4.6 INITIAL SCREENING OF PUBLIC TRANSPORT SCENARIOS

4.6.1 Objective

The objective of this chapter is to test and to compare the performance of various rail transport scenarios which are proposed for the integrated transport master plan. The scenarios have the following main objectives :

- **Reduce traffic congestion and travel duration**

The most efficient way to reduce traffic congestion is to encourage modal transfers from road transit to high capacity public transport modes (Mass Rapid Transit, Light Rail Transit, tram, conventional rail), which are speedier and more comfortable than current bus vehicles. Building an integrated public transport network based on a strong MRT system is the most effective way to cope with increasing traffic congestion. Considering that Greater Cairo is one of the most dense cities in the world, its scarce vacant space should in general be devoted to mass public transport systems, which consume the least space per passenger. Space consumption has a direct influence on the economy of cities. Unrestrained car traffic in dense cities invariably leads to severe traffic congestion, which is counterproductive and has high social costs. Cities that have managed to upgrade their public transportation networks in pace with the growth of population and wealth have largely managed to avoid the worst traffic congestion. In order to improve the economy of Cairo there should thus be given strong priority to public transportation. In fact, Cairo is an ideal case, for the high population density and demand allows for introducing many additional MRT lines with considerable financial potential.

In Cairo an urban highway lane provides a maximum capacity of 2,200 cars/hour, which corresponds to 3,300 passengers/hour considering an average vehicle occupancy rate of 1.5 person. In comparison, under optimal conditions metro line 1 in Cairo can carry up to 74,000 passengers/hours/direction, which is equivalent to a highway of 22 lanes.

- **Improve the environment**

The proposed scenarios must contribute to improving the environment in Greater Cairo by reducing car and bus vehicle travel, and thus the related pollutant emissions. Electrified modes, such as the MRT, tramway and train do not pollute within the city, and are therefore not directly harmful to the health and well-being of the population. In cities, air pollution causes respiratory problems, especially among babies and children, which can lead to a shorter life span; and noise is a main reason for stress.

- **Extend public transport services to the new settlements**

The new public transport network has to comply with the land use evolution as forecast by the master plan. The new settlements and cities under development must be served by cost-efficient public transport modes. Among priority projects are rail links to 6th of October City, 10th of Ramadan City and New Cairo.

- **Improve the transport conditions of the poor**

The public transport network has to serve in priority the poor urban areas, where the non-motorized population cannot perform long distance trips without public transport.

- **Improve transport accessibility to the main trip generators**

In order to serve a maximum number of travelers, the public transport network must serve directly the main trip generators such as dense population and employment sectors, most important educational areas and other urban activity centers.

- **Adapt the transport supply to the demand**

The public transport network must cope with the existing and future transport demand structure in order to avoid public transport transfers to the car for the same origin/destination trips. Furthermore, the cost-efficiency of public transport projects (MRT, LRT, tramway and bus priority lanes) should be increased.

The number of daily motorized trips is forecast to be multiplied by 1.8 between 2001 and 2022, following a multiplication of 2.6 times between 1973 and 2001 (Tables 4.6.1 and 4.6.2). The transport supply has to cope with this important *past and future* increase in the transport demand in order to save the city from total congestion.

Table 4.6.1 Evolution in the Number of Motorized Trips between 1973 and 1998

SYSTRA Study area	1973	1998
GCMA Population (million) (*)	5.67	9.92
Average motorized mobility per person	0.60	0.91
GCMA Daily motorized trips (million)	3.4	9.0

(*) Above six year
Data source: Household surveys, 1973 and 1998, by Systra

Table 4.6.2 Evolution in the Number of Trips between 2001 and 2022

JICA Study area	2001	2022
Population (million)	14.4	20.7
Average mobility per person	0.95	1.16
Daily trips (million)	13.7	24.0

Data source: JICA Study Team

The transport demand in 2022 has been calculated by the project team's CREATS model for each origin and destination drawing from the results of the household survey and the socioeconomic framework. Similar to the findings of the SYSTRA-DRTPC 1998 study, the main trip demand flows are still oriented from the suburban areas through the central area of Greater Cairo.

4.6.2 Methodology

The main transport corridors, which need to be served by efficient public transport systems in the year 2022, are identified according to their aptitude of meeting the following main criteria :

- Serve high-density population, employment and student locations.
- Satisfy the transport demand structure (main traffic flows by origin and destination). On this basis the adequate systems (MRT, LRT, conventional rail or busways) are proposed according to the required capacities in each corridor.
- Serve low-income areas in order to provide accessible transport for those who cannot afford an automobile.
- Interconnect with existing MRT lines.
- Avoid physical constraints such as the Nile River, facilities, buildings and infrastructures.

Four scenarios are developed in this chapter with regard to the above five criteria. Following an iterative process evaluation based on the testing and refinement of the four scenarios, a core public transport network will be elaborated. In the following chapter 4.7, the core network will be subject to a more comprehensive evaluation.

- Scenario 1 takes into account only the committed projects and is the "reference" scenario.
- Scenario 2 involves a comprehensive public transport network, called the "do maximum" scenario, which fully serves all the identified transport corridors in 2022, based on a MRT and LRT network commonly referred to as the Systra plan.
- Scenarios 3 and 4 will be determined successively following an analysis of the performances of the MRT/LRT network proposed in scenario 2 with regard to the above criteria. These scenarios will retain the best features of scenario 2 and will suggest other system alternatives according to the required capacities. It should be noted that these scenarios also aim at limiting the capital costs.

Each scenario option will be analyzed and compared in order to select the best corridor lines and systems for the optimized core network described in Section 4.7. Please note that various bus systems and priority concepts are concurrently integrated in order to verify their performance in relation to rail systems.

The development of the scenarios primarily focuses on the introduction of adequate high capacity systems (MRT, LRT and busways) on the identified corridors. In parallel, the tramway and ENR networks can either be upgraded to an LRT system or adapted in order to feed the main high capacity network.

In order to better evaluate the various public transport systems' aptitude of satisfying the demand in different corridor alignments described in the following chapters, the main characteristics of the relevant systems are recalled below.

⇨ Busway, Buslanes, Trunk Busway

- Capacity : Up to 20,000 passengers / hour / direction
- Maximum speed : 80 km/h
- Commercial speed : 20-30 km/h
- Alignment : At grade right-of-way, variable crossing

⇨ Modern tramway

- Capacity : Up to 10,000 passengers / hour / direction
- Maximum speed : 50-80 km/h
- Commercial speed : 20-25 km/h
- Alignment : At grade right-of-way, mixed crossing

⇨ Light Rail Transit (LRT)

- Capacity : Up to 30,000 passengers / hour / direction
- Maximum speed : 80-100 km/h
- Commercial speed : 20-35 km/h
- Alignment : At grade right-of-way, viaduct, tunnel

⇨ Mass Rapid Transit (MRT)

- Capacity : 30-90,000 passengers / hour / direction
- Maximum speed : 100-150 km/h
- Commercial speed : 35-60 km/h
- Alignment : Right-of-way, viaduct, tunnel

Metro lines 1 and 2 in Cairo belong to the MRT category as they can carry up to 74,000 and 63,000 passengers/hour/direction respectively under optimal operating conditions. However, due to the short distances between stations, the commercial speeds of lines 1 and 2 correspond to that of a LRT system. For more details please refer to the *Technical Report (3) : Urban Public Transport Perspectives.*

In Section 4.7, medium and short term plans will be developed on the basis of the refined scenario in 2022, accounting for implementation phasing of the various proposed systems.

4.6.3 Scenario 1 : Committed network

(1) Network Description

The first scenario consists of only the projects which are under construction or certain to be realized. They are called the "committed projects" and involve the realization of MRT line 3, extension of MRT line 2 to Moneeb, and the construction of a tramway line between Helwan station on MRT line 1 to Helwan University (Table 4.6.3 and Figure 4.6.1).

In this scenario, the existing ENR network and other tramway lines remain unchanged.

This first scenario will be used as a reference scenario; each following scenarios will be compared to this scenario in order to evaluate their respective performances.

Table 4.6.3 Committed MRT Network

	Section	Length	Status
Metro line 1	Helwan – New El Marg	44.0 km	Existing
Metro line 2	Shobra El Kheima – Giza suburban	18.9 km	Existing
Extension	Giza suburban – Moneeb	2.1 km	Scheduled: 2004-2005
	Total	21.0 km	
Metro line 3	Imbaba / Mohandiseen – Heliopolis / Cairo Airport	33.0 km	2007-2012

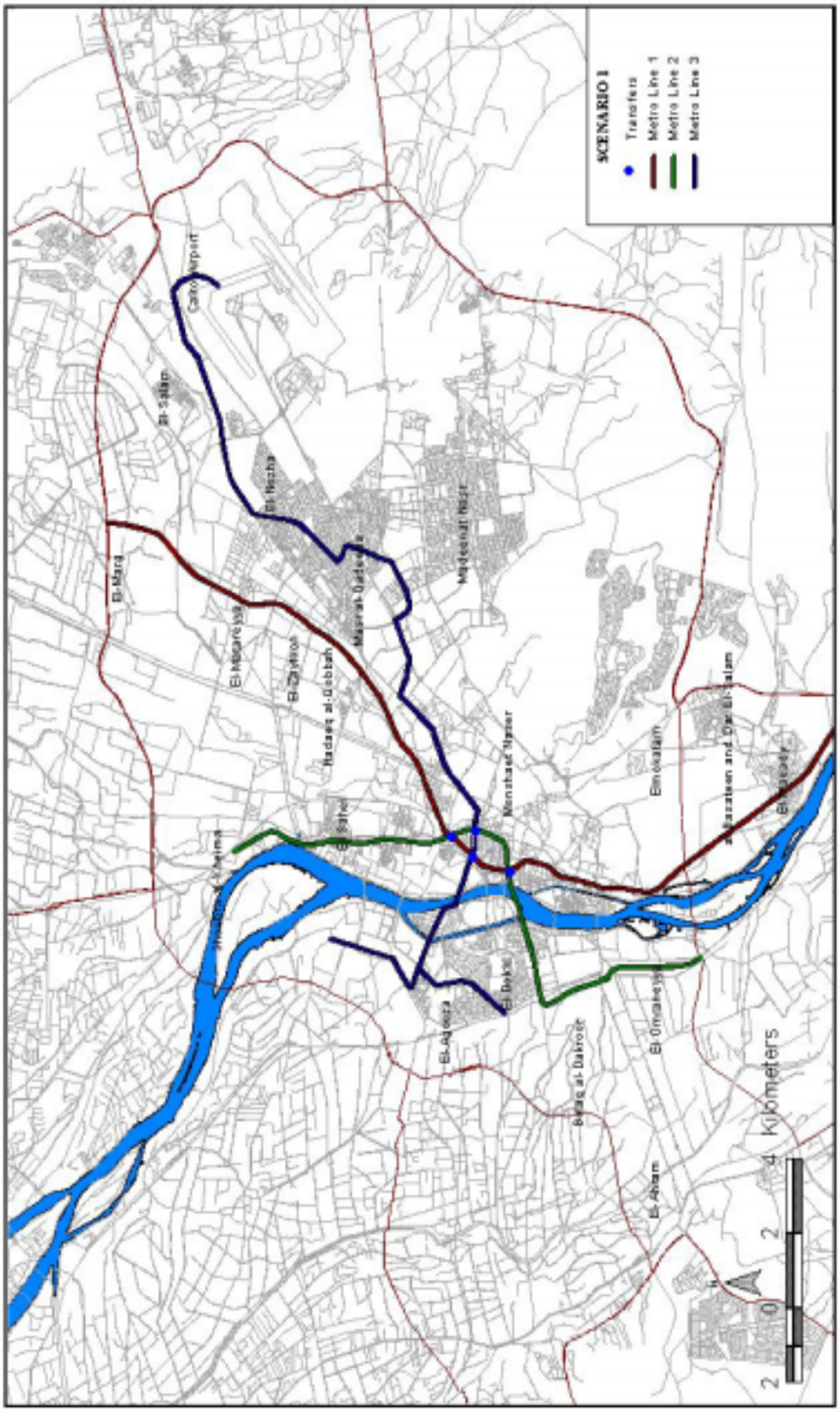


Figure 4.6.1 Scenario 1 "Committed Projects"

• *MRT supply indicators*

The headways of MRT lines 1,2 and 3 are set to 2 minutes during the peak period (Table 4.6.4).

Table 4.6.4 Scenario 1, MRT Supply Indicators in 2022

Line	Mode	Terminals	Peak headway	Average speed
1	MRT	•New El Marg •Helwan	2 min	34 km/h
2	MRT	•Shobra el Kheima •Giza - Moneeb	2 min	38 km/h
3	MRT	•Cairo Airport •Imbaba (branch 1) •Boolaq (branch 2)	2 min	38 km/h

Source: JICA Study Team

• *Tramway supply indicators*

The tramway headway is constant during both base and future years (Table 4.6.5).

Table 4.6.5 Scenario 1, Tramway Supply indicators in 2022

Line	Line Name (origin / destination)	Length (km)	Average comm. speed (km/h)	Average peak hour headway (min)
1	El Nozha – Ramses Sq.	15.93	17	12
2	Al Merghani – Ramses Sq.	12.40	17	12
3	Abd El Aziz Fahmy – Ramses Sq.	11.32	17	12
4	10th Region – Ramses Sq.	18.16	15	20
5	Al Maza – Ramses Sq.	12.50	17	20
6	Al Maza – Al Matareya Sq.	6.70	15	15
34	Sheraton – Abaseya	11.97	15	33
35	Al Matareya – Abaseya	9.65	15	13
36	Al Matareya – 10th region	14.35	15	17
36'	Al Matareya Station - 8th Region	11.33	15	22
40	Tebeen – Helwan	11.13	15	38
40'	Tebeen - Al Ezba	9.90	15	40
41	15 May – Tebeen	16.68	15	35
42	15 May – Helwan	13.68	15	31
5	Esmailia Square – Esko	10.19	15	36
12	10th Region – Alf Maskan	13.99	15	22
32	10th Region – Al Sheraton	16.34	15	19
33	Abaseya – Alf Maskan	9.50	15	50
New Helwan – Helwan univ. line		3.60	15	50
Total and averages		**229.32**	**15.4**	**26**

Source: JICA Study Team

The rolling stock required for the short Helwan extension's operations will be compensated by a decrease in supply of the other tramway lines in this sector.

• *ENR supply indicators*

The suburban train service will also remain unchanged in this scenario (Table 4.6.6).

Table 4.6.6 Scenario 1, Suburban Train Supply Indicators in 2022

Line	Line Name (origin, intermediate, destination)	Length km	Average speed (km/h)	Peak hour headways (min)
1	Cairo-Qalyob	14.0	25	40
2	Cairo-Qalyob-Qanater	23.5	42	30
3	Cairo-Qalyob-Shebeen	32.0	38	30
4	Marg-Shebeen El Qanater	20.0	54	30
5	Ain Shams-El Robaiky	45.0	14	60
6	Cairo-Imbaba-Manashi	20.0	34	30
7	Cairo-Maraziek	37.0	22	70
8	Giza Suburban-6th of October City	67.0	30	-
	Totals and Averages	**258.5**	**32**	**41**

Source: JICA Study Team

(2) Population, Employment and Student Densities

The results below are shown in Figures 4.6.2 through 4.6.4 in following pages.

In 2022, MRT lines 1 and 2 continue to serve many densely populated areas in Cairo. Namely, Boolaq and Giza on the West bank. On the East bank, they serve the important Ain Shams and Shobra districts in addition to the Gisr Al-Suweis St. axis. However, between Ain Shams and Shobra there is an very dense area of Cairo which is not served, i.e. on either side of the Port Said street axis, as far as Mostorod Bahtim on the West side.

Other very important sectors which are not served in the reference scenario are : Al-Haram St., Ain Shams East, southern part of Downtown and the western part of Nasr City.

Line 3 serves the high-density areas of Imbaba and Abaseya on its West and central sections. It should be noted that on the East section after Ain Shams to the airport, line 3 crosses relatively low-density areas. This raises a question about the importance of this section compared to other alternative corridors, and will be studied in more detail in the demand analysis.

As to the ENR network, lines 1 (Cairo-Qalyob) and 6 (Cairo-Imbaba-El Manashi) serve the highly populated areas of Shobra on the East bank, and Imbaba and Giza on the West

bank. The headways and regularities of the ENR lines would have to be improved considerably in order to satisfy the needs for urban travel.

With the exception of the five tramway lines of the Heliopolis network serving Ramses Square passing through Abaseya, the tramway network in Cairo is confined to areas with relatively low population densities, i.e. in Heliopolis and Helwan.

In terms of employment densities, MRT line 2 has an important role as it serves the very dense areas of Doqi, Al-Malik Faisal St., CBD and Shobra Al-Kheima. Line 1 serves an important work area in Maadi, CBD and Abaseya. Line 3 has the strongest role as it serves an important job sector stretching from Heliopolis to the airport in addition to Giza-Doqi and CBD.

Lines 1 and 6 of the ENR network cross the high employment sectors of Mohandiseen, CBD, Shobra and Qalyob.

The tram network in Heliopolis also has an important role for serving high employment density areas, namely Downtown and Heliopolis.

Important job sectors, which are not served by a high capacity system in the reference scenario, are namely : Old Cairo, Giza and Al-Haram St.

As for the student densities, El Azar is the only important sector which is not already served by MRT lines 1, 2 and 3.

Table 4.6.7 summarizes the number of the inhabitants, jobs and student students served within a distance of 800 meters from the MRT lines.

Table 4.6.7 Scenario 1, Socioeconomic Performance of Each Line in 2022

Line	Population	Employed	Students	Total Ratio (*)
1	1 073 525	475 617	362 667	0.18
2	892 245	496 638	314 165	0.17
3	1 130 199	729 072	402 710	0.23
Total network	3 095 969	1 701 327	1 079 542	
TOTAL study area	20 721 175	6 966 250	5 771 269	

(*) Total ratio = Pop./total pop. + Emp./total emp. + Stu./total stu.

The ratio allows to determine which line has the best performance for all three socioeconomic factors. As it can be seen, line 3 obtains the highest ratio and is the best line in terms of number of population, employed and students served.

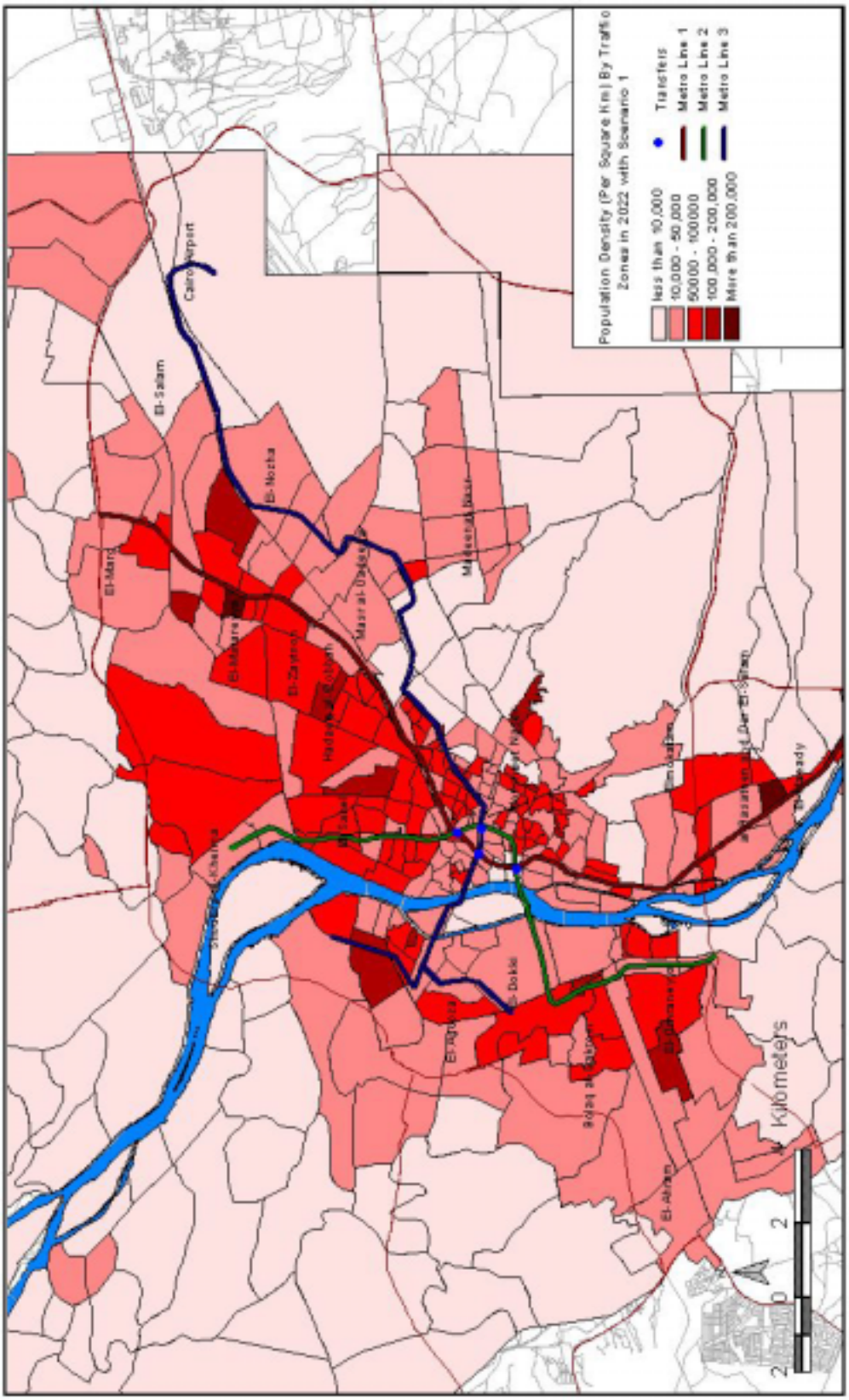


Figure 4.6.2 Scenario 1 and Population Densities

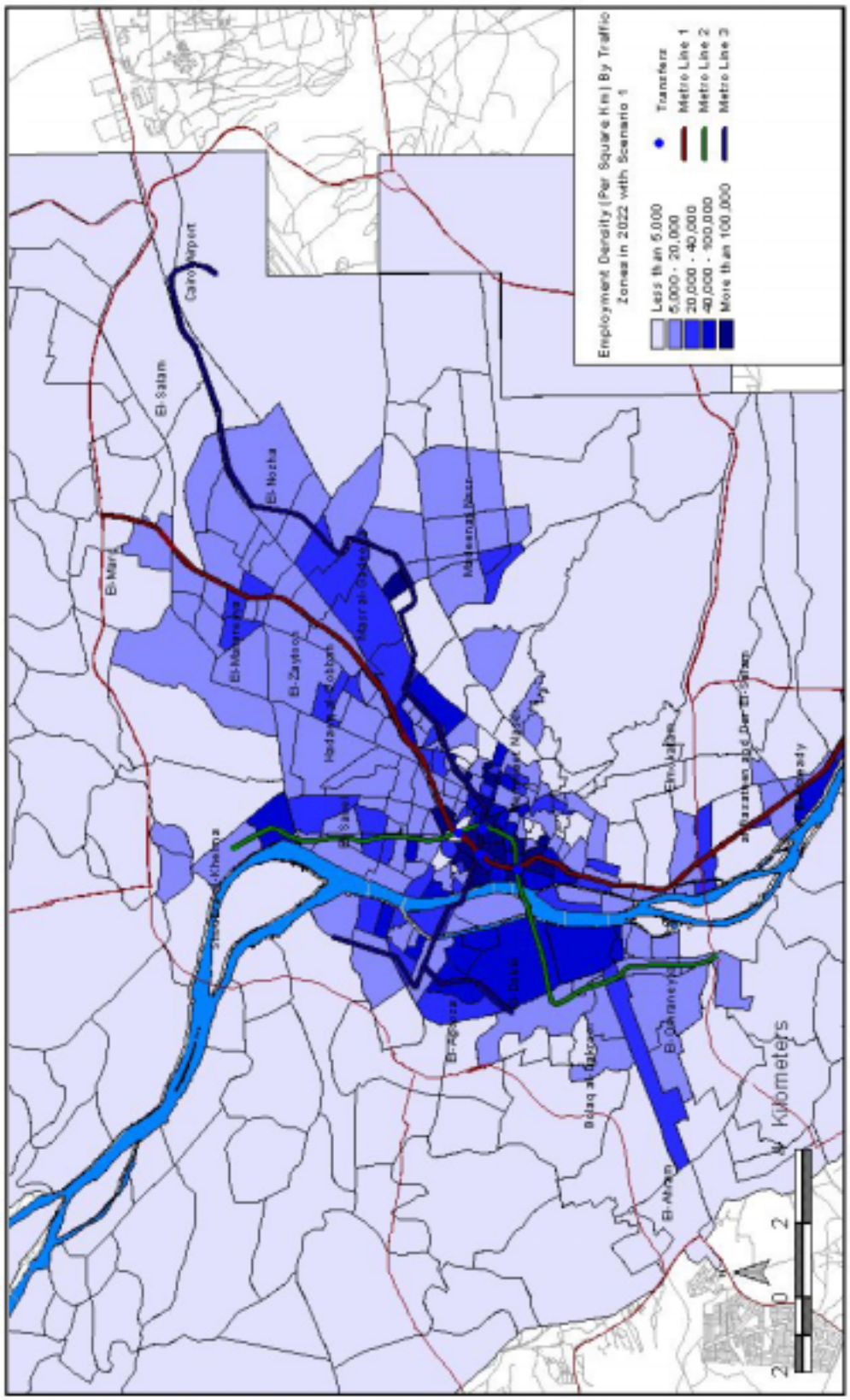


Figure 4.6.3 Scenario 1 and Employment Densities

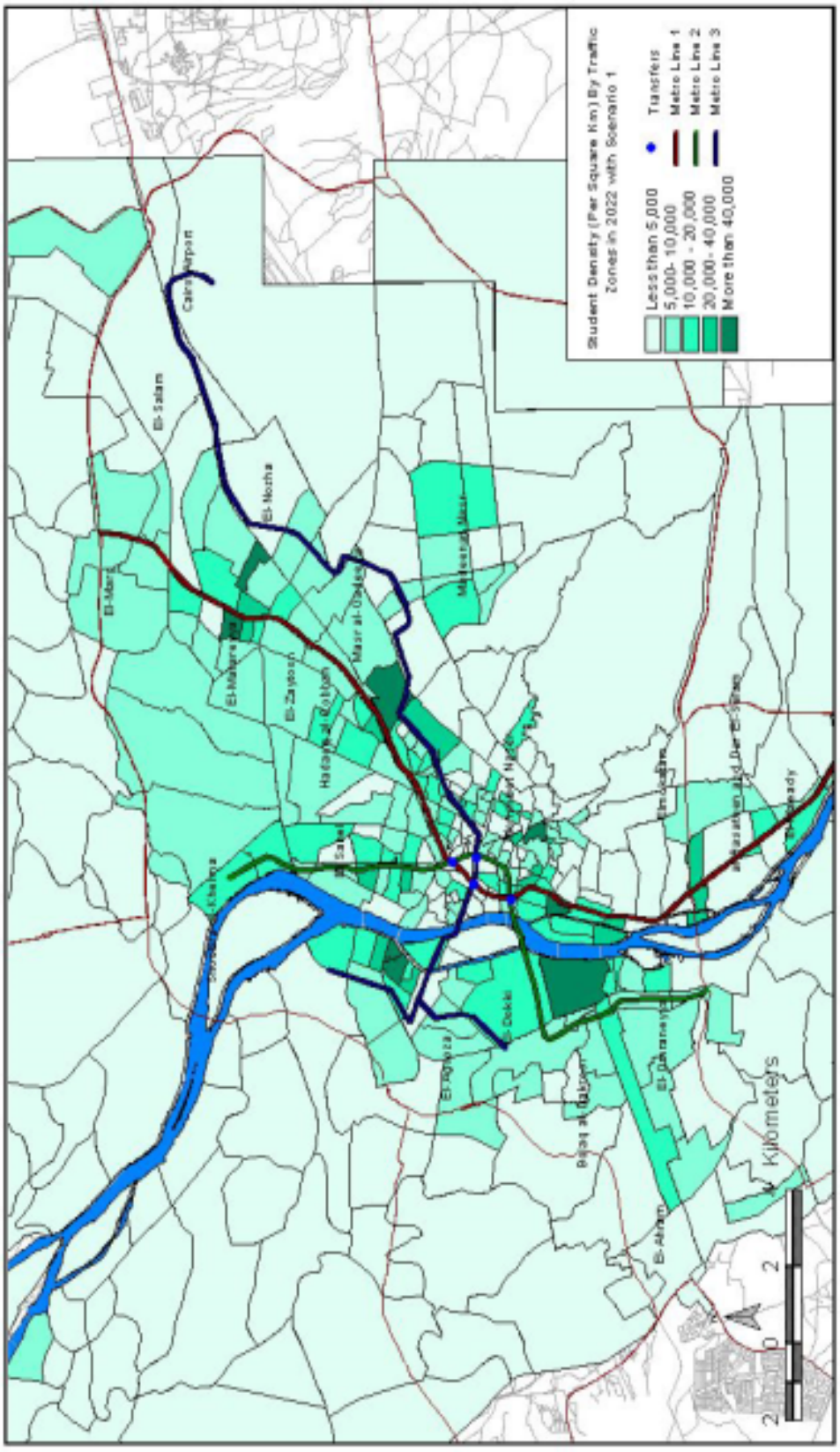


Figure 4.6.4 Scenario 1 and Student Densities

(3) Transport demand

The average daily public transport trips expected in 2022 are shown in Table 4.6.8 by modes.

Table 4.6.8 Scenario 1, Demand Simulations in 2022

	Average daily passengers (million)				
Mode	**2001**	**Modal Split (%)**	**2022**	**Modal Split (%)**	**% Increase**
Formal PRT (*)	4.299	32.3	3.354	19.1	-22
Informal PRT (**)	6.696	50.2	6.591	37.5	-2
TOTAL PRT	**10.995**	**82.5**	**9.945**	**56.5**	**-10**
MRT	**2.021**	**15.2**	**6.238**	**35.5**	**209**
ENR	**0.132**	**1.0**	**0.887**	**5.0**	**570**
TOTAL TRAM	**0.171**	**1.3**	**0.509**	**2.9**	**197**
Ferry	0.010	0.1	0.017	0.1	74
TOTAL	**13.329**	**100.0**	**17.596**	**100.0**	

(*) CTA and GCBC (**) Shared taxis and private mini buses. PRT: Public Road Transport.

In the reference scenario between 2001 and 2022, the most important change in the transport demand in Cairo is a 570% increase of the ENR ridership. This strong increase is predictable as the ENR network offers increasingly attractive travel speeds on important corridors to the CBD while the speeds on the roads decrease significantly. In fact, a general shift from private to public transport can be expected due to the important drop in the average speed on the network, as the number of cars drivers increase due to an increased wealth.

The MRT traffic will increase by 209% while the traffic of the road based public transport modes will drop by 10%. The MRT will increase its market share, at the expense of regular CTA buses, which will offer lower commercial speeds, but also at the expense of the shared taxi and the private car. Among others, line 3 diverts an important traffic along the heavy Gisr Al-Suweis St. shared taxi corridor. This is a positive evolution since the shared taxi is an important cause of the traffic congestion due to its low capacity (in terms of carried passenger per m²). It should however be underlined that the road network will be totally saturated in the meantime due to the increased private car traffic.

The trip volume of the MRT will continue to increase because of the attractiveness of this mode, which is the fastest in Greater Cairo. Nevertheless, the comfort and safety will degrade due to a high concentration of passengers reaching 8 per square meter. The headway should therefore be increases to the maximum authorized as well as the MRT capacity, e.g. with double-deck rolling stock on line1.

The trip volume forecasts for the 3 MRT lines proposed in scenario 1 are shown in the following Table 4.6.9.

Table 4.6.9 Scenario 1, MRT Daily Trips Demand in 2022

Line	Boarding Pass(million)	Pass-km (million)	Pass/km (1,000)	Max loaded section	Section one-way traffic
1	2.40	27.27	54.9	Hadayek	742 000
2	1.76	11.77	83.8	Mubarak	630 000
3	2.07	16.35	69.0	Esaf	590 000
TOTAL	**6.23**	**55.39**	-	-	-

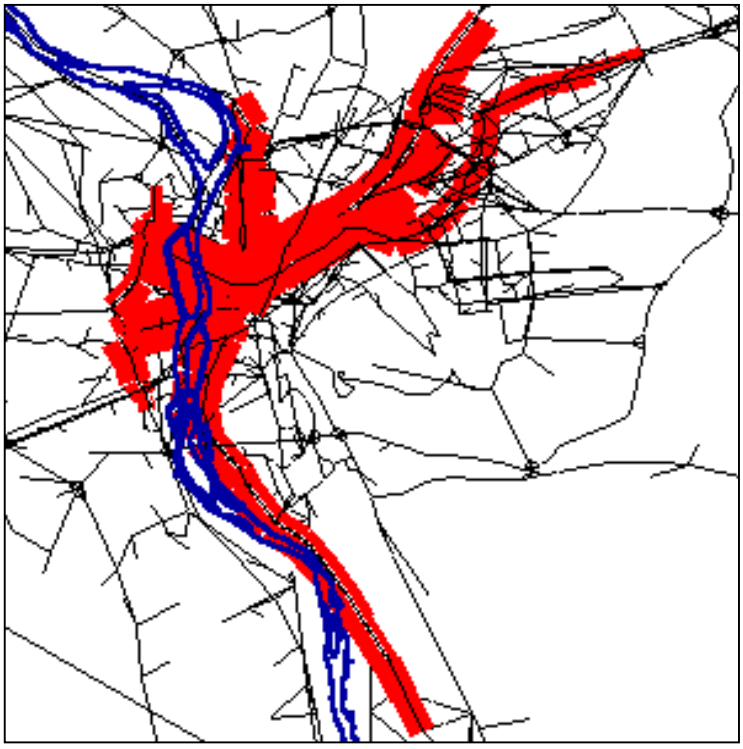
Source: JICA Study Team

The peak hour capacities of the MRT lines 1, 2 and 3 should be at least 10% of the above one-way traffic volumes in order to cope with the demand. As MRT systems can cater 30-60,000 pass/hour/direction with single-deck rolling stock, this means that the MRT lines 1 and 2 with current operations will be unable to meet the demand during the peak hours in 2022. On this basis, we can conclude that all three lines require high capacity MRT systems, among which line 1 should definitely be a double-decker. Without improved maintenance and supply measures, the operation of the lines 1 and 2 will be disturbed.

In terms of utilization measured in passengers per km of line, MRT line 2 obtains excellent results. In fact, all three lines, exceed by far the current levels for the most heavily loaded MRT systems in the world. The highest currently is the Hong Kong metro with 53.2 thousand passengers per km.

Metro lines 1 and 2 in Cairo currently operate with maximum loads of approximately 35 thousand passengers per km.

From Figure 4.6.5 it can be seen that all sections of the MRT lines are heavily and reasonably uniformly loaded, except for the branch of line 3 connecting to the airport.

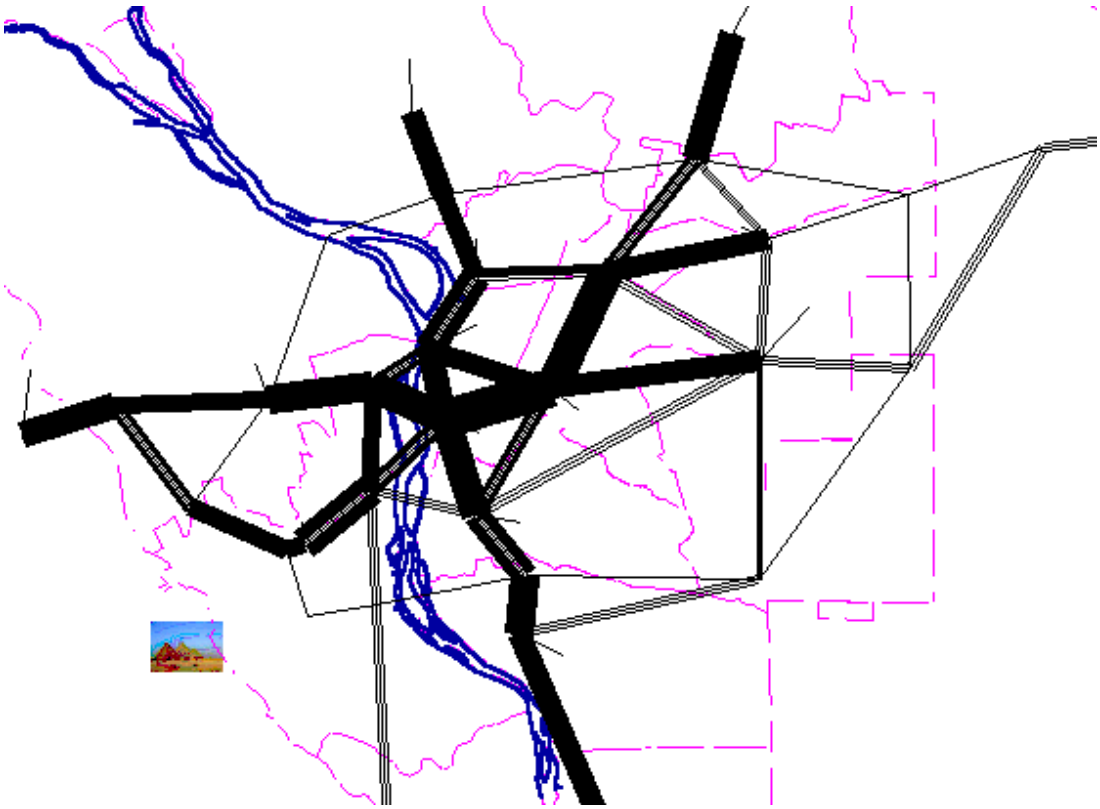


Source: JICA Study Team

Fig 4.6.5 Scenario 1 Bandwidth Diagram in 2022

From the spider diagram in Figure 4.6.6 we can see the important public transport flows (or "desire lines") which are not served by the three MRT lines, and which should be taken into consideration in the following scenarios. They are as follows :

- Along the 26th July corridor until metro line 3
- Along Al-Malik Faysal and Al-Haram Streets, and between this area and the intersection between 26th July corridor and the Desert Road
- Abaseya – Shobra and Abaseya – Al-Qal'a
- Heliopolis – Shobra Al-Kheima.



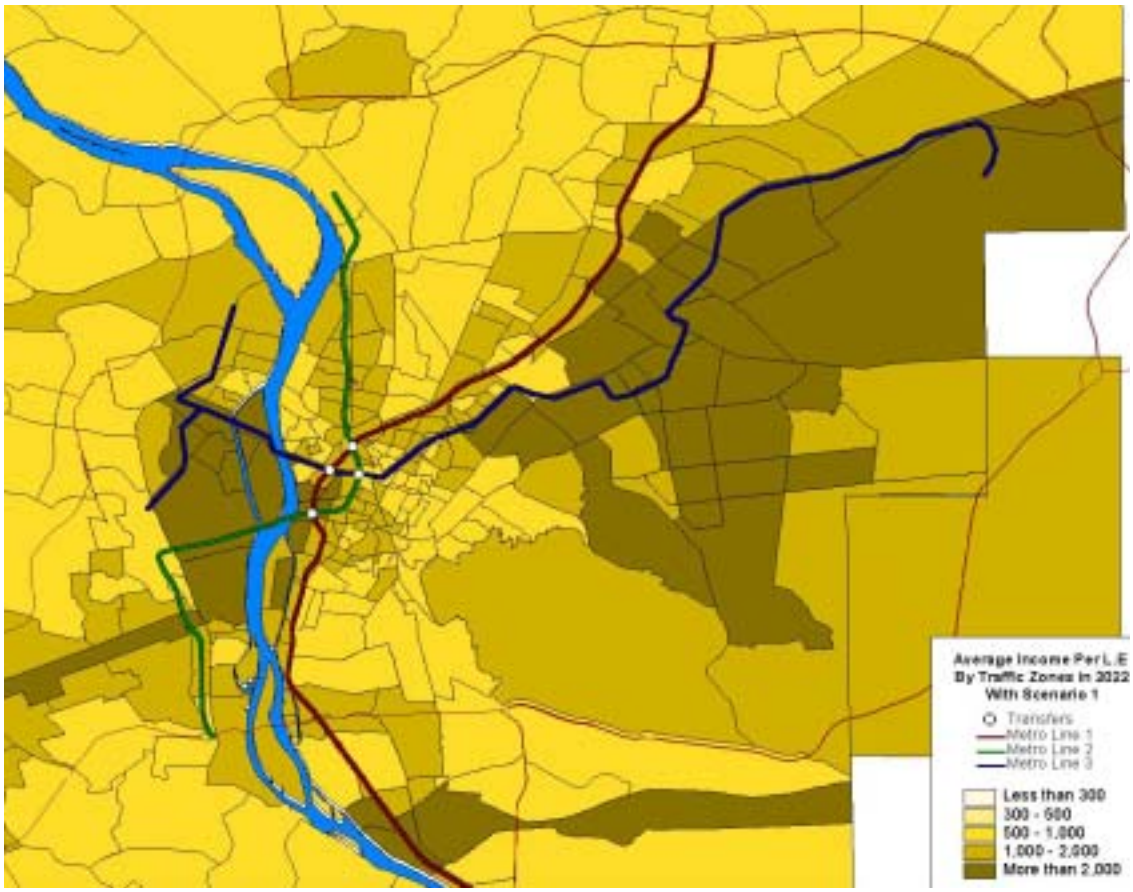
Source: JICA Study Team

Figure 4.6.6 Scenario 1 Spider Diagram in 2022

(4) Low Income Areas

A special attention must be given to serving the low-income areas of Cairo with a high capacity transport system. In this way, it is ensured that no people are actually hindered from being active due to the lack of a car.

In 2022, a very important range of low-income areas, with high population and job densities, are totally neglected in the reference scenario. These areas have a very strong potential for a high capacity system and concern : Mostorod Bahtim and Al-Zawiya in the northern part of Cairo, and to a lesser extent - due to lower job densities – the southern part of Downtown and Mokkatam (Figure 4.6.7).



Source: JICA Study Team

Figure 4.6.7 Scenario 1, Household Density by Income Levels in 2022

(5) Interfaces

In addition to the interfaces with line 1 and 2 in CBD, the MRT line 3 has been developed in due consideration of providing a connection with the tramway network in Heliopolis, thus strengthening both systems. The tramway becomes both complementary to line 3 for serving CBD, and for feeding it for longer trips, in addition to ensuring local trips in Heliopolis and Nasr City.

4.6.4 Scenario 2 : "Do Maximum Scenario"

In addition to the five main criteria for developing the scenarios, scenario 2 takes into account the following objectives :

- Implement the most cost-effective rail systems (MRT or LRT) on the identified transportation corridors in order to reduce as fast as possible the road congestion in an environmentally sustainable way.
- Decrease the headways of MRT lines 1 and 2 to two minutes in order to reduce the current congestion observed on these lines.

- Rehabilitate the existing tramway network in complement with the MRT network.
- Improve the existing suburban rail services.
- Create new track or strongly rehabilitate the existing rail track in order to link effectively and speedily the 6th of October and 10th of Ramadan cities.
- Reorganize the road based public transport network (buses and shared taxi) in coherence with the proposed rail network.

(1) Network Description

• The MRT/LRT network

Following the analysis of scenario 1 with regard to socioeconomic and structural demand issues, additional mass rapid transport corridors are proposed :

- Corridor line 4: a diametrical corridor crossing the central area and linking peripheral activity centers (Nasr city) with the CBD and opposite peripheral sectors (Giza El Ahram).
- Corridor line 5 : a circumferential corridor linking peripheral activity centers (Nasr city, Heliopolis, Shobra El Kheima) and connecting to and relieving the radial MRT lines in the central area of Cairo.
- Corridor line 6 : a diametrical corridor linking a peripheral area (Port Said street) and activity centers (CBD, Al Azar) with the peripheral activity center of Maadi. This corridor also relieves the MRT line 1 which is congested in the central section.
- Corridor line 7 : a suburban link between 6th of October and 10th of Ramadan cities which crosses the center of Cairo.

These corridors ensure connections between the main activity centers and the central area, and involves 4 new lines with regard to the reference scenario. There will be 6 lines in total as shown in Table 4.6.10, also commonly referred to as the Systra plan.

Table 4.6.10 Scenario 2, MRT/LRT Network Description in 2022

Line	Type	Length	Starting at	Passing through	Ending at
1	MRT	44 km	New El Marg	CBD area	Helwan
2	MRT	23 km	Shobra el Kheima (ring road)	CBD area	Giza – Moneeb
3	MRT	33 km	Cairo Airport	CBD- Mohandiseen	Imbaba (branch 1) Boolaq (branch 2)
C4	MRT	27 km	Nasr City	Abaseya-Roda Island	Giza Pyramids
C5	LRT	22 km	Nasr City	Heliopolis	Shobra el Kheima
C6	LRT	20 km	Maadi	CBD (East)	Port Said Street
C7	MRT	96 km	6th of October	Cairo	10th of Ramadan

Source: JICA Study Team

Drawing from the recommendations of the Systra study, these corridor lines 4, 5 and 6 will initially be tested as respectively MRT and two LRT systems, with corresponding service levels in the CREATS model. Corridor line 7 is described in more detail in the paragraph concerning the ENR suburban network. In this scenario, the total line length of the rail network amounts to 265 kilometers, including MRT lines 1 and 2 (Figure 4.6.8).

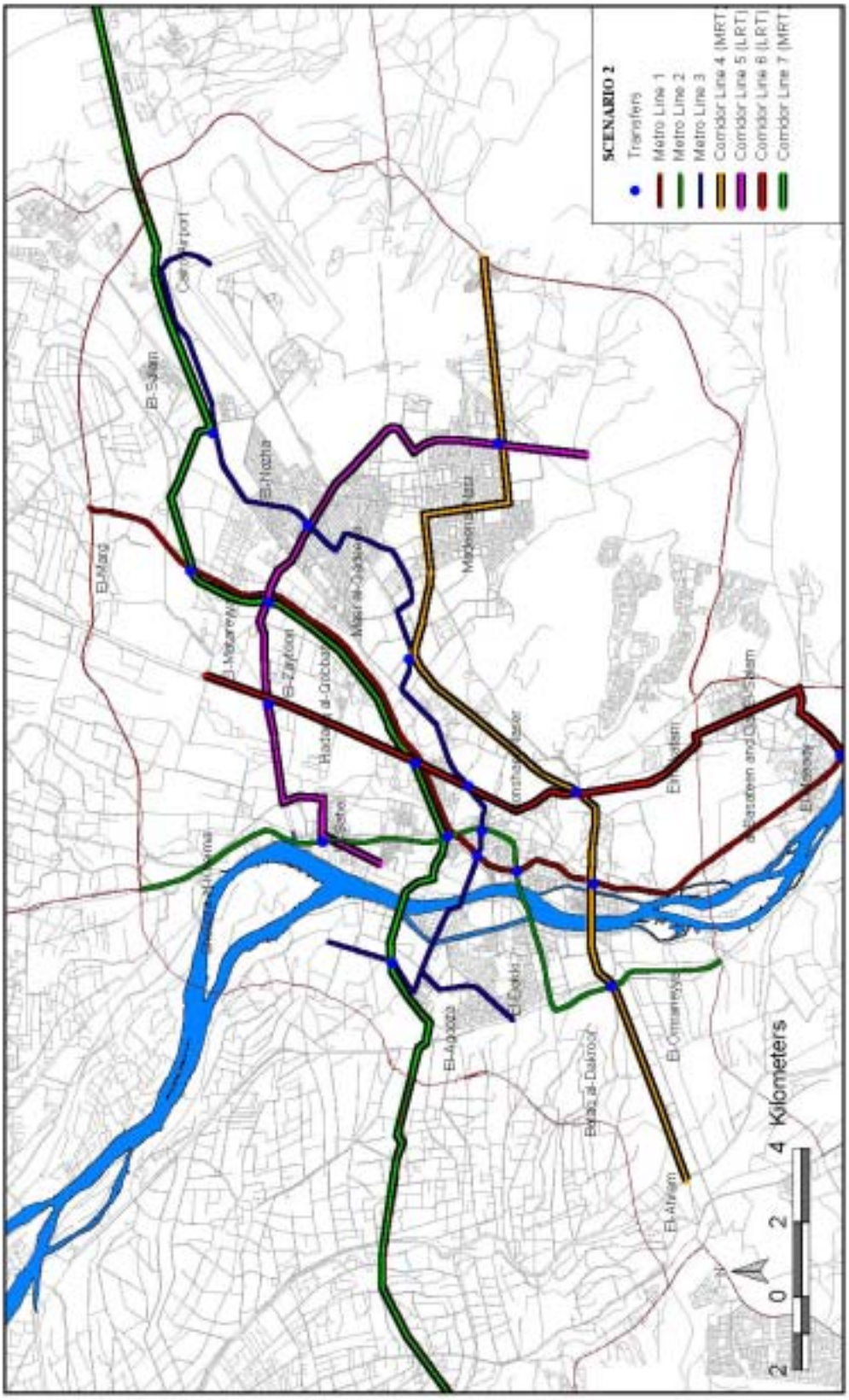


Figure 4.6.8 Scenario 2 Network in 2022

• *MRT/LRT supply indicators*

The MRT/LRT network supply characteristics of scenario 2 are shown in Table 4.6.11.

Table 4.6.11 Scenario 2, MRT/LRT Supply Indicators in 2022

Line	Mode	Terminals	Length	Headway (Peak period)	Average speed
1	MRT	• New El Marg • Helwan	44 km	2 min	34 km/h
2	MRT	• Shobra el Kheima • Giza - Moneeb	23 km	2 min	38 km/h
3	MRT	• Cairo Airport • Imbaba (branch 1) • Boolaq (branch 2)	33 km	2 min	38 km/h
C4	MRT	• Nasr City • Giza Pyramids	27 km	2 min	38 km/h
C5	LRT	• Nasr City • Shobra el Kheima	22 km	2 min	28 km/h
C6	LRT	•Maadi •Port Said Street	20 km	2 min	28 km/h
C7	MRT	• 6th of October • 10th of Ramadan	96 km	10 min	80 km/h
Total and averages			265 km	3.1 min	41 km/h

Source: JICA Study Team

• *The tramway network*

The tramway network in Cairo is currently operated on 18 lines with 89 km of tracks. A low service level and extensive ineffectual common sections of lines characterize each line.

Rehabilitation of the existing tramway network, notably the segregated tracks, should be considered as a good opportunity to obtain an efficient and modern mode of transport at a low cost.

In the frame of a tramway network reorganization, all the scenarios (except Number 1) recommend rehabilitation and segregation of the tramway tracks as well as priority at crossings during operations. As a result, the tramway will offer higher commercial speeds, reach a higher level of availability and increase its ridership.

The reorganization of the tramway network has the following objectives :

- serve and connect the main peripheral trip generators;
- feed the MRT/LRT network from dense areas not directly served by these systems and to complement the overall transport network of GC; and,

- relieve the MRT network along the main corridors where the demand exceeds the supply, e.g. the present case for line 1 between Matareya and Tahrir. The tramway network has to serve short distance trips whereas the MRT has to serve long-distance ones.

The proposed tramway network is based on a rationalization of the existing lines in order to make it faster and more attractive. The headways of the lines should be low enough to serve a maximum number of passengers and to ensure the regularity of the system so that a timetable is unnecessary. As with the MRT, people should know that a tramway is always available within short time. In this regard, the headway should not exceed 10 minutes during the day.

Tramway lines should be protected against car traffic with a physical barrier, such as the construction of a curb all along the tracks. At crossings, where no physical barrier is possible, traffic lights should be implemented and their efficiency ensured by police officers.

Following the reorganization and rationalization of the existing lines, the proposed tramway network is shown in Table 4.6.12.

Table 4.6.12 Scenario 2, Tramway Network Description in 2022

Line	Length (km)	Starting at	Ending at
T1	14.30	Attaba	Nasr City
T2	15.90	Sheraton	Nasr City
T3	13.20	Ramses	Almaza
T4	11.20	Ramses	Military college
T5	13.00	Ramses	Sheraton
T6	10.20	Attaba	Almaza
T7	11.10	Helwan	Tebbin
T8	13.70	Helwan	15th May
T9	3.90	Helwan	Helwan University

Source: JICA Study Team

The proposed tramway lines can be classified according to their functional characteristics :

- Feeder tramway lines to the MRT lines from remote areas : T1 and T2 connect to M3; T3 connects to M3 and M1; T7, T8 and T9 connect to M1 Helwan terminal.
- Main tramway lines serving important areas not served by the MRT : T8,T1 and T2.
- Tramway lines coping with the short distance demand and relieving congested MRT lines : T3, T4 and T5.

In this scenario, new tracks are planned along El Azhar Street, which is consistent with the rehabilitation of the El Azhar street area and the demolition of the El Azhar viaduct.

The tramway network of scenario 2 is shown in Figures 4.6.9 and 4.6.10.

• *Tramway supply indicators*

The tramway network supply characteristics are shown in Table 4.6.13.

Table 4.6.13 Scenario 2, Tramway Supply Indicators in 2022

Line	Line Name	Length (km)	Average comm. Speed (km/h)	Average peak hour headway (min)
T1	Attaba Nasr City	14.30	22 km/h	4 min
T2	Sheraton Nasr City	15.90	22 km/h	4 min
T3	Ramses Almaza	13.20	22 km/h	4 min
T4	Ramses Military college	11.20	22 km/h	4 min
T5	Ramses Sheraton	13.00	22 km/h	4 min
T6	Attaba Almaza	10.20	22 km/h	4 min
T7	Helwan Tebbin	11.10	22 km/h	6 min
T8	Helwan 15th May	13.70	22 km/h	6 min
T9	Helwan Helwan University	3.90	22 km/h	6 min
Total and averages		106.5 km	22 km/h	4.7 min

Source: JICA Study Team

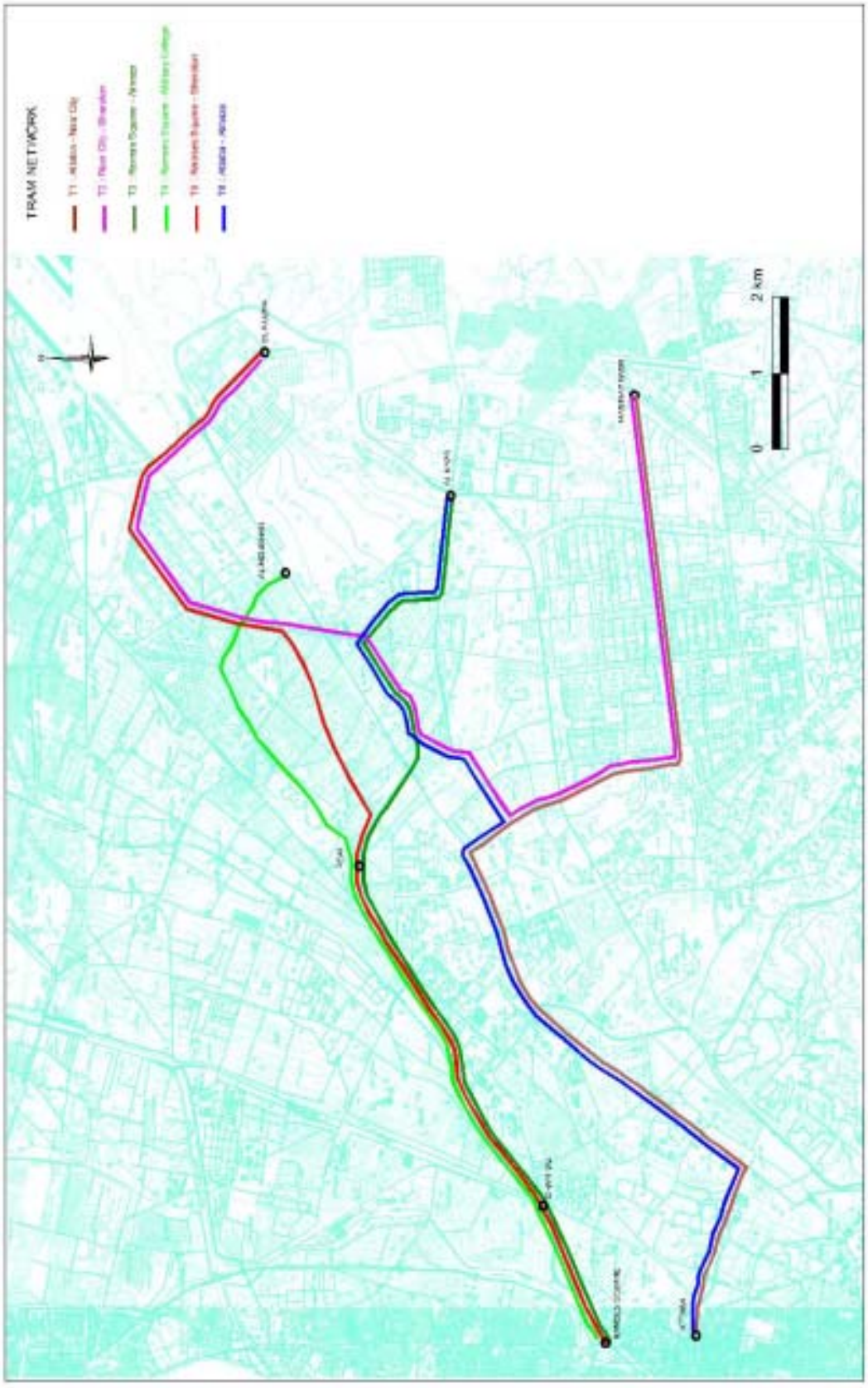


Figure 4.6.9 Scenario 2 Tram Network in Heliopolis in 2022

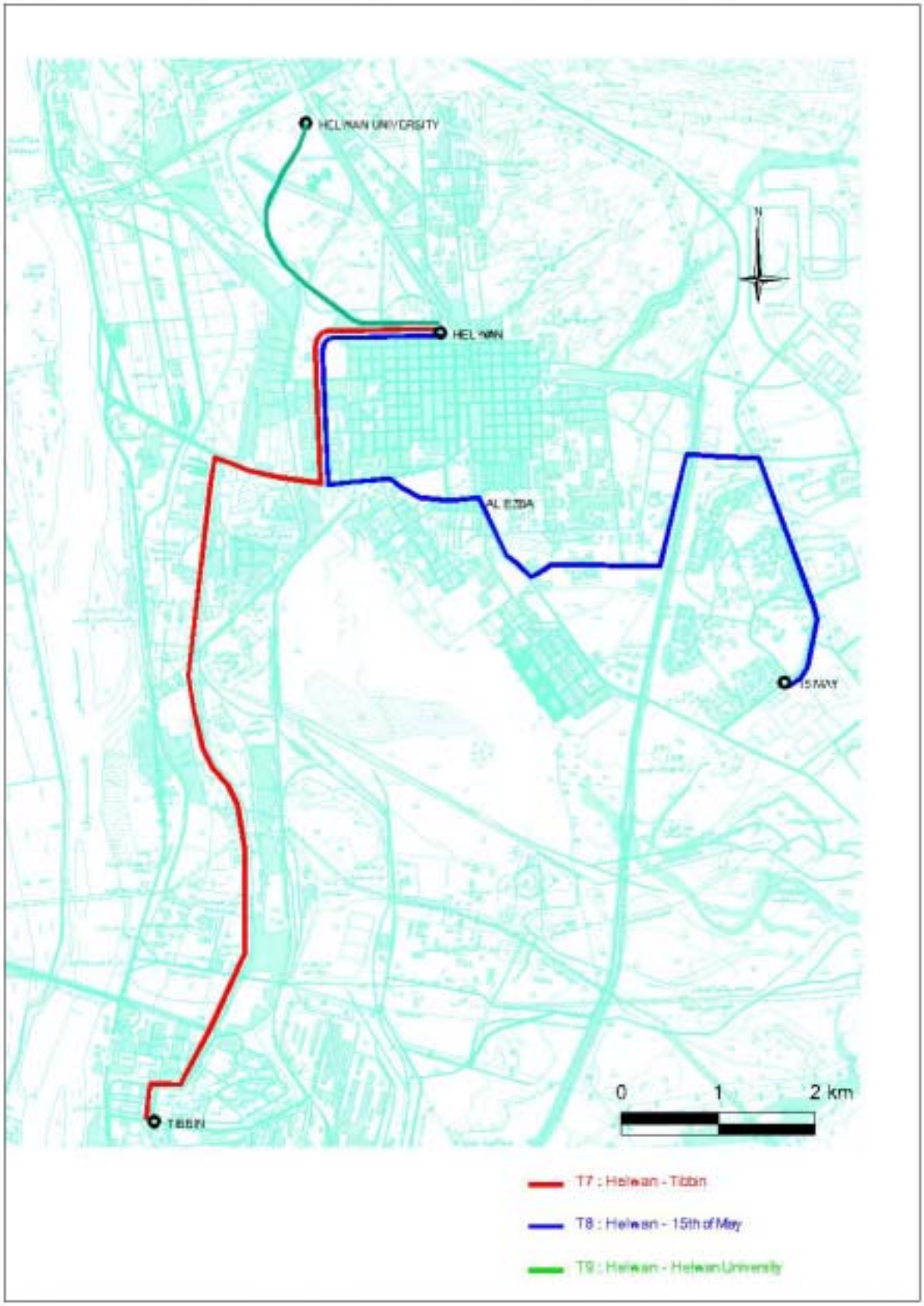


Figure 4.6.10 Scenario 2, Tram Network in Helwan in 2022

• The ENR suburban network

A project, which is currently under investigation by ENR, will be tested in this scenario, the "wings" line. It concerns a MRT connection between 6th of October and 10th of Ramadan cities, which runs from Cairo station and follows the existing railway until Imbaba, then turns right at the 26th of July corridor. This line connects with MRT lines 1 and 2 at Mubarak Station and MRT line 3 at Imbaba (see corridor line 7 in Table 4.6.14).

Consequently, the existing line 5 (Ain Shams – El Robaiky) is upgraded to line 7, and line 8 (Cairo – 6th of October) is cancelled.

This scenario also takes into account the rehabilitation of the other existing suburban lines with an important upgrading of the headway to 10 minutes.

Table 4.6.14 Scenario 2, Suburban Rail Network Description in 2022

Line	Length (km)	Starting at	Ending at
R1	14.0	Cairo	Qalyob (to Alexandria)
R2	23.5	Cairo	Qalyob / Qanater El Khayreya
R3	32.0	Cairo	Qalyob / Shebeen El Qanater
R4	20.0	El Marg	Shebeen El Qanater
Corridor line 7	96.0	6th of October City	10th of Ramadan
R6	20.0	Cairo	Imbaba / El Manashi
R7	37.0	Cairo	El Maraziek
Total	**242.5**		

Source: JICA Study Team

• ENR supply indicators

The suburban rail network supply characteristics of scenario 2 are shown in Table 4.6.15.

Table 4.6.15 Scenario 2, Suburban Rail Supply Indicators in 2022

Line	Line Name (origin, intermediate, destination)	Length (km)	Average speed (km/h)	Peak hour headways (min)
R1	Cairo / Qalyob (to Alexandria)	14.0	40	10
R2	Cairo / Qalyob / Qanater El Khayreya	23.5	40	10
R3	Cairo / Qalyob / Shebeen El Qanater	32.0	40	10
R4	El Marg / Shebeen El Qanater	20.0	40	10
C7	6th of October / 10th of Ramadan	96.0	80	10
R6	Cairo / Imbaba / El Manashi	20.0	40	10
R7	Cairo / El Maraziek	37.0	40	10
	Totals and Averages	**242.5**	**46**	**10**

Source: JICA Study Team

(2) Population, Employment and Student Densities

In the reference scenario we identified various sectors in Greater Cairo with high population, employment and student densities which were not served by the 3 MRT lines (Figures 4.6.11, 4.6.12 and 4.6.13).

The corridors of public transport systems 4, 5 and 6 have been defined accordingly in due respect of the remaining criteria.

The corridor line 4 serves the important Al-Haram St. corridor which has high population and job densities, but crosses a low density sector South of Downtown and West of Nasr City. In Nasr City, an important job sector is served, but this is also achieved with the next proposed line 5 corridor. This is the circumferential line which crosses important population and job sectors in Heliopolis, Mostorod Bahtim and Shobra El Kheima.

Corridor line 6 corridor serves the high-density population end employment corridor along the Port Said street axis and Mostorod Bahtim. This line also successfully crosses the Downtown sector which has a high population and student density as well as low incomes.

Table 4.6.16 summarizes the number of inhabitants, jobs and student students served within a distance of 800 meters from the network corridors.

Table 4.6.16 : Scenario 2, Socio-economic Performance of Each Line in 2022

Line	Population	Employed	Students	Total Ratio (*)
1	1 073 525	475 617	362 667	0.18
2	1 021 347	566 672	358 488	0.19
3	1 130 199	729 072	402 710	0.23
C4	578 280	205 454	249 730	0.10
C5	803 023	232 542	210 639	0.11
C6	2 050 359	637 537	567 155	0.29
C7	2 155 915	773 200	473 338	0.46
Total network	**8 812 648**	**3 620 094**	**2 624 727**	
TOTAL study area	**20 721 175**	**6 966 250**	**5 771 269**	

(*) Total ratio = Pop./total pop. + Emp./total emp. + Stu./total stu.

As seen from the ratios, corridor lines 6 - and especially line 7 serving the new cities - are very interesting options. For both lines, the number of population served is above all very important. Corridor lines 4 and 5 show moderate results.

Please note that the above data of corridor line 7 include the population, employed and students in the new cities 6th of October and 10th Ramadan.

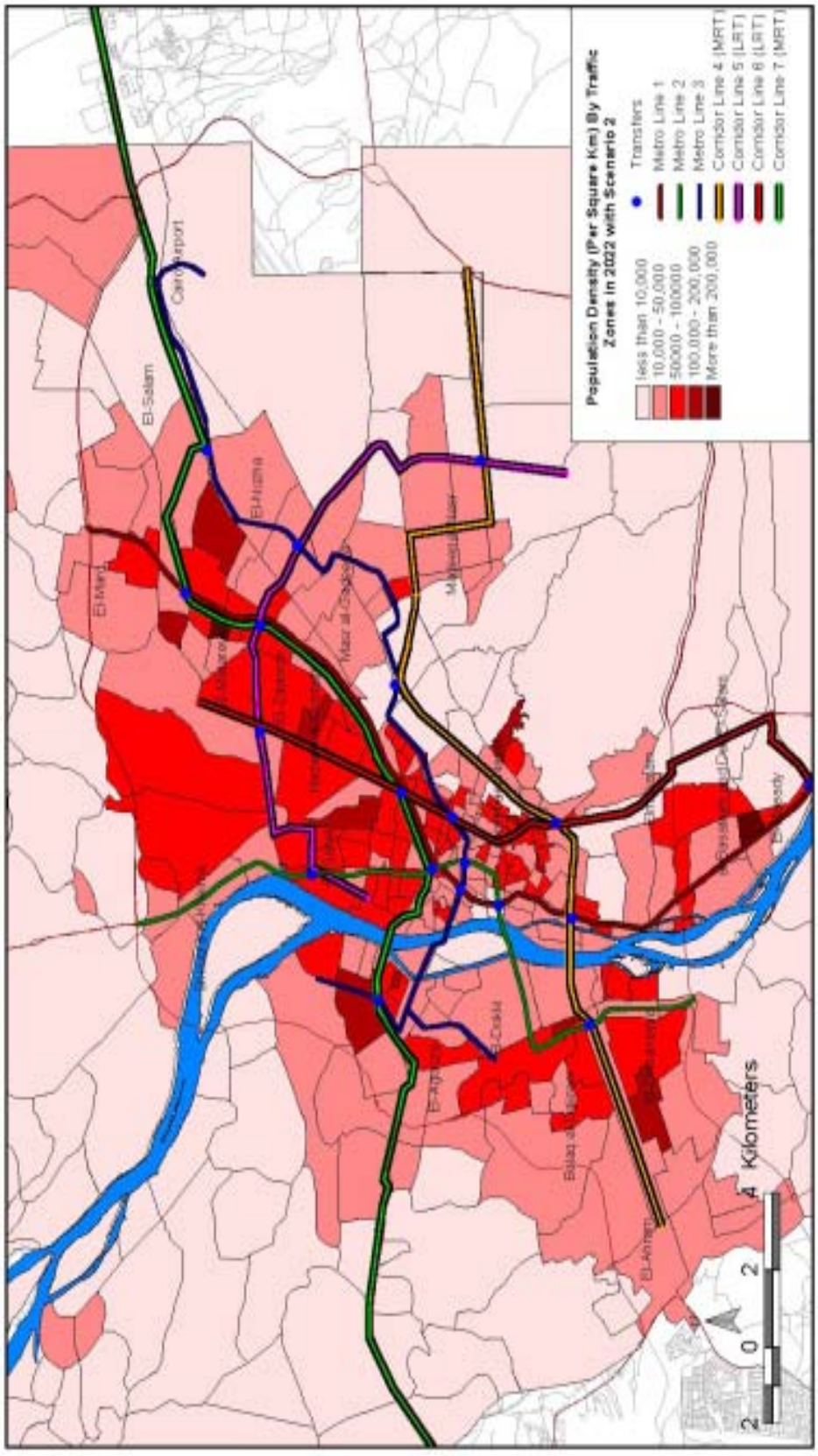


Figure 4.6.11 Scenario 2 and Population Densities in 2022

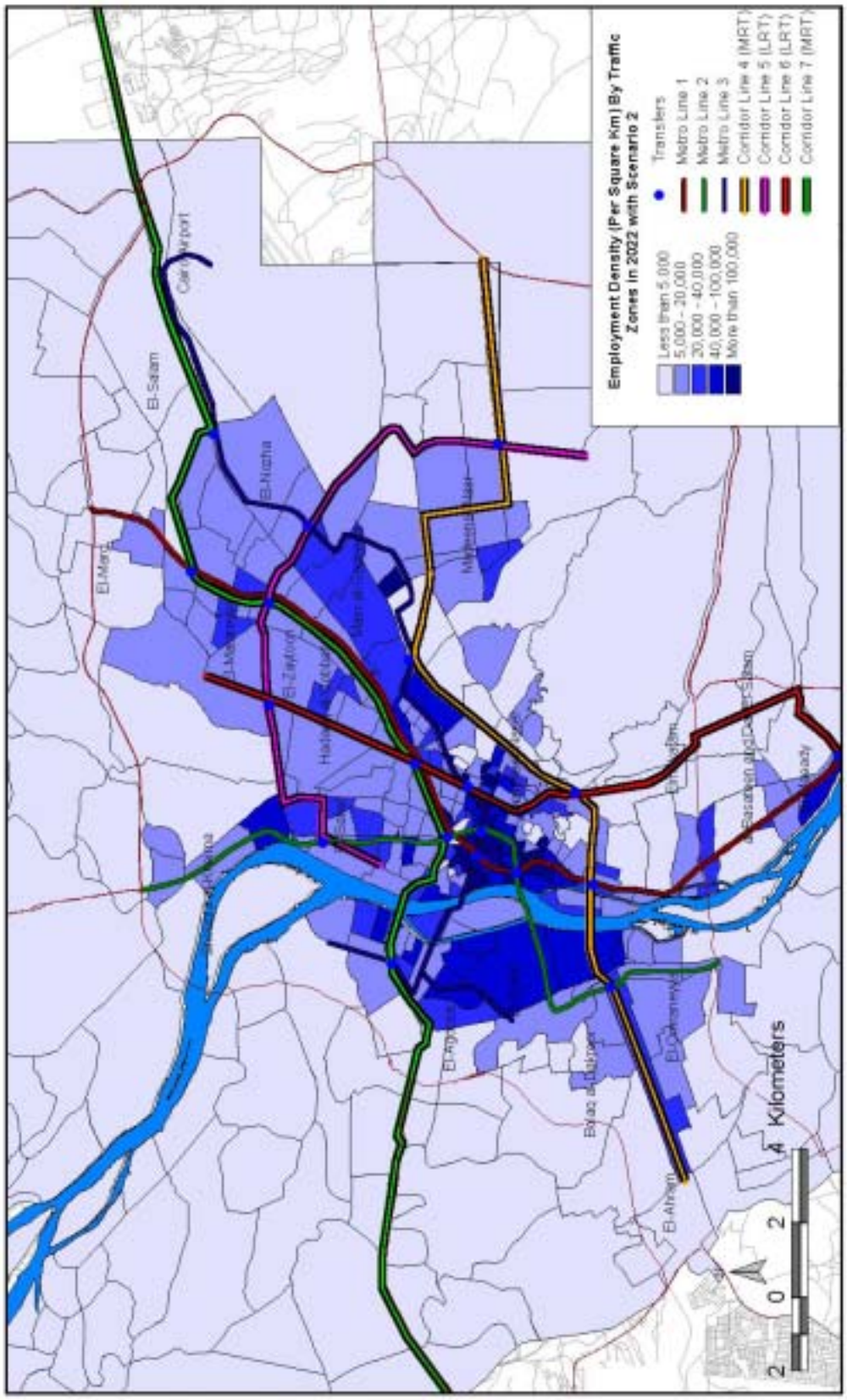


Figure 4.6.12 Scenario 2 and Employment Densities in 2022

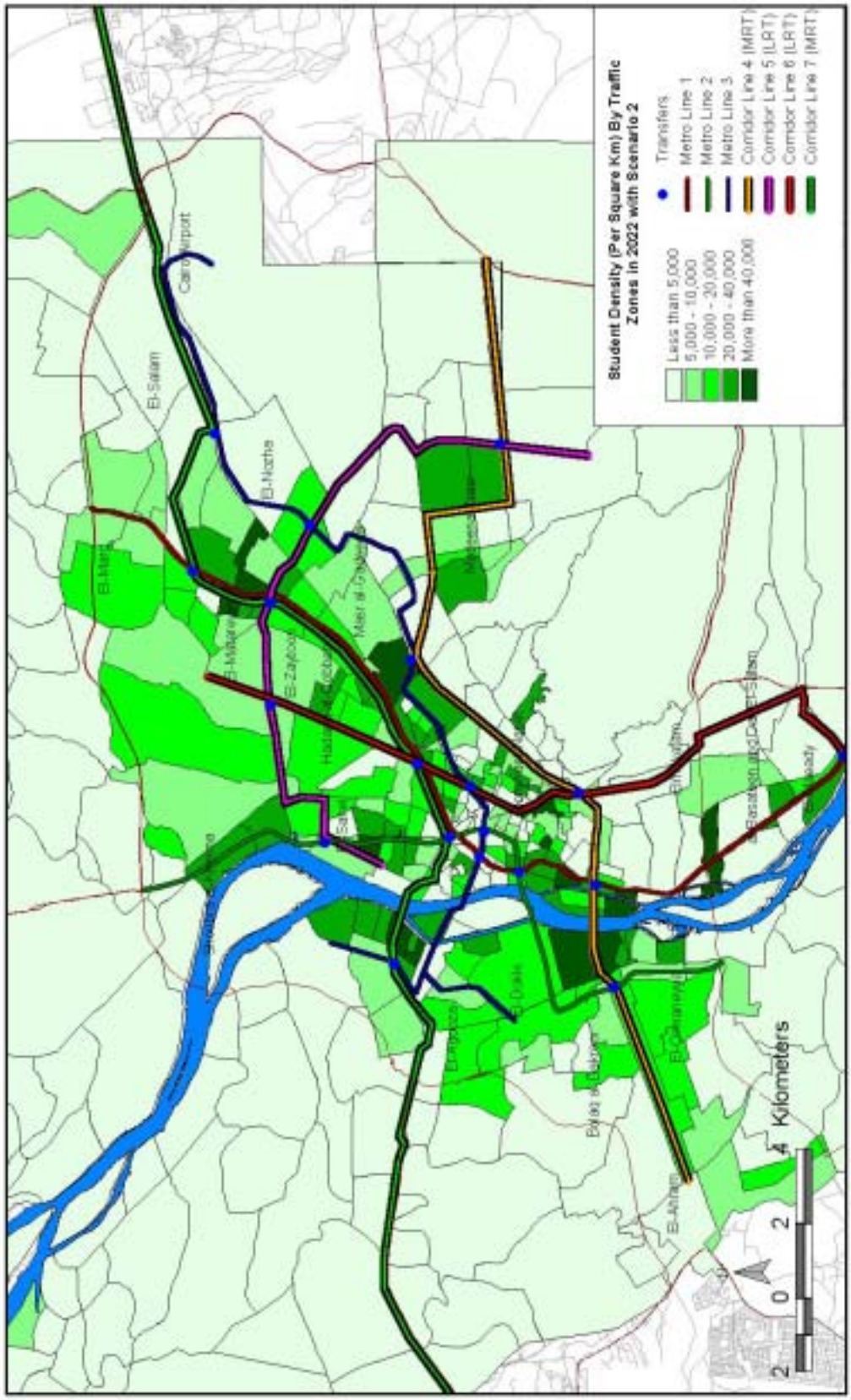


Figure 4.6.13 Scenario 2 and Student Densities in 2022

(3) Transport Demand

The results of the demand simulation for the scenario 2 are shown in Table 4.6.17.

Table 4.6.17 Scenario 2, Demand Simulations in 2022

Mode	Average daily passengers (million)				
	2001	Modal Split (%)	2022	Modal Split (%)	% Increase
Formal PRT (*)	4.299	32.3	2.445	13.3	-43
Informal PRT (**)	6.696	50.2	5.287	28.7	-21
TOTAL PRT	**10.995**	**82.5**	**7.732**	**42.0**	**-30**
MRT/LRT	**2.021**	**15.2**	**9.076**	**49.3**	**349**
ENR	**0.132**	**1.0**	**1.124**	**6.1**	**749**
TOTAL TRAM	**0.171**	**1.3**	**0.460**	**2.5**	**169**
Ferry	0.010	0.1	0.003	0.0	-67
TOTAL	**13.329**	**100.0**	**18.396**	**100.0**	

(*) CTA and GCBC (**) Shared taxis and private mini buses. PRT : Public Road Transport.

The positive tendencies for the public transport network observed in the reference scenario will be considerably reinforced in scenario 2. The ENR ridership will increase even more thanks to, on the one hand, the introduction of a MRT system on corridor line 7, which connects 6th of October City with 10th of Ramadan via CBD, and on the other hand, the general upgrading of the network's headways to 10 minutes. These improvements lead to an increased ridership in public transport of 992,000 passengers/day compared to the reference scenario.

The MRT/LRT increases its modal share so as to become the most important public transport mode in Greater Cairo.

The tram network looses ridership to corridor line 5 which intersects the MRT line 3 in the middle of the Heliopolis area. In the meantime, however, the tram network gains considerably more in ridership due to the general increase in mobility in both Helwan and Heliopolis.

The trip volume forecasts for the seven MRT/LRT lines proposed in scenario 2 are shown in Table 4.6.18.

Table 4.6.18 Scenario 2, MRT/LRT Daily Trips Demand in 2022

Line	Boarding Pass(million)	Pass-km (million)	Pass/km (1,000)	Max loaded section	Section one-way traffic
1	2.504	25.344	58.2	Murbarak	608,000
2	1.681	11.395	73.1	Murbarak	538,000
3	1.875	13.999	62.5	Imbaba	530,000
C4	1.254	10.169	46.4	El Haram	393,000
C5	0.945	5.492	47.3	El Matareya	292,000
C6	0.817	4.987	43.0	Magles El Shaab	230,000
C7	0.547	12.998	6.1	6th of October	222,790
TOTAL	**9.623**	**84.383**	-	-	-

Source: JICA Study Team

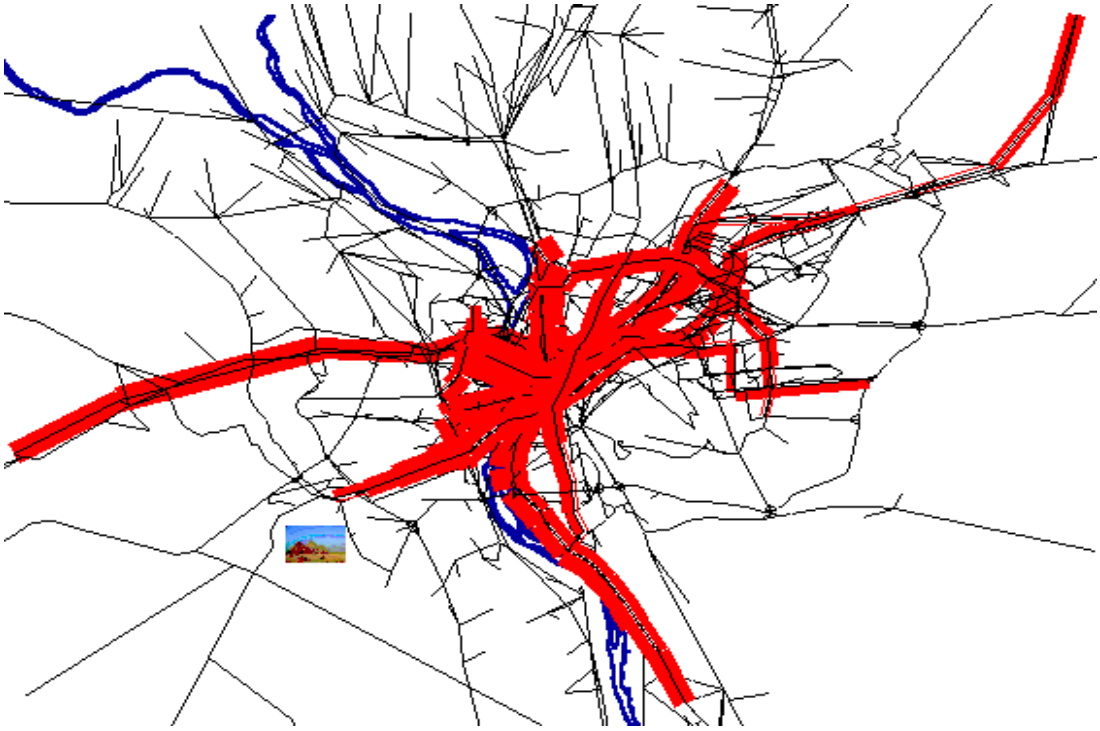
Compared to the reference scenario, line 1 has better operational results, with a higher demand and utilization per km and lower peak hour traffic.

In terms of utilization, MRT line 2 remains the most heavily loaded, each line, with the exception of C7, performing better than current levels for MRT systems in the world. In comparison, MRT lines 1 and 2 currently have a high utilization around 35 thousand passengers/km.

In order to cope with the peak hour traffic on the most heavily loaded sections, the proposed corridor line 4 will require a MRT system running at 3 minutes headway, and the corridor lines 5, 6 and 7 will require LRT systems.

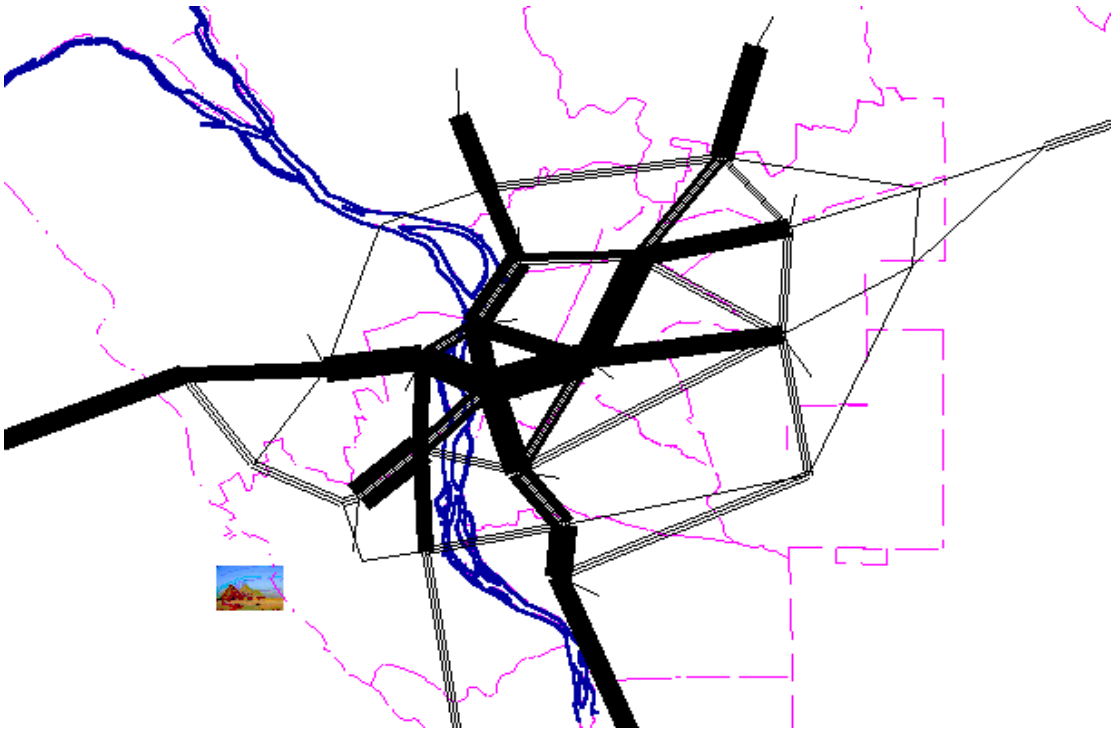
The bandwidth diagram output from the CREATS model, shows the load on each MRT and LRT proposed corridor projects. It clearly indicates that there is a stronger potential for creating a corridor which combines the West section of line 4, i.e. essentially the Al-Haram St., with the North section of line 6 (Figure 4.6.14).

The link to 6th of October and 10th of Ramadan is tested as a MRT line in this scenario. It shows strong potential on the West section along the 26th July corridor identified in scenario 1. On the far West section to 6th of October, and the East section between Ain Shams and 10th of Ramadan, the loads do not appear sufficient for a MRT system. This is confirmed in the previous analysis concerning the daily trips demand as the total number of daily trips on this line is too low for a MRT. A more conventional type of suburban express rail system should be considered instead. It should provide sufficient capacity to cater approximately 20,000 passengers/hour/direction during the peak on the most loaded section in 6th of October. As it can be seen from Figure 4.6.15, The MRT/LRT network in scenario 2 satisfies all the main public transport flows in Greater Cairo.



Source: JICA Study Team

Figure 4.6.14 MRT Bandwidth Diagram of Scenario 2 in 2022



Source: JICA Study Team

Figure 4.6.15 Scenario 2 Spider Diagram in 2022

(4) Low Income Areas

The central section of corridor line 4, and almost the totality of line 6, serve the poor income areas of Cairo and should be considered as interesting options. The west section of corridor line 7, between Imbaba and 6th of October City crosses a vast low-income area which could obtain direct access into Cairo.

(5) Interfaces

The highest level of supply in urban transportation is obtained when all modes are considered together as a single network. Creating as many interfaces as possible and coherency between the modes is essential for obtaining an effective network. Table 4.6.19 summarizes the interfaces of the proposed corridor lines.

Table 4.6.19 Interfaces of Scenario 2 in 2022

Line	Number of connections by line(1)	Total
1	2 x M2, 1 x M3, 1 x C4, 1 x C5, 1 x C6, 4 x C7	10
2	2 x M1, 1 x M3, 1 x C4, 1 x C5, 1 x C7	6
3	1 x M1, 1 x M2, 1 x C4, 1 x C5, 1 x C6, 2 x C7	7
C4	1 x M1, 1 x M2, 1 x M3, 1 x C5, 1 x C6	5
C5	1 x M1, 1 x M2, 1 x M3, 1 x C4, 1 x C6, 1 x C7	6
C6	1 x M1, 1 x M3, 1 x C4, 1 x C5, 1 x C7	5
C7	4 x M1, 1 x M2, 2 x M3, 1 x C5, 1 x C6	9
TOTAL		**48**

(1) For example, Metro Line 3 has one connection (joint station) point each with Metro Line 1, Metro Line 2, Corridor Line 4, Corridor Line 5 and Corridor Line 6, as well as two connections with Corridor Line 7. The total number of connections with other rail lines is seven (refer Figure 4.6.8 for depiction of lines).

Source: JICA Study Team

In most cases, the CBD can be reached from all parts of GC directly with no transfer, or with only one transfer among the public modes. This shows the good performance of the whole PT network.

(6) Physical Constraints

All of the proposed corridor lines follow the main road corridors in Cairo with the least interference with underground facilities and buildings. Furthermore on various sections they employ already existing tracks or right-of-ways.

4.6.5 Scenario 3

(1) Network Description

- *The MRT/LRT/busway network*

Following an analysis of the performance of the various proposed transport corridors and systems in scenario 2, we arrive at the following adaptations for The MRT/LRT network:

- The branch 2 of line 3 is extended to Behooth station on the line 2.
- The South section of Corridor line 6 is curtailed so as to connect it to line 1 and West of corridor line 4 at Sayeda-Zeinab.
- Corridor line 5 is extended to 15th of May Bridge.
- As a part of a step-down process, corridor lines 5 and 6 are tested as busways instead of LRT systems.
- Corridor line 7 is replaced by 7* which connects the 6th of October to 10th of Ramadan via the South part of Cairo in the same corridor as line 4.
- In the same time, the MRT system in this corridor is replaced with a conventional suburban train.
- The East section of corridor line 7 from Ain Shams to 10th of Ramadan is maintained.
- A new corridor line C8 with a busway system is introduced from Nasr City to Shobra in order to satisfy the demand observed on this axis.

The proposed scenarios are summarized in Table 4.6.20 and depicted in Figure 4.6.16.

Table 4.6.20 Scenario 3, Network Description in 2022

Line	Type	Length	Starting at	Passing through	Ending at
1	MRT	44 km	New El Marg	CBD area	Helwan
2	MRT	23 km	Shobra el Kheima	CBD area	Giza – Moneeb
3	MRT	34 km	Cairo Airport	CBD- Mohandiseen	Imbaba (branch 1) Behoos (branch 2)
C4	MRT	27 km	Nasr City	Abaseya-Roda Island	Giza Pyramids
C5	Busway	24 km	Nasr City	Heliopolis	15the of May Bridge
C6	Busway	10 km	Sayeda-Zeinab	CBD (East)	Port Said Street
C7*	Express train	102 km	6th of October	Abaseya-Roda Island	10th of Ramadan
C8	Busway	9 km	Nasr City	Abaseya	Shobra

Source: JICA Study Team

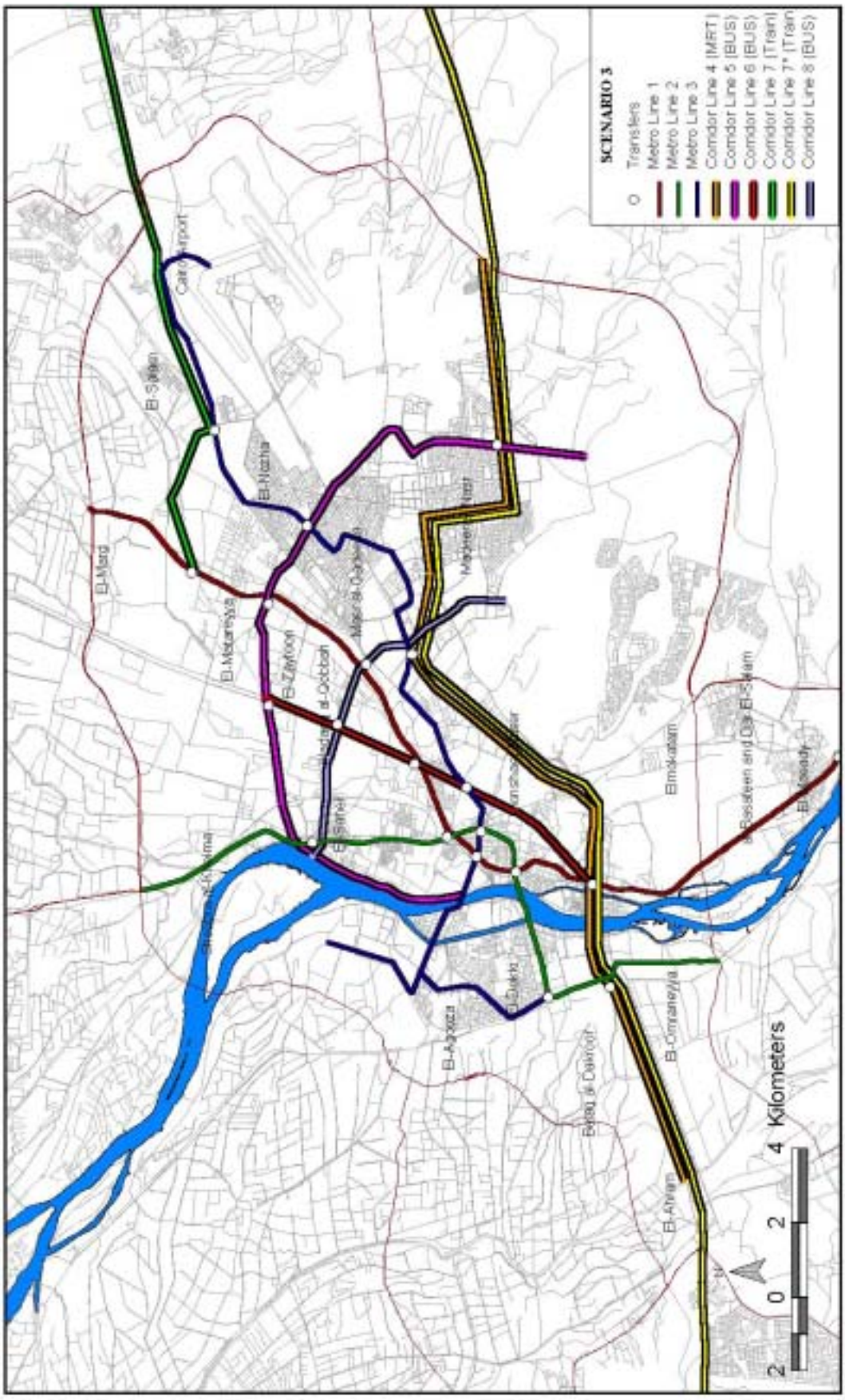


Figure 4.6.16 Scenario 3 network in 2022

• MRT/LRT/busway supply indicators

The MRT network supply characteristics of scenario 3 are shown in Table 4.6.21.

Table 4.6.21 Scenario 3 : Network Supply Indicators in 2022

Line	Mode	Terminals	Length	Headway (Peak period)	Average speed
1	MRT	• New El • Marg Helwan	44 km	2 min	34 km/h
2	MRT	• Shobra el Kheima • Giza – Moneeb	23 km	2 min	38 km/h
3	MRT	• Cairo Airport • Imbaba (branch 1) • Behoos (branch 2)	34 km	2 min	38 km/h
C4	MRT	• Nasr City • Giza Pyramids	27 km	2 min	38 km/h
C5	Busway	• Nasr City • 15th of May Bridge	24 km	2 min	32 km/h
C6	Busway	• Sayeda-Zeinab • Port Said Street	10 km	2 min	20 km/h
C7*	Express train	• 6th of October • 10th of Ramadan	102 km	10 min	80 km/h
C8	Busway	• Nasr City • Abaseya	9 km	4 min	20 km/h
TOTAL and AVERAGE			**273 km**	**3.3 min**	**37.5 km/h**

• The tramway network

The tramway network in this scenario is identical to the one in scenario 2.

• The ENR suburban network

Due to a small load on corridor line 7 from 6th of October to 10th of Ramadan in scenario 2, the corridor is downgraded to a conventional suburban train on the Ain Shams – 10th of Ramadan link.

Corridor line 7* replaces the current line 8 from Cairo to 6th of October city.

The scenario 3 takes into account the rehabilitation of the existing suburban lines with a decrease of the headway to 10 minutes (Table 4.6.22).

Table 4.6.22 Scenario 3 Suburban Rail Network Description in 2022

Line number	Length (km)	Starting at	Ending at
R1	14.0	Cairo	Qalyob (to Alexandria)
R2	23.5	Cairo	Qalyob / Qanater El Khayreya
R3	32.0	Cairo	Qalyob / Shebeen El Qanater
R4	20.0	El Marg	Shebeen El Qanater
Corridor line 7	46.0	Ain Shams	10th of Ramadan
R6	20.0	Cairo	Imbaba / El Manashi
R7	37.0	Cairo	El Maraziek
Corridor line 7*	102.0	6th of October	10th of Ramadan
Total	**294.5**		

Source: JICA Study Team

• *ENR supply indicators*

The suburban rail network supply characteristics of scenario 3 are shown in Table 4.6.23.

Table 4.6.23 Scenario 3 Suburban Rail Supply Indicators in 2022

Line	Line Name (origin, intermediate, destination)	Length (km)	Average speed (km/h)	Peak hour headways (min)
R1	Cairo / Qalyob (to Alexandria)	14.0	40	10
R2	Cairo / Qalyob / Qanater El Khayreya	23.5	40	10
R3	Cairo / Qalyob / Shebeen El Qanater	32.0	40	10
R4	El Marg / Shebeen El Qanater	20.0	40	10
C7	Ain Shams / 10th of Ramadan	46.0	50	10
R6	Cairo / Imbaba / El Manashi	20.0	40	10
R7	Cairo / El Maraziek	37.0	40	10
C7*	6th of October / 10th of Ramadan	102.0	80	10
	Totals and Averages	**294.5**	**46**	**10**

Source: JICA Study Team

(2) Population, Employment and Student Densities

Although the corridor line 6 has been reduced and the corridor line 7 has been diverged, the most important socioeconomic areas are still served.

The introduction of corridor line 8 allows for serving important population, employment and student areas along Madraset Al-Mamaleek St., Manshiyyt Al-Gamel St. and Seket El-Waily St.

Table 4.6.24 summarizes the number of inhabitants, jobs and student students served within a distance of 800 meters from the network lines.

Table 4.6.24 Scenario 3, Socio-economic Performance of Each Line in 2022

Mode	Population	Employed	Students	Total Ratio (*)
1	1 073 525	475 617	362 667	0.18
2	892 245	496 638	314 165	0.17
3	1 166 745	781 772	499 754	0.26
C4	578 280	205 454	249 730	0.10
C5	842 480	290 889	239 547	0.12
C6	835 346	372 286	194 355	0.13
C7	1 142 029	389 900	212 145	0.15
C7*	1 991 519	873 890	709 120	0.34
C8	560 259	199 064	221 334	0.09
Total network	**9 082 429**	**4 085 509**	**3 002 818**	
TOTAL study area	**20 721 175**	**6 966 250**	**5 771 269**	

(*) Total ratio = Pop./total pop. + Emp./total emp. + Stu./total stu.

Neither corridor lines 4 nor 7* are optimal in terms of socioeconomic performance due to the eastern section of these corridors which cross low density areas in the vicinity of Emtedad Ramses St. In the following scenario, these sections will be avoided.

Corridor lines 3 and 5 shows a slightly better performance due to the extensions to Behoos station and to 15th of May Bridge respectively.

Figures 4.6.17, 4.6.18 and 4.6.19 depict socio-economic relationships vis-à-vis major transport lines.

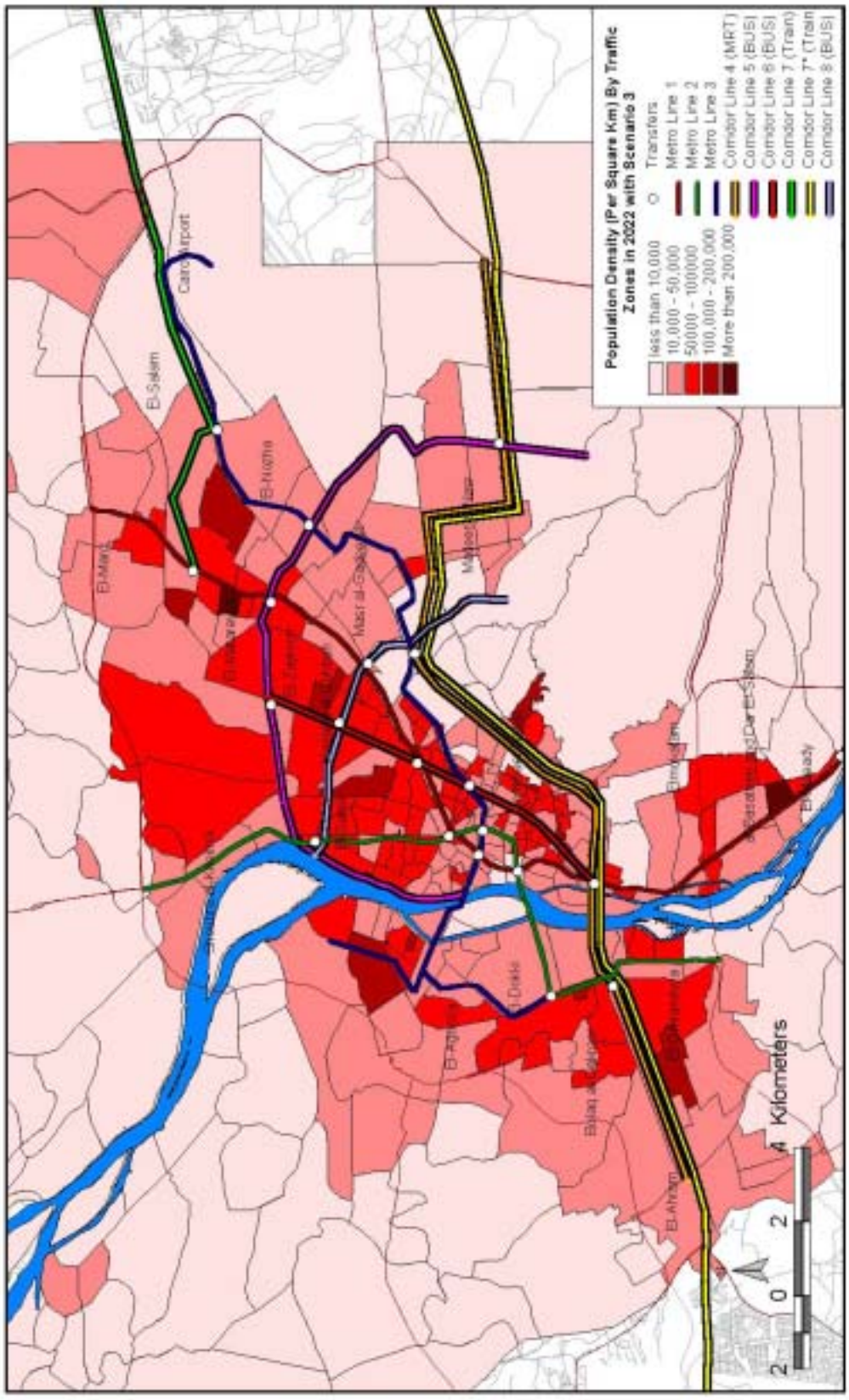


Figure 4.6.17 Scenario 3 and Population Densities

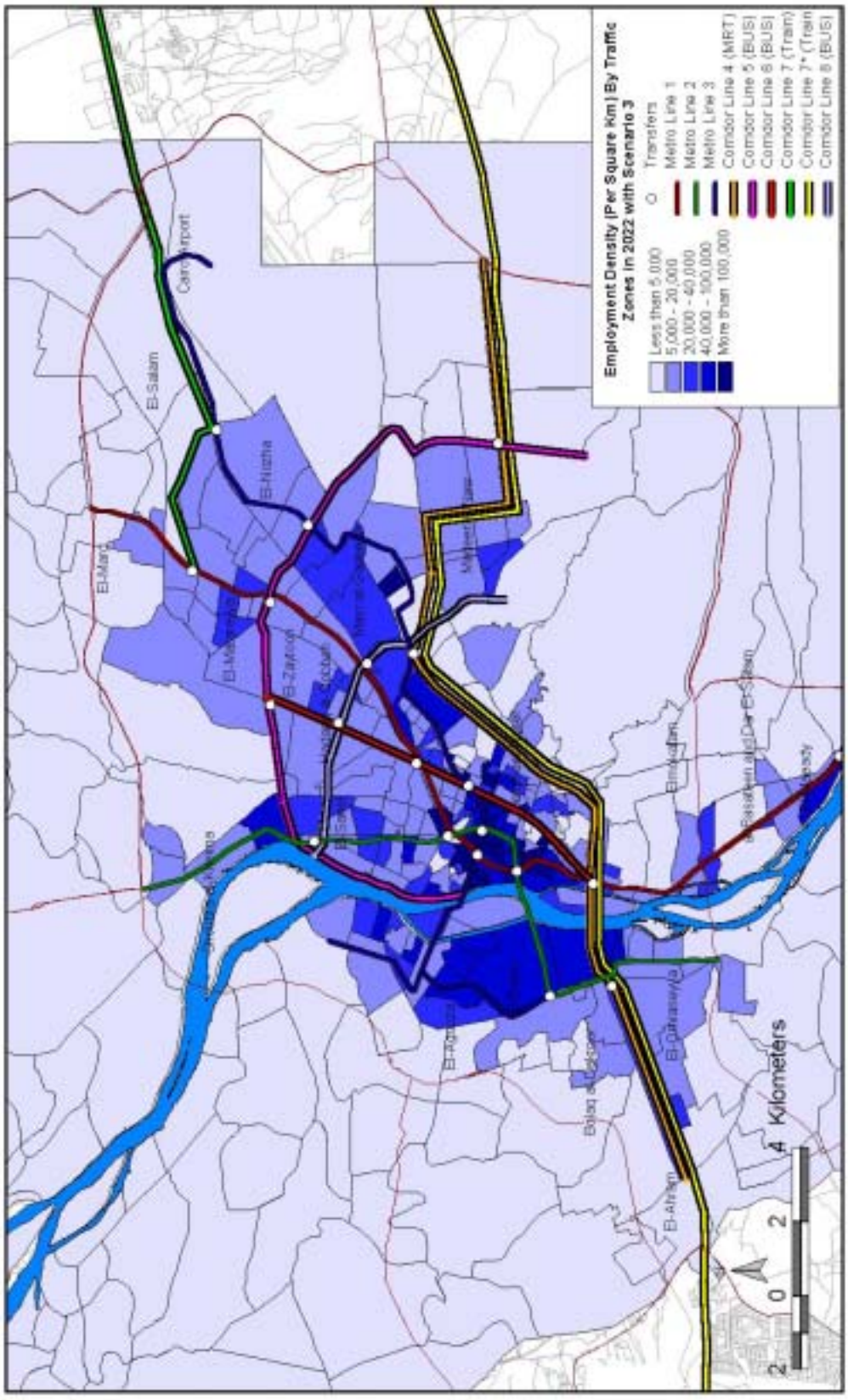


Figure 4.6.18 Scenario 3 and Employment Densities

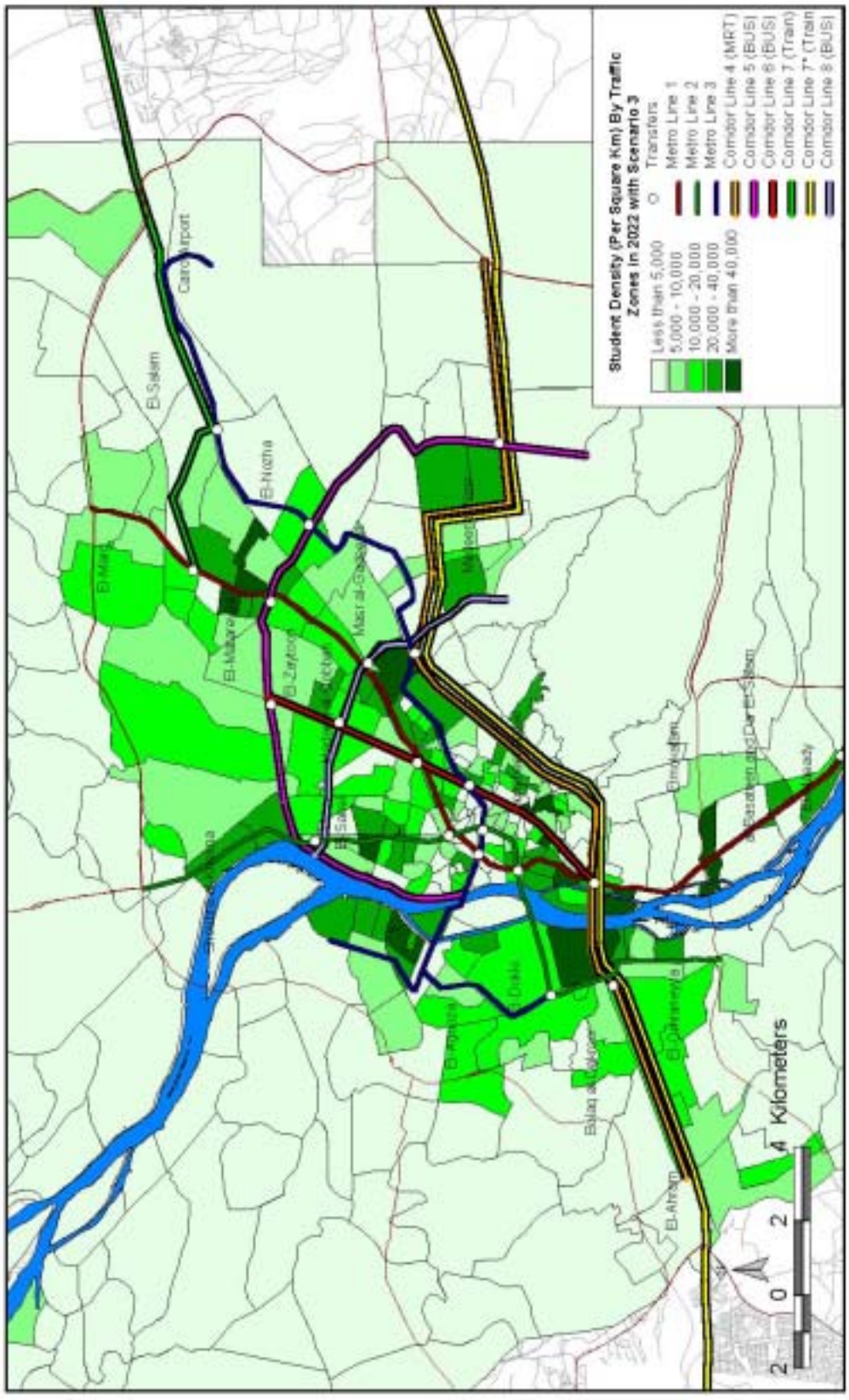


Figure 4.6.19 Scenario 3 and Student Densities

(3) Transport Demand

The results of the demand simulation for the scenario 3 are shown in Table 4.6.25.

Table 4.6.25 Scenario 3, Demand Simulations in 2022

Mode	Average daily passengers (million)				
	2001	Modal Split (%)	2022	Modal Split (%)	% Increase
Formal PRT (*)	4.299	32.3	3.181	16.7	-26
Informal PRT (**)	6.696	50.2	6.269	33.0	-6
TOTAL PRT	**10.995**	**82.5**	**9.451**	**49.7**	**-14**
MRT/LRT	**2.021**	**15.2**	**8.066**	**42.5**	**299**
ENR	**0.132**	**1.0**	**0.802**	**4.2**	**505**
TOTAL TRAM	**0.171**	**1.3**	**0.677**	**3.6**	**296**
Ferry	0.010	0.1	0.004	0.0	-62
TOTAL	**13.329**	**100.0**	**18.998**	**100.0**	

(*) CTA and GCBC (**) Shared taxis and private mini buses. PRT : Public Road Transport.

Public road transport obtains a higher market share (+7.7%) compared to scenario 2 due to the introduction of a busway on corridor lines 5 and 6 instead of LRT systems. In the same time the market share of the MRT/LRT systems drops by 6.8%. The ENR network naturally obtains a lower ridership due to the curtailment of corridor line 7. Since the corridor line 5 is changed into a busway system with less ridership, the tramway network in Heliopolis obtains better results than in the previous scenario. The trip volume forecasts for the corridor lines proposed in scenario 3 are shown in Table 4.6.26.

Table 4.6.26 Scenario 3, Network Daily Trips Demand in 2022

Line	Boarding Pass(million)	Pass-km (million)	Pass/km (1,000)	Section one-way traffic	Max loaded section
1	2.613	29.069	60.8	Mubarak	677,550
2	1.880	10.388	81.7	Mubarak	584,420
3	1.934	12.442	64.5	Zamalek	320,000
C4	1.639	14.060	60.7	El Haram	683,460
C5	0.504	2.298	22.9	El khalafawy	205,430
C6	0.126	0.463	12.6	Ahmed Maher	68,700
C7	0.080	1.190	2.0	Kilo 11	42,170
C7*	0.012	0.005	0.1	Nasr City	7,340
C8	0.134	0.426	14.9	Hadayek El Qoba	85,570

Source: JICA Study Team

- The three MRT lines obtain even better results in this scenario, on the one hand, due to the curtailment of corridor line 7, which alleviated line 1 on the central section, and

on the other hand, the extension of line 3 to Behoos station which favors both line 3 and line 2 in connection. The extension of corridor line 5 to 15th of May Bridge in connection with line 3 also increases the ridership of the latter.

- Corridor line 4 obtains even better results due to the connection with corridor lines 7* and 8.

- The attempt to connect 6th of October City with 10th of Ramadan through the South of Cairo (line C7*) has proved to be a bad solution compared to the corridor running parallel to metro line 1 in the previous scenario.

- In scenario 2, corridor line 5 was tested as a LRT and obtained a ridership in the upper limit, i.e. 30,000 on the most loaded section. In this scenario the demand is too important to be satisfied by a busway system.

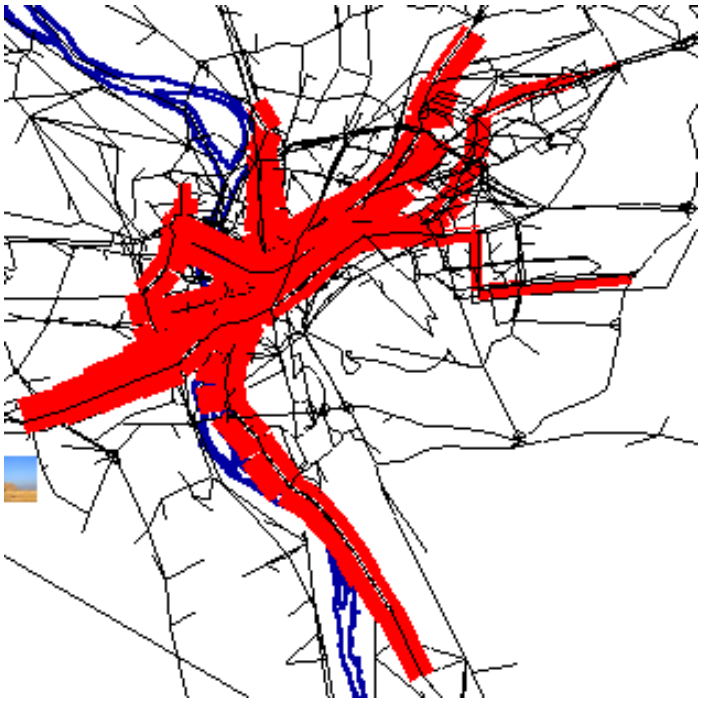
- The curtailment of the South section of corridor line 6 and its transformation into a busway gives reasonably good results since the peak hour ridership is around 7,000 passengers/hour/direction.

- The section of corridor line 7 between Ain Shams and 10th of Ramadan evidently will not require more than a busway.

- Finally, corridor line 8 provides good results for a high capacity busway system running at low headways.

The bandwidth diagram (Figure 4.6.20) is similar to the one of scenario 2, except that corridor lines 5 and 6 no longer appear as they are now tested as busways. Furthermore, the links to 6th of October and 10th of Ramadan are now tested as conventional ENR lines running parallel to corridor line 4 via Giza and Nasr City.

The West section of Corridor line 4 shows even stronger loads in this scenario.



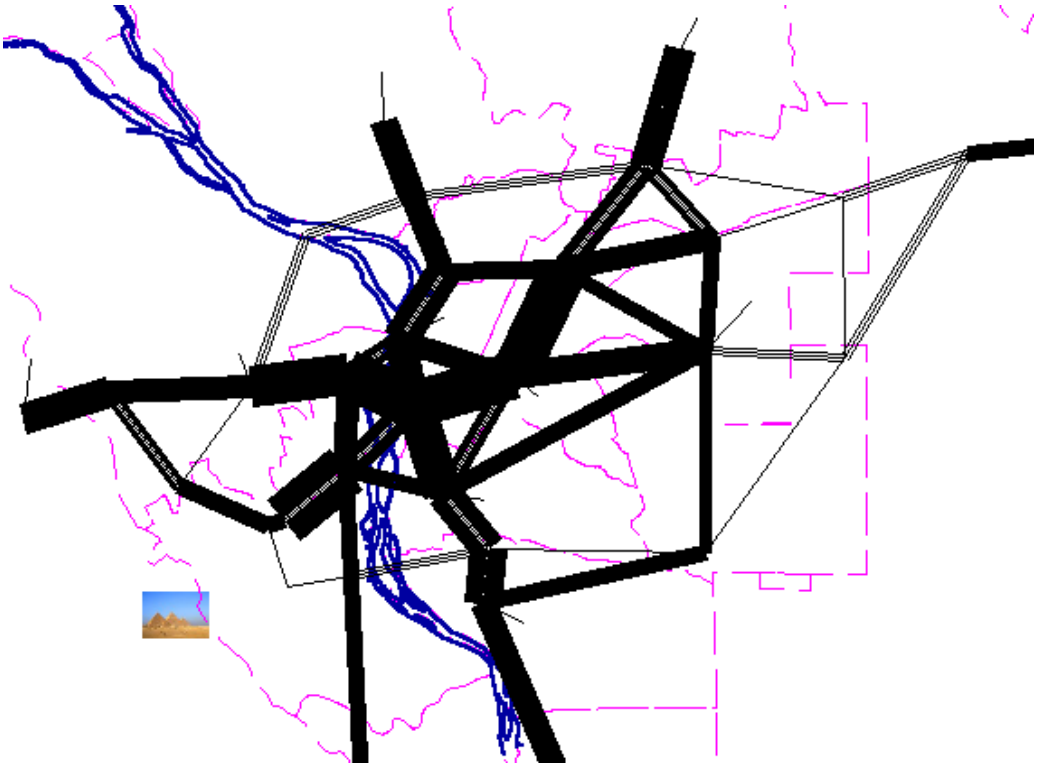
Source: JICA Study Team

Figure 4.6.20 MRT Bandwidth Diagram of Scenario 3 in 2022

We shall now consider the spider diagram of scenario 3 (Figure 4.6.21). It should be noted that in this scenario, the important 26th July corridor is no longer served due to the relocation of the rail link to 6th of October. As the daily trips demand is also very weak for this new corridor line 7*, the relocation option will not be considered in the following scenarios.

Again, there is a considerable flow between Al-Malik Faysal and Al-Haram Streets area and the intersection between 26th July corridor and the Desert Road. As this is a peripheral, local type of demand flow and not quite strong enough to justify a MRT or LRT, it should preferably be satisfied by a local busway service.

Another peripheral demand flow appears stronger in this scenario in the East of Cairo from Al-Maadi along the Ring Road to Al-Marg.



Source: JICA Study Team

Figure 4.6.21 Scenario 3 Spider Diagram in 2022

(4) Low Income Areas

The extension of corridor line 5 to 15th of May Bridge is useful in terms of serving low-income areas in the city center.

Due to a relatively low ridership, the South section of corridor line 6 was curtailed. It should however be considered to maintain this line in due consideration of serving an important low-income areas in El-Mokkatam and Dar El-Salam.

(5) Interfaces

This scenario is very interesting in terms of interfaces, on the one hand, due to the extensions of lines C5 and M3, and on the other hand, due to the introduction of corridor line 8 (Figure 4.6.27).

(6) Physical Constraints

Again, all of the proposed corridor lines follow the main road corridors in Cairo with the least interference with underground facilities and buildings. Furthermore on various sections they employ already existing tracks or right-of-ways.

Table 4.6.27 Interfaces of Scenario 3 in 2022

Line	Number of connections by line(1)	Total
1	2 x M2, 1 x M3, 1 x C4, 1 x C5, 2 x C6, 1 x C7, 1 x C7*, 1 x C8	10
2	2 x M1, 2 x M3, 1 x C4, 1 x C5, 1 x C7*, 1 x C8	8
3	1 x M1, 2 x M2, 1 x C4, 2 x C5, 1 x C6, 1 x C7, 1 x C7*, 1 x C8	10
C4	1 x M1, 1 x M2, 1 x M3, 1 x C5, 1 x C6, 4 x C7*, 1 x C8	10
C5	1 x M1, 1 x M2, 2 x M3, 1 x C4, 1 x C6, 1 x C7*, 1 x C8	8
C6	1 x M1, 1 x M3, 1 x C4, 1 x C5, 1 x C7*, 1 x C8	6
C7	1 x M1, 1 x M3	2
C7*	1 x M1, 1 x M2, 1 x M3, 4 x C4, 1 x C5, 1 x C6, 1 x C8	10
C8	1 x M1, 1 x M2, 1 x M3, 1 x C4, 1 x C5, 1 x C6, 1 x C7*	7
TOTAL		**71**

(1) For example, Corridor Line 7 has one connection (joint station) point each with Metro Line 1 and Metro Line 3. The total number of connections with other rail lines is two (refer Figure 4.6.16 for depiction of lines).
Source: JICA Study Team

4.6.6 Scenario 4

(1) Network Description

• The MRT/LRT/busway network

This scenario is an adaptation and variation of scenario 3 :

- Corridor line 6 is combined with corridor line 4 as a MRT system in order to test another alternative with the best sections of these lines.
- Corridor line 7 is attempted to run parallel with corridor line 4 while serving 6th of October from the South of Cairo and 10th of Ramadan from the North.
- Corridor line 8 provided good operational results as a busway but was not interesting from a socioeconomic point of view. The South section of this corridor is therefore modified so as to serve better Nasr City.
- Finally, a new tramway line is attempted with corridor line 9, along existing tracks, from Nasr City and connecting with line 3 and corridors 4 and 7 at Bab El-Shaaria station.

The proposed scenario is summarized in Table 4.6.28, and Figure 4.6.22.

Table 4.6.28 Scenario 4, Network Description in 2022

Line	Type	Length	Starting at	Passing through	Ending at
1	MRT	44 km	New El Marg	CBD area	Helwan
2	MRT	23 km	Shobra el Kheima	CBD area	Giza – Moneeb
3	MRT	33 km	Cairo Airport	CBD- Mohandiseen	Imbaba (branch 1) Boolaq (branch 2)
C4	MRT	26 km	Giza Pyramids	CBD (East)	Ain Shams
C5	Busway	24 km	Nasr City	Heliopolis	15th of May Bridge
C7	Train	96 km	6th of October	CBD (East)	10th of Ramadan
C8	Busway	17 km	Nasr City	Abaseya	Shobra
C9	Tram	15 km	Nasr City	Shobra	CBD (East)

Source: JICA Study Team

- *MRT/LRT/busway supply indicators*

The MRT network supply characteristics of scenario 4 are shown in Table 4.6.29.

Table 4.6.29 Scenario 4 Network Supply Indicators in 2022

Line	Mode	Terminals	Length	Headway (Peak period)	Average speed
1	MRT	• New El • Marg Helwan	44 km	2 min	34 km/h
2	MRT	• Shobra el Kheima • Giza – Moneeb	23 km	2 min	38 km/h
3	MRT	• Cairo Airport • Imbaba (branch 1) • Boolaq (branch 2)	33 km	2 min	38 km/h
C4	MRT	• Port Said Street • Giza Pyramids	26 km	2 min	38 km/h
C5	Busway	• Nasr City • 15th of May Bridge	24 km	4 min	20 km/h
C7	Express train	• 6th of October • 10th of Ramadan	96 km	10 min	80 km/h
C8	Busway	• Nasr City • Shobra	17 km	4 min	20 km/h
C9	Tram	• Nasr City • CBD (East)	15 km	4 min	22 km/h
Total and averages			**278 km**	**3.5 min**	**36 km/h**

Source: JICA Study Team

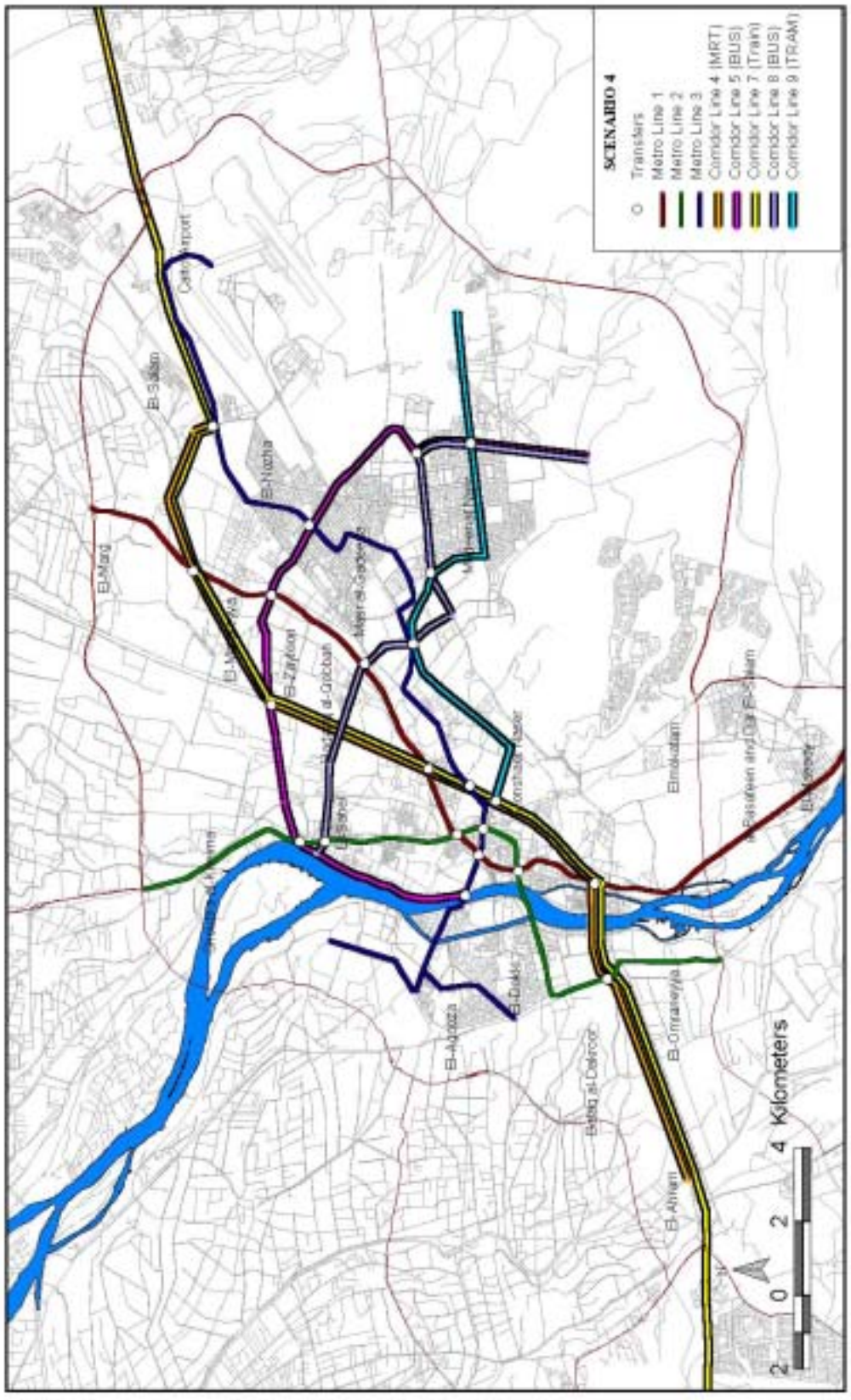


Figure 4.6.22 Scenario 4 Network

• *The tramway network*

The tramway network in this scenario is identical to the one in scenario 2.

• *The ENR suburban network*

A railway link between 6th of October and 10th of Ramadan is now attempted along corridor line 4 described previously.

Corridor line 7 replaces the current line 8 from Cairo to 6th of October city.

The scenario 4 also takes into account the rehabilitation of the existing suburban lines with a decrease of the headway to 10 minutes (Table 4.6.30).

Table 4.6.30 Scenario 4, Suburban Rail Network Description in 2022

Line number	Length (km)	Starting at	Ending at
R1	14.0	Cairo	Qalyob (to Alexandria)
R2	23.5	Cairo	Qalyob / Qanater El Khayreya
R3	32.0	Cairo	Qalyob / Shebeen El Qanater
R4	20.0	El Marg	Shebeen El Qanater
Corridor line C7	96.0	6th of October	10th of Ramadan
R6	20.0	Cairo	Imbaba / El Manashi
R7	37.0	Cairo	El Maraziek
Total	**242.5**		

Source: JICA Study Team

• *ENR supply indicators*

The suburban rail network supply characteristics of scenario 2 are shown in Table 4.6.31.

Table 4.6.31 Scenario 4, Suburban Rail Supply Indicators in 2022

Line	Line Name (origin, intermediate, destination)	Length (km)	Average speed (km/h)	Peak hour headways (min)
R1	Cairo / Qalyob (to Alexandria)	14.0	40	10
R2	Cairo / Qalyob / Qanater El Khayreya	23.5	40	10
R3	Cairo / Qalyob / Shebeen El Qanater	32.0	40	10
R4	El Marg / Shebeen El Qanater	20.0	40	10
C7	6th of October / 10th of Ramadan	96.0	80	10
R6	Cairo / Imbaba / El Manashi	20.0	40	10
R7	Cairo / El Maraziek	37.0	40	10
	Totals and Averages	**242.5**	**50**	**10**

Source: JICA Study Team

(2) Population, employment and student densities

This scenario has the same alignment features as scenario 3 except for corridor line 9 which picks up additional people, employed and students due to its crossing Nasr City.

Table 4.6.32 summarizes the number of inhabitants, jobs and student students served within a distance of 800 meters from the network lines.

Table 4.6.32 Scenario 4, Socio-economic Performance of Each Line in 2022

Mode	Population	Employed	Students	Total Ratio (*)
1	1 073 525	475 617	362 667	0.18
2	892 245	496 638	314 165	0.17
3	1 130 199	729 072	402 710	0.23
C4	1 703 818	578 148	462 120	0.25
C5	842 480	290 889	239 547	0.12
C7	3 535 431	1 554 136	931 958	0.56
C8	553 518	225 545	232 422	0.10
C9	372 147	375 545	262 652	0.12
Total network	**10 103 363**	**4 725 590**	**3 208 241**	
TOTAL study area	**20 721 175**	**6 966 250**	**5 771 269**	

(*) Total ratio = Pop./total pop. + Emp./total emp. + Stu./total stu.

It is interesting to note the enormous improvement in corridor lines 4 and 7's socioeconomic performances, which once again confirms the advantage of combining corridor lines 4 and 6 of scenarios 2 and 3 into one single line. In fact, this scenario reaches by far the most population, employed and students in Cairo (Figures 4.6.23, 4.6.24 and 4.6.25).

The ensuing analysis of the daily trips demand and structure will allow to verify the advantages of the new corridor lines 4 and 7.

The other corridor lines 5, 8 and 9 show average results.

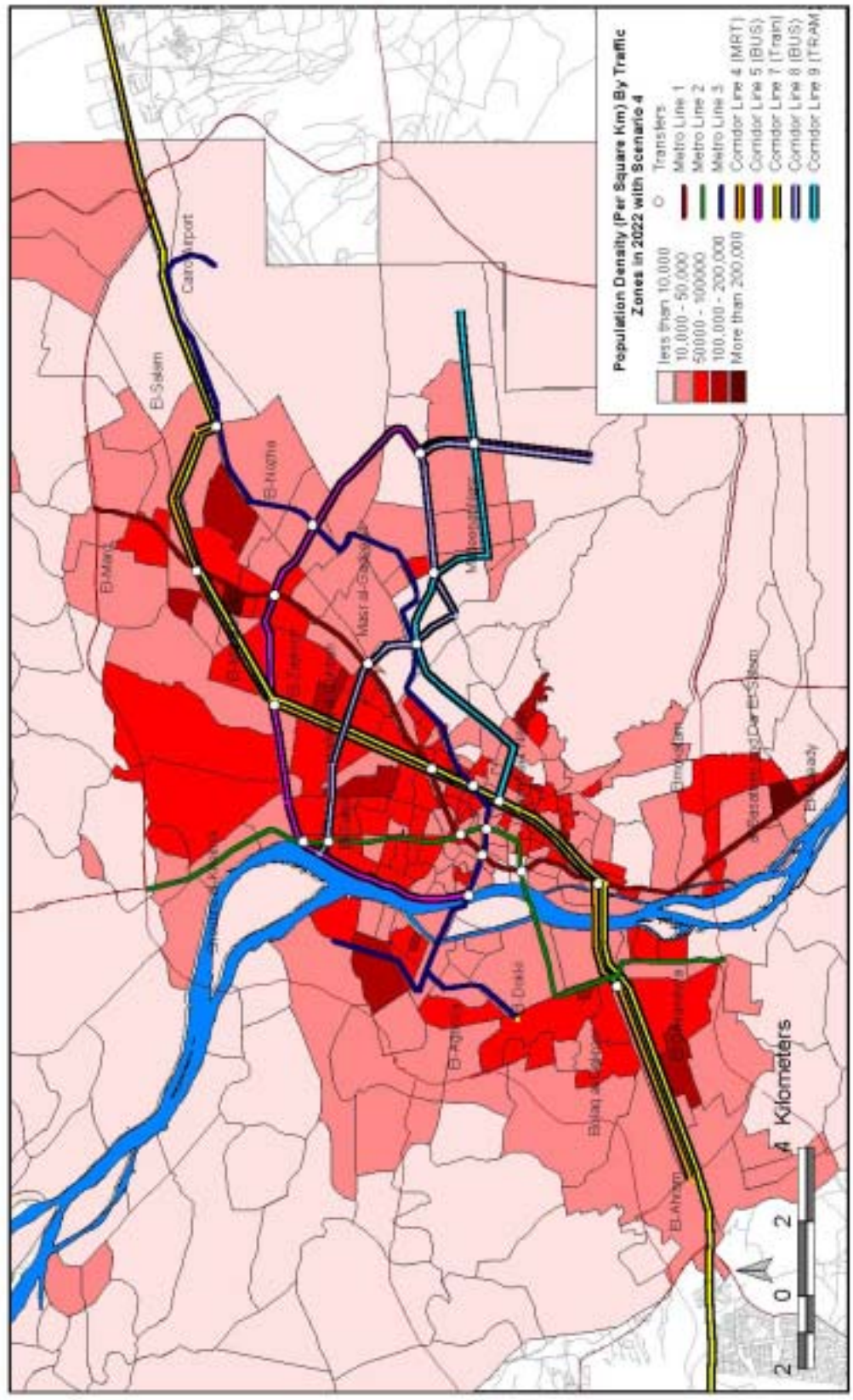


Figure 4.6.23 Scenario 4 and Population Densities

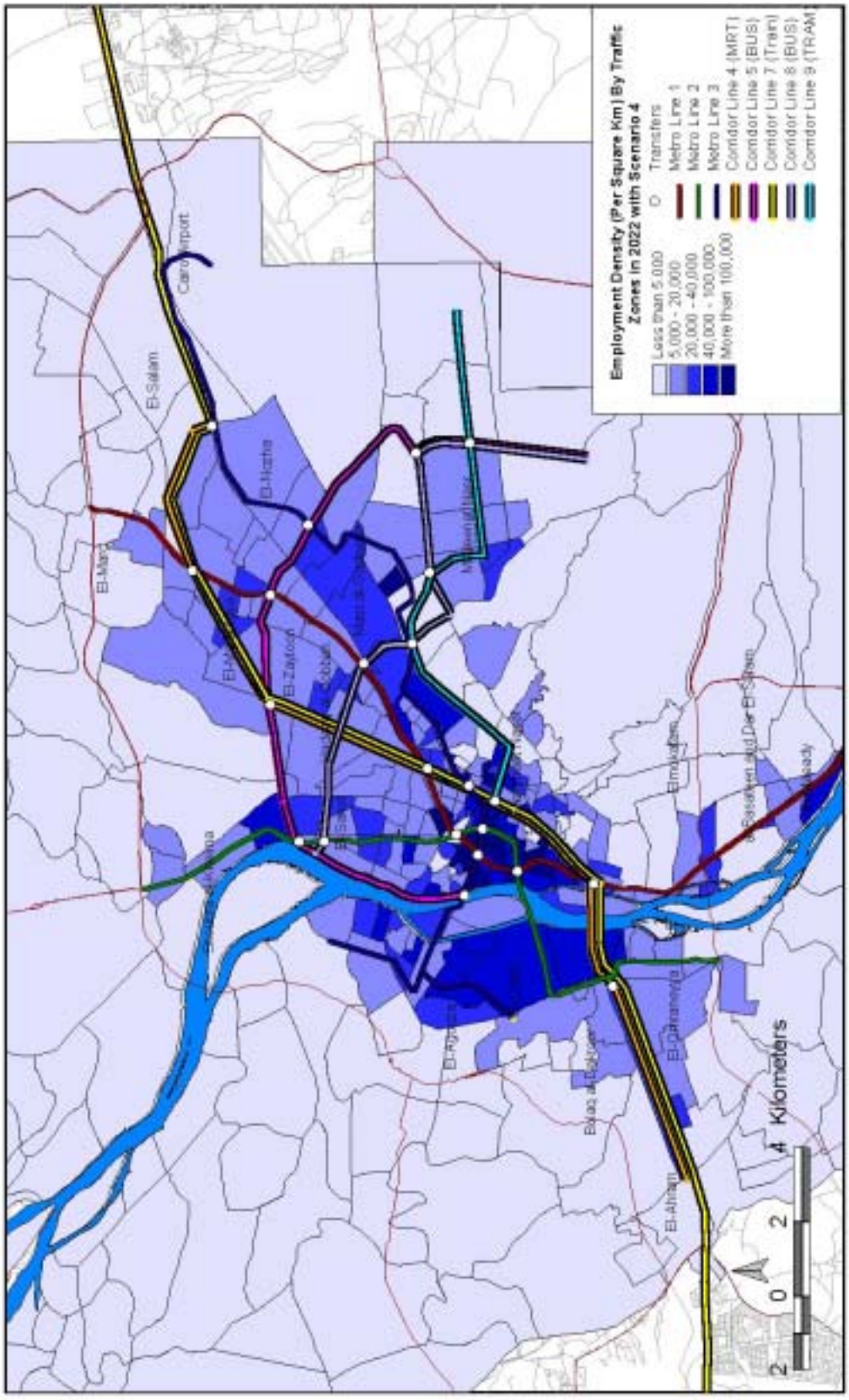


Figure 4.6.24 Scenario 4 and Employment Densities

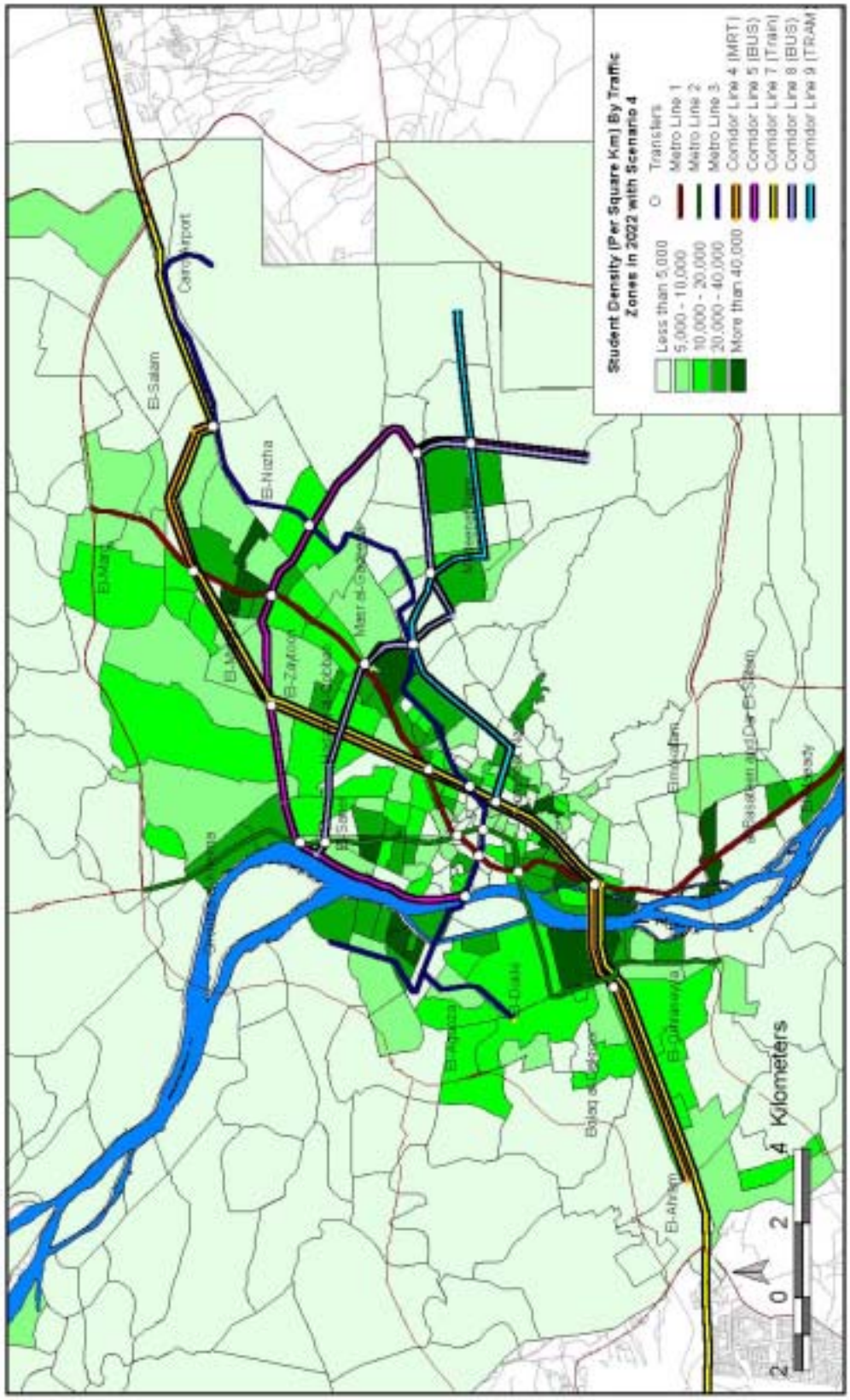


Figure 4.6.25 Scenario 4 and Student Densities

(3) Transport demand

The results of the demand simulation for the scenario 4 are shown in Table 4.6.33.

Table 4.6.33 Scenario 4 Demand Simulations in 2022

Mode	Average daily passengers (million)				
	2001	Modal Split (%)	2022	Modal Split (%)	% Increase
Formal PRT (*)	4.299	32.3	3.214	17.3	-25
Informal PRT (**)	6.696	50.2	6.451	34.7	-4
TOTAL PRT	**10.995**	**82.5**	**9.665**	**51.9**	**-12**
MRT/LRT	**2.021**	**15.2**	**7.475**	**40.2**	**270**
ENR	**0.132**	**1.0**	**0.694**	**3.7**	**424**
TOTAL TRAM	**0.171**	**1.3**	**0.773**	**4.2**	**352**
Ferry	0.010	0.1	0.003	0.0	-65
TOTAL	**13.329**	**100.0**	**18.610**	**100.0**	

(*) CTA and GCBC (**) Shared taxis and private mini buses. PRT : Public Road Transport.

The changes in modal split compared with scenario 3 are minimal. It is therefore important to take a closer look at the performance of each line in order to better understand the changes (Table 4.6.34).

Table 4.6.34 Scenario 4 Network Daily Trips Demand in 2022

Line	Boarding Pass(million)	Pass-km (million)	Pass/km (1,000)	Max loaded section	Section one-way traffic
1	2.491	27.752	57.9	629,470	Hamamat El Qoba
2	1.589	9.264	69.1	524,550	Mubarak
3	1.823	12.545	60.8	488,550	Zamalek
C4	1.572	12.698	60.5	668,310	El Haram
C5	0.461	2.150	21.0	152,830	El khalafawy
C7	0.013	0.026	0.1	7,410	El Remaya
C8	0.111	0.330	6.5	73,830	Tere't El Ismallia
C9	0.100	0.890	6.7	51,900	El Azhar

Source: JICA Study Team

- In terms of peak load and utilization (pass/km), corridor line 4 obtains almost the same result as in scenario 3 where the alignment continued towards Nasr City instead of going towards Ain Shams. This corridor line should therefore rather be selected on the grounds of its socioeconomic performance and limited costs, which are considerably better in this scenario.

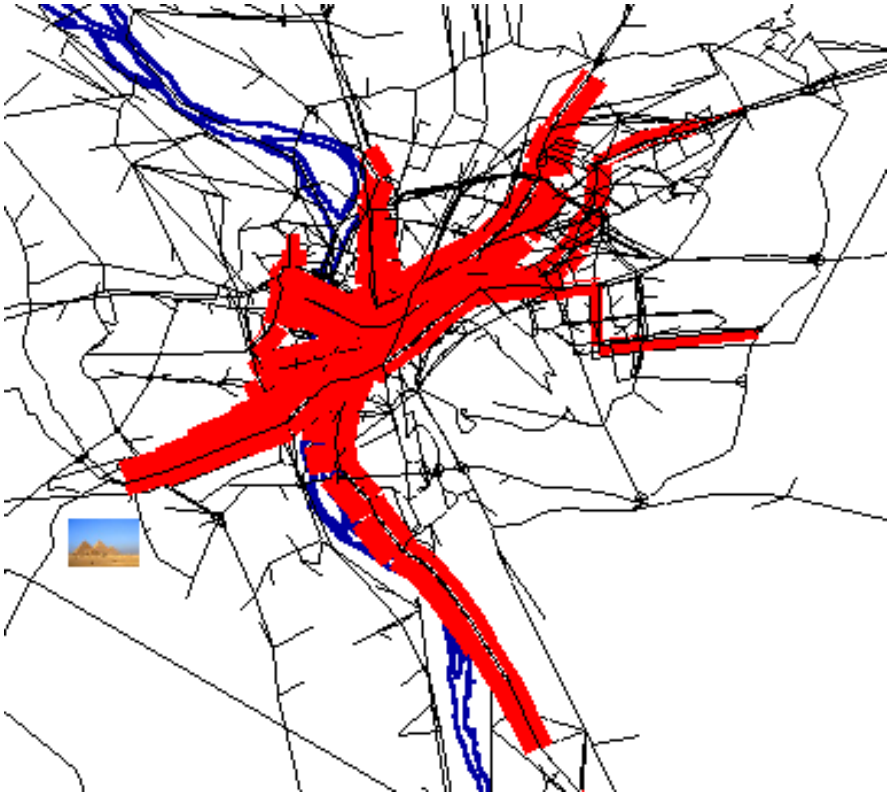
- The connection to 6th of October and 10th of Ramadan in corridor line 7 has the same low demand as in scenario 3. The alignment proposed in the scenario 2 therefore appears to the best solution for this link.

- Corridor line 5 has a lower demand than in the previous scenario but is still to high to be satisfied by a busway service.

- Corridor line 8 performed better in scenario 3 in its shorter version ending West of Nasr City instead of crossing it.

- Corridor line 9 has been tested as a tramway system and shows good results for this type of service.

The bandwidth diagram (Figure 4.6.26) shows a high uniform load on the various MRT systems as well as the proposed tram in corridor line 9.

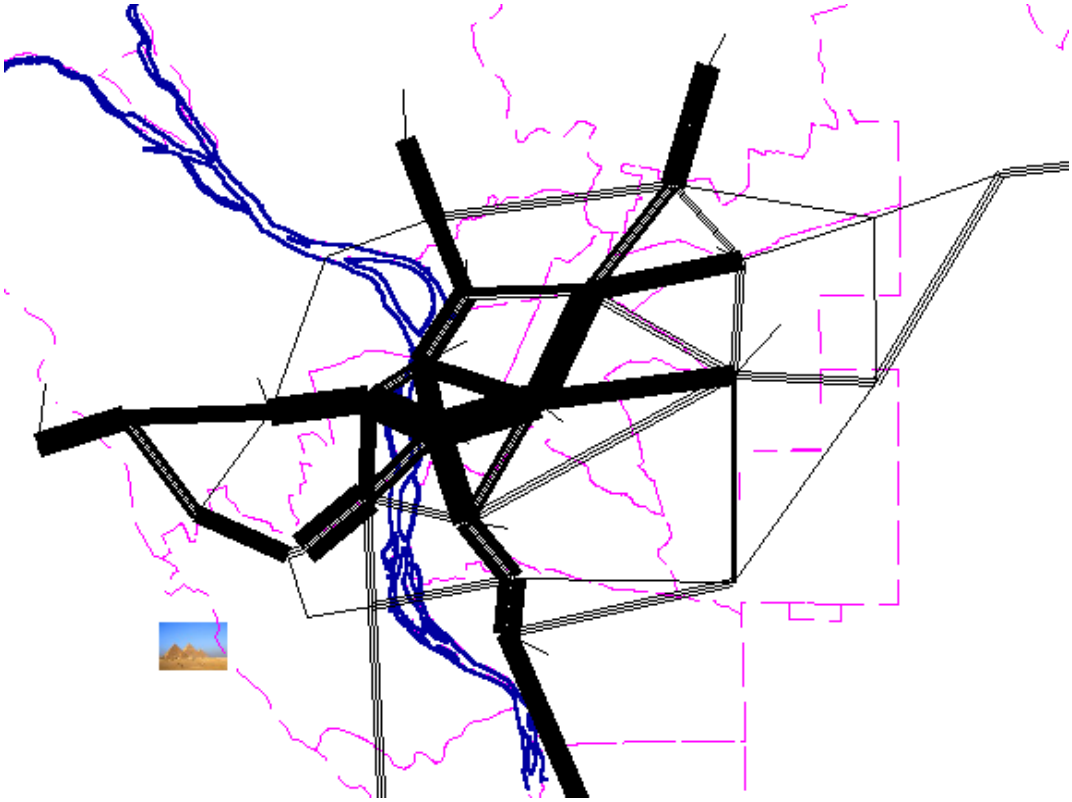


Source: JICA Study Team

Figure 4.6.26 Scenario 4 Bandwidth Diagram in 2022

From the spider diagram (Figure 4.6.27), it can be seen that the proposed 4 MRT lines, with the exception of the important 26th July corridor, adequately serve the main demand flows. The demand on the 26th July corridor could be satisfied with a LRT system between 6th of October, Cairo and 10th of Ramadan, as proposed in scenario 2.

The remaining demand flows can be adequately satisfied with busway services as proposed in scenario 3.



Source: JICA Study Team

Figure 4.6.27 Scenario 4 Spider Diagram in 2022

(4) Low Income Areas

As it were the case in scenario 3, the low-income areas are fully served by the various corridors with the exception of the areas in El-Mokkatam and Dar El-Salam. This remaining area can however be served by a busway which provides the same fare advantage as a MRT system and in the same time is more appropriate in terms of demand on this section.

(5) Physical Constraints

This scenario is the best in terms of interfaces, although line 3 is not extended to Behoos station on line 2, and corridor lines 7 and 7* are merged into one line. Corridor line 9, and

in particular the new radial direction of corridor lines 4 and 7 provide many additional interfaces in the entire network (Table 4.6.35).

Table 4.6.35 Interfaces of Scenario 4

Line	Number of connections by line (1)	Total
1	2 x M2, 1 x M3, 3 x C4, 1 x C5, 3 x C7, 1 x C8	11
2	2 x M1, 2 x M3, 1 x C4, 1 x C5, 1 x C7, 1 x C8	8
3	1 x M1, 2 x M2, 2 x C4, 2 x C5, 2 x C7, 1 x C8, 2 x C9	12
C4	3 x M1, 1 x M2, 2 x M3, 1 x C5, 7 x C7, 1 x C8, 1 x C9	16
C5	1 x M1, 1 x M2, 2 x M3, 1 x C4, 1 x C7, 2 x C8, 1 x C9	9
C7	3 x M1, 1 x M2, 2 x M3, 7 x C4, 1 x C5, 1 x C8, 1 x C9	16
C8	1 x M1, 1 x M2, 1 x M3, 1 x C4, 2 x C5, 1 x C7, 3 x C9	10
C9	2 x M3, 1 x C4, 1 x C5, 1 x C7, 3 x C8	8
TOTAL		**90**

(1) For example, Metro Line 2 has one connection (joint station) point each with Corridor Lines 4 through 7, as well as two connection points each with Metro Line 1 and Metro Line 3. The total number of connections with other rail lines is eight (refer Figure 4.6.22 for depiction of lines).

Source: JICA Study Team

(6) Physical Constraints

Again, all of the proposed corridor lines follow the main road corridors in Cairo with the least interference with underground facilities and buildings. Furthermore on various sections they employ already existing tracks or right-of-ways.