billion LE will be required. Compared to the original case, the total investment cost of this scheme can be saved by approximately 390 million LE, as shown in Table 2.10.23. This alternative case (railway + bus) can reduce the costs for system works and rolling stocks, but increase the costs for additional facilities such as a bus terminal & station plaza and the procurement of bus vehicles.

It should be noted that the cost for the running track is not different from the original case, because it is assumed that the exclusive busway be served with the segregated structure between the Shorooq Station and the 10^{th} of Ramadan that is designed so as to be converted to a railway structure when is necessary. However, the busway structure excludes the cost for the signaling and communication facilities which are needed for the railway system.

Table 2.10.23 Cost Comparison Between the Alternative Case and the Original Case

(LE million at 2003 prices)

Financial Cost	**Alternative Case Rail +Bus**	**Original Case Option 1**	**Difference**
	(a)	(b)	(a)-(b)
Running Track	1,028.2	1,028.2	0.0
System Works	354.8	630.0	-275.2
Stations	85.3	85.3	0.0
Bus Terminal & Station Plaza	9.3	0.0	9.3
Depot & Workshop (Rail)	24.1	24.1	0.0
Depot & Workshop (Bus)	6.2	0.0	6.2
Rolling Stock	76.4	152.9	-76.5
Articulated Bus Vehicle	16.2	0.0	16.2
Land	16.9	10.3	6.6
Engineering	129.4	154.4	-25.0
Local Adm.	80.9	96.6	-15.7
Contingency	182.8	218.2	-35.4
Total Cost	**2,010.5**	**2,400.0**	**-389.5**

Source: JICA Study Team

The financial and economic costs are projected as shown in Tables 2.10.24 and 2.10.25 respectively. The economic costs are estimated by converting the financial costs, using conversion rates which are assumed to be 81% for local currency items as well as 87% for foreign currency (or imported) items, taking into account the Egyptian taxation and labor market conditions.

Table 2.10.24 Investment Schedule for the Rail-Bus Joint System (Financial Cost)

(LE Million, at 2003 price)

(Financial Cost)	2004		2005		2006		Total		
	Local	Foreign	Local	Foreign	Local	Foreign	Local	Foreign	Total
Running Track	-	-	287.9	123.4	431.8	185.1	719.7	308.4	1,028.2
System Works	-	-	-	-	124.2	230.6	124.2	230.6	354.8
Station	-	-	22.7	11.4	34.1	17.1	56.8	28.5	85.3
Bus Terminal & Station Plaza	-	-	3.0	0.8	4.5	1.1	7.4	1.9	9.3
Depot & Workshop (Rail)	-	-	8.4	8.4	3.6	3.6	12.1	12.1	24.1
Depot & Workshop (Bus)	-	-	3.5	0.9	1.5	0.4	5.0	1.2	6.2
Rolling Stock	-	-	0.9	29.7	1.4	44.5	2.3	74.1	76.4
Articulated Bus Vehicle	-	-	0.0	6.5	0.0	9.7	0.0	16.2	16.2
Land	-	-	16.4	0.5	-	-	16.4	0.5	16.9
Engineering	3.9	34.9	3.9	34.9	5.2	46.6	12.9	116.5	129.4
Local Adm.	24.3	0.0	24.3	0.0	32.3	0.0	80.9	0.0	80.9
Contingency	2.8	3.5	37.1	21.6	63.9	53.9	103.8	79.0	182.8
Total Cost	**31.0**	**38.4**	**408.0**	**238.1**	**702.4**	**592.6**	**1,141.4**	**869.1**	**2,010.5**

Source: JICA study team calculations

Table 2.10.25 Investment Schedule for the Rail-Bus Joint System (Economic Cost)

(LE Million, at 2003 price)

(Economic Cost)	2004		2005		2006		Total		
	Local	Foreign	Local	Foreign	Local	Foreign	Local	Foreign	Total
Running Track	0.0	0.0	233.2	107.3	349.8	161.0	583.0	268.3	851.3
System Works	0.0	0.0	0.0	0.0	100.6	200.6	100.6	200.6	301.2
Station	0.0	0.0	18.4	9.9	27.6	14.9	46.0	24.8	70.8
Bus Terminal and Station Plaza	0.0	0.0	2.4	0.7	3.6	1.0	6.0	1.7	7.7
Depot & Workshop(Rail)	0.0	0.0	6.8	7.3	2.9	3.1	9.8	10.5	20.3
Depot & Workshop(Bus)	0.0	0.0	2.8	0.8	1.2	0.3	4.0	1.1	5.1
Rolling Stock	0.0	0.0	0.7	25.8	1.1	38.7	1.9	64.5	66.4
Bus Vehicle	0.0	0.0	0.0	5.6	0.0	8.5	0.0	14.1	14.1
Land	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Engineering	3.1	30.4	3.1	30.4	4.2	40.5	10.5	101.3	111.8
Local Adm.	19.7	0.0	19.7	0.0	26.2	0.0	65.5	0.0	65.5
Contingency	2.3	3.0	28.7	18.8	51.7	46.9	82.7	68.7	151.4
Total Cost	**25.1**	**33.4**	**315.9**	**206.6**	**569.0**	**515.5**	**909.9**	**755.6**	**1,665.5**

Note: Land cost in economic price was evaluated at zero. Necessary costs for engineering, local administration and contingency is included.

Source: JICA study team calculations

2) Additional Investment Cost

Additional investment costs were estimated to meet with the increasing passenger demands, including rolling stocks and bus vehicles. The financial cost and its economic cost in the total allocated in a time schedule are shown in Table 2.10.26.

Table 2.10.26 Additional Investment for the Rail-Bus Joint System

(LE Million, at 2003 price)

Financial Cost	**2008**		**2009**		**2010**		**2011**	
	Local	**Foreign**	**Local**	**Foreign**	**Local**	**Foreign**	**Local**	**Foreign**
Rolling Stock								
Bus Vehicle		1.8		0.9		0.9		0.9
Engineering	0.0	0.1	0.0	0.1	0.0	0.1	0.0	0.1
Local Adm.	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Contingency	0.0	0.2	0.0	0.1	0.0	0.1	0.0	0.1
Total Cost	0.1	2.1	0.1	1.1	0.1	1.1	0.1	1.1
Economic Cost in Total	***0.1***	***1.8***	***0.1***	***0.9***	***0.1***	***0.9***	***0.1***	***0.9***
Financial Cost	**2012**		**2013**		**2014**		**2015**	
	Local	**Foreign**	**Local**	**Foreign**	**Local**	**Foreign**	**Local**	**Foreign**
Rolling Stock			0.6	19.8			0.6	19.8
Bus Vehicle				4.5		3.6		3.6
Engineering	0.0	0.0	0.2	1.8	0.0	0.3	0.2	1.7
Local Adm.	0.0	0.0	1.2	0.0	0.2	0.0	1.2	0.0
Contingency	0.0	0.0	0.2	2.6	0.0	0.4	0.2	2.5
Total Cost	0.0	0.0	2.3	28.7	0.2	4.2	2.2	27.6
Economic Cost in Total	***0.0***	***0.0***	***1.8***	***25.0***	***0.2***	***3.7***	***1.8***	***24.0***
Financial Cost	**2016**		**2017**		**2018**		**2019**	
	Local	**Foreign**	**Local**	**Foreign**	**Local**	**Foreign**	**Local**	**Foreign**
Rolling Stock			1.8	59.4	0.5	14.8	0.8	24.7
Bus Vehicle		2.7		3.6		4.5		3.6
Engineering	0.0	0.2	0.5	4.7	0.2	1.4	0.2	2.1
Local Adm.	0.1	0.0	3.2	0.0	1.0	0.0	1.5	0.0
Contingency	0.0	0.3	0.6	6.8	0.2	2.1	0.2	3.0
Total Cost	0.2	3.2	6.2	74.4	1.8	22.8	2.7	33.5
Economic Cost in Total	***0.1***	***2.8***	***5.0***	***64.7***	***1.4***	***19.9***	***2.2***	***29.1***
Financial Cost	**2020**		**2021**		**2022**		**Total**	
	Local	**Foreign**	**Local**	**Foreign**	**Local**	**Foreign**	**Local**	**Foreign**
Rolling Stock	0.3	9.9	0.8	24.7			5.4	173.1
Bus Vehicle		3.6		3.6		2.7	0.0	40.5
Engineering	0.1	1.0	0.2	2.1	0.0	0.2	1.8	15.8
Local Adm.	0.7	0.0	1.5	0.0	0.1	0.0	11.0	0.0
Contingency	0.1	1.4	0.2	3.0	0.0	0.3	1.8	22.9
Total Cost	1.2	15.9	2.7	33.5	0.2	3.2	19.9	252.4
Economic Cost in Total	***1.0***	***13.9***	***2.2***	***29.1***	***0.1***	***2.8***	***16.1***	***219.5***

Source: JICA study team calculations

3) Reinvestment Cost

In order to maintain this transport system properly and functionally, reinvestment costs for improve the system works and bus vehicles will be needed at least 10 years after the commencement of the operation. The financial and economic costs in the total for the reinvestment are as shown in Tables 2.10.27.

Table 2.10.27 Reinvestment for the Rail-Bus Joint System

(LE Million, at 2003 price)

Financial Cost	**2016**		**2017**		**2018**		**2019**	
	Local	**Foreign**	**Local**	**Foreign**	**Local**	**Foreign**	**Local**	**Foreign**
System Work	-	-	-	-	-	-	-	-
Bus Vehicle	-	16.2	-	-	-	1.8	-	0.9
Engineering	0.1	1.2	-	-	-	0.1	-	0.1
Local Adm.	0.8	-	-	-	0.1	-	-	-
Contingency	0.1	1.7	-	-	-	0.2	-	0.1
Total Cost	1.0	19.1	0.0	0.0	0.1	2.1	0.0	1.1
Economic Cost in Total	***0.8***	***16.6***	***0.0***	***0.0***	***0.1***	***1.8***	***0.0***	***0.9***
Financial Cost	**2020**		**2021**		**2022**		**2023**	
	Local	**Foreign**	**Local**	**Foreign**	**Local**	**Foreign**	**Local**	**Foreign**
System Work	-	-	-	-	-	-	-	-
Bus Vehicle	-	0.9	-	0.9	-	-	-	4.5
Engineering	-	0.1	-	0.1	-	-	-	0.3
Local Adm.	0.1	-	0.1	-	-	-	0.2	-
Contingency	-	0.1	-	0.1	-	-	-	0.5
Total Cost	0.1	1.1	0.1	1.1	0.0	0.0	0.2	5.3
Economic Cost in Total	***0.1***	***0.9***	***0.1***	***0.9***	***0.0***	***0.0***	***0.2***	***4.6***
Financial Cost	**2024**		**2025**		**2026**		**2027**	
	Local	**Foreign**	**Local**	**Foreign**	**Local**	**Foreign**	**Local**	**Foreign**
System Work	-	-	-	-	124.2	230.6	-	-
Bus Vehicle	-	3.6	-	3.6	-	2.7	-	3.6
Engineering	-	0.3	-	0.3	2.9	25.7	-	0.3
Local Adm.	0.2	-	0.2	-	17.9	-	0.2	-
Contingency	-	0.4	-	0.4	14.5	25.9	-	0.4
Total Cost	0.2	4.2	0.2	4.2	159.4	285.0	0.2	4.2
Economic Cost in Total	***0.2***	***3.7***	***0.2***	***3.7***	***129.1***	***247.9***	***0.2***	***3.7***
Financial Cost	**2028**		**2029**		**Total**			
	Local	**Foreign**	**Local**	**Foreign**	**Local**	**Foreign**		
System Work	-	-	-	-	124.2	230.6		
Bus Vehicle	-	6.3	-	4.5	-	49.5		
Engineering	0.1	0.5	-	0.3	3.2	29.1		
Local Adm.	0.3	-	0.2	-	20.2	-		
Contingency	-	0.7	-	0.5	14.8	30.9		
Total Cost	0.4	7.4	0.2	5.3	162.4	340.1		
Economic Cost in Total	***0.3***	***6.5***	***0.2***	***4.6***	***131.5***	***295.9***		

Source: JICA study team calculations

4) Residual Value

The project life is assumed to be 23 years from 2007 and 2030 for this analysis, so some assets of invested infrastructures, facilities and equipment will still have residual value even in 2030. The assumed useful lives of different assets are as shown in Table 2.10.28. The residual value of each asset computed wit a straight line method is appropriated in 2030 as a negative cost.

Table 2.10.28 Useful Life Table

Assets	Years
Running Track	50
System Works	20
Station	30
Bus Terminal	50
Station Plaza	50
Depot & Workshop	30
Bus Vehicle	10
Rolling Stock	25

5) Operation and Maintenance Cost

Financial costs for the operation and maintenance of both the railway service and the busway service, including labor costs and material costs, were estimated as shown in Table 2.10.29.

Table 2.10.29 Operation and Maintenance Cost

(1) Operation & Maintenance Cost of the Railway Service

(Unit: LE Million, year 2003 prices)

Financial Cost	2007	2012	2022
Labor Cost	2.3	2.6	10.7
Material Cost	24.3	26.7	123.6
Total	26.7	29.3	134.2

(2) Operation & Maintenance Cost of the Busway Service

(Unit: LE Million, at 2003 prices)

Financial Cost	2007	2012	2022
Number of bus service per day	212	248	684
Vehicle-km per day	4,028.0	4,712.0	12,996.0
Annual OM cost of bus operation	4.4	5.2	14.2

Note: LE3.00 per vehicle-km was assumed.

Source: JICA study team calculations

(3) Economic Analysis

1) Time Saving Benefit

Based on the same procedure as the preceding analysis made in Section 2.10.3, time saving benefits are computed by transport mode. The unit time value of passengers by each transport mode was assumed as same as discussed in the previous analysis. The CREATS model revealed the total numbers of time-saving in terms of passenger-hour per day and vehicle-hour per day. Multiplying these time savings by the unit time value, a total of time saving benefit was calculated in terms of the economic cost, as shown in Table 2.10.30.

Compared to the original case, as shown in Table 2.10.12, the total time saving in 2022 slightly decreases from 729.8 to 692.6 million LE, or by 5.1%.

Table 2.10.30 Time Saving Benefits of Alternative Scheme (a Rail-Bus Joint System)

(Unit: Million LE, at 2003 prices)

Year	2007	2012	2022
Public Mode Passengers			
CTA bus Passengers	3.3	6.2	11.7
GCBC bus Passengers	0.5	0.7	-0.5
A/C bus Passengers	58.2	94.7	620.9
Ferry Passengers	0.0	0.0	0.0
Tram Passengers	-1.7	-0.2	-2.0
Metro Passengers	-11.9	-16.1	-15.0
ENR Passengers	-0.6	-1.2	-2.6
Shared Taxi Passengers	12.0	36.3	202.2
Minibus CTA Passengers	5.5	-1.1	0.3
Mini Coop Passengers	0.5	0.3	-0.8
East Wing Passengers	-33.0	-55.8	-227.1
Sub-total	32.6	63.7	587.2
Private Transport Modes			
Motorcycle	0.0	-2.1	2.7
Car	14.4	-30.2	67.4
Taxi	7.6	-17.6	35.4
Sub-total	22.0	-49.9	105.4
Total	54.7	13.7	692.6

Source: JICA study team calculations

2) Cost Saving Benefit

For the calculation of cost saving benefits, the same indicators of unit costs were utilized, as discussed in Section 2.10.3. The simulation result by the CREATS model reveals the total saving of passenger-km by public transport mode and the total saving of vehicle-km on a daily basis. Multiplying these saving amounts by the unit cost, the total cost saving benefits were computed as shown in Table 2.10.31.

Compared to the original case as shown in Table 2.10.17, the total cost saving in 2022 slightly decreases by 3.7%.

Table 2.10.31 Cost Saving Benefits of Alternative Scheme (a Rail-Bus Joint System)

(Unit: Million LE, at 2003 prices)

Year	2007	2012	2022
Public Transport Mode			
CTA bus Passengers	3.7	2.3	1.7
GCBC bus Passengers	0.6	0.4	-0.2
A/C bus Passengers	43.8	52.1	139.6
Ferry Passengers	0.0	0.0	0.0
Tram Passengers	-2.6	-0.3	-1.9
Metro Passengers	-9.1	-10.6	-9.0
ENR Passengers	-0.4	-0.7	-1.2
Shared Taxi Passengers	7.6	26.2	68.8
Minibus CTA Passengers	1.6	-0.4	0.1
Mini Coop Passengers	0.3	0.3	-0.1
Sub-total	**45.3**	**69.3**	**197.8**
Private Transport Modes			
Motorcycle	0.4	0.0	2.0
Car	15.3	-1.9	58.0
Taxi	7.1	-0.7	26.4
Truck	3.9	-1.5	-37.1
Heavy Truck	0.0	-0.6	-8.1
Sub-total	**26.6**	**-4.7**	**41.2**
Total	**71.9**	**64.6**	**239.0**

Source: JICA study team calculations

3) Cost Benefit Analysis

A cost-benefit analysis was made, based on all properties as discussed above. The analysis yields economic evaluation indicators such as EIRR (Economic Internal Rate of Return), NPV (Net Present Value) and B/C (Benefit-cost Ratio). It is assumed that the social discount rate in the Egyptian economy is 12% p.a. An economically feasible project should satisfy the following conditions:

EIRR > the social discount rate (12%)
NPV = positive
B/C > 1.0

A summary of the computed evaluation indices is shown in Table 2.10.32 in comparison with the original cases, Options 1 and 2. The annual balance sheet of the economic costs and benefits for this alternative scheme is shown in Tables 2.10.33.

As seen in this summary table, the alternative investment scheme of a rail-bus joint system yields the sufficiently high rate of EIRR, **13.2 %**, which means that under this scheme, the East Wing Projects is economically feasible. The NPV accounts for **196.6million LE** at mid-2003 prices, and the B/C ratio is **1.16**, which means that the Project will bring a considerable amount of economic benefits to the national economy as a whole. It can be assessed that the Project is economically feasible, or worth being implemented from the national economic point of view.

Compared to the originally planned cases of Options 1 and 2, this alternative scheme resulted in the most favorable condition in terms of the economic indicators.

Table 2.10.32 A Summary of Economic Evaluation of the Alternative Scheme

Indicators	Alternative Scheme (A Rail + Bus System)	Original Cases	
		Option 1	Option 2
Economic Internal Rate of Return (EIRR)	**13.2%**	11.1%	13.1%
Net Present Value (NPV) : million LE at mid-2003 prices*	**196.6**	-157.6	143.8
Benefit/Cost (B/C) Ratio *	**1.16**	0.92	1.09

*Notes: * at 12% discount rate.*
Source: JICA study team calculations

4) Economic Evaluation: A Conclusion

The Project should seek for a possibly feasible time-framework, particularly appropriate timing of the initial investment which must be responsive to the increasing passenger demand. In this regard, Option 2 seems justified as a recommendable option, that is, the investment schedule with a target that the railway service will be available in 2010 may be of a feasible solution. Now, the economic evaluation result of the alternative investment scenario, which is to provide a rail-bus joint system for the East Wing corridor, presented economically justifiable indicators, even though the operation will start from the year 2007.

Based on these implications, it is recommended that the East Wing Project should commence with the rail-bus joint system in the initial stage in order to avoid a risk in the front-heavy investment, and then along with the increasing passenger demand, the feeder bus system should be shifted to a new railway system between the Shorooq Station and the 10th of Ramadan Bus Terminal Station, which is to be constructed after 2010.

Table 2.10.33 Economic Analysis of Alternative Scheme (A Rail-Bus Joint System)

EIRR= 13.2% **NPV=196.6** **B/C=1.16**

(Unit: Million LE)

Year	Investment Cost	O&M	Total Cost	Time Saving	Cost Saving	Benefit Total	Net Benefit	NPV *1)
	(a)	(b)	(c)=(a)+(b)	(d)	(e)	(f)=(d)+(e)	(g)=(f)-(c)	(h)
2004	58.5	-	58.5	-	-	0.0	-58.5	-52.2
2005	522.5	-	522.5	-	-	0.0	-522.5	-416.6
2006	1,084.5	-	1,084.5	-	-	0.0	-1,084.5	-771.9
2007	-	31.1	31.1	54.7	71.9	126.6	95.5	60.7
2008	1.9	31.8	33.7	46.5	77.3	123.7	90.0	51.1
2009	1.0	32.5	33.4	38.3	75.6	113.9	80.5	40.8
2010	1.0	33.1	34.1	30.1	74.0	104.1	70.0	31.7
2011	1.0	33.8	34.8	21.9	72.4	94.3	59.5	24.0
2012	-	34.5	34.5	13.7	64.6	78.4	43.9	15.8
2013	26.8	45.9	72.7	81.6	88.5	170.1	97.4	31.4
2014	3.9	57.3	61.2	149.5	106.2	255.7	194.6	55.9
2015	25.8	68.7	94.5	217.4	123.9	341.4	246.9	63.4
2016	20.4	80.1	100.4	285.3	141.7	427.0	326.5	74.8
2017	69.7	91.5	161.2	353.2	159.4	512.6	351.4	71.9
2018	23.2	102.8	126.1	421.1	177.1	598.2	472.1	86.3
2019	32.3	114.2	146.5	489.0	194.9	683.8	537.3	87.6
2020	15.8	125.6	141.4	556.8	212.6	769.4	628.0	91.5
2021	32.3	137.0	169.3	624.7	230.3	855.1	685.8	89.2
2022	2.9	148.4	151.3	692.6	239.0	931.6	780.3	90.6
2023	4.8	148.4	153.2	692.6	239.0	931.6	778.3	80.7
2024	3.9	148.4	152.3	692.6	239.0	931.6	779.3	72.1
2025	3.9	148.4	152.3	692.6	239.0	931.6	779.3	64.4
2026	377.0	148.4	525.4	692.6	239.0	931.6	406.2	30.0
2027	3.9	148.4	152.3	692.6	239.0	931.6	779.3	51.3
2028	6.8	148.4	155.2	692.6	239.0	931.6	776.4	45.7
2029	4.8	148.4	153.2	692.6	239.0	931.6	778.3	40.9
2030	-1,044.0	148.4	-895.6	692.6	239.0	931.6	1,827.2	85.7

*Note: *1) Discount rate: 12 %p.a.*
Source: JICA study team calculations

(4) Financial Analysis

A number of assumptions are employed for the financial analysis, same as the previous analysis of the planned case:

- The financial investment costs, estimated at mid-2003 constant prices,, are allocated in the scheduled time-framework up to the year 2022 in such a way that the rail-bus joint service will be operated in 2007 and will generate the operating revenues from 2007;
- The evaluation period is assumed to be the period between 2004 and 2030, and the depreciation of depreciable assets are appropriated with a straight line method under an assumed useful life by asset and the residual value of the invested capitals is considered in 2030 as a negative cost;
- For the operating revenue, a distance-based fare system (a base fare plus distance-based charge) is adopted, as seen in Table 2.10.34. **An integrated fare system** is applied in such a way that passengers using this rail-bus joint system may buy one ticket for the bus and railway services.

Table 2.10.34 Assumed Integrated Fare Level for the Rail-Bus Joint System

	2007	2012	2022
Base Fare (LE)	0.63	0.74	1.00
Distance-based (LE/km)	0.03	0.04	0.05
Example Fare (LE): Ain Shams Station ~ Shorooq Station (49 km)	2.10	2.70	3.45

Source: JICA study team calculations

- Additional incomes accruing from ancillary sources related to the railway service operation, such as advertisement charges, are considered to be 6% of the operating revenue, taking into account experiences being performed in other countries.

(5) Summary Result of the Financial Analysis

The Project will be financially evaluated in terms of the following three indices, same as discussed earlier:

- FIRR (Financial Internal Rate of Return)
- The first year when the Project generates a positive annual operating profit;
- The first year when the annual net profit becomes positive (after reduction of interest and depreciation); and
- The year when the accumulated net profit becomes positive.

The results of the financial analysis are summarized in Table 2.10.35. This result is compared with that of Option 1, because the operation schedule of Option 1 is assumed to be the same as that of this alternative, that is, the service will be available in the year 2007. As seen in this table, the FIRR of the rail-bus joint system was computed at 5.8%, which is considerably higher that that of Option 1, 3.3%. Moreover, the other financial indicators in terms of the years of profit generation, are all significantly improved by shortening the period of "negative balance". The first year when the accumulated net profit becomes positive will be 2017, or 10 years after the operation, being shortened by 5 years, compared to Option 1.

Nevertheless, this financial evaluation still indicates a sensitive situation, which requires a thoughtful financial arrangement to assure the financial viability of this Project, same as discussed in Section 2.10.4.

Table 2.10.35 A Summary of Financial Analysis for the East Wing Project

Evaluation Indices	Alternative Scheme (A Rail-Bus Joint System)	Original Case (Option 1)
FIRR (Financial Internal Rate of Return)	5.80%	3.31%
The First Year of Positive Operation Profit at Annual Basis	Year 2011	Year 2014
The First Year of Positive Net Profit at Annual Basis (after Interest and Depreciation)	Year 2013	Year 2015
The First Year of Positive Accumulated Net Profit	Year 2017	Year 2022

Source: JICA study team calculations

2.11 IMPLEMENTATION PLAN

2.11.1 A Recommended Implementation Scheme

It was assessed that the East Wing Project would be economically feasible but financially less feasible. This implies a need for a deliberated design of the implementation mechanism in terms of the financial arrangement. In this regard, three alternatives are generally conceivable as follows:

(1) Alternative 1 (Government-Initiative):

The government sector (ENR) shall take the full responsibility for the construction and the operation. The investment by the government is rational and justifiable, because the Project itself has been proven to be economically feasible. Therefore, a government subsidy should be injected to an extent that the financial balance shall be assured in the long-term. This option, however, hold two sorts of issues to be tackled: (1) ENR could hardly guarantee an efficient commercial operation without restructuring of the ENR. Such an institutional arrangement will be further difficult; and (2) As the Project is financially sensitive, the external resource mobilization with a lower interest rate would be a key, despite that the Egyptian government has currently applied a severe ceiling policy for foreign debts.

(2) Alternative 2 (Privatization):

As an alternative scheme to lessen the government sector's financial burdens and constraints, a BOT (Build, Operation and Transfer) mechanism under a well-planned concession scheme is nowadays getting more popular, and may be a possible option for public service provision. However, <u>the BOT scheme is not necessarily recommended for this Project</u>, because of the following four reasons: (1) the private sector will hardly take a financial risk on such a huge amount of investment that will be constantly required over the long-term; (2) the private sector will claim some sort of government guarantee on the revenue, or a constant subsidy to avoid ridership risk which is heavily dependent on the progress of the new communities development; (3) The private sector's fund-raising capacity for the infrastructure construction is inherently subject to economic fluctuation. Therefore, the private sector could hardly guarantee the scheduled construction and operation as expected; and (4) it will normally take a long time to reach an agreement between both the government and private sectors, thereby losing otherwise-could-be benefits.

In order to make a BOT project successful, as proven through other countries' experiences, a capacity building process in the public sector is indispensable. The managerial and negotiable capacities in the government side should be strengthened, and at the same time, a well-organized legislative framework to conduct a proper BOT mechanism needs to be prepared before launching a BOT project.

(3) Alternative 3 (Public-Private Partnership):

A type of Public-Private Partnership (PPP) mechanism could be pursued. This option is flexible and applicable for the East Wing Project. The government sector (ENR) assumes responsibility for the infrastructure development, and owns its property, while the private company or a joint venture company of the public and private sectors, shall assume the responsibility for operations and maintenance including the procurement of rolling stocks, leasing the infrastructure from the owner who is the government sector. The government may recover the investment cost by a concession fee of the infrastructure to be collected from the operator. As this mechanism reinforces both weaknesses, and integrates both strengths of the public and private sectors, this is suitable for such a project like the railway improvement requiring a considerable amount of initial investments and sophisticated technologies for the operation and management. It is recommended that this option should be further pursued for the East Wing Project.

A conceptual framework of the recommended PPP scheme is explained as shown in Table 2.11.1.

Table 2.11.1 A Proposed Framework of Public-Private Partnership Scheme

	The Infrastructure Owner (The Government Sector)	**The Operator** (A Private or Joint Entity)
Investment	Provision of capital investments and construction of the infrastructures and the systems	Procurement of rolling stocks and related facilities and equipment
Tasks & Roles	- Issuing a Concessionaire for use of the Infrastructures - Issuing a business operation license with a definite set of rules and regulations - Monitoring the operation and the management	- Assuring a proper operation and services - Strengthening the human capacity - Generating operational revenues - Maintaining the Total System
Obligations	Recovering the investment by the levied Concession Fees in the long-term	Paying the Concession Fee at an agreed rate of the operation revenue.
Accountability	To the public	To the Infrastructure owner as well as the public
Access to Funds	- Government subsidy - International donor agencies	- International donor agencies - Local financing institutions and commercial banks

Source: JICA study team

2.11.2 A Cash Flown Analysis of A Public Private Partnership Model

The Study Team recommends "Alternative 3" as discussed above, to implement the East Wing Project. Under a conceptual mechanism of Public-Private Partnership (PPP), a cash flow analysis was examined to evaluate its overall profitability and Implementability based on a basic premises that the East Wing Railway Project be operated as planned in 2007.

(1) Assumptions for the Business Model

For a business model, two organizations are supposed, namely, the government (the infrastructure owner) and the operator (an operating company), and the following conditions are assumed:

1) The government sector, or ENR, be the implementing body of the Project, and invests for the infrastructure facilities. Therefore, the infrastructures belong to the government sector.
2) The cost of the foreign currency portion for the infrastructure shall be procured through an ODA soft loan scheme, while that for the local portion shall be raised internally as a government subsidy. Financial conditions of the ODA soft loan are assumed to be: 3% interest rate; 7 years grace period and 25 years repayment period.
3) The operating company shall maintain all the infrastructure facilities and operate the rail service, with procuring the necessary rolling stock. The operating entity may be any form of business corporations. However, the operating company should guarantee a good practice for the railway operation business and be capable of commercially managing the total system in a professionally proper manner.
4) It is assumed that the equity, as the initial capital, of the operating company shall be raised at 20% of the initial investment, and that in order to raise the remaining funds, the operating company can have access to an international soft loan equivalent to the amount of the foreign currency portion necessary for the rolling stock procurement and a long-term loan at a commercial bank with a 10% interest rate. An annual shortfall, if it occurs, be fulfilled with a short-term loan (one year) at a 13% interest rate at local commercial banks. Needless to say, the gearing ratio (the ratio of the equity against the total investment) is a crucial factor affecting the financial conditions of the company in the start-up period. The assumed rate of 20% seems rational as a rail business entity.
5) It is also assumed that the operating company shall operate the rail service, receiving daily fare revenues from passengers and sales revenues from some sorts of off-rail business such as commercial advertisement and kiosks, while costing repayments of the loans, depreciations of capital assets, current operating expenses and a concession fee which should be paid to the infrastructure owner for its use. Taking into account experiences in the other countries, the off-rail business revenue is assumed to be 6% of the operating revenue, as a possible level.

6) The concession is a key for this business model of the Public-Private Partnership scheme. The government sector, as the infrastructure owner, receives the concession fee from the operating company at a certain percentage of the operation revenue, and may earmark the levied fees to recover the initial investment cost in the long-term.
7) The rate of the concession fee that the operator shall pay the infrastructure owner is assumed to be 5% of the operational revenue as a base case, then an appropriate rate is examined in a range between 5% to 50% so that both parties' financial situations become favorable, or not worsened at least.

(2) Results of the Cash Flow Analysis

Based on the above assumptions, a cash flow analysis was made for each entity, and the results are summarized in Table 2.11.2. The evaluation criteria are as follows:

For the operator:

- **FIRR** (Financial Internal Rate of Return) to assess the financial feasibility on the operator's investment; and
- **ROE** (Return on Equity)[1] :to measure the profitability of the equity initially raised by investor(s), in terms of a percentage of returns on the initial investments.

For the infrastructure owner:

- **Accumulated Subsidy** to measure the amount of the subsidies that the Government provides for the infrastructure development;
- **Average Annual Subsidy** to assess the magnitude of the average annual subsidy which is shouldered by the Government;
- **Accumulated Net Profit** in 2030 to assess the financial balance between accumulated profits (equivalent to the collected concession fees) and the subsidies in the end of the project life, 2030.

As for the operating company, this business will yield as much as 21.1% of the Financial Internal Rate of Return (FIRR), and 47.2% of the ROE, given a concession fee rate of 5%. This indicates that the operating company will be able to enjoy a remarkably favorable profit from this business opportunity.

On the other hand, under this condition, the infrastructure owner (the Government) should provide a cumulative total of 2,916 million LE, through a subsidy scheme, and this amount of subsidy could not be recovered by the levied

[1] **ROE:** A measure of how well a company used reinvested earnings to generate additional earnings. It is used as a general indication of the company's efficiency; in other words, **how much profit it is able to generate given the resources provided by its stockholders. Investors usually look for companies with returns on equity that are higher and growing more than any interest rate of deposits at commercial banks**. For this analysis, ROE is computed as a percentage of the average annual returns on the initial investments during the period of the project life.

concession fees by the year 2030. The accumulated net profit will remain -1,846 million LE (negative) in 2030. Thus, this situation seems too favorable for the operator side. Therefore, the concession rate may be flexibly increased.

Should the concession fee level be 30% of the operational revenue, the operator can enjoy a 12.3% FIRR and a 26.6% ROE. These figures still stand for a financially viable level and must be attractive for investors in the business sector, considering the current Egyptian financial situation.

While, under the same concession fee rate as 30%, although the infrastructure owner should shoulder a total of 1,216 million LE, the net loss can be minimized at as low as 146 million LE in 2030. Since the positive net profit will take place in a few years after 2030, it can be said that the government subsidy will be fully recovered with this scheme. Thus, this scheme will bring a favorable condition to the government as well.

Table 2.11.2 A Summary of Cash Flow Analysis of Option 3

Condition	**The Operation Company**		**The Infrastructure Owner (the Government)**		
	FIRR (%)	ROE [2] (%)	Accumulated Subsidy (Million LE)	Average Annual Subsidy (Million LE)	Accumulated Net Profit **in 2030** (Million LE)
Base (CF [1] = 5%)	21.1	47.2	2,916	108	- 1,846
Case of CF=30%	12.3	26.6	1,216	45	- 146

Notes: 1. "CF" stands for the rate of Concession Fee to the operation revenue.
2. "ROE": Return on Equity
Source: JICA study team calculations

2.11.3 Recommendations on the Implementation

As a conceptual business model of Public-Private Partnership, an unique scheme was examined, that is, two entities of the infrastructure owner and the operator shall separately come into the same business ground and integrally play for the implementation and operation of the Project. The result of the cash flow analysis revealed that the scheme with 30% of the concession fee rate will enable both parties to manage the Project in such a way that both parties will be able to satisfy their own objectives: the operator will enjoy a sufficient level of profits, while the government will recover the vested subsidy in the long run, providing public transport services for the people.

Therefore, it is recommended that this scheme should be further pursued to materialize the implementation in consideration of the following aspects as discussed in previous sections:

1) The external resource mobilization is essential for the Project, because the Project is financially sensitive, as discussed in Section 2.10.4. The assumed financial conditions for procuring the external funds are rational and plausible in general, but depending upon funding institutions of aid organizations.

Therefore, the analysis needs to be further clarified with concrete conditions to be offered by a possible agency.

2) Since the Project itself is evaluated economically feasible, the government subsidy for the Project can be justified in the long-term from the national economy point of view, as discussed in Section 2.10.3. However, the investment schedule should be carefully decided, responding to increasing demands along with the progress of development of new communities.

3) In this regard, there are two feasible options: one is that the East Wing Project be implemented targeting at that the full railway service shall start from 2010; and the other is the alternative solution as examined in Section 2.10.5, i.e., **the rail-bus joint system** that the exclusive busway system be developed initially, then shifted to a new railway system between the Shorooq Station and the 10th of Ramadan Bus Terminal Station, in the time when the railway investment could be financially feasible after 2010. As either solution will be economically and financially feasible, technical and operational considerations should be taken for decision-making.

4) In this regard, the concept of **the rail-bus joint system** is technically rational but operationally complicated**,** needing a two step procedure: the intermodal facility development at the Shorooq Station at the initial stage and replacement of bus fleets for the railway systems together with rolling stocks in the second stage. On the other hand, **the full railway system** is technically and operationally simple, and will assures a more convenient public transport system which will be able to further facilitate the development of new communities. As a conclusion, it is recommended that the East Wing Project be commenced with the concept of the rail-bus joint system, including rehabilitation of the existing Suez Line in the section between the Ain Shams Satation and the Shorooq Station, and the new construction of the infrastructure suitable for the railway system between the Shorooq Station and the 10th of Ramadan where bus services be initially provided. It should be flexible to shift to the full railway system in the new construction section, depending upon the passenger demand in the new communities.

5) Under the proposed PPP scheme, some private sector's offers could be invited for the operating entity, through a biding process, as far as it is assured that the entity can be functionally organized with sufficiently trained staffs, as discussed in the following section 2.11.4. However, the Cairo Metro Organization (CMO) is recommended to become the operating entity for the East Wing railway service, being restructured so as to accommodate such new suburban rail services, rather than establishing a new entity. The CMO has experienced in operating in the railway business and has an advantage that the East Wing can be operated in conjunction with Metro Line 1 at Ain Shams Station. This integrated operation, in the future, will be vital when the ENR suburban rail is physically connected with the metro lines. As another option, the CMO may invite the private investor(s) to establish a new joint operating company.

2.11.4 East Wing Railway Company Organization

(1) Organization Alternatives for the East Wing Railway Company

It is recommended that the East Wing Railway Company be established as an independent operating entity, which is a concessionaire contracted with the infrastructure owner, the Egyptian National Railway (ENR). The company is the exclusive operator for the East Wing railway service, having rolling stock and relevant facilities/equipment. The entire responsibility for maintaining the infrastructure and stations is also assumed by the operating company. The operating company shall be managed on a commercial basis with a profit-oriented and efficiency-driven management system, being assured freedom in managerial resource utilization and deregulated in operation activities.

Two alternative options are conceivable for organizing such an operating company in practice. The one is that the functions expected for the operating company are devolved to the Cairo Metro Organization (CMO), then the CMO shall organize a sub-organization exclusively responsible for this sub-urban railway service under the current the CMO structure. The other is that a purely private company be selected under an international bidding process. Either option may be possible and feasible.

1) The Operating Company under the CMO

CMO is now operating the entire metro system, and has accumulated technical and operational experiences in such a sophisticated urban transit system. Since the East Wing railway service requires a 2-3 minutes headway operation in 2022, the operator should develop the same level of operating know-how, well-organized staff assignment system, technologies for safety assured by trained personnel. In this regard, the CMO holds a substantial advantage to be the operator of such new suburban rail service. The CMO will also be capable of facilitating intermodal management at the Ain Shams Station with Metro Line 1, through introduction of a joint-ticketing system and time-schedule adjustment to minimize passengers transfer time. As the CMO is currently placed under the ENR organization, this option seems rational in the administrative arrangement.

Nevertheless, this option hold a weakness, that is, the new organization will somewhat continue with the traditional bureaucratic inefficiency in management. A key is whether or not an innovative management system can be performed in a commercialized manner. In this regard, deregulation of the traditional suburban rail operation is crucial in order for the CMO to promote off-rail revenues, thereby enabling a financially sustainable operation.

2) A Private Entity

Through an international bidding process, the private sector will be given a chance to explore this rail service business as a concessionaire. Both international and local investors may offer their own proposals on how to manage the operating company, bringing their own management know-how and modernized technologies and systems for the operation. For this privatization scheme, the government needs to deregulate the public transport service provision in such a way that the private sector can pursue the commercial operation though the market mechanism as well as promote off-rail business to fulfill an anticipated financial gap or averse financial risks on revenue generation.

(2) Organizational Strategy

This section presents a proposed organizational structure for the East Wing Railway operator. The organizational structure is applicable for either the private or public sector, as it is planned according to the selected technical options and the anticipated ridership by the years 2007, 2012 and 2022. The following are incorporated into the principal management system:

- The organization will not be in charge of the design, construction, testing, upgrading of the track and equipment and commissioning of the project;
- The staff organization will be in charge of the operation, the maintenance and the management of the system.
- The general operating principles will be a centralized control of all the different tasks.

The recommended general organization for the operation and maintenance of the East Wing Railways is similar to the metro system organizations used in Cairo, and adjusted in accordance with worldwide experience in suburban railway operations.

The staffing of each department has been adjusted according to the selected technical and operational options. The labor productivity and work load are planned at an international level but adjusted in consideration of local conditions.

(3) Organizational Structure

The proposed East Wing Company Organization is structured with five departments under a general management unit as shown in Figure 2.10.1. The Board of Directors shall assume comprehensive management responsibilities. Functions and responsibilities of each department are described as follows:

1) Board of Directors

The functions and responsibilities of the Board of Directors normally include the following:

- The annual budget;
- The monthly and annual management and financial report;
- The basic functional and operations policies;
- The right to hire and to approve the General Manager; and
- The right to approve the persons selected to head the finance department.

2) General Manager (GM)

The East Wing Railways will be under the responsibility of a General Manager, supervised by the Board of Directors, who will be responsible for the management of all activities. It will be General Manager's responsibility to define goals and policies for the system and to oversee their implementation. The GM will review the budget and will control major expenditures. The GM will also be involved in any negotiations with the city or with manufacturers and subcontractors, being helped by an assistant and a secretary, and will have under his/her responsibility five main departments:

- Maintenance Department;
- Operation Department;
- Finance Department;
- Administration Department; and
- Safety and Quality Assurance Department under GM’s direct responsibility.

3) Maintenance Department

Maintenance Department will be supervised by a Maintenance Manager and will include four main functional units of: Rolling stock; Track and civil work; Computerized systems; and Signaling systems.

4) Operations Department

This Department will be responsible for operating the East Wing Railways system. It will consist of three main functional units:

- Operation Planning Division
- Central Control Room Division; and
- Line Operational Division.

<u>Operation Planning Division</u>

This Division will carry out studies concerning operational methods. This will include studies on various equipments such as trains and signaling in order to prepare, in co-ordination with the training group, possible regulation modifications. It will also determine the train timetable and staff lists according to the line’s ridership scheduling.

<u>Central Control Room Division</u>

This Division will be responsible for:

- The line train traffic control from the Central Control Room,
- Managing all the centralized information on: 1) Defects in the equipment; and 2) Management of the central control room staff.

Line Operational Division

This Division will be responsible for:

- Management of the line staff (supervisors, drivers, ticketing staff, ...);
- Manoeuvres on the yard operational tracks;
- Train driving;
- Passenger relations; and
- Ticket selling.

5) Finance Department

Finance Department will be supervised by a Financial Manager approved by the Board of Directors. Finance Department will be responsible for all fiscal matters related to the East Wing Railways. The main function of this Department will be:

- Provision of all accounting and financial management services required by the organization including salary payments, the maintenance of all bank accounts;
- Preparation of a draft budget proposal for review by management and the provision of monthly and yearly financial performance reports;
- Preparation and execution of all approved purchase orders for equipment, materials, and supplies for the East Wing Railways system and the maintenance of detail procurement records; and
- Establishment of a library of vendor information and specifications.

6) Administrative Department

Administrative Department will be supervised by an Administrative Manager, and be responsible for the following tasks:

- Personnel administration, including the maintenance of employment records, recruitment and staffing, and health administration and other benefit plans;
- Provision of training for employees in non-technical disciplines;
- Establishment of a comprehensive safety program, including safety education, and the enforcement of safety procedures throughout the organization; and
- Public relations.

7) Safety and Quality Assurance Department

Safety and Quality Assurance Department will be supervised by a Safety and Quality Assurance Manager who will report directly to the General Manager. The task of this department is to:

- Inform, advise and assist the various operational units of the East Wing Railways system as to quality and safety, within the limits of the legislation currently in force;

- Review and approve permanent and temporary operating and maintenance procedures proposed by the concerned services;
- Carry out incident inquiries with safety personnel in the concerned service;
- Check the compliance of operating and maintenance procedures through audits; and
- Keep the General Manager informed about the measures which have been introduced.

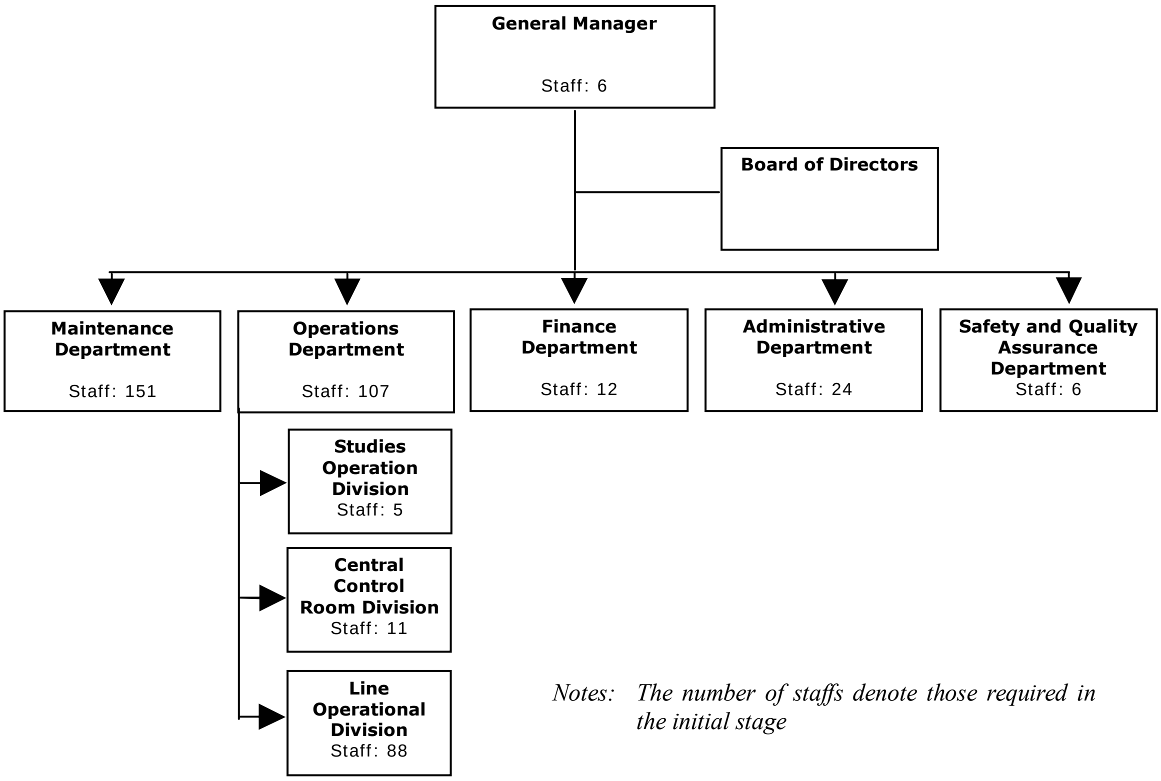


Figure 2.11.1 An Organizational Structure of the East Wing Railway Operation Company

(4) Staffing Requirements

This section estimates the staff requirements for each department of the East Wing Railways Operation Company, based on the following general principles:

1) An efficiency-oriented commercial operation is the basic employment framework of the organization;
2) Numbers of staff respond to the planned operation schedule and service volume of the railway system, referring to the current operation of Cairo Metro Organization as well as the international levels of a similar system;

3) Concerning the managers: one person per post, thus highly efficient managerial personnel are expected;
4) Concerning the staff working conditions:

- Equivalence of 1.5 rest day every 5.5 work day (7/5.5 factor);
- 1.20 absenteeism factor (holidays, illness, refreshment training, etc.); and
- For operating staff and post assured 24 hours per day; 3 shifts per day.

1) Staff Estimates at the Initial Operating Stage

The number of staff required for each department is estimated by professional/skill category and by class/grade. The result is tabulated in Table 2.11.3. For the operation during the period between 2007 and 2012, or the initial stage, a total of 306 staff need to be employed. This is the minimum number of staff to operate the railway service.

2) Staff Estimates at the Initial Operating Stage

Along with the increasing passenger demands, the East Wing Railway Company should be strengthened in terms of its operation capability, while its organizational structure is being kept the same. The necessary staff in 2012 and 2022 are estimated, based on the same assumptions, and the results are summarized in Table 2.11.4. In 2012, the company needs a total of 375 employees, increasing from 306 employees in 2007. A minor increase is sufficient enough to operate the system to meet with the 2012 demand.

However, in 2022 when the full operation of the railway system is required, the staff capacity will need to be significantly enhanced to approximately 900 employees. Great increases will be needed in the maintenance department and the operations department, while the management side is conservative in terms of the staff numbers.

Table 2.11.3 Staff Requirements of the East Wing Railway Company (2007)

Department	Profession/Skill	Class/ Grade [1]						TL
		M	SE	E	ST	T	W	
Management Unit	General Manager	1						1
	Assistant GM	2						2
	Secretary						3	3
	Sub-total	**3**					**3**	**6**
Safe & Quality Dep't	Manager	1						1
	Technician				2			2
	Secretary						3	3
	Sub-total	**1**			**2**		**3**	**6**
Maintenance Dep't [2]	Manager	1						1
	Secretary						2	2
	Rolling Stock		1	3	3	10	45	62
	Civil Work		1	1	3	4	9	18
	Track			1	2	3	9	15
	CCR & Telecom.		1	1	5	5	4	16
	Signaling			1	4	6	8	19
	Fare Equipment			1	2	2	4	9
	Misc. Equipment			1	2	2	4	9
	Sub-total	**1**	**3**	**9**	**21**	**32**	**85**	**151**
Operation Dep't	Manager	1	1					1
	Secretary						2	2
	Technical Studies		1	2			2	5
	CCR & Telecom.			1	6	2	2	11
	Ticket Sales & Control						50	50
	Line Supervisor		1	1	4	6	8	20
	Train Drivers [3]					17		95
	Sub-total	**1**	**3**	**4**	**10**	**25**	**64**	**107**
Finance Dep't	Manager	1						1
	Secretary						2	2
	Budget Officer		1	1			1	3
	Treasury		1		2		1	4
	Contracts		1		1			2
	Sub-total	**1**	**3**	**1**	**3**		**4**	**12**
Administrative Dep't [4]	Manager	1						1
	Secretary						2	2
	Personnel Adm.		1	2		1	1	5
	Recruitment		1	1			1	3
	Training-Safety		1	2	2	2	2	9
	Public Relations		1	1	2			4
	Sub-total	**1**	**4**	**6**	**4**	**3**	**6**	**24**
Total		**8**	**13**	**20**	**40**	**60**	**165**	**306**

Notes:

1) M: Managerial class; SE: Senior Engineer; E: Engineer; ST: Senior Technician; T: Technician; and W: Worker

2) The repair of certain equipments can be performed under a service contract. Service contracts will be used primarily for components repairs and overhauls which are not time-critical to passenger operation. Cleaning will be performed under a service contract.

3) For the calculation of the driver number, the following has been assumed:
A working time per day per driver: 8 hours;
An extra driver time for stabling, maneuvers, refreshing training: 20 %
An extra driver time for holidays, illness, etc.: 20 %

4) Certain tasks, such as cleaning or guarding, will be performed under a service contract.

Source: JICA study team calculations

Table 2.11.4 A Summary: East Wing Railways Staffing in 2007, 2012 and 2022

Department	Total	Number of Staff by Grade					
		Manager	Senior Engineer	Engineer	Senior Technician	Technician	Other Staff
Initial stage (2007)							
Management	**6**	3	-	-	-	-	3
Safety/Quality	**6**	1	-	-	2	-	3
Maintenance	**151**	1	3	9	21	32	85
Operations	**107**	1	3	4	10	25	64
Finance	**12**	1	3	1	3	-	4
Administration	**24**	1	4	6	4	3	6
Total	**306**	**8**	**13**	**20**	**40**	**60**	**165**
For Operation in 2012							
Management	**6**	3	-	-	-	-	3
Safety/Quality	**6**	1	-	-	2	-	3
Maintenance	**184**	1	3	10	24	40	106
Operations	**135**	1	3	4	10	36	81
Finance	**15**	1	3	2	4	1	4
Administration	**30**	1	4	7	6	5	7
Total	**375**	**8**	**13**	**23**	**44**	**83**	**204**
For Operation in 2022							
Management	**8**	4	-	-	-	-	4
Safety/Quality	**7**	1	-	-	3	-	3
Maintenance	**461**	1	6	21	50	95	288
Operations	**331**	1	7	8	19	82	214
Finance	**32**	1	4	8	6	4	9
Administration	**63**	1	8	12	15	12	15
Total	**902**	9	25	49	93	193	533

Source: JICA Study Team

CHAPTER 3

FEASIBILITY STUDY OF THE WEST WING AND TRAFFIC MANAGEMENT PROGRAM AT CENTRAL GIZA (AREA 2)

CHAPTER 3 FEASIBILITY STUDY OF THE WEST WING AND TRAFFIC MANAGEMENT PROGRAM AT CENTRAL GIZA (AREA 2)

3.1 INTRODUCTION

3.1.1 Objectives

As outlined in the Inception Report (2) of the CREATS Phase II Study, the objectives of the feasibility study of the Component A-2 are:

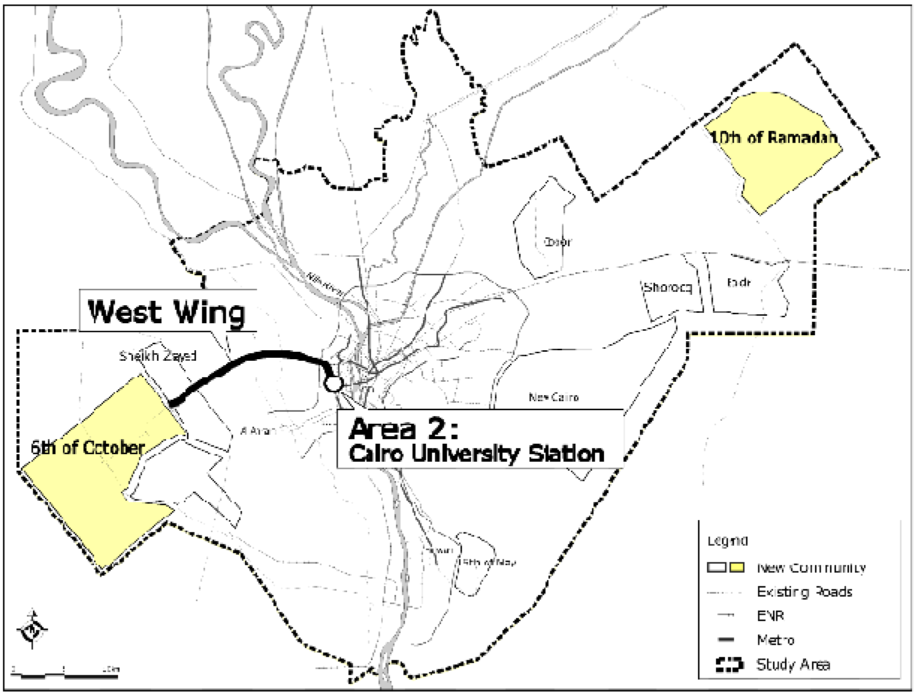
- To conduct a feasibility study to develop public transport system within the West Wing Corridor, linking central Cairo with 6th of October City, and
- To formulate a short-term traffic management and intermodal facility development plans in Central Giza (Area 2), which is linked with West Wing public transport strategy.

3.1.2 Study Area

The study area of the Program A-2, which is the "Feasibility Study of the West Wing public transport development and Traffic Management Program at Central Giza (Area 2)", is defined as the West Wing corridor between Central Giza and 6th of October City, see Figure 3.1.1.

However, it is unavoidable to include other influential areas during the analyses. For example, completing the West Wing public transport system could decrease the number of cars moving between Cairo CBD and 6th of October, which in turn might cause an increase of travel speed on the roads. This (positive) impact will not only affect the corridor area but the whole study area.

Therefore, the practical study area is equal to the area defined in the Transport Master Plan, although the planning of the public transport system focuses on the area between the Central Giza and the 6th of October City along the West Wing route.



Source: JICA Study Team

Figure 3.1.1 Study Area

3.2 EXISTING SITUATION OF THE WEST WING AND CENTRAL GIZA

3.2.1 West Wing

(1) Existing and Future Socio-economic Situation

In the Master Plan Study, the existing situation for the new communities was examined in detail. Study Team members visited all relevant public authorities and offices to collect the appropriate information. The population of the Study Area and the New Communities were projected based on possible future economic growth scenario, because economic growth was considered as a key factor in new community development. Resulting future population estimates are given in Table 3.2.1 (refer to Section 2.4.3, *Chapter 2: URBANIZATION STRUCTURE AND SOCIO-ECONOMIC FRAMEWORK*, Volume III, Transportation Master Plan and Feasibility Study of Urban Transport Projects in the Greater Cairo Region in the Arab Republic of Egypt, PHASE I Final Report, November 2002 by JICA.

According to the Master Plan, the total population of the new communities, including 6^{th} of October and Sheikh Zayed along the West Wing corridor will grow from about 200,000 in 2001 to about 1,165,000 in 2022.

The biggest new community along the corridor is 6^{th} of October City. Although Sheikh Zayed is formally separated from 6^{th} of October City, both communities are linked in practical terms. Employment in both communities was estimated to increase from 172,000 to 386,000 persons: the number of students from 88,000 students in 2001 to 269,000 students in 2022. The expected growth is larger than on the East Wing except for the forecasted growth of total population, a logical consequence of the different number of new community developments on both corridors.

Table 3.2.1 Population Distribution of New Communities

	2001	2007	2012	2022
New Communities in the East Wing Corridor	**288**	**416**	**685**	**1,376**
Oboor	42	50	112	300
Shorouq	25	50	112	300
Badr	25	38	88	200
10th Ramadan	196	278	373	576
New Communities in the West Wing Corridor	**200**	**332**	**513**	**1,165**
6th October	200	302	426	865
Sheik Zayed		30	87	300
New Cairo	**120**	**165**	**272**	**699**
Total of New Communities	**488**	**914**	**1,469**	**3,241**
Rest of the Study Area:	13,904	15,184	16,180	17,480
The Study Area	**14,392**	**16,098**	**17,649**	**20,721**

Source: JICA study team, based on the GOPP data.

(2) Transport Demand

Person trips related to the 6th of October City Sector (including Sheikh Zayed), which are number of trips made by residents of the City as well as visitors to the City, in 2001 were 355,705 per day including both intra-zonal and inter-zonal trips, according to the Home Interview Survey, which was conducted for the Master Plan. These person trips are estimated to increase to 1,969,640 in 2022 (i.e. by 5.5 times), as summarized in Table 3.2.2.

Table 3.2.2 Forecast Person Trips and Population in the 6th of October City Sector

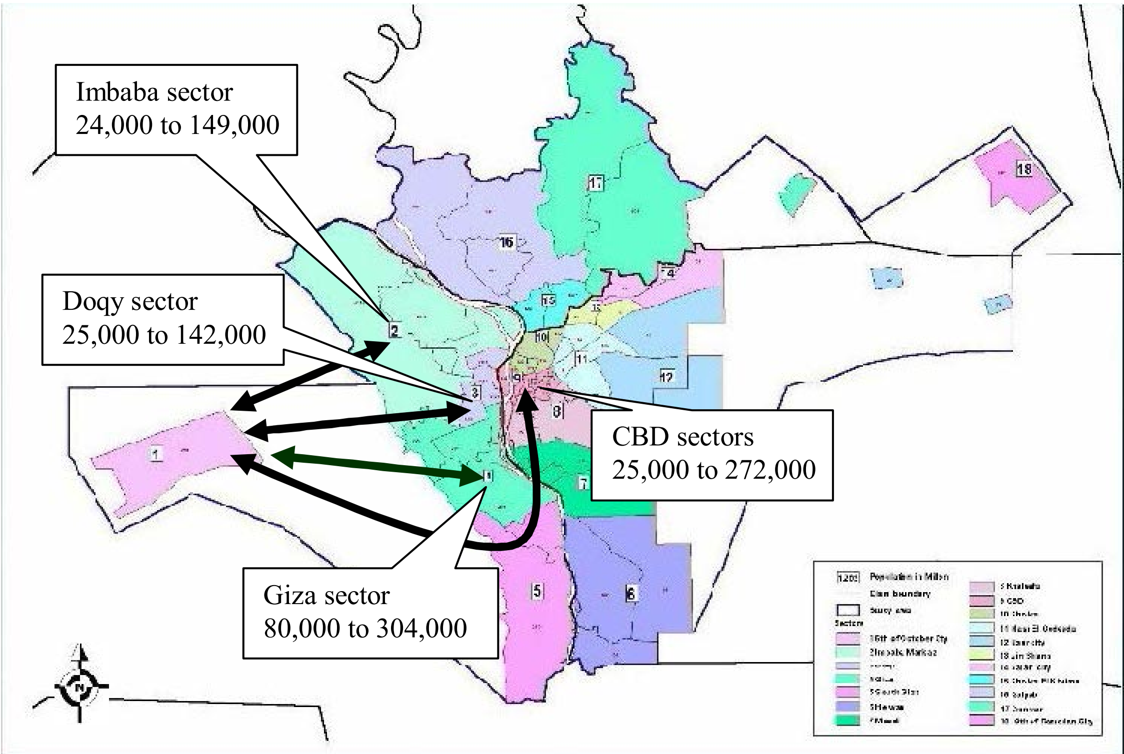
Year	2001	2022
Intra-zonal Trips	194,430	1,157,646
Inter-zonal Trips	161,275	811,994
Total Trips	355,705	1,969,640
Population	200,018	1,165,350

Source: JICA Study Team

Figure 3.2.1 shows the major trips per origin/destination in terms of the 18 sectors as defined in the Master Plan. It is apparent that sectors in the west of the Study area have strong relationships with 6th of October City and with Sheikh Zayed. Among them, the Giza sector was the biggest sector with 80,000 trips per day, followed by Doqy and Imbaba sectors with respectively 25,000 and 24,000 trips per day in 2001.

The forecasting results of the Master Plan demonstrate that, in 2022, Giza sector will remain the biggest area with 304,000 trips per day, followed by the aggregated sectors of CBD area with 272,000 trips per day, Imbaba and Doqy sectors with respectively 149,000 and 142,000 trips per day. The CBD sectors include Khaleefa, CBD and Shobra.

The results clearly demonstrate that, although Giza sector would remain the biggest and most important origin/destination for 6th of October City, the distant CBD would develop a strong relationship with 6th of October City as well as with the East Wing. This also implies that both transport demand and travel distance will substantially increase in 2022.



Source: Study Team

Figure 3.2.1 Changes in Numbers of Person Trips from 2001 to 2022

Transport demand forecast on the West Wing in the Master Plan

The Master Plan Future computed transport demand on the West Wing in 2022 at 490,000 passengers per day and 18,500 passengers per hour and per direction at the maximum congested sections.

The traffic volume in 2022 will need a high capacity transport mode such as railway. Although a busway system could serve in the early years of the planning horizon, a railway system will have to be considered to cope with the high volume of the demand in future.

(3) Existing Transport Services Along the West Wing

1) Road and Bus Services

On the West Wing, the 26th of July Corridor connects the Giza side of Cairo CBD to Alexandria Desert Road and links up to 6th of October City via a branch road. A second road[1] in the south of the corridor connects the new community with the Pyramid area in Giza. Similar to the situation in the East Wing, shared taxi is the dominant road-based public transport service to connect with Cairo city.

2) Egyptian National Railway (ENR) Services

ENR operates once a day and per direction a passenger train service between Cairo and 6th of October City since July 14 2001. The distance from Cairo to 6th of October City is 81 km and the travel time over that distance is 1 hour 25 minutes, due to the important detour of the alignment. The fare is 1.25 LE for third class cars. The average number of passengers per day is very small, approximately 20 to 40 per day, as shown in Table 3.2.3. Most of the passengers are ENR-related people, according to ENR.

Table 3.2.3 ENR Railway Service between Cairo and 6th of October

Station	km	Fare	Daily Passengers
Cairo	0	1.25 LE	40
Giza	13	1.25 LE	28
Hawamdeya	27	1.25 LE	12
Badrasheen	32	1.25 LE	16
Tarafaya	34	1.25 LE	24
6th of October	81	1.25 LE	20

Source: ENR

The low number of passengers is caused by the long travel time and the low frequency, consequently favoring road-based transport services such as the shared-taxi. The location of the 6th of October Station is inconvenient for passengers, because it is 5 km far from the city center.

3.2.2 Central Giza

The three alignment options that are selected for the detailed feasibility study are:

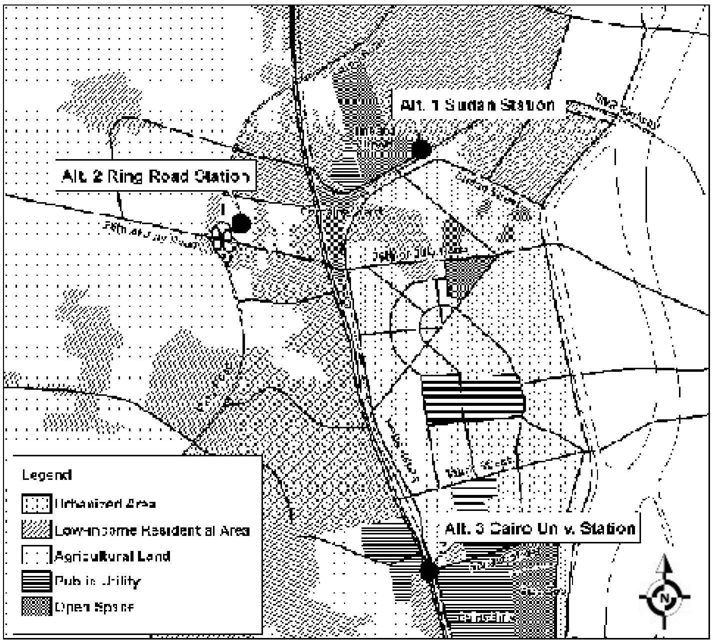
- Option 1: Sudan Station on future Metro Line 3,
- Option 2: Ring Road Terminal on a possible extension of future Metro Line 3, and
- Option 3: Cairo University Station on Metro Line 2.

[1] The second road is from 26th of July Street to Pyramid Road via Alexandria Desert Road

(1) Land Use

Area 2 of the Component A-2 for the area traffic management program, which is an intermodal point of West Wing, has three candidate sites on the western bank of the River Nile including the Central Giza Area.

In terms of land use, there are three major types of land use patterns in this area. These are urban area, low-income residential area and agricultural land. The land use pattern is shown in Figure 3.2.2.



Source: JICA Study Team

Figure 3.2.2 Major Land Use Pattern in Western Bank of River Nile

Urbanized areas ares characterized as a low-density population and a well-developed infrastructure, such as the Central Giza Area. Population density of Central Giza was about 20,000 person/km2 in 2001. The area has been growing as a center of business and commercial activities as well as Cairo CBD Area.

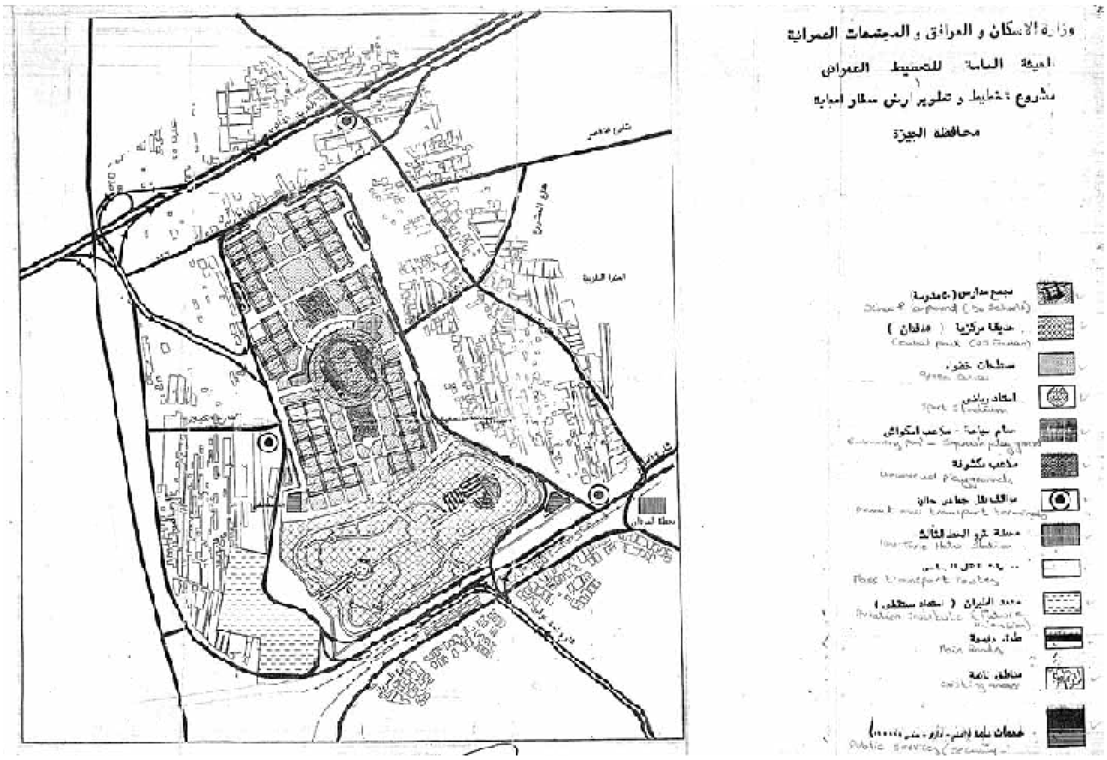
Low-income residential areas are characterized as high-density population, disorderly brick-built houses, and poor infrastructure, especially in respect to roads and waste disposal service. The surrounding area of Central Giza, from outside of Sudan Street up to Ring Road, belongs to this category. Highest population density in the area was 130,000 person/km2 in 2001 (Source: CAPMAS).

Although most of the agricultural land is used for agriculture, some of the area is used for a dumping site where a small number of people live and make slums. The agricultural land spreads over the inside and outside of the Ring Road.

The current land use pattern of each option is described as follows:

1) Sudan Station Area

Sudan Station is located in the south-eastern corner of the old Imbaba airport, facing Matar Street. Although the old Imbaba airport area is vacant land at present, the GOPP has a development plan for building schools, a stadium etc there, and this has been approved as a committed project. A conceptual plan of the development is shown in Figure 3.2.3.



Source: GOPP

Figure 3.2.3 Development Plan of Imbaba Airport by GOPP

A low-income residential area spreads out to the west of the old Imbaba airport area. This residential area is high density, the population density was approximately 44,000 person/km2 in 2001. Most of the residences are high-rise and built of brick and the area lacks public services, particularly for infrastructure, garbage collection and public transport. Matar Street, which faces the area, functions as the center of the community since shops, a post office, a fire department and also a shared taxi terminal are located along the street.

The selection of the area as a terminus of the West Wing, from the points of view of land use and land availability, means that there would not be any room for developing a terminal for the West Wing in the old Imbaba airport, and even outside of it, without demolishing existing building in the above area.

2) Ring Road Station Area

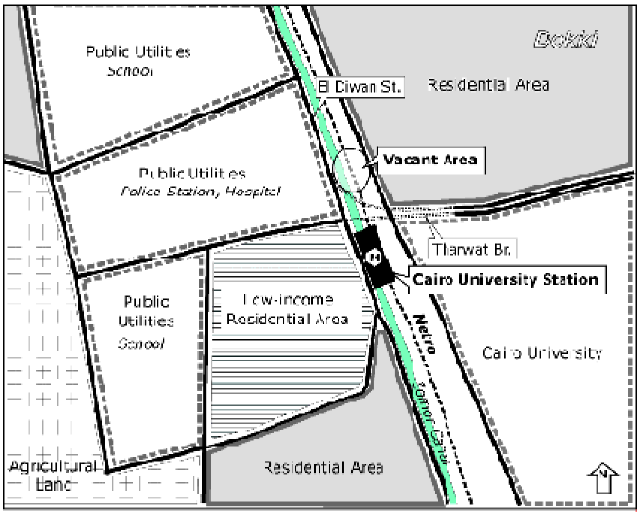
The Ring Road Station is planned to be located on the north-eastern corner of an interchange of 26th of July Road and Ring Road. The planned area is agricultural land and has enough room for developing a terminal for the West Wing. The other three corners of the interchange are low-income residential areas. The population of the surrounding area of the interchange was about 47,000 and the density was about 24,000 person/km2 in 2001.

It is possible to develop an intermodal point there according to Planning Law, which stipulates that agricultural land must be protected except for areas inside the Ring Road.

3) Cairo University Station Area

Cairo University Station is planned to be located in an adjacent area of the station of Metro Line 2. A low-income residential area is right in front of the station and public utilities spread over the area between the Ring Road and Zomor Canal. Cairo University's premise are located just behind the station as its name appears.

The population within a 800m-radius area of the Metro station was about 66,500 and the density was 27,000 person/km2 in 2001. Furthermore, the population would be increasing to 110,500 in 2022, according to the projection of CREATS Master Plan. The annual growth rate is 4.7% which indicates very high ratio compared with a 2.6~3.0% national growth rate and 1.5% in the above Sudan Station area. In addition, Cairo University is located behind the Metro station and has approximately 155,000 students and more than 12,000 employees. The major land use pattern in Cairo University Station is shown in Figure 3.2.4.



Source: JICA Study Team

Figure 3.2.4 Major Land Use Pattern in Cairo University Station

In terms of land availability, there is limited vacant space just to the north of the Metro station, along Zomor Canal. Otherwise, there would not be any room for the development, without demolishing existing buildings (see Figure 3.2.4).

However, from the perspective of the population and number of passenger, it is thought that this area requires not only a bus terminal for the West Wing but also a terminal for public transport such as buses, mini buses, shared taxi and taxi.

(2) Traffic Management

1) Traffic Management Facilities

Traffic Signal Control

There are no signalized intersections around Sudan St. and the Ring Rd in Central Giza. In Agooza and Doqy of Central Giza, and the area surrounded by Sudan St., Abdel Salam Aref St. and Gamal Abdel Naser St. (Neel), there are twelve (12) signalized intersections. Some traffic lights are not working properly. During peak periods, nearly all major signalized intersections are manually controlled by traffic policemen. Manual operations are based on an assessment of spot conditions through visual observation by these policemen and/or information received via transceivers. This intersection control system leads to long cycle times. During peak periods, the cycle time on major signalized intersections ranges between 110 and 323 seconds (see Table 3.2.4). Furthermore, traffic congestion at many U-turn points on Gameat El Dewal El Arabeya St., Ahmed Oraby St. and Doqy St.- Batal Ahmed Abdel Aziz St. are caused by conflicts between through traffic and entering traffic. Thus, a technical solution for the existing situation will be necessary to improve the situation.

Table 3.2.4 Signal Phase Patterns/Cycle Time Length by Manual Control

No.	Signalized Intersection	Signal Phase Patterns	Cycle Time length (sec)
1	Abdel Salam Aref St.- Doqy St.	2	110-323
2	Tahreer St.- Doqy St.	2	121-184
3	Saray St.-Abdel Aziz Saud St.	3	123-203

Source: JICA Study Team

Notes: 1) Location=Congested signalized intersection with travel speed under 10km/h or less.
*2) Survey period=Midday peak period (12:00-14:00). Evening peak period (16:00-18:00)**

a. Parking

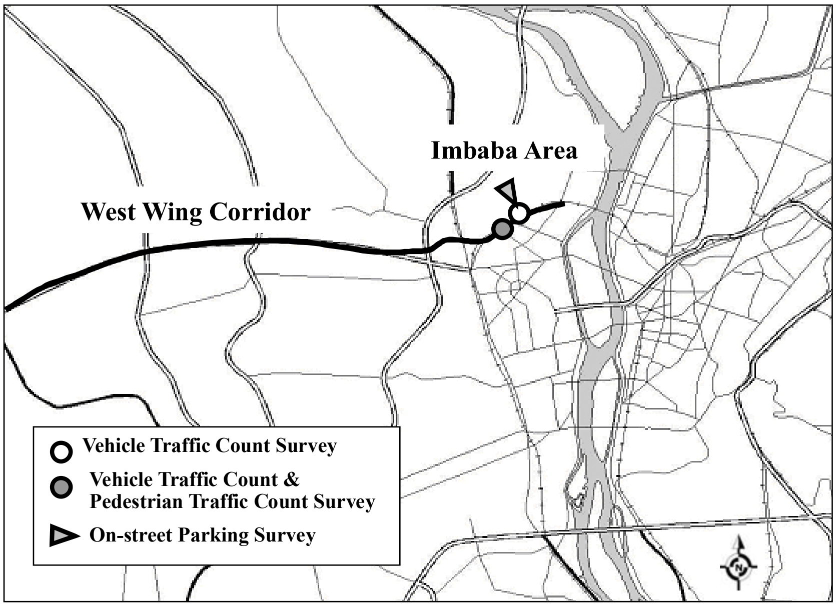
The maximum hourly parking demand in the Central Giza area, surrounded by Sudan St., Abdel Salam Aref St. and Gamal Abdel Naser St., was about 51,000 vehicles between 12:00 and 14:00. This is based on the results of the parking survey in the Master Plan. High parking demand was seen at Doqy and the residential area of Agooza. In most of the streets of Central Giza, parking space occupancy exceeds 100%. The present level of on-street parking capacity is far from sufficient to meet parking demand.

b. Traffic Safety

Traffic safety facilities such as pedestrian bridges and pedestrian crossings with signal lights are insufficient in number, and most pedestrian crossings are not pedestrian-friendly due to incessant passing vehicles that do not stop for pedestrians wishing to cross the street. Very few streets in Agooza and Dpqy of Central Giza have a pedestrian crossing with traffic signal lights.

2) Current Traffic Condition

A vehicle traffic count survey, pedestrian traffic survey and an on-street parking survey were conducted to obtain information for the intermodal plan for the West Wing Corridor. The applied method for the traffic surveys is discussed in Chapter 5 Component A-3: Traffic Management Program along Metro 4 Corridor. The vehicle traffic count survey was conducted for 3 types of vehicles during peak periods at the North Side of Oraby Bridge, and at the intersection of Ahmed Oraby St. and Sudan St.. The pedestrian traffic survey was conducted at the intersection of Matar St.-Bashteel Rd. The on-street parking survey was executed at the same locations as the pedestrian traffic survey. Based on the results of the traffic surveys, the current traffic condition is described hereafter. The locations of traffic survey are shown in Figure 3.2.5.



Source: JICA Study Team

Figure 3.2.5 Locations of Traffic Survey

c. Vehicle Traffic Count Survey

Table 3.2.5 shows the two-way hourly traffic volumes at Imbaba area. The traffic volume was in the range of 1,903 and 3,764 passenger car unit (PCU). The detailed traffic volume is as follows: intersection of Oraby Bridge, 2,181-3,764 PCU, and intersection of Ahmed Oraby–Sudan, 1,903-2,987 PCU. PCU (Passenger Car Unit) is as follows: The types of vehicles for the counting are classified into 3 types: 1) Buses/trucks: Large buses (Public buses, Private buses), Large trucks (3 Axles truck, Heavy truck), Big military: PCU at 2.5. 2) Shared taxies (urban and intercity): PCU at 1.7. 3) Others: Passenger cars and Taxi (urban taxi and intercity taxi), Minibuses, Small trucks (Light commodity vehicle, 2 Axles truck), others (small military, small police, ambulance and etc.): PCU at 1.0.

Table 3.2.5 Traffic Volume at Imbaba Area

Location	Street	Section	Maximum Two-Direction Hourly Traffic Volume (PCU)
Oraby Bridge (North Side)	Matar St.	Northern	2,181
		Southern	3,204
	Ahmed Oraby Bridge	Eastern	3,764
Ahmed Oraby–Sudan	Sudan St.	Northern	2,390
		Southern	2,987
	Ahmed Oraby St.	Eastern	1,903

Source: JICA Study Team

d. Pedestrian Traffic Survey

Table 3.2.6 shows the hourly pedestrian volumes crossing in both directions at the intersection of Bashteel Rd-Bashteel Rd. The volume ranges between 569 and 1,446 pedestrians.

Table 3.2.6 Pedestrian Traffic Volume at Oraby Bridge

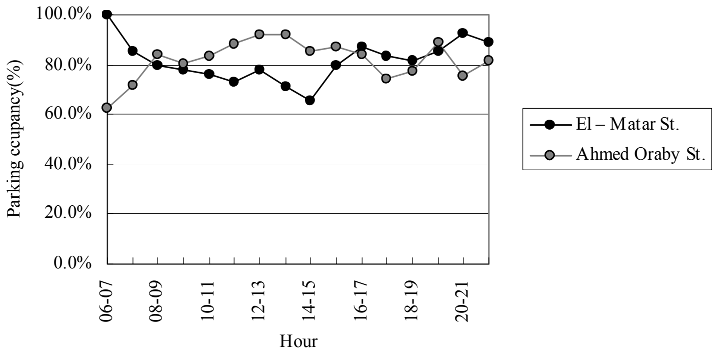
Location	Street	Section	Maximum Two-Direction Hourly Pedestrian Traffic Volume (Pax.)
Oraby Bridge (North Side)	Bashteel Rd.	Northern	569
		Southern	1,348
	Matar St.	Western	789
		Eastern	1,446

Source: JICA Study Team

e. On-Street Parking Survey

Parking Occupancy

Figure 3.2.6 shows the ratio of on-street parked vehicles to legally allowed on-street parking capacity (referred to as parking occupancy). Parking occupancy fluctuates between 60% and 100% at the intersection of Matar St.-Bashteel Rd.

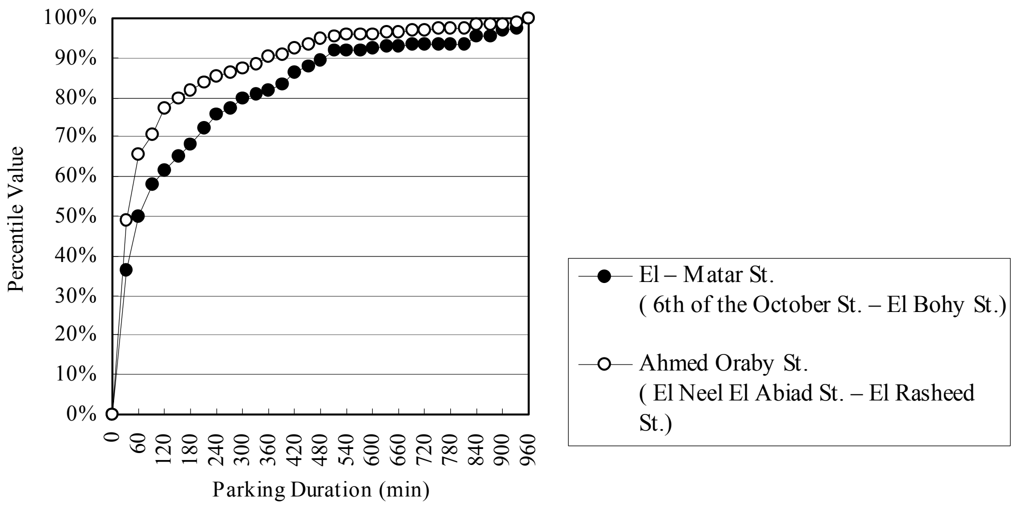


Source: JICA Study Team

Figure 3.2.6 Parking Occupancy at Intersection of Matar St.-Bashteel Rd.

Parking Duration

The duration of parking on Matar St. and Ahmed Oraby St. is shown in Figure 3.2.7. The average parking duration was observed to be 3.19 hours on Matar St., and 2.12 hours on Ahmed Oraby St.. Between 50.2 and 65.6% of total cars parked for less than 1 hour, 11.5–11.8% for 1 to 2 hours, 4.3–6.5% for 2-3 hours and 18.4–31.8% parked for more than 3 hours. Long-term parking (more than 8 hours) was 8.3% on Matar St., 4.3% on Ahmed Oraby St.



Source: JICA Study Team

Figure 3.2.7 Cumulative Parking Duration Distribution

Turnover Rate

Table 3.2.7 shows the parking turnover rate on Matar St. and Ahmed Oraby St.. The average turnover rate was in the range of 3,95 to 5,92 times.

Table 3.2.7 On-Street Parking Duration

Street	Section	Parked Vehicles (Vehicles)	Parking Capacity (PCU)	Ave. Parking Duration (hour)	Ave. Parking Turn-over Rate
Matar St.	6 th of October St.-Boohy St.	217	55	3.19	3.95
Ahmed Oraby St.	Neel El Abyad St. (Hesn Restaurant) -Madina El Monawara St.	604	102	2.12	5.92

Source: JICA Study Team

(3) Intermodality

The current Intermodal status of each option is described as follows:

1) Sudan Station

The first option foresees the terminus of the West Wing at the old Imbaba airport. At present, no transport infrastructure facilities are available yet at that particular location. GOPP has reserved the old airport for future development and has reserved, in the development plan, land for the development of some schools and stadium.

For the time being, no public transport services are offered at this location and the existing public transport services in the Imbaba area are unstructured, of poor quality and highly chaotic.

The value of the proposed location could substantially increase with the development of Metro Line 3. In the original plans for Metro Line 3, two metro stations are foreseen in the area. The first is Sudan Station, which is at approximately a 500 meters distance from the proposed location for the West Wing Intermodal terminal. The second station, Imbaba Station provides a direct link with ENR railway but is at an even further distance from the Imbaba airport and future West Wing terminus.

The selection of the old Imbaba airport as terminus for the West Wing public transport service has been proposed because both Imbaba and Sudan stations have no suitable land available for the development of Intermodal facilities and the alignment for reaching both locations is also highly complicated. However, if no changes are proposed in the existing alignment for Metro Line 3, the integration of the West Wing bus service with Metro Line 3 will be difficult because of the long distance between the proposed terminal at Imbaba airport and both metro stations.

For this option, the optimal Intermodal integration of public transport services will require either the establishment of an efficient feeder service by bus or minibus or an extension of the Metro Line 3 to Imbaba airport. The feeder service option will be difficult to uphold from an efficiency point of view, even if bus operations were highly efficient. The need for an additional modal transit over a short distance would make this option very unattractive. The extension of Metro Line 3 to Imbaba airport is a second solution. However, at present, this option has not yet been discussed and an alternative extension of the proposed Metro Line 3 has been suggested towards another location (see option 2).

2) Ring Road Terminal

The second option proposes the development of an Intermodal terminal at the crossing of the Ring Road with 26th of July Corridor. Although sufficient land is available for the development of an Intermodal bus terminal, the existing intersection linking the Ring Road and 26th of July Corridor poses a serious obstacle for the development of the terminal.

Furthermore, the proposed location has no direct connection with any existing or planned metro services in Cairo and will, under its present design, be entirely dependent upon road-based public transport. However, a formal request has been made by the Ministry of Housing, Utilities & New Communities (GOPP) to the Ministry of Transport for the extension of Metro Line 3 to that location, but no decision in that respect has been taken. The Intermodal efficiency of this terminal will be substantially improved if the link with the metro can be realized in the future.

However, given the time frame for developing Metro Line 3 and the uncertainty related to the possible extension of Metro Line 3 to the proposed new terminal, the integration of the new West Wing public transport service with the Cairo metro network will only be realized in a longer-term future. In the intermediate time, linking the West Wing bus with the public transport system in Cairo will have to be achieved via feeder bus services, mini buses and the efficient use of shared taxis. The efficiency of this Intermodal service will be determined by the integration of the different road-based public transport services at the level of timetables, fares and ticketing, in order to avoid unattractive delays at the terminal site.

Attractive in principle, the Ring Road terminal is faced with several development problems that could constitute a direct threat to its future success and consequently, to the success of the new proposed link. During the short and medium term, the interconnectivity with the public transport system in Cairo will have to be assured by road-based public transport services. The road-based Intermodal terminal at that particular location is faced with infrastructure development problems, related to the complexity of the existing intersection of 26th of July Corridor and the Ring Road. Several solutions are available and will have to be analyzed in detail. The first is the adding of additional access ramps to the interchange, requiring an additional 2 flyovers. The second solution is to build tunnels under the existing intersection to link the terminal to the Ring Road and 26th of July Corridor. The final option is the complete reconstruction of the existing interchange.

3) Cairo University Station

The third option plans to link 6th of October City to Cairo via Cairo University Station, thereby connecting the inter-city public transport service directly to Metro Line 2. The proposed alignment is along 26th of July Corridor until Zomor Canal. From there on, the alignment would go parallel to the alignment of the ENR railway line and along the canal. The route will end at Cairo University Station, where a direct connection is established with Metro Line 2.

This option would not generate major technical problems in the alignment but the development of an efficient Intermodal terminal at Cairo University Station will be much more complicated. The construction of an Intermodal terminal at Cairo

University Station could require destroying a densely populated area and the relocation of many households to create the necessary space for its construction.

At present, bus and mini-bus services at this location are not structured or integrated and there is no formal bus stop. The absence of a functional bus stop near Cairo University Station is a direct consequence of the limited space available along the alignment of Metro Line 2, forcing buses, minibuses and shared taxis to stop wherever possible, in particular on the roundabout square near the metro station and in the parallel (narrow) road.

A possible alternative for integrating bus services to Cairo is to develop, in addition to the terminal at Cairo University Station, an Intermodal (bus) terminal at the intersection where the bus lane leaves the 26th of July Corridor alignment, from where a set of relevant feeder lines into Cairo are offered. As with option 2, the success and efficiency of this Intermodal service will depend upon the integration of services.

3.3 BASIC PLANNING POLICY AND STRATEGIES

3.3.1 Introduction

The strategic framework for improving the interconnectivity between Cairo and 6th of October City and other urban developments in that corridor was established during Phase 1 of the CREATS Study. The very high volumes of traffic demand in Greater Cairo will force public decision-makers to focus more on *integrating and interconnecting transport systems* rather than on continued infrastructure development. Also if infrastructure needs to be developed, it should be designed in such a way that it not only responds to the particular needs of the present, but also is suitable to cater for ever-increasing future traffic demand.

The strategic approach of the CREATS Study for infrastructure development therefore directly addressed the strategy on how to structure an optimal network integrating all (public) transport modes and on how to efficiently manage these vested assets. The optimal development, therefore, needs to satisfy three critical factors:

- Economic effectiveness and financial affordability;
- Technical optimization of operations and maintenance; and
- Environmental friendly technologies and enforcement to users.

3.3.2 Capacity and Demand

Before recommending an optimal design for the West Wing public transport system, the wide difference of capacity for different transport systems has to be considered. According to Research Report 329 (The performance of busway transit in developing cities, 1992) of TRL (Transport Research Laboratory), the maximum recorded passenger flows varied from 7,300 passengers/hour/direction (**p/h/d**) in Ankara to 26,100 p/h/d with 2-lane in Assis Brasil, Port Alegre, during the morning peak hour. The corresponding maximum recorded passenger flows during the evening peak periods varied from 6,500 p/h/d in Ankara to 20,300 p/h/d in San Paulo, where overtaking lanes at bus stops facilitate high flows. In addition, in Bogotá, Colombia, the maximum passenger flows recorded by the JICA Study in the period 7:00-8:00 a.m. were approximately 30,000-33,000 p/h/d in the inbound direction on Av, Caracas, with a 2-lane segregated Busway. The passenger flows on Av. Caracas are among the highest in the world.

These demands show the maximum-recorded passengers on busways in other countries, which are in the range between 20,300 and 33,000 p/h/d. It should be noted that the maximum-recorded passenger flows are made with 2-lane/direction on segregated busway during peak hours; thus, the busway can empirically carry more than 20,000 p/h/d as long as the exclusive bus lane is additionally provided. Besides, the capacity is related to how to operate the busway network. Such a highest capacity is realized at a less than 2 minutes headway operation. Taking safety operation into consideration, the minimum headway will be more than 2.0 minutes. Therefore, the maximum capacity of one-lane busway operated by a normal dispatching system should be estimated at 6,000~8,100 p/h/d, based on the minimum headway. Moreover, given one-lane per direction and a two-bus platoon dispatching system, the reasonable capacity of the busway is 12,000-16,200 p/h/d, as shown in Table 3.3.1. When the demand exceeds this level, "rail connection" will be one of conceivable alternative options, although the "busway with 2 lanes per direction" is still a possible option. Of course, the introduction of a "rail system" should be carefully examined in terms of economic and financial justifications.

In this context, and regardless of operating schedules, frequency and headway, if the number of passengers on a busway is 10,000p/h/d or less, it is possible to operate buses on the busway with one lane per direction. The efficiency will, however, depend upon the size of the buses. In principle, bus lanes/busways can carry nearly **10,000 p/h/d** when bypass opportunities are introduced at critical points such as loading/unloading areas.

Meanwhile, the light rail transit can accommodate between 10,000-30,000 p/h/d in segregated alignments. The mass rapid transit system can accommodate 30,000-90,000 p/h/d at much higher speeds. As an example thereof, the maximum capacity of Cairo Metro Line 1 is estimated to be some **70,000 p/h/d**. The capacity of a freeway lane is, at 2,000-3,000 persons per hour, comparatively low.

The detailed demand forecasts in the Master Plan demonstrated that in the year 2022, the West Wing corridor would have to cater for about 200,000 passengers per day per direction. The 26th of July Corridor is a central infrastructure axis on this corridor and constantly feeds the public and private transport networks in Cairo. Any plan for a future public transport system needs therefore to be carried out according to the above-described functional hierarchy of available public transport systems. Each mode is allocated to specific corridors or functions as deemed appropriate for meeting forecasted demand, guaranteeing acceptable capacity and speed. Each mode thus has its own domain where it can operate under optimal conditions as part of a multi-modal system in complement with other modes.

Given the present and expected future demand, the public transport service between 6th of October City and Cairo could ultimately consist of dual-track railway operation between 6th of October City and Ramses station. In the interim, a cost-effective and high-capacity solution is the construction of a trunk busway whose design will permit upgrading to rail once warranted by future demand.

The final recommendation in Phase 1 of the CREATS Study argued that public transport to and from 6th of October City and other urban settlements along that the corridor should consist of one bus lane/direction within an exclusive alignment. Figure 3.3.1 shows, as an example, the Bogotá City, Colombia trunk busway system.

Source: JICA Study Team

Figure 3.3.1 Trunk Busway System in Bogotá City

3.3.3 Meeting Expected Demand for the West Wing Corridor

(4) Future Upgrading on the Same Alignment as MRT

The estimated population of the 6th of October City Sector, including Sheikh Zayed in 2022 is 1,165,000[2], as shown in Table 3.2.1, making it the largest of the satellite cities. Adding the other urban settlements in the corridor, the West Wing will have a population of 2 million by 2022, putting substantial pressure on the

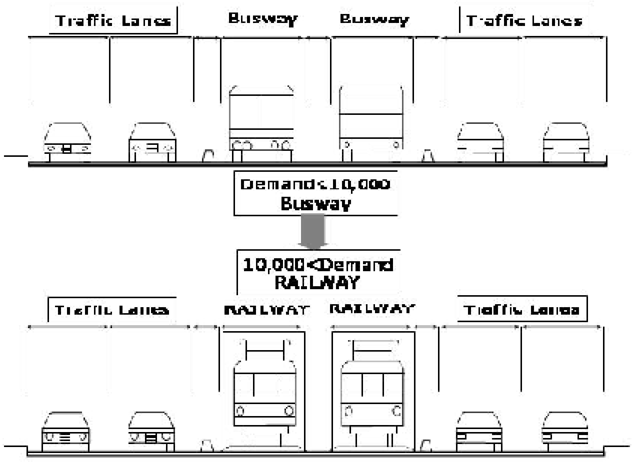
[2] The population projection for each of the New Communities was made in the Master Plan to establish a social framework, based on an analysis of new town development potential. This feasibility study is based on the justified population framework (refer to Section 2.4.3, Chapter 2: Urbanization Structure and Socio-Economic Framework, Volume III, Transportation Master Plan and Feasibility Study of Urban Transport Projects in the Greater Cairo Region in the Arab Republic of Egypt, Phase I Final Report, November 2002 by JICA).

transport system. As was concluded after the analyses made during the CREATS Master Plan Study, the type, modal composition and extent of the public transport system must be structured so as to satisfy a variety of transport needs.

However, limited public resources to develop and improve the transport system force decision-makers to balance the needs with an offer that is economically and financially affordable / feasible.

This means, in concrete way, that an alignment should be fixed that enables the development of an efficient bus system that in the long(er)-term can be upgraded to a rail-based transport system without the need for substantial additional investments (including costly changes in the existing alignment). The recommendation for the development of the West Wing, proposed in the Final Report of Phase 1, incorporated the demand-adapted approach and is presented in Figure 3.3.2.

The principle of the recommendation is that an alignment should be outlined that enables the immediate development of a busway but, at the same time, enables the future upgrading to railway on the same alignment.



Source: JICA Study Team

Figure 3.3.2 Concept of Demand Adapted Development Plan

(5) Bus Service Expansion by Increasing Passenger Demand

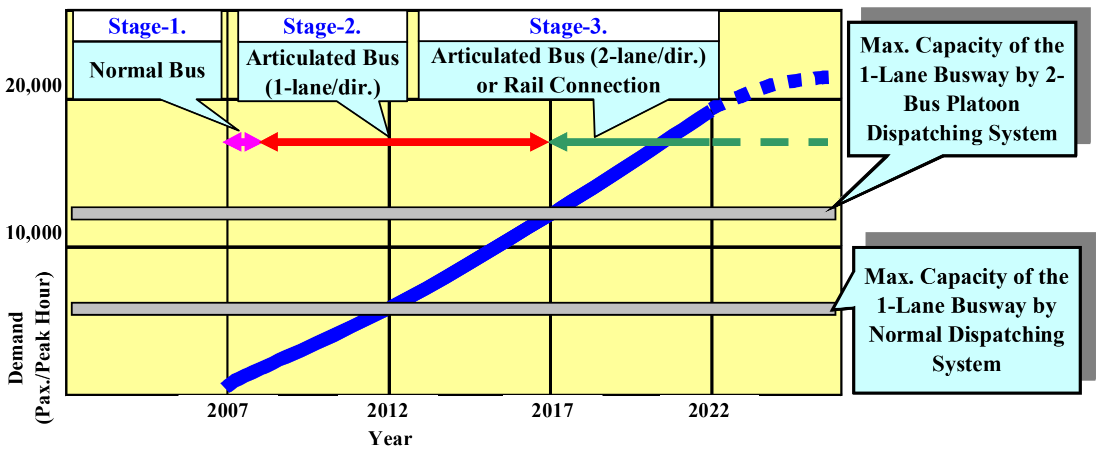
When recommending the design for the bus way system on the West Wing Corridor, in accordance with cost performance, a flexible busway system had to be taken into consideration. The type of bus services and the number of lanes should be considered depending on the increase in passenger demand. When considering the minimum headway as 2-3 minutes, the type of normal bus with air-condition can carry approximately 2,000-3,000 passengers per hour per direction (1-lane), and the two-bodied bus as Articulated bus or Bi-articulated bus can carry approximately 6,000-8,000 passengers per hour per direction (1-lane). In addition, it is possible that passenger capacity increases by introducing a method of 2-bus platoon dispatching system. The platoon dispatching system departs and arrives with a 2-bus platoon at the same time, as a result, the busway can carry: single-body bus, approximately 4,000-6,000, two-bodies bus, 12,000-16,200 persons per hour per direction.

Two types of bus services will be provided in specified target years based on the passenger demand: a normal bus with air-condition and an articulated bus. In the first stage, the bus service, normal bus with air-conditioning, will operate during a few years when the passenger demand is still low. In the second stage, after 2009, articulated buses can be introduced depending on the increase in passenger demand. In the third stage before 2022, a two (2) - lanes busway or a railway connection should be operated according to passenger demand. The buses run on the fully segregated busway. The final bus type and the number of lanes will be determined based on an estimation of passenger demand. Table 3.3.1 summarizes the proposed functions of bus service. Figure 3.3.3 illustrates the bus service by passenger demand.

Table 3.3.1 Proposed Functions for Bus Service

Items		Structure	
		Normal Bus	Articulated Bus
1. Bus Capacity		100 Pax	200-270 Pax 1)
2. Minimum Headway		2 or 3 min	2 or 3 min
3. Max. Passenger Capacity of the 1-Lane Busway	Normal Dispatching System 2)	2,000-3,000 Pax/hour/dir.	6,000-8,100 Pax/hour/dir.
	2-Bus Platoon Dispatching System 3)	4,000-6,000 Pax/hour/dir.	12,000-16,200 Pax/hour/dir.

Source: JICA Study Team
Note: 1) Bus capacity of articulated bus vary based on bus size.
2) Normal dispatching system: one bus departs and arrives based on constant intervals
3) 2-bus platoon dispatching system: 2 buses depart and arrive at the same time based on constant intervals



Source: JICA Study Team

Figure 3.3.3 Bus Service by Passenger Demand