2.3 Analysis of Transport Demand and Services

2.3.1 Metro Network Service in Greater Cairo Region

Metro Line 1 has 35 stations, 5 of which are underground, and presently operates train sets of 9-coaches with a headway spacing of 3.5 minutes during peak hours. Metro Line 1 carries approximately 1.2 million passengers per day. As for travelling time, it takes 68 minutes in total from the start to the end of the route; 44 minutes from Helwan to Mubarak Station and 24 minutes from Mubarak to El Marg. It was designed to carry two million passengers per day by operating with 2.5-minute headway at a maximum speed of 100 km/h.

Meanwhile, Metro Line 2 has 18 stations, 12 of which are underground and presently operates 8-coach trains with 2.45-minute headway. It carries approximately 0.73 million passengers per day. The full journey from Shubra El Kheima to El Moneib Station takes 35 minutes when the trains operate at maximum speed (80 km/h).

Sources: National Authority for Tunnels (NAT)

Figure 2-41 Metro Line 1 and 2 Routes and Stations

2.3.2 Trend of Metro Demand

According to the recent data shown in Table 2-31, the average number of passengers per day between 05:15-24:15 amounted to 1.217 million on Metro Line 1 and 0.73 million on Metro Line 2 in 2005/2006.

As for the Metro Line 2, the number of passengers has increased by an average of 2.7 % per year between 2000 and 2006. On the other hand, passenger numbers on Metro Line 1 decreased by an average of 2.8 % per year between 1999 until 2003. However, from 2003 until the present, the passenger numbers have been increasing by an average of 2.5 % per year. It is noted that the number of passengers transferring from Metro Line 1 to Metro Line 2 and from Metro Line 2 to Metro Line 1 represents approximately 40% of the total entry of passengers on Metro Line 2.

Table 2-31 Metro Line Operating Data for Cairo Metro Organization (CMO)

Metro Line 1 (43km)		**00/99**	**01/00**	**02/01**	**03/02**	**04/03**	**05/04**	**06/05**
No. of Passenger	Mil/day	1.24	1.21	1.18	1.13	1.14	1.18	1.22
	Mil/year	451.2	442.2	429.5	413.3	418.8	429.5	441.1
No. of Unit	3Cars/U.	115	139	139	139	138	144	159
No. of Trips*	No/day	400	400	410	414	414	414	426
Revenue	Mil. LE	126.10	126.95	128.79	139.13	153.11	160.14	164.75
Metro Line 2 (21km)		**00/99**	**01/00**	**02/01**	**03/02**	**04/03**	**05/04**	**06/05**
No. of passenger	Mil/day	0.56	0.64	0.69	0.69	0.65	0.68	0.73
	Mil/year	204.3	234.7	251.8	252.2	239.3	247.9	266.6
No. of Unit	3Cars/U.	62	66	70	70	70	70	70
No. of Trips*	No/day	450	456	498	498	498	500	500
Revenue	Mil. LE	62.66	73.52	81.59	88.95	102.17	110.99	121.27
Total (64km)		**00/99**	**01/00**	**02/01**	**03/02**	**04/03**	**05/04**	**06/05**
No. of Pass.	Mil/day	1.80	1.85	1.87	1.82	1.79	1.86	1.95
Revenue	Mil. LE	188.76	200.47	210.38	228.08	255.28	271.13	286.02
Costs	Mil. LE	443.02	509.16	541.63	567.65	751.42	701.85	713.08

Sources: NAT

Table 2-32 Passenger Volume/Day at Each Metro Line 1 Station

station code	Station	Entry	Exit	Total Traffic	Station rank according to traffic
1	Helwan	46,857	43,705	90,562	3
2	Ain Helwan	3,803	5,490	92,294	33
2	Helwan University	25,142	23,437	48,579	20
3	Zahraa Helwan	6,549	6 520	13,068	31
4	Hadaeq Helwan	13,573	13,394	26,966	26
5	Al-Maasarah	13,045	12,277	25,322	27
6	Tora Al-Asmant	1,645	1,597	3,242	35
7	Kotssica	11,086	10,706	21,793	28
8	Tora Al-Balad	4,580	4,470	9,050	34
9	Thakanat Al-Maadi	7,817	7,585	15,403	30
10	Maadi	35,454	37,065	72,519	11
11	Hadaeq Al-Maadi	31,712	31,861	63,573	15
12	Dar Al-Salam	30,409	30,234	60,644	16
13	Al-Zahraa	18,251	16,760	35,010	23
14	Mar Gergess	5,911	5,450	11,361	32
15	Al-Malek Al-Saleh	15,763	18,409	34,172	24
16	Al-Sayyeda Zeinab	37,119	38,379	75,497	9
17	Saad Zaghloul	28,680	28,087	56,767	18
18	Anwar Al-Sadat 1	32,503	31,640	64,143	14
19	Nasser	50,177	47,939	98,116	2
20	Ahmed Orabi	13,907	13,824	27,732	25

21	Hosni Mubarak 1	33,579	46,613	80,192	8
22	Ghamra	41,088	41,205	82,294	7
23	Al-Demerdash	42,599	40,806	83,405	6
24	Mansheyet Al-Sadr	31,534	35,883	67,417	13
25	Kobri Al-Qobba	45,939	40,088	86,027	5
26	Hamamat Al-Qobba	10,365	9,078	19,444	29
27	Saray Al-Qobba	21,085	20,032	41,117	22
28	Hadaaek Al-Zayton	27,699	28,797	56,496	19
29	Helmeyet Al-Zayton	45,797	40,279	86,076	4
30	Al-Matareya	23,216	22,202	45,418	21
31	Ain Shams	35,245	32,246	67,491	12
32	Ezbet Al-Nakhl	54,056	49,132	103,188	1
33	Al-Marg Al-Qademah	39,001	34,004	73,005	10
50	Al-Marg Al-Gadedah	26,766	33,105	59,871	17
	Total	911,953	902,300	1814,253	
21/18	Transferring between Hosni Mubarak and Sadat	276,960			
	Total	1,188,913			

Sources: NAT

Table 2-33 Passenger Volume/Day at Each Metro Line 2 Station

station code	Station	Entry	Exit	Total Traffic	Station rank according to traffic
34	Shobra Al-Kheima	52,621	41,555	94,176	2
35	Koleyet Al-Zeraah	24,332	23,199	47,531	6
36	Al-Mezalat	16,120	17,817	33,937	13
37	Al-Khalafawy	10,396	10,922	21,318	18
38	Saint Tereza	10,867	11,330	22,197	17
39	Rod Al Farag	16,473	18,763	35,236	12
40	Messara	14,559	15,571	30,130	15
21	Hosni Mubarak 2	29,014	26,578	55,593	5
41	Al-Ataba	44,200	51,028	95,228	1
42	Mohammed Naguib	22,022	22,871	44,893	9
18	Anwar Al-Sadat 2	19,936	18,013	37,919	10
43	Al-Obera	5,887	6,327	12,213	20
44	Al-Doqi	22,741	23,722	46,463	7
45	Al-Bohouth	31,790	33,282	65,072	3
46	Cairo University	28,376	27,824	56,200	4
47	Faissal	19,379	18,506	37,885	11
48	Al-Geiza	23,238	22,692	45,930	8
49	Om Al-Masreyeen	13,840	14,321	28,161	16
51	Saqyet Mekki	8,947	8,818	17,766	19
52	Al-Moneib	19,291	13,631	32,922	14
	Total	434,030	426,770	860,800	
21/18	Transferring between Hosni Mubarak and Sadat	303,821			
	Total	737,851			

Sources: NAT

2.3.3 Preferences and Choices of Cairo Metro Users

There have been a few surveys conducted to measure the opinion of users regarding the Cairo Metro system. The users' preferences and choices are very important to improve the level of service and to assist in developing the operation and pricing policies. This section summarizes the preferences and choices of Cairo Metro users based on the previous study in 2003 by Egypt National Institute of Transport (ENIT).

(1) Socio-economic Characteristics of Metro Line 2 users

- Males exceed females by one-third in general. This proportion increases to almost two-thirds in the evening, and decreases to one-sixth at noon
- The age categories 20-30 years, and 30-50 years are the highest age group among the Metro users with percentages of 30.9% and 37.3% respectively. Meanwhile, the age category beyond 60 years is lowest because of the absence of facilities for aged passengers (e.g. escalators) in some stations.
- Government employees represent 29.9% of Metro users followed by private sector employees and students with percentages of 26.4% and 24.4%, respectively. Thus, government employees and students represent about half of the users due to the special discount offered to them with the use of multiple trip tickets.
- 66.0% of the labour force consists of males while females represent 57.4% of students, and 77.3% of unemployed. In other words, the unemployment rate among males is 3.2% while it is 14.2 % among females.
- 31.1% of the metro users have a monthly income of less than 300 LE, while those having a monthly income of more than 1,000 LE represent 10.9% of the metro users. The average monthly income of metro users is 517.9 LE Furthermore, the average monthly incomes of males and females are 615.9 LE and 389.0 LE, respectively.
- The average monthly income of the self-employed users is the highest, followed by the public sector employees, then the private sector employees, and finally the governmental employees.
- 11.3% of metro users own a car. Ownership rate is higher for males than females with 13.6% and 8.2%, respectively. The Metro Line 2 users who own a car is 3.1% of the users with monthly incomes of less than 300 LE and 37.8% of the users with monthly incomes of higher than 1,000 LE

(2) Trip Characteristics

- The average number of stations per trip is 8.2 stations. This consists of 8.7 stations for single trip tickets and 7.7 stations for multiple trip tickets.
- To calculate the average trip cost, it is assumed that the average usage of multiple trip tickets is 50 trips per month. The determined average fare of metro line usage is 53.7 piaster while the average fare of the mode used to reach to the origin station is 27.1 piaster, and that of the mode from the metro station to the final destination is 27.8 piaster. Hence, the total average trip cost of metro users is 108.6 piaster in 2003.
- The average total trip time was found to be 47.5 minutes. This includes 13.3 minutes travel time from origin to the metro station, 21.1 minutes for metro line journey, and 13.1 minutes from the metro station to the final destination.

- Work is the major trip purpose whereas 62.6% of the sample size use the metro line to travel to work, and 22.7% of the sample size use the metro for educational purpose trips.
- 31.4% of passengers use the metro line for six times per week per direction, while 20.6% use metro line for five times. Thus, the average number of trips is 3.8 trips per week per direction, i.e. 7.6 trip per week. This average is lower than that estimated by CREATS study for Greater Cairo Region 2002, which is 1.64 trip per person per day (i.e. 11.48 trip per week).
- Most passengers (68.4%) walk to reach to the metro line, while 66.1% walk from the metro line to their final destination.
- Shared taxi is the most popular motorized mode where 26.9% of users use this mode to reach to the metro line, while 25.9% use it to reach their final destination.

(3) Preferences of Metro Line users

- The majority of metro line users (87.5%) prefer using the service as it saves time. Comfort and safety are the next reasons for the passenger's choice of metro line with percentage of 45.2% and 31.8%, respectively.
- Regarding passenger's evaluation of the level of service, speed and reliability are being valued as excellent by 90.3% and 87.7% of the users respectively, while 41.1% of the passengers evaluate fare as excellent and 46.1% evaluate it as good.
- 97.7% of the users choose journey time and reliability as the most preferred characteristics of metro line service, while 70.3% choose safety, 49.7% choose cleanness, 45.5% choose fare, 23.6% choose availability of female-only cars, and 16.6% choose congestion rate.

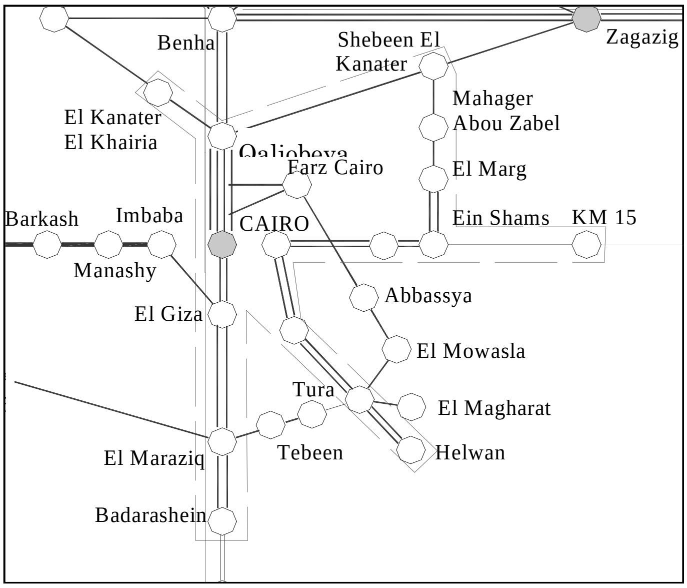
2.3.4 Egyptian National Railways (ENR) Suburban Railway Service and Demand

ENR operates seven suburban railway lines in the Greater Cairo Region as shown in Table 2-34 and Figure 2-42. The average number of passengers amounts to 142,000 per day. This represents approximately 12% of all the ENR passengers. However, this figure represents only 7% of metro line passengers.

Table 2-34 Number of Passenger and Suburban Trains in the Greater Cairo Area

Length (km)	Section	No. of Passenger per day	No. of Trains (Cars)
14	Cairo-Qaliobeya (N)	11,250	25 (9)
32	Cairo-Shebeen El-Kanater (NE)	26,600	38 (7)
20	El-Marg- Shebeen El-Kanater (NE)	32,400	44 (6)
23	Cairo-El-Kanater Al-Khairia (NW)	29,400	42 (7)
32	Cairo-Imbaba-Badarashein (S)	19,800	22 (9)
30	Ain Shams-Abur-Shuruq (E)	4,900	14 (7)
18	Cairo-Imbaba-Manashy (W)	17,000	34 (5)
	Total	141,350	

Sources: ENR



Source: ENR

Figure 2-42 Existing Urban Railway Network in Greater Cairo

Table 2-35 Number of Passengers per day on Each Line in 2005/2006

No	Lines	Passenger per day
1	Cairo/Alexandria	321,969
2	Cairo/Ismailia/Port Said	47,474
3	Cairo/Luxor/Aswan	239,194
4	Ismailia/El Qantara/Ber El Abd	3
5	Ein shams/Suez	5,080
6	Ismailia/Suez	17,930
7	Tanta/El Mansoura/Domiatta	35,100
8	Cairo/Shebin El Qanater/El Mansoura	65,511
9	Abou Kebir/El Salhiya	21,828
10	Faqus/El Samana	1,402
11	El Mansoura/Sandob/El Materia	10,868
12	Cairo/El Qanater/Menuf/Tanta	46,101
13	Menuf/Kafr El Zayat	20,393
14	Benha/Menuf	16,428
15	Benha/Mit Bira/Zefta/Mit Ghamr	10,446
16	Tanta/El Santa/Zefta/Zagazig	37,734
17	Mahalet Rouh/Elsanta	7,167
18	Tanta/Qelein/Sherbin	38,095
19	Tanta/Qelein/Desouk/Damanhur	33,743
20	Desouk/Motobus/El Bouseli	5,640
21	El Bouseli/Motobus/El Qassabi	2,181
22	Alexandria/Rashid	9,042
23	Alexandria/Marsa Matruh	10,654
24	Matruh/Samala/El Saioum	22
25	Cairo/El Khatatba/Etay El Baroud	41,737
26	El Wasta/El Fayum	7,861
27	Beni Suef/ El Lahun	551
	Suburban Lines	139,250

	Main Lines	608,637
	Branch lines	445,519
	Total	1,193,405

Source: ENR

2.3.5 Bus Service

The share of various transport modes is roughly summarized in this section. In Table 2-36, the number of buses operated in the bus fleet was estimated by the JICA Study Team by applying the ratio of operated/registered buses. This was done because no information was available from the Cairo Transport Authority (CTA). The difference between "operated" and "registered" buses can be considered as buses operated by mainly public bodies (national government, local government, public company, public school and so on) which are used as shuttle buses, and all registered buses. The previous transportation study by JICA estimated the operability ratio of the CTA fleet as 0.75. Subsequently, the operable CTA bus fleet was given as 4,130 buses at present.

Table 2-36 Estimated Number of Buses in the Fleet

Year	Public Bus Number operated	Public Bus Number registered	Ratio of Operated/Registered
2000	4500 reported by CREATS	5,652	0.796
2001	N.A.	N.A.	
2002	N.A.	N.A.	
2003	4905 estimated figure	6,121	
2004	5223 estimated figure	6,562	
2005	5506 estimated figure	6,917	

Sources: JICA Study Team

The daily number of passengers transported by the metro is roughly 2 million while the total public transport mode passengers are estimated to be 13.7 million. Applying the assumption that a bus transports 1,000 passengers per day, 4,130 units will transport 4.1 million passengers per day. The remaining 7.6 million passengers are considered to be carried by private bus. The registered private bus fleet in 2005 was 12,263 units. Applying the same assumptions, with 0.796 as the ratio of operated/registered and 0.75 being the operability ratio, a workable number of private buses is estimated to be 7,321 units. This calculation results in each private bus handling an average of 1,038 passengers a day.

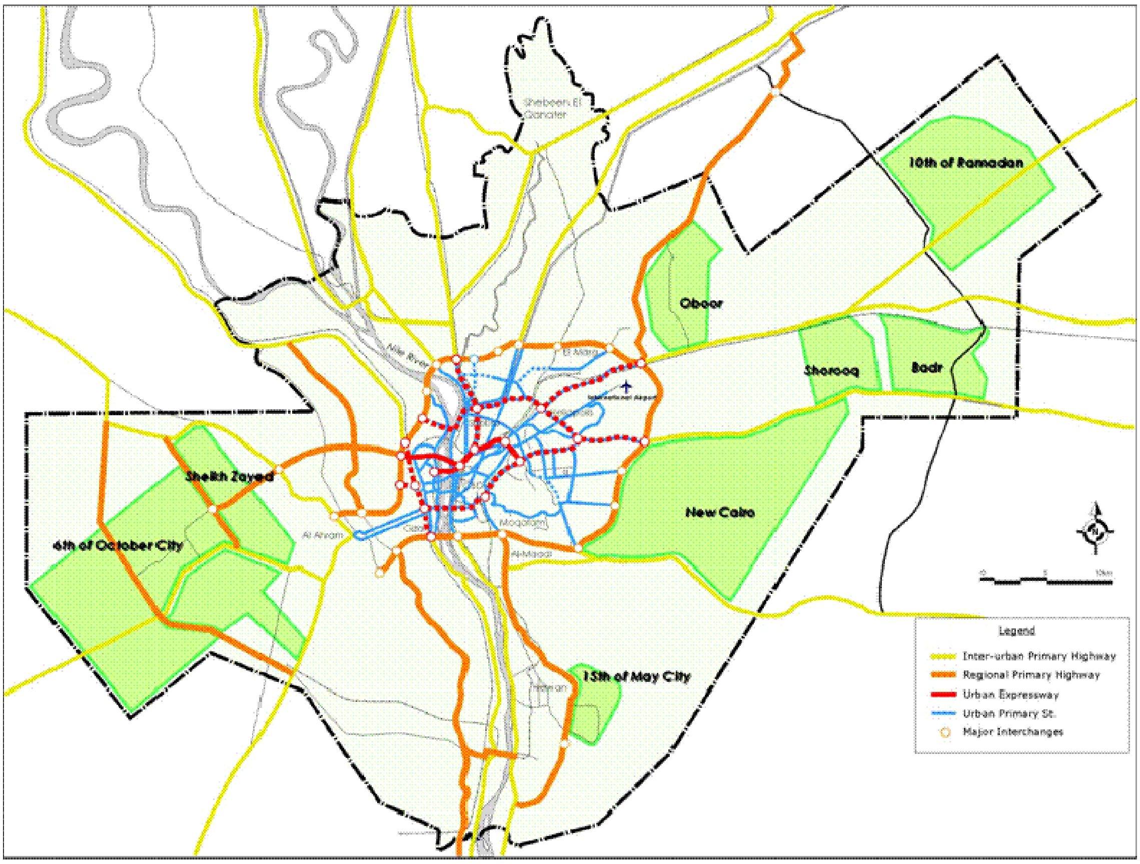
Table 2-37 Estimated Passenger Transport Share

Total Demand	13.7 million
Metro	2.0 million
CTA	4.1 million
Private Bus	7.6 million

Sources: JICA Study Team

2.3.6 Existing Road Network in Greater Cairo Region

As presented in Figure 2-43, the road transport system in the study area is classified into two major categories: (a) The Regional Corridor Network and (b) The Urban Corridor Network. The Regional Corridor Network is characterized by higher design speeds to serve the regional traffic movements. Generally, the major regional corridors are divided and accommodate high design speeds (80 - 100 km/hr). The Urban Corridor Network distributes the traffic among the urban centres, mostly inside the Ring Road.



Source: JICA Study Team

Figure 2-43 Existing Major Road Network in Greater Cairo Region

2.3.7 Existing Traffic Demand on Regional Roads

The Alexandria Desert Road is already widened to 4-lanes in each direction. This road is classified as a Toll Road, with maximum allowable speed of 100 km/hr for passenger cars. The users have to pay a fee of 2 LE for passenger cars to enter the road. The average daily traffic (ADT) for this road in 2006 was 27,551 vehicles per day. The second access between Cairo and Alexandria is the agriculture road. This corridor has also reached the maximum planned width. At present, this road appears to be an urban road and accommodates a maximum allowable speed limit of 60 km/hr. The road has the highest ADT rate recorded among all regional roads in Egypt (104,835 vehicles per day were recorded in the Cairo-Banha section for 2006). Table 2-38 shows the ADT on the main road network based on recent data. Table 2-39 shows the ADT based on an earlier transportation study data and updated with new data obtained from the General Authority for Roads, Bridges and Land Transport (GARBLT).

Table 2-38 ADT on the Main Road Network

Station	Year 2001	Year 2002	Year 2003	Year 2004	Year 2005	Year 2006
Cairo- Ismailiya	35,026	39,147	41,451	43,582	45,405	49,236
Tanta-Damanhour	30,327	31,600	32,486	32,105	32,105	34,320
Giza-Bani Suif	12,192	31,600	32,486	32,105	32,475	12,312
Cairo-Suez Desert Road	12,170	13,043	13,499	12,846	12,206	15,941
Abou Hamad-Ismailiya	9,194	9,763	10,209	10,000	10,406	11,376
Tanta-Quesna	34,716	39,959	38,286	39,570	42,413	46,507
Moustrad-Belbeis	14,204	15,453	14,938	14,470	14,548	14,292
Cairo-Banha	80,358	88,688	92,010	93,648	97,304	104,835
Meet Ghamar- Agah	21,909	23,607	25,260	25,370	26,264	27,850
Alexandria Desert Road	23,736	24,588	25,237	25,483	26,726	27,551
Cairo-Fayoum Desert Road	9,187	10,830	10,575	11,958	12,737	13,831
Minya-Asuit	4,555	4,855	4,880	5,613	6,584	7,183
Damanhour-Alexandria	43,332	31,389	34,160	35,830	36,018	39,182

Source: JICA Study Team

Table 2-39 ADT on Major Arterial Highways

No.	Corridor Name	2000 Volume (vehicles./day)	2006 Volume (vehicles/day)	Average Annual Growth
NH11	Alexandria Desert Road	17,886	27,551	7.5%
NH04	Ismailia Desert Road	32,772	49,236	7.0%
NH41	Ismailia Agriculture Road	10,109	11,376	2.0%
NH03	Suez Desert Road	10,962	15,941	6.4%
NH21	Upper Egypt Desert Road	10,349	12,312	2.9%
NH22	Fayoum Desert Road	10,792	13,831	4.2%

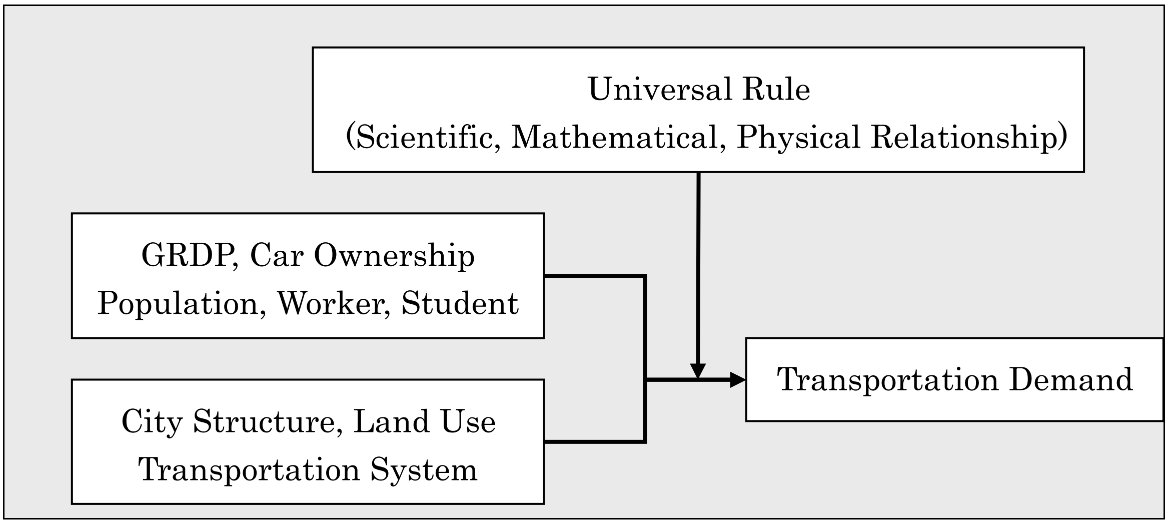
Source: JICA Study Team

2.4 Description of Transport Demand Forecasting Model

2.4.1 Methodology

(1) Transportation Model Structure

Urban area is required to be the base of transportation investment decisions on a comprehensive, cooperative, and continuing transportation planning process. A significant element of this process involves projecting future transportation demand. The most accepted method of projecting future transportation demand, and for evaluating investment strategies to serve the projected demand, is the use of travel demand forecasting models. Transportation modeling aims to find the relationship between the urban situation and people's movements. These models utilize socioeconomic data from the previous chapter to estimate travel demand by simulating the transportation system that represents transportation supply. Together with the socioeconomic data and simulated transport network, the mathematical travel models simulate the ability of the transportation system to serve the estimated demand. Figure 2-44 shows the general principle of transportation modelling.

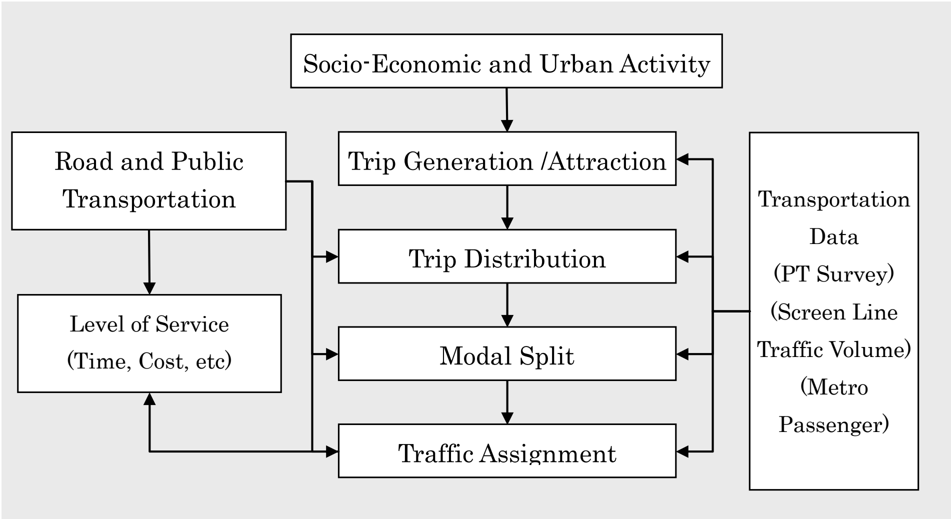


Source: JICA Study Team

Figure 2-44 Principle of Transportation Modeling

Travel models have been implemented using a wide variety of model structures, computer software systems, and data sets. While it is rare to find two models that have identical characteristics or components, majority of travel models applied globally are similar in that context. The transport model framework uses a conventional four-step approach which has been well-tried and found to be effective in many cities around the world. The concept of the four-step approach is shown as Figure 2-45. This includes the following four basic steps or components:

- Trip Generation and Attraction Model: estimating the amount of travel and where it begins and finishes;
- Trip Distribution Model: linking the trip ends together to form trips between the origins and destinations;
- Modal Split Model: accessing the modal shares of the available travel modes; and,
- Assignment Model: usage of each segment of the road and public transport networks.



Source: JICA Study Team

Figure 2-45 Concept of Four-Step Approach of Transport Modelling

The main thrust of the model is to represent the travel demand of the residents within the study area, and their usage of private and public transport such as private car, taxi, shared taxi, tram, bus, metro and so on.

(2) Zone System in Study Area

The models predict trips over the transportation network based on attributes of traffic analysis zones, which are set up based on the JICA SDMP zone system. Zonal attributes used in trip production include population and employment. A key component of the model development process was the development of the zone system to cover the study area. The study area is defined from zones 1 to 464 in the traffic survey zoning system. To secure accuracy of the modelling and forecasting for the purpose of this study, the original survey zone system, composed of 464 zones, is grouped into a traffic analysis zone system (TAZ) forming 163 zones for the metro passenger forecasting stage

(3) Modelling and Forecasting Tools

During all steps of travel model calibrations and demand forecast, the JICA STRADA system and the facilities of EXCEL spread sheets are employed. JICA STRADA is a geographic information system designed specifically for planning, managing, and analysis of transportation systems. The software provides a set of tools for travel demand modelling as well as capabilities for geographic database management, presentation graphics and transportation models. The JICA STRADA system is applied for simulating travel time and cost. For better precision, efficiency and minimization of trial errors, model calibrations and forecasts in trip generation, trip distribution and modal split steps are programmed using Excel spread sheet facilities. As a final step, traffic assignment stage is computed by the JICA STRADA system.

2.4.2 Trip Generation and Attraction Models

(1) Modelling Trip Generation and Attraction by Zone

The objective of the trip generation and attraction model is to forecast the number of trips that will start and arrive in each traffic zone within the study area. The linear regression model is adopted in the study. The model parameters are calibrated based on the revised person trip survey data in SDMP and the zonal population in 2008. The models' parameters are calibrated as shown in Table 2-40.

Oi = ai*X1i + bi*X2i Dj = aj*X1j + bj*X2j

where; Oi: Trip Generation in zone i
Dj : Trip attraction in zone j
X1i, X2j: Attributes in zone i, j
ai, aj, bi, bj: Coefficient

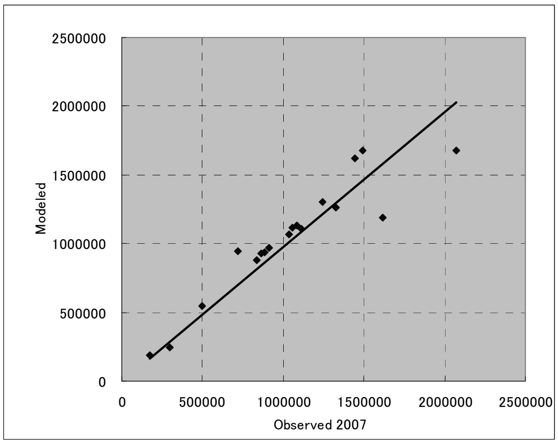
Table 2-40 Calibrated Parameters of Trip Generation and Attraction Models

Model Type	Population	Worker at Office Base	Correlation Ratio
Trip Generation	0.94236	0.77436	0.99784
Trip Attraction	0.94243	0.77412	0.99798

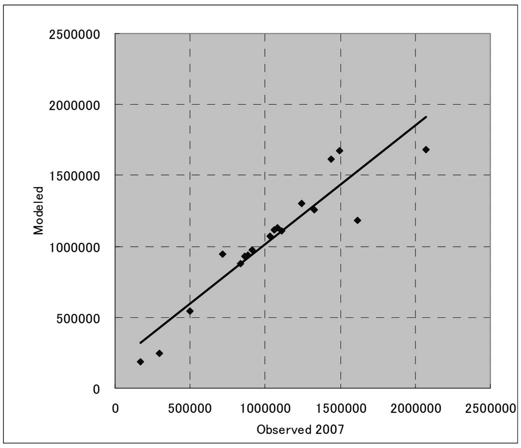
Source: JICA Study Team

(2) Verification of Trip Generation and Attraction Models

To verify and confirm the accuracy of the models developed, a comparative analysis of trip generation and attraction between the observed data and modelling results has been made. Figure 2-46 explains the correspondence between observed and modelled trip generation and attractions in 2008.



(Trip Generation Model)



(Trip Attraction Model)

Source: JICA Study Team

Figure 2-46 Verification of Trip Generation and Attraction Models

2.4.3 Trip Distribution Model

(1) Modelling Trip Distribution

The Gravity Model applied linking the trip production and attractions to form the trip matrices. The trip distribution model type applied in the study is the Doubly Constrained Gravity Model as shown in the following formulas:

$$X_{ij} = A_i B_j \times k O_i^{\alpha} D_j^{\beta} L_{ij}^{\gamma}$$

in which;

$$A_i = \frac{1}{\sum_j B_j k D_j^{\beta} L_{ij}^{\gamma}} \qquad B_j = \frac{1}{\sum_i A_i k O_i^{\alpha} L_{ij}^{\gamma}}$$

$$\sum_j T_{ij} = O_i, \quad \sum_i T_{ij} = D_j, \quad \sum_i O_i = \sum_j D_j$$

where; Xij : trip distribution from i to j
Oi : trip generation of zone i
Dj : trip attraction of zone j
Lij : travel length from i to j (kilometre)
k,α,β,γ: coefficient
Ai, Bj: balancing factor

To balance a sum of trip distribution in a certain zone, the doubly-constrained method considering balancing factors is applied after estimation of each distribution by the gravity model. This type of model is also known as Fratar Balancing. The forecast matrix should then be such that the sum of each trip generated per zone is within a given convergence criterion of the corresponding forecasted generation for that zone, and the sum of each trip attracted per zone is within a given convergence criterion of the corresponding forecasted attraction.

Calibration results of the gravity models before applying the doubly-constrained method are shown in the following table.

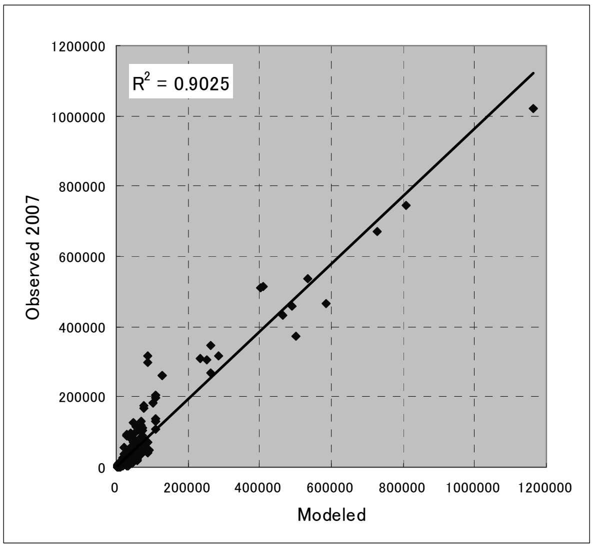
Table 2-41 Parameters of Trip Distribution Model

Parameter	α	β	γ	K	correlation ratio
Value	0.4791	0.5048	-0.9197	0.7437	0.9025

Source: JICA Study Team

(2) Validation of Trip Distribution Model

To verify and confirm the accuracy of the models developed, a comparative analysis of trip distribution between the observed data and modelling results has been made. Figure 2-47 explains the correspondence between observed and modelled trip generation and attractions in 2007.



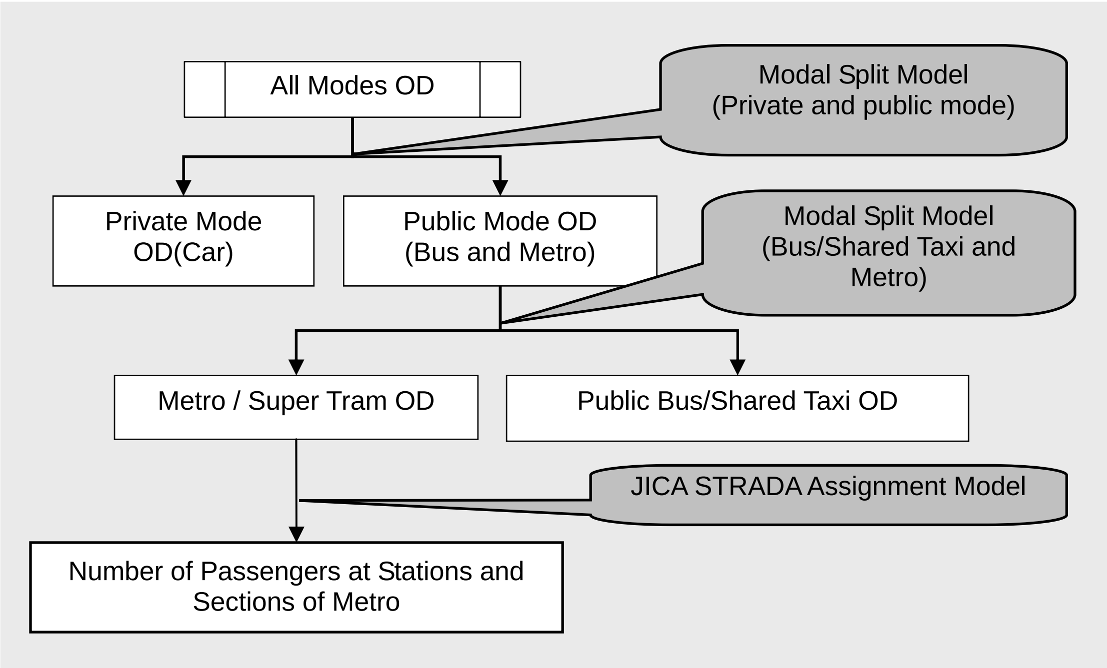
Source: JICA Study Team

Figure 2-47 Verification of Trip Generation and Attraction Models

2.4.4 Modal Choice Model

(1) Methodology of modelling modal split among private mode, public mode and metro

For the evaluation of the metro line network, creation of a new modal split model is needed, which can split public mode users to bus users and then metro line and public bus / shared taxi users. This will be applicable to the analysis of the metro line projects as shown in Figure 2-48. The goal of this model is to predict the share and absolute number of trips for using the proposed new metro line. This model provided the number of passengers in private cars, public bus/shared taxi and metro line. The revised 2008 OD matrixes by SDMP are used to calibrate the modal split model parameters in the study. Figure 2-48 describes the flow chart in the stage of modal split modelling.



Source: JICA Study Team

Figure 2-48 Work Flow for Modal Split Modelling and Projection of Metro Line Passengers

(2) Modal Choice Model for Private Car Share

a) Modelling modal share between private and public modes

The share of private car use is closely related to the status of motorization, which is measured by car ownership rate. Based on existing studies, such as JICA CREATS and SDMP, the trend of private car share is summarized in Table 2-42. This data explains that the growth rate of car ownership is higher than trips of private car share.

Table 2-42 Trend and Estimation of Private Mode Share Against Car Ownership Rate

Year	Cars per 1,000 persons	Private Mode Share
2001	51.0	20.10%
2007	66.9	22.90%
2012	79.9	24.40%
2017	112.6	28.00%
2022	145.2	32.50%
2027	177.6	36.20%

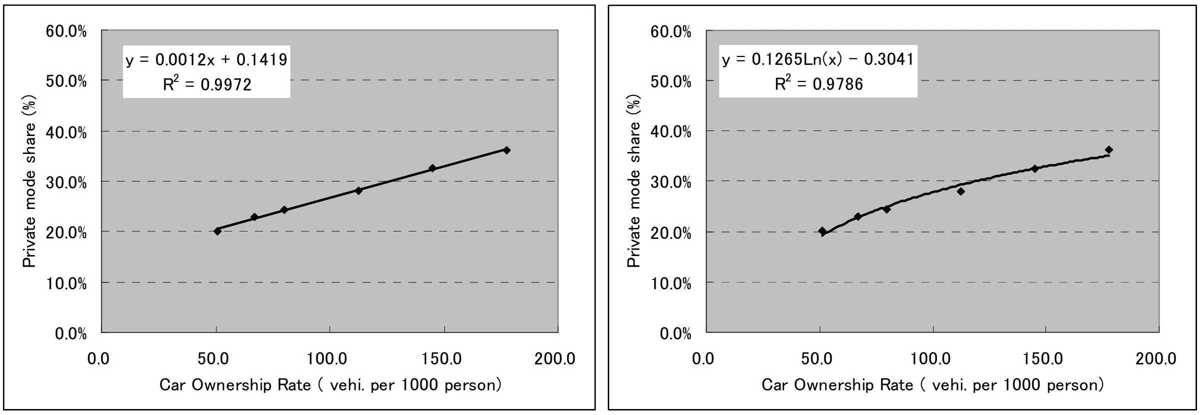
Sources: JICA CREATS, SDMP

Considering this phenomenon, two types of modal share model are studied as follows.

- Model 1 linear regression model with car ownership rate
- Model 2 log function model with car ownership rate

The first model is a simple linear regression model, which assumes that the level of service of public transport mode would not drastically change after the 2027 situation. Meanwhile the second model which applies the log formula, considers lower growth rate of private car usage against that of the first model with the linear function. The parameters of the models are calibrated using the car ownership and modal share information indicated in Table 2-43.

- *Model 1; Modal Share of private car = 0.0012 * car ownership rate + 0.1419*
- *Model 2; Modal Share of private car = 0.1265 * Ln(car ownership rate) -0.3041*



(Linear function Model) (Log function Model)

Source: JICA Study Team

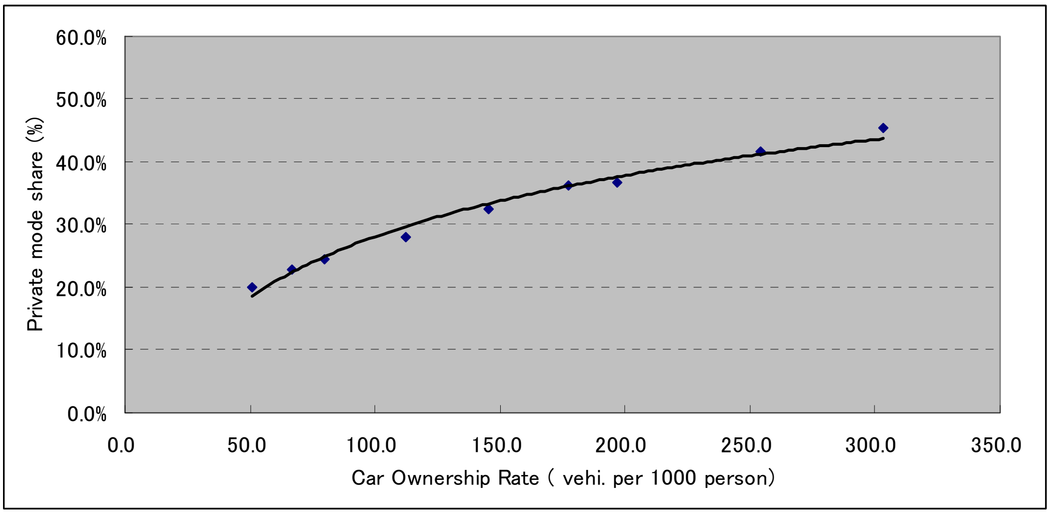
Figure 2-49 Private Car Modal Split Model

It is not accurate to assume a balance between public and road transport services, Therefore, the buffering of modal share by two types of models is obtained as the private car modal share in this study. Table 2-43 and Figure 2-50 show the estimated modal share of private car mode in the past and future.

Table 2-43 Private Car Modal Share Model in This Study

Year	Cars per 1000 persons	Private Mode Share	Remarks
2001	51.0	20.10%	CREATS
2007	66.9	22.90%	SDMP
2012	79.9	24.40%	this study estimation
2017	112.6	28.00%	this study estimation
2022	145.2	32.50%	this study estimation
2027	177.6	36.20%	this study estimation
2030	197.1	36.4% - 36.9%	this study estimation
2040	254.4	39.6% - 43.4%	this study estimation
2050	303.2	41.8% - 49.1%	this study estimation

Source: JICA Study Team



Source: JICA Study Team

Figure 2-50 Private Car Modal Share Model in This Study

(3) Modal Choice Model for Metro Mode Share

a) Modelling Metro Modal share among Public Mode

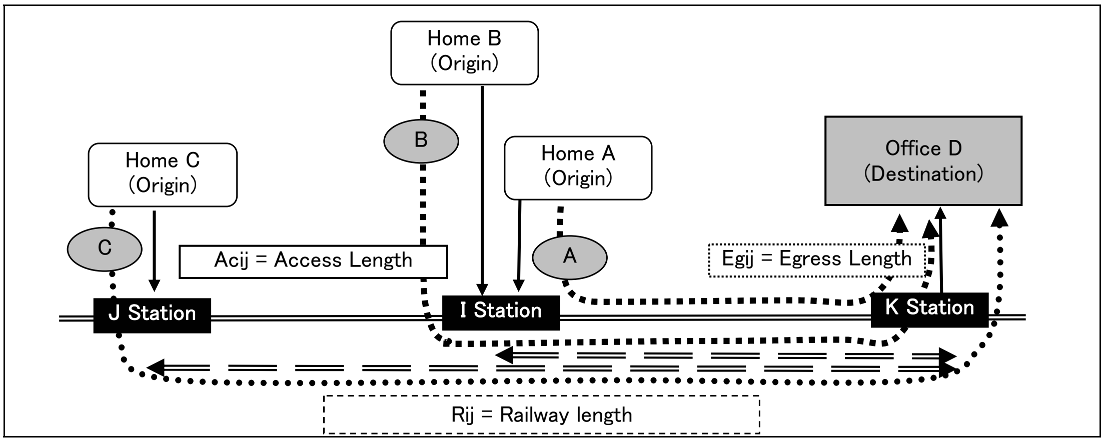
The new modal split model is a log type model, as indicated below:

Pij _metro = U_metro / (U_metro + U_bus)
Uij_metro = a1 * Tij_merto + a2 * Rij / (Acij + Egij)
Uij_bus = b1 * Tij_bus + b2

Where Pij_metro = Modal share of Metro Mode between i zone to j zone
Uij = Utility function between i zone to j zone
Tij_metro = Travel time by Metro mode between i zone to j zone (Unit: minute)
Tij_bus = Travel time by Bus mode between i zone to j zone (Unit: minute)
Acij = Access travel length from i Origin Zone to embarking Metro station
Egij = Egress travel length from alighting Metro station to j destination Zone
Rij = Travel Length between embarking and disembarking at Metro stations
a1; model parameter for Metro Travel Time
a2; model parameter for station accessibility
b1; model parameter for Bus Travel Time
b2; model constant parameter

b) Consideration of explanatory factors in the Metro modal split model

As explanatory factors of the modal split model, travel time by mode and the accessibility of metro stations ((access + egress) / railway)) are selected. Usually, travel fare by mode is also applied as an explanatory factor in the model. However, based on the analysis of RPS and SPS survey, existing private and public mode passengers are not willing to pay increased fares for the new transit service, and they just prefer to pay the same level as that for existing transport services. The accessibility of metro stations ((access + egress) / railway)) is one of the major factors based on the analysis of CREATS HIS data. Figure 2-51 illustrates the concept of station accessibility. Station accessibility is defined as the function, Rij / (Acij + Egij), so that values in the illustration and the sample patterns are ranked in order, i.e., “Pattern C > Pattern A > Pattern B. The modal share of metro also follows this order.



Source: JICA Study Team

Figure 2-51 Explanatory Illustration for Station Accessibility

c) Assumption of travel time by mode

Travel speed and waiting time are assumed for modelling purposes. Travel time and travel length among all zone pairs were simulated using the JICA STRADA assignment module, with the assumptions listed in Table 2-44.

Table 2-44 Assumption of Travel Time by Mode for the Modelling Period

Mode	Service Speed (km/h)	Waiting Time (minutes)	Remarks
Metro	40	5	Existing Metro Line 1 and 2 data
Tram, Super Tram and Bus Exclusive Lane Use	30	10	
Bus Mixed Transport Condition	20	10	

Source: JICA Study Team

d) Calibration Results of Metro Modal Split Model

The parameters of the metro modal split model are identified and calibrated using the maximum likelihood method, which attempts to find the set of parameters that is most likely to result in the choices observed in the Present OD Matrix in SDMP. Using the model, metro mode share is calculated and shown in Table 2-45.

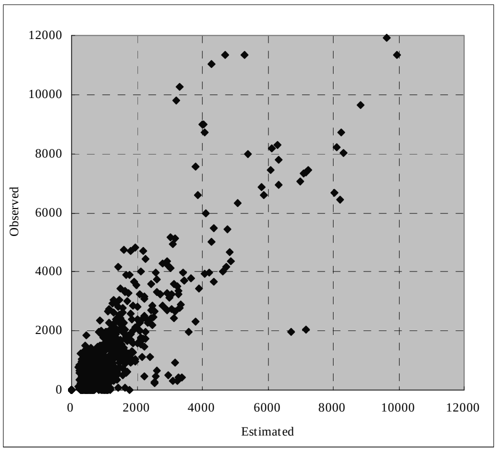
Table 2-45 Model Calibration Results

Item	Travel Time (t - value)	Station Accessibility (t - value)	Constant (t - value)
Rail Mode	-0.067948488 (-1.7385)	0.138827632 (0.6038)	-
Bus Mode	-0.04817359 (-1.2440)	-	0.486960221 (0.4869)
correlation ratio	R-square= 0.8839		

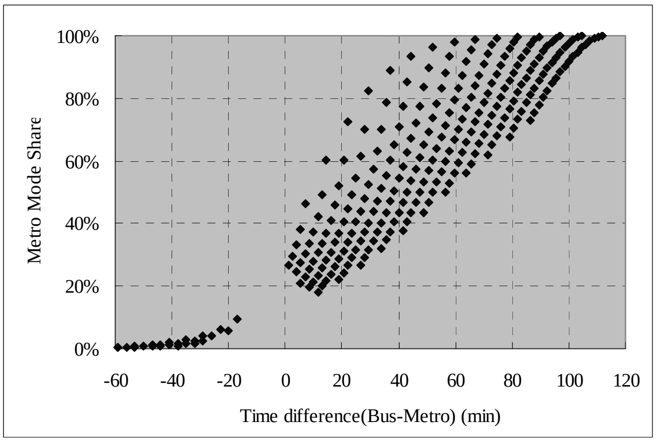
Source: JICA Study Team

Note: T-value represents the degrees of incidence to the modal share by explanatory variables including the travel time and station accessibility.

In Figure 2-52, the calibration result shows the modal share by the public transport mode including buses and metro in the model (observed data in the vertical axis), and the metro modal split model (estimated data in the horizontal axis). The metro modal split model is considered to be reliable, since the correlation ratio (R-square) is estimated at 0.8839 as shown in Table 2-45. The right hand graph in Figure 2-52 shows the modal share of metro by time difference, between metro and buses.



Modal Split Model (Bus and Metro) Calibration Results



Rail Share and Transport Time Difference

Source: JICA Study Team

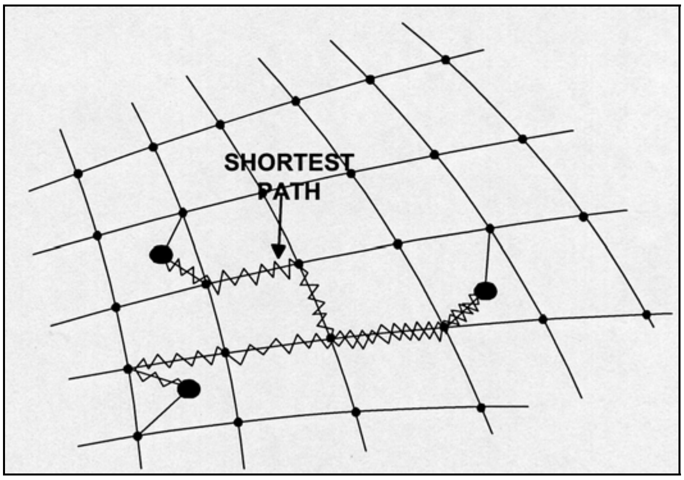
Figure 2-52 Modal Split Model (Bus and Metro) Calibration Results and Estimated Rail Mode Share

2.4.5 Trip Assignment Model

The trip assignment is the process of allocating a given set of trip interchanges to a specific transportation network. The traffic assignment accomplishes this by:

- Identifying a set of routes that might be used by passengers. The passenger wants to minimize impedance, which is a function of speed and fare. These routes are stored in a data structure called a tree. This step is often referred to as the tree-building stage.

- Assigning suitable proportions of the trip table (MRT OD Matrix) to these routes or trees results in flow in the network.



Source: JICA Study Team

Figure 2-53 Concept of Traffic Assignment and Finding a Tree/Route

In this study, the Mass Rapid Transit (MRT) traffic assignment process allocates passenger traffic to MRT transportation networks and links. This step takes as input data a MRT matrix that indicates the volume of passenger traffic between origin and destination pairs. Applying the traffic assignment stage above, daily station and cross section passengers of the metro line are projected. The passengers during peak hours are estimated by this daily passenger volume with the application of a peak rate.

In this study, the JICA STRADA assignment module is applied for the bus mode and metro mode assignment models. JICA STRADA prepares three types of assignment modules, namely, Incremental, User Equilibrium and Stochastic User Equilibrium. Equilibrium means that any passenger could not reduce his travel time even if he selects any others routes, or divert to any routes. In other words, equilibrium is intended to find the best balanced points between demand and supply on transportation reality. In this study, the Incremental assignment module, which is the most suitable for public mode assignment, is selected.

2.5 Estimation of Present and Future Transportation Demand Matrix

Based on the socio–economic framework up to 2050 and the transportation models developed, the present and future transportation demand are estimated according to the following four-step approach: (1) trip generation and attraction, (2) trip distribution, (3) modal split and (4) trip assignment. The original estimated OD matrices have 464 traffic zone bases, but are not presented in this report due to its large volume. Therefore the forecasting results in this report are integrated into a sector zone system with 18 zones. The demand data and OD matrixes with the original 464 zones are only prepared in electronic based data using Excel or JICA STRADA data format.

2.5.1 Trip generation and attraction in the present and future

The present and future trip generations by zone are estimated as shown in Table 2-46. The original related data has been estimated using 464 traffic zone system, to facilitate understanding of the trend and how to change. The data in Table 2-46 have been integrated into an 18 sector zone system shown in the Figure 2-39.

Based on projected growth rate from 2008 up to 2027, sector zones such as 6th October City, Nasr City including New Cairo and 10th of Ramadan City exhibit remarkable effects because these include new urban community development projects. After 2027 up to 2050, the large scale development projects will be shifted to the outskirts of the study area, such as Helwan, and Qanater, where new urban communities are projected, following the Cairo Vision 2050.

Table 2-46 Trip generation and attraction (unit: thousand trips per day)

No.	Sector Zone	Gi2008	Gi2027	Gi2050	Growth Rate 2027/2008	Growth Rate 2050/2008	Growth Rate 2050/2027
1	6th October	351.7	1,879.0	2,812.4	5.34	8.00	1.50
2	Imbaba Markaz	1,579.9	2,585.0	4,450.0	1.64	2.82	1.72
3	Dokki	1,470.7	1,692.5	2,313.0	1.15	1.57	1.37
4	Giza	2,124.3	2,711.9	4,491.8	1.28	2.11	1.66
5	South Giza	513.3	627.1	865.4	1.22	1.69	1.38
6	Helwan	903.6	1,064.0	3,326.3	1.18	3.68	3.13
7	Maadi	1,098.3	1,712.2	2,873.7	1.56	2.62	1.68
8	Khaleafa	921.3	968.1	1,322.8	1.05	1.44	1.37
9	CBD	719.6	593.3	802.5	0.82	1.12	1.35
10	Shobra	1,094.0	1,118.9	1,556.2	1.02	1.42	1.39
11	Masr El Gedeeda	1,619.2	1,585.1	2,171.9	0.98	1.34	1.37
12	Nasr City	1,369.0	2,583.9	3,473.3	1.89	2.54	1.34
13	Ain Sham	1,062.5	1,385.6	1,907.4	1.30	1.80	1.38
14	Salam City	841.7	773.4	1,071.9	0.92	1.27	1.39
15	Shobra El Kheima	1,137.8	1,404.4	1,927.4	1.23	1.69	1.37
16	Qalyob	882.7	1,103.4	1,477.9	1.25	1.67	1.34
17	Qanater	1,298.2	2,102.6	4,918.2	1.62	3.79	2.34
18	10th of Ramadan	191.7	687.5	1,038.2	3.59	5.42	1.51
	Total	19,179.5	26,577.9	42,800.3	1.39	2.23	1.61

Source: JICA Study Team

2.5.2 Trip Distribution (OD Matrix) by All Transportation Mode

The trip distribution patterns of person trips by all transportation modes in year 2008, 2027 and 2050, are shown in Table 2-47 to Table 2-49.

The trip distribution pattern in 2008 shows that the main movement of traffic is in the south-north direction traffic from Giza block (line structured by Imbaba, Dokki and Giza Zones) and West block (line structured by Shobra, Masr El Gedeeda and Nasr City-New Cairo Zones). Both lines meet at CBD and Shobra, and flows to Shobra El Kheima and Qalyob. In twenty (20) years, from 2008 to 2027, the main movement of traffic shifts to the west-east direction. Giza block grows to the triangle including 6th October. The West block also grows by merging the 2008 West block, Qanater and 10th of Ramadan.

Table 2-47 All Mode Origin and Destination Matrix by Sector Zone in Year 2008 (unit: thousand trip per day)

O	D	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	Total
1	6th of October	192	31	27	61	11	4	9	6	5	7	6	6	5	3	9	7	5	2	396
2	Imbaba Markaz	31	842	349	184	6	17	17	24	46	27	47	32	7	4	12	14	4	3	1,665
3	Dokki	25	328	466	271	11	22	32	46	58	43	48	59	19	16	23	19	12	3	1,499
4	Giza	62	191	270	1,084	93	38	103	75	52	43	45	36	17	13	23	16	15	2	2,176
5	South Giza	11	6	11	94	324	32	9	8	5	4	6	8	3	1	2	1	1	1	526
6	Helwan	4	16	20	40	31	571	97	32	19	15	17	19	10	7	11	6	6	2	923
7	Maadi	10	17	32	106	9	95	484	132	53	29	68	48	20	9	9	6	6	5	1,137
8	Khaleafa	6	24	46	75	6	31	132	317	74	31	66	48	17	15	19	9	13	3	932
9	CBD	5	47	57	51	5	19	54	72	70	71	73	39	36	30	29	22	38	1	720
10	Shobra	7	27	40	43	4	14	29	33	72	354	137	60	39	34	120	43	44	6	1,107
11	Masr El Gedeeda	5	58	51	47	7	18	64	66	73	132	372	182	202	119	73	48	119	7	1,644
12	Nasr City	5	36	38	34	8	20	48	47	38	60	185	524	108	80	80	21	56	9	1,398
13	Ain Sham	6	7	21	17	3	11	24	16	36	37	210	104	339	107	42	14	86	10	1,089
14	Salam City	4	4	15	12	2	7	10	15	30	32	130	74	116	269	20	10	95	8	850
15	Shobra El Kheima	9	13	21	25	2	12	9	19	29	127	76	78	40	19	532	80	62	10	1,162
16	Qalyob	6	13	18	16	1	7	7	9	21	43	44	20	14	12	85	530	51	6	902
17	Qanater	5	5	14	14	1	6	6	13	37	47	106	53	86	103	65	52	725	15	1,352
18	10th of Ramadan	2	2	3	2	1	2	5	2	2	6	7	10	11	8	9	6	15	122	214
	Total	396	1,665	1,498	2,176	526	923	1,137	932	719	1,106	1,644	1,398	1,089	850	1,162	902	1,352	214	19,690

Source: JICA Study Team

Table 2-48 All Mode Origin and Destination Matrix by Sector Zone in Year 2027 (unit: thousand trip per day)

O	D	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	Total
1	6th of October	1,142	167	91	298	39	19	45	29	17	25	23	19	22	9	29	24	18	23	2,038
2	Imbaba Markaz	167	2,105	532	344	11	33	41	41	58	42	76	64	18	10	24	21	15	8	3,610
3	Dokki	87	507	494	311	12	29	47	43	48	43	54	76	27	17	31	20	21	7	1,873
4	Giza	302	350	309	1,767	106	40	126	70	47	50	57	50	26	14	31	18	25	5	3,395
5	South Giza	39	100	12	108	430	38	12	7	4	4	8	9	4	1	2	2	2	2	783
6	Helwan	20	31	25	44	39	1,552	291	31	24	18	29	32	15	7	14	7	10	4	2,191
7	Maadi	48	40	48	131	11	288	1,042	173	56	39	97	76	40	13	17	9	11	10	2,150
8	Khaleafa	29	39	41	70	5	38	174	343	62	30	82	67	23	14	24	10	17	6	1,073
9	CBD	16	60	47	47	4	23	56	63	52	53	59	41	34	19	28	19	40	4	666
10	Shobra	24	44	42	51	4	17	40	32	54	368	126	69	48	28	136	49	87	12	1,231
11	Masr El Gedeeda	22	88	55	60	9	27	90	83	59	120	345	230	211	94	82	53	186	19	1,831
12	Nasr City	19	70	51	46	10	30	77	65	42	68	237	1,485	155	94	94	29	203	48	2,822
13	Ain Sham	23	19	30	26	4	15	47	21	33	46	221	151	498	118	58	22	173	23	1,528
14	Salam City	8	9	16	14	2	10	13	14	20	26	103	83	127	199	22	14	161	12	853
15	Shobra El Kheima	31	26	29	34	2	14	17	24	28	142	85	96	54	21	663	113	151	19	1,548
16	Qalyob	21	26	19	18	2	8	9	9	18	49	50	28	22	15	118	668	142	12	1,235
17	Qanater	19	23	25	22	2	9	13	18	38	95	161	197	177	165	159	141	2,306	48	3,616
18	10th of Ramadan	22	7	7	5	1	4	12	5	4	11	19	47	26	14	17	12	47	495	756
	Total	2,038	3,709	1,872	3,395	693	2,194	2,149	1,073	665	1,230	1,831	2,821	1,527	852	1,548	1,229	3,615	756	33,198

Source: JICA Study Team

Table 2-49 All Mode Origin and Destination Matrix by Sector Zone in Year 2050 (unit: thousand trip per day)

O	D	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	Total
1	6th of October	1,445	260	120	490	52	28	63	43	24	35	31	26	27	12	36	30	25	49	2,796
2	Imbaba Markaz	264	2,577	614	451	16	52	59	55	71	61	96	82	29	16	36	31	29	13	4,550
3	Dokki	117	589	575	385	17	51	67	55	59	60	71	92	38	22	45	27	37	10	2,315
4	Giza	496	460	384	2,228	137	68	164	95	61	70	78	70	39	21	50	27	43	9	4,499
5	South Giza	53	301	17	139	520	54	15	9	5	5	10	12	5	2	3	2	3	2	1,156
6	Helwan	28	46	45	70	54	2,384	385	50	34	31	50	48	25	12	23	12	21	7	3,324
7	Maadi	67	59	69	171	15	377	1,423	207	68	53	122	100	50	18	28	14	23	12	2,874
8	Khaleafa	43	53	53	95	7	53	208	379	69	39	100	96	32	19	33	12	26	8	1,324
9	CBD	23	73	57	61	5	33	67	70	59	63	68	50	40	22	37	21	48	7	805
10	Shobra	33	62	59	71	6	30	53	42	64	450	151	89	65	35	166	61	108	15	1,557
11	Masr El Gedeeda	30	108	72	81	11	49	115	100	69	145	404	288	252	111	106	62	228	28	2,258
12	Nasr City	26	88	67	66	13	46	100	93	51	87	295	1,673	195	114	110	35	244	84	3,386
13	Ain Sham	28	30	41	40	5	26	57	30	40	63	263	191	586	146	79	31	221	32	1,908
14	Salam City	10	14	22	21	2	15	18	18	23	33	121	102	155	235	32	20	214	16	1,072
15	Shobra El Kheima	38	38	43	53	4	24	27	32	36	172	109	112	76	31	767	142	196	26	1,925
16	Qalyob	28	48	26	26	3	13	14	12	21	60	58	35	31	22	147	765	174	16	1,497
17	Qanater	26	36	41	40	3	21	25	27	46	116	204	237	224	216	204	173	3,212	69	4,918
18	10th of Ramadan	47	12	10	9	2	7	14	8	7	15	28	83	37	20	23	16	67	633	1,037
	Total	2,800	4,853	2,315	4,496	872	3,329	2,873	1,324	804	1,556	2,257	3,385	1,906	1,072	1,926	1,480	4,917	1,037	43,201

Source: JICA Study Team

2.5.3 Present and Future Modal Split

(1) Modal Share between Car, Bus and Rail Mode

By applying the modal split models developed in the previous section, to the OD matrix in each year respectively, the modal shares by OD matrix type are projected. Table 2-50 describes the summary results of modal share among "car mode", "bus mode" and "rail mode". The car mode represents private passenger car, taxi and truck. The bus mode includes public bus, mini bus and shared taxi. The Rail mode represents all passengers using rail borne transport, in particular Metro, ENR, tram and super tram in the future plan.

- Car mode includes passenger car, taxi, and truck
- Bus mode includes public bus, mini bus, shared taxi,
- Rail mode includes metro, tram and railway

The overall trend of modal share is represented by the increase of car mode share by motorization expansion and the increase of rail mode share by new line implementations. The car mode share in the present year 2008 is 23%, whereas in future 2050, it will almost double, about 45%. The rail mode share in 2008 is only 12 %, and will be 18% in 2050. However, the actual number of rail mode passenger will escalate following the new line installation, reaching 7.8 million passengers per day in 2050, which is more than triple that of 2008. Consequently, the share of bus mode will decrease annually.

Table 2-50 Result of Modal Share Estimation

Year	Metro Line 4 Phase 2 Alternative	No. of Trip (thousand trip per day)			Modal share (%)		
		Car mode	Bus mode	Rail mode	Car mode	Bus mode	Rail mode
2008		4,584	12,693	2,412	23.3%	64.5%	12.2%
2027	Alt 1 North	9,593	12,365	4,744	35.9%	46.3%	17.8%
	Alt 2 East	9,599	12,374	4,730	35.9%	46.3%	17.7%
2050	Alt 1 North	19,374	16,017	7,809	44.8%	37.1%	18.1%
	Alt 2 East	19,381	15,975	7,845	44.9%	37.0%	18.2%

Source: JICA Study Team

(2) Rail Mode Trips by Sector Zone

Table 2-51 describes the trip generation using rail mode transport by sector zone. These are accomplished by calculation using the rail mode OD Matrix. The significant difference between Metro Line 4 phase 2 alternatives is observed in Nasr City and Shobra El Kheima zones. Alternative 1 services the northern corridor, which results in the large demand from Shobra El Kheima. Alternative 2 meanwhile is planned along the eastern corridor, which gives a large demand from Nasr City.

Table 2-51 Rail Mode Trip by Sector Zone, (unit: thousand trips per day)

No.	Sector Zone	2008	2027 Alt 1	2027 Alt 2	2050 Alt 1	2050 Alt 2
1	6th October	5.6	461.1	457.4	731.3	727.4
2	Imbaba Markaz	71.1	284.6	286.4	631.4	634.5
3	Dokki	168.4	325.3	326.8	421.9	424.1
4	Giza	259.8	520.3	518.5	771.0	769.9
5	South Giza	13.8	25.5	25.6	59.7	59.8
6	Helwan	131.4	148.2	148.1	513.2	513.5
7	Maadi	245.3	325.7	326.4	555.3	556.6
8	Khaleafa	145.3	172.5	183.4	246.4	259.4
9	CBD	173.0	172.8	170.9	213.0	212.4
10	Shobra	198.2	230.4	203.8	321.3	305.6
11	Masr El Gedeeda	299.4	419.2	390.9	521.2	506.5
12	Nasr City	98.3	457.4	599.0	654.7	825.8
13	Ain Sham	149.4	292.7	271.1	389.7	368.2
14	Salam City	112.2	152.7	150.2	205.9	204.3
15	Shobra El Kheima	140.5	241.8	186.1	371.6	305.8
16	Qalyob	92.8	146.0	138.4	248.5	240.2
17	Qanater	106.2	267.4	249.0	775.7	755.7
18	10th of Ramadan	0.9	100.8	97.9	177.2	175.0
	Total	2,412	4,744	4,730	7,809	7,845

Source: JICA Study Team

(3) Rail Mode OD Matrix by Sector Zone

Table 2-52 to Table 2-56 show the rail mode OD matrix per year, by Metro Line 4 phase 2 alternatives. These OD matrices are assigned on the public transport network in the next stage followed by the transport assignment. Thereafter, the concrete number of metro passengers is obtained. The transport assignment results are discussed in the next section.

Table 2-52 Rail Mode Origin and Destination Matrix by Sector Zone in Year 2008 (unit: thousand trips per day)

O	D	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	Total
1	6th of October	0	0	0.3	0.9	0.2	0.4	0.5	0.3	0.2	0.4	0.3	0.2	0.4	0.2	0.6	0.4	0.3	0	5.6
2	Imbaba Markaz	0	0.7	14	18.6	0.5	6.4	3	3.3	6.9	2.2	7.3	4.5	0.7	0.4	1.5	0.8	0.3	0	71.1
3	Dokki	0.3	14.2	42	32.6	0.9	8.6	5.9	9	11.2	7.2	10	9.4	3.8	4.6	3.3	3.5	2	0.1	168.4
4	Giza	0.9	20.8	32.5	85.8	6.7	14.8	28.6	12.9	12.9	9.4	10.2	5.7	4.2	3.3	4.1	3.8	2.9	0	259.8
5	South Giza	0.2	0.5	0.9	6.8	0	0.5	0.8	0.7	0.6	0.5	0.9	0.8	0.5	0	0.1	0.1	0.1	0	13.8
6	Helwan	0.3	6.4	7.9	16.3	0.5	2.9	35.1	13.9	10.6	7.2	6.6	5.6	4.8	3.2	5.2	2.5	2.2	0.1	131.4
7	Maadi	0.6	2.9	6.2	29.3	0.7	34.5	56	34.3	19.2	9.3	28.6	10.2	7.1	2.7	1.3	1.2	0.9	0.2	245.3
8	Khaleafa	0.3	3.2	9	13.1	0.5	13.4	34.9	25.2	11.3	5.4	9.9	3.6	2.7	4.2	3.8	2	2.9	0	145.3
9	CBD	0.2	7.1	10.8	12.2	0.6	10.5	19.6	10.6	11.8	16.7	19.3	5.7	11.3	10.8	7.6	7.2	10.8	0	173
10	Shobra	0.4	2.2	6.4	9.5	0.6	6.5	9.2	6.5	17.1	32.6	29.1	9.4	6.9	8.3	32.3	10.8	10.1	0.1	198.2
11	Masr El Gedeeda	0.3	9.8	10.8	11.1	1.1	6.9	26.7	10	19.2	28	39.9	12.1	39.4	29.9	14.7	13.1	26.2	0.1	299.4
12	Nasr City	0.2	5.1	6.3	5.2	0.9	5.9	10.2	3.5	5.5	9.1	12.2	0.3	6.5	6.7	11.1	3.7	5.8	0	98.3
13	Ain Sham	0.5	0.8	4.3	4.1	0.5	5.2	8.4	2.4	11.3	6.5	41.3	6.1	24	13.5	4.2	1.9	14.5	0	149.4
14	Salam City	0.3	0.3	3.9	3.1	0.3	3.4	3.4	3.7	11.2	7.6	33.5	6.3	14.9	3.1	2.1	0.9	14.3	0	112.2
15	Shobra El Kheima	0.7	1.8	2.7	5.7	0.2	5.8	1.3	3.7	7.4	33.8	15	10.9	3.8	1.8	22.4	15	8.5	0	140.5
16	Qalyob	0.4	0.8	3.5	3.5	0.1	2.9	1.4	2	6.9	10.9	11.8	3.5	1.9	1.6	16.2	20.1	5.2	0.1	92.8
17	Qanater	0.3	0.5	2.6	2.3	0.1	1.8	0.9	3.1	10.6	11.3	23.2	5.2	14.1	16.1	9	5.3	0	0	106.2
18	10th of Ramadan	0	0	0.1	0	0	0.1	0.2	0	0	0.1	0.1	0	0	0	0	0.2	0	0	0.9
	Total	5.8	77.1	164.3	260.2	14.4	130.4	246	145.1	173.7	198.3	299.2	99.5	147.1	110.5	139.6	92.6	107	0.9	2,411.7

Source: JICA Study Team

Table 2-53 Rail Mode Origin and Destination Matrix by Sector Zone in Year 2027 Alternative 1 North Extension
(unit: thousand trips per day)

O	D	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	Total
1	6th of October	204.7	37.8	35.9	65.2	6.7	5.7	15.6	7.5	5.2	10.1	9.2	7.5	11.4	3.7	15.9	10.4	6.1	2.5	461.1
2	Imbaba Markaz	37.9	62.4	57.8	46.5	0.9	9.2	6.9	6.3	10.2	5.1	14.2	15.7	1.9	1	2.9	1.7	1.4	2.9	284.6
3	Dokki	33.1	55.8	67.5	59.9	0.8	8.1	7.7	8.2	11.4	6.9	12.8	28.4	6.5	4.5	4	4.1	2.5	2.9	325.3
4	Giza	66.6	48.2	59.6	207.4	5.9	13.1	28.1	13	12.5	12	16.2	15	6.2	3	4.7	3.6	3.9	1.4	520.3
5	South Giza	6.7	1.4	0.8	6.1	3.5	0.4	1	0.5	0.4	0.4	1.1	1.6	0.7	0	0.1	0.1	0.1	0.7	25.5
6	Helwan	5.6	9.3	7.2	14.4	0.4	14.3	36.8	11	7.9	5.9	6.9	10.4	5.4	2.8	4.8	2.2	1.9	1.1	148.2
7	Maadi	18.2	6.2	7.9	29.9	1	36.4	72.8	35.9	17.3	10.3	35.1	26.4	12.4	3.6	1.6	1.2	1	8.3	325.7
8	Khaleafa	7.2	5.4	8.1	13.3	0.3	10.6	36.4	29.7	12.1	4.8	16.5	9.8	3.5	3.4	4.5	1.9	2.4	2.6	172.5
9	CBD	5	10.3	10.9	12	0.4	7.8	17.3	12	10.1	12.3	17.3	13.9	13.2	8	7.1	5.2	8.6	1.3	172.8
10	Shobra	9.7	5.4	6.1	12	0.5	5.4	10.6	5.6	12.7	29.8	27.9	18.5	9	7.4	31.5	9.9	21.3	7.1	230.4
11	Masr El Gedeeda	8	17.6	13.6	16.9	1.4	7	31.9	16.6	17.5	26.1	58.4	50.9	54	26.7	17.6	14.7	33	7.4	419.2
12	Nasr City	7.2	17.9	15	12.1	1.7	10.3	27	8.6	14	18.3	53.6	123.6	34.7	21.8	32.6	8.8	46.6	3.5	457.4
13	Ain Sham	13.4	2	8.1	6	0.8	5.8	17.3	3	12.5	8.5	56.6	32.9	56.3	22.9	6.3	2.8	26.9	10.8	292.7
14	Salam City	4.8	0.7	4.1	2.8	0.3	3	3.9	3.2	8.1	6.8	29.4	19.1	25.5	8.5	2.9	1.2	23.7	4.5	152.7
15	Shobra El Kheima	17	3.3	3.1	6.7	0.1	5.3	1.5	4.4	6.7	33.4	18.5	32.8	5.6	2.8	43.8	18.1	27.2	11.6	241.8
16	Qalyob	8.5	1.7	3.6	3.2	0.2	2.7	1.4	2	5.1	9.8	13.2	8.8	2.7	1.8	19.5	31.4	23.5	6.9	146
17	Qanater	6.1	1.8	4.3	2.9	0.1	1.6	1.2	2.4	8.6	23.6	28.2	45	28.5	24.4	29	22.9	20.3	16.4	267.4
18	10th of Ramadan	2.5	2.3	2.7	1.4	0.5	1.3	9.2	2	1.4	6	7.6	4.6	12.1	4.7	10.2	7.2	16.4	8.7	100.8
	Total	462.1	289.5	316.3	518.7	25.5	148.1	326.5	171.9	173.7	230	422.8	464.9	289.7	151	238.9	147.4	266.6	100.6	4,744.3

Source: JICA Study Team

Table 2-54 Rail Mode Origin and Destination Matrix by Sector Zone in Year 2027 Alternative 2 East Extension (unit: thousand trips per day)

O	D	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	Total
1	6th of October	204.7	37.8	35.9	65.2	6.7	5.7	15.6	7.9	5.2	9.6	8.6	7.6	10.9	3.7	13.6	10.4	5.8	2.5	457.4
2	Imbaba Markaz	37.9	62.4	57.8	46.5	0.9	9.2	6.9	6	10.2	5	14.9	17.3	1.8	1	2.6	1.7	1.4	2.9	286.4
3	Dokki	33.1	55.8	67.5	59.9	0.8	8.1	7.7	8.4	11.3	6.3	13.1	31.4	6.3	4.5	3.2	4	2.4	2.9	326.8
4	Giza	66.6	48.2	59.6	207.4	5.9	13.1	28.1	13.1	12.3	10.7	16	16.3	6	3	3.5	3.6	3.8	1.4	518.5
5	South Giza	6.7	1.4	0.8	6.1	3.5	0.4	1	0.5	0.4	0.4	1.2	1.6	0.7	0	0.1	0.1	0.1	0.7	25.6
6	Helwan	5.6	9.3	7.2	14.4	0.4	14.3	36.8	11.1	7.9	5.6	6.9	11.2	5.3	2.8	4.3	2.1	1.8	1.1	148.1
7	Maadi	18.2	6.2	7.9	29.9	1	36.4	72.8	36.5	17.4	9.5	34.4	28.9	12	3.6	1.3	1.2	1	8.3	326.4
8	Khaleafa	7.5	5.4	8.3	13.3	0.3	10.7	37	32.6	14.4	4.9	18.8	11.8	3.5	3.6	4.3	2	2.4	2.6	183.4
9	CBD	5	10.3	10.9	11.7	0.4	7.8	17.4	14.4	10	10.8	16.1	15.5	12.5	8	5.2	5.2	8.4	1.3	170.9
10	Shobra	9.2	5.3	5.6	10.7	0.5	5.1	9.7	5.8	11.1	24.6	22.7	18.4	6.8	6.8	25.1	9.3	20.3	6.7	203.8
11	Masr El Gedeeda	7.5	18.3	13.4	16.5	1.5	7	31.2	18.9	16.3	21.3	43.7	55.8	47.9	25.4	12.7	15.1	31.2	7.1	390.9
12	Nasr City	7.3	19.7	17.5	13.5	1.8	11	29.3	10.4	15.7	17.9	58	252.3	35.9	23.3	25.5	9.2	47.1	3.6	599
13	Ain Sham	12.9	2	7.8	5.7	0.8	5.7	16.6	2.9	11.8	6.5	50.4	34.3	51.5	21.8	3.6	2.4	24	10.4	271.1
14	Salam City	4.8	0.7	4.1	2.8	0.3	3	3.9	3.4	8.1	6.2	28.2	20.5	24.1	8.5	2.2	1.1	23.6	4.5	150.2
15	Shobra El Kheima	14.5	3	2.4	4.9	0.1	4.7	1.2	4.2	5	26.2	13.1	26.7	3.1	2	31.1	15.6	18.6	9.6	186.1
16	Qalyob	8.4	1.7	3.6	3.2	0.2	2.7	1.4	2	5	9.2	13.5	9.2	2.4	1.7	16.9	29.3	21	6.9	138.4
17	Qanater	5.9	1.8	4.3	2.8	0.1	1.5	1.2	2.4	8.3	22.5	26.1	45.6	25.4	24.3	19.7	20.7	20.3	16.2	249
18	10th of Ramadan	2.5	2.3	2.7	1.4	0.5	1.3	9.2	2	1.4	5.8	7.4	4.7	11.6	4.7	8.4	7.1	16.2	8.7	97.9
	Total	458.4	291.8	317.3	516	25.6	147.8	326.9	182.5	171.8	202.9	392.9	609.1	267.7	148.8	183.4	140.2	249.4	97.5	4,730.0

Source: JICA Study Team

Table 2-55 Rail Mode Origin and Destination Matrix by Sector Zone in Year 2050 Alternative 1 North Extension
(unit: thousand trips per day)

O	D	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	Total
1	6th of October	370.1	65.4	45.7	96.2	8.6	9.6	20.5	9.9	7	13.1	11.6	9.3	14	4.4	19.6	13.1	9.5	3.6	731.3
2	Imbaba Markaz	65.4	281.6	92.2	73.1	1.3	15.9	9.6	9.1	15.6	7.5	21.7	22	2.8	1.7	4.1	2.3	2.3	3.3	631.4
3	Dokki	42.2	87.2	90.9	70.3	0.9	12	9.3	9.3	13.2	8.8	15.1	33.1	7.7	5.2	5	4.7	4.5	2.6	421.9
4	Giza	97.4	77	70.1	353.4	6.9	15.9	35.2	15.5	15	16.6	20	18	8	3.6	5.9	4.5	6.5	1.4	771
5	South Giza	8.6	3.6	0.9	7.3	30.8	0.7	1.2	0.6	0.4	0.5	1.3	1.8	0.8	0	0.1	0.1	0.2	0.6	59.7
6	Helwan	10.1	14.7	9.4	17.8	0.9	269.4	107.5	13.3	12.4	7.8	11.4	15.9	6.7	3.1	5.6	3	3.1	1.1	513.2
7	Maadi	23.5	8.6	9.4	37.4	1.1	106.3	182	46	20.2	12.9	41.2	31.2	18.6	4.2	2.1	1.5	1.8	7.4	555.3
8	Khaleafa	9.2	7.8	8.7	15.2	0.3	16.6	47	71	13.7	5.8	19	11.1	4.1	3.9	5.2	2.1	3.5	2.3	246.4
9	CBD	6.6	15.7	12.5	14.5	0.5	11.7	20.3	13.8	13.1	16	20.2	16	15.1	9	8.2	6	12.6	1.3	213
10	Shobra	12.5	7.8	7.8	16.5	0.6	6.9	13.5	6.8	16.5	69.2	35.9	22.9	11.3	9	38.7	12.1	26.7	6.5	321.3
11	Masr El Gedeeda	10.1	26.3	15.9	20.9	1.6	10	37.5	19.3	20.4	33.2	80.3	59.3	62.2	30	20.5	17	49.9	6.9	521.2
12	Nasr City	8.9	24.7	17.4	14.8	2	14.4	32.1	10.2	16.4	22.7	62.7	252.7	39.7	24.7	38.4	10.2	58.3	4.4	654.7
13	Ain Sham	16.1	3.1	9.4	7.6	0.9	7.2	22.7	3.6	14.4	10.6	65.6	37.5	104.6	26.1	7.4	3.4	40	9.7	389.7
14	Salam City	5.6	1.3	4.7	3.4	0.4	4.9	4.5	3.7	9.2	8.2	33.1	21.6	29.1	34.6	3.5	1.5	32.7	4.1	205.9
15	Shobra El Kheima	20.8	4.7	3.9	8.2	0.1	6	2	5.2	7.8	41.1	21.9	38.6	6.7	3.4	133.5	21.4	35.8	10.4	371.6
16	Qalyob	10.7	2.5	4.3	4	0.2	3.3	1.8	2.2	5.9	11.9	15.5	10.3	3.3	2.2	23.2	113.4	27.6	6.3	248.5
17	Qanater	10.5	6.1	6.5	4.8	0.2	2.6	2.3	3.7	11.9	29.9	42.3	56.6	41.3	33.9	38	27.2	438.7	19.2	775.7
18	10th of Ramadan	3.6	2.7	2.5	1.3	0.5	1.2	8.3	1.9	1.3	5.5	7.1	5.2	11.1	4.3	9.2	6.4	19.2	86	177.2
	Total	731.8	640.8	412.1	766.6	57.8	514.5	557.2	245	214.4	321.2	525.9	663.1	387	203.1	368.2	250.1	773	177.1	7,808.9

Source: JICA Study Team

Table 2-56 Rail Mode Origin and Destination Matrix by Sector Zone in Year 2050 Alternative 2 East Extension
(unit: thousand trips per day)

O	D	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	Total
1	6th of October	370.1	65.4	45.7	96.2	8.6	9.6	20.5	10.4	6.9	12.9	10.9	9.5	13.5	4.4	16.8	13	9.2	3.6	727.4
2	Imbaba Markaz	65.4	281.6	92.2	73.1	1.3	15.9	9.6	8.9	15.6	7.5	23	24.3	2.7	1.7	3.8	2.3	2.3	3.3	634.5
3	Dokki	42.2	87.2	90.9	70.3	0.9	12	9.3	9.6	13	8.5	15.5	36.6	7.5	5.2	3.9	4.7	4.4	2.6	424.1
4	Giza	97.4	77	70.1	353.4	6.9	15.9	35.2	15.7	14.7	15.7	20.2	19.6	7.7	3.6	4.5	4.5	6.3	1.4	769.9
5	South Giza	8.6	3.6	0.9	7.3	30.8	0.7	1.2	0.6	0.4	0.5	1.4	1.9	0.8	0	0.1	0.1	0.2	0.6	59.8
6	Helwan	10.1	14.7	9.4	17.8	0.9	269.4	107.5	13.4	12.4	7.8	11.4	16.9	6.6	3.1	5	3	3	1.1	513.5
7	Maadi	23.5	8.6	9.4	37.4	1.1	106.3	182	46.8	20.4	12.5	40.9	34.1	17.3	4.2	1.7	1.5	1.8	7.4	556.6
8	Khaleafa	9.6	7.9	9	15.3	0.3	16.6	47.7	74.3	16.4	6.2	21.7	13.3	4.1	4.1	4.9	2.2	3.5	2.3	259.4
9	CBD	6.6	15.8	12.4	14.2	0.5	11.7	20.4	16.6	13	15.4	18.9	17.8	14.4	9	6	6	12.4	1.3	212.4
10	Shobra	12.3	7.8	7.5	15.6	0.6	6.8	13.2	7.1	15.8	65.6	33.7	25.2	9.3	8.9	31.9	11.8	26	6.4	305.6
11	Masr El Gedeeda	9.6	27.6	15.9	21	1.7	10.1	37.3	22	19.2	31.3	69.9	66.3	57.1	29	14.8	17.7	49.4	6.8	506.5
12	Nasr City	9.1	27.3	20.3	16.4	2.1	15.4	34.9	12.3	18.4	25	69.4	403.5	41.4	26.3	30	10.7	59.3	4.4	825.8
13	Ain Sham	15.6	3	9.2	7.3	0.9	7.1	21.4	3.5	13.6	8.9	60.3	39.4	99.6	25	4.4	3	36.7	9.4	368.2
14	Salam City	5.6	1.3	4.7	3.4	0.4	4.9	4.5	3.9	9.2	8	32.3	23.2	27.6	34.6	2.7	1.4	32.7	4.1	204.3
15	Shobra El Kheima	17.9	4.4	2.9	6	0.1	5.3	1.6	5	5.8	33.3	15.5	31.3	3.8	2.5	118.5	18.5	24.7	8.6	305.8
16	Qalyob	10.6	2.5	4.3	4	0.2	3.3	1.7	2.2	5.9	11.6	16.1	10.8	2.9	2.1	20	111	24.6	6.2	240.2
17	Qanater	10.3	6.1	6.4	4.7	0.2	2.6	2.2	3.8	11.7	28.9	41.4	57.5	37.9	33.9	26.1	24.4	438.7	19.1	755.7
18	10th of Ramadan	3.6	2.7	2.5	1.3	0.5	1.2	8.3	1.9	1.3	5.5	7	5.3	10.7	4.3	7.6	6.4	19	86	175
	Total	727.9	644.5	413.7	764.5	57.9	514.8	558.5	257.9	213.8	304.8	509.7	836.4	365	201.7	302.8	242.2	754.2	174.8	7,844.9

Source: JICA Study Team

2.6 Estimation of Present and Future Metro Passengers

The trip assignment stage gives the exact number of metro passengers by distributing the rail mode demand matrix on the rail mode network. This stage is done by JICA STRADA system.

2.6.1 Metro Passengers by Line No.

Table 2-57 and Table 2-58 explain the number of passengers of metro by lines, each year. (Note that the number of passengers for Metro Line 4 includes both for phase 1 and phase 2 sections). For Metro Line 4 alternative 1, the total passenger volume is expected to be 5.36 million per day, which is the same for alternative 2. However the passenger volumes on Metro Lines 1 and 2 are lower than alternative 2, because the alignment of Metro Line 4 phase 2 section runs along the northern corridor where Metro lines 1 and 2 also compete. In Metro Line 4 alternative 2, the passenger volumes of Metro Line 4 is bigger than alternative 2, but its phase 2 section is in conflict with Metro Line 3. It is also noted that the demand of Metro Line 3 is very low, as compared with alternative 1.

The demand for Metro Line 1 in 2050 surpasses the design capacity. This result suggests improving the capacity or installing new public transportation service in this area.

Table 2-57 Summary of Metro Daily Demand (Metro Line 4 Alternative 1 North Extension)

Year		Metro Line 1	Metro Line 2	Metro Line 3	Metro Line 4	Total
2008	No. of Passengers (Station Boarding / Alighting)	1,237,000	977,000			2,214,000
	Section Maximum Passengers per hour per direction	54,100	42,200			
2027	No. of Passengers (Station Boarding / Alighting)	2,105,000	1,381,000	1,686,000	1,968,000	3,964,000
	Section Maximum Passengers per hour per direction	62,100	36,300	59,100	53,100	
2050	No. of Passengers (Station Boarding / Alighting)	2,704,000	1,821,000	2,087,000	2,347,000	5,362,000
	Section Maximum Passengers per hour per direction	64,600	42,800	67,400	55,700	

Source: JICA Study Team

Table 2-58 Summary of Metro Daily Demand (Metro Line 4 Alternative 2 East Extension)

Year		Metro Line 1	Metro Line 2	Metro Line 3	Metro Line 4	Total
2008	No. of Passengers (Station Boarding / Alighting)	1,237,000	977,000			2,214,000
	Section Maximum Passengers per hour per direction	54,100	42,200			
2027	No. of Passengers (Station Boarding / Alighting)	2,131,000	1,452,000	1,487,000	1,814,000	4,017,000
	Section Maximum Passengers per hour per direction	63,000	39,100	40,000	40,300	
2050	No. of Passengers (Station Boarding / Alighting)	2,700,000	1,896,000	1,904,000	2,360,000	5,365,000
	Section Maximum Passenger per hour per direction	63,600	44,000	44,000	53,000	

Source: JICA Study Team

2.6.2 Station and Section Passengers for Metro Line 4 Phase 1

Table 2-59 and Table 2-60 show the detailed demands, station passengers, section passengers and per hour per direction (phpd) demands on the maximum loaded section. The demand of Metro Line 4 phase 1 surely considers the passengers from/to the phase 2 section and 6th October line section. The peak rate is assumed as 14%. The maximum loaded section during peak hour appears to be in the section between station No. 4 (Giza Square) and station No. 5, which is true for both alternative 1 and alternative 2 cases.

Table 2-59 Detailed Metro Demands for Metro Line 4 Phase 1 (To/From Phase 2 Alternative 1 North Extension)

Station No	Year 2027			Year 2050		
	Station Passengers	Section Passengers	phpd	Station Passengers	Section Passengers	phpd
(Phase 2)						
↓↑		356,000	24,920		414,100	28,990
Phase 1 Station No. 1	53,700			63,500		
Transfer Line 1 / Line 4	187,900			222,300		
↓↑		378,900	26,520		444,700	31,130
Phase 1 Station No. 2	24,800			29,800		
↓↑		368,000	25,760		432,700	30,290
Phase 1 Station No. 3	27,000			32,600		
↓↑		375,400	26,280		441,900	30,930
Phase 1 Station No. 4	180,700			245,400		
Transfer Line 2 / Line 4	261,200			355,900		
↓↑		580,000	40,600		761,800	53,330
Phase 1 Station No. 5	42,000			52,100		
↓↑		570,000	39,900		751,800	52,630
Phase 1 Station No. 6	63,000			78,200		
↓↑		566,400	39,650		743,300	52,030
Phase 1 Station No. 7	137,400			175,500		
↓↑		557,500	39,030		735,400	51,480
Phase 1 Station No. 8	91,600			117,000		

↓↑		537,500	37,630		715,400	50,080
Phase 1 Station No. 9	69,900			84,000		
↓↑		509,000	35,630		679,600	47,570
Phase 1 Station No. 10	115,800			168,300		
↓↑		462,400	32,370		617,800	43,250
Phase 1 Station No. 11	47,000			81,400		
↓↑		434,000	30,380		578,000	40,460
Phase 1 Station No. 12	52,400			63,100		
↓↑		398,700	27,910		538,500	37,700
Phase 1 Station No. 13	80,700			187,400		
↓↑		365,100	25,560		442,800	31,000
(6th October Line)						

Source: JICA Study Team

Table 2-60 Detailed Metro Demands for Metro Line 4 Phase 1 (To/From Phase 2 Alternative 2 East Extension)

Station No	Year 2027			Year 2050		
	Station Passengers	Section Passengers	phpd	Station Passengers	Section Passengers	phpd
(Phase 2)						
↓↑		402,500	28,180		502,100	35,150
Phase 1 Station No. 1	98,500			116,300		
Transfer Line 1 / Line 4	344,800			407,000		
↓↑		394,300	27,600		470,100	32,910
Phase 1 Station No. 2	25,100			30,200		
↓↑		383,100	26,820		457,700	32,040
Phase 1 Station No. 3	26,700			32,300		
↓↑		390,700	27,350		467,000	32,690
Phase 1 Station No. 4	196,800			264,900		
Transfer Line 2 / Line 4	284,400			384,300		
↓↑		575,200	40,260		757,400	53,020
Phase 1 Station No. 5	41,900			52,000		
↓↑		565,200	39,560		747,400	52,320
Phase 1 Station No. 6	62,800			78,000		
↓↑		562,000	39,340		739,200	51,740
Phase 1 Station No. 7	137,600			176,300		
↓↑		552,600	38,680		729,900	51,090
Phase 1 Station No. 8	91,800			117,600		
↓↑		532,600	37,280		709,900	49,690
Phase 1 Station No. 9	68,700			83,100		
↓↑		505,300	35,370		675,100	47,260
Phase 1 Station No. 10	115,800			168,500		
↓↑		458,600	32,100		613,200	42,920
Phase 1 Station No. 11	47,000			81,500		
↓↑		430,300	30,120		573,400	40,140
Phase 1 Station No. 12	51,700			62,400		
↓↑		395,600	27,690		534,600	37,420
Phase 1 Station No. 13	81,200			188,500		
↓↑		361,500	25,310		437,700	30,640
(6th October Line)						

Source: JICA Study Team

2.7 Conceptual Analysis of Bus Feeder Service and Transit Facility Plan

Any mass transit system relies heavily on feeder transport to provide it with an adequate level of ridership. In Cairo, metro passengers will choose from among the following alternative means of travel between their homes and metro stations (and vice versa):

- Walking
- Private car
- Taxi
- Shared taxi, and
- Small bus

There are other alternatives, such as motorcycles or bicycles, which have been excluded here owing to their doubtful relevance to local conditions in Cairo.

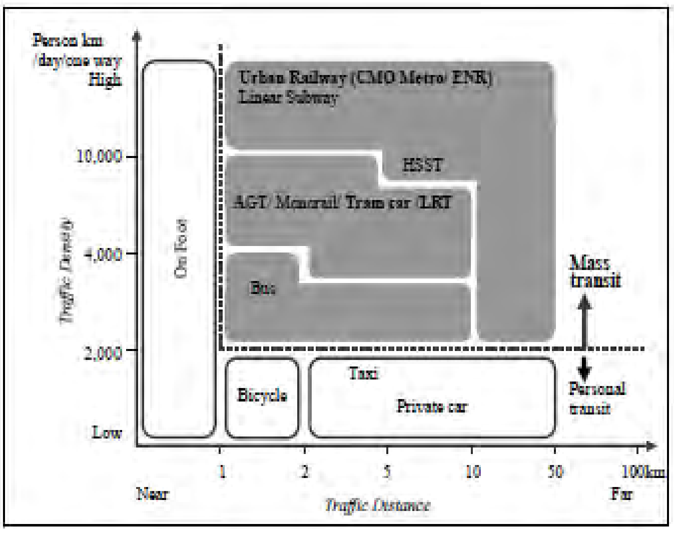
This section considers the main factors for determining the types and scale of feeder transport and modal interchange facilities which must be provided for Metro Line 4. The analysis does not involve a detailed assessment of passenger arrival and departure patterns at stations, since at the time of writing, the ridership forecasts on which such an assessment will rely have yet to be finalized. Instead, it is more of a conceptual assessment which considers the following:

- Main factors involved in making modal choice decisions for feeder transport
- Overall conceptual design of modal interchange facilities for feeder transport at different categories of station along the metro route
- Methods and approach for determining the modal interchange facilities required at terminal and other major stations, as well as the pick-up and set down facilities for feeder transport at other (ordinary) metro stations
- "Soft infrastructure" or institutional changes needed for better integration of metro and feeder transport. These will comprise changes to the organization of feeder services, their regulation, their scheduling and their fare structures.

2.7.1 Modal Choice Decisions for Feeder Transport

Modal choice decisions for feeder transport will be made in relation to distance, travel time, convenience and cost.

The effect of modal choice decisions for feeder transport is reflected in the relationship between traffic density and distance in the choice of mode, both for main trips and feeder trips, as shown in Figure 2-54.



Source: SDMP study report

Figure 2-54 Choice of Transport Mode Reflected in Relationship between Traffic Density and Distance

The diagram evidently indicates that people will choose to walk to metro stations if the distance is one kilometre or less. This is considered to be a realistic assumption for the planning of feeder transport facilities and services in Greater Cairo. In the case of longer feeder trip distances, say 1-3 km, it is likely that shared taxis (microbuses) will be the preferred form of feeder transport. In the special case of longer trips (greater than 3 km) to and from stations at the terminal ends of the metro, it is likely that large buses and private cars will be the preferred forms of feeder transport.

2.7.2 Overall Conceptual Design of Modal Interchange Facilities

The design of stations along the route of Metro Line 4 will need to incorporate facilities for the transfer of passengers between road transport vehicles and the metro concourse and platforms (and vice versa). These facilities may be classified into two types:

- ***Full modal interchange facilities*** at, or near, the terminal stations and possibly at one or two major intermediate stations
- ***Pick-up and set-down facilities*** at all other stations not having sufficient demand for major interchange facilities

(1) Modal Interchanges for Terminal Stations

Essential features of the large modal interchange stations to be provided mainly at or near the terminal stations will include multi-level car parks and off-road parking bays for buses, taxis, and shared taxis.

The provision of multi-level car parks or park and ride facilities at or near the terminal stations will be an important strategy to encourage private cars travelling long distance traffic to take the metro. The concept would be similar to that employed in the design of the Blue Line underground metro in Bangkok as one of the examples.[6] Since the opening of the park and ride facilities and the meteoric increase in fuel prices in 2008, the Blue Line succeeded in attracting a substantial volume of private car owners coming from the outer suburbs of Bangkok to use the metro.

In the case of the western end of the Metro Line 4 route, it might be expected that car traffic originating from the 6th October area and in other areas along Alexandria Road will prefer to take the metro services if adequate car parking facilities are provided near the strategic road intersections. There is a reason to believe that said facilities provided at the terminal ends of the Phase 2 northern or eastern routes would have similar benefits in terms of car users opting to travel through the metro.

In addition to car parking (park and ride) facilities, the modal interchanges will need to provide diagonal parking bays for large and small buses, as well as lay-by[7] facilities for private cars, taxis and shared taxis.

JICA Study Team has developed conceptual layout plans for two types of modal interchange terminal: one for a large underground terminal (El Remayah Square) and another for an above ground terminal (El Giza Station). While these facilities will be of different size, the same facilities (park and ride for cars and parking bays for other road transport) will apply to both types.

a) Underground Modal Interchange Facility

A conceptual layout for a large modal interchange facility has been developed for the proposed El Remayah Square Station, as shown in Figure 2-55 below. This station has an important strategic location at the intersection of the Alexandria Desert Road (providing access to the ring road and all points to the north), and Fayoum Road (which connects with 6th October City). The station will be an integral part of the El Remayah Square redevelopment project, an underground road tunnel, which is proposed for construction at said locations.

The significance of this layout is that government regulations related to buildings and land use in this highly significant tourist area prohibits building large structures

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[6] The Blue Line, which entered service in 2004, incorporates a main multi-level car park ,with space for 2,000 cars, at Lad Phrao metro station which is the fourth station from the northern terminal station at Bang Sue. This location was chosen as it is at the intersection of two important access roads to the city of Bangkok, providing access to the eastern suburbs (Lard Phrao Road) and the northern and western suburbs (Ratchadapisek Road) respectively. Another park and ride facility is provided at the Thailand Cultural Centre station (an intermediate station), while smaller car parking facilities are provided at another three stations, including Sam Yan, which is the second station from the southern terminal station at Hua Lompong.

[7] A “lay-by” is a designated paved area beside a main road where cars can stop temporarily (Free Online Dictionary).

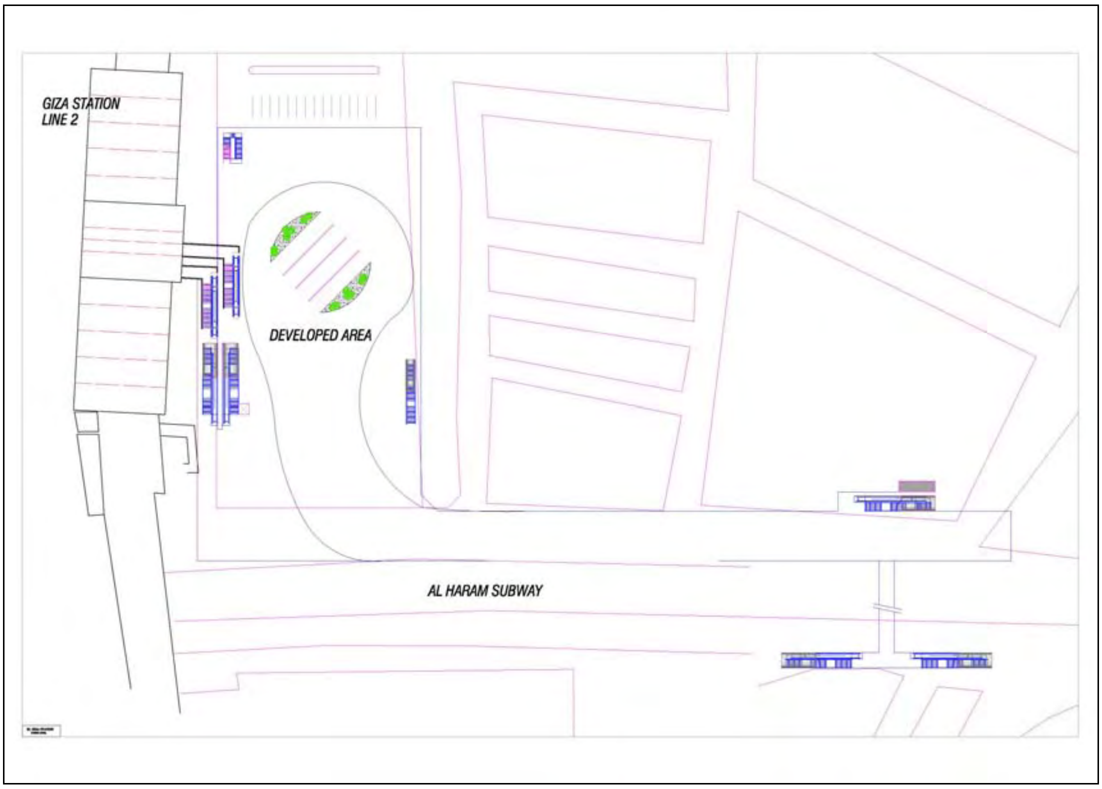
above ground. Hence, the modal interchange facility will have to be built underground. It is proposed to be constructed above the level of the road tunnel, which is consequently above the level of the metro tunnel. Underground pedestrian access would be provided above the level of the road tunnel to connect the station concourse to the commercial areas, car parking facilities and the bus terminal at its immediate upper levels. The entire complex will be constructed in a circular pattern, with multi-level car parking provided at the outer segment, and bus bays and feeder transport drop-off and pick-up points at the inner segments. Road vehicles exiting the interchange terminal would be provided with bi-directional access to the Fayoum Road Tunnel at its immediate lower level.

Source: JICA Study Team

Figure 2-55 Concept drawing of El Remayah Station, showing the layout of Underground "park and ride" and modal interchange facilities

b) Aboveground Modal Interchange Facility

A conceptual layout has been developed for an aboveground modal interchange terminal at the El Giza Station which Metro Line 4 would share with Metro Line 2 and the ENR. The site of this terminal is currently used for bus parking, but would be redeveloped to provide multi-level car park, as well as for improved bus and taxi parking facilities. The site is facing Pyramids Road and will be provided with bidirectional access to this road in the future. Similar to El Remayah Square terminal, the El Giza facility will have a circular layout, with taxi and shared taxi facilities provided at the centre of the layout, and bus parking facilities around its circumference (see Figure 2-56). A multi-level car park would be behind the traffic circular layout. Pedestrian access and egress between the terminals and stations would be provided for Metro Line 4 by means of escalators and an underground walkway. Meanwhile, escalators and a pedestrian overpass will be provided for Metro Line 2 and ENR stations.



Source: JICA Study Team

Figure 2-56 Concept Drawing of El Giza Station, Showing the Layout of Above-ground "Park and Ride" and Modal Interchange Facilities

The type of layout envisaged for the modal interchange at El Giza Station may also be suitable for the terminal ends of the Phase 2 alternative routes, near the Ring Road on the northern route and near New Cairo on the eastern route.

(2) Pick-up and Set-down Facilities for Other Stations

In the case of other, or ordinary stations, many of which are expected to attract smaller passenger volumes than the terminal stations. The concept design of feeder transport facilities will involve the provision of lay-bys, or dedicated road lanes, for loading and unloading passengers from feeder buses, shared taxis, taxis and private cars. These transit facilities will be located at both sides of the primary road, near the station entrances, as shown in Figure 2-57.

Source: SDMP study report

Figure 2-57 Plan Arrangement of "Pick-up and Set-down" Facilities for Feeder Transport at Ordinary Stations

Areas allocated for boarding and alighting buses, shared taxis, and private cars will be located within the kerb-side (stopping) lane, since the stopping time will be short at ordinary stations, due to the comparatively light demand. By contrast, the areas allocated for boarding and alighting taxis will be separate because taxis will require space to wait for passengers. One traffic lane each for stopping and passing will be provided at both sides of the primary road. Sidewalks along the primary road in front of the station entrances will have a width of not less than 5 metre to accommodate waiting spaces and seats for passengers.

While this diagram illustrates the concept design of the feeder lay-by facilities to be provided at ordinary stations, it must be noted that the length of these facilities will vary from station to station depending on the level of the passenger demand forecast at each station.

2.7.3 Methods and Approach for Determination of Feeder Transport Requirements

The scale of feeder transport facilities to be provided along Metro Line 4 will depend on the level of peak passenger demand (in terms of the peak pattern of feeder passenger arrivals and departures) which is forecasted for each station in the year 2050, or in earlier years if phased development of these facilities is desired.

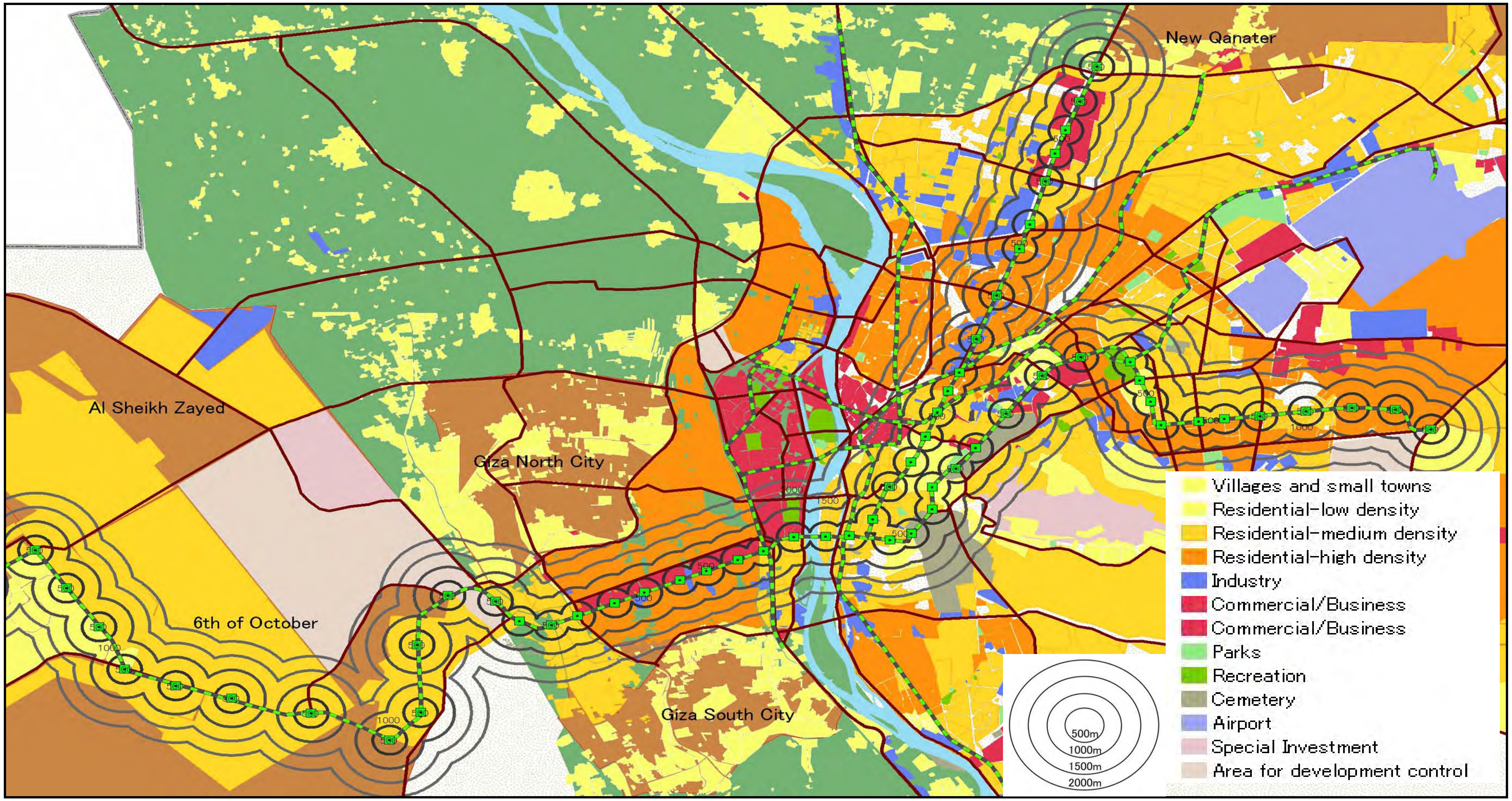
The first step in the planning of feeder transport facilities is to estimate the distribution of passenger demand around each station. This may be done by superimposing on a land use map circles, varying radii around each station location. The radii may be chosen to represent the distance limits applicable to each type of feeder trip. For example, the inner most circles will have radii of 500 and 1,000 metre to represent walking trips to and from the station. Another example are trips by feeder bus and shared taxi represented by circles with radius of 1-3 km or more, and so on. The distribution of forecasted passenger demand by feeder trip length would then be considered for each station location.

The methodology involved in estimating the distribution by feeder trip distance of the forecasted demand for each station is illustrated in Figure 2-58 and Figure 2-59. The former shows the picture for the whole line, including the Phase 2 alternative routes, while the latter shows Phase 1 route in more detail.

Although the passenger demand forecasts are not yet available, the likely density of demand around the stations can be assessed from the land use categories applicable in the surrounding areas. For example, it can be seen that demand is likely to be particularly heavy for stations in the eastern section of Phase 1 route; the central section of the Phase 2 alternative 1 route; and the eastern half of the Phase 2 alternative 2 route, since these sections pass through areas which have been designated for high density residential development.

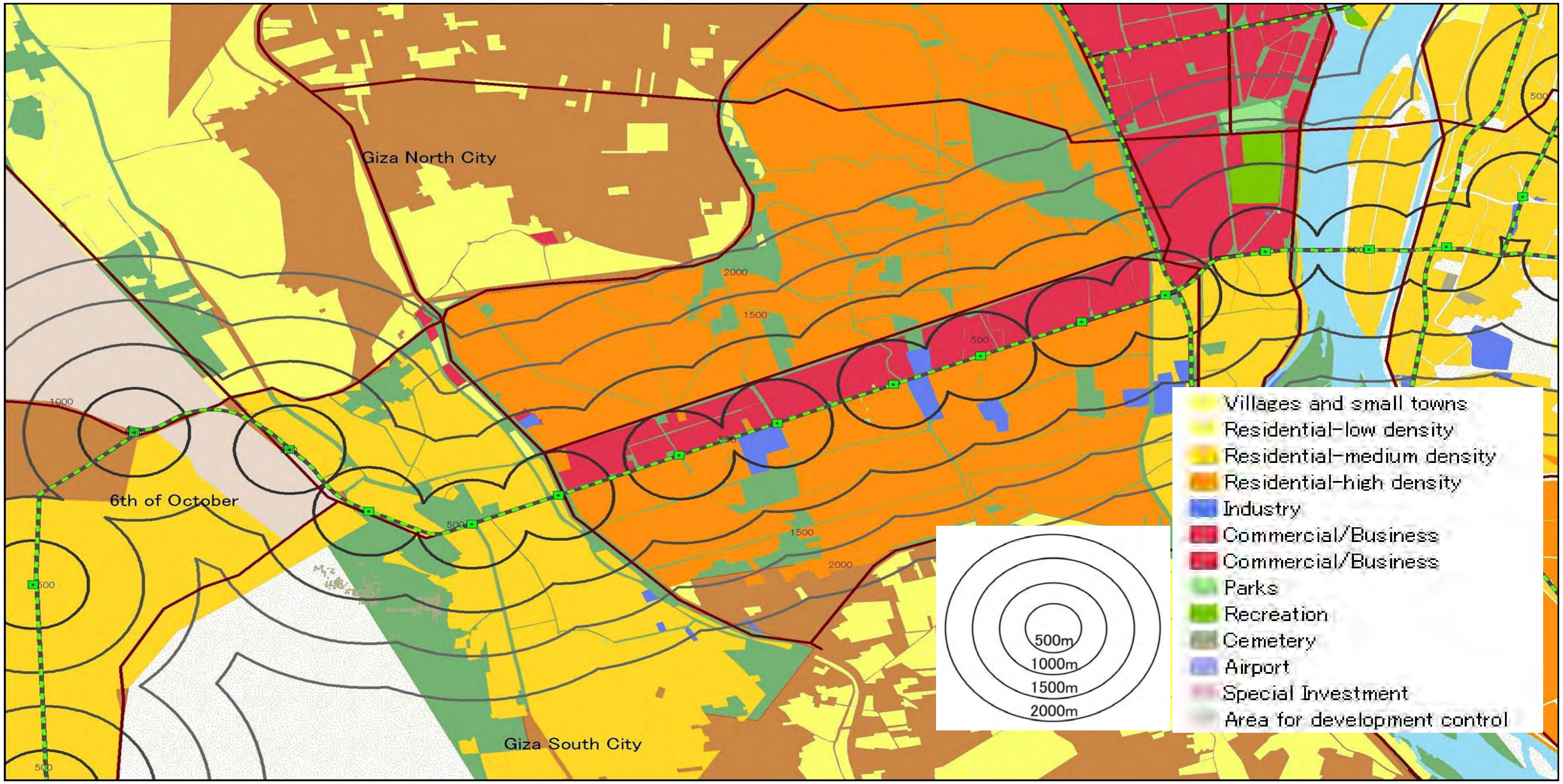
Once the distribution of demand by feeder trip distance has been determined for each station, planning factors may be used to determine the level of capacity and scale of the feeder transport facilities to be provided at each station location.

The feeder facility planning factors recommended in the SDMP report are given in Table 2-61, for a modal interchange facility at the Central Station, and in Table 2-62 for pick-up and set-down facilities at ordinary stations. These planning factors were derived from guidelines issued by the Japan Transportation Planning Association (1998).



Source: JICA Study Team

Figure 2-58 Distribution of Passenger Demand Forecast by Feeder Trip Distance (Entire Route of Metro Line 4)



Source: JICA Study Team

Figure 2-59 Distribution of Passenger Demand Forecast by Feeder Trip Distance (Metro Line 4 Phase 1 route)

Table 2-61 Planning Factors for Determining Requirement of Feeder Transport Facilities at Major Stations

No	Item	Formula	Q'ty
[1]	Passengers at the central station[1)]	-	76,600persons/day
[2]	Total number of visitors at the station square[2)]	[1] x1.5	114,900persons/day
[3]	Visitors for buses	[2] x share for buses (0.12)	13,788 persons /day
[4]	Visitors for taxes	[2] x share for taxes (0.01)	1,149 persons /day
[5]	Visitors for shared taxes	[2] x share for shared taxis (0.27)	31,023 persons /day
[6]	Visitors for private cars	[2] x share for private cars (0.02)	2,298 persons /day
[7]	Visitors for walk and bicycles	[2] x share for walk and bicycles (0.58)	66,642 persons /day
[8]	Boarding passengers at peak time for buses[3)]	[3] x peak factor (0.14) x boarding rate (0.5)	965 persons
[9]	Boarding passengers at peak time for taxes[3)]	[4] x peak factor (0.14) x boarding rate (0.5)	81 persons
[10]	Boarding passengers at peak time for shared taxes[3)]	[5] x peak factor (0.14) x boarding rate (0.5)	2,172pers.
[11]	Alighting passengers at peak time for buses[3)]	[3] x peak factor (0.14) x boarding rate (0.5)	965 persons
[12]	Alighting passengers at peak time for taxes[3)]	[4] x peak factor (0.14) x boarding rate (0.5)	81 persons
[13]	Alighting passengers at peak time for shared taxes[3)]	[5] x peak factor (0.14) x boarding rate (0.5)	2,172 persons
[14]	No of boarding platforms for buses[4)]	[8] ÷ 30 passengers per bus÷ no. of departing buses per berth (60minutes/5minutes interval)	3berths (2.6)
[15]	No of boarding platforms for taxes	[9] ÷ 1.2passengers per taxi x time for boarding (10/60 minutes)÷60 minutes	1berth (0.2)
[16]	No of boarding platforms for shared taxes[4)]	[10] ÷ 12passenger per share taxi ÷no. of departing taxes per berth (60minutes/4minutes interval)	13berths (12.1)
[17]	No of alighting platforms for buses	[11] x time for alighting (2/60minutes) ÷ 60minutes	1berth (0.5)
[18]	No of alighting platforms for taxes	[12] ÷1.2passengers per taxi x time for alighting (30/60minutes) ÷ 60minutes	1berth (0.6)
[19]	No of alighting platforms for shared taxes	[13] x time for alighting (2/60minutes) ÷ 60minutes	2berths (1.2)
[20]	No of platforms for private cars[3)]	[6] x peak factor (0.14)÷ 1.2passengers per car x time for stopping per car (1minute) ÷60minutes	5berths (4.5)

Source: Planning guideline for station squares, Japan Transportation Planning Association, 1998
Note 1) Number of alighting and boarding per day at station No. 22 in 2027
Note 2) Coefficient in assumption
Note 3) Peak factor based on the actual practices at the existing stations
Note 4) Interval in the peak time

Table 2-62 Planning Factors for Determining Requirement of Feeder Transport Facilities at Ordinary Stations

No	Item	Formula	Q'ty
[1]	Passengers at the central station1)	-	50.000persons/day
[2]	Total number of visitors at the station square2)	[1] x1.2	60,000persons/day
[3]	Visitors for buses	[2] x share for buses (0.06)	3,600persons/day
[4]	Visitors for taxes	[2] x share for taxes (0.01)	600persons/day
[5]	Visitors for shared taxes	[2] x share for shared taxis (0.33)	19,800persons/day
[6]	Visitors for private cars	[2] x share for private cars (0.02)	1,200persons/day
[7]	Visitors for walk and bicycles	[2] x share for walk and bicycles (0.58)	34,800 persons/day
[8]	Boarding passengers at peak time for buses3)	[3] x peak factor (0.14) x boarding rate (0.5)	252persons
[9]	Boarding passengers at peak time for taxes3)	[4] x peak factor (0.14) x boarding rate (0.5)	42 persons
[10]	Boarding passengers at peak time for shared taxes3)	[5] x peak factor (0.14) x boarding rate (0.5)	1,386 persons
[11]	Alighting passengers at peak time for buses3)	[3] x peak factor (0.14) x boarding rate (0.5)	252 persons
[12]	Alighting passengers at peak time for taxes3)	[4] x peak factor (0.14) x boarding rate (0.5)	42 persons
[13]	Alighting passengers at peak time for shared taxes3)	[5] x peak factor (0.14) x boarding rate (0.5)	1,386 persons
[14]	No of boarding platforms for buses4)	[8] ÷ 30 passengers per bus÷ no. of departing buses per berth (60minutes/10minutes interval)	2berths (1.4)
[15]	No of boarding platforms for taxes	[9] ÷ 1.2passengers per taxi x time for boarding (10/60 minutes)÷60 minutes	1berth (0.1)
[16]	No of boarding platforms for shared taxes4)	[10] ÷ 12passenger per share taxi ÷no. of departing taxes per berth (60minutes/5minutes interval)	10berths (9.6)
[17]	No of alighting platforms for buses	[11] x time for alighting (2/60minutes) ÷ 60minutes	1berth (0.1)
[18]	No of alighting platforms for taxes	[12] ÷1.2passengers per taxi x time for alighting (30/60minutes) ÷ 60minutes	1berth (0.3)
[19]	No of alighting platforms for shared taxes	[13] x time for alighting (2/60minutes) ÷ 60minutes	1berth (0.8)
[20]	No of platforms for private cars3)	[6] x peak factor (0.14)÷ 1.2passengers per car x time for stopping per car (1minute) ÷60minutes	3berths (2.3)

Source: Planning guideline for station squares, Japan Transportation Planning Association, 1998

Note 1) Number of alighting and boarding per day at medium-scale stations for average rates including station no.19, 20, etc in 2027

Note 2) Coefficient in assumption

Note 3) Peak factor based on the actual practices at the existing stations

Note 4) Interval in the peak time

2.7.4 Institutional Changes Needed for Better Integration of Metro and Feeder Transport

As noted earlier, metro passengers will consider distance, travel time, convenience, and cost in making their feeder transport choices.

While the provision of adequate feeder transport infrastructure at metro stations will contribute to greater convenience to passengers, the mere existence of such facilities will not guarantee that they will switch from their accustomed modes of transport to the metro.

Worldwide experience on the development of urban mass transit projects shows that ridership maximization depends on the achievement of a high degree of integration between mass transit systems and feeder transport. This integration has to occur at all levels – physical integration (infrastructure linkages), operational integration (services and scheduling), and commercial integration (fares and ticketing). The mass transit systems generally acknowledged as world leaders have all achieved a high level of integration of their infrastructure, operations and fare structures with feeder transport. The most notable examples outside the west are the mass transit systems of Singapore and Hong Kong.

At the core of any plan for feeder services linked to a mass transit system will be a contractual relationship between the mass transit operator and the operators of feeder transport services. Essential features of this relationship will be:

- Linked service scheduling; and
- Integrated ticketing and fare structures

Under their contractual relationship with a mass transit operator, feeder service providers will be committed to provide a specified daily number of services on specific routes. They will also be required to provide service during peak hours.

An integrated ticketing system, under which passengers may purchase a ticket allowing them to travel both on designated feeder services and the mass transit system, is necessary to provide passengers with convenience and low travel cost.

In Cairo, it is reasonable to expect that adequate physical linkages can be provided between the metro systems and feeder transport by incorporating suitable infrastructure in the design of metro projects. However, achievement of the necessary level of operational and commercial integration is a much more difficult prospect. This is largely due to the characteristics of existing public transport services in Greater Cairo.

It must be expected that the majority of feeder services to and from the metro stations along the route of Metro Line 4 will be provided by microbuses, or shared taxis as they are known locally, as well as small 26-seater buses. The fleets of shared taxis and small feeder buses operating throughout Greater Cairo are owned by large numbers of small companies or individual operators. Not only the ownership structure of this industry but also its regulation is highly fragmented. The Cairo governorate regulates privately-operated small bus services, but only within its own territory. While the other governorates comprising the Greater Cairo Region have similar regulatory responsibilities within their territories, there is no consistency among the forms and standards of regulation applied by the various authorities.

In addition, almost by definition, shared taxis do not operate on fixed routes or in accordance with fixed timetables. This, coupled with the lack of any cohesiveness in the ownership and operation of public transport feeder services in Greater Cairo, is a major impediment to the introduction of coordinated feeder and metro services, supported by a system of integrated ticketing for all public transport services throughout the metropolitan area. The introduction of such a system would be the prime requirement for improving the convenience and costs of using feeder transport for short trips to and from the metro, rather than for mainline trips.

It is desirable that the concept of integrated ticketing be also extended with the provision of park and ride facilities at the outer ends of the metro system. The metro operator may charge for the use of these facilities, but users may pay this charge based on the price indicated on their tickets. Alternatively, as adopted in Bangkok for example, passengers avail of discounts on parking charges once they have their parking tickets validated by machines provided in the metro concourse.[8]

Initiatives to integrate the cost of parking into the price of a metro ticket are within the capacity of the metro operator to apply. However, feeder service and fare integration will require a fundamental reform of the structure and regulation of the urban public transport system in Greater Cairo. In particular, government policy initiatives will be required to encourage the highly fragmented minibus and shared taxi industry to form cooperatives. This will empower them to negotiate and establish integrated service and ticketing systems with metro operators.

8 In Bangkok, users of the park and ride facilities receive smart cards on entry and may validate these smart cards after taking their metro trips, in order to qualify for a parking charge of 10 baht for every two hours, as compared with the standard charge of 30 baht.

CHAPTER 3
TRACK ALIGNMENT STUDY FOR PHASE 1 SECTION

CHAPTER 3 TRACK ALIGNMENT STUDY FOR PHASE 1 SECTION

3.1 Basic Concept of Route Selection

The basic concept of route selection for Phase 1 Section is as follows:

- Phase 1 route starts from El Malek El Saleh Station of Metro Line 1 via El Remayah Square and Grand Egyptian Museum (GEM) to the Workshop/Depot near the Military Area in 6th October Governorate.
- The connections with Metro Line 2 and Egyptian National Railway (ENR) station for passenger transfer are considered.
- The access track to the ENR track is considered.
- The distance between stations is around 1 km in terms of train operation and passenger convenience.
- The station is located considering accessibility to and from the various public transport and potential commercial development sites adjacent to the station.
- The existing road space is utilized in order to avoid influence on existing infrastructures and buildings, and to minimize land acquisition.
- In case the route affects the existing structures, appropriate countermeasures will be studied.
- The minimization of the construction cost is considered.
- The minimization of the impact on road traffic during construction is considered.

3.2 Basic Design Parameter Related with Route Selection

The basic design criteria of the alignment have not been established yet. However, the basic design parameters are assumed as follows:

- Minimum radius of curve is 250 m for main tracks, and 1,000 m for stations
- Maximum gradient is 40 ‰ (per mil) for main track, and 2 ‰ for station
- Maximum design speed is 100 km/h and maximum operation speed is 80 km/h
- Maximum cant is 160 mm and maximum cant deficiency is 100 mm

According to these assumed design parameters, the speed restrictions and length of transitional curves for each radius of curves are calculated as follows:

Table 3-1 Speed Restrictions and Length of Transitional Curves

R (m)	Theoritical Cant (mm)	Practical Cant (mm)	Deficiency of Cant (mm)	Speed restriction (km/h)	Transitional Curve Length (m)
	$11.8V^2/R$	$8.26V^2/R$	Cm−Co		
250	260	160	100	75	120
300	260	160	100	80	130
350	260	160	100	90	145
400	260	160	100	95	155
450	260	160	100	100	160
500	235	160	75	100	160
550	215	150	65	100	150
600	195	135	60	100	135
700	165	115	50	100	115
800	145	100	45	100	100
1000	115	80	35	100	80
1200	95	65	30	100	65
1400	80	55	25	100	55
1600	70	50	20	100	50
2000	55	40	15	100	40
3000	35	25	10	100	25
4000	30	20	10	100	20

Source: JICA Study Team

3.3 El Malek El Saleh to El Remayah Square

3.3.1 Basic Policy for Route Selection and Station Location

CREATS (Cairo Regional Area Transportation Study in 2002) report has mentioned the necessity of a new metro line between Giza Plateau area and As Sayyida Zainab District as part of the highly required corridor with mass transit. Based on the CREATS results, SDMP has proposed the route starting from El Malek El Saleh Station (Metro Line 1) passing through Salah Salem St., Giza Square, El Giza Station (Metro Line 2), Pyramids Road, and connecting to the El Remayah Square.

JICA Study Team will select the suitable route with following basic policy of SDMP, as well as take NAT's opinion and requirement into account.

Basic policy from SDMP

- To run through the existing and planned urban areas as much as possible.
- To minimize land acquisition as much as possible.
- To ensure the convenience of passenger transfer between the Metro Line 4 and the existing Metro Lines 1 and 2.
- To minimize landscape effects in the Pyramids areas, the section passing near said areas should be designed as underground.

Requirement from NAT

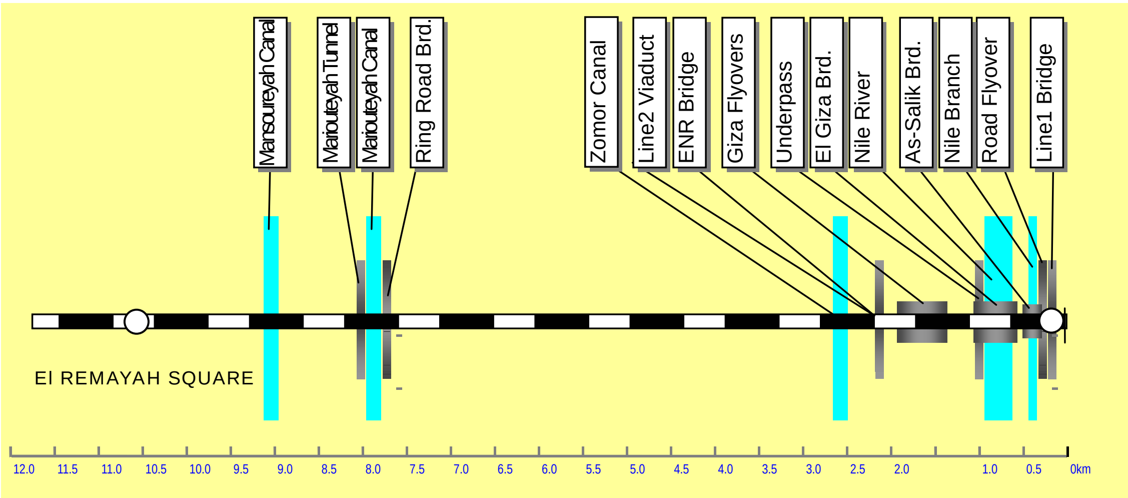
- To place the stations approximately 1 km apart.
- To avoid passing below high rise buildings and Mosques as much as possible.
- Minimum radius is 250 m.
- Direct access with short distance to the other metro lines within the paid area.

- Consideration of comfort and convenience of transferring passengers to and from other public transport.
- Consideration of construction easiness and minimization of cost and social impact.
- Minimization of main public utilities and traffic diversions during construction.
- Minimization of landscape effect for the whole line.
- Not to adopt viaduct structure except at suburban desert area.

3.3.2 Route Selection

(1) Existing Structures and Hazards on the Route

There are some road bridges, flyovers, underpass, railway bridges viaduct, and canals crossing Salah Salem Street and Pyramids Road as shown in Figure 3-1.

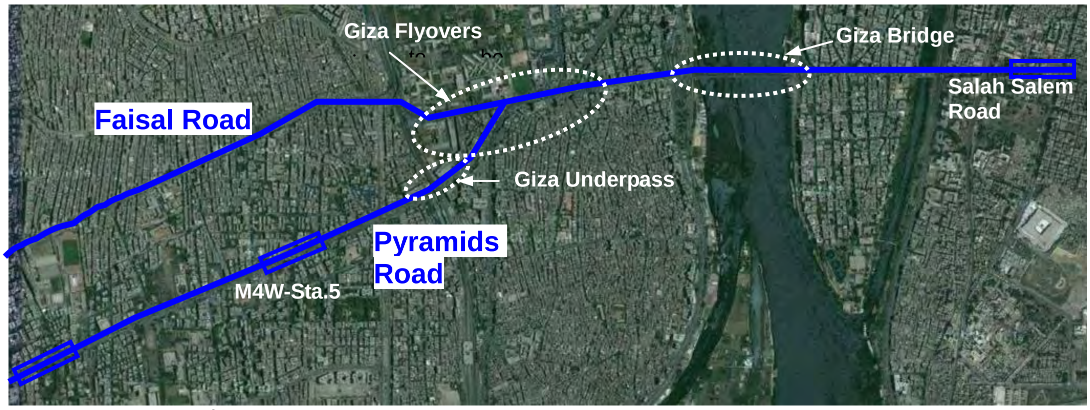


Source: JICA Study Team

Figure 3-1 Main Crossing Structures Between El Malek El Saleh and El Remayah Square

(2) Route Comparison Between PYRAMIDS Road and King Faisal Road

There are two possible routes between Giza Square and El Remayah Square. One is along the Pyramids Road and other is along the King Faisal Road. In order to select the optimum route, study focused on the significant area at Giza Square and the ridership along the street, especially for passenger transfer from Metro Line 2 and ENR. Possible routes are shown in Figure 3-2.



Source: JICA Study Team

Figure 3-2 Possible Routes between El Malek El Saleh and Sta.6

a) Giza Square

Giza Square is one of the congested areas in the central city. This intersection has three main roads with six directions. Furthermore, a flyover is connecting five directions by extending the original structure. Therefore, the layout of the foundation and piles are complicated.

In addition to this, main stations for bus and minibus exist around the Giza Square, as well as taxi pick up and drop off points. This situation caused heavy traffic jam throughout the day, in spite of the existence of the flyover.

Taking into account the above significant situation, JICA Study Team will study how to pass this area with minimum effect on traffic and existing structures during and after the construction.

Source: JICA Study Team

Figure 3-3 Existing Conditions of Giza Square

i) Existing Structures Condition

The flyover, shaded red in Figure 3-3, was originally constructed with steel structure. It was then extended with reinforced concrete structure, shaded blue in the same figure. The following photos are taken under the flyover (Figure 3-4):

Giza Sq.: Northern slope from under the flyover

Giza Sq.: Toward King Faisal Street

Giza Sq.

Figure 3-4 The Flyover

ii) Construction Methodology

Considering the location of existing structures, buildings and road traffic condition, construction of tunnel by cut and cover method at this place seems so difficult. In addition, the track level at this section will be over 30 m deep, as it passes underneath the Nile River before reaching this section. Therefore, the tunnel should be constructed using shield tunnelling method.

In case the route passes from Salah Salem Street to King Faisal Street, it needs to consider the underpinning of all the existing foundations of these flyovers and after that Tunnel Boring Machine (TBM) will proceed in demolishing these foundations.

On the other hand, in case the route passes along the Pyramids Road, the tunnel can be constructed along the south side of the flyover. It will cross only part of the flyover as it passes underneath the Salah Salem Street. Therefore, it will involve less additional works, such as injection and underpinning works as compared to that along the King Faisal route.

JICA Study Team will recommend the route along the Pyramids Road from the viewpoint of construction. More details of the construction method will be provided in *Volume 3*.

iii) Connection of Metro Line 2

The existing El Giza Station (Metro Line 2) is located at the cross point of Pyramids Road which is an important transfer station to and from bus and minibus. If the Pyramids Road route is selected, Metro Line 4 station can be constructed adjacent to the existing station with smooth connection between Metro Line 2 and other public transport.

In case the King Faisal Street route is selected, a new station for Metro Line 4 will be far from the existing Faisal Station (Metro Line 2), which is nearly 300 m away from the King Faisal Street. Moreover, King Faisal Street will pass through the Metro Line 2 with a steeply curved flyover. Thus, it is hard to find appropriate station location for smooth access to and from the existing road as well as existing station. In addition to this, there is a canal named Zomor under the crossing road which will require certain amount of land acquisition, and station will be inside the curve section.

JICA Study Team will recommend the route along the Pyramids Road from the viewpoint of connection with Metro Line 2 and other public transport.

Source: JICA Study Team

Figure 3-5 Location of Faisal Station and El-Giza Station on Metro Line 2

b) Ridership

i) Existing Condition

[Pyramids Road] : This is a main road connecting Eastern and Western area and well known as a symbolic and tourist road connecting central Greater Cairo and Giza Pyramids area. The width of this road is approximately 35 m, including a pedestrian lane, with straight section from El Giza Station, until the end of the road near the Pyramids area. It is noted that there are some malls, hotels, amusement centres, hospitals and some government buildings along this road.

Source: JICA Study Team

Figure 3-6 Current Condition of Pyramids Road

[King Faisal Street]：This street complements Pyramids Road, which runs parallel, 500 m to the north side of said road. Traffic volume on this street is almost same as Pyramids Road. Minibuses and private cars mainly take this route. Its width is approximately 30 m to 35 m. Its pedestrian lane is narrow and at some locations, the said lane is occupied by parked private cars. There are many residential buildings along the street with average of 10 stories. Ground floor is used as commercial space. The traffic accumulation ratio of King Faisal Street is higher than Pyramids Road. Ridership also seems higher at this street.

Source: JCA Study Team

Figure 3-7 Current Condition of King Faisal Street

c) Examination on Environmental and Social Aspects

The characteristics of the current conditions of Pyramids Road and King Faisal Street can be said as follows:

- The width of Pyramids Road is generally wider than that of King Faisal Street, considering the pedestrian sidewalk and side rotaries along the former.
- Accordingly, the average proximity of residential dwellings and other buildings to King Faisal Street is higher than that of Pyramids Road.
- The existing traffic congestion at King Faisal Street is rather high than the Pyramids Road, since the former is functioning more as the trunk for local daily life of the people.

In the context above, the comparison of two roads for preferable alignment of the metro line is summarized below from the viewpoints of environmental and social acceptability or mitigatability.

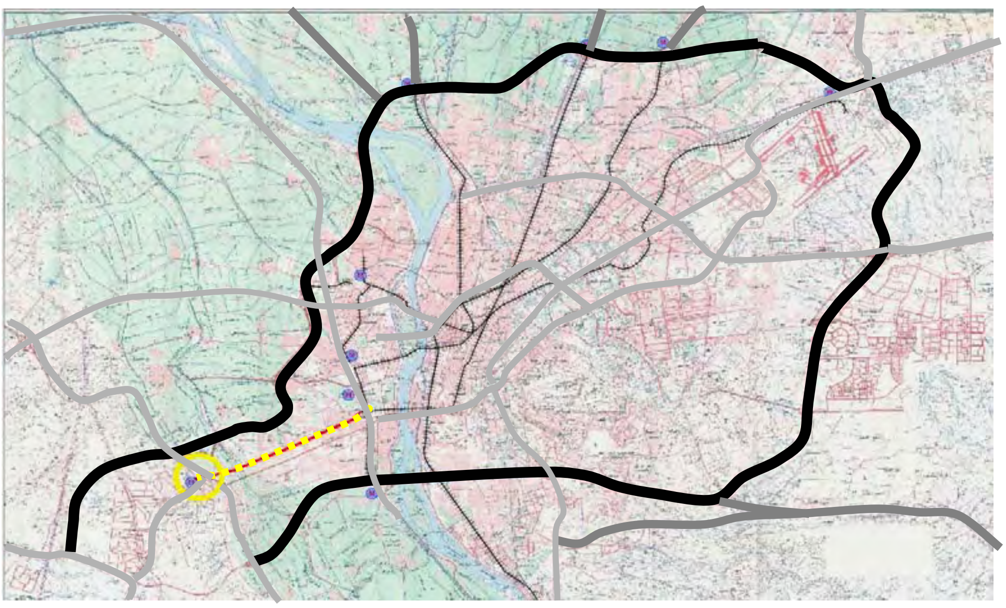
Table 3-2 Consideration from Viewpoints of Environmental and Social Acceptability

Likely Environmental Pollution	-Impacts of air and noise pollution on the surrounding areas due to the construction works of the stations will be less in case the Pyramids Road for Metro line alignment is selected, compared with King Faisal Street, considering the attenuation by distance from sources to receptors.
Natural Environment	-There is no significant difference for both cases if selected as metro line alignment, since the remarkable natural conditions along both roads are not recognized.
Likely Social Impacts	-The case of King Faisal Street would induce higher probability of causing land acquisition and resettlement due to the station construction, compared with that of Pyramids Road, since the width of the former is relatively narrow. -Traffic congestion caused by the station construction would be more significant in case metro line alignment will run along King Faisal Street, since its current traffic density is generally higher than that of Pyramids Road.

Source: JICA Study Team

d) Another Factor

GOPP has a toll road project with a viaduct structure along the King Faisal Street.



Source: GOPP

Figure 3-8 Plan for Toll Road Along King Faisal Street

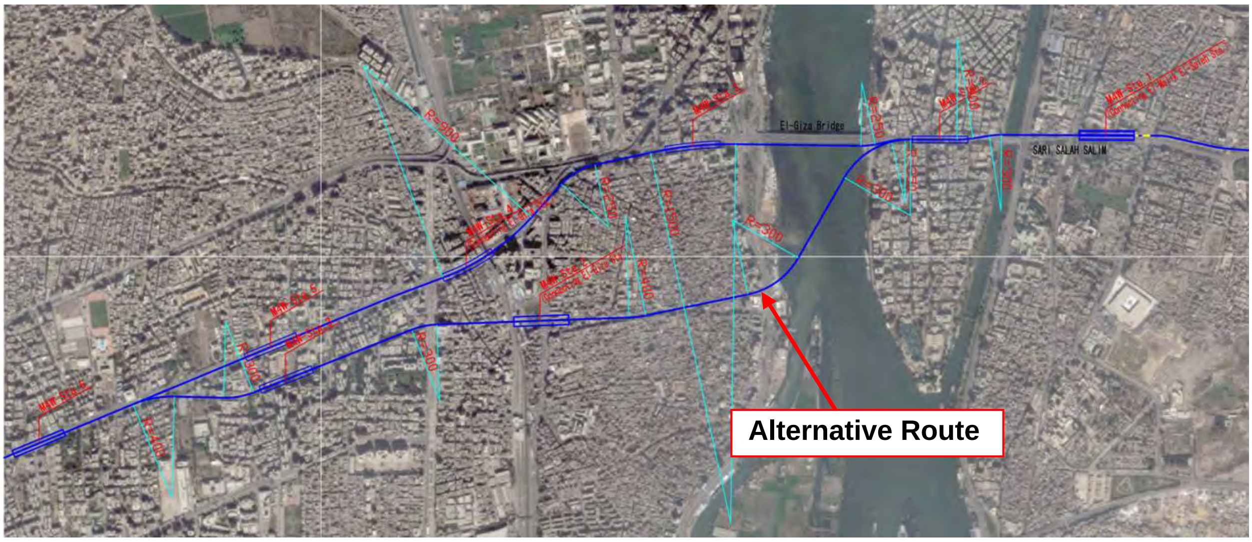
e) Conclusion

- Pyramids Road route has advantage in terms of construction easiness and construction cost.
- Pyramids Road route has advantage in terms of connection with Metro Line 2.
- King Faisal Street may have an advantage in terms of ridership by enhancing the feeder service along this street. However, social environmental loss will be created with the construction of toll way viaduct and metro line along this street.
- Magnitude of land acquisition and resettlement will be less in case of selecting Pyramids Road as metro line alignment.
- Less impacts due to pollution and other social aspects are expected in case Pyramid Road is selected as the metro line alignment.
- As a result, JICA Study Team recommends the route passing along the Pyramids Road.

JICA Study Team will conduct further study such as details of construction methodology, construction cost, and construction period, etc., which will be presented in the *Volume 3*.

(3) Case Study of Avoiding Giza Flyover Route

The section from El Malek El Saleh Station (Metro Line 1) to El Giza Station (Metro Line 2) has some construction difficulties. JICA Study Team examined the possibility of selecting another alternative route to avoid such concerns.



Source: JICA Study Team, Map: Quickbird
*At the moment, Metro Line 4 has been planned passing through the south side of Giza Bridge. After this study, that route was changed to north side from the point of alignment.

Figure 3-9 Alternative Route Avoiding Main Construction Difficulties

a) Route Selection

With the same basic policies as mentioned in Section 3.3.1, possible alternative route was studied based on site survey and satellite image map. The following possible alternative route is illustrated in Figure 3-9.

- Running along Salah Salem Street, and approaching to El Rauda Island after crossing Nile Branch.
- Crossing the Nile River towards the south.
- Passing through Abu Hamila Street and crossing in front of ENR Giza station.
- Passing through western residential area of ENR station and running parallel to the south side of Pyramids Road.

b) Existing Conditions

List of existing site condition is as follows:

1: Abu Hamil Street has some small curves, and its width is about 15 m. Surrounding area consists of built-up area with low-rise residents and/or small stores. Small mosques also exist along this street.	
2: The road is cranked in front of ENR Giza station. Commercial building at its corner and a mosque cause obstructions. There is also a school behind said building.	

3: The distance to the Metro Line 2 station is very far (approximately 400 m).	
4. Crowded area with low-rise residential buildings. There is no direct connection to the main road.	
5. The street parallel to the Pyramids Road has about 10 m width only. Traffic volume is very low because this street ends without connecting to Pyramids Road.	

6. There is a theatre at the corner of the Pyramids Road. Some residential buildings behind the theatre are under construction.	

Source: JICA Study Team

Figure 3-10 List of Existing Site Conditions

c) Examination of Environmental and Social Aspects

The selection of the route passing along Abu Hamila Street and western residential area of ENR will induce a more significant impact compared with the route along El Malek El Saleh－El Rauda－Giza Square－El Giza from the following viewpoints:

- Magnitude of social impacts will be high, especially on land acquisition and resettlement due to the narrow roads with less availability of limited areas for construction activities.
- The social status is recognized as middle-low levels, meaning that more careful considerations would be necessary for socially sensitive receptors.
- The probability of inducing the impacts on small mosques is expected to be high.

Therefore, it is recommended to avoid selecting the route along Abu Hamila Street and western residential area of ENR as the original route is technically feasible.

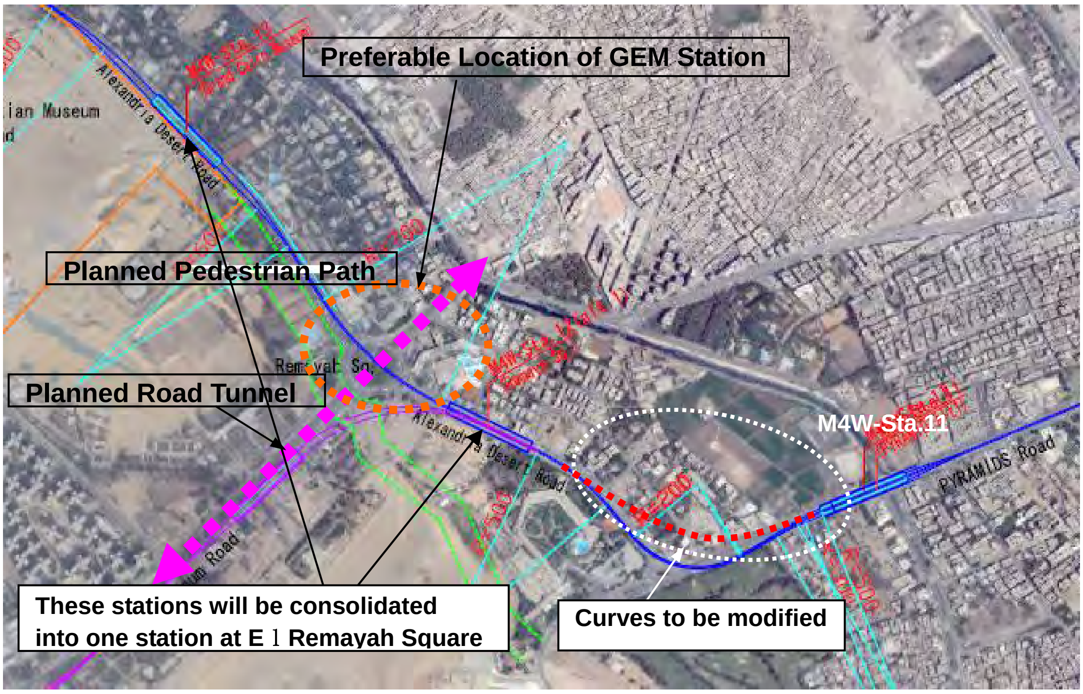
d) Conclusion

- It is so difficult to allocate a station without land acquisition issues.
- The length required to cross Nile River is long
- Connection with Metro Line 2 is not convenient.
- No place for ensuring some yards for construction.
- It is so difficult to allocate various public transport facilities and potential commercial development sites adjacent to the stations.

As a result, JICA Study Team will not recommend the alternative route.

(4) The Intersection of Pyramids Road with Alexandria Desert Road

If the alignment goes under the roads at the intersection of Pyramids Road and Alexandria Desert Road, the radius of curvature required will be R=200 m. In terms of operation purpose, adopting a larger radius of curvature is preferable. According to NAT's comment, minimum radius of curvature shall be R=250 m. Therefore, JICA Study Team will utilize R=250 m in this section which will pass under a residential area.



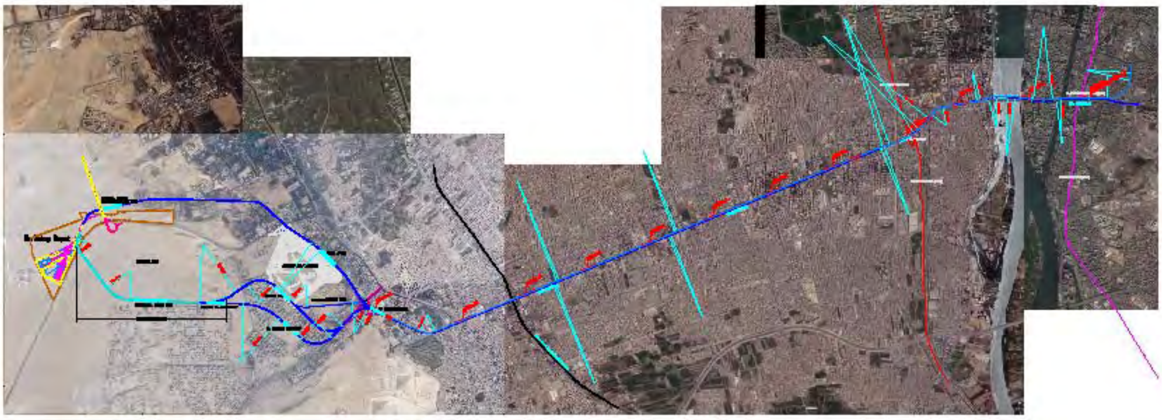
Source: JICA Study Team

Figure 3-11 Alternative Alignments Around the Intersection of Pyramids Road with Alexandria Desert Road

The detailed alignment study to minimize the affected buildings including hard points will be conducted after the topographical and dilapidation surveys are completed. This section is planned to consist of underground structures. Basically, station facilities will comprise of cut and cover structures, and bored tunnel structures between stations.

(5) Proposed Route

As a result of the study, JICA Study Team proposed the route as follows (refer to Figure 3-12):



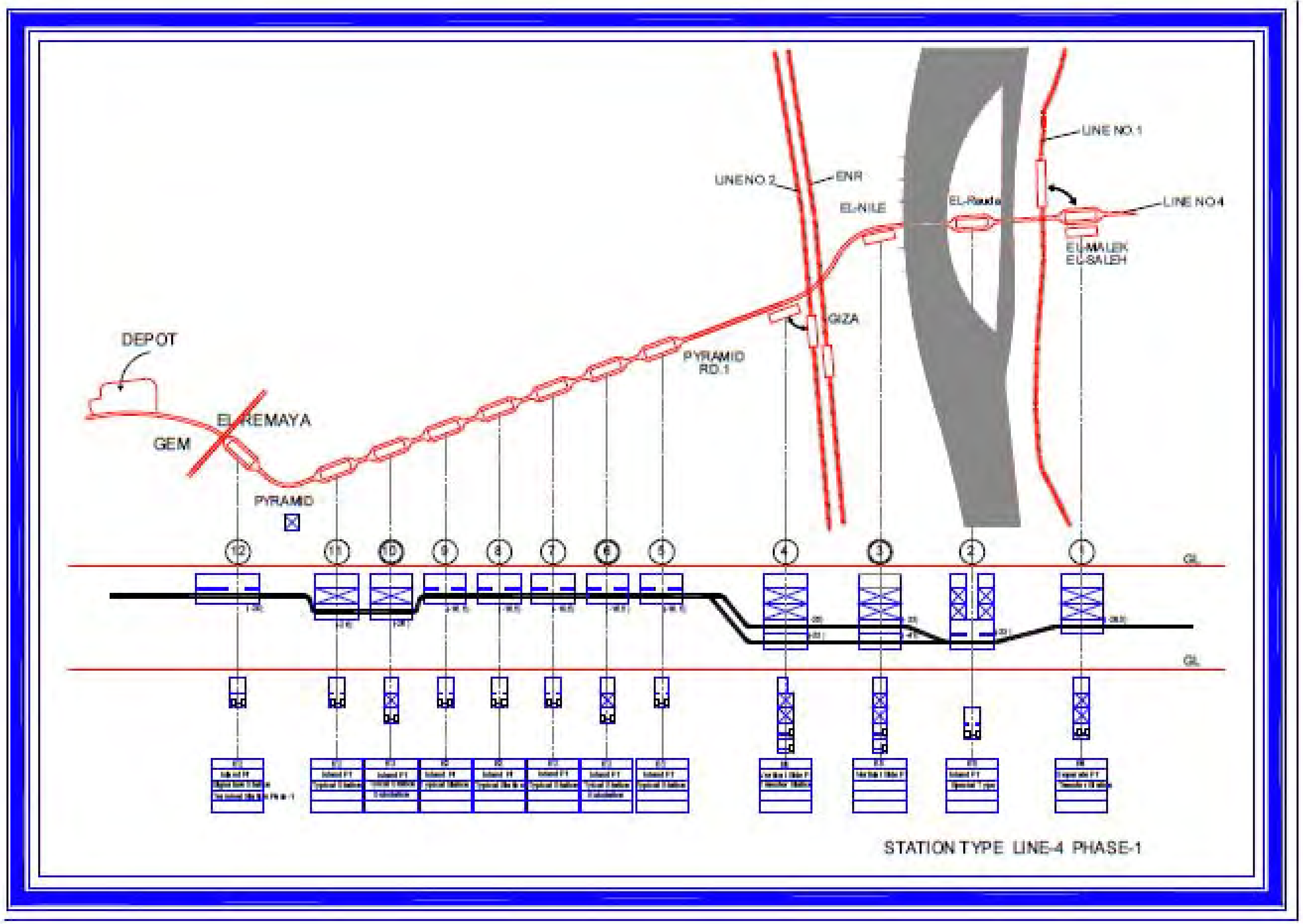
Source: JICA Study Team

Figure 3-12 Proposed Route for Phase 1 Section

< Proposed Route >

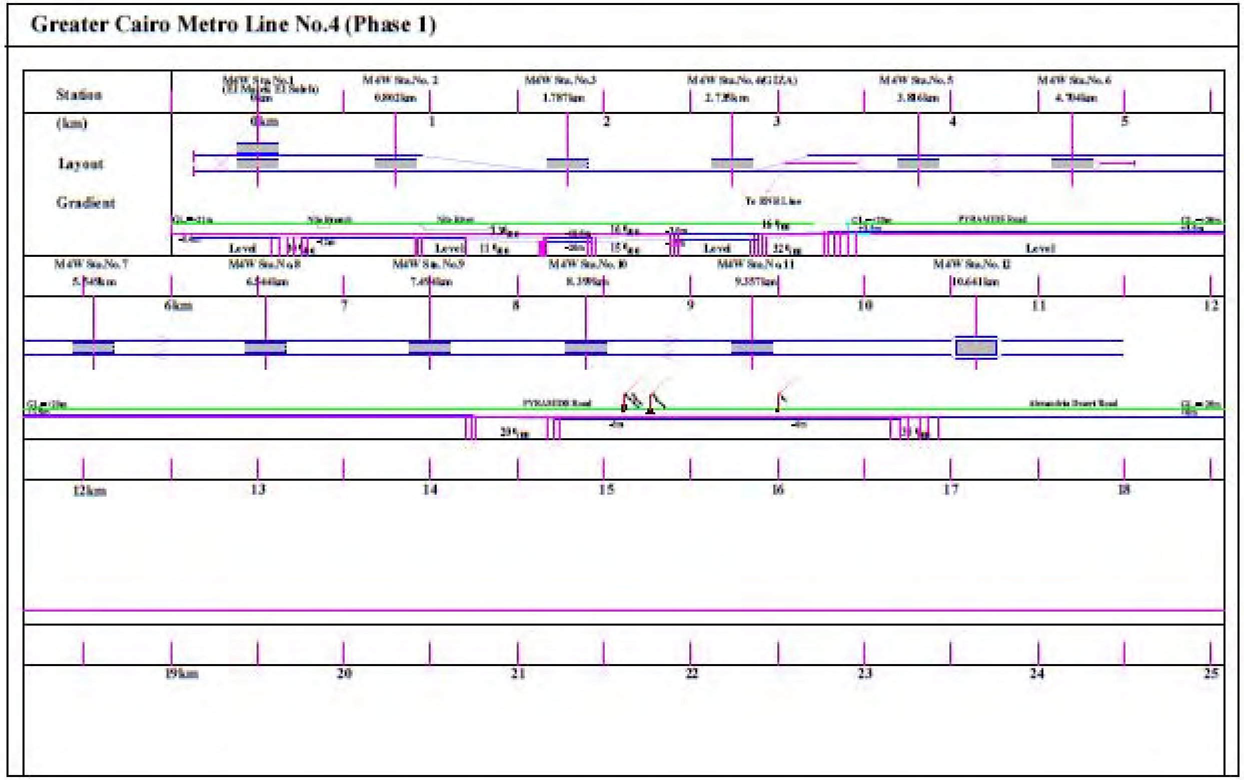
- The route will start from El Malek El Saleh Sta. (Connecting Metro Line 1)
- Runs along Salah Salem Street
- Passing El Rauda, Giza Square and El Giza Station (Connecting Metro Line 2 and ENR Line)
- After the El Giza Sta., it will running under Pyramids Road
- The route will finally turn at Alexandria Desert Road to El Remayah Square

Total length of the route between El Malek El Saleh and El Remayah Square is approximately 10.6 km with 12 stations. Schematic layout of station location and schematic vertical alignment are shown in Figure 3-13 and Figure 3-14, respectively.



Source: JICA Study Team

Figure 3-13 Schematic Layout of Station Locations



Source: JICA Study Team

Figure 3-14 Schematic Vertical Alignment