Chapter 6 Urban Transport Development Policy

6.1 Mass Transit Development Scenario

6.1.1 "Do-Nothing" Scenario

As shown in Chapter-2 (Traffic Survey) and Chapter-5 (Demand Forecast), traffic situation in Karachi would become worse in the future if no transport project is implemented because of:

- Population growth (1.67 times from 2010 to 2030)
- Economic growth, which increases the trip rate[1]
- Increase in car ownership rate, which increases the trip rate and decrease road space
- Expansion of urbanized area, which increases the trip length (1.64 times from 2010 to 2030)

Heavier traffic will cause the deterioration of bus services which results in more modal shift to motorcycle and private cars, and increase the traffic on roads.

To evaluate the situation without transport investment, a "Do-Nothing" scenario was analyzed in which the following conditions were assumed:

- No mass transit system including KCR would be implemented.
- Population growth, economic growth and urban development are the same conditions as the demand forecast in "with master plan" case.
- The number of buses would increase according to passenger demand.

The last assumption is an optimistic case for "Do-Nothing" scenario. The "Do-Nothing" scenario means that no mass transit system will be implemented, but improvement of bus transport services will be taken place. In case that no action about public transport is taken in the future, as has been in the last 20 years, the number of buses would not increase even if traffic demand increases.

Figure 6-1-1 illustrates the simulation result of "Do-Nothing" scenario. Orange, red, and brown colour indicates the road section where traffic volume exceeds the capacity (volume to capacity ratio (V/C) exceeds 1.0). The V/Cs less than 1.5 (orange and red) would be possible but those of 1.5 and more (brown) that the transport network cannot deal with the demand. The result shows that most roads will suffer from traffic saturation in case of "Do-Nothing" scenario.

6.1.2 "Road Development" Scenario

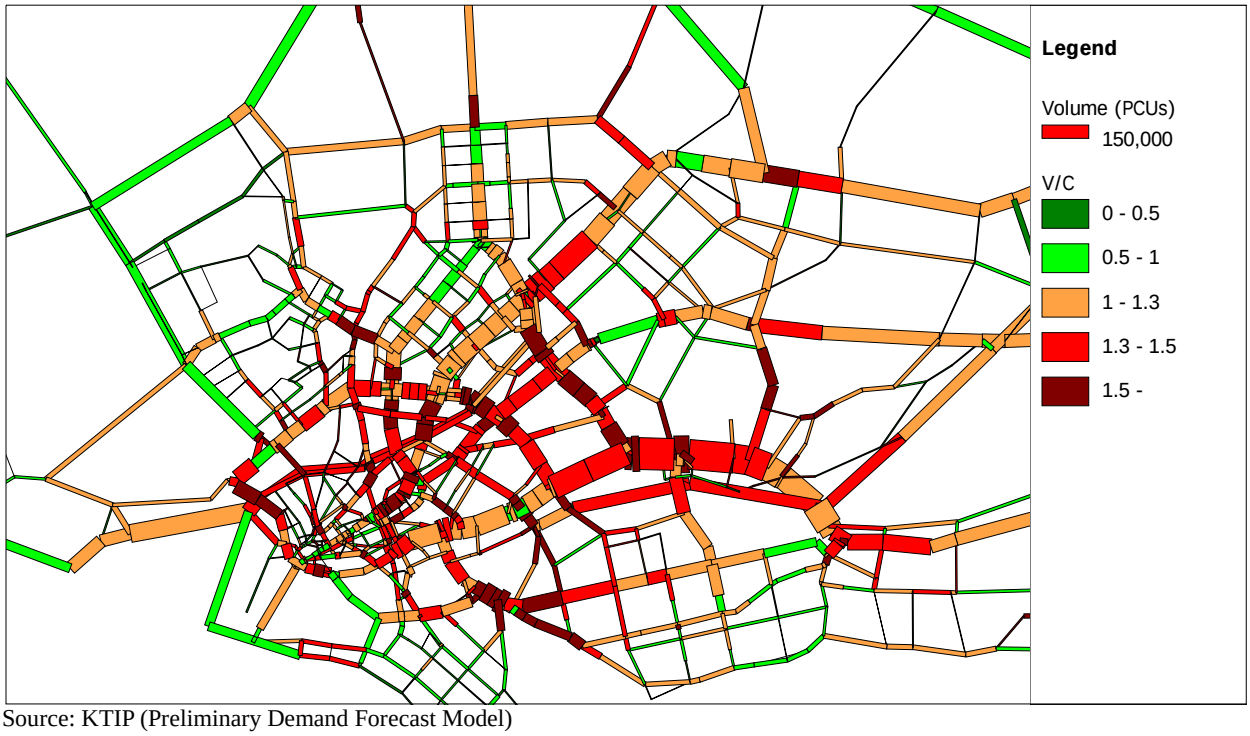
Karachi has developed road infrastructure such as flyovers and underpasses recently, which has improved traffic situation in Karachi. The "Road Development" Scenario was prepared to evaluate the present trend concentrating on road development. The condition of this scenario is the same as that of the "Do-Nothing" Scenario except for the road network used in the traffic assignment. The road network for the "Road Development" Scenario is the same as the road network in KUTMP 2030 in which new roads in total length of 740km is included[2]. Since the road network in the urbanized area in Karachi has been developed, further development of the road network would be difficult.

Figure 6-1-2 shows the result of the traffic assignment for "Road Development" Scenario. It is observed that traffic on some roads is significantly improved compared to "Do-Nothing" Scenario, but congestion will remain in many roads.

[1] In the demand forecast, trips rates in the future are assumed to be the same as the present rates.
[2] Refer to Chapter 7 for the list of road projects in this scenario

Source: KTIP (Preliminary Demand Forecast Model)

Figure 6-1-1 Do-Nothing Scenario (2030)

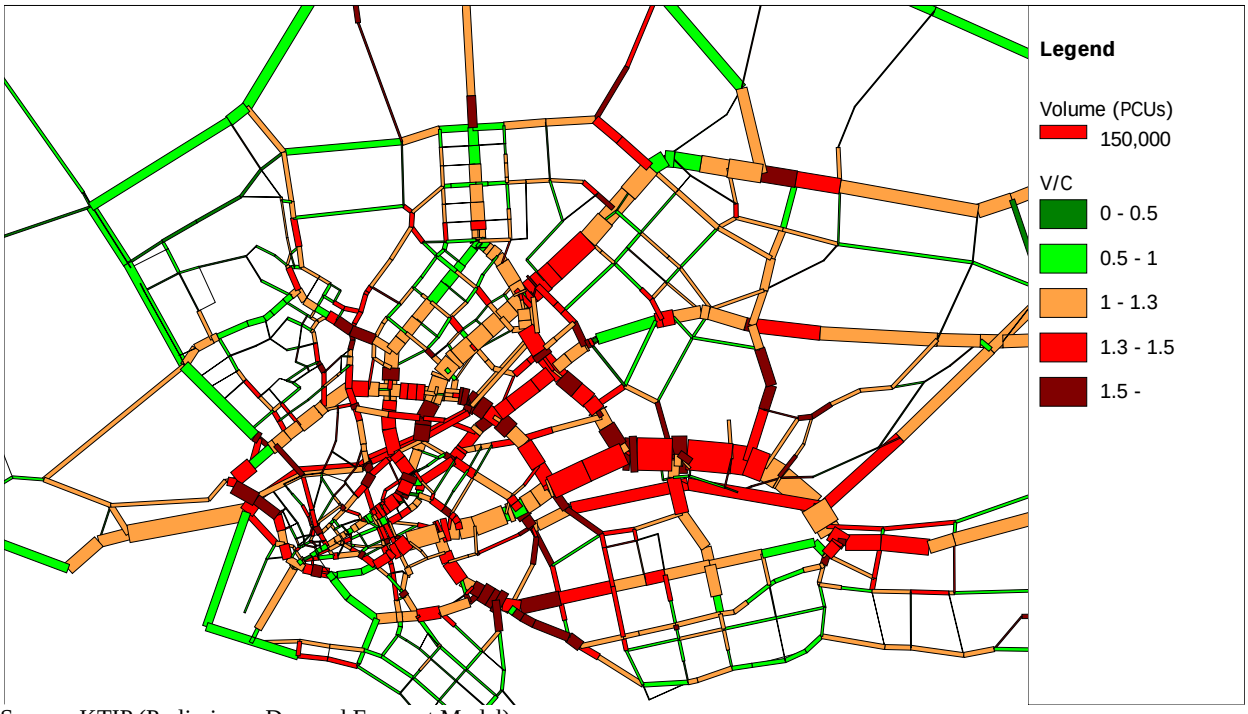


Source: KTIP (Preliminary Demand Forecast Model)

Figure 6-1-2 Road Development Scenario (2030)

6.1.3 "Road Development + KCR" Scenario

KCR is a committed project by the Government of Pakistan (GOP) – it was approved by the GOP on September 3, 2009, although its financial arrangement has not been agreed yet. The "Road Development + KCR" Scenario is the case when only KCR is developed as a mass transit system in addition to road development. Figure 6-1-3 shows the result of the traffic assignment for this scenario. Traffic is improved by KCR project although its impact on road traffic is not clear from this figure. Since KCR provides the transport service for the circular direction, roads for radial directions remain congested.



Source: KTIP (Preliminary Demand Forecast Model)

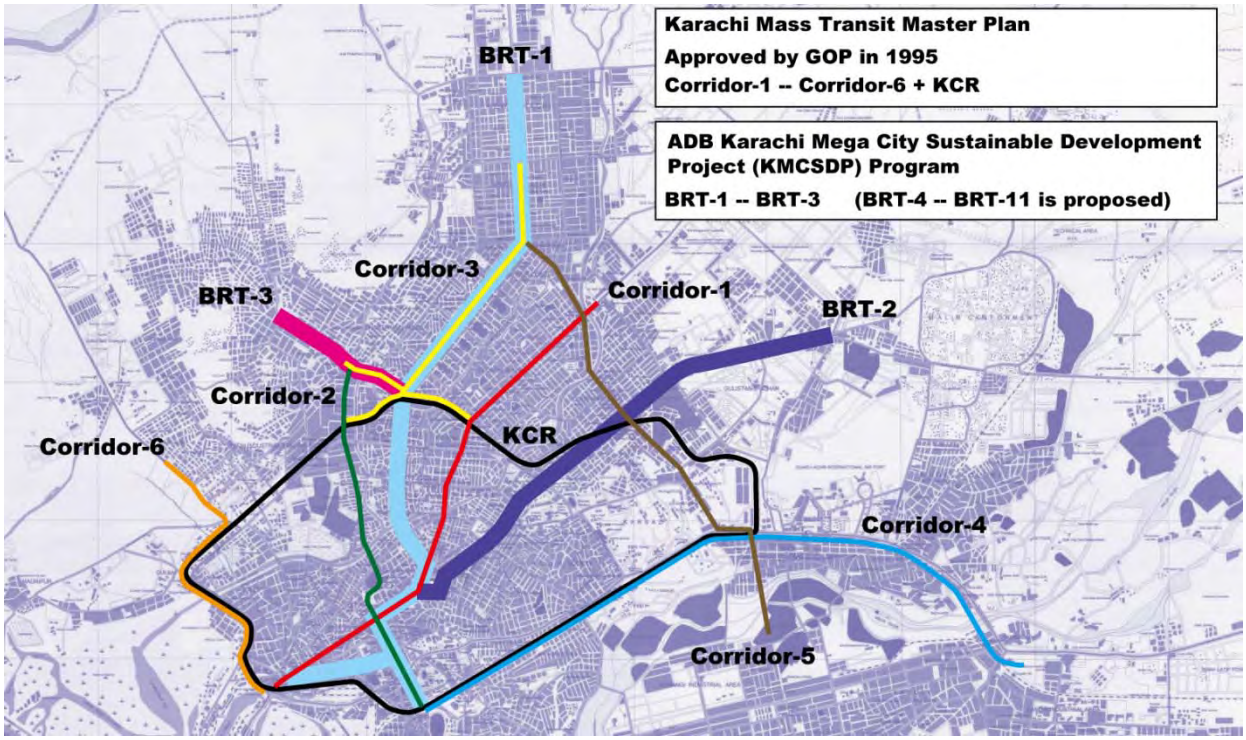
Figure 6-1-3 "Road Development + KCR" Scenario (2030)

6.1.4 "Do-Existing Plan" Scenario

As has been reviewed in Chapter-1, the existing plan is difficult to be implemented because of the changes in road infrastructure. Development of Corridor-2 is almost impossible within a feasible scheme. Corridor-4 and Corridor-6 are duplicated with KCR alignment.

In this study, convertible elevated structure, where the mass transit system can be changing from BRT into Railway, is not considered with following reasons.

Firstly, planning of railway-based system at ground level is unrealistic from the perspective of complete separation between road and rail. Such a plan would worsen the traffic situation in the city more and more. Secondly, if BRT system is originally built on such elevated structure, which has enough strength and width for railway system, it would be uneconomic. Even in such excessive case, it would be impossible to install underground structure after the elevated structure is once constructed. Finally, even if these engineering and resettlement problems should be solved, construction of 6 corridors and KCR is not possible scenario in view of budget and schedule.



Source: KMTC (Illustration in KTIP)

Figure 6-1-4 Existing Mass Transit Plan

6.1.5 Scenario by Network Type

The public transport network depends on the type of mass transit system. For example, a low capacity system requires dense network while the dense network is costly in case of a large capacity transit system. To analyze the best mass transit system, the following three scenarios were evaluated.

1) Mass Rapid Transit (MRT) development along high priority corridors
2) Light Rail Transit (LRT) development along major corridors
3) Bus Rapid Transit (BRT) development along major roads

In this analysis, MRT means a large capacity railway system (heavy rail, rail rapid transit) with a number of train cars (typically 6-12 cars). The concept of MRT scenario comes from the idea that it might be more feasible to construct a large capacity transit system along the priority corridor than constructing a lot of parallel LRT routes with short intervals. Although the cost of a MRT line is higher than a LRT line, the total cost of MRT network might be lower than that of LRT network because of the less number of lines. Feeder service is inevitable for this scenario.

The concept of LRT scenario is similar to that of the approved plan of Karachi Mass Transit Corridors. This scenario provides public transport service along major corridors. Construction period of a line in this scenario is shorter than that of MRT scenario.

The concept of BRT scenario is based on the "Study on a Public/ Private Partnership based Environmental-friendly Public Transport System for Karachi" and the BRT study by ADB. It is proposed 14 BRT routes in the study. The service area is largest among three scenarios.

Table 6-1-1 shows the comparison of these scenarios.

Table 6-1-1 Comparison of Scenarios

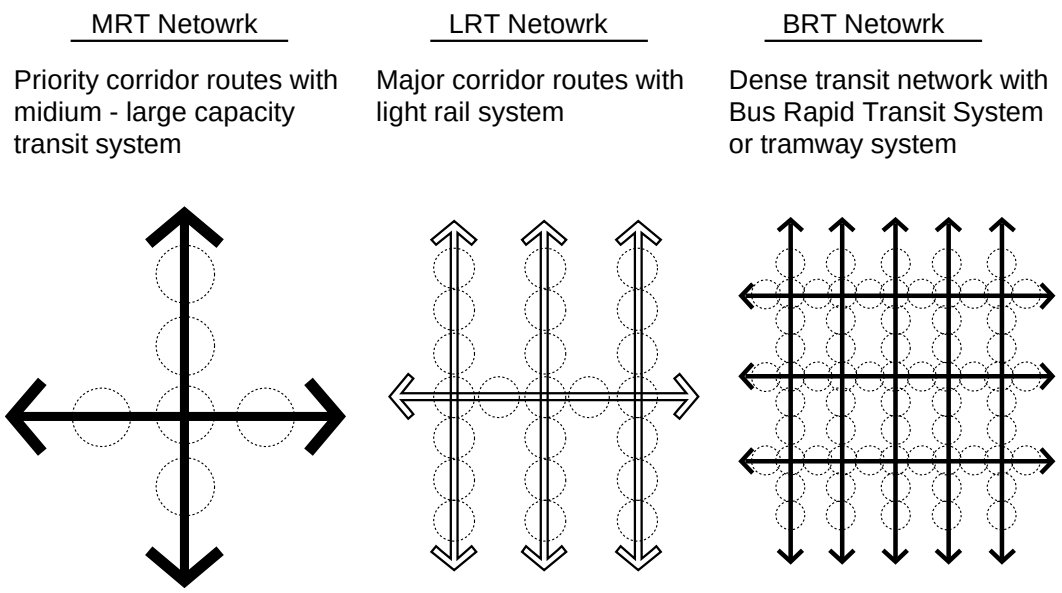
	MRT Network	LRT Network	BRT Network
Train composition	6 – 12 cars	3 – 6 cars	1 – 3 cars
Distance between stations	1 – 2 km	500 – 1000m	50 – 500m
Schedule Speed	30 – 40 km/h	25 – 35 km /h	15 – 30 km/h
Capacity of a car	200 – 250	150 – 200	100
Structure	Elevated / Underground / At grade in suburban	Elevated / Underground / At grade	At grade / Elevated in special cases
Level crossing	Not used	Used in case of surface section	Used
Station	Large scale with long platform	Compact size compared to MRT station	Bus stops on roads
Inter-modal facilities	Station plaza for feeder service at many stations	Station plaza for feeder service area at major stations	Bus terminal at both ends and major bus stops.
Capacity expansion by doubling track/ lane	Difficult	Difficult	Possible if road space allows
No. of routes in Karachi possible in 20 years*	2 – 3 routes	3 – 4 routes	6 – 8 routes
Risk of delay	- Financing - Power supply - Land acquisition	- Financing - Power supply - Land acquisition	- Consensus of road users - Opposition from bus transporters

Note: This table shows only a typical example of a single system. Combination of different systems is not represented.
* The possible number of routes in 20 years is just the JICA Study Team's opinion considering financial and political situation in Karachi

Source: JICA Study Team

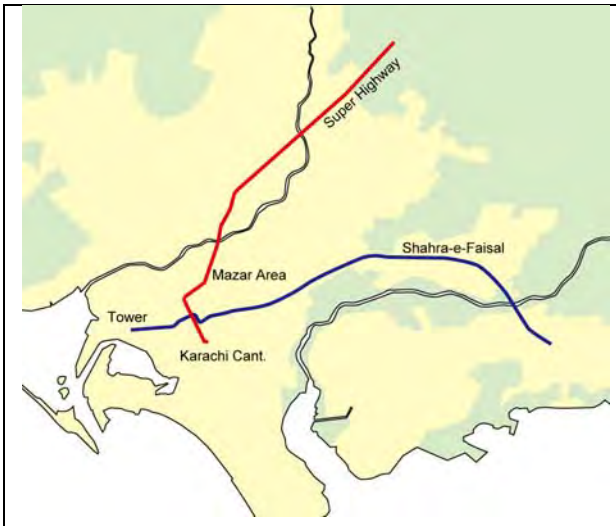
The disadvantages in each scenario can not be underestimated. The best scenario would be the mixture of these scenarios. However, these scenarios give a picture to reach the best mix.

The concept of these scenarios is shown in Figure 6-1-5.



Source: JICA Study Team

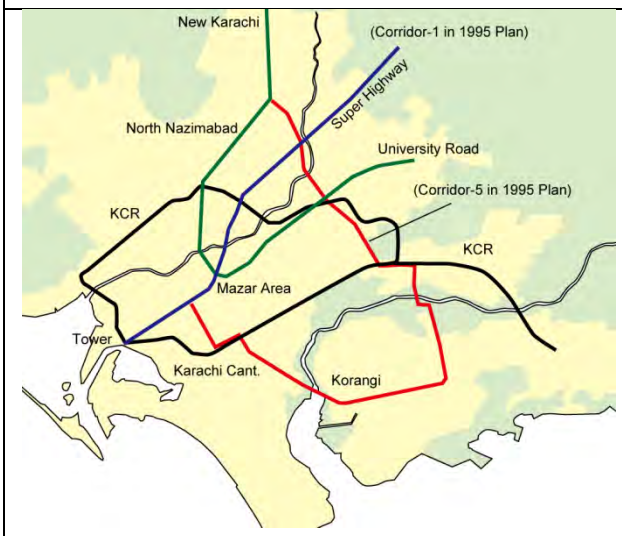
Figure 6-1-5 Conceptual Illustration of Mass Transit Scenario



MRT Network Scenario

Two MRT routes are constructed along the busiest corridors. Only MRT system of 8-car train with 40km/h is introduced.

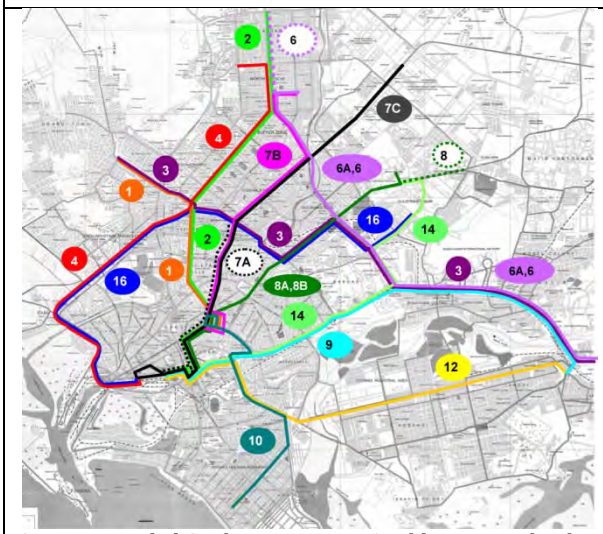
Coverage area of this scenario is very small. The advantage is that the east-west line (in blue color) can be constructed as elevated structure, and the early implementation would be possible. On the other hand, the north-south line (in red color) needs underground section.



LRT Network Scenario

Four LRT routes are constructed with a total length of 96 km. Only LRT system of 4-car train with 30km/h is introduced.

The service area is very large but the construction cost is highest among the scenarios. This network requires road widening to avoid underground construction.



Source: Detailed Study on a Private / Public Partnership based Environmental-friendly Public Transport System for Karachi

BRT Network Scenario

The network of this scenario is based on the network proposed in Environment Friendly PPP Study. The KCR line will be converted to BRT routes in this scenario.

This scenario requires road widening in the center of the city. Since BRT system uses a part of lanes of the road, which reduces the road capacity, the positive impact on road traffic is not clear.

Source: KTIP

Figure 6-1-6 Concept of Network Type

6.1.6 Scenario by Marketing Segment

Marketing is also an important factor for mass transit scenario. Unlike intercity trains, a mass transit system in urban area does not provide different services such as first class, second class and economy class in most cases. Usually, an urban transport system provides the same level of service to all passengers. If the target of the mass transit system is the same as those who can not afford to pay the higher fare than existing minibuses, MRT and LRT will be very difficult choice. For example, KCR study by JICA shows that its financial interest rate of return (FIRR) is only 2.3% under the condition of keeping the fare structure similar to that of existing buses. If the target passengers are high income class those who use private cars, the improvement of the road congestion would be very significant.

Table 6-1-2 Comparison of Market Segment of Mass Transit

Target	Low income	Mid income	High income
Present transport mode	- Minibus/ Coach - Walk	- Motorbike - Buses (no choice)	- Private car
Favourable system	Any type of system	BRT/ LRT/ MRT with air -condition	MRT/ LRT / monorail with air-condition and less congestion
No. of buses after mass transit development	Decrease	Decrease a little	Same
No. of motorbike after mass transit development	Decrease a little	Decrease	Decrease a little
No. of cars after mass transit development	Very low decrease	Decrease a little	Decrease
Congestion after mass transit development	Improved a little	Improved	Significantly improved
Financing of MRT/LRT	Public budget and soft loan from international organizations for capital cost, and subsidy for operation & maintenance	Public budget and soft loan from international organizations for capital cost	Public budget and market loan for capital cost PPP scheme
Financing of BRT	Public budget and soft loan for capital cost, and soft loan for rolling stock	Public budget and soft loan for capital cost, and market loan for rolling stock / PPP	Public budget for capital cost and full private operation
Risk	Opposition from existing bus transporters	Vague target	Small demand

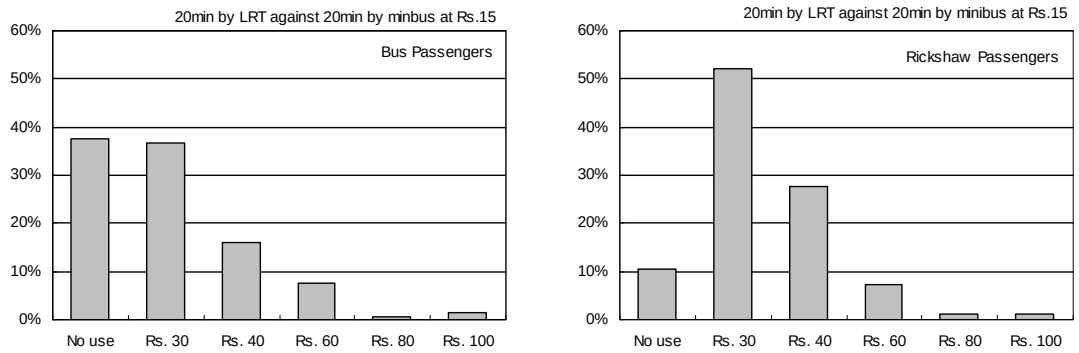
Source: JICA Study Team

To evaluate the proper fare level, the Passenger Interview Survey was conducted in 2010, in which the following two pictures were shown to interviewees and ask their willingness to pay for using LRT.

Source: JICA Study Team

For public transport passengers, bus and rickshaw, the condition of the interview was that fare minibus was Rs. 15 and the travel time was the same of 20 minutes. The left chart shows that 60% of bus passengers can pay Rs. 30 or more for LRT when minibus fare is Rs.15, while most

of them don't want to pay Rs.80 or more. On the other hand, the right chart shows that 90% of rickshaw passengers can pay Rs. 30 or more under the same condition. However, like bus passengers, most of them don't want to pay Rs. 80 or more. This result implies that public transport passengers can pay Rs.30 – Rs.60 if the transport mode is more comfortable than minibuses.



Source: JICA Study Team (PIS)

Figure 6-1-7 Willingness to pay for LRT (Bus and Rickshaw)

The willingness-to-pay survey implies that people who are using bikes and cars can pay a higher fare for mass transit than that of existing buses, if the mass transit is developed as a world standard level. There is a high risk about the opposition from existing transporters if the target of mass transit passengers is the same as the present bus passengers. Financially sustainable operation is the key for the successful operation of a mass transit system. The present bus fare level is far from the sustainable operation for the mass transit project which requires a large scale capital investment. From this, it is proposed to provide the mass transit system for the present bike and car users with adequate cost and retain the existing bus routes for low income people.

6.1.7 Conclusion of Scenario Analysis

It can be concluded from the scenario analysis that:

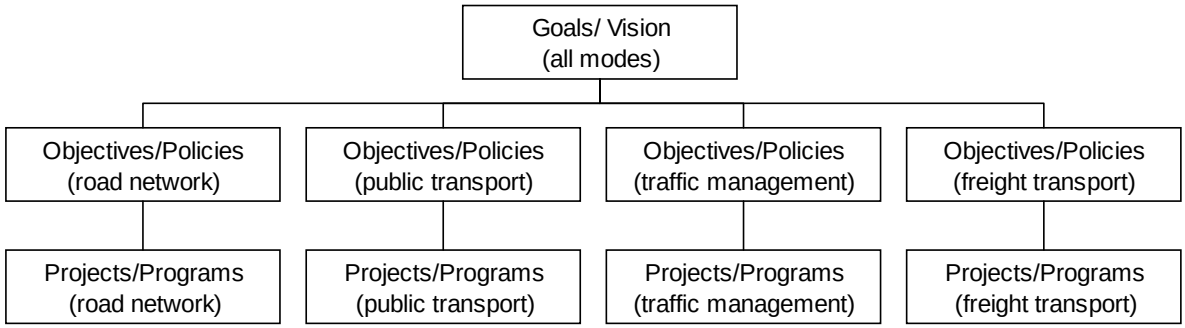
1) Road development will remarkably improve the road traffic along major corridor. However, serious traffic congestion will still remain.
2) KCR will improve the road traffic in CBD to some extent. However, traffic congestion will still remain especially for radial directions.
3) Construction of a number of LRT will not be efficient in terms of cost performance. A large number of resettlement will be necessary in case of elevated structure in CBD.
4) BRT network will not be the solution for the increase in traffic demand in the future, because of it capacity and impact on road traffic.
5) MRT network with one or two lines is not enough for the future demand.
6) The future mass transit network should be the mixture of MRT and BRT.
7) The target of mass transit development should be middle income people, who are using motorcycles as transport mode.

6.2 Development Policies and Guidelines

6.2.1 Development Goals

(1) Policy Structure

There are several wordings used in urban transportation planning which express the public sector statement such as “vision”, “goal”, “objective”, “mission”, “strategy”, “principal”, “plan”, “action plan”, and “policy”. A popular hierarchy is goals–objectives–policies. The structure should be as simple as possible for the better understanding although transportation development involves multi-sectors such as road, transit system, traffic management, land use, environment and so on. It is proposed three layers of the policy statements from the analysis of the policies in KSDP 2020. The goals (or vision), which is the top layer, should be the same among sub-sectors in urban transportation. Objectives (or policies) are established by four transport sub-sector such as road network, public transport, traffic management, and freight transport, which was classified in the TOR of the Study. The figure below illustrates the proposed policy structure for Karachi Urban Transportation Master Plan (KUTMP) 2030.



Source: JICA Study Team

Figure 6-2-1 Proposed Policy Structure for KUTMP

(2) Goals/ Vision

Based on the analysis of urban transport scenario, the following goals have been proposed for KUTMP 2030.

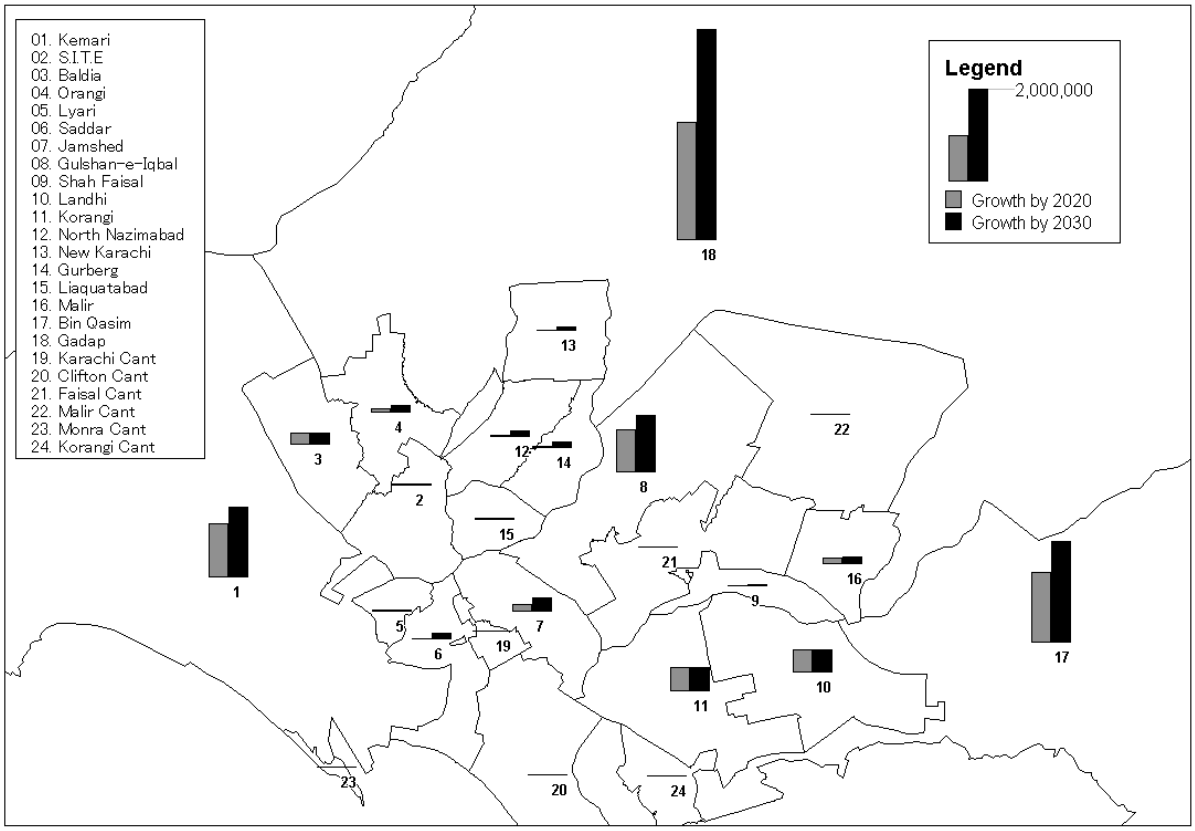
- Travel in Karachi is no longer a stressful activity but a comfortable one with shorter travel time, less congestion, reasonable prices, less waiting time, easy to access, a number of choices, and so on.
- The transport system in Karachi has enough capacity to satisfy the traffic demand.
- Mass transit system is successfully operated along the circular route and the priority corridors, providing fast and comfortable transport service with adequate cost.
- Traffic on road system in Karachi is safe for cars and pedestrians, even though traffic speed is increased because of less congestion.
- Bus is convenient, comfortable and reasonable transport mode in Karachi, services of which are available in entire urbanized area.
- Road network supports economic activity with the minimum environmental impact on Karachi residents.

(3) Transport Sector Development Policy

Achievement of Future Land use Plan considering Population Growth

The largest challenge in the transport sector development in Karachi is a large scale population growth in suburban areas. Karachi has a population of 18.9 million in 2010 as estimated in Chapter 4, which will reach 27.6 million in 2020 and 31.6 million in 2020. In other words, the population increase in the first 10 years will be 8.6 million and the next 10 years will be 4.0 million. KSDP 2020 allocated the future population in suburban areas such as Keamari, Bin Qasim, and Gadap, where transport infrastructure is presently very poor, and KUTMP 2030 assumed this trend will continue. Figure 6-2-2 shows the volume of population growth by town up to 2030. As shown in the figure, the population growth is very large in the suburban areas (1.1 million in Keamari, 2.1 million in Bin Qasim, and 4.5 million in Gadap by 2030) followed by Gulshan-e-Iqbal, Landhi, and Korangi Town.

Transport development in these areas is very important to achieve the land use plan in KSDP 2020 and the future plan in KUTMP 2030. Without proper transport infrastructure, these people will suffer from lack of job opportunities. Therefore, the transport development should focus on the suburban development.

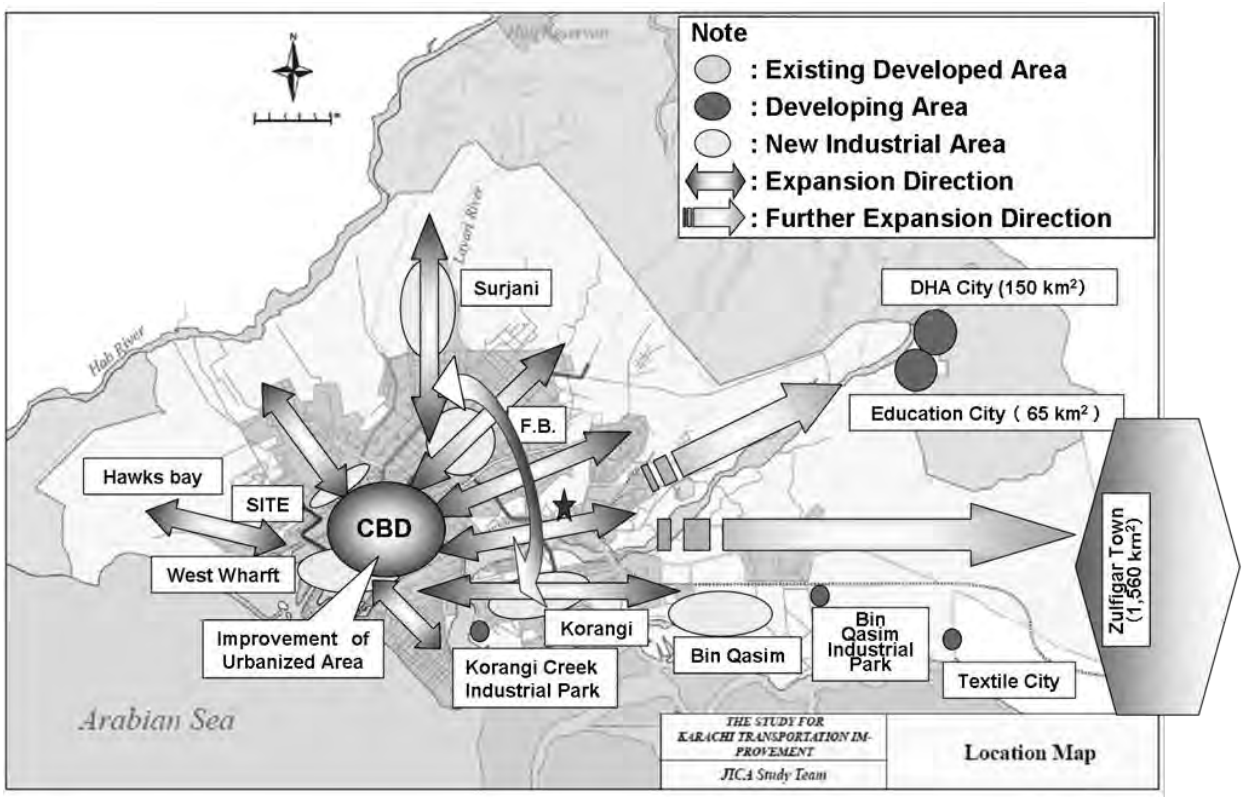


Source: KTIP (Population in 2020 is from KSDP 2020)

Figure 6-2-2 Population Growth by Town

Transport Development along Development Directions

Figure 6-2-3 illustrates the development directions for the next 20 years. As illustrated, the city will expand all directions. DHA City and Education City are proposed development of new cities along Super Highway. Although Zulfikarabad is a proposed plan in Thatta district, it will bring about some impact on the urbanization in Karachi. The transport development should provide proper transport system along these directions to support the urban growth.



Source: Illustrated in KTIP based on information from CDGK

Figure 6-2-3 Development Directions

Road and Mass Transit Development

As illustrated in the future land use plan, a large area needs to be developed in the future. The major issue of the development of this area is speed of implementation. In this area, road network should be developed in the early stage to promote the urban development, and expansion of the bus network in short periods is very important.

On the other hand, CBD and suburban area should be connected with mass transit systems because road network cannot satisfy the future traffic demand. The corridors to be developed are very clear from the urban structure.

In CBD, a large capacity transit system should be introduced to reduce the traffic congestion. However, it takes time and should be a long term project. Fortunately, KCR connects the centre of the city and the north of Lyari River by the circular route avoiding the most congested area. Utilizing KCR to access to CBD should be considered in the short-term project.

6.2.2 Road Network Policies

(1) Policy Description

From the assessment of the present road network, the following policies are proposed to achieve the goals. The future arterial road network improvement in Karachi should be planned to satisfy these policies.

- The road network plan in 2030 is developed based on the plan in KSDP 2020.
- The future road network should be developed to support of the future land use plan and existing development plans.
- The future road network should support public transport system.
- The capacity and density of road network should meet the future traffic demand as much as possible.
- The future road network and facilities should reduce road congestion.
- Accessibility for whole inhabitants in Karachi should be improved.
- Traffic accident should be reduced and the road system should ensure safeness.

The starting point of the planning of the future road network is KSDP 2020. Ring Roads are proposed in KSDP 2020 to bypass the traffic in the centre of the city and provide arterial road system in the suburban area which will be developed as new urbanized areas in the future. The arterial road improvement is also an important policy in KSDP 2020. For the introduction of mass transit system in the future, the proposed method such as reserve of road space and widening of roads should be considered in KUTMP 2030.

As is shown in the demand forecast, the east-west corridor along Shahrah-e-Faisal Road will have the heaviest traffic in the future. Since this road has already been suffered from traffic congestion at present, capacity expansion is necessary. The future road network should be developed to meet this huge traffic demand.

Although Karachi has relatively wide road network, there are some bottleneck sections with narrow width. The widening of such bottleneck sections will improve road traffic to a large extent. M.A. Jinnah Road between Tower and KMC, Jahangir Road, and Nawab Siddique Ali Khan Road are examples of such bottleneck sections. On the other hand, land acquisition along these roads is very expensive and difficult. Because of this, underground is proposed for mass transit system in KUTMP 2030. Widening of these roads should be considered as a long term issue.

Traffic safety is one of the most important issues in the road network development. Several traffic accidents happened at existing signal-free roads, and it is said that the accident rate rose as compared to before the roads became signal-free. When an arterial road becomes a signal-free road, it will be difficult to go across the road for pedestrian and increase in traffic accidents will be concerned. Therefore, installation of pedestrian bridge will be important.

6.2.3 Guideline of Road Development

(1) Road Type

According to KMP-2020, the roads in Karachi were classified into five categories such as "Expressways", "Principal Arterials", "Minor Arterials", "Collector Streets" and "Local Streets" with reference to the AASHTO standards.

In this study, inter-city and suburban arterial roads are clarified as "Highways", and roads in Karachi are classified into the following six functional categories.

1) Expressways

The function of expressways is to pass many automobiles rapidly among major towns of urban area. They are designed by higher design standard, and access is fully controlled.

2) Highways

The function of highways is to connect suburban area and urban area or Karachi and other cities.

3) Principal Arterials

Principal arterials connect main traffic generations and highways and compose as the frame roads in Karachi. As mobility is an important factor in these roads, access by at-grade is limited.

4) Minor Arterials

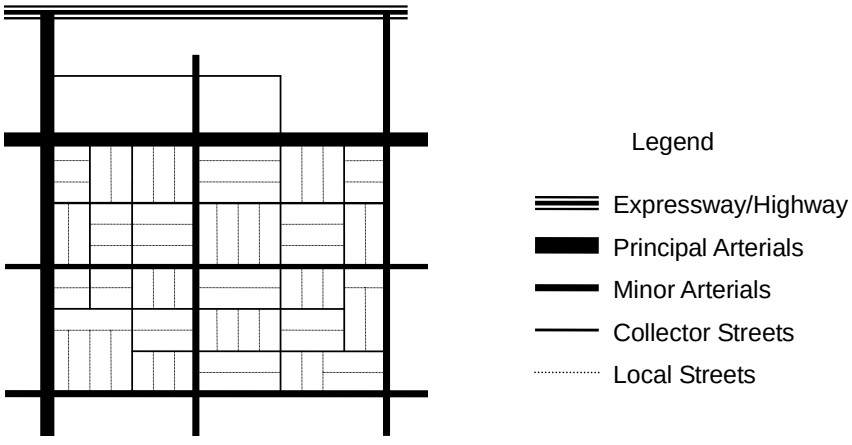
Minor arterial roads connect to the urban expressways, highways, principal arterials or other minor arterials. They provide moderate mobility and access function.

5) Collector Streets

Collector streets connect to principal arterials, minor arterials or other collector streets to collect and distribute the local traffic in the residential, commercial or industrial area.

6) Local Streets:

Local streets connect to the collector streets or other local streets and form town block. They provide easy access to the adjacent property.



Source: KTIP

Figure 6-2-4 Image of Road Type

JICA Study team classified major roads as follows.

Table 6-2-1 Major Roads by Road Type

Road Type	Name of Major Roads
Expressway	Lyari Expressway
Highway	Super Highway, National Highway, RCD Highway, Northern Bypass
Principal Arterial	・ Shahrah-e-Faisal -- M.T. Khan Road, ・ University Road -- M.A. Jinnah Road ・ Shahrah-e-Pakistan -- Jahangir Road ・ Chaudry Faizal Ellahi Road -- Shahrah-e-Usman -- Khayaban-e-Sher Shah Suri -- Nawab Siddique Ali Khan Road – Business Recorder Road ・ West Wharf Road – Mauripur Road – Estate Avenue – Hakim Ibn-e-Sina Road –Sir Shah Suleman Road – Karsaz Road ・ SabaValiullah Road – Shaheed Rashid Minhas Road ・ Jinnah Avenue (and its extention to Super Highway) ・ Korangi Road – Mian S.M Farooq Road – Landhi Flyover
Minor Arterial	(Small part of minor arterial roads) Shahrah-e-Orangi, Chaudhry Khaliq-uz-Zaman Road, Sunset Boulevard, etc.

(2) Road Design Criteria

A road consists of carriageway, median, shoulder, stopping lane, footpath, planting strip, service road and so on, and the width of these components vary according to the road classification.

The lane width of 3.5m is applied for Expressway and Highway, which the width of 3.25m is applied for Principal Arterial. In case of Minor Arterial, the width of 3.0 is applied. Shoulders are installed outside of the carriageways of Expressways and Highways, while stopping lanes and footpaths are installed instead of shoulders in case of Principal and Minor Arterials which pass through the urban area.

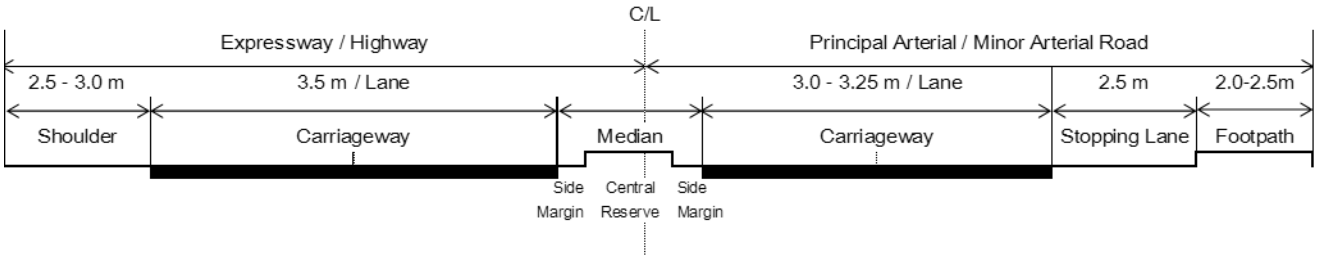
Typical condition of each road item by road classification is set as below while referring to the example of normal cross sections in Karachi and the Road Structure Ordinance of Japan.

Typical road cross-sections by road classification are shown in Figure 6-2-6.

Table 6-2-2 Typical Condition of Each Road Item by Road Classification

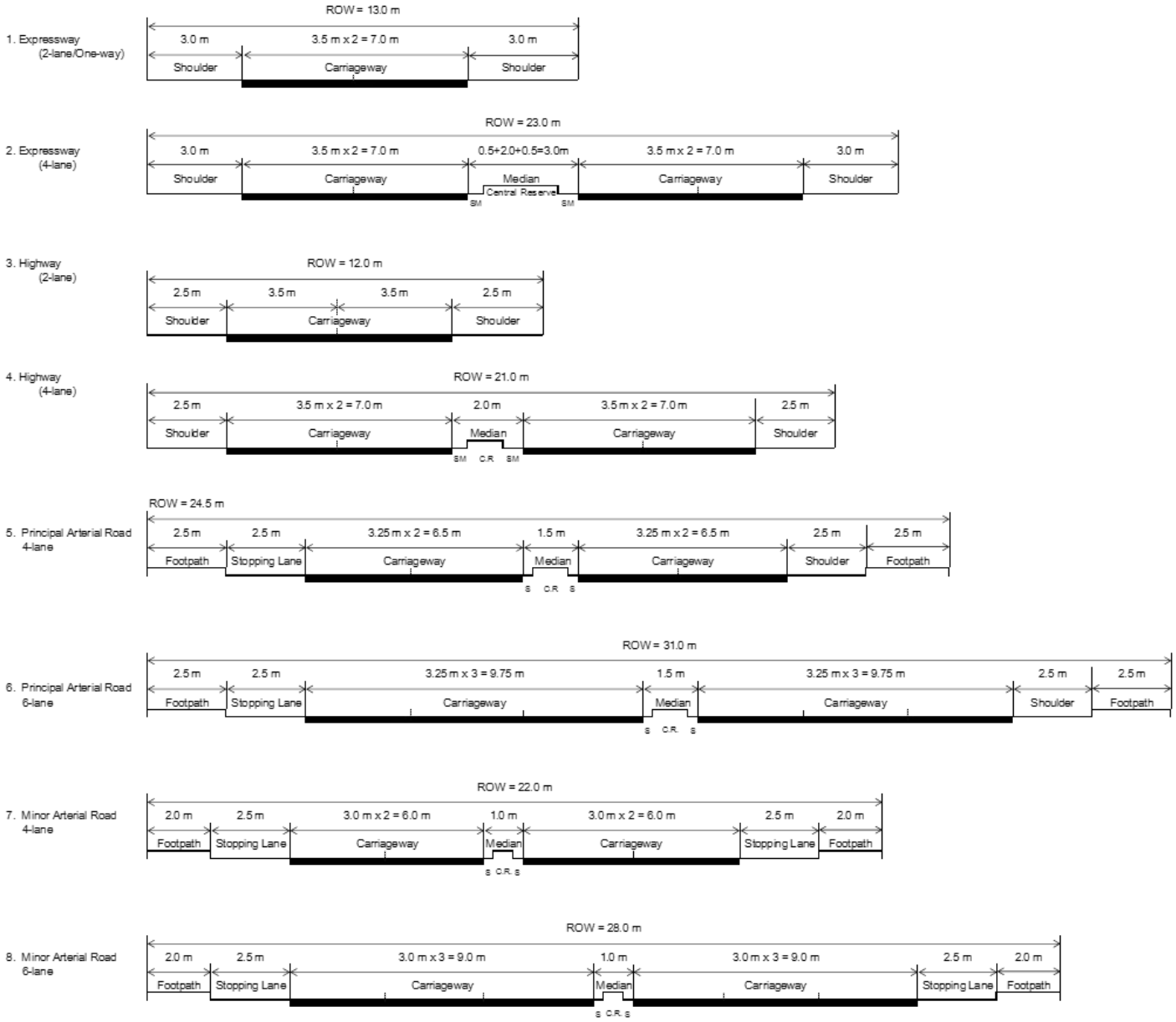
Classification	No. of lanes	Lane width (m)	Shoulder (m)	Stopping Lane (m)	Median (m)			Footpath (m)	RoW (m)	Remarks
					Side Margin	Central Reserve	Total			
Expressway	2	3.5	3.0	-	-	-	-	-	13.0	One way
	4				0.5	2.0	3.0		23.0	
Highway	2	3.5	2.5	-	-	-	-	-	12.0	
	4				0.5	1.0	2.0		21.0	
Principal Arterial	4	3.25	-	2.5	0.25	1.0	1.5	2.5	24.5	
	6								31.0	
Minor Arterial	2	3.0	-	2.5	-	-	-	2.0	15.0	
	4				0.25	0.5	1.0		22.0	
	6								28.0	

Source: JICA Study Team



Source: JICA Study Team

Figure 6-2-5 Typical Road Item by Road Classification



Source: JICA Study Team

Figure 6-2-6 Typical Road Cross-section by Road Classification

6.2.4 Public Transport Policies

(1) Basic Policy

To achieve the goals, the following policies are proposed for public transport in Karachi.

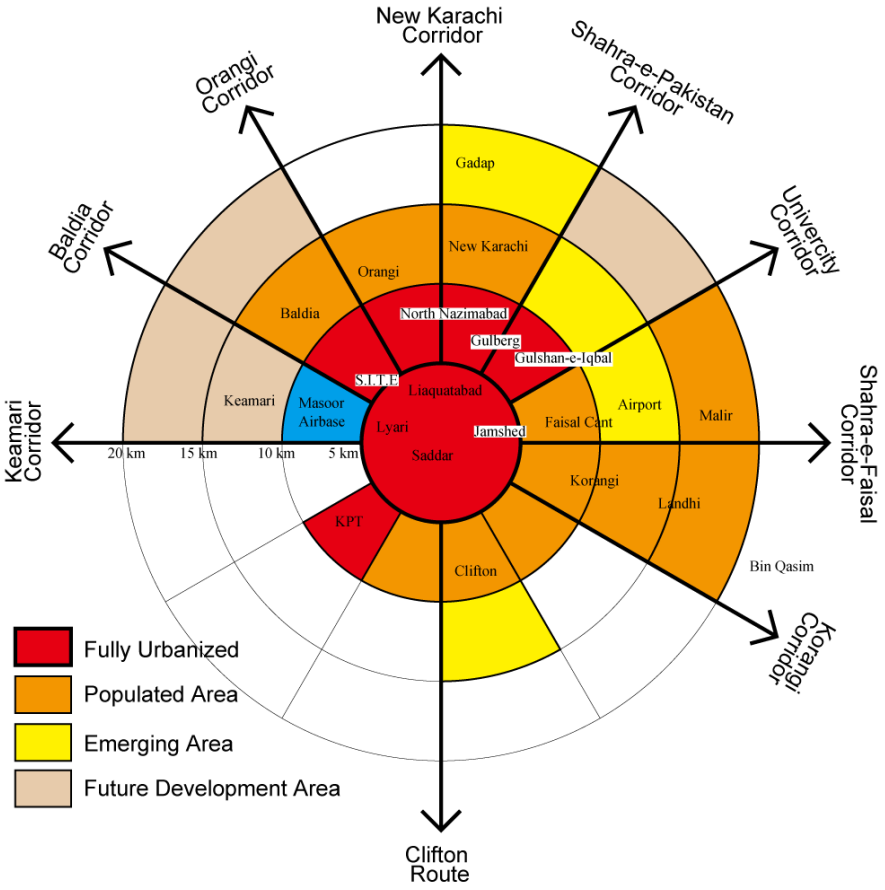
- Mass transit system should provide higher services than existing buses in order to satisfy the need of such transit system and promote modal shift from private mode to public one.
- The new mass transit and the existing buses are operated together to satisfy various needs of public transport.
- Karachi Circular Railway (KCR) should be developed as a Mass Rapid Transit System along the present circular route.
- Rail-base mass transit system should be developed along priority corridors to connect the CBD and the suburban area.
- Bus Rapid Transit (BRT) should be introduced on major roads.

As discussed in the scenario analysis, the future mass transit system should provide enough service to those who are willing to pay a higher fare than the existing minibuses for higher quality of services. There are two purposes of this policy: 1) to ensure financial sustainability of the project, and 2) to avoid conflict with existing bus operators from competition.

The KCR route is a precious urban space, and there are some ideas to use it as other types of the transit system such as LRT and BRT. The notified Corridor-3, Corridor-4, and Corridor-6 are planned to use KCR route. In addition, BRT routes are proposed along KCR in "Private-Public partnership based environmental friendly public transport system for Karachi (2006)" and the succeeding study by ADB. However, due to the bottleneck sections of radial road network, KCR is the only route to connect the center of the city and the suburban areas. KCR should be developed as a MRT system according to the existing KCR plan.

(2) Public Transport Development Corridor

Karachi has been fully urbanized within a 5-km radius area and mostly populated within a 10-km radius area. The 15-km radius area is being developed rapidly recent years. In the near future, the area within a radius of 20-km will be urbanized. To achieve the goal of the master plan, public transport services should be provided to the entire 20-km radius area, connecting the centre of the city. The distance of 20 km is proper for the operation of most mass transit system. The mass transit corridors were studied by taking into accounts of the density of public transport network and the available existing roads. The mass transit system should be provided to 9 radial corridors as illustrated in Figure 6-2-7.



Source: JICA Study Team

Figure 6-2-7 Concept of Urban Structure and Transport Corridor

Source: JICA Study Team
* Corridors do not necessarily mean mass transit routes.

Figure 6-2-8 Public Transport Corridors

(3) Type of Mass Transit System

There are many mass transit systems in the world, but they can be categorized into three groups: 1) Mass Rapid Transit, 2) Medium Capacity Transit, and 3) Bus Rapid Transit.

Mass Rapid Transit (MRT) is a rail-base system with a large capacity. If passenger demand exceeds 35,000 passengers per hour per direction, MRT is the only system to satisfy the demand. Medium Capacity Transit includes Light Rail Transit (LRT), monorail, Automated Guide Transit (AGT), and Tram. Bus Rapid Transit (BRT) is a bus-base system.

For long distance trips, high speed with a large capacity system is suitable while short distance trips require a number of stations for walking access to destinations.

Characteristics of these mass transit systems are summarized in Table 6-2-3.

Table 6-2-3 Comparison of Mass Transit Systems

		Mass Rapid Transit (MRT)	Medium Capacity Transit			Bus Rapid Transit (BRT)
			Monorail	Automated guide transit (AGT)	Tram	
Overall view						
Vehicle size[*1]	Width	2.78 m	3.02 m	2.49 m	2.40 m	2.50 m
	Height	4.02 m	2.92 m	3.34 m	3.40 m	3.50 m
	Length	19.5 m	16.5 m	9.0 m	18.4 m	12.2 - 20 m
Scheduled speed		30-40 km/hour	30 km/hour	30 km/hour	20 km/hour	20 - 30 km/hour
Train set		4-10 Cars	4-6 Cars	4-6 Cars	1-2 Cars	1 Car
Passenger Capacity[*2]	Seat	50	40	20	30	40
	Stand	200	110	50	75	60
	Total	250	150	70	105	100
Maximum Frequency		30 trains/hour	30 trains/hour	30 trains/hour	30 trains/hour	60-180 cars/hour
Transportation Capacity (PHPDT[*3])		30,000-75,000	18,000-27,000	8,500-12,500	3,100-6,300	6,000-18,000
Construction Cost Ratio[*4]		Elevated: 1.0 Underground: 2.0	0.9	0.8	< 0.1	< 0.1
Operational Cost Ratio[*5]		Elevated: 1.0 Underground: 1.5	0.5	0.5	0.25	< 0.1
Slope		3.5%	6%	6%	3.5%	10%
Characteristics		- Popular system - Only solution to carry more than 35,000 PHPTD	- Rubber tyre - Less noise - Slim structure	- Rubber tyre - Less noise - Popular in Japan and airport access in the world	- Run on urban streets - Popular in Europe	- Many types - Use road lanes - Rapidly developed in the world recently

Note *1) Vehicle size refers existing examples; Mass Rail Transit - Tokyo Metro, Monorail - Tokyo Monorail, Automated Guide Transit - Nippori-Toner Liner, Tram - PORTRAM, Toyama, Japan and Bus System - CNG bus, Karachi.
*2) Passenger Capacity consists of seated and standing passenger. Standing Passenger density is assumed 6 persons/m2
*3) Peak Hour Peak Direction Traffic.
*4) Figure shows rough estimated ratio of each system's construction cost with a premise of one of the Mass Rail Transit Elevated equals 1.0.
*5) Figure shows rough estimated ratio of each system's maintenance cost with a premise of one of the Mass Rail Transit Elevated equals 1.0.

Source: JICA Study Team based on "Urban Transportation in Future"

(4) System Selection

Mass transit system to be introduced to Karachi should be selected based on the following criteria.

1) Demand

Passenger demand is the most important criterion to select a mass transit system. The capacity of the system needs to satisfy the passenger demand in the future. The number of passengers per direction in a peak hour is the basic data of the future demand for the system selection.

2) Cost

The mass transit system in Karachi should be economically reasonable. Cost efficiency is as important as the system capacity. This includes construction cost, rolling stock cost, operation and maintenance cost.

3) Environment

Energy efficiency is an important criterion to select the mass transit system in Karachi to save energy consumption in the country. Energy-efficient system will reduce greenhouse gas emission which contributes to the world environment problem.

4) Space

A mass transit system uses urban spaces to some extent. For example, surface transport system such as tram and BRT use two lanes of roads along the route. Elevated systems need space for the columns. The available space for mass transit development is one of the important criteria for the system selection.

5) Sustainability

Procurement of additional rolling stock and repair parts should be easy for the sustainable operation of the mass transit system. For this, popular system in the world should be selected for mass transit system in Karachi. From this, monorail and AGT are not recommended for the urban transport system in Karachi because the market of these systems is relatively small and not popular in the world.

It is better that rolling stock and spare parts can be purchased in the country's market.

6) Single System

Every railway lines should employ the same system as much as possible in view of efficient operation and maintenance. At least track gauge, vehicle size, and power supply system should be the same among railway lines. The standardization of the railway system in Karachi enables not only integrated operation but also share of depot, workshop, maintenance facility and machinery. The railway system can be efficient and robust by the standardization.

Due to the last criterion, the railway system should be as same as that of KCR. Since KCR SAPROF Study in 2009 proposed a Mass Rapid Transit (MRT), it is reasonable to introduce MRT for urban railway system in Karachi. Although medium capacity transit system would be suitable depending on the corridor demand, introduction of a number of systems would not be successful in Karachi considering cost performance, capacity of local authorities, and the limited number of system suppliers. The gap of demand and system capacity should be solved by the best combination of MRT and BRT.

6.2.5 Guideline of Rail Base Transit

(1) Introduction

The railway system in Karachi should be safe, high-volume and high-speed railway transportation service with high frequency, punctuality, reliability, economic efficiency and a low accident rate. At the same time, the system should be state of arts, technology proven, and internationally popular. The railway planning should not rely on the special technology. For example, the gradient of the railway line should be less than 3.5%, which is the maximum gradient of most urban railway system in the world. The following guidelines (Route Planning, Station Planning, and Rolling Stock Planning) have been applied to the railway planning in the master plan.

(2) Route Planning

In route planning of the railway system in Karachi, following points should be considered.

1) Right-of-way

The railway system should be constructed within the right-of-way of roads as much as possible to avoid land acquisition and resettlement. Since construction cost and rolling stock cost of the railway system is expensive, additional cost should be avoided.

2) Alignment

The minimum radius of a railway system is 160m, and the maximum gradient is 3.5% in general. However, sharp curves and steep slope should be avoided as much as possible because they will reduce the speed.

Design criteria concerning alignment of railway are shown in Table 6-2-4.

Table 6-2-4 Design criteria concerning alignment

No.	Items	Technical Features
1	Track Gauge	1,435 mm
2	Design Maximum Speed	90 – 110 km/h
3	Minimum Curve Radius	Main Line: R=160m Platform: R=400m Siding / Depot: R=100m
4	Maximum Gradient	Outside platform: 35 ‰ Platform : 2 ‰ Depot: Level

Source: JICA Study Team

3) Relation with Road Traffic

Railway lines should be fully segregated from road traffic to ensure the frequency, speed, and safety. Level crossing is not recommended.

4) Structure

In the master plan network up to 2030, underground sections should not be constructed as much as possible to reduce the construction cost. The route should be planned along the roads where elevated structure is possible. However, underground will be one of the options in the center of the city where roads are not wide enough to accommodate elevated structure, but the introduction of mass transit system is very important. At-grade sections are only possible where roads and the railway are separated by flyover or underpass.

5) Passenger Access to Stations

Passenger access to railway stations should be separated from road traffic by pedestrian bridges or underground walkways to ensure the safety of passengers.

6) Social Environment

Demolition of buildings and resettlement should be avoided as much as possible.

(3) Station Locations

The following four items should be considered in the planning of station locations.

1) Distance between Stations

The distance between stations affects the scheduled speed of a railway system. If trains need to stop at many stations, the scheduled speed will decrease. Many stations will increase the initial investment cost and O&M cost. Since the railway system in Karachi forms important corridors of public transport system, the scheduled speed should be higher than that of normal bus systems and economical feasibility is very important. On the other hand, passenger demand will decrease if the number of stations is small. The appropriate distance between stations of urban railway system considering these factors is approximately one kilometre. The urban railway system in Karachi also should employ the economical distance.

2) Stations at High Demand Locations

Stations should be located in the area that attracts a large number of passengers such as government buildings, large-scale hospitals, public facilities and libraries adjacent to public facilities.

3) Connection with Other Transit Lines

Transfer between transit lines should be considered for the locations of stations. Distance between stations of different lines should be as short as possible for convenient transfer. Feeder bus connections are also important.

4) Access to Stations

Passenger access to stations is an important factor of the locations of stations. The inconvenient access to stations was one of the reasons of the failure of KCR. The access by bus and cars should be also considered.

(4) Station Facilities

The necessary facilities of a station are shown in Table 6-2-5 by the structure type.

Table 6-2-5 Main station facilities

		Elevated	At-grade	Underground
Platform	Platform	○	○	○
	Elevator	○	-	○
Business & operation	Office room	○	○	○
	Ticket booth	○	○	○
	Entrance gate	○	○	○
	Entrance and exit	○	○	○
Electric & Machinery	substation	▲	▲	▲
	Air-conditioning machine room	-	-	○
	Electricity room Electric accumulator room	○	○	○
	Signal & telecom equipment room	○	○	○
	Ventilation & smoke exhaustion machinery room	-	-	○
	Drainage pump room	-	-	○

Note: ○ : requisite facilities; ▲: if needed; - : unnecessary
Source: Prepared by the JICA Study Team

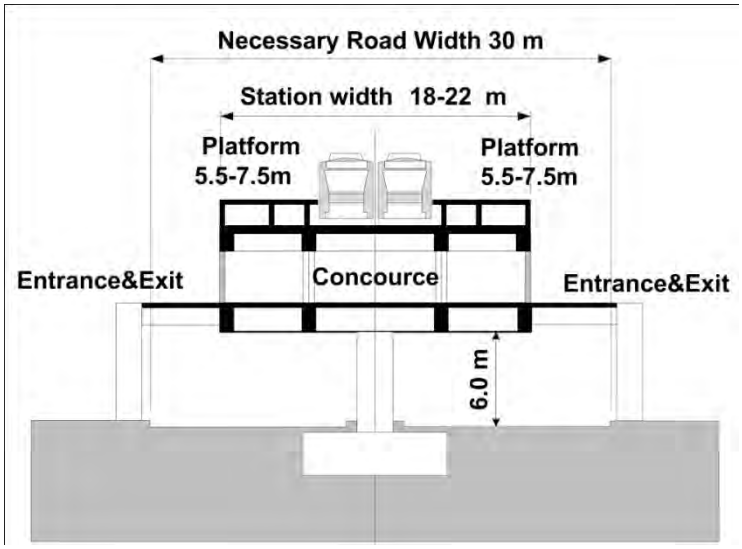
The structure should be designed with minimum required spaces for both public section and operational section to minimize construction cost for the station facility. The station facility should have up-to-date operational system and passenger environment with safety control and universal access well considered and designed.

(5) Cross Section

1) Elevated Station

The station at any large street in the city would be elevated above the road surface, or median section with minimum head clearance kept for vehicle traffic. The elevated station may be designed for both side-platform type and center-platform type depending on the actual situation that each station may have. Concourse, which has public passenger area and operational area, would be provided above the road and below the railway track and platforms to enable smooth flow of passengers between street sides and platforms. Where more space is available on median surface, another alternative design may be studied.

The sidewalks would be connected with pedestrian bridges to the station building by stairs, escalators or lifts for easy access. Typical cross section is shown in Figure 6-2-9.



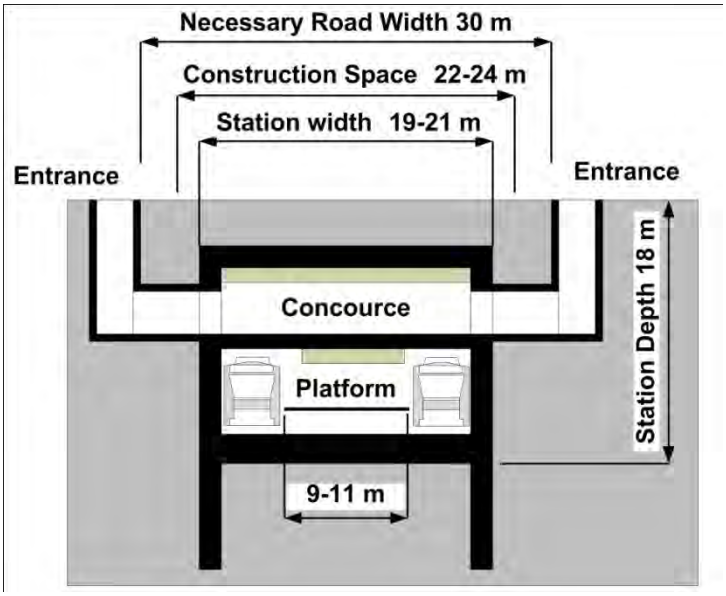
Source: Illustrated by the JICA Study Team

Figure 6-2-9 Cross section of elevated station

2) Underground Station

Most facilities of an underground station are located below the surface except for entry boxes, ventilation shafts, and substation facilities. The concourse would be provided between street level and track level for passenger access. The station box structure is longer than the elevated station structure to accommodate more mechanical equipment in the station such as air-conditioning system, tunnel ventilation system and larger fire fighting system.

Typical cross section is shown in Figure 6-2-10.



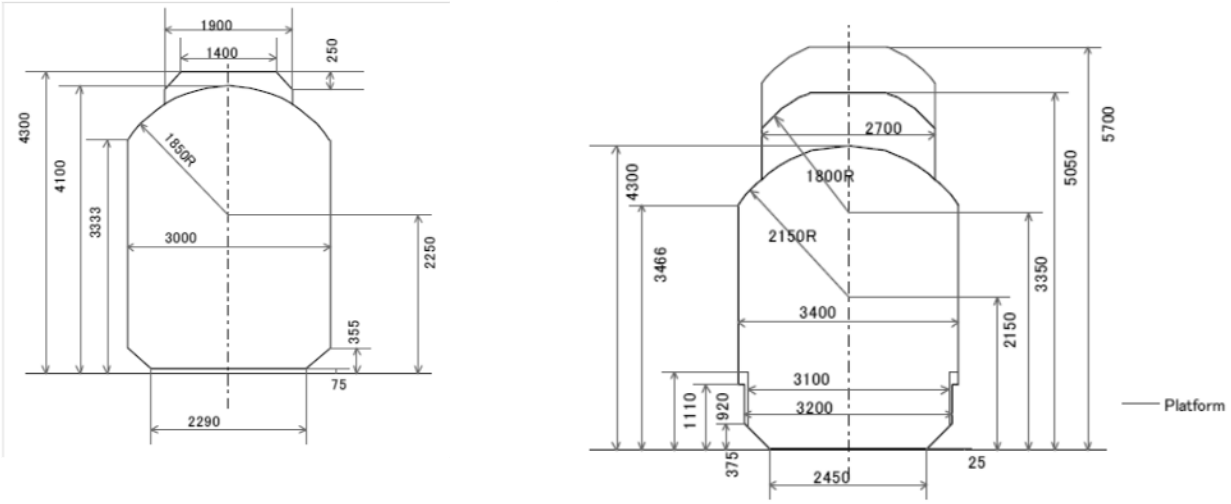
Source: Illustrated by the JICA Study Team

Figure 6-2-10 Cross section of underground station

(6) Rolling Stock and Other Technical Factors

1) Size of a Car

A car used for the Mass Rail Transit (MRT) or Light Rail Transit (LRT) shall be the typical size of EMU (Electric Multiple Unit), of which length is around 20 meters, and the width is 3 meters. Figure 6-2-11 shows the rolling stock gauge and structure gauge which are used for the planning of urban railway system in Karachi.



Source: Proposed by the JICA Study Team

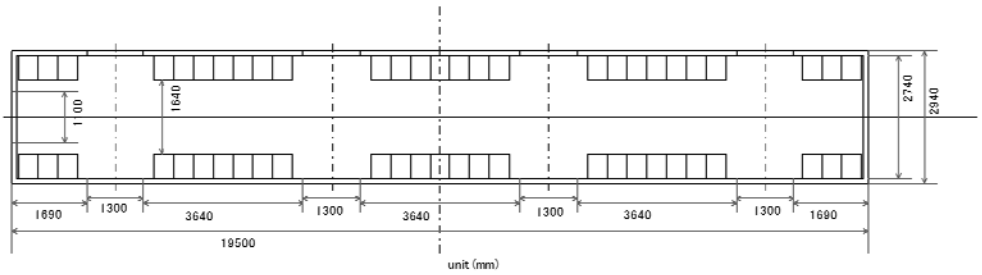
Figure 6-2-11 Proposed Gauge (Left: Rolling Stock Gauge, Right: Structure Gauge)

2) Capacity of a car

To calculate the capacity of a car, the seat arrangement of the car is assumed as shown in Figure 6-2-12 and 6-2-13 for intermediate cars and end cars, respectively. The capacity of seated passengers is the number of seats and that for standing passengers are calculated from the floor space available for the standing passengers.

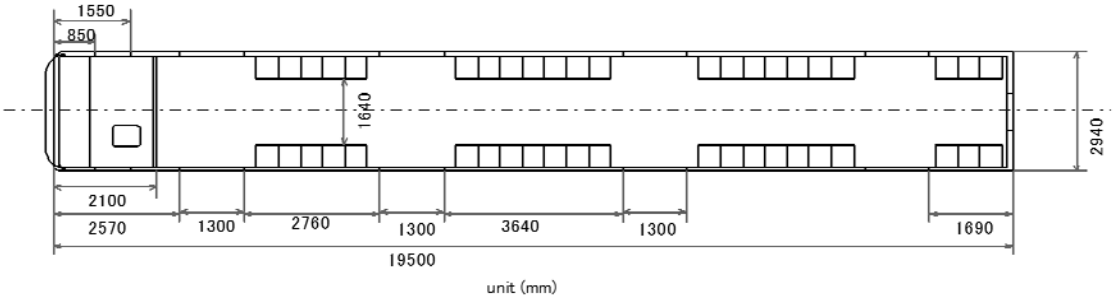
The seat capacity is 54 persons, and the floor space available for the standing passengers is 32.46 m^2 in case of intermediate cars.

The capacity of end car with driving cabin is smaller than that of intermediate cars. In this case, the seat capacity is 44 persons and the floor space for standing passenger is 30.94 m^2.



Source: Proposed by the JICA Study Team

Figure 6-2-12 An example of seat arrangement for intermediate car



Source: Proposed by the JICA Study Team

Figure 6-2-13 An example of seat arrangement for end car

As for the number of doors of a car side, 3-door type or 4-door type is generally selected for a commuter train of 20 m length. If the door number increases, the dwelling time of stations can be shortened. In this case, the seat capacity decreases and the capacity of standing passengers increase, resulting in the increase of car capacity.

3) Capacity of a Train

The capacity of a train differs by the possible density for standing passengers. Table 6-2-6 shows train capacities for different train compositions (4-car, 6-car, and 8-car) and different passenger densities when cars in Figure 6-2-13 and 6-2-14 are used. The passenger density of 6 persons /m^2 is very high, and the car is heavily congested with this density. The density of 8 persons /m^2 is so high that it will cause delay at stations because passengers need to be pushed in by station staff. Although the density of 4 persons /m^2 is desirable, the density of 6 persons /m^2 is employed in the planning to reduce the number of necessary rolling stock.

Table 6-2-6 Train Capacity

Train composition	Floor space (m^2)	Capacity of seated passengers	Capacity of standing passengers			Total Capacity		
			4 persons/ m^2	6 persons/ m^2	8 persons/ m^2	4 persons/ m^2	6 persons/ m^2	8 persons/ m^2
4-car train	126.80	196	507	760	1,014	703	956	1,210
6-car train	191.72	304	766	1,150	1,533	1,070	1,454	1,837
8-car train	256.64	412	1,026	1,539	2,053	1,438	1,951	2,465

Source: JICA Study Team

4) Hourly Capacity

Hourly capacity depends on the train capacity and the number of train services per hour that is calculated from the headway. Table 6-2-7 shows hourly capacities by the number of cars per train by headway in case of the standing passenger density of 6 persons /m^2. The minimum headway is assumed as 2.5 minutes, which was employed in KCR SAPROF Study in 2009. The maximum capacity of 4-car, 6-car, and 8-car trains is calculated as 22,900, 34,900, and 46,800, respectively.

Table 6-2-7 Hourly Capacity of Railway

	No. of trains	12	15	20	24
	Headway	5.0	4.0	3.0	2.5
Train composition	4-car train	11,472	14,340	19,120	22,944
	6-car train	17,448	21,810	29,080	34,896
	8-car train	23,412	29,265	39,020	46,824

Source: JICA Study Team

5) Gauge

The standard gauge (1435 mm) is employed in the master plan because new technologies and improvements developed in other railway systems can be easily applied and materials for the railway system may be provided with reasonable prices.

6) Power Supply System

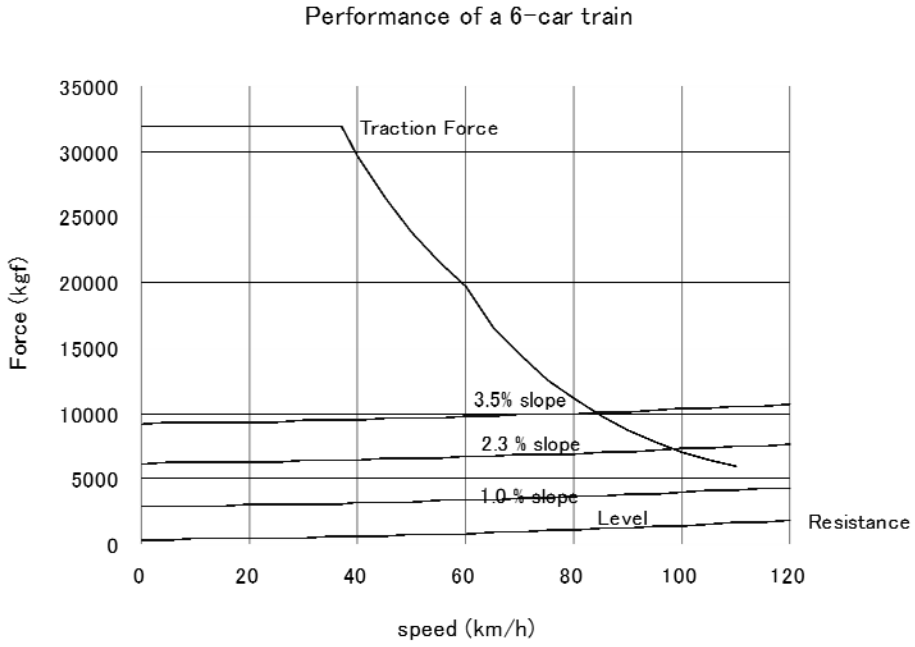
The selection of power supply system is made mainly from the view of investment cost. Generally, DC power supply system is applied in the urban railway system where a large number of trains are operated. On the other hand, AC power supply system is applied in the inter-city railway system where the distance between stations is long and rather small number of trains is operated.

From this, DC power supply system is assumed in the planning. However, this will not affect the master plan because it can be decided in the stage of more detail study.

7) Performance of a train

Figure 6-2-14 shows the train performance for a 6-car train which is used in the urban railway planning. The train can run on a slope of 3.5 % at speeds of more than 80 km/h. Acceleration is assumed as 3.12km/h/s. Even if one car out of 4 motor cars failed and the traction force is reduced to 75 %, the train can run at the scheduled speed.

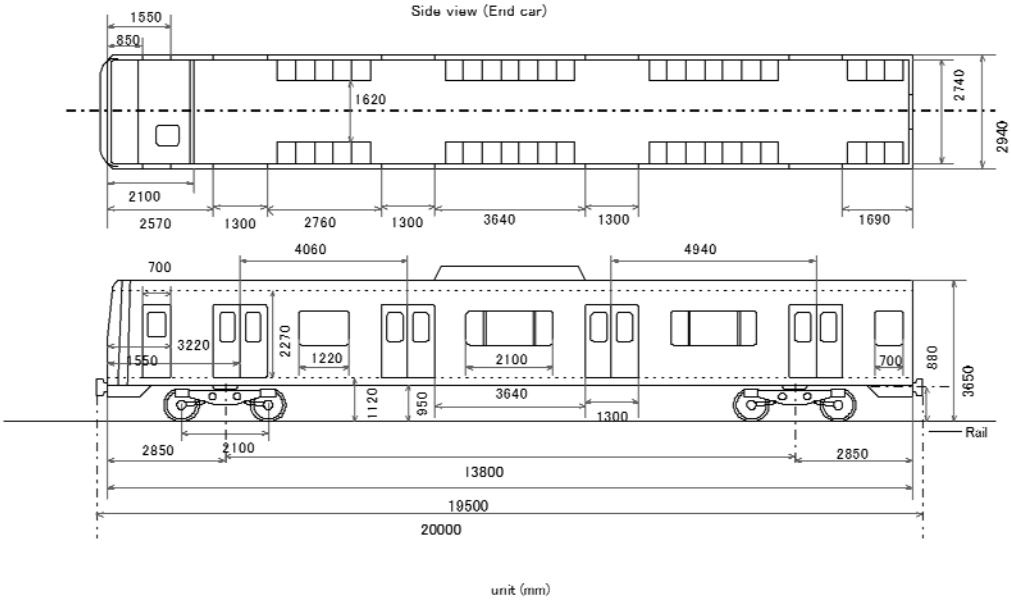
This train performance data is necessary information to calculate the average speed between stations.



Source: JICA Study Team

Figure 6-2-14 An example of a train performance

Figure 6-2-15 shows the image of EMU train.



Source: JICA Study Team

Figure 6-2-15 General view of an end car

6.2.6 Guideline of Bus Rapid Transit (BRT)

(1) BRT Type

There are many types of Bus Rapid Transit in the world. For transport planners in Karachi, the concept of "BRT" has been largely influenced by "Detailed study on a Private /Public Partnership Based Environmental Friendly Public Transport System for Karachi, 2006", in which three levels of BRT type are defined as follows:

Table 6-2-8 Defining levels of BRT

Level	Name	Capacity	Characteristics
Level- 1	Bus Lane	6-8,000	- Minimum portion bus lane (kerbside) - Used by general bus network - Can be improved with signal priority and better road signage
Level- 2	Busway	8-10,000	- Developed Bus lane (centre roadway) - Generally segregated from other traffic - Gives buses traffic signal priority - Used by general bus network (not centrally managed)
Level- 3	BRT	25,000+	- Centrally managed bus system - Dedicated bus fleet and exclusive services - Uses high level technology ITS (vehicle location & real time management) - High standards of bus stations and off-bus fare collection

Source: "Detailed study on a Private /Public Partnership Based Environmental Friendly Public Transport System for Karachi, 2006", (Tabulated by JICA Study Team)

The capacity of 25,000 without passing lanes would be possible only when buses run as a platoon with slow speed to prevent collision. For the planning purpose, the capacity of a BRT should be considered as 10,000-15,000 per direction per hour without passing lanes. With passing lanes, capacity depends on the number of passing lanes, and it would be unlimited.

In case of dedicated bus lanes in the center of the road, which is the most successful practice in the world, bus doors are placed on the right side of the bus because stations are provided in the median of both lanes. This means that buses on the dedicated lanes cannot run on lanes of general roads because boarding and alighting in the city streets and roads are done by the left side doors.

(2) Road Condition

Introduction of BRT system or Busway reduces traffic capacity because the system occupies a part of road space. Therefore, BRT system and Busway should not be constructed on the roads where the number of lanes for both directions is less than six because of negative impact on road traffic. However, it is possible to construct BRT system or Busway along 4-lane roads if one lane for each direction is enough for road traffic. It is also possible along one-way roads with 3 or 4 lanes.

(3) Vehicle Body

General types of buses are not suitable for BRT system considering efficient boarding and alighting operation and ticketing system. It is necessary to introduce dedicated types of vehicle for BRT system. Since roads in Saddar Area are not wide enough to accommodate segregated lanes, vehicle design should consider both sides boarding and alighting with proper arrangement of doors so that the vehicles can run on general traffic lanes. Roof top riding should not be allowed for BRT, Busway, and Bus Lane.

(4) Structure

BRT system should be developed in the existing right-of-way of roads. Concrete pavement is

proposed along the lanes to avoid frequent maintenance works in case of asphalt pavement. However, the design should be reasonable enough so that CDGK can afford to maintain the lanes. In the ADB Mega City Project, it was proposed to construct elevated sections along narrow roads where providing exclusive lanes at-grade type for BRT is difficult. However, it is not recommended that such kind of permanent structure be constructed for BRT system. Instead, BRT system should be designed so that it can be converted to rail base transit system in the future.

(5) Ticketing System

In case of Bus Lane and Busway, fare collection is done inside buses, while passengers buy a ticket outside buses and enter the bus stations in case of BRT system. For this, an integrated ticketing system of the international standard should be introduced. One of the examples is the smart card system which was introduced in the pilot project of CNG Green Bus.

The fare level should be higher than that of the existing minibuses to sustain the financial condition of the BRT system. The fare system should be integrated with that of MRT network including KCR.

(6) BRT service in CBD

Due to the limited space for segregated lanes for buses, feeder bus system has been proposed as "shuttle bus service" by transport planners in Karachi. On the other hand, the shuttle bus service was not recommended in "Green Route Confirmatory Study for Karachi (2008)" because the report analyzed that such service would bring about more congestion.

BRT service is not possible in CBD because there is no space available for the segregated lanes for BRT unless the roads are widened. Instead, the buses for BRT should be designed so that they can run in the roads in CBD, where various types of vehicles are mixed.

Photo: JICA Study Team

6.2.7 Traffic Management

Development of the road network and mass transit system are not enough to solve the traffic related problem in the central business district (CBD) of Karachi. Since the construction of new roads and flyovers are very difficult in CBD, it is necessary to introduce proper traffic management. There will remain a lot of bottlenecks which cause traffic congestion. Low capacity intersection, improper function of traffic lights, on-street parking, encroachment to carriageways, high traffic generation at schools and commercial buildings, illegal stopping of vehicles, animal cart, and many other activities along roads create bottlenecks at many places. Removal of such bottlenecks is very important issue in traffic management.

There are a lot of measures proposed for traffic management in KSDP 2020. In the master plan, the measures are categorized into five groups according to the basic approach such as (1) modal shift from low occupancy vehicles to high occupancy vehicles, (2) traffic control at intersections and streets, (3) increase in road capacity, (4) demand control at peak hours, and (5) control of trip generation. There are two types in each approach: (a) encourage the activities that improve road traffic and (b) discourage the activities that cause traffic congestion. In other word, carrot and stick measures are necessary. Table 6-2-9 summarizes traffic management measures.

Table 6-2-9 Measures of Traffic Management

Approach	Encourage activities that improve road traffic (carrot)	Discourage activities that cause traffic congestion (stick)
Modal Shift	- Development of bus priority lanes - Modernization of bus fleets - Construction of comfortable bus stops - Construction of parking facilities at stations for Park & Ride - Development of pedestrian network - Development of transit mall	- Regulation of car use by number - Tax on private cars - Route regulation of low occupancy vehicle - Regulation of car-own
Traffic Control	- Improvement of traffic signalling system - Improvement of intersections - Introduction of one-way streets - Introduction of reversible lanes	- Strict law enforcement on traffic rules
Increase in Road Capacity	- Construction of parking facilities - Construction of rickshaw and taxi pool	- Removal of encroachment - Regulation of parking - Regulation for rickshaw and taxies of waiting on roads
Peak Control	- Priority use of lanes for public transport in peak time - Transit mall in day time	- Time regulation of cargo loading / unloading - Time regulation of lane use by private cars and para-transit
Trip generation control	- Relocation of bus terminals	- Enforcement of parking facilities of a large scale building - Prohibit car use for schools

Source: Prepared by the JICA Study Team

The carrot measures need investment while the stick measures are difficult to enforce. Considering the possibility of implementation, the following measures are proposed to be applied in the master plan.

(1) Improvement of intersections

The capacity of intersection can be increased with minor improvement such as adding a right turn lane or left turn lane, layout change, marking, setting curbs and islands, and so on. The major intersections along wide roads have been improved recently, but the minor intersections in CBD need to be improved.

(2) Modernization of traffic signalling system

This is one of the most important measures for the proper traffic management. The present traffic signals, which were installed under the first stage of Urban Traffic Control System in the early 1990', are operated in fixed time period which need to be controlled manually at each location. To enable flexible signal phasing based on the real time traffic flow, it is necessary to modernize the traffic signalling system. This is also important issue for the successful operation of BRT system.

(3) Relocation of illegal bus terminals to outside CBD

There are many inter-city buses parked in Saddar illegally. Since the main destination of these inter-city buses is toward Super Highway, it is necessary to relocate the buses to the bus terminal along Super Highway.

(4) Construction of parking facilities

Lack of parking spaces causes a large number of on-street parking vehicles which brings about serious congestion. Parking buildings should be constructed at proper locations to accommodate the parking demand.

(5) Promote park and ride for mass transit corridors

Modal shift from private mode to mass transit system the most effective measures of traffic management which can reduce road traffic to a large extent. The expansion of the urbanized area will increase car use in suburban areas where road infrastructure is well developed while local public transport cannot cover the entire area. It is necessary to provide park & ride facilities at stations of mass transit system in suburban areas.

(6) Designation of public transport routes

The mixture of different size and different speed vehicles is one the reasons of traffic congestion. Auto Rickshaw, Suzuki Pickup, and Qinqi Rickshaw should be prohibited along major streets in congested areas. The bus routes should be removed in case that the occupancy is small in the congested areas.

6.2.8 Freight Transport Policies

Truck traffic causes various problems in several parts of Karachi such as New Truck Terminal along Hawks Bay Road, National Highway near Landhi Town, SITE Industrial Area, and Super Highway. In addition, Sunset Boulevard in Clifton Area is a major route of truck transport, which causes traffic congestion. Truck terminals, or truck parking places, are located at strategic sites where access to ports and industrial areas is convenient. KSDP 2020 proposes to shift truck terminals along Northern Bypass, which is far from the port and industrial areas. In addition to the terminals at the strategic sites, parking area of trucks should be developed near the ports and industrial areas by the port authorities and the corresponding agencies of the industrial areas. Traffic management is also the major policy of freight transport as well as infrastructure development. Truck routes should be designated, and the regulation of permitted hours should be enhanced. Roads of the truck routes should be maintained in a regular base.

6.3 Road Network

6.3.1 The 29 corridors

The 29 corridors shown in Table 6-3-1 and Figure 6-3-1 were approved as "signal free corridors" by the City Nazim in 2009 (Notification No. DCO/CDGK/PS/373/09). A signal free corridor is an arterial road having grade separation with other roads for high speed movement without interruption by traffic signals. CDGK has already implemented three signal free corridors (C-1, C-2 and C-3), and C-4 corridor is now under implementation.

The remaining corridors should be improved as signal free corridors in the future, except for the corridors where Bus Rapid Transit (BRT) will be introduced, and construction of flyover and underpass is very difficult. Roads in the centre of the city where pedestrian movement is heavy should not be converted to signal free corridors.

Table 6-3-1 List of 29 Corridors

S.No	Corridor	Limits Of Corridor
1	C-1	From Shahrah-e-Faisal To Gulbai Chowrangi Via Hasan Square
2	C-2	From Nagan Chowrangi To Shahrah-e-Faisal Via Nipa Chowrangi
3	C-3	From Shahrah-e-Liquat Upto Malir Cantonment Link Road Via University Road
4	C-4	From Keamari Boat Basin To Steerl Mills Juncttion
5	C-5	From Park Tower, Shahrah-e-Iqbal To Avari Tower Via Abdullah Haroon Road, Aga Khan Road
6	C-6	From Hino Chowrangi,Korangi To Napier Road Via Jail Chowrangi
7	C-7	From Abdullah Shah Ghazi To Keamari Oil Terminal Via Bilawal Chowrangi
8	C-8	From Korangi Main Road To M.T Khan Road Via Mai Kolachi
9	C-9	From M.A Jinnah (Near KMC Head Office Dr. Ziauddin Ahmad Road To Submarine Chowrangi Via Quaid-e-Awam Flyover
10	C-10	From Jinnah Bridge To Northern Bypass Via Guru Mandir & Sakhi Hassan Chowrangi
11	C-11	From Guru Mandir To Sohrab Goth Via Liaquatabad No.10
12	C-12	From Manghopir Road To Super Highway Via Surjani Chowrangi
13	C-13	From Rashid Minhas Road (UBL Sports Complex) To Manghopir Road Via Sakhi Hassan Chowrangi
14	C-14	From Ibrahim Hyderi To FTC, Shahrah-e-Faisal Via Hino Chowrangi
15	C-15 (a)	From Coastal Highway to Mehran Highway Near E.P.Z
	C-15 (b)	From Coastal Highway to Hussaini Chowrangi Via Lalabad
16	C-16	From Shahrah-e-Faisal To Coastal Highway Via Shah Faisal Fly
17	C-17	From 12000 Road To Malir Court Via Shahrah-e-Altaf Hussain
18	C-18	From Shahrah-e-Faisal To Supper Highway Via Jinnah Avenue
19	C-19	From Shahrah-e-Faisal To Coconut Garden,Road Along Race Course Ground
20	C-20 (a)	From Safoora Chowrangi, up to Manghopir Road Via Saba Cinema And Power House Chowrangi
21	C-21 (a)	From Kalaboard Malir Via Khokhrapar Memon Goth, Upto Bakra Piri Malir # 15
	C-21 (b)	From Malir # 15 To (SaudaBad) Rabban Dada Via Jinnah Square
22	C-22	From Bhayani Heights To Shahrah-e-Noor Jahan Via Mukka Chowk
23	C-23	From Nawab Siddique Ali Khan To 6000 Road Surjani Via Shahrah-e-Noor Jahan
24	C-24	Board Office Chowrangi To Shahrah-e-Orangi Upto Northern Bypass Via Banaras Chowk
25	C-25	From Gharibabad Underpass,Shahrah-e-Ismail Shaheed Vis KDA Chowrangi To Shahrah-e-Noor Jahan
26	C-26	From Jinnah Bridge To Cape Monze Via Hawksbay
27	C-27	From Metroville To Hub River Road Balida Via Faqir Colony Road
28	C-28	From Estate Avenue,Chakiwara Road To M.A Jinnah Road
29	C-29	From Manghopir Road Via Banaras Chowk To Northern Bypass

Source: JICA Study Team, based on the Notification No. DCO/CDGK/PS/373/09 by CDGK

Generally, signalized intersections are the major crossing points for pedestrian in urban street system. Converting a road with signalized intersection to a signal free corridor will reduce the opportunity of pedestrian crossing. Therefore, proper alternative for pedestrian crossing such as pedestrian bridges or underpasses should be provided to these corridors.

6.3.2 Ring Roads

Four ring roads were proposed in KSDP-2020 to divert traffic from congested radial roads as shown in Figure 6-3-2. Central Ring Road (R1), Inner Ring Road (R2), and Northern Ring Road (R3) already exist although improvement is necessary for these roads.

The west and north parts of Outer Ring Road (R4) should be constructed, but the shape of the northeast part should be changed as shown in Figure 6-3-2 because the distance of the original route is too long for a ring road.

6.3.3 Missing Links

Completion of missing links was proposed in KSDP-2020 as one of the issues of the road network in Karachi. A missing link is an incomplete section of a route. Some of missing links are completely "missing", some are too narrow to be a part of the connected roads, and some are just alternative routes to connect the major roads.

Construction or upgrade of missing links will improve the road network, and small missing links should be completed step by step. Figure 6-3-3 shows the major missing links between arterial roads. These missing links should be completed in the master plan period.

6.3.4 Access roads to New Cities

DHA City and Education City Projects are planned near the Super Highway, which locates about 40km far from Karachi CBD area. To connect these cities, Malir River Expressway and the extension of University Road are proposed.

In addition to these new cities, Textile City Project is planned near the Port Qasim. To deal with the traffic of the project, existing 2-lane section of GT Link Road should be widened.

These roads are shown in Figure 6-3-4.

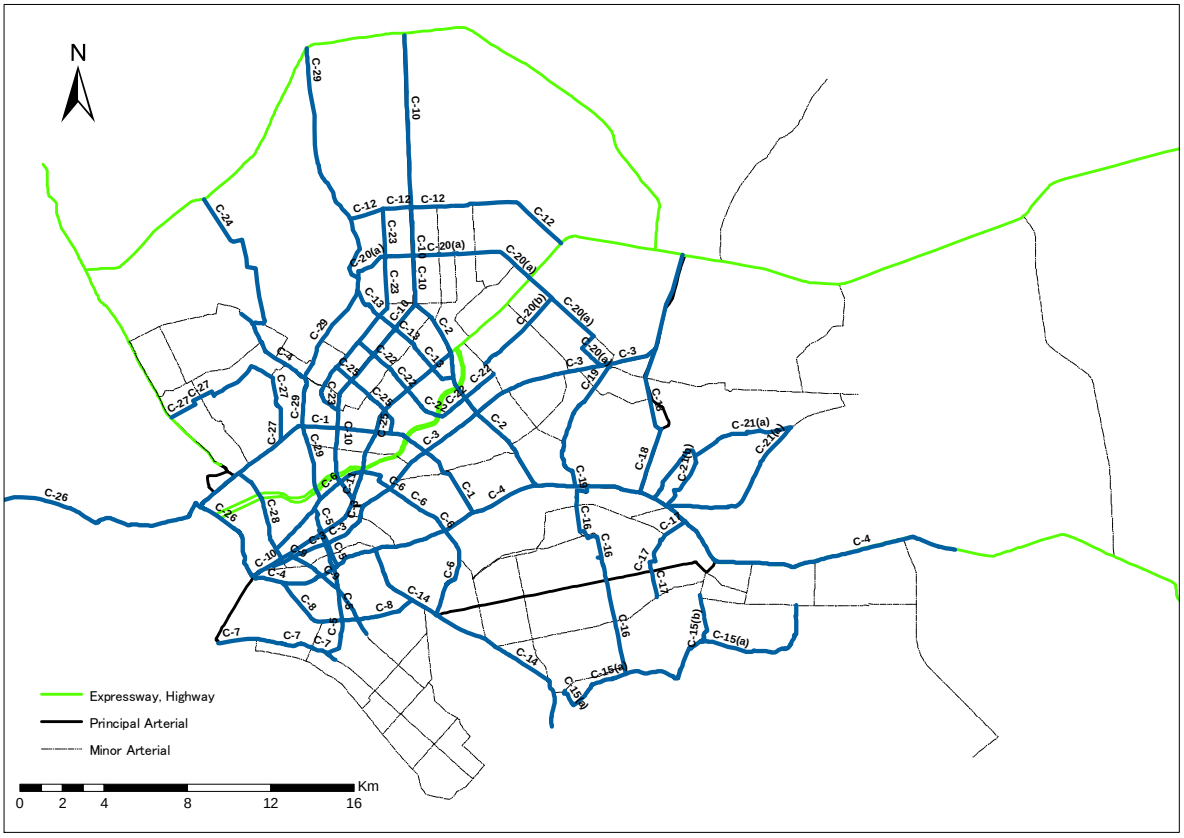
6.3.5 Access Road to Pakistan Deep Water Container Port

Karachi Port Trust (KPT) has a plan to construct "Pakistan Deep Water Container Port" at Keamari to deal with container traffic. The project of the deep water port was inaugurated by the Prime Minister of Pakistan in April 2009. The target year of the completion of the project is scheduled as 2013.

Cargo Village is another project by KPT. The project area is located at Western Backwater of KPT. That land will be reclaimed to undertake activities for containerized, general and bulk cargo, export processing zone, industrial zone, customs and other related facilities. This is scheduled for completion in 2019.

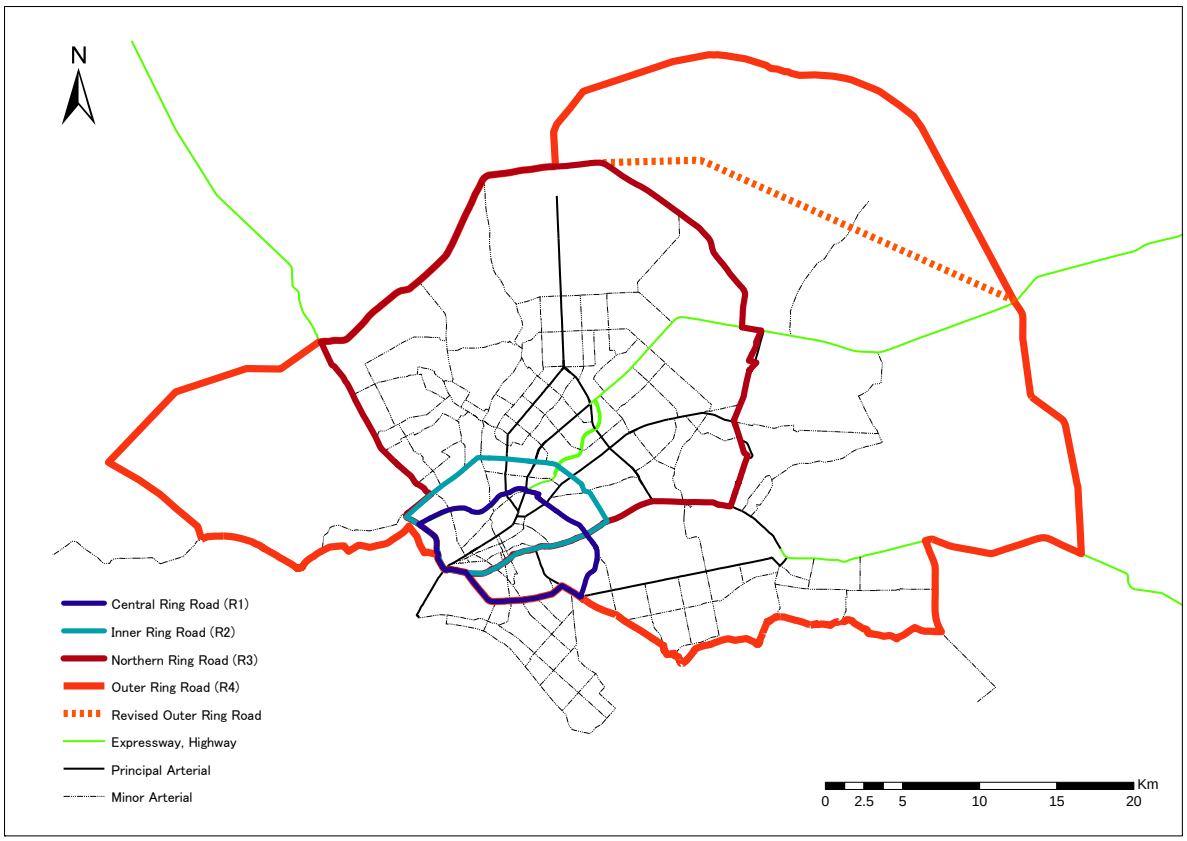
To connect these project sites and Manora Island, KPT has a plan to construct an expressway with a port bridge (Karachi Harbour Crossing). This project is scheduled for completion in 2015.

The locations of these projects are shown in Figure 6-3-5.



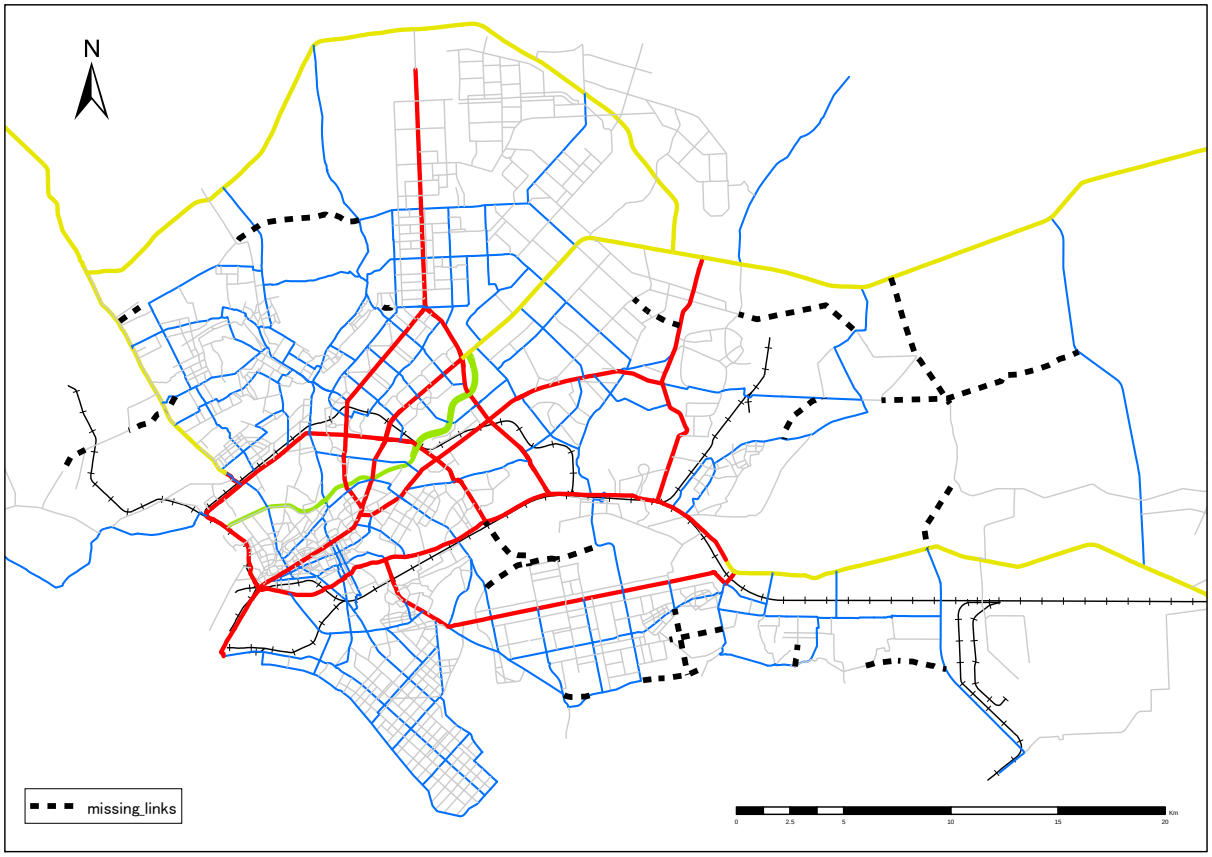
Source: JICA Study Team

Figure 6-3-1 Location of 29 Corridors



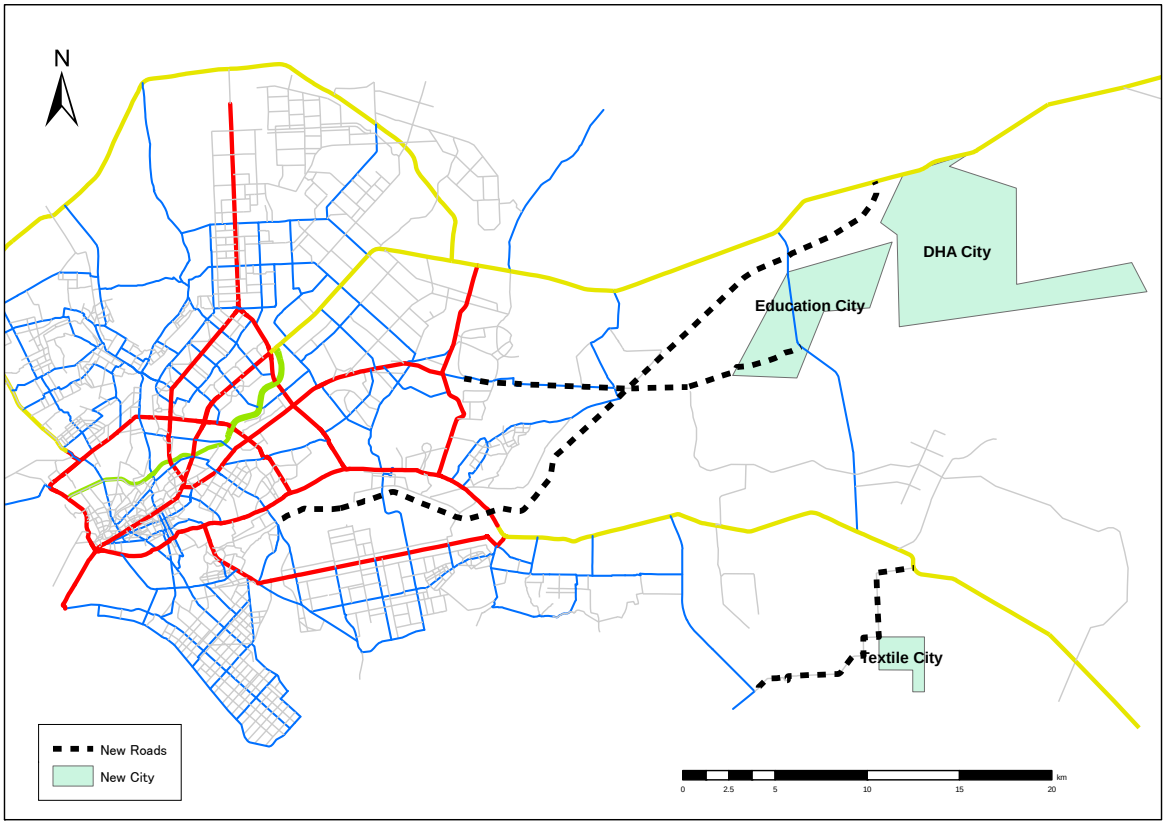
Source: JICA Study Team

Figure 6-3-2 Planned Four Ring Roads



Source: JICA Study Team

Figure 6-3-3 Missing links



Source: JICA Study Team

Figure 6-3-4 Access Roads to New Cities

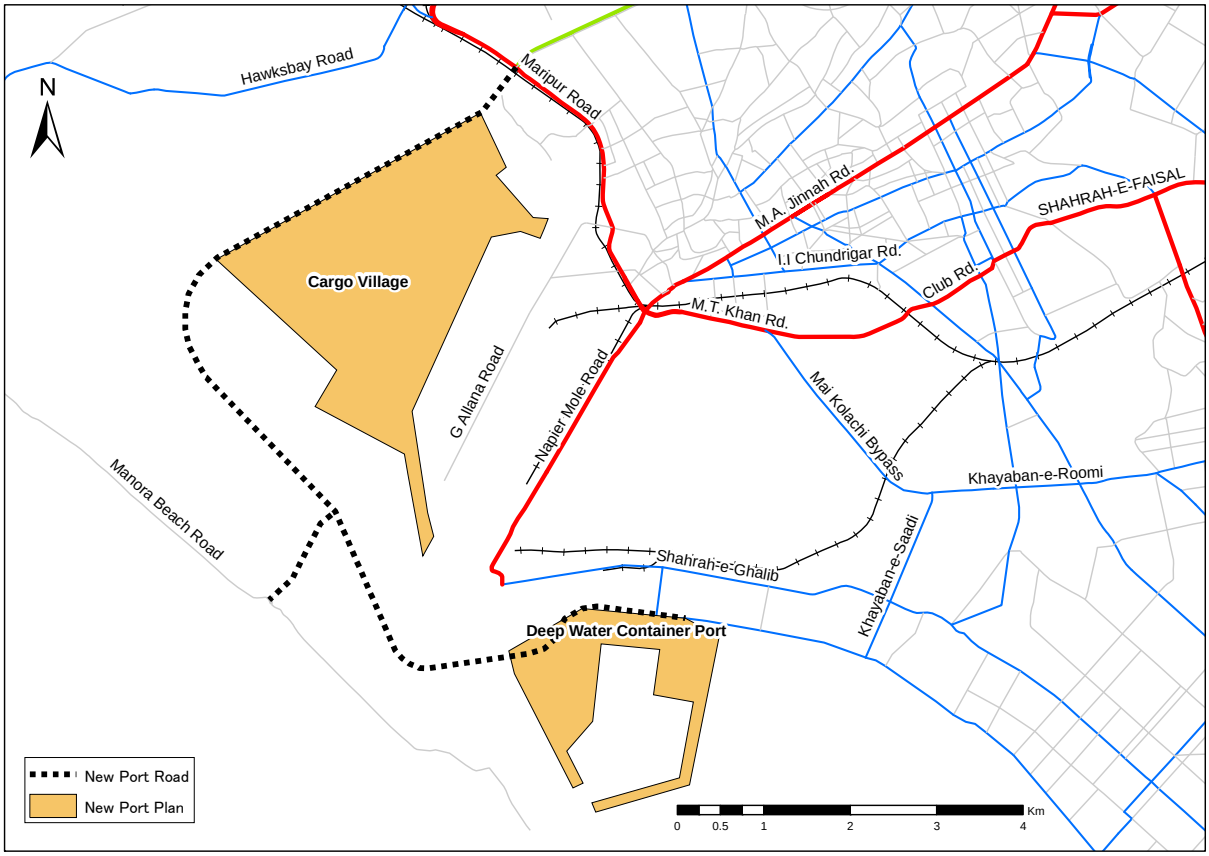
6.3.6 Arterial Road Network in 2030

Figure 6-3-6 shows the proposed arterial road network in 2030. Newly defined major roads are as follows.

Table 6-3-2 Newly Defined Major Roads by Road Type

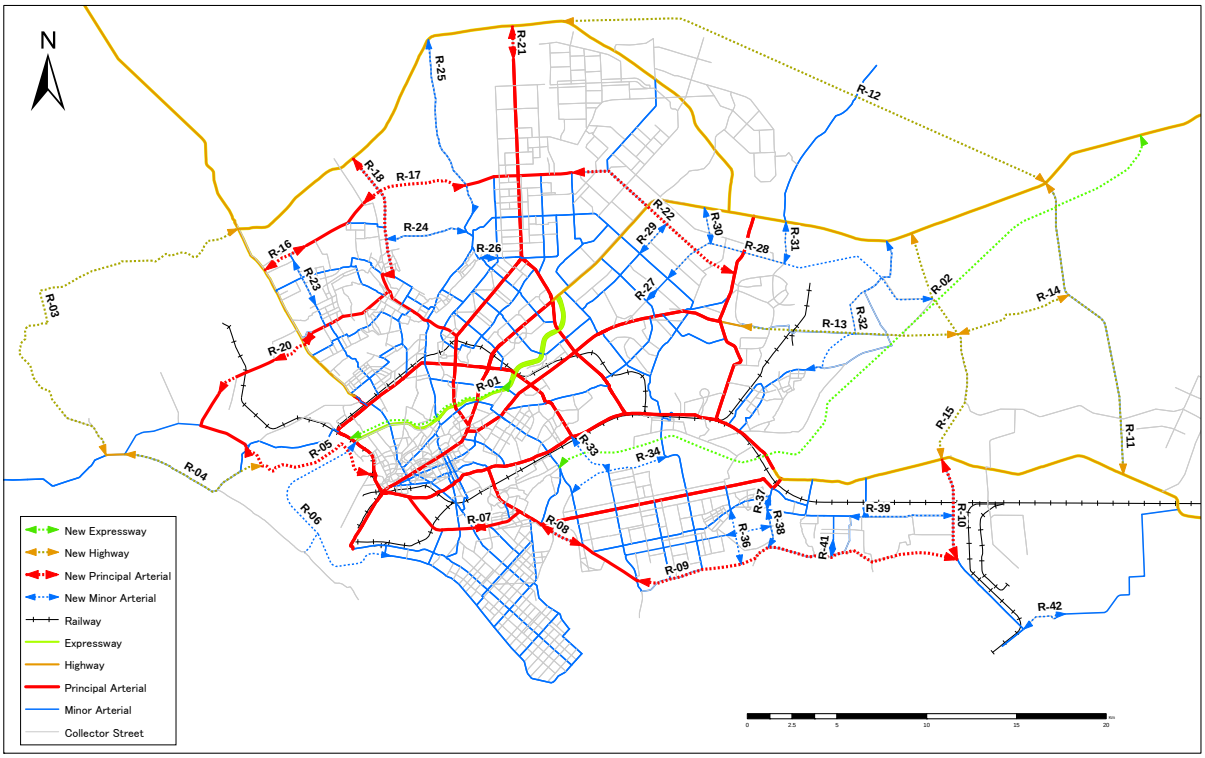
Road Type	Link No.	Name of Major Roads
Expressway	R-01	• Lyari Expressway Outbound Direction (Right Bank)
	R-02	• Malir Expressway
Highway	R-03-04	• RCD-Hawksbay Connecting Road – Hawksbay-West Wharf Connecting Road
	R-11-12	• Super HW-Edu.City-National HW Connecting Road – Northern BP-Super HW Connecting Road
	R-13-14	• Extension of University Road
	R-15	• Super HW-National HW Connecting Road
Prinicpal Arterial	R-05	• Hawksbay-West Wharf Connecting Road
	R-07	• Sunset Boulevard Road
	R-08-10	• Korangi Road (Bridge) – Korangi Creek Road – Coastal Road – Port Bin Qasim Road
	R-16-17	• RCD-New Karachi Connecting Road
	R-18	• Orangi-Northern BP Connecting Road
	R-19-20	• Baldia-RCD -Keamari Connecting Road
	R-21	• Northern Link Road
	R-22	• Northern HW Link Road
Minor Arterial	R-06	• Access Road to Pakistan Deep Water Container Port
	R-23	• Road in Baldia Town
	R-24	• New Karachi Link Road
	R-25	• Extension of Manghopir Road
	R-26	• Extension of Zahid Hussain Road
	R-27	• Dow University Road
	R-28	• Suparco Road
	R-29	• PCSIR Road
	R-30	• Road between Super HW and Suparco Road
	R-31	• Malir Cantt Road
	R-32	• Malir Rausi Road
	R-33	• Extension of Habib Rehmatullah Road
	R-34	• 4000 Feet Road
	R-35	• Korangi Industrial Area (14000) Road in the Navy
	R-36	• Extension of Korangi Industrial Area (15000) Road in the Navy
	R-37-38	• (15000) Road and its Extension
	R-39	• Extension of Mujahid Road
	R-40	• Road between Shahrah-e-Faisal and Extension of Mujahid Road
	R-41	• Road between Mujahid Road and Coastal Road
	R-42	• GT Link Road

Source: KTIP



Source: JICA Study Team

Figure 6-3-5 Access Road to Pakistan Deep Water Container Port



Source: JICA Study Team

Figure 6-3-6 Arterial Road Network in 2030

6.3.7 New Cities Roads Development

Road is fundamental infrastructure for any city to support daily life, as well as industrial activities. Therefore, road network should be developed with new urban development. On the other hand, there is no detail plan of arterial roads in proposed new cities such as DHA City, Education City, and Textile City. The necessary length of arterial roads in these new cities was estimated as shown in Table 6-3-3, assuming that the road density is 3.2km /km^2, which is as same as the present density in Karachi City. The length of new roads for the new cities would be 304 km in total.

Table 6-3-3 Proposed Roads in the New Cities

Location	Area (km^2)	Necessary Road Length (km)	Proposed Road Length (km)	
			Minor Arterial	Collector
DHA City	60	192	96	96
Education City	30	96	48	48
Textile City	5	16	8	8
Total (km)	-	304	152	152

Source: JICA Study Team

6.3.8 Access Roads Development to the Public Transport Stations

Access road to public transport stations is very important for feeder services. Although KCR runs through a strategic route in Karachi, the approach to each station is very poor. It is necessary to provide adequate access roads to KCR stations. The necessary length of the access roads was estimated at 8.4 km, assuming the average access length is 300m to 28 stations. Those access roads will be developed as 6-lane roads.

6.3.9 Access Ramp Development, Intersection Improvement and Overpass

(1) Access Ramp

The inbound section of Lyari Expressway has access ramps with Shahrah-e-Pakistan, Sir Shah Suleman Road, Manghopir Road and Mauripur Road only. It is necessary to construct additional access ramps with the major crossing roads such as Chakiwara Road, Business Recorder Road, Jahangir Road and Shaheed Rashid Minhas Road to improve accessibility between Lyari Expressway and roadside areas. These access ramps should be constructed at the same time when the outbound section will be constructed.

The access ramps of Malir Expressway should be constructed at the points where the highway and major arterial roads intersect with the expressway.

(2) Intersection Improvement

Intersections should be improved where the traffic congestion will be expected in the future. Flyovers should be constructed at intersections where a highway and a principal arterial road intersect, while traffic signals should be installed at intersections where a principal arterial and a minor arterial road intersect although overpass or underpass should be considered depending on the traffic volume.

(3) Overpass

Overpasses are proposed where Malir Expressway passes over the Korangi Link Road and Pakistan Railway. Roads crossing railway lines should be overpasses.

Figure 6-3-7 shows the location of access ramps that should be constructed and intersections that should be upgraded during the master plan period.

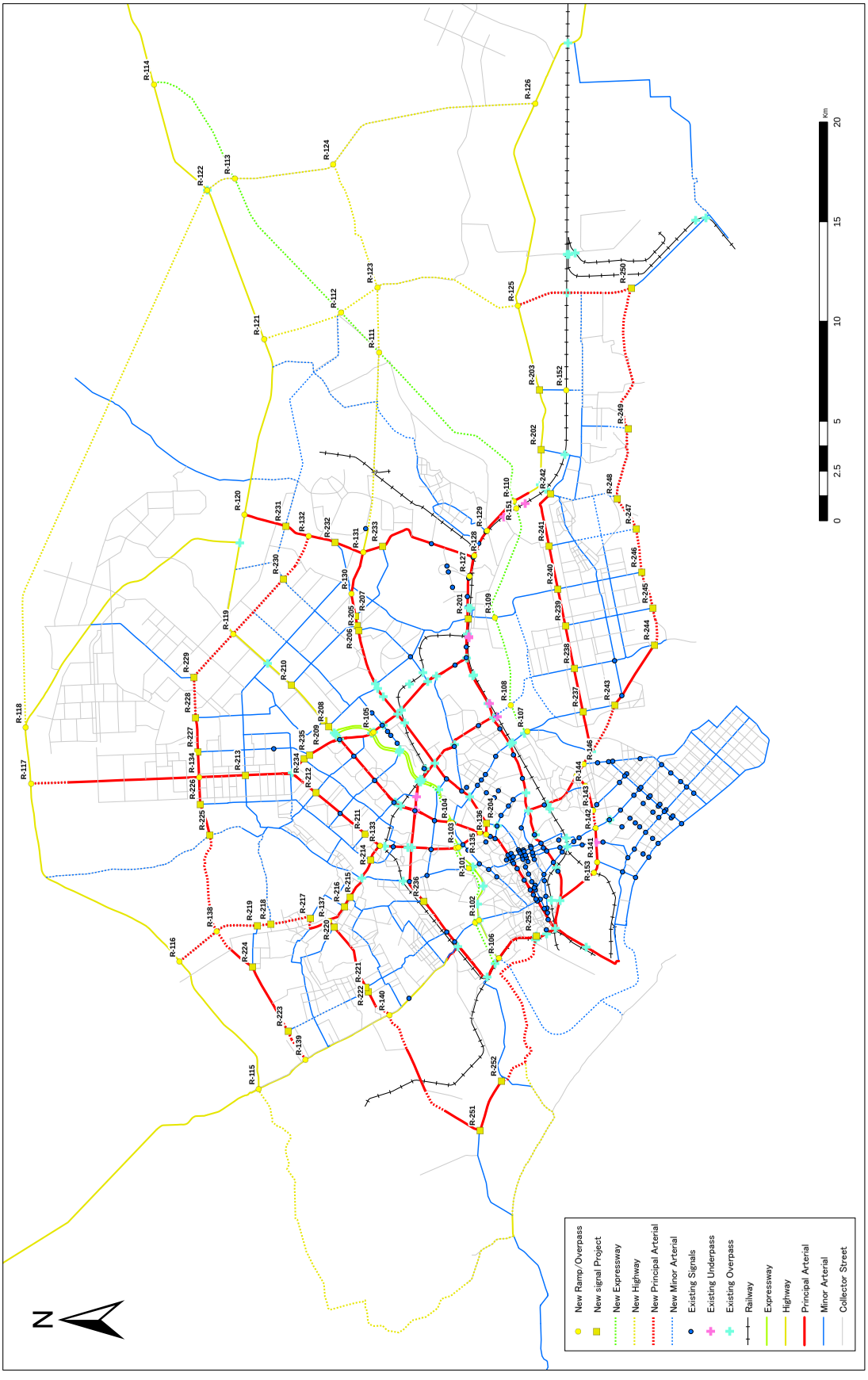


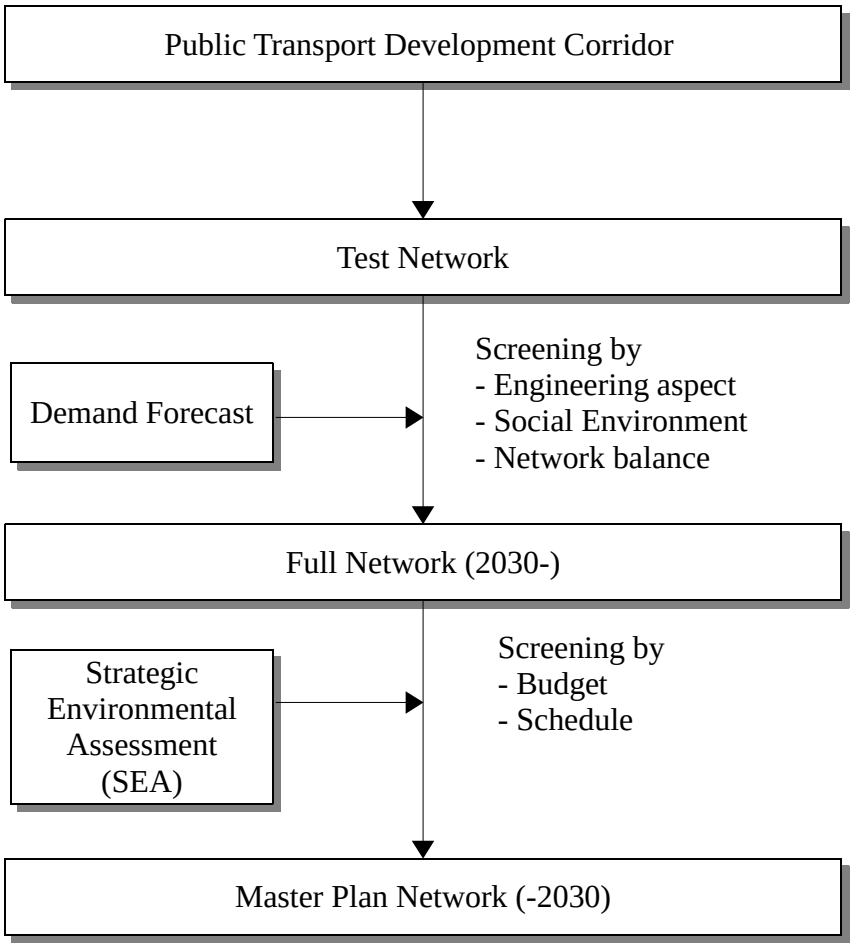
Figure 6-3-7 Location of Access Ramps and Intersections

Source: KTIP

6.4 Public Transport Network

6.4.1 Approach

Public transport network in KUTMP 2030 has been worked out to satisfy the Public Transport Corridors illustrated in 6.2.3 Public Transport Policies. In the beginning, a "test network" was prepared, and each route was evaluated in view of engineering aspect. After the evaluation, unfeasible routes were dropped out, and the remaining routes were reorganized to the "full network". The full network is the future network of public transport in Karachi beyond KUTMP 2030. From the full network, the master plan network was worked out considering budget and schedule. Figure 6-4-1 shows the flowchart of this process.



Source: KTIP

Figure 6-4-1 Flowchart of Network Development

6.4.2 Test Network

(1) Concept of the Test Network

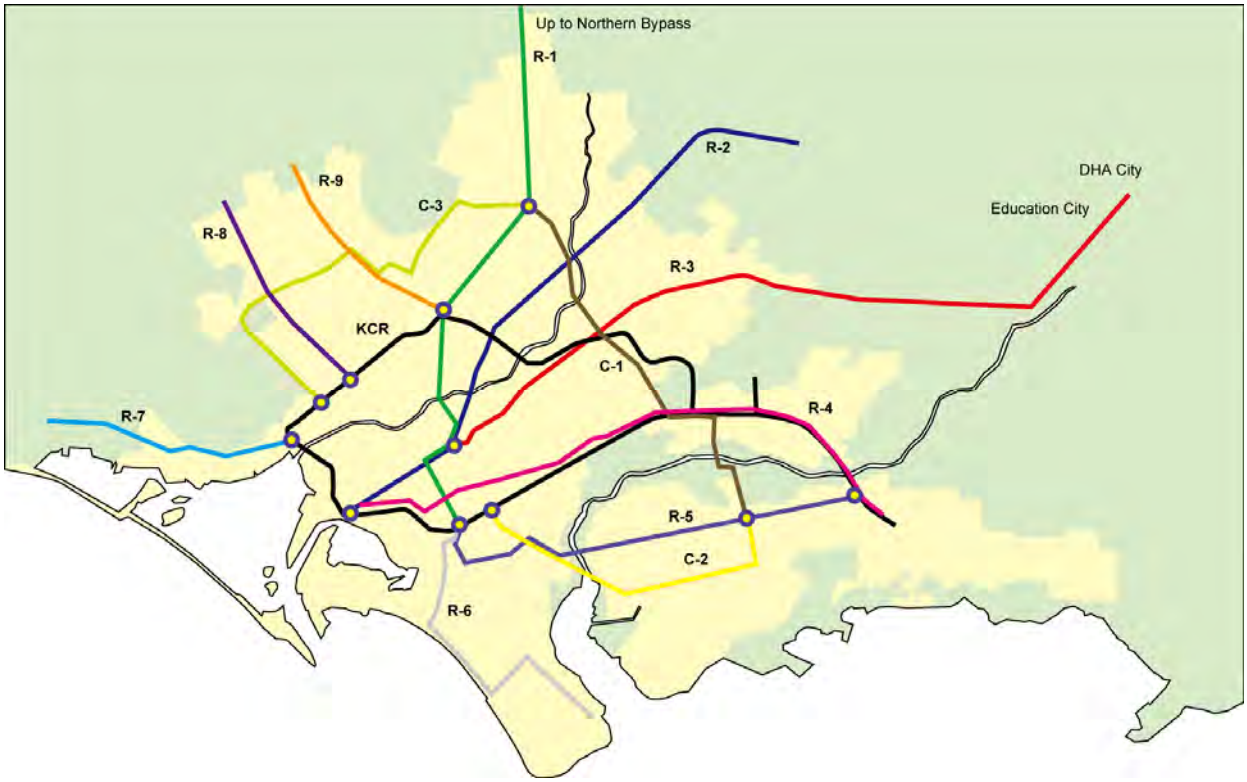
To reach the best network for the master plan up to 2030, a "test network" was prepared as the starting point of the exercise of network analysis. The test network was worked out from the existing mass transit plan, corridor studies, demand forecast, and the future development corridors illustrated in the development policy. As shown in Figure 6-2-7 and Figure 6-2-8, the future public transport network is formulated by 9 radial corridors and two circular routes.

Corridor-2 in Karachi Mass Transit Corridors (1995) was excluded because of the engineering difficulty of construction. The route of Corridor-4 was changed from the railway line to Shahrah-e-Faisal Road as R-4 to avoid duplication with KCR.

Table 6-4-1 List of routes in Test Network

Route	Corresponding existing plan	Remark
R-1	BRT-1	This route runs through Liaquatabad, North Nazimabad, New Karachi, and the emerging area in Gadap, connecting these towns to Saddar.
R-2	Corridor-1	This connects Tower and Super Highway running through M.A. Jinnah Road and the major road in Gulberg Town.
R-3	BRT-3	This route runs along University Road and connects the east development areas such as Education City and DHA City.
R-4	Corridor-4	This route runs along Shahrah-e-Faisal Road, which is the busiest road in Karachi. It is possible to construct this route as elevated structure without underground section.
R-5	--	This is a new route along the industrial area in Korangi and Landhi, where commuter trip demand is very high.
R-6	--	This is a new route in Clifton, where the area is developed as car-oriented city, and public transport is poor.
R-7	--	This is a new route in Keamari connecting Hawks Bay Area (population increase in one million in the next 10 years) and the center of the city. Without this route, the development of Hawksbay Area is difficult.
R-8	Corridor-6	This is the revised route of Corridor-6 to provide transport service in Baldia Town. This route stops at a KCR station because it is difficult to construct the route to the center of the city.
R-9	BRT-2/ Corridor-3	This route runs through Orangi Town. This route terminates at North Nazimabad Station due to Baranas Flyover,
C-1	Corridor-5	Traffic demand is high along this route although this is not along radial corridors. The north-south route between Shah Faisal Town and Korangi & Landhi Town connects the divided areas by Malir River.
C-2	--	This connects C-1 and the center of the city, running through the residential area in Korangi.
C-3	--	This route provides circular route in Baldia, Orangi, and North Nazimabad, connecting a KCR station and C-1.
KCR	KCR	The KCR route is extended to the east.

Source: KTIP



Source: KTIP

Figure 6-4-2 Test Network

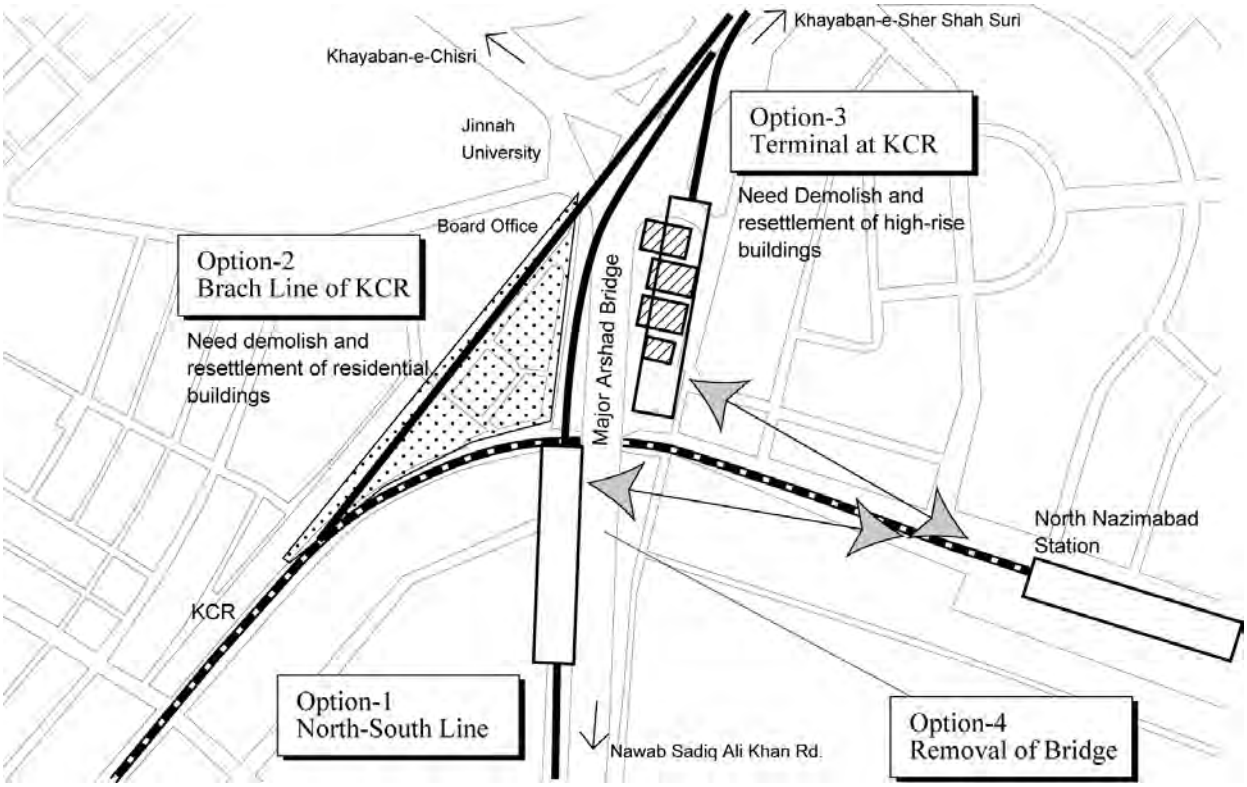
(2) Route and System Alternatives

1) R-1 (New Karachi, Surjani)

There are two issues for R-1: (i) transfer with KCR and (ii) Structure along Nazarul Islam Road (Mazar Area – Lyari River).

North Nazimabad Station of KCR is located approximately 300m away from Major Arshad Bridge. Due to the distance and the existence of the bridge, the transfer between R-1 and KCR is not easy in case of the railway system. Since the convenient transfer from the corridors of radial direction to the circular line is an important issue for the successful operation of KCR, it is necessary to ensure the convenient transfer between R1 and KCR. There are four options considered for this transfer as shown in Figure 6-4-3.

Option-1 is construction of the rail line which crosses KCR north and south. This is the base option. To avoid demolish of buildings, the station should be constructed to the west of the bridge. Option-2 is the direct connection with KCR line as the branch line. The branch line is the original KCR route in MRVP Plan (1957). It is also proposed in the Transport Sector Report in KSDP 2020. This option is the best in terms of smooth transfer with KCR, but it required a large scale land acquisition and resettlement. Option-3 is the case when R-1 terminates at KCR line. The terminal station is constructed to the east of the bridge. This option requires demolish and resettlement of high- rise buildings. In Option-4, the bridge is removed, and KCR and its station are constructed as elevated structure. R-1 can be elevated structure over the elevated KCR line or at-grade under KCR line. This option requires a large scale construction work and brings about the negative impact on road traffic during construction.



Source: Analysis in KTIP

Figure 6-4-3 Options of R-1 for Transfer to KCR

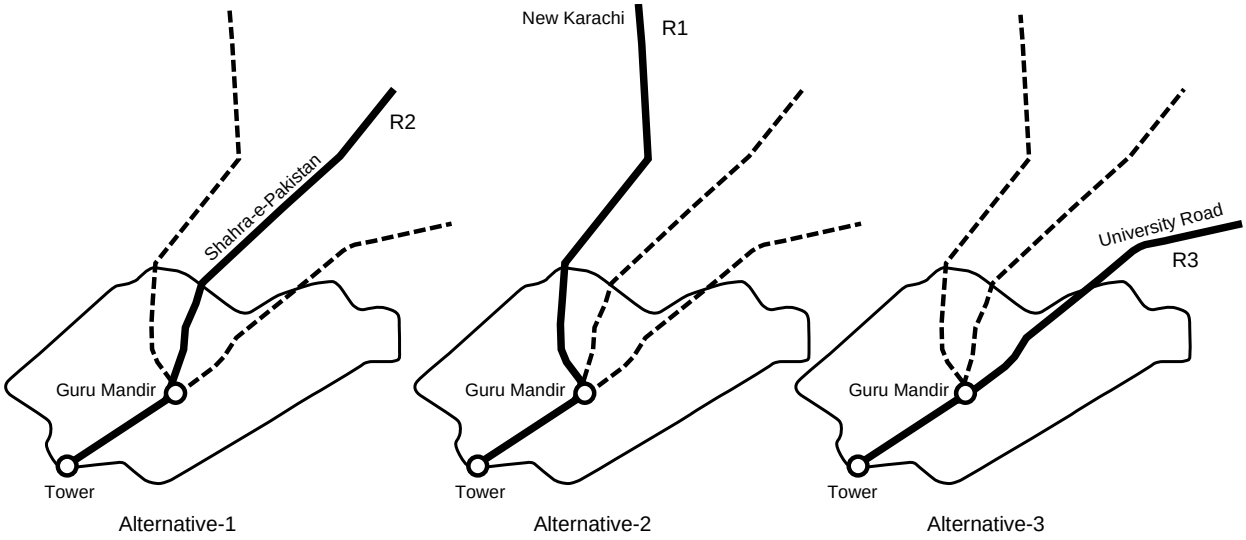
The second issue is the difficulty of elevated structure between Lyari River and Guru Mandir due to the roadside commercial activity. There are many auto rickshaw shops and workshops along this road and the road width become narrower than the actual ROW. It is necessary to restrict the commercial activity along this road in case of surface system and elevated structure. The second issue is also related to the connection with R-2 and R3. If R-1 goes to the centre of the city running along M. A. Jinnah Road instead of R-2, it should be underground structure between the north of Lyari River and Mazar Area because the route along M. A. Jinnah Road should be constructed as underground structure (discussed in R-2).

In case that R-1 is constructed as BRT system, a large scale bus terminal should be constructed at the terminal near Mazar Area.

2) R-2 (Sohrab Goth, Super Highway)

R-2 is the same route of Corridor-1 in Karachi Mass Transit Study in 1990 (KMTS), but the route is extended along Super Highway to support the future land development in the test network. In the test network, R-2 goes through M.A. Jinnah Road to Tower as same as Corridor-1. This route goes to Tower along M. A. Jinnah Road as underground structure. The road along this corridor has an elevated section in the length of 1.9km.

On the other hand, R-1 and R-3 can also go to Tower. It is necessary to evaluate which corridor should be directly connected with the section between Guru Mandir and Tower in the next step. Figure 6-4-4 shows these alternatives.



Source: Analysis in KTIP

Figure 6-4-4 Alternatives of Connection with Tower – Guru Mandir

3) R-3 (University Road)

This corridor was proposed as BRT line-3 in the Megacity Project by ADB. R-3 or R-2 can reach the eastern development area such as Education City and DHA City.

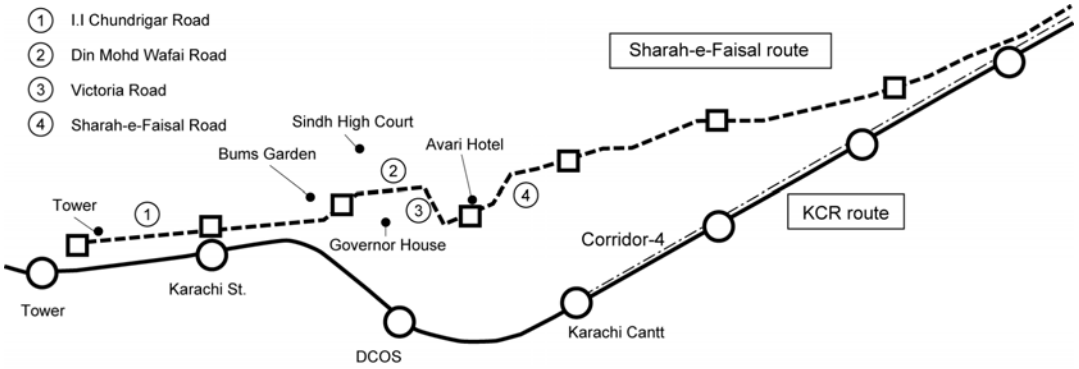
The road of this corridor has an elevated section near NIPA in the length of 900m, and there is no other bottleneck except for the elevated section along this road. However, if this route goes to Education City and DHA City, it is necessary to pass through the restricted area of Malir Cantonment.

Elevated railway and BRT are possible, while surface railway is difficult due to flyovers and many intersections along this corridor.

4) R-4 (Shahrah-e-Faisal Road)

Shahrah-e-Faisal Road and National Highway 5 (NH-5) run through a high traffic demand corridor between CBD and Bin Qasim east and west. Bin Qasim Industrail Area plays an important role in the economy, but it already suffers from traffic congestion along the corridor. In the future, increase in the traffic demand along this corridor is very high due to population growth in Bin Qasim and the industrial area.

There are two alternatives for this corridor: Shahrah-e-Faisal route and KCR route, as shown in Figure 6-4-5.



Source: Analysis in KTIP

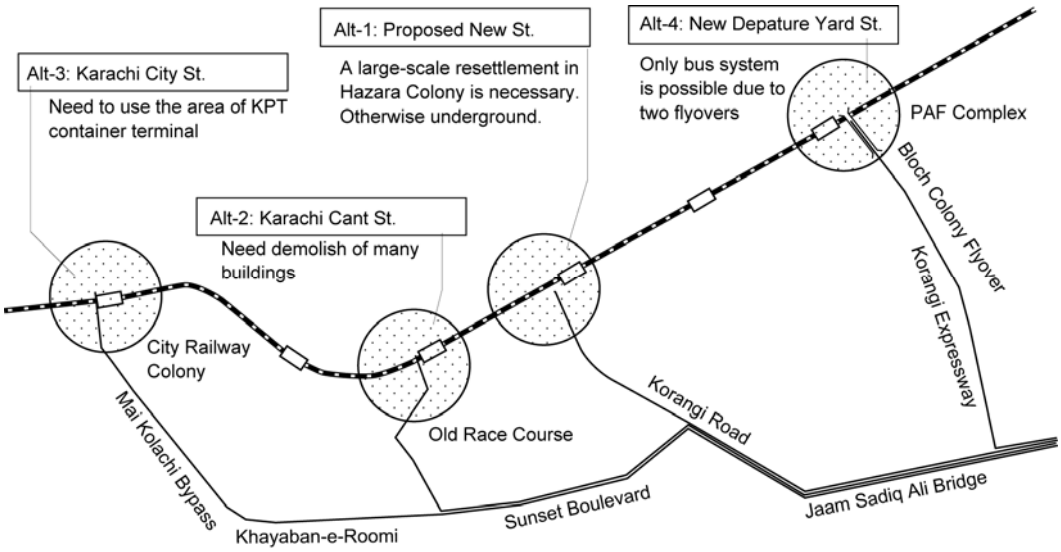
Figure 6-4-5 Alignment of R-4 (Shahrah-e-Faisal and KCR route)

R-4 is the similar to Corridor-4 in KMTS. Corridor-4 was planned along the main line of Pakistan Railways while R-4 is proposed to be developed along Shahrah-e-Faisal.

The length of this route is about 25km between Tower and Landhi. Since there is no available land for the depot of along the route, the section in the length of 25km should be constructed at once. Since traffic is heavy along this corridor, any railway system having level crossing is not recommended. There are several buildings to be demolished in case of elevated structure, but the number is small. BRT is only possible from FTC building to the east.

5) R-5 (Korangi Town, Landhi Town)

This is the east-west corridor in Korangi Industrial Area. The connection of the industrial area to the center of the city is not easy. There are some alternative routes for R-5 in view of transfer point with KCR, and every alternative has difficult problems as shown in Figure 6-4-6. Alt-1 is Karachi Cant. Station via Korangi Road. In case of elevated system, a large scale of resettlement would be necessary in Hazara Colony. Alt-2 is Karachi Cant. Station from Old Race Course via Sunset Boulevard. This route also involves demolish of buildings in case of elevated structure. Alt-3 is Karachi City Station via Mai Kolachi Bypass. Only bus system is possible for Alt-3, but full scale BRT is not possible. The route of Alt-3 goes to Tower. This alternative is difficult because it goes through KPT Container Terminal.



Source: Analysis in KTIP

Figure 6-4-6 Connection of R-5 with KCR Station for CBD Access

In the test network, Alt-2 is applied to R-5 while Alt-3 is applied to C-2.

6) R-6 (Clifton Cantonment)

A medium capacity transit system is suitable for this route because of the less traffic demand. The major issue is the connection with KCR because demolish of some buildings will be required in case of elevated structure. The necessity of R-6 is smaller than other corridors, but this is proposed to provide modern type urban transport system in Clifton where public transport service is insufficient but private mode is dominated.

7) R-7 (Keamari Town)

Hawks Bay Road is the only route for R-7. Elevated type system would be suitable for this route because this road is not wide enough to accommodate an exclusive lane for BRT. There are two alternatives: 1) independent route and 2) KCR branch line. KCR branch line along Howks Bay Road is proposed in Transport Sector Report of KSDP 2020. In any case, some factories and warehouses near Truck Stand should be removed.

Using the existing railway line through PAF Masroor is another option of KCR branch for R-7.

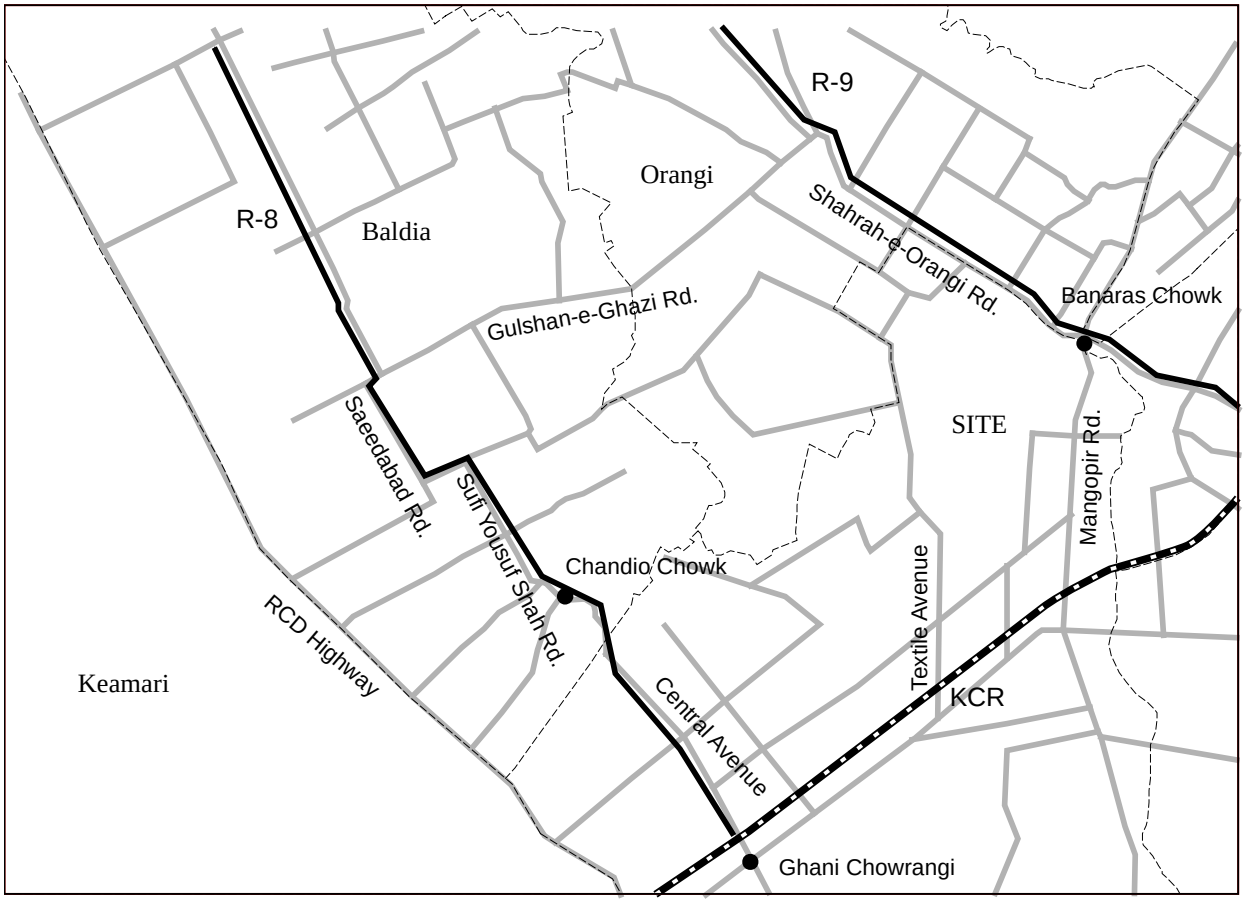
8) R-8 (Baldia Town)

RCD Highway (Hub River Road) is the major access route between Baldia Town and CBD although the road runs along the western boundary of Baldia Town. Central Avenue, Sufi Yousuf Shah Road, and Saeedabad Road run for the radial direction to Baldia Town, but these roads are narrow and winding, especially in the section of Central Avenue between SITE area and Chandio Chowk.

This route is proposed along Hub River Road because there is no available road going through Baldia Town. Central Avenue, which connects Baldia Town and Estate Avenue, is too narrow to accommodate a mass transit system. The traffic demand forecast shows that BRT system can provide enough capacity for this route.

9) R-9 (Orangi Town)

There are only two roads going through Orangi Town for the radial direction: Textile Avenue and Shahrah-e-Orangi Road. Textile Avenue is too narrow to accommodate a mass transit system. Due to the construction of Banaras Chowk Flyover, the mass transit route cannot use Manghopir Road in the direction of Shahrah-e-Orangi Road. The only possible route is Sharah-e-Orangi Road connecting Orangi Town and North Nazimabad Town as BRT system.



Source: Analysis in KTIP

Figure 6-4-7 Alignment of R-8 and R-9

10) C-1 (Shah Valiullah Road - Rashid Minhas Road – Malir River Bridge)

C-1 is the same route as Corridor-5 in KMTS. This route has enough road space for BRT system except for the section between Shahrah-e-Faisal Road and Malir River Road. Considering high traffic demand, this route should be railway system.

11) C-2 (Korangi Road)

C-2 forms a circular route with C-1, connecting Korangi and New Karachi. This line goes through a residential area in Korangi, providing access to CBD and the north area of Malir River, while R-5 goes through the industrial area.

12) C-3 (Baldia – Orangi – North Nazimabad Town)

This is a transversal route for Balia and Orangi using Gulshan-e-Ghazi Road, which has enough width for mass transit, considering the difficulty of radial direction corridors for Baldia and Orangi Town due to the lack of available roads. This route uses Manghopir Road to connect C-1 at Nagan Chowrangi. A large scale of resettlement is necessary to connect Nagan Chowrangi and Manghopir Road. This route has many curves with small radiant because of the road network.

13) KCR and its Extension

The revitalization project of Karachi Circular Railway (KCR) was approved by the GOP in 2009. The project will use the present right of way (ROW) of Pakistan Railway (PR) along the same line of the previous KCR, consisting of the loop line where no train is operated and the main line where inter-city trains are operated. In addition to the previous KCR line, the extension from Drigh Road toward Bin Qasim along the main line of PR is nominated for Shahrah-e-Faisal Corrdior. This extension is a part of Corridor-4 of Karachi Mass Transit Corridor.

(3) Evaluation of Test Network

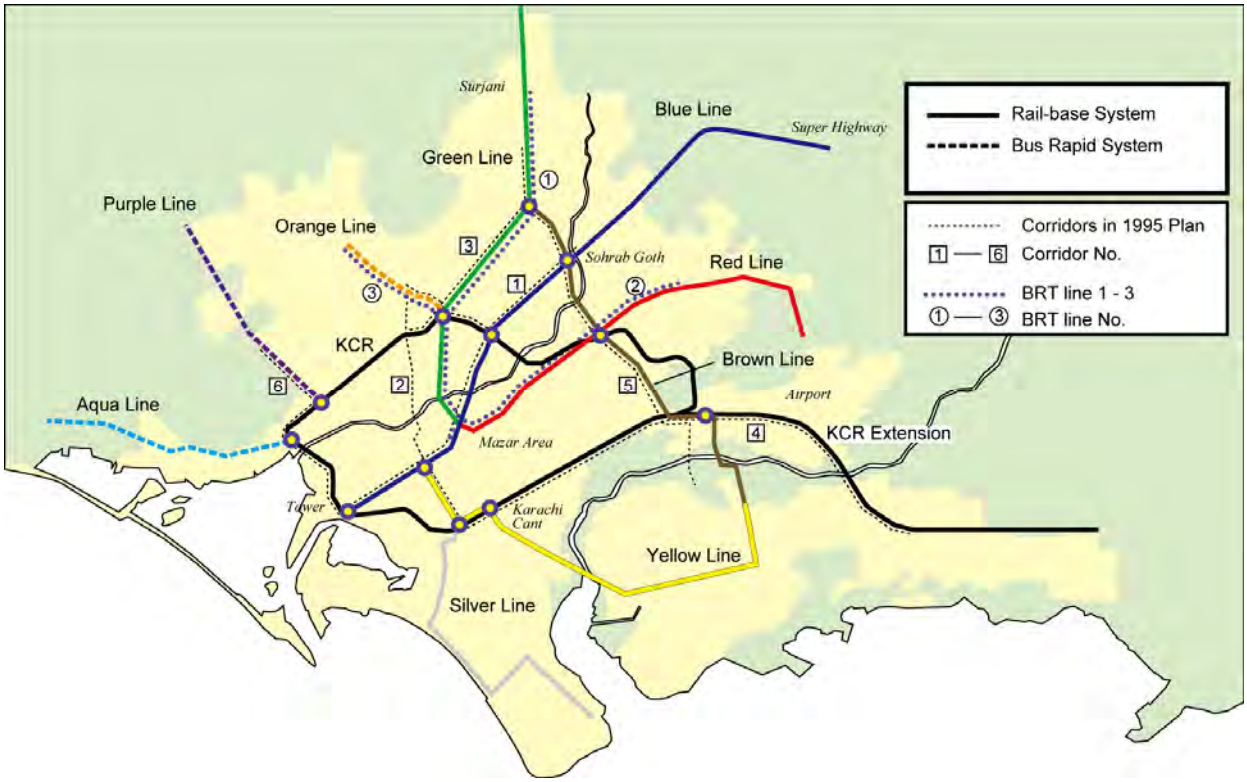
The test network is not realistic in view of cost performance considering the scale of resettlement and traffic demand especially in case of R-8, R-9, and C-3. Although R-4 is a good route for a mass transit system, it duplicates with KCR.

R-7 (Keamari Town) is also difficult route because it requires widening of Mauripur Road and land acquisition in the industrial area near New Truck Stand. However, R-7 remains for the master plan network because there is no alternative to support the new development with a population of one million in Keamari Town.

6.4.3 Full Network

The full network was formulated from the remaining routs of the test network after excluding C-3 and R-4. The full network consists of seven (6) MRT route, one LRT routes, and three (3) BRT routes as shown in Figure 6-4-8. Each line is given a code name by color.

The Priority Corridor-1 in the 1995 Plan remains as Blue Line (R-2) using the same route, and so does the Corridor-5 as Brown Line (C-1). Green Line (R-1) and Red Line (R-3) are connected at Mazar Area considering efficient train operation for both lines. Yellow Line (C-3) goes to Saddar Area having underground section from Karachi Cant Station. Purple Line is proposed as the alternative of R-8 in the test network, using RCD Highway like Corridor-6 in the 1995 Plan but terminate at a KCR station. Orange Line (R-8) has only 3.6km as a BRT route due to limited space of roads. Aqua Line (R-7) and Silver Line (R-6) remain from the test network.



Source: KTIP

Figure 6-4-8 Full Network

The route plan of each line is described as follows.

1) Green Line

This line forms the north-south corridor going through Liaquatabad, North Nazimabad, New Karachi, and the future development area in the north. The section from Board Office to the north was proposed as a part of KCR in MVRP Plan (1952), Corridor-3 in KMTS (1990), and BRT line-1 in the Megacity Project by ADB recently.

This line is connected with Red Line at Guru-Mandir for through operation.

There is an underground section between Guru-Mandir and Nazimabad No.1 Chowrangi because the road is too narrow to accommodate elevated structure.

The line goes under Lyari River in the east side of the road bridge in order to avoid reconstruction and/or reinforcement of pier/abutment of the road bridge and Lyari Expressway.

The transfer station with KCR is located to the west of the road bridge over KCR line to avoid buildings to the east of the bridge, although the distance to the KCR station becomes longer than the case when the station is located to the east of the bridge.

The alignment passes over Nagan flyover. The height from ground level to rail-level is approximately 40 m. The alignment passes in the median strip between main lane and the service road in the east side of Shahrah-e-Usmania because the high voltage power line is in the green belt of the centre of a road.

Green Line merges Brown Line at Nagan Chowrangi, and the first station to the north of Nagan Chowrangi is proposed as three-story structure, which consists of the platform for Green line in the top floor, the platform for Brown line in the middle floor and the concourse in the lowest floor.

2) Blue Line

Blue Line has an underground section between Tower and Daak Khana with the total

length of 8.3km.

The line runs to the west side of Liaquatabad Flyover because the east side is narrow for the elevated structure although the distance of transfer to KCR station becomes longer.

The rail level is 20 to 25 m high from ground level due to crossing over Sohrab Goth flyover and Lyari Expressway.

3) Brown Line

The route of Brown Line is as same as Corridor-5 along Rashid Minhas Road except for the section in the south of Shahrah-e-Faisal Road. The corridor has heavy traffic with more than 140,000 vehicles (or 122,000 PCUs) per day[1] along Rashid Minhas Road. The potential traffic demand for crossing Malir River between Shahrah-e-Faisal and Landhi through Malir Bridge Road is very high.

4) Red Line

The transit corridor along University Road was not justified in the KTMS for the project up to 2000, but it was proposed as BRT line-2 in the Megacity Project by ADB. The corridor has heavy traffic with more than 125,000 vehicles (92,000 PCUs) per day[2] between NIPA and Civic Center. Universities and colleges are located along University Road, and more and more students become to use motorcycles and cars instead of public transport.

Red Line is proposed to connect with Green Line at Guru-Mandir for through operation, instead of having the terminal station. Since Green Line is planned as underground near Guru-Mandir, Red Line has an underground section from the transfer station with Green Line in the length of 1.0 km.

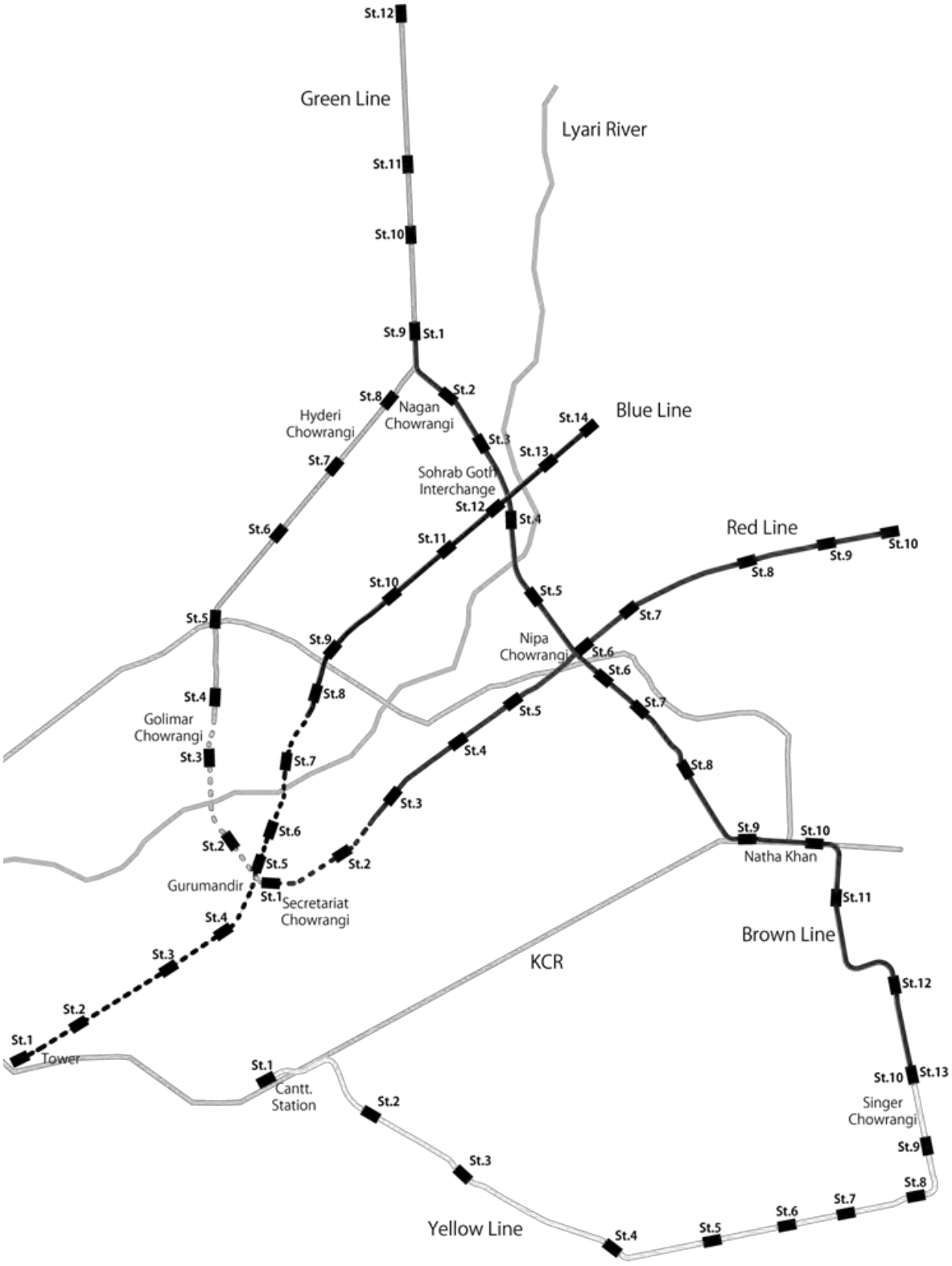
5) Yellow Line

Yellow Line goes through Korangi Industrial Area east and west, connecting to the CBD via Karachi Cant Station. This is a high demand corridor with traffic volume of more than 60,000 vehicles (54,000 PCUs) along Main S.M. Farooq Road, and 48,000 vehicles (28,000 PCUs) along Korangi Road[3]. The traffic congestion in peak hours in Korangi Industrial Area is the risk to the economic activity by discouraging investment to the industrial sector in Karachi.

For this corridor, R-5 and C-2 are proposed for Main S.M. Farooq Road and Korangi Road, respectively, in the test network. In case of R-5, it is necessary to construct the depot for its operation, but C-2 can use the same depot of C-1 by adopting through operation.

In the test network, C-2 terminates at a station of KCR. Since Green Line (R-1) is proposed to terminate at Guru-Mandir, the section of R-1 between M.A. Jinnah Road and Karachi Cant Station has been merged to C-2, forming Yellow Line.

[1] Confirmatory Green Routes Study for Karachi, March 2010 (PCU was estimated in KTIP from the traffic volume)
[2] ditto (Location code: MB-80)
[3] ditto (Location code: MB-C31 and MB-C47)



Source: KTIP

Figure 6-4-9 Route Alignment and Station Locations

6.4.4 Master Plan Network

(1) Screening from Full Network

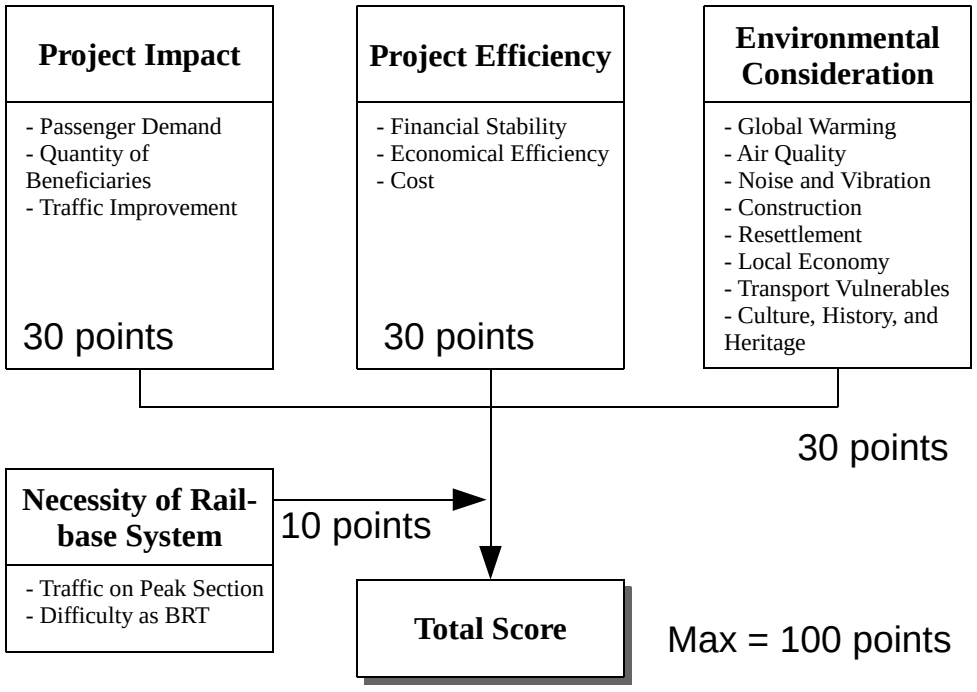
The full network contains seven railway lines including KCR. Considering the financial framework for the transport development in Karachi, the railway network is very difficult to realize within the target year of 2030. For a realistic master plan, two more railway lines in addition to KCR, which is an approved project by the Government of Pakistan, could be included in the master plan. An alternative system should be proposed for other lines as the second option of the railway system. As the first step, Silver Line is excluded from the master plan network as a railway system because traffic demand is smaller than other railway routes. To select the railway lines from the rest of 5 lines in the full network, a Strategic Environmental Assessment (SEA) was carried out.

(2) Strategic Environmental Assessment (SEA)

SEA is a holistic method to reach a conclusion in this kind of complex decision making process taking into account of environmental issues and stakeholders' participation. The JICA Study Team conducted three stakeholder meetings, five interview surveys along the proposed railway lines, and an interview survey for 50 key informants. The details of the SEA are described in Appendix-5.

In the SEA, railway systems for KUTMP 2030 were selected from the following view points: (i) Project Impact, (ii) Project Efficiency, (iii) Environmental Consideration, and (iv) Necessity of Rail-base System, as illustrated in Figure 6-4-10.

Note that the preliminary demand forecast was used for this evaluation.



Source: KTIP

Figure 6-4-10 Scoring for Rail System Selection

Table 6-4-2 shows the result of the scoring. Blue Line and Green Line are given a high score in the Project Impact criteria, while Brown Line shows a high score in Project Efficiency. In the Environmental Consideration criteria, Blue Line was given the highest point, followed by Green Line and Red line. These three lines are radial direction corridors. In total, Blue Line is given the highest score, followed by Green Line.

In view of network balance, selection of Blue Line and Green Line is not the good choice

because these lines come close each other. Instead, it is better to select one line for the radial direction and one line for circular direction to formulate the balanced network. From this, Blue Line and Brown Line were selected for the rail-base system in the master plan network.

Table 6-4-2 Scoring Result

Evaluation factors	Green	Brown	Red	Yellow	Blue	Point
Passenger Demand	6.81	7.41	4.90	6.11	10.00	10
Quantity of Beneficiaries	8.67	5.80	6.54	7.03	10.00	10
Traffic Improvement	6.95	4.56	7.13	3.47	10.00	10
subtotal	22.43	17.77	18.56	16.60	30.00	30
Financial Stability	0.00	10.00	2.82	6.05	2.73	10
Economical efficiency	6.18	10.00	3.26	0.00	8.23	10
Cost	8.10	8.68	10.00	5.86	0.00	10
subtotal	14.28	28.68	16.08	11.90	10.96	30
Global Warming	3.00	1.50	2.25	0.75	3.00	3
Air Quality	2.40	1.20	1.20	1.20	2.40	3
Noise and Vibration	0.30	0.30	0.30	0.60	0.30	2
During Construction	0.60	0.30	0.60	1.20	0.60	2
Affected Structures/ Resettlement	5.60	6.40	7.60	6.40	6.40	8
Local Economic Activities	3.75	3.50	3.50	3.50	4.00	5
Transportation Vulnerables	2.40	2.40	2.40	2.40	2.40	4
Culture, History and Heritage	4.00	4.00	4.00	4.00	3.60	4
subtotal	22.05	19.60	21.85	20.05	22.70	30
Traffic on Peak Section	2.13	2.49	0.00	1.97	5.00	5
Difficulty as BRT	3.75	1.25	0.00	2.50	5.00	5
subtotal	5.88	3.74	0.00	4.47	10.00	10
	65	70	56	53	74	100

Source: KTIP

(3) Proposed Network

The master plan network consists of four MRT routes and five BRT routes. The master plan network attaches great importance to urban development in Gadap Town where the increase in the population of more than 4 million is expected in the land use plan. Blue Line and Brown Line formulate urban development corridors crosswise. The summary of the system is shown in Table 6-4-3. The total length of the mass transit network is 189.8 km in which MRT network accounts for 98.5 km and BRT network for 91.8 km.

Table 6-4-3 List of Mass Transit Route in Master Plan

Code Name	System	Length	No. of stations
KCR	MRT	43.1 km	24
KCR Extension	MRT	14.5 km	11
Blue Line	MRT	22.4 km	18
Brown Line	MRT	18.5 km	16
Yellow Line	BRT	20.4 km	41
Green Line	BRT	21.1 km	27
Red Line	BRT	24.4 km	26
Orange Line	BRT	3.9 km	8
Purple Line	BRT	9.7 km	19
Aqua Line	BRT	11.8 km	24

Source: KTIP

(4) Demand and Supply Analysis

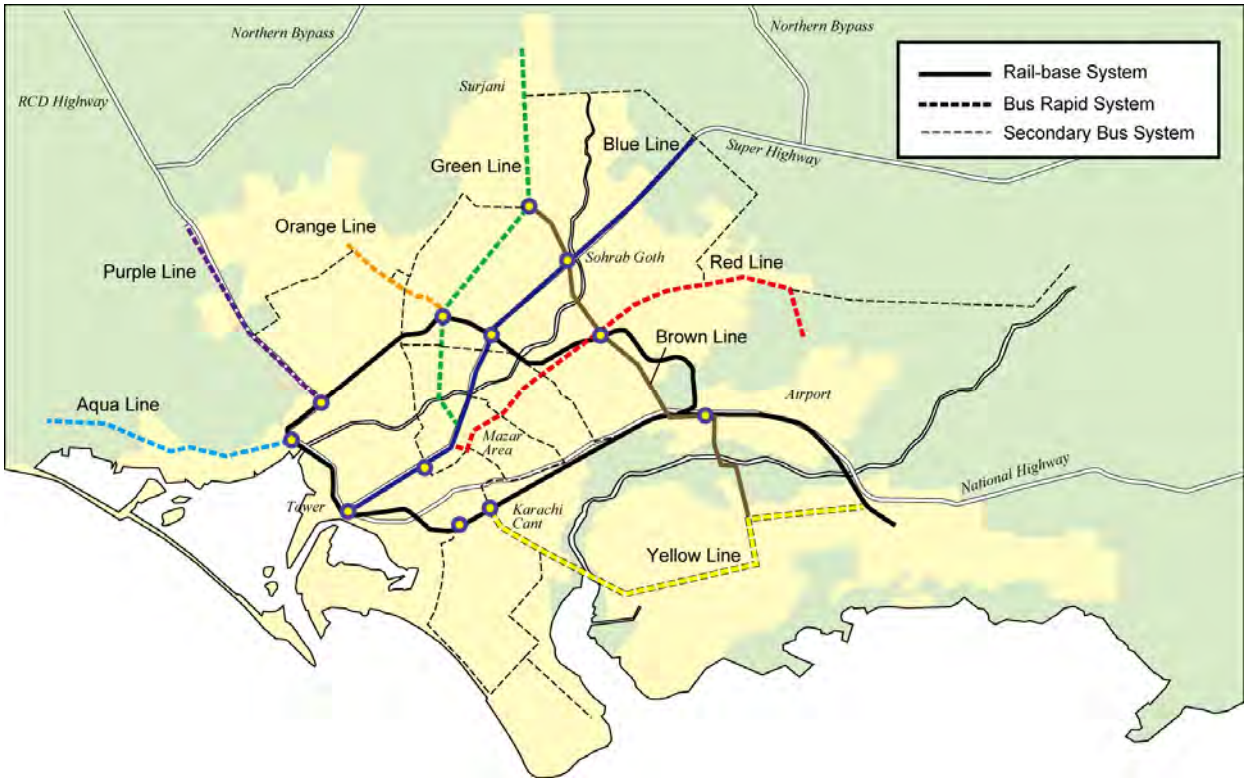
Passenger volume of the master plan network was estimated for the year 2030. Since the HIS has not been completed yet, the passenger volume is preliminary estimation. It was assumed that the travel speed of MRT, LRT, and BRT is 40km/h, 30km/h, and 27.5km/h, respectively, while capacity constraints of them is 80,000 passengers per direction per hour, 45,000, and 15,000, respectively. Table 6-4-4 shows the result of the demand forecast of each line.

Table 6-4-4 Passenger Volume of Mass Transit in 2030

Code Name	Maximum section per direction		Boarding ('000 per day)	Passenger-kms (million per day)
	Day	Peak Hour		
KCR	290,000	21,700	505	16.3
KCR Extension	412,000	30,900	487	8.7
Blue Line	357,000	27,000	661	10.9
Brown Line	286,000	21,500	736	8.8
Yellow Line	235,000	17,600	653	6.0
Green Line	244,000	18,300	432	4.9
Red Line	144,000	10,800	355	4.0
Orange Line	247,000	18,500	397	2.2
Purple Line	53,000	4,000	83	0.6
Aqua Line	330,000	24,700	449	2.2
Total	-	-	4,758	64.6

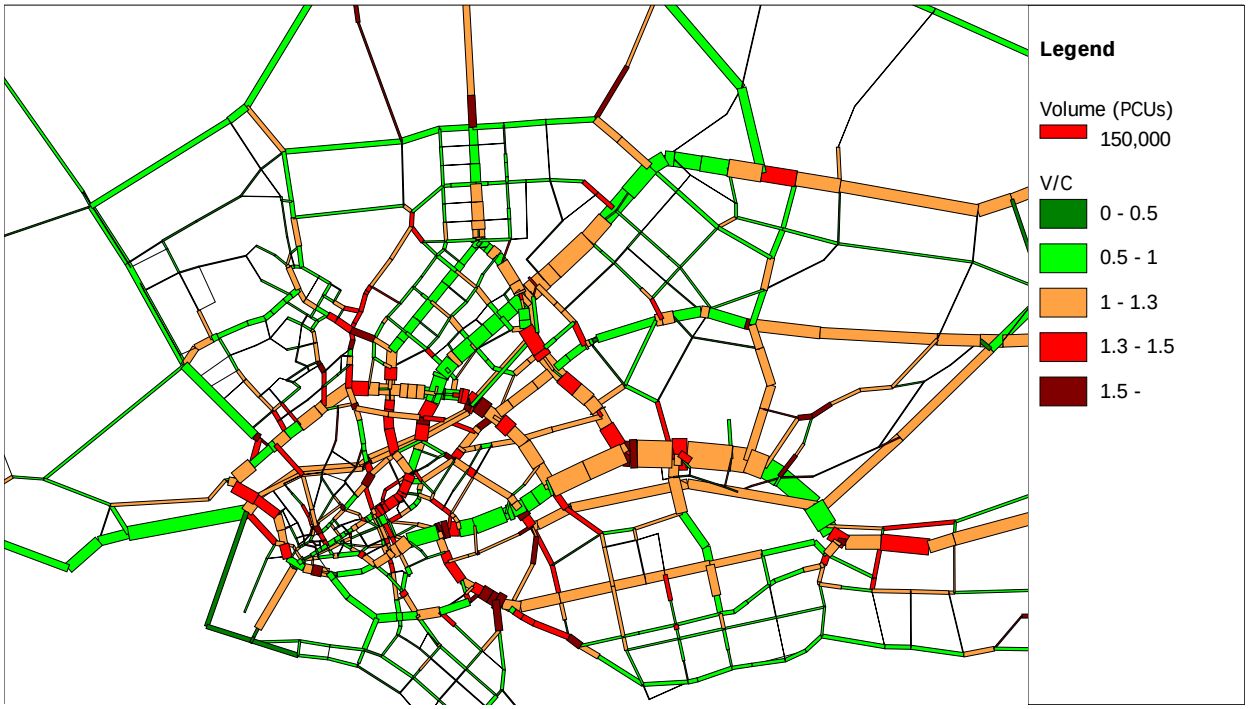
Note: No. of transfer passengers are not included
Source: KTIP

Figure 6-4-12 shows the impact of the master plan network on the road system. The result shows that the road traffic would be improved by the master plan network, but there would still remain congested roads. However, the remaining congest roads are acceptable level considering cost and benefit performance and limited budget for transportation development.



Source: KTIP

Figure 6-4-11 Master Plan Network



Source: KTIP (Demand Forecast Model)

Figure 6-4-12 Volume to Capacity Ratio in 2030 (Master Plan)

(5) Energy Consumption

KUTMP 2030 does not assume that the shortage of electricity supply against the demand will continue for the master plan period. Unless the energy problem is solved, the city cannot achieve goals and visions illustrated in KSDP 2020. However, it is necessary to evaluate the impact of the mass transit system in the master plan on the demand and supply of electricity in Karachi.

Rail-base system consumes electricity for the following usage: (i) traction power of trains, (ii) auxiliary facility power of trains, and (iii) service power in stations. In the master plan stage, the energy consumption is estimated by a simple method with some assumptions as follows.

- Traction power consumption by train = 50 kWh/ 1000 ton-km
- Auxiliary facility capacity = 265kW
- Gross train weight = 262 ton per train
- Service power consumption ratio = 0.8 (service power to train power)
- Power factor = 0.9

These are taken from KCR SAPROF 2009, JICA. The result of the estimation is shown in Table 6-4-5. The necessary power is calculated as 72.8 MW, and this is not small demand accounting for 5.4% of the present capacity of KESC (1,351 MW).

Table 6-4-5 Estimation of Power Consumption by MRT (2020)

	KCR	Blue Line	Brown Line	Total
Headway (minutes)	3.0	3.5	4.0	-
Train composition	8-car	6-car	6-car	-
Power Consumption (kWh/ day)	630,000	278,000	201,000	1,109,000
Maximum Effective Power (MW)	35.1	20.1	17.6	72.8

Source: Estimated in KTIP

However, the demand of 72.8 MW is relatively small compared to the increase in electricity demand projected by NTDC[1] as 11,837 MW from 2009-10 to 2029-30.

Electricity is also important for BRT system because efficient operation depends on signalling at intersections with road traffic.

To supply electricity in Pakistan, Water Resources & Power Development Authority (WAPDA) has a long-term power development programme which will meet the future energy demands. According the programme, the installed capacity of power generation would be 106,656 MW in 2030, while the present capacity is expected to be 21,117 MW[2]. Construction of the hydroelectric system would be the major source of the energy supply. Power plant at Thar and Lakhra coal fields is expected to increase the electricity capacity in Karachi, although it is not clear how much portion of the generation would be available for Karachi. According to KSDP 2020, a nuclear power plant, having the capacity of 2000 MW, would be constructed in Bin Qasim Coastal Area to meet the future load demand of Karachi and lower Sindh area.

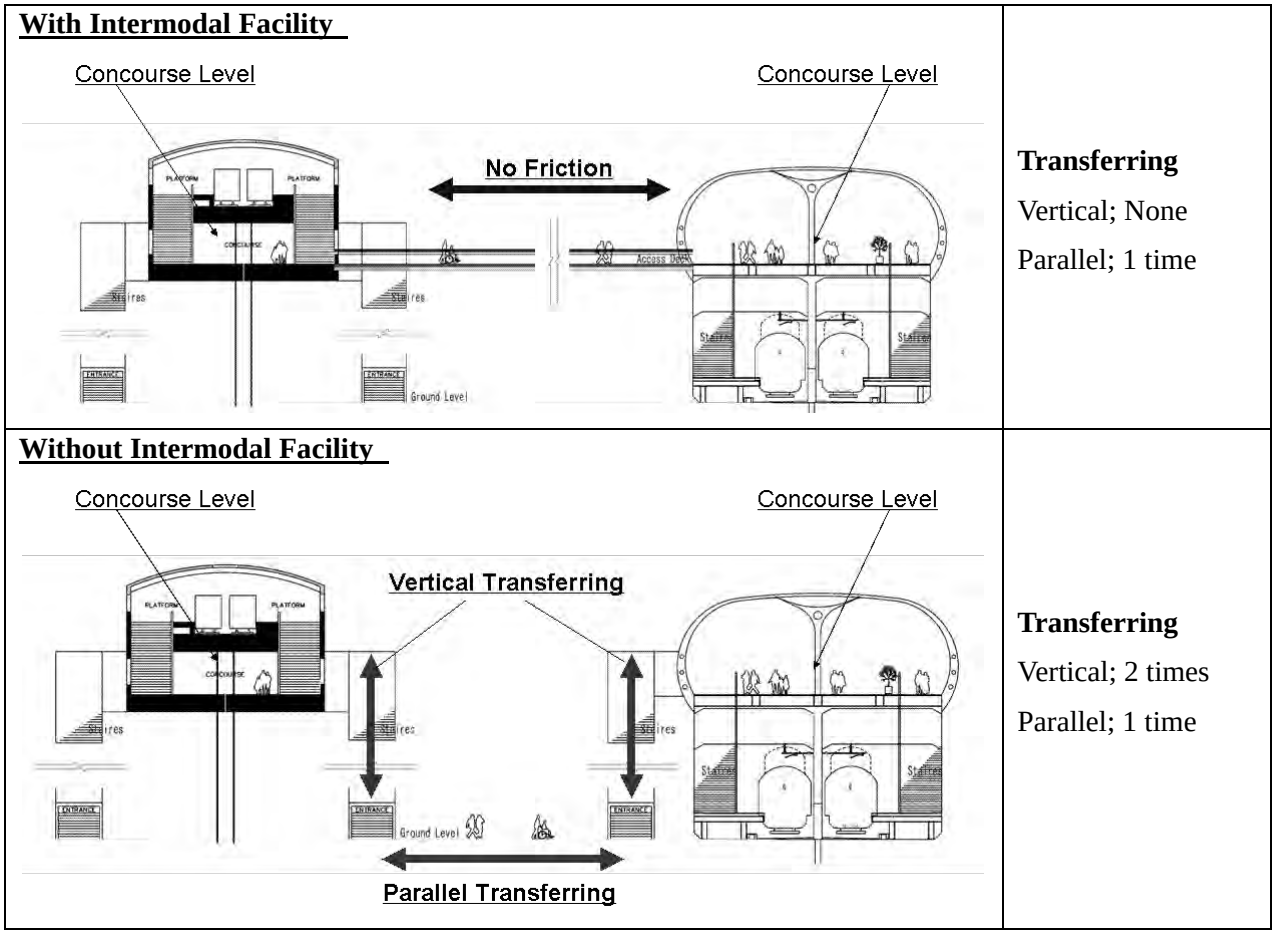
On the other hand, Karachi Electric Supply Company (KESC) does not have such a long-term development programme. For the successful implementation of the railway system, it is necessary to establish the long-term plan of electricity supply in Karachi. Since the development of the railway system is approximately a 10-years project, it would be enough time to install the necessary capacity for the railway operation.

[1] National Transmission & Despatch Company Limited (NTDC): "Electricity Demand Forecast based on Multiple Regression Analysis, February 2011"
[2] Economic Survey 2011

6.4.5 Intermodal Facilities

An intermodal facility is a facility for passengers who transfer between transport modes. Since the transfer is one of the disadvantages of public transport against private mode, good intermodal facilities can encourage people to use public transport modes. If intermodal facility is poor or there is no such facility, public transport users would feel inconvenience which results in less ridership of public transport systems. Therefore, intermodal facilities should be carefully planned where transfer between transport modes occurs.

Figure 6-4-13 illustrates the concept of an intermodal facility between two stations. The top figure shows the connection between two stations when two concourses are connected by a pedestrian bridge, while the bottom figure show the situation when no intermodal facilities are provided.



Source: JICA Study Team

Figure 6-4-13 Concept of Transfer Between Two Stations

Passengers can transfer between two stations without vertical movement in the top figure while they need two vertical movements and crossing streets in the bottom figure. Passengers feel more comfortable if two concourse areas connected with flat access.

It is important to make every effort not to use vertical movements. In case that vertical movement is necessary, escalators or elevators should be provided. It is desirable that the distance of walking is less than 200m.

Chapter 7 Urban Transport Master Plan

7.1 Project Identification

7.1.1 Road and Traffic Management

Projects of the road sector in KUTMP 2030 are classified into: 1) Expressway, 2) Highway, 3) Arterial Road, 4) Overpass, and 5) New City Road while those of traffic management are 1) Signaling, 2) Parking, and 3) Pedestrian Bridges.

(1) Expressway

There are two expressway projects: 1) completion of Lyari Expressway (10km), and 2) construction of Malir Expressway (41km). Malir Expressway will provide an alternative route for Shahrah-e-Faisal Road and connect DHA City and Education City (Figure 6-3-6).

(2) Highway

To formulate Outer Ring Road proposed in KSDP 2020, four highway projects are identified with the total length of 80km. In addition, three highway projects are identified for the extension of University Road and the connection between Super Highway and National Highway. The highway projects are very important for the development in the suburban areas to accommodate the future population (Figure 6-3-6).

(3) Arterial Road

For arterial road network, 33 projects with the total length of 306 km are identified. Access Road to Pakistan Deep Water Container Port, which is proposed by KPT, is included in this project group (Figure 6-3-6).

(4) Overpass

There are 53 overpass projects in KUTMP 2030 for Lyari Expressway, Malir Expressway, Super Highway, Northern Bypass, National Highway, and other important roads (Figure 6-3-7).

(5) Traffic Signal

The project of installation of traffic signal is identified at 53 intersections (Figure 6-3-7).

(6) New City Road

In addition to the arterial roads, Minor Arterial Road (152km) Project and Collector Road (152km) Project in the suburban area are identified.

(7) Parking

There are four parking projects identified as proposed in KSDP 2020.

(8) Truck Terminal

Truck terminal projects are proposed at three locations (Northern Bypass, Super Highway, and National Highway).

7.1.2 Public Transportation and Intermodal Facilities

(1) KCR

Karachi Circular Railway (KCR), having a total length of 41.9 km with 24 stations. From the present plan prepared in KCR SAPROF (2008, JICA), airport access was excluded, and the extension line from Drigh Road toward Bin Qasim along the main line of Pakistan Railway in the length of 15 km was added as KCR Extension Project.

(2) MRT

Blue Line and Brown Line are proposed as MRT projects with the length of 22.4km and 18.5km, respectively. Green Line and Red Line are planned as BRT system in KUTMP 2030, but they should be developed as MRT lines after the period of KUTMP 2030.

(3) BRT

BRT network constitutes the parts of mass transit corridors in KUTMP 2030, rather than the supplementary network of MRT system. BRT corridors proposed by ADB (BRT Line 1, 2, and 3) are included in the BRT network as Green Line, Red Line and Orange Line. These lines are initially proposed in "Private-Public partnership based environmental friendly public transport system for Karachi, 2006 (PPP Study)". The PPP Study proposed BRT lines along KCR, Blue Line, Brown Line, and KCR Extension, but these routes are not selected in the master plan. Purple Line is proposed as a BRT system to connect Baldia and the center of the city. To support the development in Keamari, Aqua Line is proposed as a BRT system.

(4) Trunk Bus Network

The Truck Bus Network consists of a part of the BRT Network and the Secondary Network proposed in "Detailed Study on a Private / Public Partnership based Environmental-friendly Public Transport System for Karachi".

(5) Bus Network Development in Emerging Areas

In the new emerging areas in Keamari, Gadap, and Bin Qasim, new bus services will be provided to meet the traffic demand.

(6) Modernization of Bus Fleet

Introduction of modern type bus fleet and replacement of old vehicles are the part of the master plan projects.

7.2 Preliminary Cost Estimation

7.2.1 Estimate Condition

"Project cost" consists of all the necessary cost directly used for the project, such as land acquisition, resettlement, design and other engineering services, construction, purchase, management cost, financial cost, interest payment, charges, tax, and so on. For the master plan stage, only the construction cost and rolling stock purchase cost are estimated.

To evaluate the project list quickly, unit costs were used for the cost estimation.

7.2.2 Road Project

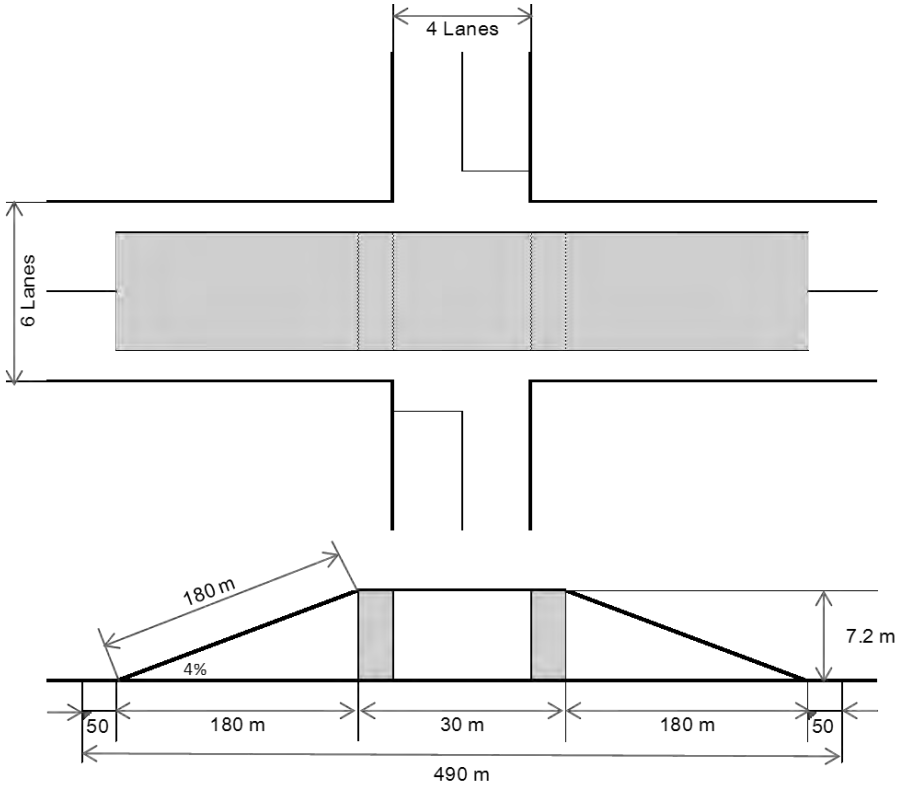
(1) Unit Cost

The unit costs for road project had been calculated from past road projects, and those are provided by CDGK.

Road Construction on the ground	: Rs. 5,000 / m^2
Road Construction on the embankment	: Rs. 20,000 / m^2
Bridge /Overpass Construction	: Rs. 70,000 / m^2
Signal Installation	: Rs. 1 million / entrance
Pedestrian Bridge Construction	: Rs. 20 million / unit

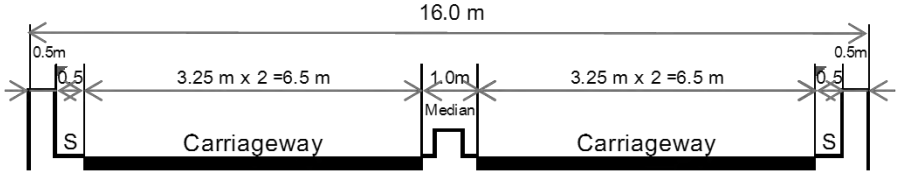
(2) Typical overpass

The ground plan and cross-section of typical overpass are shown as Figure 7-2-1 and 7-2-2. Also, construction cost by number of lanes is shown as Table 7-2-1.



Source: JICA Study Team

Figure 7-2-1 Ground Plan of Typical Overpass



Source: JICA Study Team

Figure 7-2-2 Cross-section of Typical 4-Lane Overpass

Table 7-2-1 Construction cost of Overpass by Lanes

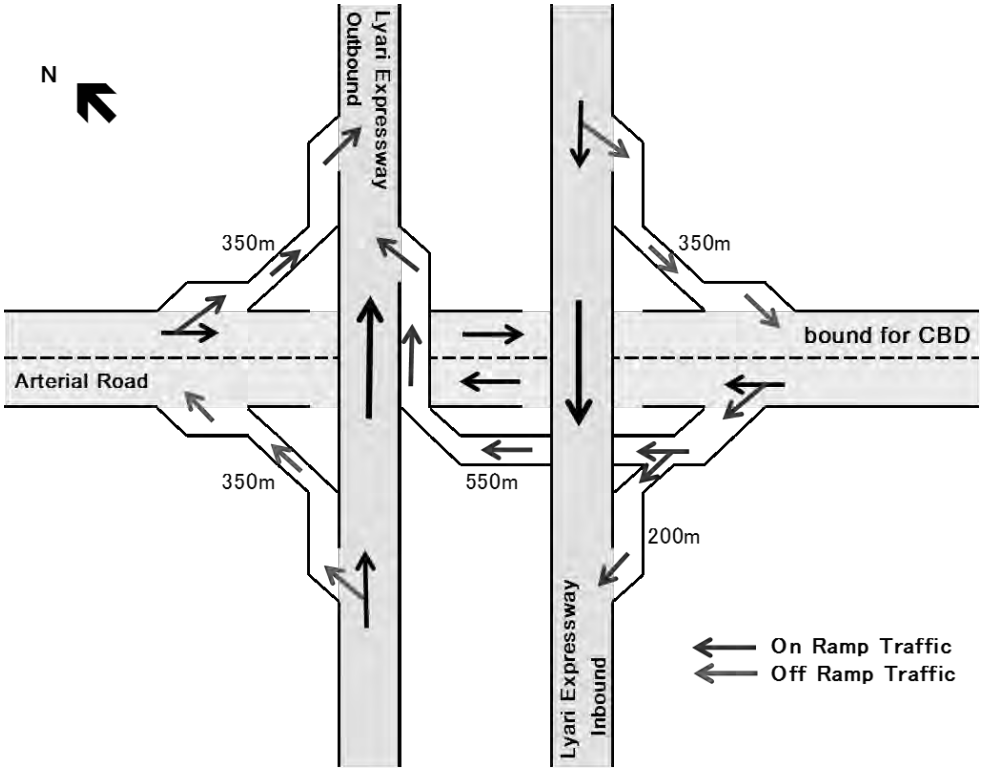
Lane	RoW (m)	Length (m)	Area (m^2)	Unit Price (Rs./m^2)	Cost (Rs. Million)
2	9.5	490	4,655	70,000	326
4	16.0		7,840		549
6	22.5		11,025		772

Source: JICA Study Team

(3) Typical Ramp for Lyari Expressway

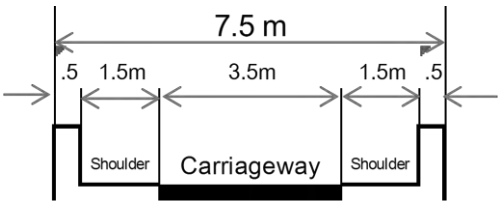
The ground plan and cross-section of typical ramp for Lyari Expressway are shown as Figure 7-2-3 and Figure 7-2-4.

In this structure, it is not possible to go directly to CBD for the traffic which get off from the outbound expressway and to get on the inbound expressway from the arterial road bound for CBD, but those traffics will be small and no obstacles.



Source: JICA Study Team

Figure 7-2-3 Ground Plan of Ramp for Lyari Expressway



Source: JICA Study Team

Figure 7-2-4 Cross-section of Ramp

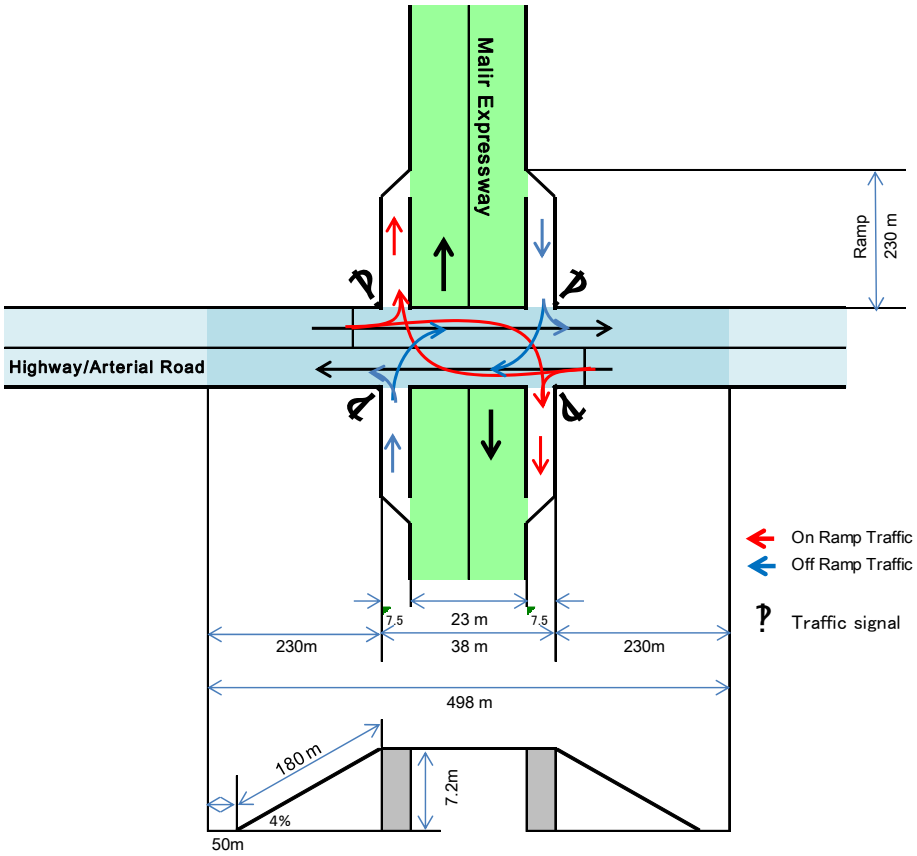
Length of a ramp is set by using examples from existing ramp, which the Lyari Expressway intersects with Sir Shah Suleman Road.

Suppose the total length of ramps is 1800 m, the construction cost is Rs. 945 million.

(350+350+350+550+200) m x 7.5 m x Rs. 70,000 /m2 = Rs. 945,000,000

(4) Typical Ramp for Malir Expressway

The ground plan of a typical ramp and its cross-section for Malir Expressway are shown in Figure 7-2-5.



Source: JICA Study Team

Figure 7-2-5 Ground Plan of Ramp for Malir Expressway

Suppose the length of approach ramp is 230 meter and its width is 7.5 meters, the construction cost is Rs. 121 million.

230 m x 7.5 m x Rs. 70,000 /m^2 = Rs. 120,750,000

Cost of traffic signal installation is Rs. 1 million.

Therefore, total cost for 4 approach ramp is

Rs. (120.75 + 1) million x 4 directions = Rs. 487 million.

Total of construction cost is shown at Table 7-1-7.

Table 7-2-2 Construction cost of Ramp for Malir Expressway by Road Type by Lanes

Road Type	Number of Lanes	RoW (m)	Length (m)	Area (m^2)	Unit Price (Rs./m^2)	Overpass (Rs. Million)	Approach (Rs. Million)	Total Cost (Rs. Million)
Highway	2	12.0	498	5,976	70,000	418	487	905
	4	21.0		10,458		732		1,219
Principal Arterial	4	24.5		12,201		854		1,341
	6	31.0		15,438		1,081		1,568
Minor Arterial	4	22.0		10,956		767		1,254
	6	28.0		13,944		976		1,463

Source: JICA Study Team

(5) Result of Cost Estimation

The results of the cost estimation by project are shown in Table 7-2-3, 7-2-4, 7-2-5, and 7-2-6.

Table 7-2-3 Cost Estimation of Road Projects

No.	New Project	Distance (km)			Planned width (m)	Cost (Unit: Rs. Million)		
		Road	Bridge	Total		Road	Bridge	Total
R-01	Lyari Expressway (Right Bank)	-	10.18	10.18	13.0	0	9,263	9,263
R-02	Malir Expressway	41.12		41.12	23.0	18,915	0	18,915
R-03	RCD-Hawksbay Connecting Road (Highway), Part of Outer-ring Road	25.04		25.04	12.0	1,502	0	1,502
R-04	Hawksbay-West Whaf Connecting Road, Part of Outer-ring Road	8.26	0.40	8.66	12.0	275	336	611
R-05	Hawksbay-West Whaf Connecting Road	9.36		9.36	24.5	3,981	0	3,981
R-06	Access Road to Pakistan Deep Water Container Port	-	-	-	-	-	-	40,963
R-07	Sunset Boulevar Road, Part of Central and Outer-ring Road	0.90		0.90	31.0	67	0	67
R-08	Korangi Road Bridge	0.48	2.20	2.68	24.5	40	2,541	2,581
R-09	Coastal Road, Part of Outer-ring Road	18.99		18.99	24.5	1,836	0	1,836
R-10	Port Bin Qasim Road, Part of Outer-ring Road	5.78		5.78	24.5	362	0	362
R-11	Super Hway-Edu.City-National Hway Conneting Road, Part of Outer-ring Road	17.66		17.66	24.5	1,457	0	1,457
R-12	Northern Bypass-Super Highway Connecting Road, Part of Outer-ring Road	28.90		28.90	12.0	1,734	0	1,734
R-13	Extention of University Road	9.13	3.04	12.17	21.0	842	4,472	5,314
R-14	Extention of University Road	6.67		6.67	21.0	534	0	534
R-15	Super Hway-National Hway Conneting Road	13.80		13.80	21.0	1,449	0	1,449
R-16	RCD Hway-New Karachi Connecting Road	2.73		2.73	24.5	285	0	285
R-17	RCD Hway-New Karachi Connecting Road	6.18		6.18	24.5	757	0	757
R-18	Orangi-Northern Bypass Connecting Road	7.77		7.77	24.5	680	0	680
R-19	Barida-RCD Hway Connecting Road, Part of Transit Route CR-5	0.86		0.86	24.5	106	0	106
R-20	Kemari-RCD Hway Connecting Road	3.52		3.52	24.5	431	0	431
R-21	Northern Link Road	1.89		1.89	24.5	175	0	175
R-22	Northern Hwy Link Road	11.18		11.18	24.5	941	0	941
R-23	Road in Balida Town	2.81		2.81	22.0	258	0	258
R-24	New Karachi Link Road	4.74		4.74	22.0	379	0	379
R-25	Extention of Manghopir Road	10.47		10.47	22.0	785	0	785
R-26	Extention of Zahid Hussain Road	0.97		0.97	22.0	107	0	107
R-27	Dow University Road	0.91		0.91	22.0	55	0	55
R-28	Suparco Road	16.86		16.86	22.0	1,729	0	1,729
R-29	Pcsir Road	2.22		2.22	22.0	133	0	133
R-30	Road between Super Hway and Suparco Road	2.10		2.10	22.0	231	0	231
R-31	Malir Cantt Road	2.37		2.37	22.0	189	0	189
R-32	Malir Rausi Road	10.41		10.41	22.0	957	0	957
R-33	Extension of Haib Rehmatullah Road	3.16		3.16	22.0	348	0	348
R-34	4000 Feet Road	5.90		5.90	22.0	649	0	649
R-35	Extension of Korangi Industrial Area (14000) Road (In the Navy)	2.53		2.53	22.0	279	0	279
R-36	Extension of Korangi Industrial Area (15000) Road (in the Navy)	3.12		3.12	22.0	344	0	344
R-37	15000 Road	0.83		0.83	22.0	29	0	29
R-38	Extension of 15000 Road	2.24		1.60	22.0	224	0	224
R-39	Extension of Mujahid Road	5.79		5.79	22.0	466	0	466
R-40	Road between Shahrah-e-Faisal Road and Extension of Mujahid Road	0.54		0.54	22.0	32	0	32
R-41	Road between Mujahid Road and Coastal Road	1.02		1.02	22.0	113	0	113
R-42	GT Link Road including expansion of the bridge	2.71	0.25	2.96	22.0	163	210	373
	Sub Total	418.76	19.51	437.63	-	43,839	16,821.6	101,624

(Unit Cost for bridge is 70,000 Rs. /m^2)

Source: JICA Study Team

Table 7-2-4 Cost Estimation of Overpass Projects

No.	New Project	Cost (Rs. Million)
R-101	Lyari Expwy x Garden Road (Outbound)	368
R-102	Lyari Expwy x Chakwara Road (Inbound/Outbound)	945
R-103	Lyari Expwy x Nawab Siddique Alikhan Road (Inbound/Outbound)	945
R-104	Lyari Expwy x Jahangir Road (Inbound/Outbound)	945
R-105	Lyari Expwy x Rashid Minhas Road (Inbound/Outbound)	945
R-106	Lyari Expwy x Maripur Road (Inbound)	184
R-107	Malir Expwy x Expressway	368
R-108	Malir Expwy x Extension of Haib Rehmtullah Road	1,254
R-109	Malir Expwy x Extension of 13000 feet Road	1,463
R-110	Malir Expwy x Shahrah-e-Faisal Road	1,568
R-111	Malir Expwy x Extension of University Road	1,219
R-112	Malir Expwy x Super Hway-National Hway Connecting Road	1,219
R-113	Malir Expwy x Super Hway-National Hway Connecting Road	1,219
R-114	Malir Expwy x Super Highway	368
R-115	Northern Bypass x RCD Bypass	549
R-116	Northern Bypass x Orange-N.Bypass Connecting Road	549
R-117	Northern Bypass x Extension of 90 meter Road	549
R-118	Northern Bypass x Outer-ring Road	549
R-119	Super Highway x Extention of Gulshan-e-Maymar Road	549
R-120	Super Highway x Jinnah Avenue	549
R-121	Super Highway x Super Hway-National Hway Conneting Road	549
R-122	Super Highway x Super Hway-Education City-National Hway Conneting Road	549
R-123	Extension of Univ. Road x Super Hway-National Hway Conneting Road	549
R-124	Extension of Univ. Road x Super Hway-Education City-National Hway Conneting Road	549
R-125	National Highway x Super Hway-National Hway Conneting Road	549
R-126	National Highway x Super Hway-Education City-National Hway Conneting Road	549
R-127	Shahrah-e-Faisal Road x Airport Road	326
R-128	Shahrah-e-Faisal Road x Jinnah Avenue	326
R-129	Shahrah-e-Faisal Road x Malir Rausi Road	326
R-130	University Road x Extension of University Road (Cantt Road)	326
R-131	Jinnah Avenue x Extension of University Road (Cantt Road)	326
R-132	Jinnah Avenue x Extention of Gulshan-e-Maymar Road	326
R-133	Nawab Siddique Ali Khan Road x Shahrah-e-Orangi	326
R-134	Chaudry Fazal Ellahi 5000 Road x Surjani town Road	326
R-135	Nawab Siddique Ali Khan Road x Jahangir Road	326
R-136	Nawab Siddique Ali Khan Road x Newma Jinnah Road	326
R-137	Shahrah-e-Orangi x Gulshan Ghazi Road	326
R-138	Shahrah-e-Orangi x RCD Hway-New Karachi Connecting Road	326
R-139	RCD Highway x RCD Hway-New Karachi Connecting Road	326
R-140	RCD Highway x Kemari-RCD Hway Connecting Road	326
R-141	Khayaban-e-Roomi Road x Khayaban-e-Saadi Road	326
R-142	Khayaban-e-Roomi Road x Chaudhy Khaliq-uz-Zaman Road	326
R-143	Sunset Boulevard Road x Commercial Avenue	326
R-144	Sunset Boulevard Road x South Circular Avenue	326
R-145	Sunset Boulevard Road x Korangi Road	326
R-146	Korangi Road x Khayban-e-Ittehad Road	326
R-151	Malir Expwy / Pakistan Railway	549
R-152	Road between Shahrah-e-Faisal Road and Extension of Mujahid Road / Pakistan Railway	326
R-153	Mai Kolachi Bypass / Pakistan Railway	549
	Sub Total	27,540

Source: JICA Study Team

Table 7-2-5 Cost Estimation of Traffic Signal

No,	New Projct	Cost (Rs. Million)
R-201	Shahrah-e-Faisal Road x Gulistan-e-Johar Road	3
R-202	National Hway x Radio Pakistan Road	3
R-203	National Hway x Road near the National Univ. of Karahi in Shah Latif Town	3
R-204	Jinnah Road x New M.A. Jinnah Road	8
R-205	University Road x Johar Mor Road	3
R-206	University Road x Suparco Road	3
R-207	University Road x Race Course Road	3
R-208	Super Highway x Abdul Hassan Isphahani Road	3
R-209	Super Highway x Road near the Al-Asif Square (Sohrab Goth)	3
R-210	Super Highway x Suparco Road	3
R-211	Khayaban-e-Sher Shah Suri Road x Shahrah-e-Humayum Road	4
R-212	Khayaban-e-Sher Shah Suri Road x Shahrah-e-Aurangzeb Alamgir Road	4
R-213	Chaudry Fazal Ellahi Road x Bahadur Ali Road	4
R-214	Shahrah-e-Orangi Road x Shahrah-e-Noor Jahan	4
R-215	Shahrah-e-Orangi Road x Sabri Chowk Road	3
R-216	Shahrah-e-Orangi Road x Shahrah-e-Farooq-e-Azam Road	4
R-217	Orangi Road x Road in Islam Chowk	3
R-218	New Orangi Road x New Karachi Link Road	4
R-219	New Orangi Road x Road in Ghaziabad	3
R-220	Gulshan-e-Ghazi Road x Road to Qaim Khani Colony	4
R-221	Gulshan-e-Ghazi Road x Road in Baldia	3
R-222	Gulshan-e-Ghazi Road x Road along the Baldia Stadium	3
R-223	RCD Hway-New Karachi Connecting Road x Road in Pervz Musharaf Colony	3
R-224	RCD Hway-New Karachi Connecting Road x Road in Ghaziabad	4
R-225	RCD Hway-New Karachi Connecting Road x Mangopir Road	4
R-226	Road 6000 x Shahrah-e-Noor Jahan	3
R-227	Road 6000 x Shahrah-e-Molana Shaukat Ali Road	3
R-228	Extention of Gulshan-e-Maymar Road x Road in Site Super Housin Phase I	3
R-229	Extention of Gulshan-e-Maymar Road x Northern Hwy Link Road	3
R-230	Extention of Gulshan-e-Maymar Road x Suparco Road	4
R-231	Jinnah Avenue x Suparco Road	4
R-232	Jinnah Avenue x Extension of University Road	4
R-233	Jinnah Avenue x Race Course Road	3
R-234	Shah Valiullah Road x Allama Turabi Road	3
R-235	Shah Valiullah Road x Shahrah-e-Molana Shaukat Road	3
R-236	Estate Avenue x Textile Avenue	3
R-237	Mian S.M Farooq Road x Korangi Industrial Area (3000) Road	4
R-238	Mian S.M Farooq Road x Shahrah-e-Khurshid Ahmed Road	4
R-239	Mian S.M Farooq Road x Korangi Industrial Area (9000) Road	4
R-240	Mian S.M Farooq Road x Malir River Bridge Road	4
R-241	Mian S.M Farooq Road x Korangi Industrial Area (15000) Road	4
R-242	Mian S.M Farooq Road x Landhi Road	4
R-243	Korangi Road x Korangi Industrial Area (3000) Road	3
R-244	Korangi Creek Road x Extension of Shahrah-e-Khurshid Ahmed Road	4
R-245	Coastal Road x Korangi Creek Road	3
R-246	Coastal Road x Korangi Industrial Area (9000) Road	3
R-247	Coastal Road x M Shafi Usmani (13000) Road	3
R-248	Coastal Road x 15000 Road	3
R-249	Coastal Road x Road between Mujahid Road and Coastal Road	3
R-250	Coastal Road x Port Qasim Road	3
R-251	Hawks Bay Road x Kemari-RCD Hway Connectin Road	3
R-252	Hawks Bay Road x Muripur-New Road connecting Road	3
R-253	Maripur Road x G.Allana Road	4
	Sub total	184

Source: JICA Study Team

Table 7-2-6 Cost Estimation of Other Projects

No.	New Projects	Dimension	Cost (Rs. Million)
R-261	New City Road (Minor Arterial, 152km)	152 km x 22 m	16,720
R-262	New City Road (Collector, 152km)	152 km x 15 m	11,400
R-271	Access Road to the Public Transport Stations (28 stations)	200m x 31m x 28 locations	868
R-281	Pedestrian Bridge	250 points	2,500
R-291	Car Paring Plaza in Civic Centre, Premises (M-3)	1.5 acres	243
R-292	Saddar Parking Plaza at Shahabuddin Market, Adjacent Empress Market (M-4)	1.61 acres	1,694
R-293	Clifton Parking Plaza near Schon underpass, Clifton (M-5)	2932 yd2	225
R-294	Two Parking Plazas in Jheel Park, Allama Iqbal Road, off Tariq Road (M-6)	3.0 acres	1,868
R-301	Truck Terminal on the Northern Bypass	60 ha	3,000
R-301	Truck Terminal on the Super Highway	30 ha	1,500
R-303	Truck Terminal on the National Highway	30 ha	1,500
	Sub total		41,518

Source: JICA Study Team

(6) Total Cost

Total construction cost for related to roads are Rs. 171 billion as shown in Table 7-2-7. This is the total cost up to 2030. Note that in the transport sector report of KSDP 2020, it was estimates at Rs. 90 billion (Table 5-7).

Table 7-2-7 Summary of Cost Estimates of Road Projects

Item	Cost (Rs. million)
Road Project	101,624
Overpass Project	27,540
Traffic Signal	184
Others	45,518
Total	170,866

Source: JICA Study Team

7.2.3 MRT & LRT

In the transport sector report in KSDP 2020, the project cost of LRT is as small as Rs. 36 billion for Priority Corridor-I, Rs. 27 billion for Priority Corridor-II, and Rs. 60 billion for KCR. However, railway system cannot be implemented in such costs. The JICA Study Team estimated the project costs based on information of the recent projects in developing countries.

(1) Unit Cost

There is no cost sample for MRT and LRT project recently in Karachi except for the feasibility study of KCR by JICA (2008-2009). Since the design of mass transit lines in KUTMP 2030 is conceptual stage, the breakdown of unit costs is as simple as station by type, rail road by type, depot, and rolling stock. Information of unit costs has been collected from the recent MRT projects, and these unit costs were compiled into the simple breakdown. Table 7-2-8 shows the estimated unit costs. In addition to the cost in the table, the cost of engineering services, general administration, commissioning charges are necessary. In this stage, it is assumed that these costs are 10% of the construction cost.

Table 7-2-8 Unit Cost of MRT & LRT

Item	Type	Unit	Cost (Unit: Rs. Million)
Station (200m)	Elevated	No.	1,800
	Underground	No.	4,400
	Underground (Trench shaped)	No.	2,800
	At-grade	No.	700
Rail road	Elevated	Km	1,900
	Underground	Km	4,500
	Underground (Trench shaped)	Km	3,000
	At-grade	Km	700
Depot	-	No.	11,500
Rolling stock (Car)		No.	200

Source: Estimated by JICA Study Team

(2) Cost Estimation

The project cost of MRT systems were estimated by using the unit costs. The project cost of KCR was estimated in KCR SAPROF by JICA in 2009. Considering the price escalation and some modifications of the plan, the cost of KCR was also estimated as the same method as other lines using the unit costs. The results are shown in Table 7-2-9.

Table 7-2-9 Construction Cost of MRT/ LRT

Route Name	Length			Station			Depot	Cost
	Underground km *	Elevated km	At-grade km	Underground no.	Elevated no.	At-grade no.	no.	Rs. Billion
KCR	5.3	21.5	16.3	2	11	11	1	112.8
KCR-Extension	0.0	0.0	14.5	0	0	11	1	21.7
Blue Line	8.3	14.1	0.0	7	11	0	1	126.2
Brown Line	0.0	18.5	0.0	0	16	0	1	75.5
Total	13.6	54.1	30.8	9	38	22	4	336.1

* Underground section of KCR is trench shaped section

Note: The cost of KCR is 34% higher than KCR SAPROF due to the simple application of the unit prices instead of detail estimation and price escalation from 2008

Source: Estimated by JICA Study Team

The necessary number of train-cars was calculated by assuming 3 minutes headways and 6-car composition of a train for MRT, 5 minutes headway and 4-car composition of a train for LRT. The results of rolling stock cost and the total cost are shown in Table 7-2-10.

Table 7-2-10 Rolling Stock Cost and Total Cost of MRT/ LRT

Route Name	Length Total *km*	Headway *minutes*	No. of trains *trains*	No. cars per train *cars/train*	Rolling Stock *no.*	Cost (Rs. Billion) Rolling stock	Const-ruction	ES Admin	Total
KCR	43.1	4.0	40	6	240	47.9	112.8	11.3	172.0
KCR-Extension	14.5	3.0	20	6	117	23.5	21.7	2.2	47.3
Blue Line	22.4	3.3	26	6	156	31.2	126.2	12.6	170.1
Brown Line	18.5	4.0	19	6	113	22.6	75.5	7.5	105.6
Total	98.5		104		626	125.3	336.1	33.6	495.0

Source: Estimated by JICA Study Team

7.2.4 BRT

(1) Unit Cost

BRT cost was estimated in "Private/ Public Partnership based Environmentally-friendly Public Transport System for Karachi, 2006" Considering price escalation from 2006 to 2011, the following unit costs are used for KUTMP 2030. Table 7-2-11 shows the result of the unit cost estimation of BRT.

The cost estimates in the Feasibility Study (Volume-2) were used for Green Line and Red Line.

Table 7-2-11 Unit Cost of BRT

Item	Type	Unit	Cost (Rs. Million)
BRT Route	At-grade	Km	30
BRT Station	At-grade	No.	20
Pedestrian Bridge	With escalators	No.	45
Bus Depot	-	No.	90
Ticketing System	-	Lump Sum	900
ITS control center & signaling		Lump Sum	220
Bus	Articulated Bus (160 seats)	No.	17

Source: Estimated by JICA Study Team based on cost estimation in "Private/ Public Partnership based Environmentally-friendly Public Transport System for Karachi, 2006"

(2) Cost Estimation

The result of the cost estimation in the Feasibility Study (Volume-2) was used for the cost of Green Line and Red Line. Route length of the two corridors is 21.0 and 24.4 km, respectively. The necessary number of buses was estimated at 389 for the two corridors.

In the cost estimation of other corridors, it is assumed that the distance between stations is 500m in average, and the BRT systems are operated along one-lane per direction (two-lanes for both directions) with one-minute headway. The necessary number of buses has been worked out at 244 vehicles including 10% of spare vehicles. The cost of the ticketing and signaling system is a lump sum for all routes. Pedestrian bridges are proposed at all stations for access from sidewalk to the median of the road. The total costs of BRTs are summarized in Table 7-2-12.

Table 7-2-12 Total Cost of BRT

Route Name	Length		Station	Pedestrain Bridge	Depot	Ticketing	Signaling & ITS	Bus	Cost
	At-grade km	Elevated km	no.	no.	no.	no.	no.	no.	Rs. Million
Green Line	21.0		27	27	1			194	5,958
Red Line	24.4		26	26	1			195	6,083
Yellow Line	20.4		41	41	1			108	5,167
Orange Line	3.9		8	8	1			21	1,077
Purple Line	9.7		19	19	1			52	2,489
Aqua Line	11.8		24	24	1			63	3,053
Total	91.2		145	145	6	1	1	633	24,950

Source: Estimated by JICA Study Team (using unit price in Table 7-2-11), Feasibility Study (Volume-2)

7.3 Project Prioritization

7.3.1 Intermediate Target Years

The intermediate target years were set at year 2020 for short term projects, 2025 for mid term projects, and 2030 for long term projects. The target year of short term projects is as same as that of KSDP 2020. Since the development of a mass transit system takes time, more than five years in case of Karachi, the period of nine years from 2012 is the realistic time frame for the "short" term projects.

7.3.2 Road and Traffic Management

(1) Basic Approach for Prioritization of Road and Traffic Management Projects

The proposed projects are categorized into (1) short-term project (-2020), (2) mid-term project (2020-2025), and (3) long-term projects (2025-2030) based on the following policies.

- On-going projects are short-term projects.
- Urgent need projects should be short-term projects.
- Road projects in suburban areas should be developed according to the development schedule of the suburban areas.

(2) Road Network in 2020

Figure 7-3-1 shows the road network in 2020, while the road network in 2030 is shown in Figure 6-3-6.

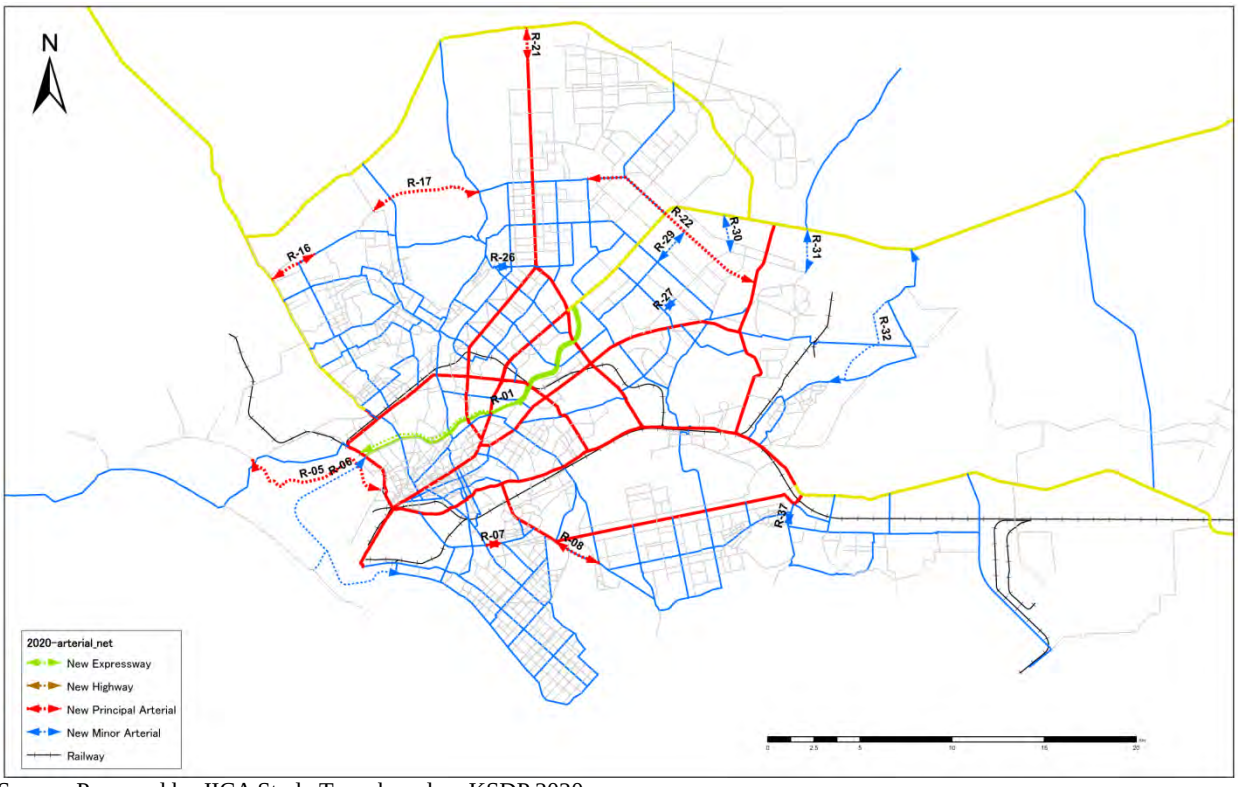
Completion of Lyari Expressway and its overpasses is given high priority because the present expressway serves only one-way direction while it can play an important role for the connection between the center of the city and the suburban areas. Hawksbay – West Wharf Connecting Road (R-05) is important for the urban development of Hawksbay in Keamari and the project should be implemented in short-term. Karachi Port Trust (KPT) has a development plan of freight terminal (Cargo Village), and the feasibility study of the Harbor Bridge was conducted. This road project (R-06) is included in the short-term projects.

To support suburban development in the northern area, RCD Highway – New Karachi Connecting Road (R-16, R-17) and Northern Highway Link Road (R-22) should be constructed in the short-term.

Korangi Bridge (R-08) connects Korangi Industrial Area and Clifton. Since the existing road is narrow, it is necessary to construct this bridge in the short-term.

(3) Mid-term Projects

Most other road projects are proposed as mid-term projects because the road network should be developed before the urban developments. Malir Expressway is given a high priority among them because it connects DHA City and Education City which will have been developed in short-term period, and Shahrah-e-Faisal Road would be saturated in mid-term. A part of Outer Ring Road (R-12), connecting Northern Highway and Super Highway, can be long-term, or beyond the master plan period of 2030 due to low traffic demand.



Source: Proposed by JICA Study Team based on KSDP 2020

Figure 7-3-1 Road Network in 2020

7.3.3 Public Transport System

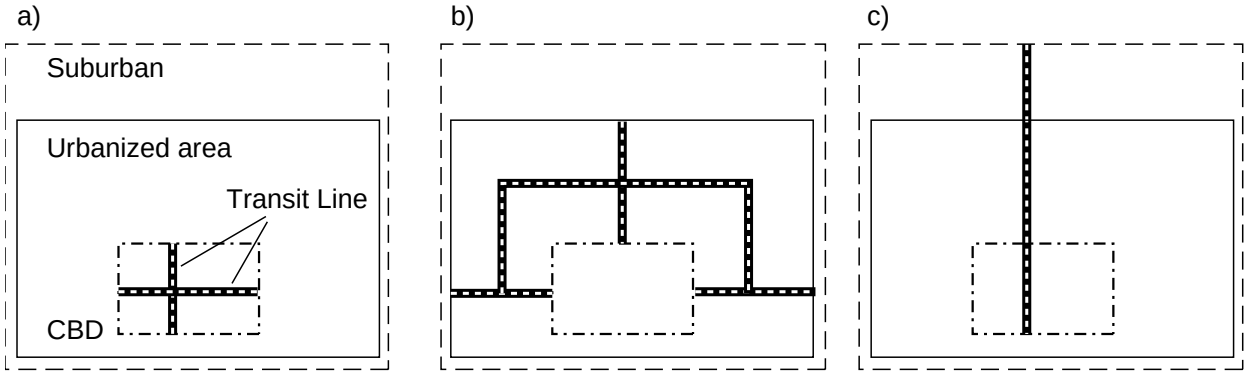
(1) Prioritization of Mass Transit System

The first stage of KCR is given the top priority to provide the route to access to the center of the city. Feeder routes connecting KCR stations will be provided for the transport between the center and suburban areas. The issue of priority setting is which feeder routes should be given the next priority.

The most important criteria for the prioritization are traffic demand, relation of traffic volume and capacity, and cost performance. In addition to the priority settings for mass transit network, bus projects should be initiated soon because the mass transit development takes time even if they are high priority project.

(2) Development Strategy

There are three options for the first step as shown in Figure 7-3-2. First, mass transit system is developed in the center of the city, where the congestion is the most serious. This will take time because it is costly due to the limited space for transit system in CBD. This approach would reduce the congestion in CBD and bring about a large scale economic benefit. Second, mass transit system is developed between suburban area and the edge of CBD where construction is relatively reasonable. This approach would contribute to the suburban development emphasized in KSDP 2020. In the last option, mass transit system is developed line by line. It means that urban development is concentrated along the selected corridor.



Construction of Mass Transit in the center of the city

Construction of Mass Transit in urbanized area excluding CBD

Construction of Mass Transit along major corridor through CBD, urbanized area, and suburban area

Source: JICA Study Team

Figure 7-3-2 Railway Development Alternatives (1st Step)

Table 7-3-1 shows the comparison of these alternatives as the first step. The important aspect is the consistency with the land use development and the risk from the project. From this, the alternative of b) is evaluated being the best at the moment. This avoids underground construction and expands mass transit network in urbanized area in Karachi. The risk of cost increase, delay, failure in land acquisition, failure in financing, etc would be the minimum among these alternatives.

Table 7-3-1 Comparison of Railway Development Alternatives

Item	a)	b)	c)
Priority Development area	CBD	Urbanized area other than CBD	A major corridor
Contribution to Mass Transit Oriented Urban Development	Not effective	Can promote development of sub centers	Possible along the corridor
Suburban development for KSDP 2020	Negative impact	Can support to expand the urbanized area to some extent	Only promote along the corridor but effectively
Impact on road traffic	Traffic circulation in the city will be improved by reducing traffic congestion in Saddar Area where most bottlenecks exist.	Traffic will be improved along major roads although the congestion in Saddar Area remains heavy.	Traffic will be improved along the corridor.
Depot	Need depots in the center of the city where possible land is limited	Need depots for each line at the fringe of urbanized area	Land is easily acquired in suburban areas for a large size depot
Other Infrastructure	Need intermodal terminals inside urbanized area where land acquisition is difficult	Need feeder bus system and intermodal terminals at the ends of lines	Need intermodal facility at major stations
2nd step development	Need a strategic plan for transition point from underground to elevated section (see 6.4.2)	Need a strategic plan for transition point from underground to elevated section (see 6.4.2)	2nd step is another project.
Corresponding routes (example) in Karachi Mass Transit Program	Corridor-1 and 2 inside KCR (underground + elevated)	Corridor-1, BRT-1 & 2 up to Mazar Area, and Corridor-5	Corridor-1 and its extension along Super Highway
Alternative in case of delay	No alternative	Can shift another route if a project delays	Phased development is possible.

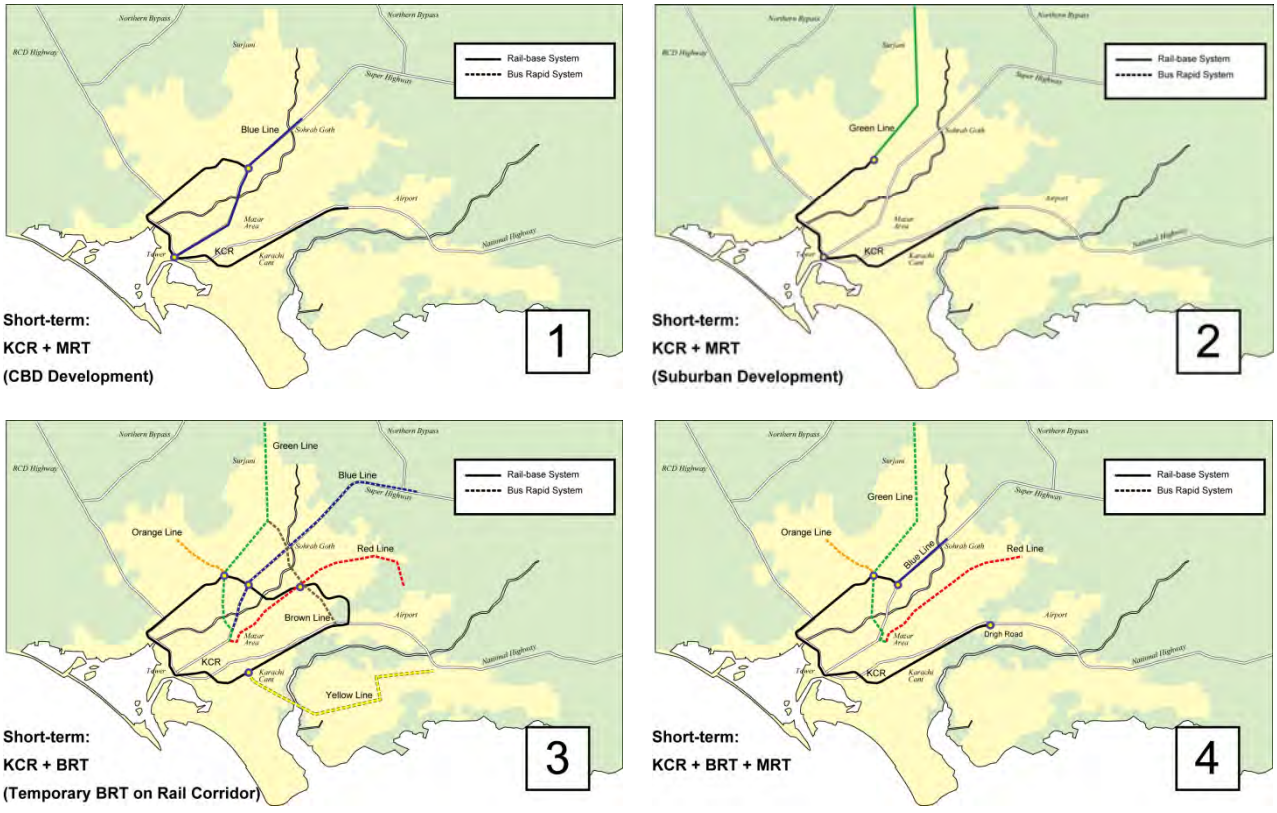
Source: JICA Study Team

(3) Short-term (-2020) Mass Transit Network

The start of the mass transit development is important for the success of the KUTMP 2030. Based on the analysis of the development strategy, following four options were prepared.

i) KCR and a MRT in CBD
ii) KCR and a MRT between KCR station and the suburban area
iii) KCR and BRT routes for future conversion to MRT
iv) KCR, BRT routes, and the first step of a MRT

The networks of these options are illustrated in Figure 7-3-3. The first option intends to resolve the congestion in CBD in short term by providing a mass transit system between the center of the city and the suburban area. The idea is based on the strategy (a) in Table 7-3-1. The second option intends to provide a mass transit service to suburban area in short term. Since the area along the extension of Blue Line has not been populated, Green Line is proposed as the short term line in this option. Instead of MRT construction, which takes time and cost, expansion of BRT network along MRT routes in short term periods is the third option. The BRT routes will be converted to MRT in the future. The last option is to start a MRT in parallel with BRT construction. Conversion from BRT to MRT is not considered in this option. Option-2, 3, and 4 are variations of the strategy (b) in Table 7-3-1. In case of the strategy (c), KCR cannot be included because the total cost becomes higher than the acceptable level of the short term period. Since KCR is given the high priority, this strategy was not considered.



Source: JICA Study Team

Figure 7-3-3 Options for Short-term (-2020) Network

Table 7-3-2 shows the route length and cost of the options.

Table 7-3-2 Summary of Short-term Options

Item	Type	Option-1	Option-2	Option-3	Option-4	Unit
Route Length	MRT	47.7	45.5	43.1	42.5	km
	BRT	0.0	0.0	88.8	53.3	
	Total	47.7	45.5	131.9	95.8	
Cost	MRT	225.5	184.8	157.2	165.2	Rs. billion
	BRT	0.0	0.0	23.8	16.9	
	Total	225.5	184.8	180.0	182.1	

Source: JICA Study Team

The advantage and disadvantage of these options are summarized in Table 7-3-3. Option-1 is the only case which can provide direct access to Saddar, where the commercial and business activities are most busy in the city. However, construction of a mass transit system along M.A. Jinnah Road is so expensive that the north part of KCR cannot be constructed. Option-2 can contribute to promote the development in Gadap, but other system such as BRT can also provide direct access to the northern development area although the travel time becomes large. The cost efficiency of this option would be small. Option-3 is the most balanced network with the combination of KCR and BRT system. However, railway system will not be constructed until the end of the life period of BRT infrastructure. Option-4 is rather a snapshot toward mid-term or long-term period and requires subsequence investment on Blue Line. However, this is the most proper approach to achieve the master plan network in 2030.

Table 7-3-3 Advantage and Disadvantage of Options

	Advantage	Disadvantage
Option-1	- Can avoid the risk when KCR is delay - Can improve the congestion in CBD - Less negative impact on road traffic	- Expensive - Lack of capacity along other corridors
Option-2	- Can promote suburban development - Less negative impact on road traffic - Can increase KCR passengers	- Expensive - CBD remains congested - Lack of capacity along other corridors
Option-3	- Large service area of mass transit - Can implement in short-period - Less cost	- Duplicate investment from BRT to MRT - Negative impact on car users - CBD remains congested
Option-4	- Large service area of mass transit - More strategic to the next step to 2030	- Negative impact on car users - CBD remains congested

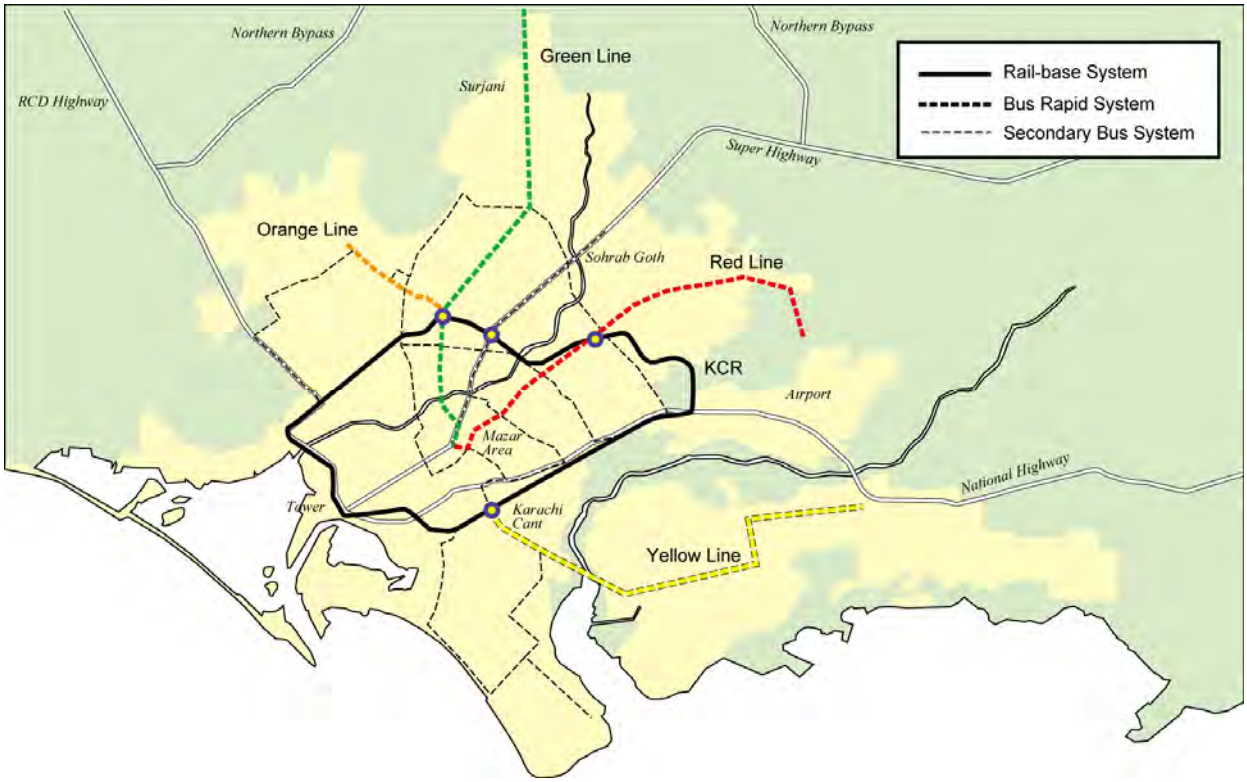
Source: JICA Study Team

Based on the comparison among the options, it has been concluded that Option-3 or Option-4 would be the most appropriate approach. In view of the implementation of KCR, dividing the KCR line into short-term and mid-term period is not efficient investment approach. The loop of KCR is better to be completed in the short-term period. In addition, JICA also intends to support KCR project in the short-term period. From this, the better network for the short-term period has been worked out based on Option-3. However, construction of BRT along Blue Line and Brown Line was excluded because of the future development of the railway system. Once the infrastructure of BRT is developed, it should not be demolished for the future conversion within the project life period.

Figure 7-3-4 shows the short-term mass transit network. The network consists of KCR and four BRT systems (Green Line, Red Line, Yellow Line and Orange Line).

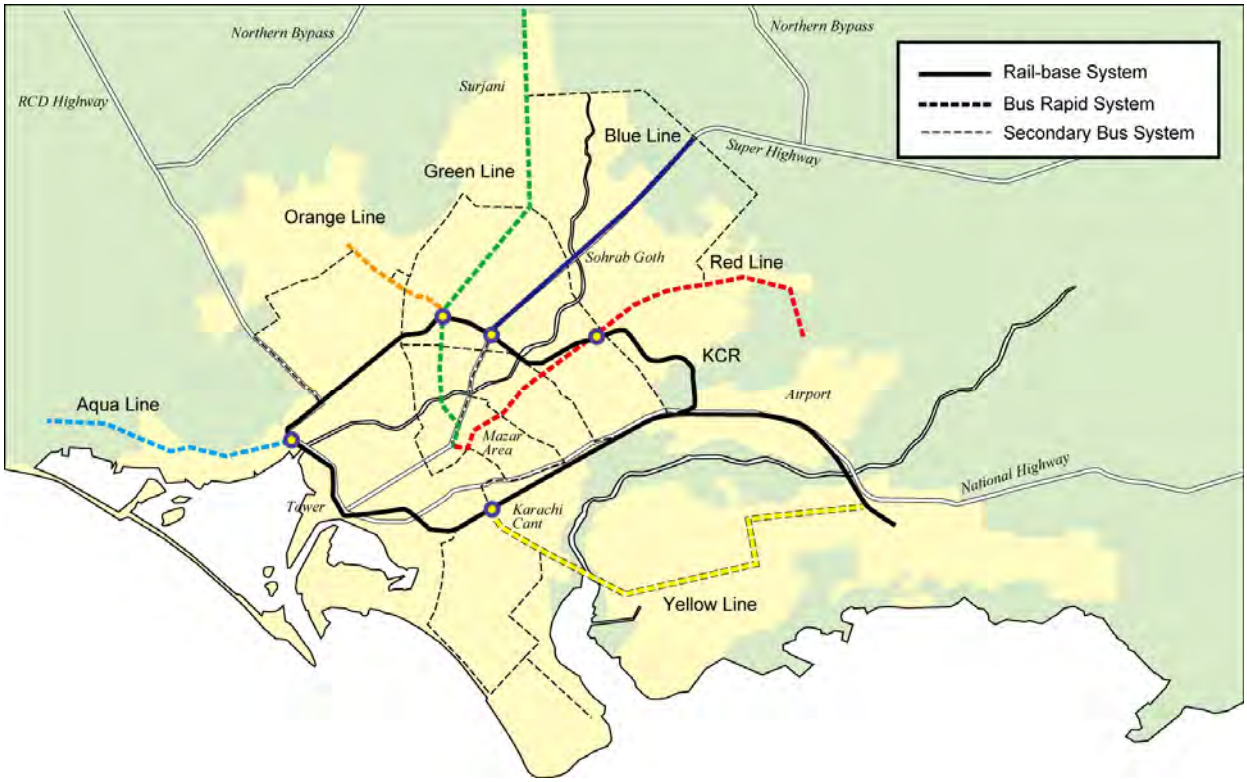
(4) Mid-term (-2025) Mass Transit Network

The mass transit network in the mid-term is affected by the short-term network. Figure 7-3-5 shows the mid-term mass transit network.



Source: Proposal in M/P stage of KTIP

Figure 7-3-4 Short-term (2020) Mass Transit Network



Source: Proposal in M/P stage of KTIP

Figure 7-3-5 Mid-term (2025) Mass Transit Network

Table 7-3-4 shows the cumulative investment cost by short-term (2020), mid-term (2025), and long-term (2030) for the mass transit development.

Table 7-3-4 Cumulative Investment of Mass Transit System by 2020, 2025, and 2030

Unit: Rs. Billion

Mass Transit System	Year		
	2012-2020	2012-2025	2012-2030
KCR	157.2	163.1	172.0
KCR-Extension	0.0	39.3	47.3
Blue Line	0.0	116.4	170.1
Brown Line	0.0	0.0	105.6
BRT	13.2	22.5	25.0
Total	170.4	341.3	520.2
Investment in each period	170.4	170.9	178.9

Source: Estimated by JICA Study Team

7.4 Implementation Plan of Short Term Project

7.4.1 Road and Traffic Management

(1) Responsible Organization

Most of road related projects will be implemented by CDGK, excluding the Lyari Expressway and Access Road to Pakistan Deep Water Container Port which will be implemented by NHA and KPA respectively.

(2) Implementation Schedule

Implementation schedule is planned by considering the following conditions.

- Ongoing projects will be implemented at short term
- Some projects in order to resolve the already exposed problems will be implemented at short term
- Previously arranged projects will be implemented at scheduled time
- Some projects in newly development area will be implemented according to the order of development.

Table 7-4-1 shows the breakdown of implementation schedule.

(3) Investment Costs

Total amount of investment cost for all the proposed road related projects is shown in Table 7-4-1. Total investment cost amounts to Rs. 165 billion. Most are for road development projects.

Investment costs are allocated to different phases according to the implementation schedule.

Table 7-4-1 Summary of Cost Estimation for Road Related Projects

(Unit: Rs. Million)

	Short (2012-2020)	Middle (2021-2025)	Long (2026-2030)	After (2031-)	Total
Roads	56,031	41,969	30,878	1,734	130,612
Overpasses	10,217	4,804	11,423	1,098	27,542
Sub Total (for Road Development)	66,248	46,773	42,301	2,832	158,154
Signals	98	86	0	0	184
Parking	4,030	0	0	0	4,030
Sub Total (for Traffic Management)	4,128	86	0	0	4,214
Pedestrian Bridges (for Traffic Safety)	2,250	250	0	0	2,500
Truck Terminal	3,000	1,500	1,500	0	6,000
Total	75,626 (44.1%)	48,609 (28.6%)	43,801 (25.7%)	2,832 (1.7%)	170,868 (100.0%)

Source: JICA Study Team

Table 7-4-2(a) Implementation Schedule

(Unit: Rs. Million)

No.	New Project	Total	Short								Middle					Long					After
			2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2030
Roads / Bridges																						
R-01	Lyari Expressway (Right Bank)	9,263	====	====	====	====																
R-02	Malir Expressway	18,915													====	====	====	====	====	====	====	
R-03	RCD-Hawksbay Connecting Road (Highway), Part of Outer-ring Road	1,502																	====	====	====	
R-04	Hawksbay-West Whaf Connecting Road, Part of Outer-ring Road	611										====	====	====								
R-05	Hawksbay-West Whaf Connecting Road	3,981							====	====	====											
R-06	Access Road to Pakistan Deep Water Container Port	40,963				====	====	====	====	====	====	====										
R-07	Sunset Boulevar Road, Part of Central and Outer-ring Road	67				====	====	====														
R-08	Korangi Road Bridge	2,581				====	====	====														
R-09	Coastal Road, Part of Outer-ring Road	1,836								====	====	====	====	====								
R-10	Port Bin Qasim Road, Part of Outer-ring Road	362												====	====	====						
R-11	Super Hway-Edu.City-National Hway Conneting Road, Part of Outer-ring Road	1,457															====	====	====			
R-12	Northern Bypass-Super Highway Connecting Road, Part of Outer-ring Road	1,734																				====
R-13	Extention of University Road	5,314											====	====	====							
R-14	Extention of University Road	534										====	====	====								
R-15	Super Hway-National Hway Conneting Road	1,449												====	====	====						
R-16	RCD Hway-New Karachi Connecting Road	285				====	====	====														
R-17	RCD Hway-New Karachi Connecting Road	757				====	====	====														
R-18	Orangi-Northern Bypass Connecting Road	680										====	====	====								
R-19	Barida-RCD Hway Connecting Road, Part of Transit Route CR-5	106										====	====	====								
R-20	Kemari-RCD Hway Connecting Road	431										====	====	====								
R-21	Northern Link Road	175	====	====	====																	
R-22	Northern Hwy Link Road	941	====	====	====																	
R-23	Road in Balida Town	258										====	====	====								
R-24	New Karachi Link Road	379												====	====	====						
R-25	Extention of Manghopir Road	785												====	====	====						
R-26	Extention of Zahid Hussain Road	107							====	====	====											
R-27	Dow University Road	55	====	====	====																	
R-28	Suparco Road	1,729										====	====	====								
R-29	Pcsir Road	133	====	====	====																	
R-30	Road between Super Hway and Suparco Road	231	====	====	====																	
R-31	Malir Cantt Road	189				====	====	====														
R-32	Malir Rausi Road	957							====	====	====											
R-33	Extension of Haib Rehmatullah Road	348															====	====	====			
R-34	4000 Feet Road	649											====	====	====							
R-35	Extension of Korangi Industrial Area (14000) Road (In the Navy)	279											====	====	====							
R-36	Extension of Korangi Industrial Area (15000) Road (in the Navy)	344											====	====	====							
R-37	15000 Road	29	====	====	====																	
R-38	Extension of 15000 Road	224										====	====	====								
R-39	Extension of Mujahid Road	466											====	====	====							
R-40	Road between Shahrah-e-Faisal Road and Extension of Mujahid Road	32												====	====	====						
R-41	Road between Mujahid Road and Coastal Road	113										====	====	====								
R-42	GT Link Road including expansion of the bridge	373										====	====	====								
	Roads / Bridges Sub Total	101,624																				
Overpasses																						
R-101	Lyari Expwy x Garden Road (Outbound)	368				====	====	====														
R-102	Lyari Expwy x Chakwara Road (Inbound/Outbound)	945	====	====	====				====	====	====											
R-103	Lyari Expwy x Nawab Siddique Alikhan Road (Inbound/Outbound)	945	====	====	====	====	====	====														
R-104	Lyari Expwy x Jahangir Road (Inbound/Outbound)	945	====	====	====				====	====	====											
R-105	Lyari Expwy x Rashid Minhas Road (Inbound/Outbound)	945	====	====	====				====	====	====											
R-106	Lyari Expwy x Maripur Road (Inbound)	184	====	====	====																	
R-107	Malir Expwy x Expressway	368															====	====	====	====	====	
R-108	Malir Expwy x Extension of Haib Rehmtullah Road	1,254															====	====	====	====	====	
R-109	Malir Expwy x Extension of 13000 feet Road	1,463															====	====	====	====	====	
R-110	Malir Expwy x Shahrah-e-Faisal Road	1,568															====	====	====	====	====	
R-111	Malir Expwy x Extension of University Road	1,219															====	====	====	====	====	
R-112	Malir Expwy x Super Hway-National Hway Connecting Road	1,219															====	====	====	====	====	
R-113	Malir Expwy x Super Hway-National Hway Connecting Road	1,219															====	====	====	====	====	
R-114	Malir Expwy x Super Highway	368															====	====	====	====	====	
R-115	Northern Bypass x RCD Bypass	549															====	====	====			
R-116	Northern Bypass x Orange-N.Bypass Connecting Road	549										====	====	====								
R-117	Northern Bypass x Extension of 90 meter Road	549	====	====	====																	
R-118	Northern Bypass x Outer-ring Road	549																				====
R-119	Super Highway x Extention of Gulshan-e-Maymar Road	549	====	====	====																	
R-120	Super Highway x Jinnah Avenue	549	====	====	====																	
R-121	Super Highway x Super Hway-National Hway Conneting Road	549												====	====	====						
R-122	Super Highway x Super Hway-Education City-National Hway Conneting Road	549															====	====	====			
R-123	Extension of Univ. Road x Super Hway-National Hway Conneting Road	549												====	====	====						
R-124	Extension of Univ. Road x Super Hway-Education City-National Hway Conneting Road	549															====	====	====			
R-125	National Highway x Super Hway-National Hway Conneting Road	549												====	====	====						
R-126	National Highway x Super Hway-Education City-National Hway Conneting Road	549															====	====	====			
R-127	Shahrah-e-Faisal Road x Airport Road	326	====	====	====																	
R-128	Shahrah-e-Faisal Road x Jinnah Avenue	326				====	====	====														
R-129	Shahrah-e-Faisal Road x Malir Rausi Road	326							====	====	====											
R-130	University Road x Extension of University Road (Cantt Road)	326											====	====	====							
R-131	Jinnah Avenue x Extension of University Road (Cantt Road)	326											====	====	====							
R-132	Jinnah Avenue x Extention of Gulshan-e-Maymar Road	326	====	====	====																	
R-133	Nawab Siddique Ali Khan Road x Shahrah-e-Orangi	326				====	====	====														
R-134	Chaudry Fazal Ellahi 5000 Road x Surjani town Road	326							====	====	====											
R-135	Nawab Siddique Ali Khan Road x Jahangir Road	326				====	====	====														
R-136	Nawab Siddique Ali Khan Road x Newma Jinnah Road	326							====	====	====											
R-137	Shahrah-e-Orangi x Gulshan Ghazi Road	326											====	====	====							
R-138	Shahrah-e-Orangi x RCD Hway-New Karachi Connecting Road	326										====	====	====								
R-139	RCD Highway x RCD Hway-New Karachi Connecting Road	326												====	====	====						
R-140	RCD Highway x Kemari-RCD Hway Connecting Road	326										====	====	====								
R-141	Khayaban-e-Roomi Road x Khayaban-e-Saadi Road	326										====	====	====								
R-142	Khayaban-e-Roomi Road x Chaudhy Khaliq-uz-Zaman Road	326				====	====	====														
R-143	Sunset Boulevard Road x Commercial Avenue	326				====	====	====														
R-144	Sunset Boulevard Road x South Circular Avenue	326							====	====	====											
R-145	Sunset Boulevard Road x Korangi Road	326							====	====	====											
R-146	Korangi Road x Khayban-e-Ittehad Road	326							====	====	====											
R-151	Malir Expwy / Pakistan Railway	549																	====	====	====	
R-152	Road between Shahrah-e-Faisal Road and Extension of Mujahid Road / Pakistan Railway	326											====	====	====							
R-153	Mai Kolachi Bypass / Pakistan Railway	549																				====
	Overpasses Sub Total	27,542																				

Source: JICA Study Team

Table 7-4-2(b) Implementation Schedule

(Rs. Million)

No.	New Project	Total	Short									Middle					Long					After
			2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2030
Signals																						
R-201	Shahrah-e-Faisal Road x Gulistan-e-Johar Road	3	====																			
R-202	National Hway x Radio Pakistan Road	3		====																		
R-203	National Hway x Road near the National Univ. of Karahi in Shah Latif Town	3		====																		
R-204	Jinnah Road x New M.A. Jinnah Road	8			====																	
R-205	University Road x Johar Mor Road	3				====																
R-206	University Road x Suparco Road	3				====																
R-207	University Road x Race Course Road	3				====																
R-208	Super Highway x Abdul Hassan Isphahani Road	3					====															
R-209	Super Highway x Road near the Al-Asif Square (Sohrab Goth)	3					====															
R-210	Super Highway x Suparco Road	3					====															
R-211	Khayaban-e-Sher Shah Suri Road x Shahrah-e-Humayum Road	4						====														
R-212	Khayaban-e-Sher Shah Suri Road x Shahrah-e-Aurangzeb Alamgir Road	4						====														
R-213	Chaudry Fazal Ellahi Road x Bahadur Ali Road	4						====														
R-214	Shahrah-e-Orangi Road x Shahrah-e-Noor Jahan	4							====													
R-215	Shahrah-e-Orangi Road x Sabri Chowk Road	3							====													
R-216	Shahrah-e-Orangi Road x Shahrah-e-Farooq-e-Azam Road	4							====													
R-217	Orangi Road x Road in Islam Chowk	3													====							
R-218	New Orangi Road x New Karachi Link Road	4													====							
R-219	New Orangi Road x Road in Ghaziabad	3													====							
R-220	Gulshan-e-Ghazi Road x Road to Qaim Khani Colony	4												====								
R-221	Gulshan-e-Ghazi Road x Road in Baldia	3												====								
R-222	Gulshan-e-Ghazi Road x Road along the Baldia Stadium	3												====								
R-223	RCD Hway-New Karachi Connecting Road x Road in Pervz Musharaf Colony	3													====							
R-224	RCD Hway-New Karachi Connecting Road x Road in Ghaziabad	4													====							
R-225	RCD Hway-New Karachi Connecting Road x Mangopir Road	4														====						
R-226	Road 6000 x Shahrah-e-Noor Jahan	3														====						
R-227	Road 6000 x Shahrah-e-Molana Shaukat Ali Road	3						====														
R-228	Extention of Gulshan-e-Maymar Road x Road in Site Super Housin Phase I	3						====														
R-229	Extention of Gulshan-e-Maymar Road x Northern Hwy Link Road	3						====														
R-230	Extention of Gulshan-e-Maymar Road x Suparco Road	4						====														
R-231	Jinnah Avenue x Suparco Road	4												====								
R-232	Jinnah Avenue x Extension of University Road	4			====																	
R-233	Jinnah Avenue x Race Course Road	3										====										
R-234	Shah Valiullah Road x Allama Turabi Road	3								====												
R-235	Shah Valiullah Road x Shahrah-e-Molana Shaukat Road	3								====												
R-236	Estate Avenue x Textile Avenue	3									====											
R-237	Mian S.M Farooq Road x Korangi Industrial Area (3000) Road	4										====										
R-238	Mian S.M Farooq Road x Shahrah-e-Khurshid Ahmed Road	4										====										
R-239	Mian S.M Farooq Road x Korangi Industrial Area (9000) Road	4										====										
R-240	Mian S.M Farooq Road x Malir River Bridge Road	4										====										
R-241	Mian S.M Farooq Road x Korangi Industrial Area (15000) Road	4										====										
R-242	Mian S.M Farooq Road x Landhi Road	4	====																			
R-243	Korangi Road x Korangi Industrial Area (3000) Road	3						====														
R-244	Korangi Creek Road x Extension of Shahrah-e-Khurshid Ahmed Road	4											====									
R-245	Coastal Road x Korangi Creek Road	3											====									
R-246	Coastal Road x Korangi Industrial Area (9000) Road	3											====									
R-247	Coastal Road x M Shafi Usmani (13000) Road	3												====								
R-248	Coastal Road x 15000 Road	3												====								
R-249	Coastal Road x Road between Mujahid Road and Coastal Road	3												====								
R-250	Coastal Road x Port Qasim Road	3														====						
R-251	Hawks Bay Road x Kemari-RCD Hway Connectin Road	3												====								
R-252	Hawks Bay Road x Muripur-New Road connecting Road	3								====												
R-253	Maripur Road x G.Allana Road	4								====												
	Signals Sub total	184																				
Others																						
R-261	New City Road (Minor Arterial, 152km)	16,720										====	====	====	====	====	====	====	====	====	====	
R-262	New City Road (Collector, 152km)	11,400										====	====	====	====	====	====	====	====	====	====	
R-271	Access Road to the Public Transport Stations (28 stations)	868					====	====	====	====	====	====	====	====	====	====						
R-281	Pedestrian Bridge	2,500	====	====	====	====	====	====	====	====	====	====										
R-291	Car Paring Plaza in Civic Centre, Premises (M-3)	243		====	====																	
R-292	Saddar Parking Plaza at Shahabuddin Market, Adjacent Empress Market (M-4)	1,694				====	====															
R-293	Clifton Parking Plaza near Schon underpass, Clifton (M-5)	225								====	====											
R-294	Two Parking Plazas in Jheel Park, Allama Iqbal Road, off Tariq Road (M-6)	1,868								====	====											
R-301	Truck Terminal on the Northern Bypass	3,000					====	====	====	====	====											
R-302	Truck Terminal on the Super Highway	1,500										====	====	====	====	====						
R-303	Truck Terminal on the National Highway	1,500															====	====	====	====	====	
	Sub total	41,518																				
	Grand Total	170,868																				

Source: JICA Study Team

Table 7-4-3(a) Breakdown of Cost Estimation for Road Related Projects

No.	New Project	Total	Short (-20)	Middle (-25)	Long (-30)	After (30-)	Total
Roads / Bridges							
R-01	Lyari Expressway (Right Bank)	9,263	9,263	0	0	0	9,263
R-02	Malir Expressway	18,915	0	5,404	13,511	0	18,915
R-03	RCD-Hawksbay Connecting Road (Highway), Part of Outer-ring Road	1,502	0	0	1,502	0	1,502
R-04	Hawksbay-West Whaf Connecting Road, Part of Outer-ring Road	611	0	611	0	0	611
R-05	Hawksbay-West Whaf Connecting Road	3,981	3,981	0	0	0	3,981
R-06	Access Road to Pakistan Deep Water Container Port	40,963	35,111	5,852	0	0	40,963
R-07	Sunset Boulevar Road, Part of Central and Outer-ring Road	67	67	0	0	0	67
R-08	Korangi Road Bridge	2,581	2,581	0	0	0	2,581
R-09	Coastal Road, Part of Outer-ring Road	1,836	734	1,102	0	0	1,836
R-10	Port Bin Qasim Road, Part of Outer-ring Road	362	0	362	0	0	362
R-11	Super Hway-Edu.City-National Hway Conneting Road, Part of Outer-ring Road	1,457	0	0	1,457	0	1,457
R-12	Northern Bypass-Super Highway Connecting Road, Part of Outer-ring Road	1,734	0	0	0	1,734	1,734
R-13	Extention of University Road	5,314	0	5,314	0	0	5,314
R-14	Extention of University Road	534	0	534	0	0	534
R-15	Super Hway-National Hway Conneting Road	1,449	0	1,449	0	0	1,449
R-16	RCD Hway-New Karachi Connecting Road	285	285	0	0	0	285
R-17	RCD Hway-New Karachi Connecting Road	757	757	0	0	0	757
R-18	Orangi-Northern Bypass Connecting Road	680	0	680	0	0	680
R-19	Barida-RCD Hway Connecting Road, Part of Transit Route CR-5	106	0	106	0	0	106
R-20	Kemari-RCD Hway Connecting Road	431	0	431	0	0	431
R-21	Northern Link Road	175	175	0	0	0	175
R-22	Northern Hwy Link Road	941	941	0	0	0	941
R-23	Road in Balida Town	258	0	258	0	0	258
R-24	New Karachi Link Road	379	0	379	0	0	379
R-25	Extention of Manghopir Road	785	0	785	0	0	785
R-26	Extention of Zahid Hussain Road	107	107	0	0	0	107
R-27	Dow University Road	55	55	0	0	0	55
R-28	Suparco Road	1,729	0	1,729	0	0	1,729
R-29	Pcsir Road	133	133	0	0	0	133
R-30	Road between Super Hway and Suparco Road	231	231	0	0	0	231
R-31	Malir Cantt Road	189	189	0	0	0	189
R-32	Malir Rausi Road	957	957	0	0	0	957
R-33	Extension of Haib Rehmatullah Road	348	0	0	348	0	348
R-34	4000 Feet Road	649	0	649	0	0	649
R-35	Extension of Korangi Industrial Area (14000) Road (In the Navy)	279	0	279	0	0	279
R-36	Extension of Korangi Industrial Area (15000) Road (in the Navy)	344	0	344	0	0	344
R-37	15000 Road	29	29	0	0	0	29
R-38	Extension of 15000 Road	224	0	224	0	0	224
R-39	Extension of Mujahid Road	466	0	466	0	0	466
R-40	Road between Shahrah-e-Faisal Road and Extension of Mujahid Road	32	0	32	0	0	32
R-41	Road between Mujahid Road and Coastal Road	113	0	113	0	0	113
R-42	GT Link Road including expansion of the bridge	373	0	373	0	0	373
	Roads / Bridges Sub Total	101,624	55,597	27,475	16,818	1,734	101,624

Source: JICA Study Team

Table 7-4-3(b) Breakdown of Cost Estimation for Road Related Projects

No.	New Project	Total	Short	Middle	Long	After	Total
			(-20)	(-25)	(-30)	(30-)	
Overpasses							
R-101	Lyari Expwy x Garden Road (Outbound)	368	368	0	0	0	368
R-102	Lyari Expwy x Chakwara Road (Inbound/Outbound)	945	945	0	0	0	945
R-103	Lyari Expwy x Nawab Siddique Alikhan Road (Inbound/Outbound)	945	945	0	0	0	945
R-104	Lyari Expwy x Jahangir Road (Inbound/Outbound)	945	945	0	0	0	945
R-105	Lyari Expwy x Rashid Minhas Road (Inbound/Outbound)	945	945	0	0	0	945
R-106	Lyari Expwy x Maripur Road (Inbound)	184	184	0	0	0	184
R-107	Malir Expwy x Expressway	368	0	0	368	0	368
R-108	Malir Expwy x Extension of Haib Rehmtullah Road	1,254	0	0	1,254	0	1,254
R-109	Malir Expwy x Extension of 13000 feet Road	1,463	0	0	1,463	0	1,463
R-110	Malir Expwy x Shahrah-e-Faisal Road	1,568	0	0	1,568	0	1,568
R-111	Malir Expwy x Extension of University Road	1,219	0	0	1,219	0	1,219
R-112	Malir Expwy x Super Hway-National Hway Connecting Road	1,219	0	0	1,219	0	1,219
R-113	Malir Expwy x Super Hway-National Hway Connecting Road	1,219	0	0	1,219	0	1,219
R-114	Malir Expwy x Super Highway	368	0	0	368	0	368
R-115	Northern Bypass x RCD Bypass	549	0	0	549	0	549
R-116	Northern Bypass x Orange-N.Bypass Connecting Road	549	0	549	0	0	549
R-117	Northern Bypass x Extension of 90 meter Road	549	549	0	0	0	549
R-118	Northern Bypass x Outer-ring Road	549	0	0	0	549	549
R-119	Super Highway x Extention of Gulshan-e-Maymar Road	549	549	0	0	0	549
R-120	Super Highway x Jinnah Avenue	549	549	0	0	0	549
R-121	Super Highway x Super Hway-National Hway Conneting Road	549	0	549	0	0	549
R-122	Super Highway x Super Hway-Education City-National Hway Conneting Road	549	0	0	549	0	549
R-123	Extension of Univ. Road x Super Hway-National Hway Conneting Road	549	0	549	0	0	549
R-124	Extension of Univ. Road x Super Hway-Education City-National Hway Conneting Road	549	0	0	549	0	549
R-125	National Highway x Super Hway-National Hway Conneting Road	549	0	549	0	0	549
R-126	National Highway x Super Hway-Education City-National Hway Conneting Road	549	0	0	549	0	549
R-127	Shahrah-e-Faisal Road x Airport Road	326	326	0	0	0	326
R-128	Shahrah-e-Faisal Road x Jinnah Avenue	326	326	0	0	0	326
R-129	Shahrah-e-Faisal Road x Malir Rausi Road	326	326	0	0	0	326
R-130	University Road x Extension of University Road (Cantt Road)	326	0	326	0	0	326
R-131	Jinnah Avenue x Extension of University Road (Cantt Road)	326	0	326	0	0	326
R-132	Jinnah Avenue x Extention of Gulshan-e-Maymar Road	326	326	0	0	0	326
R-133	Nawab Siddique Ali Khan Road x Shahrah-e-Orangi	326	326	0	0	0	326
R-134	Chaudry Fazal Ellahi 5000 Road x Surjani town Road	326	326	0	0	0	326
R-135	Nawab Siddique Ali Khan Road x Jahangir Road	326	326	0	0	0	326
R-136	Nawab Siddique Ali Khan Road x Newma Jinnah Road	326	326	0	0	0	326
R-137	Shahrah-e-Orangi x Gulshan Ghazi Road	326	0	326	0	0	326
R-138	Shahrah-e-Orangi x RCD Hway-New Karachi Connecting Road	326	0	326	0	0	326
R-139	RCD Highway x RCD Hway-New Karachi Connecting Road	326	0	326	0	0	326
R-140	RCD Highway x Kemari-RCD Hway Connecting Road	326	0	326	0	0	326
R-141	Khayaban-e-Roomi Road x Khayaban-e-Saadi Road	326	0	326	0	0	326
R-142	Khayaban-e-Roomi Road x Chaudhy Khaliq-uz-Zaman Road	326	326	0	0	0	326
R-143	Sunset Boulevard Road x Commercial Avenue	326	326	0	0	0	326
R-144	Sunset Boulevard Road x South Circular Avenue	326	326	0	0	0	326
R-145	Sunset Boulevard Road x Korangi Road	326	326	0	0	0	326
R-146	Korangi Road x Khayban-e-Ittehad Road	326	326	0	0	0	326
R-151	Malir Expwy / Pakistan Railway	549	0	0	549	0	549
R-152	Road between Shahrah-e-Faisal Road and Extension of Mujahid Road / Pakistan Railway	326	0	326	0	0	326
R-153	Mai Kolachi Bypass / Pakistan Railway	549	0	0	0	549	549
	Overpasses Sub Total	27,542	10,217	4,804	11,423	1,098	27,542

Source: JICA Study Team

Table 7-4-3(c) Breakdown of Cost Estimation for Road Related Projects

No.	New Project	Total	Short (-20)	Middle (-25)	Long (-30)	After (30-)	Total
Signals							
R-201	Shahrah-e-Faisal Road x Gulistan-e-Johar Road	3	3	0	0	0	3
R-202	National Hway x Radio Pakistan Road	3	3	0	0	0	3
R-203	National Hway x Road near the National Univ. of Karahi in Shah Latif Town	3	3	0	0	0	3
R-204	Jinnah Road x New M.A. Jinnah Road	8	8	0	0	0	8
R-205	University Road x Johar Mor Road	3	3	0	0	0	3
R-206	University Road x Suparco Road	3	3	0	0	0	3
R-207	University Road x Race Course Road	3	3	0	0	0	3
R-208	Super Highway x Abdul Hassan Isphahani Road	3	3	0	0	0	3
R-209	Super Highway x Road near the Al-Asif Square (Sohrab Goth)	3	3	0	0	0	3
R-210	Super Highway x Suparco Road	3	3	0	0	0	3
R-211	Khayaban-e-Sher Shah Suri Road x Shahrah-e-Humayum Road	4	4	0	0	0	4
R-212	Khayaban-e-Sher Shah Suri Road x Shahrah-e-Aurangzeb Alamgir Road	4	4	0	0	0	4
R-213	Chaudry Fazal Ellahi Road x Bahadur Ali Road	4	4	0	0	0	4
R-214	Shahrah-e-Orangi Road x Shahrah-e-Noor Jahan	4	4	0	0	0	4
R-215	Shahrah-e-Orangi Road x Sabri Chowk Road	3	3	0	0	0	3
R-216	Shahrah-e-Orangi Road x Shahrah-e-Farooq-e-Azam Road	4	4	0	0	0	4
R-217	Orangi Road x Road in Islam Chowk	3	0	3	0	0	3
R-218	New Orangi Road x New Karachi Link Road	4	0	4	0	0	4
R-219	New Orangi Road x Road in Ghaziabad	3	0	3	0	0	3
R-220	Gulshan-e-Ghazi Road x Road to Qaim Khani Colony	4	0	4	0	0	4
R-221	Gulshan-e-Ghazi Road x Road in Baldia	3	0	3	0	0	3
R-222	Gulshan-e-Ghazi Road x Road along the Baldia Stadium	3	0	3	0	0	3
R-223	RCD Hway-New Karachi Connecting Road x Road in Pervz Musharaf Colony	3	0	3	0	0	3
R-224	RCD Hway-New Karachi Connecting Road x Road in Ghaziabad	4	0	4	0	0	4
R-225	RCD Hway-New Karachi Connecting Road x Mangopir Road	4	0	4	0	0	4
R-226	Road 6000 x Shahrah-e-Noor Jahan	3	0	3	0	0	3
R-227	Road 6000 x Shahrah-e-Molana Shaukat Ali Road	3	3	0	0	0	3
R-228	Extention of Gulshan-e-Maymar Road x Road in Site Super Housin Phase I	3	3	0	0	0	3
R-229	Extention of Gulshan-e-Maymar Road x Northern Hwy Link Road	3	3	0	0	0	3
R-230	Extention of Gulshan-e-Maymar Road x Suparco Road	4	4	0	0	0	4
R-231	Jinnah Avenue x Suparco Road	4	0	4	0	0	4
R-232	Jinnah Avenue x Extension of University Road	4	4	0	0	0	4
R-233	Jinnah Avenue x Race Course Road	3	0	3	0	0	3
R-234	Shah Valiullah Road x Allama Turabi Road	3	3	0	0	0	3
R-235	Shah Valiullah Road x Shahrah-e-Molana Shaukat Road	3	3	0	0	0	3
R-236	Estate Avenue x Textile Avenue	3	3	0	0	0	3
R-237	Mian S.M Farooq Road x Korangi Industrial Area (3000) Road	4	0	4	0	0	4
R-238	Mian S.M Farooq Road x Shahrah-e-Khurshid Ahmed Road	4	0	4	0	0	4
R-239	Mian S.M Farooq Road x Korangi Industrial Area (9000) Road	4	0	4	0	0	4
R-240	Mian S.M Farooq Road x Malir River Bridge Road	4	0	4	0	0	4
R-241	Mian S.M Farooq Road x Korangi Industrial Area (15000) Road	4	0	4	0	0	4
R-242	Mian S.M Farooq Road x Landhi Road	4	4	0	0	0	4
R-243	Korangi Road x Korangi Industrial Area (3000) Road	3	3	0	0	0	3
R-244	Korangi Creek Road x Extension of Shahrah-e-Khurshid Ahmed Road	4	0	4	0	0	4
R-245	Coastal Road x Korangi Creek Road	3	0	3	0	0	3
R-246	Coastal Road x Korangi Industrial Area (9000) Road	3	0	3	0	0	3
R-247	Coastal Road x M Shafi Usmani (13000) Road	3	0	3	0	0	3
R-248	Coastal Road x 15000 Road	3	0	3	0	0	3
R-249	Coastal Road x Road between Mujahid Road and Coastal Road	3	0	3	0	0	3
R-250	Coastal Road x Port Qasim Road	3	0	3	0	0	3
R-251	Hawks Bay Road x Kemari-RCD Hway Connectin Road	3	0	3	0	0	3
R-252	Hawks Bay Road x Muripur-New Road connecting Road	3	3	0	0	0	3
R-253	Maripur Road x G.Allana Road	4	4	0	0	0	4
	Signals Sub total	184	98	86	0	0	184
Others							
R-261	New City Road (Minor Arterial, 152km)	16,720	0	8,360	8,360	0	16,720
R-262	New City Road (Collector, 152km)	11,400	0	5,700	5,700	0	11,400
R-271	Access Road to the Public Transport Stations (28 stations)	868	434	434	0	0	868
R-281	Pedestrian Bridge	2,500	2,250	250	0	0	2,500
R-291	Car Paring Plaza in Civic Centre, Premises (M-3)	243	243	0	0	0	243
R-292	Saddar Parking Plaza at Shahabuddin Market, Adjacent Empress Market (M-4)	1,694	1,694	0	0	0	1,694
R-293	Clifton Parking Plaza near Schon underpass, Clifton (M-5)	225	225	0	0	0	225
R-294	Two Parking Plazas in Jheel Park, Allama Iqbal Road, off Tariq Road (M-6)	1,868	1,868	0	0	0	1,868
R-301	Truck Terminal on the Northern Bypass	3,000	3,000	0	0	0	3,000
R-302	Truck Terminal on the Super Highway	1,500	0	1,500	0	0	1,500
R-303	Truck Terminal on the National Highway	1,500	0	0	1,500	0	1,500
	Sub total	35,518	9,714	16,244	15,560	0	41,518
	Grand Total	164,868	75,626	48,609	43,801	2,832	170,868

Source: JICA Study Team

(4) O&M Costs

The operation and maintenance (O&M) costs for the proposed projects are estimated based on the measures summarized in Table 7-4-4. In addition, the O&M costs for existing arterial roads in Karachi City are also estimated.

Table 7-4-4 Measures for O&M Cost Estimations

Road Facility	Measure of Estimation
Road (at-grade section)	3% of initial cost
Existing Roads	Refer to unit price for 4 lane roads 3% of total length/year
Overpass/Bridge	1% of initial cost
Signal (including existing signals)	3% of initial cost
Pedestrian Bridge (Including existing bridges)	1% of initial cost
Parking	3% of initial cost

Source: JICA Study Team

Total annual O&M costs in 2030, when most proposed projects will be completed, is Rs. 4,933 million. Total O&M during the planning period is Rs. 76,901 million.

Table 7-4-5 O&M Cost Estimation

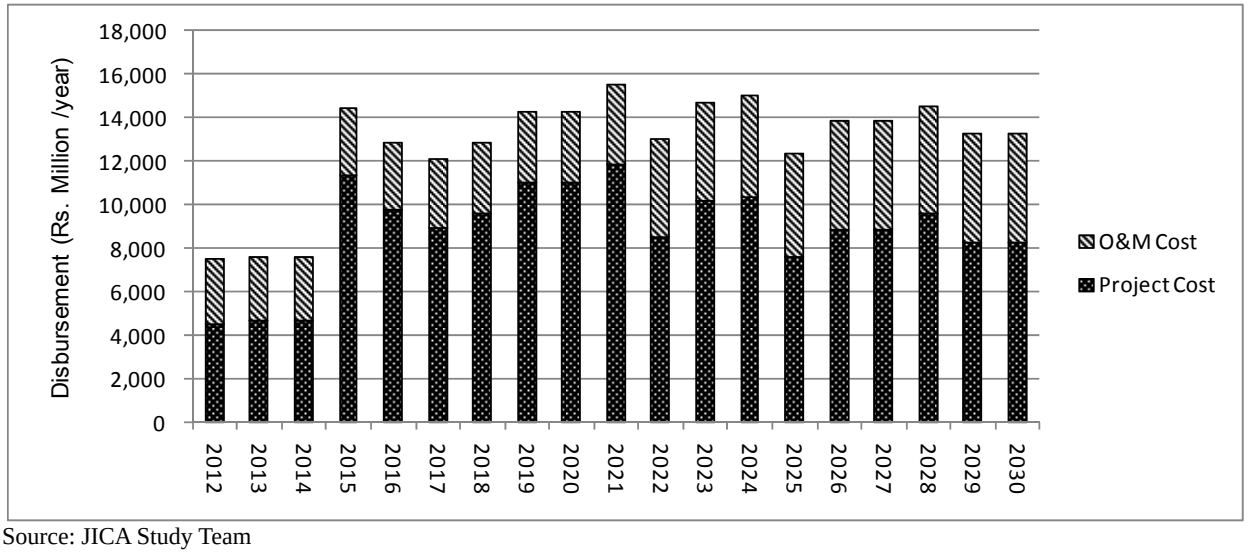
(Unit: Rs. Million)

	Annual (2030)	Short (2011-2020)	Middle (2021-2025)	Long (2026-2030)	Total
Roads (including existing arterial roads)	4,753	30,347	20,712	23,538	74,597
Signals + Parking (including existing signals)	149	480	736	743	1,959
Pedestrian Bridges (including existing bridges)	31	60	130	155	345
Total	4,933	30,887	21,578	24,436	76,901

Source: JICA Study Team

(5) Annual Disbursement for Road Related Projects

Figure 7-4-1 shows the annual disbursement for road related project. The O&M cost will increase year by year reflecting the increase in road network scale in Karachi, and the ratio of O&M cost of total disbursement will be around 40%.



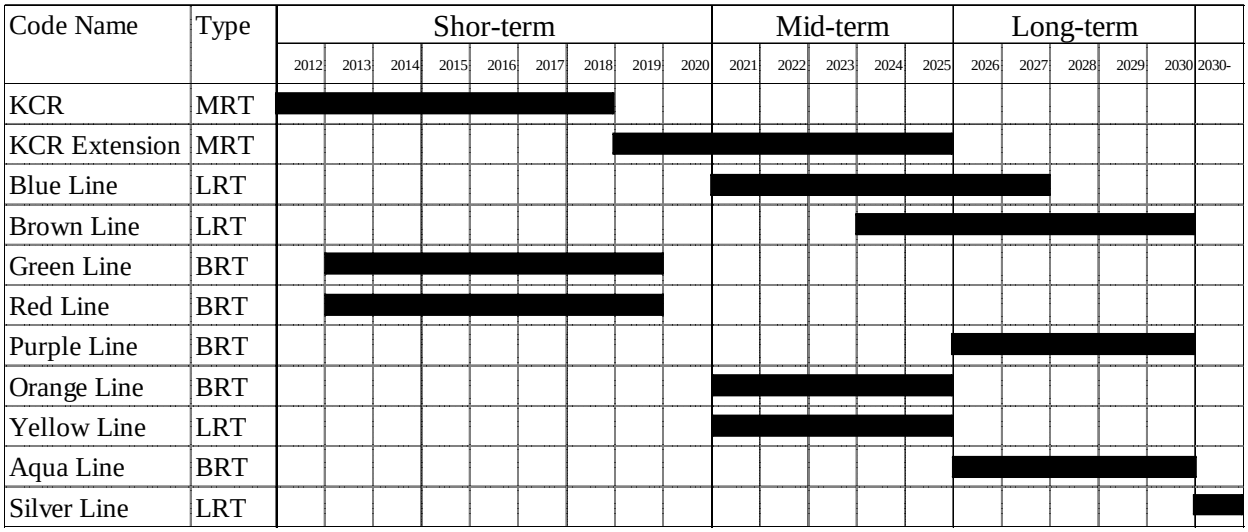
Source: JICA Study Team

Figure 7-4-1 Annual Disbursement for Road Related Projects

7.4.2 Public Transport and Intermodal Facilities

(1) Schedule of Mass Transit Development

Figure 7-4-2 shows the proposed schedule of mass transit lines in KUTMP 2030. It is assumed that a rail-base project takes seven years to be implemented while a BRT project takes five years.

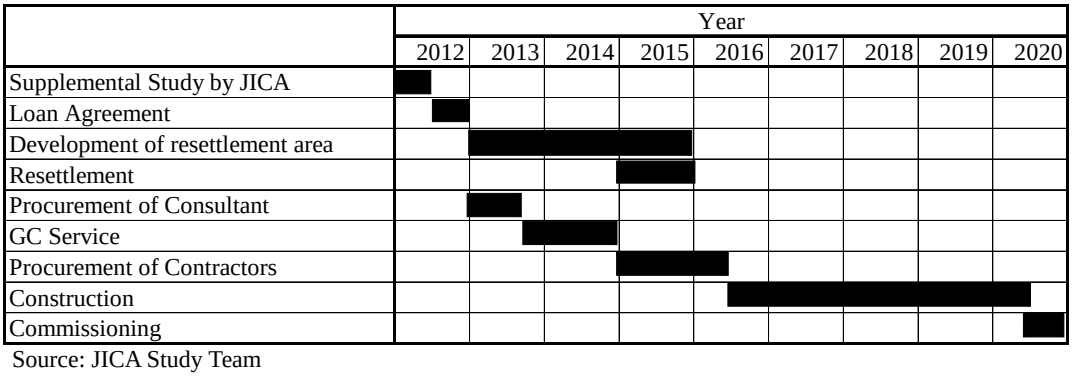


Source: JICA Study Team

Figure 7-4-2 Master Plan Schedule (Mass Transit Projects)

(2) KCR (Karachi Circular Railway)

Implementation plan of KCR was prepared in the SAPROF Study (May 2009, JICA) in which total project period was estimated as seven years from 2010. The start of the project has been delayed due to the social environmental issue and power supply issue. On the other hand, land acquisition for the project has been completed, according to KUTC. The KCR project requires a large scale of resettlement of illegal occupancies along Pakistan Railways' land. The SAPROF Study estimated that the total number of households to be resettled would be approximately 2,500, and it is necessary to prepare the residential area for those who need to move out from the right-of-way. The project will start in 2013 with procurement of the consultant for General Consultant (GC) service. The construction will take four years and KCR will open in 2021.

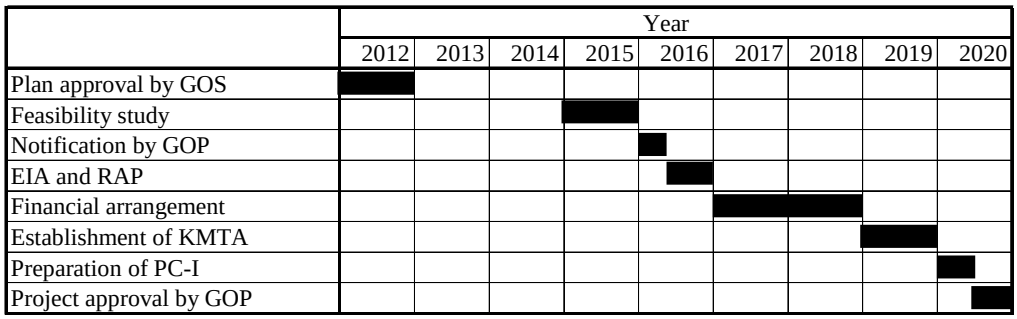


Source: JICA Study Team

Figure 7-4-3 Project Implementation Schedule – KCR

(3) Railway Development

Blue Line and Brown Line are mid-term and long-term project, respectively. In short-term, feasibility studies and EIA should be carried out and the plan should be approved by the authorities. Institutional arrangement in short-term is also necessary for the implementation of the projects. The project should be approved by PDWP, CDWP, ECNEC, and EAD. For the implementation of Blue Line and Brown Line, establishment of Karachi Mass Transit Authority (KMTA) is proposed (Chapter 8).

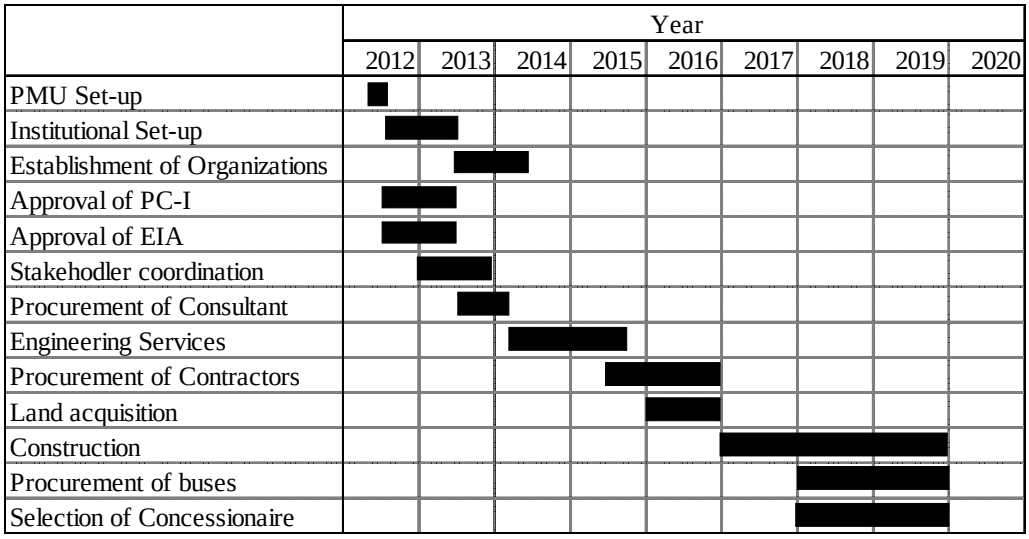


Source: JICA Study Team

Figure 7-4-4 Project Implementation Schedule – Blue Line & Brown Line

(4) BRT (Green Line & Red Line)

In case of BRT, design and construction do not take time compared with railway system. Instead, it is necessary to evaluate traffic impact on roads and stakeholder coordination is very important. It is proposed to establish a Project Management Unit (PMU) for the BRT project. KMTC will be the core of the PMU, but it should be under the strong leadership such as the governor. PMU should be responsible for the environmental management and monitoring based on the approved EIA.



Source: JICA Study Team

Figure 7-4-5 Project Implementation Schedule –BRT

Chapter 8 Implementation Framework for Mass Transit Development

8.1 Implementation Schemes of Operation & Maintenance

This section describes the most common approaches to implement the Operation & Maintenance (O&M) of a mass transit system. For purposes of easy understanding, and as different operation schemes could have in turn different maintenances approaches, the description is done separately for the operation and maintenance aspects of the functions of an owner/operator.

This section is further subdivided into 3 subsections that first describe the most common schemes, then evaluate them, and finally propose the most suitable scheme for the mass transit development in the master plan.

It should be worth mentioned that like the most appropriate funding/implementation scheme (PPP), the final and most suitable O&M scheme will be only known after a full-blown feasibility study is completed, where a detailed cash-flow analysis is available to make the proper decision. Therefore, the recommendations presented herewith are based on assumptions of how a plausible PPP scheme will be implemented, and on previous experiences on O&M schemes in other Asian countries.

8.1.1 Alternative Operation & Maintenance (O&M) Schemes

(1) The Owner/Agency

Karachi Mass Transit Cell (KMTC) has not been empowered to operate a mass transit system. The operating organization will be newly established outside the existing Government agencies and supported by GOS and CDGK so that no other Ministry or local Government will directly execute operation.

This section describes organization plan of Karachi Mass Transit Authority (KMTA) in terms of its positioning, role and responsibility as Regulatory/Operator & Implementing Agency of the mass transit system, and indicate those responsibilities and tasks that could be given in concession according to the type of PPP scheme, if any, adopted during the implementation of the mass transit system.

Table 8-1-1 shows the list of tasks KMTA is responsible for the service operation and maintenance. This is the key to which tasks an individual party can access, review, handle and ultimately how a task is routed and approved.

Table 8-1-1 KMTA Tasks and Duties

No.	Task Category	Description of the Task Category
I.	Management	To formulate policies, prescribe and promulgate the rules and regulations for the attainment of the objectives of the Authority Implements, enforces, and applies the policies, plans, standards, guidelines, procedures, decisions, rules and regulations issues, legal affairs, and public relations.
II.	Administration	The administration-related departments and section shall advise and assist the Management in the formulation and implementation of rules and regulations necessary to carry out the objectives and policies of the authority concerning administrative, finance, accounting, budget, human resources, etc.
III.	Operation	To ensure the safe, reliable and efficient operating of the railway and satisfactory service to the passengers on a day-to-day basis.

No.	Task Category	Description of the Task Category
IV.	Maintenance	To perform the daily and the long term planning and execution of scheduled and unscheduled, preventive and corrective maintenance actions to ensure overall systems are ready for required operation at all times.
V.	Engineering & Construction	Advise and assist the Management in the formulation and implementation of rules and regulation necessary to carry out the objectives and policies of the KMTA concerning engineering. Monitor and be counterpart of Consultants and supervise Contractors.

Source: KTIP

Among the tasks and duties mentioned in Table 8-1-1 above, the Operations (III) and Maintenance (IV) are the tasks that could be given in concession to a private party in case such party has entered into a PPP with KMTA and requires return on investment.

(2) Operation Approach

The railway businesses, in general, since its expansion of the industry in 19th century, have been developing from the railway core operations with its strong expertise on the railway engineering as well as the operational supervision, evaluation, management and control activities, then dealing with travel comfort and pleasure, safety and security, environment, and further onto the IT based ticketing, fare collection and settlement system serving also as a managerial information tool. This can be illustrated as the vertical and horizontal integration process of a railway institution.

The railway industry around the world, however, has been introducing re-organizing or re-shaping to introduce a more effective operations and a clear responsibilities among different types of operations. Some auxiliary services such as the rolling stock and station clean-up, station security, ticketing, IT services are outsourced. Holding company options have been used when a railway has a few lines and/or its business has a wide range of activities.

Those vertical and horizontal disintegrations are considered as a way to make clear the responsibilities of each activity and at the same time to aim more effective operations. One should note as the key feature in those cases that the railway companies always keep their main operations and their management under their direct control and thus they maintain their institutional capacity within the organization.

Furthermore, air and shipping transportation industries where companies operate in a very competitive market, they have been introducing outsourcing some of the activities to dedicated service companies. Some cases are found in airplane cabin or vessel crew on board, security staff, IT development staff is dispatched under the outsourcing contracts.

Given the above future operation modality, possible type of contract would be, i) Operation and Maintenance Concession under PPP Net Cost Scheme, ii) Operation and Maintenance Concession under PPP Gross Cost Scheme, iii) Direct Operation and Contracting Maintenance, iv) Direct Operation and Direct Maintenance, and v) Direct Operations with Contractual and Outsourcing as illustrated in the following table. It should be noted that the most suitable mode of contract for O&M would be defined more certainly during the feasibility study stage. Table 8-1-2 describes these types of contracts.

For purposes of convention, in the Table 8-1-2 the *Government* is the Public party of the PPP, and *Concessionaire* to the Private party of the PPP scheme.

Table 8-1-2 Type of Contract

Type of Contract	Definition
Concession O&M (PPP Net Cost)	The government manages civil infrastructure delivery using private sector contractors; government engages the private sector to provide electrical and mechanical (E&M) assets and trains and to undertake operation and maintenance (O&M) through a concession; The government leases civil infrastructure to the concessionaire; The government sets safety standards and fare structure; The concessionaire determines services to be provided and retains fare and other revenue, in which; and additional payments may need to be made by the government to the concessionaire to cover revenue shortfall, or the reverse if revenue exceeds costs; This type is applicable when using PPP scheme such as BOT for E&M portion and BLT for infrastructure.
Concession O&M (PPP Gross Cost)	The government manages civil infrastructure delivery using private sector contractors; The government engages the private sector to provide E&M and trains and to undertake O&M through a concession; government sets safety and service standards, service levels, and fare structure and level; The government pays the concessionaire an amount equal to the costs the concessionaire incurs in providing agreed services as established through a competitive, quality-based tender; and The government retains all fare revenue; Same as above, this type is applicable when using PPP scheme such as BOT for E&M portion and BLT for infrastructure.
Direct O & Contract M	The government manages civil infrastructure and E&M systems using private sector contractors; The government engages in overall operation activities by their own staffing; The government contracts with external entity to provide maintenance services; This type is applicable when using ODA or own funds to finance the project and outsourcing maintenance.
Direct O&M	The government manages civil infrastructure and E&M systems using private sector contractors; The government engages in overall operation and maintenance activities by their own staffing; This type is applicable when using ODA or own funds to finance the project and direct maintenance by Government.
Direct Operations with Contractual and Outsourcing	The government manages civil infrastructure and E&M systems using private sector contractors; The government engages in overall operation activities by their own staffing for core operations but some non-core operations are contracted out or outsourced; The government contracts with external entity to provide maintenance and other railway related services; This type is applicable when using ODA or own funds to finance the project and outsourcing some operation (non-core) and maintenance tasks.

Source: Prepared by the JICA Study Team

(3) Maintenance Schemes

1) General

Maintenance management is a concept which integrates all the activities of maintaining and controlling rolling stock and other facilities ranging from commissioning to heavy repair.

In order to maximize the effectiveness and productivity of the system as a whole, a planned but also corrective maintenance policy is required. The primary aim is the prevention of faults that arise with a view to restoring the items concerned to their former condition as quickly as possible at any time. Maintenance involves carrying out the functions of inspection, servicing and repair.

To achieve optimum efficiency of maintenance efforts, maintenance philosophy and planning should not only consider the previous and present condition of the items concerned, but also their future expectancy and life cycle and the economic aspects of maintenance. Early failures, unexpected failures and failures due to wear and tear can also occur within the life cycle of any individual component. Each of the above problems must be approached in a different manner.

The **Maintenance Philosophy** for the mass transit system in Karachi must therefore not only provide for preventive maintenance, but also for predictive maintenance and to a certain extent trouble-shooting maintenance in respect of specific items. The aim will be that the operation of the rolling stock and other facilities provided, will be safe and the service and maintenance of all facilities and rolling stock will be carried out accurately so as to extend their life to a point economically and physically justified.

This section describes the general maintenance alternative schemes available for the mass transit system. There are, however, only two basic schemes for maintenance, to wit:

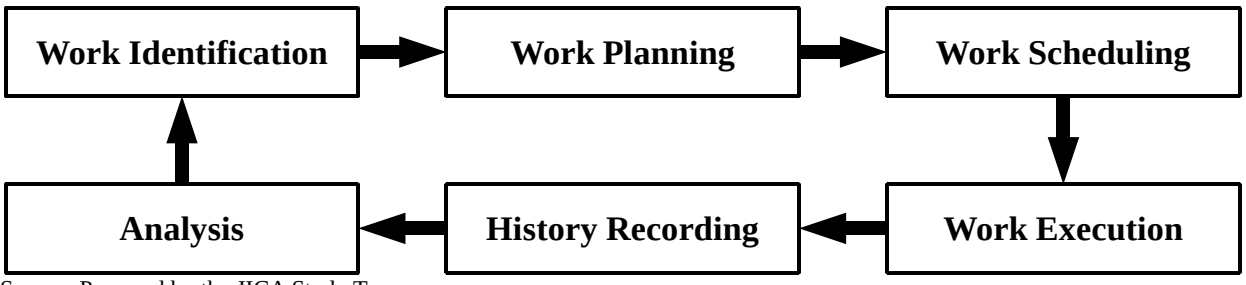
- Direct Maintenance (by Owner/Operator)
- Outsource Maintenance (by third party contractor)

As its name indicates, Direct Maintenance is the scheme where the Owner/Operator carries out the maintenance activities with an in-house work force. This scheme is self-explained, and does not require further elaborate description. Outsourced maintenance, on the other hand, has different options for the degree and tasks to be outsourced. The section below describes those options.

2) Maintenance Outsourcing Schemes

An important consideration in making the maintenance outsourcing decision is what aspects of maintenance to outsource. If we consider the maintenance management process as consisting of six major steps, as shown in Figure 8-1-1, then a number of options exist.

World Class Maintenance Management System



Source: Prepared by the JICA Study Team

Figure 8-1-1 Maintenance Task Work Flow

In the first instance, organizations may choose simply to outsource the work execution step, while retaining the remaining steps in-house. This is often done on a limited basis, for example, when employing contractors to supplement an in-house work force during times of high workload. This is the minimalist approach to outsourcing.

An alternative approach is to outsource all of the above activities with the exception of the analysis and work identification steps. In this approach, the contractor is permitted to plan and schedule his own work, and decide ***how*** and ***when*** work is to be done, but the outsourcing organization retains control over ***what*** is to be done.

A third approach is to outsource all of the above steps, thus giving control over the development of equipment maintenance strategies (i.e. Preventive and Predictive Maintenance programs) to the contractor. In this instance, the contract must be structured around the achievement of desired outcomes in terms of equipment performance, with the contractor being given latitude to achieve this to the best of his ability. There are advantages and disadvantages to each approach, and the most appropriate approach will depend on the client's particular situation.

Accordingly, outsourcing needs to be well targeted and framed by properly worded contracts. When outsourcing railway maintenance there are two contractual strategies to follow: i) functional requirements, and ii) job specific requirements. As stated in paragraphs above, variations of the two do exist and it is also possible to choose a mixture.

Contracts based on functional requirements, also known as Key Performance Indicators (KPI), are typically related, for example, to track quality, track availability, rolling stock availability, AFC availability, etc. A price for the contract is negotiated prior to the implementation of the contract, bonuses and penalties are used if performance is better, or worse than agreed upon. The time horizon for contracts could be 5 to 10 years, but also longer depending on investment.

Contracts based on job specification requirements are for example rail grinding, tamping, inspection and revision of signaling system, station equipment repair, etc. Typical time horizon is short, equal to the duration of the job.

Looking at how maintenance fits into the wider asset management strategy of an organization also raises interesting challenges.

For example, one challenge that needs to be met is how the maintenance contractors will interface with the railway operators, and the relative responsibilities and duties of each party. Many organizations today are adopting Total Productive Maintenance principles, which encourage operators to take a higher level of responsibility for equipment performance, and also encourage them to perform many minor maintenance tasks. There is also a growing realization that the manner in which equipment is operated can have a huge bearing on maintenance costs and the maintenance activities required to be performed if equipment performance targets are to be met. A high level of teamwork between the Maintenance contractors and the railway operators is, therefore, vital to the successful completion of the contract. This leads to the view that an alternative, and possibly better, approach to the outsourcing of maintenance is to include operation in the scope of the contract. Hence, the letting of Operations and Maintenance contracts.

Finally, taking things one step further again, there is also a growing realization that maintenance is limited in achieving higher equipment performance by the fundamental design of the equipment being maintained. The best that maintenance can achieve is the inherent reliability and performance of the equipment that is built in by design. There is, therefore, a school of thought that says that the best way to overcome this limitation, in an outsourcing environment, is to also give the contractor responsibility for the design of the equipment. This can be done either by giving him responsibility for ongoing equipment modifications, or by giving him responsibility for the initial design of the equipment, as in a BOOM (Build, Own, Operate and Maintain) contract, which is gaining favour in many infrastructure projects.

Accordingly, there is a trend to contract the Original Equipment Manufacturer (OEM) as Maintenance Contractor for newly implemented projects, where equipment is not well known to the owner and it is still under warranty.

8.1.2 Evaluation of O&M Schemes

(1) Operation Schemes

We do not want to fail to reiterate that, as mentioned several times before, the decision on the type of operation approach will have to be defined at a later stage, after the results of a full-blown feasibility study. In this subsection we evaluate each type of contract approach by their own merit in consideration of possible funding schemes.

1) Operation by Concession

The first two types of contracts of the five mentioned in Table 8-1-2 correspond to the appropriate contract for an implementation funding under PPP scheme. They are applicable for either a wholly private funded project under BOT or in case of a funding scheme with a Public participation by means of Viability Gap Funding (VGF). A PPP scheme with Public contribution in the capital investment is the most probable funding scheme for funding the mass transit system in Karachi. In case of a fully private investment project, the Concessionaire owns the infrastructure and the Electro Mechanical (E&M) system, and in case of a Public participation on the capital investment, the Government would own the infrastructure and leases it to the Concessionaire, while the concessionaire owns the E&M system.

The main difference between the first two schemes, the gross and net costs schemes, is who controls the revenue collection and the way of payment to the Private concessionaire. In case of the Net Cost Scheme the Concessionaire collects the revenue and pays an agreed fix amount or a percentage of the revenue to Government (the Implementing and Supervisory Agency, in our case KMTA). Although the risk of low ridership rests on the Private party in this case, the concessionaire would usually request a kind of Minimum Revenue Guarantee (MRG). In case of Gross Cost Scheme the Government retains the fare revenue, by either collecting by itself or collected by Concessionaire and then transferred completely to Agency, and pays an agreed fix amount to Concessionaire. The risk in this case is entirely on the Government side.

There are some points that are worth mentioning for both cases, to wit:

- The Net Cost Scheme puts most of the risk on concessionaire, but to make the project commercially viable the Government is usually required to provide a MRG. However, the *floor line* should be carefully defined, as if it is too high will lead to lack of encouragement by the concessionaire to improve services or keep excellent maintenance, as a possible reduction in capacity will eventually not affect greatly its profit. On the other hand, it should be some kind of protection for the concessionaire if the planned railway network assumed during forecast analysis is not completed as scheduled by the Government.
- Under the Net Cost Scheme the Owner/Government has little hand-on control regarding operation and maintenance of the system (a.k.a. *Loss of Control*), and also difficult to gain experience for its own in-house technical staff (a.k.a. *Loss of Expertise*).
- In case of Gross Cost Scheme the Owner/Government bears all the risk; there is a fix amount to be paid to Concessionaire for O&M services, where such amount if bidden out prior to the selection of the Concessionaire. Therefore, there is not need of MRG.
- The Government (Implementing Agency) has more control on the operation and

maintenance activities (supervisory control), but requires a sufficient level of technical capability to perform such supervisory control.

As we can clearly see both schemes have merits and demerits that are being weighted differently by different agencies around the world. The conditions, requirements and needs of each agency or government will rule the decision on the best appropriate contract scheme.

Each type of contract could be tailored to the needs of the Government and the project situation by incorporating specific clauses to address some issues mentioned above. For example, loss of control and expertise can be addressed by a tight requirement of performance supervision by the Owner to Concessionaire and approved training throughout the concession period to the in-house staff, respectively.

Bangkok Sample Case

The Blue Line of MRT (Mass Rapid Transit), sometimes referred to as the Bangkok Metro, is Bangkok's underground metro system. It was constructed under a concession concept. Most civil infrastructure were provided by the government sector, Mass Rapid Transit Authority of Thailand (MRTA), and handed over to their concessionaire under a 25-year concession agreement. Bangkok Metro Company Limited (BMCL) is the only private sector company that won a bid in MRTA's concession contract for the blue line. As MRTA's concessionaire, BMCL provides E&M equipment for the subway project and fully operates the system. To maintain the system, BMCL has subcontracted Siemens, which was the Original Equipment Manufacturer (OEM) for the system, to a 10 years maintenance contract.

MRTA has developed its activities and operations, different from what its management originally had wished, as a supervising agency managing project on the basis of operation contracts with the concessionaires starting with the current Blue Line under the so-called "Net cost concession scheme" basis. Under this "net-cost scheme" the concessionaire assumes full responsibilities in operating the railway and MRTA simply receives the fee that has created the feeling and atmosphere within the authority to get closer the "practical" operations.

Thus, MRTA is planning to bid out the concession of future lines under the so-called "Gross Cost Concession Scheme" where MRTA will directly collect passenger fare whereas the concessionaire will stay an operator receiving technical fee for the operations. MRTA will be more responsible for the railway operations but its role still stays as "supervision, monitoring and control" of the concessionaire. MRTA still stay "indirectly" responsible for the railway operations.[1]

There seems to have several reasons for the change in contract scheme, to wit:

- Thai government wishes to have direct control over the fare structure and fare level for public good, by taking overall responsibilities for market risk associated with low patronage.
- No private entities are likely to become the concessionaire for new line if Net Cost Scheme continues to be used, since the Blue Line experience revealed business under the existing scheme is rather unprofitable.
- MRTA has a strong wish to improve indirect and remote management circumstances and get closer to the system operation and maintenance for their technical capacity building.
- MRTA is expected to become a center of mass transit technology and eventually contribute to partial localization of system manufacturing or spare parts production in a long-term.

[1] *JICA SAPI for Mass Transit Development of Bangkok, 2010*

2) Direct Operation by Owner

The last three types of contracts of the five mentioned in Table 8-1-1 correspond to a project implementation funded by Government's funds, either by ODA or other direct funding schemes. Albeit there is no contribution from Private sector on the project capital funding, except for Direct O&M by the Government, these schemes are also considered as PPP schemes as Private participation is still included in the operation and/or maintenance of the system, conveying some of the risks to the Private sector.

All these cases the government, using own funds, contracts private contractors to build the infrastructure and E&M systems. The difference among them is the outsourcing of operations or maintenance. The case of maintenance outsourcing is evaluated in detail in subsequent subsections.

If Government has good financial condition this scheme could be applied, but the world trend is to include the participation of private sector to reduce the financial burden of the State, which could use those resources in other more urgent matters.

(2) Maintenance Schemes

1) Benefits

First of all, the advantages of outsourcing the railway maintenance works over in-house maintenance are enumerated below. Companies surveyed in the UK indicated that the main benefits were reported to be[2]:

- Reduction the cost of obtaining the service 78%
- Reduction in the headcount of the organization 65%
- Increased flexibility of the business enterprise 61%

Very often not only the potential economical savings are identified as the main reason, but there are also other potential advantages that could defend a decision to outsource one or more activities:

- Outsourcing enables budget flexibility allowing operators to pay for only the services that are needed and when they are needed.
- Using a contractor to focus 100 percent on a particular area lets the Owner/Operator better manage existing assets, and focus in-house resources on core functions
- A trend toward outsourcing maintenance and adopting asset management applications is helping operators make the improvements which are crucial to keeping a railway system up and running, and keeping costs down.
- Warehousing and supply chain management will improve. Procurement of needed spare parts and equipment will be faster by employing technical experts doing the canvassing, evaluating, and testing up to acceptance of delivered spare parts.
- Less red tape or bureaucratic procedures. If maintenance is under the government, it always requires government ruling such as Commission on Audit, Government Procurement Act, etc. to carry out purchases of spare parts.
- Standby funds always available.
- It also reduces the need to hire and train specialized staff by the government operator, bringing in engineering expertise from the outside, and reduces capital expense, yielding better control of operating costs. Salary is attractive to acquire/hire qualified personnel

[2] *An Overview to Outsourcing – Trends and Different Options. SINTEF, Norway, Nov. 2003*

(engineers. technicians, consultants, etc.).

- Unique technical expertise of the contractor, Improved quality of work and access to skilled personnel
- Reduced risk

Nevertheless, one of the main reasons to resort to outsource the railway maintenance activities in case of a newly built railway system, in a country with no previous experience on mass transit railway systems, is the limited in-house resources, lack of equipment and expertise.

Secondly, as mentioned in previous subsection, the level of outsourcing, i.e., *How much maintenance to be outsourced?*, can vary, having advantages and disadvantages to each approach, and the most appropriate approach will depend on the client's particular situation.

Needless to say, the degree of involvement of the Owner/Operator in maintenance activities will depend greatly on the technical capability of its in-house work force.

In case of experienced and well established Operator around the world, when an outsourcing scheme is applied, they usually keep control ***what*** and ***when***. However, in case of newly formed Operator or Owner/Agency, the approach would be to outsource all activities under an equipment performance type of contract (functional requirements or KPI).

2) Pitfalls and Concerns

In the previous sections we discussed potential benefits that could be the result of an outsourcing strategy. However, there is no guarantee that these benefits are achieved, and there could be also negative effects of the outsourcing:

- Loss of control
- Loss of expertise
- Taxes
- Contractor is not capable for doing the job

Loss of control

When work is outsourced to a contractor, the Owner/Operator transfers control over the activity that is outsourced to the contractor. To some extent, the Owner/Operator can assure against this by conducting audits to the contractor, but full control is almost impossible to obtain. The overall responsibility will be placed at the Owner/Operator, at least in the view of the public/customers.

Loss of expertise

A negative effect of outsourcing is often that the customer loses important knowledge, competence and expertise within the area that is being outsourced, or in case or a newly formed operator, they fail to gain suitable experience, remaining clueless of the maintenance procedures and skills.

"Loss" in here is applicable to existing experienced Owner/Operator "losing" expertise and control, but in case of a new Owner/Operator means losing possibility to acquire such expertise and control.

8.1.3 Proposed O&M Scheme

This subsection introduces our proposed O&M scheme, which is a general description of the most appropriate scheme suitable to the most probable funding scheme. We first suggest the outline of the responsibilities to be addressed by and between the Government and KMTA.

It should be again stressed the importance of setting up on time KMTA, which was described in Subsection 8.1.6. The rationale of the organization of KMTA is then described in basic terms at this time.

Finally, the most appropriate and possible operational and maintenance scheme is recommended for the mass transit system in Karachi. This scheme will be confirmed with later evaluation of the entire Karachi railway network, and it shall be further developed on a more detailed description in terms of organizational structure and maintenance plan.

(1) Share of Responsibility at Government Level

National Government (GOP) and local Government (GOS) will cooperate and develop the mass transit system in Karachi. The KMTA should be established as an implementing agency and it should also play a regulator/supervisor role. To enable faster decision-making and disciplined project execution, the KMTA should have a certain degree of autonomy. Since the mass transit system in Karachi will be Pakistan's first urban modern MRT system, the Government must establish a regulatory system to monitor security, safety, and other key KMTA performance indices.

One-window decision-making is critical throughout the project. This integrated responsibility and authority would help to achieve a well-integrated MRT system, and effectively control the project costs and schedule. For these reasons, the MRTC must be involved from the Engineering Service (E/S) phase.

KMTA should be responsible to all activities starting from the Engineering Service, Construction through Operations and Maintenance.

(2) Operation & Maintenance Proposal

1) Organization Rationale of KMTA

Consistency of responsibility and autonomy will facilitate integration of the Operation and Maintenance (O&M) perspective into system design, which will reduce lifecycle costs and achieve long-term sustainability. Such a system would also make it possible to identify future KMTA leaders (technical managers required for the O&M phase) during the E/S and construction phases. Early identification of future leaders will lead to early capability-building activities in the organization, as they develop competency and acquire a holistic understanding of the integrated systems.

The KMTA organization has started with a core team, and it will gradually evolve into its full form before start of the O&M phase. With the KMTA in charge of all phases, the engineers, supervisors, technicians, and operators (required for O&M phase) can be trained during the construction phase by the system contractors and OEMs to equip them with necessary knowledge and skills to handle supervisory tasks for the O&M activities effectively. The technical training should be done by visiting successful cases overseas and by inviting contractors and OEMs to Karachi. There should also be independent training on management and operational skill development, such as financial and business planning, maintenance auditing and service operations and general problem-solving.

All successful overseas metro systems, such as the Tokyo and Delhi Metros, share four key principles in their organizational design:

- The rail business unit is designed as a function-based organization. This is necessary to achieve the required level of competency in each railway system function, which needs to have specialized functional areas.
- The non-rail business unit (non-core) is designed differently from the rail business unit (core). This is important because the culture, skills, recruitment process, and business unit basis differ for the two businesses. Railway businesses require rigid adherence to technical standards to ensure safety and achieve specific operating standards, while

non-rail businesses need creativity and flexibility to enhance non-fare box revenue.

- All decision-making authority is delegated to the board. Complete empowerment of the KMTA board of directors can achieve transparent corporate governance, faster decision-making, and rapid project implementation.
- An internal independent safety monitoring unit. This is important for controlling the system's safety and security by monitoring daily O&M activities. Since an MRT system involves running trains through narrow passages with a high density passenger load, it is critical to ensure safe and secure operations.

2) Proposal Operation & Maintenance Scheme

Given a proper setting of KMTA as mentioned above, KMTA should engage in the task of implementing the mass transit system in Karachi.

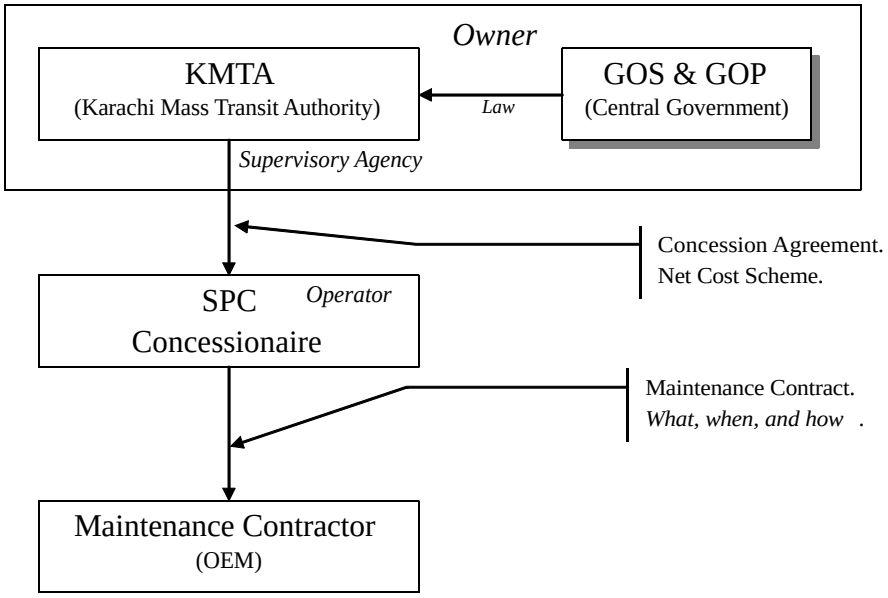
The Study Team, taking in consideration all available information, site conditions, potential technical and financial capabilities of future KMTA, is suggesting the following O&M scheme for the first line of the mass transit system in Karachi:

- The suitable funding scheme, as described in Subsection 8.2, is a PPP based on a BOT scheme, with Public sector participation as a form of VGF for funding the infrastructure of the system (Civil Works)
- KMTA shall give in concession the infrastructure of the line
- KMTA and Concessionaire shall enter on a BOT Agreement under the Net Cost Scheme mode for a period to be defined by both parties for the operation of the system
- The Concessionaire/Operator shall outsource the maintenance activities, preferably to a contractor closely linked or associated to the main OEM (Rolling Stock)

The reasons to choose this scheme are summarized below:

- The limitations in the National and State Budgets to be used in the implantation of a mega project such as the mass transit system in Karachi. Thus, it is required the participation of the Private Sector on a PPP mode to ease the fiscal budget constrains.
- Up to date, the implementing and supervisory agency KMTA has not yet being established. Then, it is not baseless to say that the required technical level of knowledge and capability to have a direct control of the O&M activities would not be achieved by its in-house staff by the time of the opening for revenue of the first line. Thus, the most appropriate mode of implementing the O&M activities, at least for the first few years, is to give most of the responsibility and risks to the Concessionaire, i.e., a Net Cost Scheme.
- Due also to the complexity and difficulty of the maintenance of the E&M systems, and the condition of having a Warranty period in effect right after the opening for commercial revenue, it is highly recommendable to subcontract (outsource) all maintenance activities to a well experienced and capable contractor, preferable to the rolling stock OEM, as it is one of the critical and more complex railway subsystems that should be properly maintained.

Accordingly, all parties (the Owner, Operator, and Maintenance Contractor) should adopt the concept of fully integrated teams. A detailed description of the organizational structure of each party will be developed at a later stage. The recommended functional organization structure is shown in Figure 8-1-2.



Source: KTIP

Figure 8-1-2 Functional Organization Structure for O&M Maintenance Scheme

The following measures should be taken in consideration to avoid the issues seen in other railway systems as the mentioned samples herein.

- It is important that the Owner/Operator be able to have some hands-on over the maintenance process in order to keep the growth of the capacity building of the in-house workforce at all levels, especially the technician level.
- Although in the beginning all works should be assigned to the Maintenance Contractor, eventually, KMTA would desire to have more control and expertise throughout Capacity Building programs over the years in order to reach a level where the ***what*** and ***when*** are controlled by the Owner/Operator.
- Approved training programs should be carried out periodically to the benefit of the KMTA's in-house technical staff in all related activities of the O&M of the system.

Eventually, KMTA should be able to take more responsibilities, control, and risks in time for the implementation of new railway lines that will increase the network in Karachi, and also in time when the Concession Agreement for the first line expires, and KMTA would have to take control.

8.2 Legal and Institutional Framework

8.2.1 Overview

In the post devolution period, City District Government Karachi (CDGK) became responsible for urban transport and the subject of mass transit was also transferred from the Provincial Government. Under the current set up of CDGK responsibilities for mass transit, public transport management & operation, traffic control and parking management and road works & maintenance are shared by the three departments: Karachi Mass Transit Cell (KMTC), Transport & Communication Department (TCD) and Work & Service Department. In addition to CDGK, there are agencies and authorities dealing with traffic and public transport issues: DIG (Deputy Inspector General) Traffic Karachi, for example, is responsible for traffic control and enforcement. At the provincial level Transport Department, Government of Sindh (GOS), has set up two authorities for public transport: Provincial Transport Authority (PTA) and District Regional Transport Authority (DRTA). The role of PTA is to look after public transport

matter related to intercity transport. DRTA look the matter of CDGK/Karachi City public transport issues. Furthermore, PTA, having its own board chaired by Secretary Transport, GOS issues permits and renews them. It also formulates and regulates the intercity transport policy. DRTA is a part of Regional Transport Authority (RTA) and it also constituted its board chaired by District Coordination Officer (DCO) and others relevant department members allocates different routes, issues different routes permits and renews them. There is no MRT in Karachi except Karachi Circular Rail (KCR) which is out of commission for several years. Subsequent to the Devolution Laws KMTC took over in 2003 the concession process of Karachi LRT System planned along Corridor-1 on a concession basis. The Project Implementation on Corridor-1 was part of the Master Plan for Karachi Mass Transit System notified by Ministry of Communications in 1995. All efforts to implement LRT in Karachi on a concession/BOT basis have not been successful and the reasons for the failure were identified and analyzed in the Progress report. After a decade of unsuccessful LRT attempt KMTC undertook a study on environmentally friendly public transport system for Karachi based on the Public-Private Partnership (PPP). The study recommended a Bus Rapid Transit (BRT) network of 140 km of exclusive corridors. In line with the findings and recommendations of the KMTC's study the GOP has agreed to provide Rs. 2.5 billion subsidies for the induction of 4,000 CNG dedicated buses during next 5 years. The first phase of this project would have been kicked off with 500 buses by 2010 under the PPP funding arrangement. The concessionaires have been unable to secure financing and, subsequently the tender process (pre-qualification stage) has been aborted. Meanwhile, CDGK/TCD has initiated CNG bus operations which are a successful pilot project but the project sustainability is questionable.

8.2.2 Issues and Problems

Despite of the time and money spent by GOP. GOS, CDGK and private sector on their efforts to implement the MRT projects on a concession or PPP basis have not produced good results and the momentum built up for the participation of private entities in social and economic development of Sindh, particularly, in mass transit system, may have faded away. There are number of obstacles, constraints and weakness remain in CDGK institutional arrangements and in order to succeed in mass transit development programs, projects and schemes GOS and CDGK have no choice but to remove the constraints like:

- Institutional Capacity Constraints;
- Human resources Constraints;
- Financial resources Constraints
- Legal Power Constraints; and
- Financial Sustainability Constraints

On top of these disadvantages City of Karachi has been affected by the national socio-economic and political conditions that resulted in the additional obstacles in attracting private capital, domestic or foreign, to the economic development activities of the City of Karachi, However, some of the obstacles listed below are beyond the control of CDGK:

- Poorly developed domestic capital market;
- Lack of access to long-term debt, domestic and international;
- Exposure to foreign currency risk;
- Absence of a credible regulatory and institutional framework at local level
- Lack of experience in PPP projects in public sector.

Nevertheless, these constraints and obstacles will remain for a quite some time and will continue to hinder the planning and implementation of mass transit systems in Karachi.

8.2.3 Institutional Arrangements

Institutional arrangements must take into account all these obstacles, constraints and the policy changes required. The quality, choice and safety of Karachi mass transit systems are poor and public acceptability of transport will only be achieved if bus services are improved and all other mass transit program including MRT is implemented to a high standard. Furthermore, to facilitate the increasing number of daily commuters in Karachi a MRT network, consisting of LRT, metro and perhaps monorail, need to be planned and developed along with a BRT network. This requires policy decisions and regulations which create incentives for the private sector to operate in the public interest. Under the current political and economic environment BRT and MRT lines are not likely be constructed in Karachi based on a conventional BOT project financing. A conventional BOT or PPP formula will not work under the socio-economic and political conditions of the country unless GOP and GOS change their policies and strategies and pull the resources and initiate the development of infrastructure required by the MRT and BRT. There is a dire need of momentum rebuilding and public and private sector confidence. Infrastructure such as rails, underpasses, and stations in case of LRT and dedicated corridors, pedestrian bridges and bus stations in case of BRT are the responsibilities of the Government not of the private sector. GOS has promulgated a Sindh Public-Private Partnership Ordinance 2009 aimed at expanding infrastructure services and improving their reliability and quality. This legislation will provide a needed legal framework for the participation of private entities in social and economic development of Sindh. The new PPP Ordinance which is the first in Pakistan would also provide required regulatory and institutional framework for the new policies of the Government. There is a need for policy changes at the highest level of GOP, GOS and CDGK in order to provide a safe, comfortable, efficient mass transit system to the city of over 16 million people at affordable fare structure as 7 million trips are being made daily by public transport which is totally inefficient. In order to restore public and private sector confidence in the Public-Private Partnership in Karachi mass transit it is imperative for the Government to take charge of land acquisition including expeditious compensation to Affected Persons (APs), arrange and process expeditiously ODA loans to finance all basic infrastructure and, if necessary, busses or rolling stocks. This will create environment to attract private sector for the operations and maintenance of the public facilities.

8.2.4 Institutional requirements

The total investment cost of KUTMP 2030 is estimated as approximately US$ 8.2 billion in total and approximately US$ 3.0 billion is proposed for the next 10 years. At least the half of the amount is expected to come from the private sector with PPP mode as one of the preferred routes. It is, therefore, important for GOS and CDGK to take initiative to create its own financial and institutional mechanisms within the existing regulatory and institutional framework and set policy objectives. The key objective of the new policy is to secure long-term loans from ODA and investments from public and private sector. Leverage local and central government funds, external assistance as well as private funds, support private investment and to create a conducive environment to utilize the efficiencies, innovativeness, flexibility and speed of the private sector to provide better infrastructure and service at an optimal cost. The Plan of action includes:

(1) Set up a transparent, consistent, efficient administrative mechanism within CDGK to create level playing field for all participants and protect interest of all stakeholders
(2) Prepare a projects list to be offered for PPP and take them forward with assistance of the GOS/PPP Unit through a transparent selection process.
(3) Putting in place an effective and efficient institutional mechanism by strengthening CDGK mass transit administration for planning and implementation of BRT projects.
(4) Provide Viability Gap Funding (VGF) where the essential projects are intrinsically unviable.
(5) Create “Karachi Mass Transit Authority (KMTA)”, a municipal transit organization set up in

CDGK to implement the policy objective and channel a long term investment of public and private agencies into Karachi mass transit projects. Or as the alternative

(6) Create "Karachi Mass Transit Corporation (KMTC)" a 30 year Public Private Partnership (see details of the KMTC organization).

8.2.5 Institutional Development Plan

Required institutional arrangements for the implementation of Karachi mass transit will be carried out in three phases over the next 20 years: Phase 1: 2015-2020, Phase II: 2020-2025 and Phase III:2025-2030. In Phase I the KCR revitalization and operation are given priority consideration in Karachi MRT system development while the establishment of efficient management unit in CDGK for BRT is also an immediate agenda. In Phase II a "Karachi Mass Transit Authority (KMTA), an CDGK economic enterprise of CDGK (Alternative A) or Karachi Mass Transit Corporation (KMTC), a 30 year Public-Private Partnership (Alternative B) will be established in order to implement the new policy objectives of CDGK and channel a long term investment of public and private agencies into Karachi mass transit project. These institutional arrangements will be further studied and tested during the next three years (2012-15) taking into account the socio-economic, and financial reality of the country.

(1) Revitalization of KCR

Karachi Circular Railway (KCR) is expected to play a key role in the Karachi transportation improvement. Present KCR was conceived in 1952 and was constructed with a smaller radius and opened to traffic in two phases: Drigh Road to Wazir Mansion in 1964, extended to Karachi City Station. It has 14 stations. 30 level crossings of which 8 have been grade separated and 30 km of route length it has 5 major and 44 minor bridges. It received patronage till mid eighties. 24 trains operated on KCR loop while 80 trains operated on the main line between Karachi and Landhi. These trains carried over six million KCR commuters per annum and Pakistan railways earned Rs. 5.5 million per annum. The fare being Rs. 3/person per trip of the entire KCR Loop (30 Km) 1990-1991 Pre-feasibility study by Japanese Railways Technical service (JARTS) recommended re-vitalization of KCR by a study commissioned by Government of Sindh for viable implementation plan for KCR revitalization (2001-2002) July 2003 federal Ministry of Railways presented revival plan to Governor of Sindh. Plan was agreed in principle. Expert Committee was formed for formulating proposals. January 2004, Chief Secretary, GOS, notified the composition of KCR Board of Directors and the summary of KCR project was approved by the Governor of Sindh and Federal Minister of Railways. DDWP approved PC-II of the Project amounting Rs.16.83 million. A corporation (KUTC) was set up on the pattern of Rail Mass Transit Hong Kong and Delhi Metro Rail Corporation (DMRC). The equity share of KUTC is held by Ministry of Railways (MOR) for 60%, GOS for 25% and CDGK for 15%. Total capital Rs.10, 000 million of which Rs. 5,462 million is the value of asset transferred from MOR to KUTC by land and existing assets of Pakistan Railway. MOR will invest Rs. 100 million. The cash investment of KUTC is, therefore, only Rs. $, 100 million, of which Rs. 2,500 million from GOS and Rs.1, 500 million from CDGK and Rs. 100 million from MOR. At the time of incorporation of KUTC funding arrangements included Municipal Bonds and /or Asset Backed Securities if KUTC, which includes GOP through MOR, GOS and CDGK in addition to GOP financing from PSDP, bilateral funding from donor countries and project financing on BOT basis. March 2005 Prime Minister opened KCR. March 2006 a feasibility study on revival of KCR was undertaken by Japan Eternal Trade Organization (JETRO). Followed by Special Assistance for Project Formation 9SAPROF) for KCR financed by Japan International Cooperation Agency (JICA) in May 2009. KCR may require a huge cash injection by GOP, GOS, CDGK and ODA. The revitalization will be undertaken in stage. but complete by 2020. The JICA "Master Plan" will further define the revitalization plan.

(2) Karachi Mass Transit Cell (KMTC)

KMTC was established under KDA in February 1987 with the responsibilities to carry out Karachi Mass Transit Study as part of the Karachi Special Development Program besides extending technical assistance to other departments on the urban transport system development and other transport infrastructure improvement programs in the City. In 1994, National Mass Transit Authority (NMTA) was established in Islamabad and the KMTC was formally transferred from the GOS to GOP. Consequent upon transfer of Mass Transit Program, KMTC was placed under the administrative counter of GOS Planning and Development Department in February 1995 and then in GOS Transport Department in July 1997 with budgetary support of Karachi Building Control Authority (defunct KDA). In pursuance of SLGO-2001 the Cell was devolved in CDGK on December 2002 to continue its functions and duties. The major functions of KMTC are:

- Prepare master plan for the development, construction, operation and maintenance of appropriate mass transit based on bus and train service;
- Seek advice and assistance for preparation and execution of any transport related plan/program and project;
- Advice/assist Government on matters relating to transport policy, transit schemes and transit ways;
- Work out details including up-dating the design, configuration and cost of the mass transit master plan and take all necessary measures for its effective and economical implementation;
- Plan and implement various transport routes structures/alignments and may take such steps as may be necessary or useful in the construction or re-construction repair, maintenance and operation of the transport or transit system;
- Arrange for provision of adequate transport facilities for all segments of the population;
- Coordinate, management, control and develop public transport, procure plants, machinery, instruments, equipment and materials required for its use;
- Seek and obtain advice and assistance from government or any agency within or outside the province for the preparation and execution of any plan, program or project, connected with its functions and purposes;
- Case studies, surveys, experiments and technical researches to be made or contribute towards the cost of any such studies, surveys, experiments or technical researches made by any other agency;
- Determine a building line along with the roads and transits ways, between which ot shall not be lawful without the consent of the department to construct or maintain any structure or make any excavation;
- Perform any other function, supplement, incidental or consequential concerning the department;
- Frame work and implementation schemes for all or any of the following:

    a) Construction, expansion, operation and development of the transport network including the mass transit system, and allied/ancillary works.
    b) Carry out research and development in the field of transportation.
    c) Undertake training of the department employees and others related personnel for capacity building and strengthening of the institution.
    d) Create general awareness of the public through seminar, workshop, media conference and other publicity measures.

KMTC has exposed to the tender process of the Corridor-1 and Corridor-2 under a BOT and Concession basis. It original mandate was to implement Karachi Mass Transit Program (1987-1991) completed with technical and financial assistance of World Bank which

recommended a 87 km transit network with six(6) priority corridors of high travel demand duly approved by GOP in 1995. KMTC took over the concession process in 2003 of Corridor-I from National Mass Transit Authority (NMTA), a defunct federal agency. The BOT ended unsuccessfully. Later on, KMTC conducted, in consultation with a private consultant, a detailed study on environmentally friendly public transport system for Karachi based on the Public-Private Partnership (PPP). The study recommended a BRT network of 140 km of exclusive corridors. Furthermore, in line with the findings and recommendations of the KMTC's study the GOP has agreed to provide Rs. 2.5 billion subsidies for induction of 4,000 CNG dedicated buses during next 5 years. The first phase of this project would have been kicked off with 500 buses by 2010 under the PPP funding arrangement. The concessionaires have been unable to secure a bank financing and, subsequently the tender process (pre-qualification stage) has been aborted. Meanwhile, TCD has initiated its own been CNG bus operations ventures which is a successful pilot project but the sustainability is doubtful.

(3) Transport & Communications Department (TCD)

TCD basically comprised of functional divisions ensuring traffic control, engineering measures, road safety, and enforcement education and parking management. More specifically, TCD is responsible to perform the following functions:

i) Planning and design of road network components conducting traffic surveys, preparation and implementation of traffic management schemes, covering geometric design and addressing air pollution controls measures.
ii) Management of offices of District Regional Transportation Authority (DRTA), Karachi funding under the Motor Vehicle Ordinance 1965 and Motor Vehicles Rules 1969. Its priority functions include public transport route classification. Issuance of road permits to public service vehicles and goods vehicles beside other responsibilities.
iii) Installation Management, Operation Maintenance of traffic signals in the jurisdiction of capital CDGK.
iv) Management and operation of inters lash intra-city bus terminals in the city.
v) Provision of traffic control devices including traffic signs, road marking and other control measures.
vi) Identification of accident black spots and implementation of counter measures including pedestrian bridges etc. in coordination with Works & Services Department, CDGK.
vii) Impart and safety education and public awareness program.

TCD financed a pilot project for the operation of CNG buses in Karachi. The project was initiated in 2009 with 50 CNG buses on two routes from Surjani to Korangi and Merewether Tower. The third route was open in 2010 between Orangi and Clifton. CDGK purchased CNG buses and developed bus terminals. Operation was outsourced to private company. Recently, concessions for the operation of three routes have been awarded to three separate private operators.

(4) Works and Services Department

Works & Services Department of CDGK is engaged in construction, repairs and maintenance of road works and associated public works such as flyover/bridges, pedestrian bridges, underpasses, electrical and mechanical works, environmental works, drainage works. It also engages in the works on behalf of TCD, KW&SB, Health, Dam and Weirs Works. Works and Services Department has prepared a summary of environment impact assessment report of corridor-IV (Shahrah-e-Faisal).

(5) Institutional Reform

The JICA Karachi Transportation Improvement Project (KTIP) envisages that Karachi mass transit systems will be consisting of the revitalized KCR, a BRT and MRT network within next 20 years. Immediate consolidation of overlapping functions of mass transit based on both bus and trail service. Merger and consolidation of KMTC and CDGK Policy, Planning Design & Mass Transit Division shall be the first step. With a strengthened policy, planning and coordination unit for mass transit CDGK will be able to set up dedicated BRT management. Under the authority of the highest decision maker of CDGK (the City Nazim) the new units will plan and implemented a BRT with clear directives and budget. The fund required for the BRT will be much smaller than MRT and infrastructure development, including exclusive corridors, stations and pedestrian bridges will be constructed by the Works and Services Department utilizing bilateral and/or multilateral aid. CDGK will be responsible for land acquisition and compensation of APs. ODA will fund CNG busses and private sector will operate and maintain the BRT. If CDGK and ODA agree to finance infrastructure and busses the Private Sector can concentrate on the operations and maintenance. PPP contractual arrangement TCD remains responsible for Traffic Control & Operation, Public Transport Management & Operation, Road Safety Education, Parking Management & Control and Works and Services will be responsible for construction of infrastructure and stations. The new KMTC will be responsible for planning and design of Mass Transit working close cooperation with GOS PP Unit and KCR and other stakeholders. CDGK will take initiative to manage and operate urban transportation for Karachi and complete the BRT network in the first 5 years. The CDGK's expanded Mass Transit Cell or Division start plan MRT in cooperation with KCR and GOS PPP Unit and new institutional arrangements for MRT and BRT management and operations. The BRT operations are extremely important and useful in terms of public education to become responsible commuter rail passengers. Parallel to the above activities CDGK through a special unit/cell created as a result of the merger and consolidation of management skills and know how in bus operation start planning, design of BRT corridors, stations and associated facilities such as maintenance and repair shops and pedestrian bridges. KMTC and CDGK BRT Division will prepare a concession agreement in consultation with GOS/PPP Unit and manage entire tender process.

(6) Strengthening of CDGK Mass Transit Administration

As evident from the above, weaknesses in CDGK's institutional arrangements for mass transit are:

i) Absence of overall lead body invested with the legal powers for establishing and implementing transport policy;
ii) Lack of co-ordination between departments and agencies involved in mass transit and inadequate legislation to ensure coordination, and
iii) Insufficient resources, both human and financial allocated to mass transit

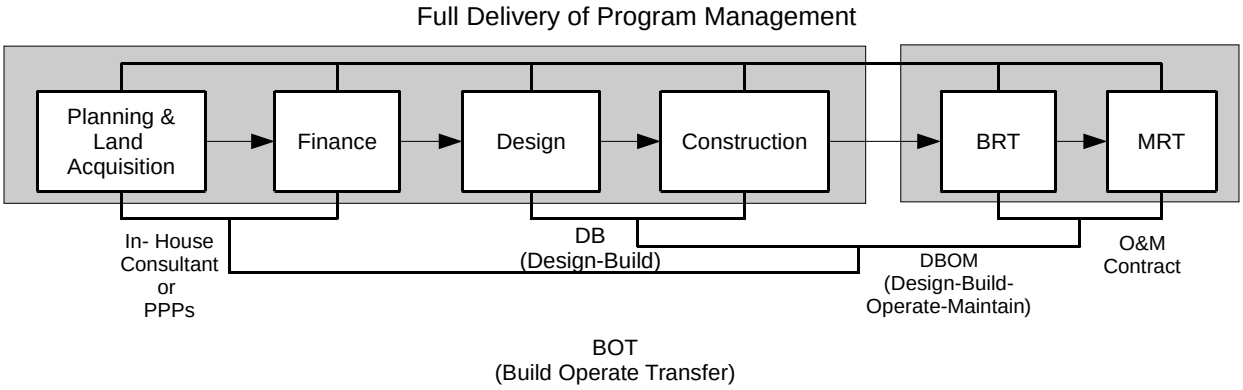
As stated earlier that the responsibilities for mass transit, public transport and traffic management, urban infrastructure development are shared among three departments of CDGK: Karachi Mass Transit Cell (KMTC), Transport & Communications Department (TCD), and Works & Services Department. There are duplication and overlapping of duties and responsibilities amongst these departments. Cases in point, KMTC and a TCD Mass Transit Division/Unit. It is necessary to pull together human resources in order to build a required institutional capacity. KMTC's TOR have a comprehensive coverage, and enable KMTC to undertake duties and responsibilities of a mass transit administration. Furthermore, with an appropriate legal power, i.e. power of granting concession, it is a legitimate institution to implement mass transit system on a PPP basis. For the BRT implementation the expanded KMTC by the merger with TCD mass transit unit will be able to serve as a grantor of concession and administer required tender process and concession agreement. The desired institutional structure of the new KMTC and its transformation to a new Karachi Mass Transit

Authority (KMTA) will be dealt in the final report of the JICA study.

8.2.6 Institutional Arrangements for the Implementation of Mass Transit System

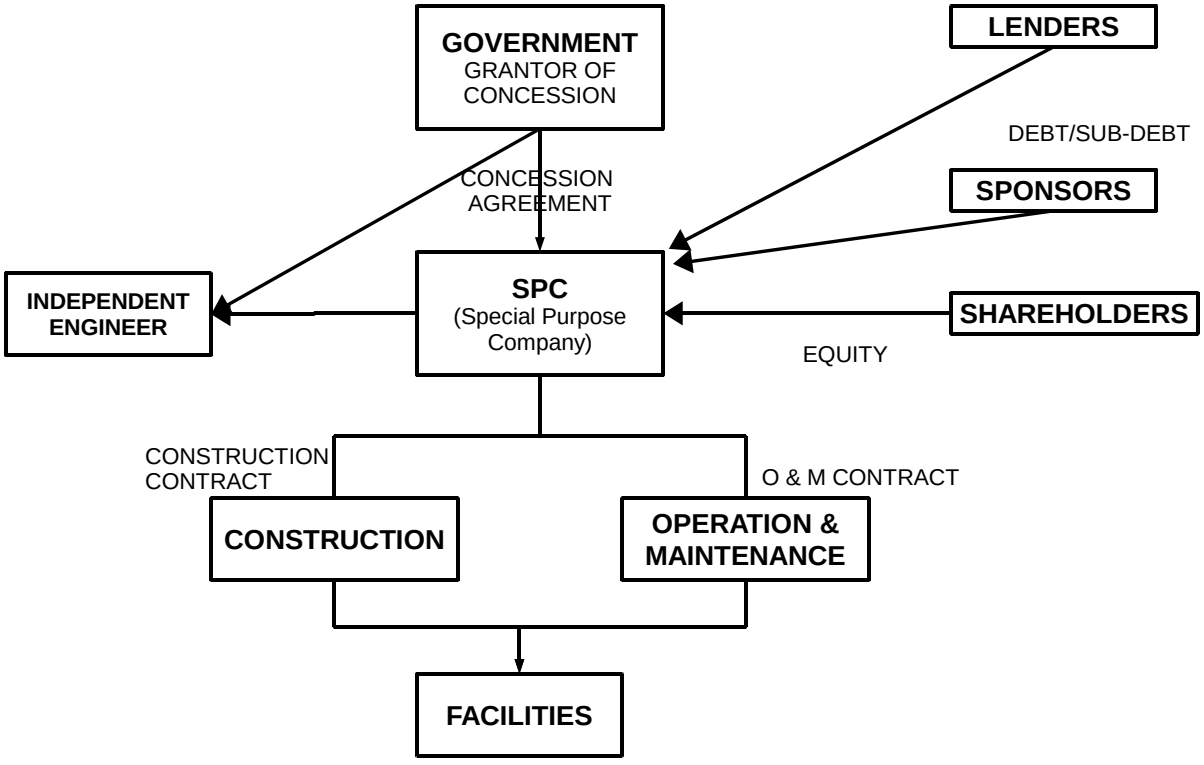
(1) Contractual arrangements for Delivering Mass Transit Facilities

Figure 8-2-1 shows the PPP Contractual arrangements for delivering mass transit facilities. In delivering BRT projects to Karachi conventional BOT scheme as shown in Figure 8-2-2 will no longer function as a logical and reliable project finance instrument. A new and innovative approach to project financing is needed that combine ODA and BOT. As seen from Figure 8-2-3 the construction and installation of infrastructure, i.e. dedicated corridors, bus stations, pedestrian bridges, will be financed by ODA and constructed by CDGK with some outsourcing arrangements via work contracts. Busses will be purchased by CDGK with the ODA loan. Private Sector participation is only in the operation and maintenance of busses via concession agreements.



Sources: Prepared by JICA Study Team

Figure 8-2-1 PPP Contractual Arrangements for Delivering Mass Transit Facilities



Sources: Prepared by JICA Study Team

Figure 8-2-2 Conventional Project Financing Structure

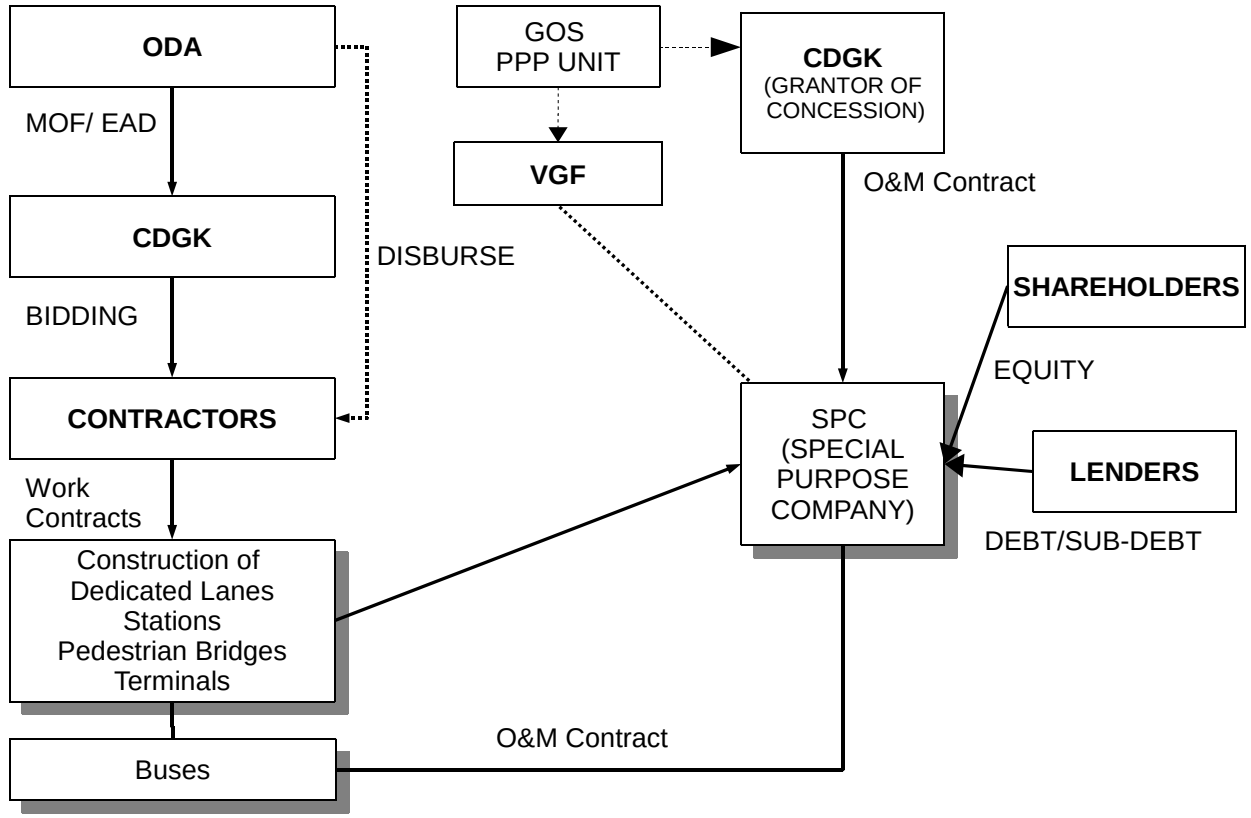
(2) Financing, Development and Operation of BRT

Funding will be made by GOP/ PSDP and ODA.

- Financing the construction of dedicated corridors, stations, pedestrian bridges and other associated facilities by ODA with the support of GOP.
- Financing of CNG buss (5,000) by ODA with support of GOP.
- Operations and maintenance will be contracted to private companies on a PPP mode.

Figure 8-2-3 shows the new form of contractual arrangement which combine ODA and private Sector participation in the operation and maintenance of the facilities constructed through public funding.

In this scenario CDGK will be the grantor of O&M Concession and the Borrower of ODA loans.



SPC= Special Purpose Company (a Concessionaire)
VGF=Validity Gap Funding

Sources: Prepared by JICA Study Team

Figure 8-2-3 Project Financing Structure for BRT

8.2.7 Alternatives of Institutional Arrangement

Mass transit development requires a large outlay of capital investment and an organization. In order to succeed in obtaining a PSDP, ODA loans from bilateral and multi-lateral donors and capital injection from public and private sector a consorted effort must be made by GOP, GOS and CDGK to create a conducive environment so as to utilize the efficiencies, innovativeness, flexibility and speed of the private sector to provide better infrastructure and services at an

optimal cost. Recently, GOS has promulgated Sindh Public Procurement Act 2009 followed by a Public-Private Partnership Ordinance 2009 aimed at expanding infrastructure services and improving their reliability and quality. This will provide a legal framework for the private investment in mass transit.

(1) Institutional Arrangements: Alternative A- KMTA

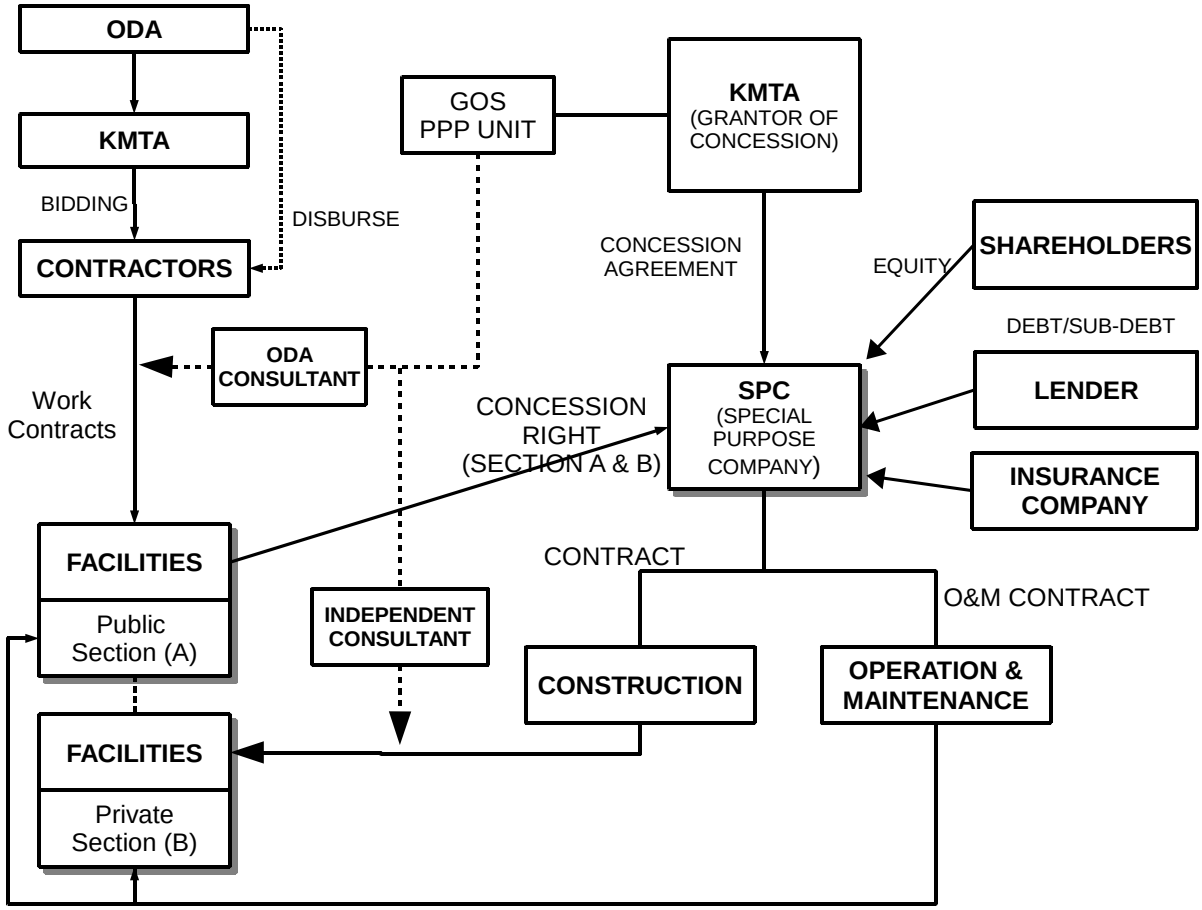
After the careful planning by CDGK/KMTC in consultation with GOS PPP Policy Board and PPP Unit and stakeholders several alternatives for the institutional arrangements will be emerged. One of them could be the creation of Karachi Mass Transit Authority (KMTA) under the aegis of CDGK. KMTA shall have its own Board and members are the representatives of key stakeholders, e.g. Member of Provincial assembly, Member of City Council, Business Community, etc. The duties and responsibilities of the Board include:

a) To interact with the Treasury in multilateral/bilateral funding for furthering the objectives of the policy. Through the process of P-1 PSDP
b) To prioritize, approve, authorize expenditure for MRT projects,
c) To approve VGF, MRG of Concession Agreements for projects,

The management of KMTA shall be the responsibility of the Director General who shall be supported by four General Managers: Planning, Operations, Engineering, and Finance.

Responsibilities of KMTA

KMTA is a municipal Mass Transit Organization to be established and managed by CDGK and will have overall responsibility to deliver services to the traveling customers and for overall safety of the Karachi Mass Transit Systems. It would engage private sector operators for running the Systems including train and station operations, collecting fares and public safety. KMTA will develop, with GOS, GOP and ODA assistance tracks with trains, stations and related infrastructure to the standards and performance levels required in order to give the public with a reliable service over the network in a safe, efficient and economic manner. Infrastructure will be constructed by private sector through work contracts funded by ODA loan and PSDP.

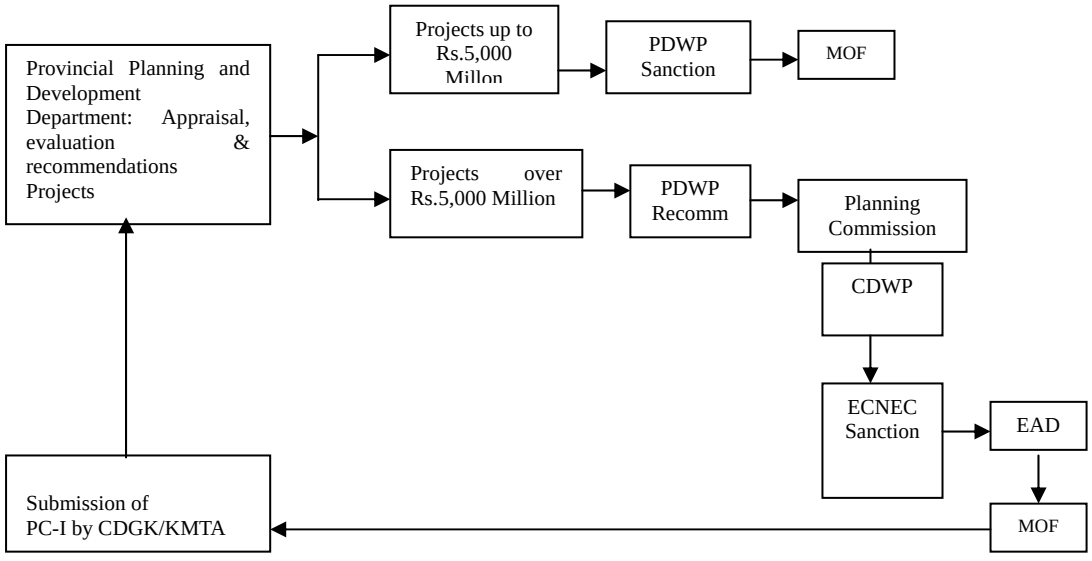


Sources: Prepared by JICA Study Team

Figure 8-2-4 Project Financing Structure for Alternative-A

Proceeding ODA Loans

CDGK and/or KMTA submit PC-1 to PDWP through Provincial Planning and Development Department. After the appraisal of the Planning Commission PC-1 will be submitted to CDWP and final approval of ECNEC. After the ECNEC approval EAD will disburse fund to KMTA.



Sources: Prepared by JICA Study Team

Figure 8-2-5 Proceeding ODA Loans

(2) Karachi Mass Transit Corporation (KMTC) –Alternative B

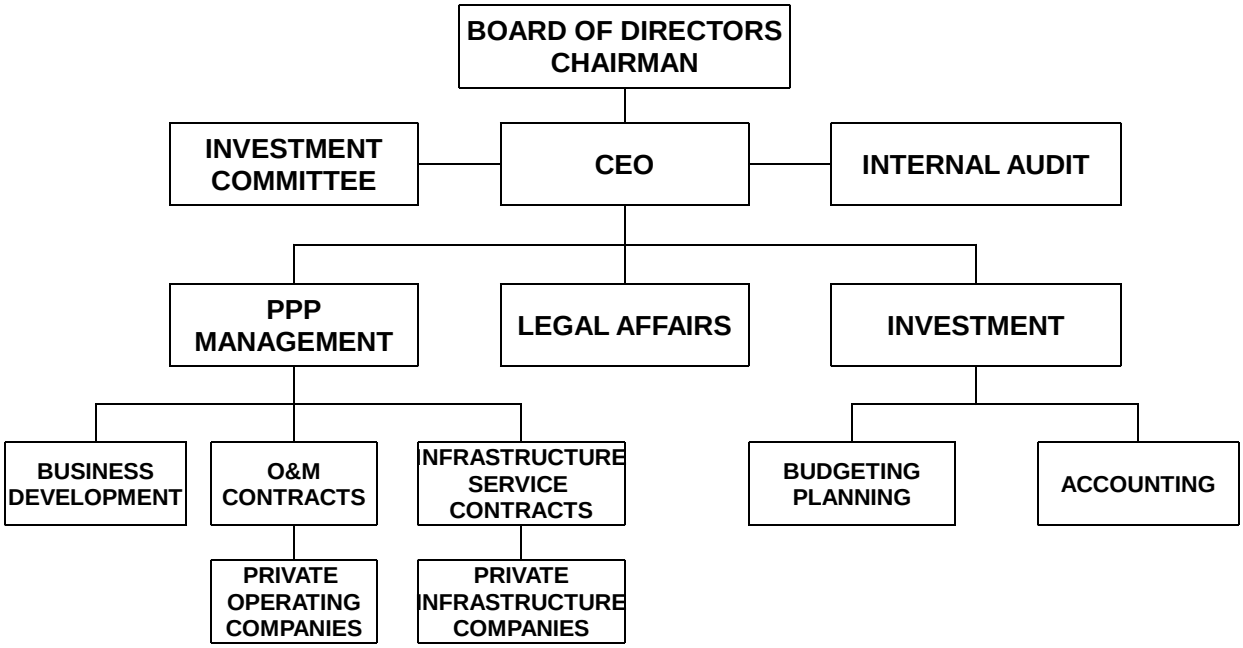
KMTC will be constituted as a 30 year Public Private Partnership. It shall have a Board of Directors, chaired by the Chief Minister of Sindh, and members are consisting of the representatives of key stakeholders, e.g. Member of Provincial assembly, Ministry of Communications, Ministry of Railways, Ministry of Finance and other relevant Central Administration, CDGK, Private infrastructure and operation companies,, Business Community, etc. The duties and responsibilities of Board of Directors include

Responsibilities of KMTC

KMTC will engage private sector operators for running the Systems including train and station operations, collecting fares and public safety. KMTC will develop through PPP financial arrangements tracks with trains, stations and related infrastructure to the standards and performance levels required in order to give the public with a reliable service over the network in a safe, efficient and economic manner

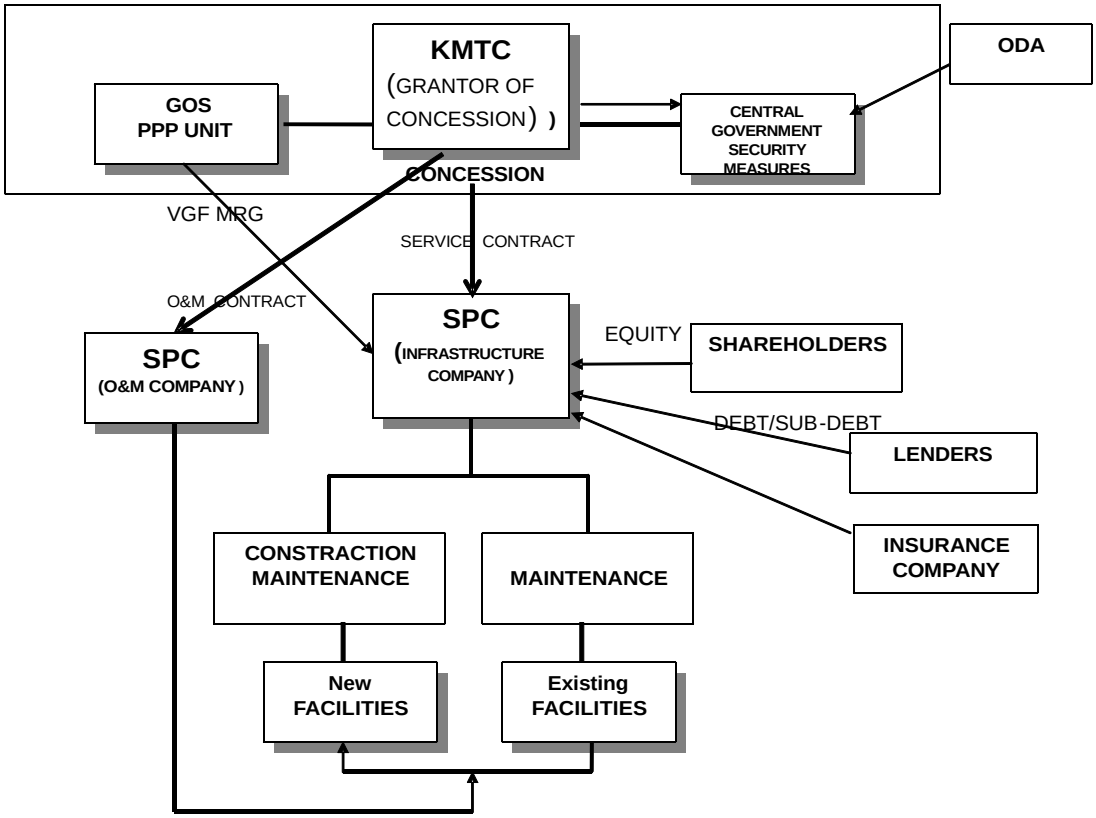
Private Sector Participation – Build Lease Transfer (BLT)

Under the Concession Agreement/Lease Agreement with KMTC, Private infrastructure companies (SPC) will finance, construct and procure trains, track, tunnels, signals and stations and lease these facilities to KMTA and carry out the maintenance and engineering work of infrastructure under the PPP Service Contract. KMTC, based on the terms and conditions of the Lease Agreement and Service Contract, pays the SPC a fixed fees and service level fees which is increased or diminished to reflect the company's actual performance.



Sources: Prepared by JICA Study Team

Figure 8-2-6 Organization of Karachi Mass Transit Corporation (KMTC)



Sources: Prepared by JICA Study Team

Figure 8-2-7 Financial Structure of Alternative B

Chapter 9 Priority Mass Transit Project

9.1 Selection of Priority Mass Transit Project

Priority Mass Transit Projects are the candidates of the feasibility study of KTIP. There are five mass transit projects proposed as short-term projects (-2020) consisting of KCR, Blue Line (MRT), Red Line (BRT), Green Line (BRT), and Orange Line (Busway). Priority Mass Transit Projects are selected from these projects except for KCR because PC-1 of KCR is already approved by GOP.

This chapter describes the methodology of the prioritization and evaluation of the full network for the master plan network described in 6.4.4.

The criteria for the selection are: 1) Economic viability, 2) financial viability, 3) impact on the natural environment, 4) impact on the social environment, and 5) stakeholders' opinion,

9.2 Economic and Financial Evaluation

9.2.1 Economic Evaluation

(1) Methodology of Economic Evaluation

The method of the economic evaluation follows the international practice. Economic Internal Rate of Return (EIRR) and Benefit to Cost Ratio (B/C) are the major indicators for the economic evaluation of the mass transit projects. KCR SAPROF study (2008, JICA) is the major source of parameters for economic and financial evaluation.

Benefit items by the projects are: 1) travel time reduction of mass transit users and road users and 2) reduction in vehicle operation cost by converting buses to mass transit system. Traffic volume, travel time, and travel distance are computed in the traffic assignment by JICA STRADA.

These indicators are calculated by comparing "with project case" and "without project case". In this case, "without project case" represents the case when only KCR project is implemented, while "with project case" represents the case when KCR and the target project to be evaluated are implemented. The results of the demand forecast in 2020 and 2030 are used for these indicators. The same indicators as 2030 are used for the period after 2030.

The evaluation periods of 40 and 15 years were used for MRT projects and BRT projects, respectively, considering the difference in the project life between the two systems.

(2) Project Cost for Economic Evaluation

The project cost for the economic evaluation is calculated from the cost estimation, using a conversion factor of 0.85 as used in KCR SAPFOF Study except for rolling stock cost. Since the rolling stock cost reflects the competition price in the international market, the financial cost is used for the economic cost. The cost of the replacement of rolling stock of MRT is assumed to take place after 20 years of the initial investment.

(3) Operation and Maintenance Cost for Economic Evaluation

O&M cost is also calculated from the estimation of the financial cost of O&M using the conversion factor of 0.85. The estimation of O&M financial cost is described in 9.2.2.

(4) Economic Benefit

Reductions in vehicle operating cost and travel time cost are the components of the economic benefit.

For the vehicle operating cost, unit cost per vehicle-km was estimated from the data in "Pakistan Transport Plan Study (PTPS), 2006, JICA" as shown in Table 9-2-1.

Table 9-2-1 VOC per Vehicle-Km (Rs. Per km)

PTPS (at November 2005 price)			KTIP (at May 2011 price)		
Motorcycle	Car	Bus	Motorcycle	Car	Bus
1.61	6.19	19.94	3.11	11.96	38.53

Source: Estimated in KTIP using VOC data in Pakistan Transport Plan Study (2006, JICA)

The value of time was estimated by the following formula.

Value of time = average monthly income per employee / 150 hours × work trips to all trips ratio

The average monthly income was Rs. 7,600 in 2005 according to "Karachi Master Plan 2020 and Socio Economic Survey Report - 2005 Karachi City Profile". Using Consumer Price Index (CPI) from 2005 to 2011 (2.00 = 253.17/ 125.97), the income in 2011 was estimated as Rs. 15,200. From this, the value of time at work was estimated as Rs. 101 per hour. "Work trips to all trips ratio" is estimated as 0.49 in the HIS of KTIP (work trips include home to work, work to home, and on-business). Multiplied by the ratio, the value of time has been worked out at Rs. 49.65 per hour. This value of time is applied to bus passengers and motorcycle passengers. On the other hand, the value of time of car passengers was estimated as Rs. 110 from the PIS by using the logit model.

(5) Economic Internal Rate of Return (EIRR)

Economic Internal Rate of Return (EIRR) is an economic indicator to evaluate the validity of the concerned project. If EIRR exceed the economical opportunity cost of capital in the country, the investment on the project can be justified. In most cases, 12% is used for the opportunity cost of capital.

EIRR was calculated for the five MRT lines in the full network: Green Line, Blue Line, Red Line, Brown Line, and Yellow Line as shown in Table 9-2-2. The construction period was assumed to be 5 years, and the investment cost is allocated for the period. The opening year is set as 2020 for the evaluation. The result shows that Green Line and Red Line have EIRR which is lower than 12%. Only Brown Line and Yellow Line have higher EIRR. The EIRR of Blue Line is as same as the opportunity cost of capital.

Table 9-2-2 EIRR of MRT Lines in the Full Network (cost: in Rs. Billion)

Economic Value	Green Line	Blue Line	Red Line	Brown Line	Yellow Line
Capital Cost	115.7	162.9	88.6	102.8	124.1
O&M (in 2020)	1.26	1.84	0.90	1.37	1.13
VOC saving (in 2020)	3.35	5.08	1.47	3.32	3.00
TTC saving (in 2020)	9.57	14.46	7.89	15.1	11.82
EIRR	11.8%	12.4%	10.9%	12.9%	10.0%

Source: Estimation in KTIP

9.2.2 Financial Evaluation

(1) Methodology of Financial Evaluation

The purpose of the financial evaluation in Interim Report is to evaluate financial stability of the projects themselves. In the implementation, there will be several financial entities such as operators and infrastructure owners depending on the institutional arrangement. The financial analysis by financial entity will be done in the feasibility study for the selected project. In the master plan stage, the revenue and expenditure are calculated for the project entity which bear all costs and receive all revenues.

As same as the economic evaluation, the evaluation periods of 40 and 15 years were used for MRT projects and BRT projects, respectively.

(2) Capital Cost for Financial Evaluation

Construction cost and bus purchase cost estimated in Chapter 7 are the capital cost for the financial evaluation.

(3) Operation and Maintenance (O&M) Cost for Financial Evaluation

O&M cost of the proposed railway systems were estimated by a simple model using unit cost of the system performance. The applied formula for railway O&M is:

O&M Cost = a × car-km + b × no. of cars + c × pax-km + d × kWh + e × no. of staff

The constant values (a, b, c, d, and e) were calculated from the O&M estimation of KCR in KCR SAPROF (2008, JICA) by applying Consumer Price Index (CPI) from May 2009 to May 2011 (1.28 = 253.17/197.74).

Table 9-2-3 Unit Costs for O&M Estimation of Railway System

Constant	Valuable	Unit Cost Rs.		Remark
		2008	2011	
a	car-km	13.95	17.86	Maintenance of track, electric, signal & telecommunications, and train operation except for electricity
b	no. of cars	720,000	922,000	Maintenance of rolling stock (yearly)
c	passenger-km	0.158	0.202	Operation of station
d	kWh	6.6	8.5	Train operation (electricity)
e	no. of staff	283,320	362,740	Administration and personnel

Source: Estimated in KTIP using KCR SAPROF data

The number of staff was also estimated by using the information of the KCR SAPROF report.

O&M costs of a BRT system consist of (i) fuel, (ii) lubricants, (iii) tyre and parts replacement, (iv) ITS operation and maintenance, (v) vehicle maintenance, (vi) depot maintenance, (vii) personnel, and (viii) other administrative expenditures. The applied unit costs for BRT system are:

O & M cost = a × vehicle-km + b × no. of buses + c

The constant values (a, b, c) were estimated from the data in "Private /Public Partnership based Environmentally-friendly Public Transport System for Karachi". CPI from March 2006 to May 2011 (1.90 = 253.17/132.97) was used to adjust the price escalation.

Table 9-2-4 Unit Costs for O&M Estimation of BRT System

Constant	Valuable	2006	2011	Remark
a	vehicle-km	13.97	26.60	Fuel & lubricants cost, tyre and parts replacement, vehicle maintenance cost
b	no. of buses	594,250	1,131,430	Depot maintenance, personnel (yearly)
c	-	-	10% of above costs	Administrative cost, ITS O&M cost

Source: Estimated in KTIP using data of "Private /Public Partnership based Environmentally-friendly Public Transport System for Karachi"

(4) Revenue

It is assumed that fare of MRT and BRT is a flat rate of Rs. 30 and Rs. 20, respectively. This assumption is applied only for the simulation purpose, in order to compare the feasibility of the proposed lines, and does not exclude the possibility to introduce a distance base fare system. Passenger volume is estimated based on the fare setting. The daily revenue is multiplied by 360 to estimate the yearly revenue.

Table 9-2-5 shows the fare level of railway systems in the world. The fare of Cairo Metro is very low and the metro system requires a large subsidy. In most Asian countries, except for Japan and other developed countries, the fare level is less than Rs. 100, around Rs. 30 – R. 60. From the Passenger Interview Survey, this fare level is possible in Karachi.

Table 9-2-5 Examples of Fare Level in the World (in Rs.)

Country	GDP per Capita	Name of Metro	Fare system	Minimum	Maximum
Thailand	$9,700	Bangkok Metro	Number of Station based fare	42	98
		Bangkok BTS	Zone based fare	42	112
Philippines	$4,100	Manila LRT (Yellow Line)	Number of Station based fare	24	40
		Manila LRT (Purple Line)	Number of Station based fare	24	30
India	$3,700	Delhi Metro	Own fare system	15	57
		Kolcata Metro	Distance based Fare (km)	8	23
China	$8,400	Beijing Metro	Flat-fare	-	27
		Shanghai Metro	Distance based Fare (km)	40	133
Egypt	$6,500	Cairo Metro	Flat-fare	-	14

Source: Collected from Web-site of each operator and compiled in KTIP (converted to Pakistan Rupee)
: GDP per Capita (2011 est.) collected from the webpage of Central Intelligence Agency (CIA)

(5) Financial Internal Rate of Return (FIRR)

Financial Internal Rate of Return (FIRR) is compared to market interest rate to evaluate the profitability of the project. It has been calculated for the five lines as shown in Table 9-2-5. The result shows that all the projects are not profitable with very low FIRR. This means that these projects cannot be implemented in commercial base. Note that in KCR SAPROF (2008, JICA), FRR of KCR was calculated at 2.3%.

Table 9-2-6 FIRR of MRT lines (unit: Billion)

	Green Line	Blue Line	Red Line	Brown Line	Yellow Line
Revenue (in 2010)	4.11	6.19	2.00	5.43	4.76
FIRR	0.13%	0.73%	0.75%	2.33%	1.46%

Source: Estimation in KTIP

9.3 Environmental and Social Considerations

9.3.1 Strategic Environmental Assessment (SEA)

In "National Environmental Policy of 2005" of Pakistan, SEA for development project is introduced as follows:

> *Strategic Environmental Assessment would be promoted as a tool for integrating environment into decision-making.*

However, there is no explicit guideline for SEA study on development projects within the environmental policy of Pakistan. Further, SEA in Pakistan is not subject to examination by EPA for "No Objection Certificate (NOC)". Thus, no project proponent is obliged to submit any part of SEA study to Pakistan's Environmental Protection Agency (PEPA). On the other hand, JICA guidelines state that applying SEA on a master plan study is one of its seven principles. Thus, SEA as a basic tool in order to assess planning of five corridors for KTIP has been carried out.

SEA provides tools in the project planning stage in the following manner:

a) It promotes environmentally sound and sustainable project by integrating the environment into sector-specific decision-making process;

b) It strengthens and streamlines the way project EIA is carried out, prior identification of potential impacts and information needs are identified. Thereby the clearance of strategic issues and concerns related to justification of the project is carried out in well advance of project implementation. It will, therefore, reduce the time and effort necessary to conduct individual reviews; and

c) It helps achieve environmental protection and sustainable development, carry out at the early stage identification of the best practicable environmental option such as an early warning of irrevocable, cumulative and large-scale changes of the natural and social environment during and after the implementation of the project.

9.3.2 Options of Corridors subject to SEA

The future mass transit network has been proposed as the full network in Chapter 6. The SEA has been applied to the proposed network to reach the master plan network. Corridors for the SEA were selected from the full network as Green Line, Blue Line, Red Line, Brown Line, and Yellow Line. KCR and its extension are considered as the basic network for the master plan and it was not selected for the SEA study. Silver Line was excluded because of the small passenger demand.

To evaluate these corridors, evaluation items were prepared for the following viewpoints: 1) Project Impact, 2) Project Efficiency, and 3) Environmental Considerations. Environmental considerations consist of Natural Environment and Social Environment. For the final decision of the master plan network, 4) Necessity of Rail-base system was studied in Chapter 6.

These evaluation items have been quantified using scoring technique as described in the following sections. .

9.3.3 Identification of Evaluation Parameters

(1) Project Impact

The proposed projects are expected to bring about a large scale of positive impact on transportation system in Karachi. The degree of the impact is one of the major criteria to evaluate the necessity of the project. There are three groups which enjoy the benefit from the impact: (i) passengers of mass transit system, (ii) people living along the mass transit corridors, and (iii) road users. From this, the following parameters have been selected to evaluate the project impact.

1) **Passenger Demand:** passenger-kms on the mass transit system
2) **Quantity of Beneficiaries:** population within 1 km buffer zone from the mass transit line
3) **Traffic Improvement:** reduction in vehicle-hours of cars

(2) Project Efficiency

Efficient use of investment money is one of the most important factors to evaluate the project priority. The projects will bring about economic benefit and revenue, and the efficiency is evaluated by comparing project cost and them. The amount of investment cost is also an important factor because a large scale investment of a mass transit system would reduce the opportunity of other investments. The following parameters have been selected for the evaluation of project efficiency.

1) **Financial Stability:** Financial Internal Rate of Return (FIRR)
2) **Economical Efficiency:** Economical Internal Rate of Return (EIRR)
3) **Cost:** Capital Investment cost (assuming the demand in 2020)

(3) Natural Environment

Unlike the normal project–level EIA, an environmental impact matrix under the SEA is designed to roughly grasp the potential environmental impacts deriving from each alternative option. Based on the rapid field reconnaissance survey of the selected corridors, the following parameters on the natural environment are considered important to study on SEA:

1) **Global greenhouse gas (GHG) emission:** reduction of CO2 due to the modal shift of the transportation;
2) **Air pollution during operation:** reduction of air pollution due to the modal shift of the transportation;
3) **Noise and vibration during operation:** reduction of noise and vibration due to the modal shift of the transportation, and occurrence from mass transit system; and
4) **Issue on the environment during construction:** negative impacts /issue, which are air pollution, noise, vibration, water quality, solid waste and cutting planted trees, expected to occur due to construction of the project.

No other natural environment is considered significantly affected by the project, or do not have to study as there is no sanctuaries, national parks etc. existing within or in the vicinity of project area. Thus it is omitted from the SEA study.

(4) Socio-economic Environment

Within the framework of SEA on the socio-economic impact assessment for KTIP, social dimensions of the local communities stretching along each corridor subject to study have been examined. The following is the parameters of assessment holistically and qualitatively assessed and the results are reflected in the matrix of SEA:

1) **Affected structures/Resettlement:** personal and property rights that the local residents are affected, or experience personal disadvantage which may include a violation of their civil rights, fears and aspirations, their perceptions about safety and security of family, fears about the future of community, and the aspirations for their future and the future of their children, a state of complete physical, mental, social and spiritual wellbeing and not merely the absence of disease or infirmity are holistically assessed;

2) **Local economic activities:** how they work and interact with one another on a day-to-day basis in terms of economic activities including local bus and taxi including rickshaw operators that would be affected by the implementation of the project;

3) **Transportation vulnerable:** the extent to which vulnerable people are able to participate in decision making in terms of planning and/or designing of the project that affect their lives, works and the administrative resources provided for this purpose; and

4) **Culture, history and heritage:** shared beliefs, customs, values and language or dialect, including historical heritage of the community and its cohesion, stability, character, services and facilities;

9.3.4 Scoring System for Evaluation

Based on the above classification, SEA study that is based on the multiple criteria assessment (MCA) has been carried out. It is one of the systems to quantify the qualitative analysis. MCA consists of: 1) Project Impact; 2) Project Efficiency; and 3) Environmental Assessment. Its evaluation criteria are as follows:

#	Evaluation Items	Parameters	Rating Method
	Project Impact		
1	Passenger Demand	Passenger-km	Min = 0, Max = 100
2	Quantity of Beneficiaries	Population within 1 km buffer zone	Min = 0, Max = 100
3	Traffic Improvement	Reduction in vehicle-km of cars	Min = 0, Max = 100
	Project Efficiency		
1	Financial Stability	FIRR	Min =0, Max = 100
2	Economical Efficiency	EIRR	Min = 0, Max = 100
3	Cost	Capital Investment Cost	Max = 0, Min = 100
	Environmental Assessment		
1	Affected structures/ Resettlement	No. of affected structures	If 0=100, Max = 0
2	Local economic activities	Reduction in bus passengers	If 0=100, Max = 0
3	Transportation vulnerable	Rating: Lowest=1 and Highest=5	Rating*20
4	Culture, history and heritage	Rating: Lowest=1 and Highest=5	Rating*20
5	Global warming (CO2 reduction)	Rating: Lowest=1 and Highest=5	Rating*20
6	Air Quality	Rating: Lowest=1 and Highest=5	Rating*20
7	Noise and vibration	Rating: Lowest=1 and Highest=5	Rating*20
8	During the Construction	Rating: Lowest=1 and Highest=5	Rating*20

The above scoring points are further converted to 30 points assigned to project impact, project efficiency, and environmental analysis, respectively, out of 100 points assigned to the master plan study as a whole.

Each item of evaluation is intended to demonstrate relative importance of each corridor. Each corridor's evaluation result as overall indicators are therefore calculated based on the weighting system of relative importance.

Within the framework of social environment analysis, impacts on the resettlement and heritage sites are considered as the significant factors than other factors such as impacts on the bus operators and transportation vulnerable. Noise, vibration, air pollution, disturbances during the construction period and trees planted on the green belt/roadside are the significant factors subject to analysis on the natural environment.

Particular attention should be paid to the fact that SEA has been carried out in conjunction with the development of KCR Project, which is planned to implement in a staged development manner i.e. implementation of a section of KTIP corridor is carried out while a section of KCR Project is implemented.

9.3.5 Result of SEA

(1) Project Impact

Passenger demand was estimated for each line under the condition that only the line subject to the evaluation would be constructed in addition to KCR and its extension. The preliminary demand forecast model was used. Passenger-km and vehicle-hours were calculated from the results of the demand forecast. Population along the line was estimated from population map by UC, using the buffer function of GIS software.

Table 9-3-1 Basic Data of Evaluation Parameters for Project Impact

	Green	Brown	Red	Yellow	Blue
Passenger Demand (Million pax-km per day)	8.04	8.18	5.83	7.16	11.97
Quantity of Beneficiaries (Million in 1.0km radius)	2.5	1.7	1.9	2.0	2.9
Traffic Improvement (veh-hours per day of car users)	59,131	158,097	157,097	193,114	209,669

Source: Estimation in KTIP using the preliminary demand forecast model

(2) Economic Efficiency

Economic Internal Rate of Return (EIRR), Financial Internal Rate of Return (FIRR), and Cost are summarized in Section 9.2.

(3) Natural Environment

1) Pre-Construction Period

The impacts on the natural environment are almost non-existent during pre-construction stage. However it is still important to examine the method of construction, plans, schedules, process of construction, manpower plans and other preparatory activities in terms of environmental impact analysis so as to ensure if there would be any room for reduction of negative impacts on the natural environment.

2) Construction Period

Examination of the situation around the project site and the land use are important, when considering environment issues under examination. Thus positive and negative impacts to each parameter was predicted and estimated qualitatively based on the "would-be-situation" around the project site.

Table 9-3-2 indicates issues on the environment during the construction period. Adequate measures should be planned and implemented in order to reduce negative impacts of environment during construction stage.

Table 9-3-2 Evaluation of Issues on SEA during Construction

Case / Item	No Project	Green Line	Brown Line	Red Line	Yellow Line	Blue Line	KCR
a) Air Pollution, Noise and Vibration	N	●	●	-	●	●	●
b) Water Pollution	N	-	●	-	●	●	●
c) Solid Waste	N	●	-	●	-	●	-
d) Cutting Trees	N	●	●●	●●	●	●	N
Overall Score	5	2	1	2	2	1	4

Note: N-No negative impact/issue, ●: There is potential issue which should be considered during construction
Grade: 1-Largest impacts/issue, 5: Smallest impact/ issue.
Source: JICA Study Team

a) Air Pollution, Noise and Vibration

The cases of Blue Line, Brown Line and Yellow Line, these corridors are designed on the existing narrow road under 30m wide. The Tower area on Blue Line and the area between station # 10 and #11 on Yellow Line are particularly on the narrow road. In these areas, air pollution, noise and vibration from construction site are considered negative.

In addition road traffic near the construction sites will be further worsened during the construction period. Thus, it is necessary to mitigate negative impacts with measures of i) regular maintenance of the construction machinery; ii) efficient and punctual scheduled operation of the construction works; iii) minimizing the scale and duration of the temporary lane occupation of the road for construction purposes; and iv) create alternative routes to bypass affected traffic volume at the construction sites.

b) Water Pollution

In case of Brown Line, Yellow Line and Blue Line, there are areas of crossing the river. The water quality of Lyari and Malir River is seriously deteriorated because of industrial and domestic discharge generally directly flowing into the river. When excavating riverbed for bridge construction, there will be a possibility that pollutant would cause significant impacts on the safety of construction workers as well as the general public.

c) Solid Waste Management

In case of Blue Line, Blue Line and Red Line, there is a possibility of constructing underground section. The constructor will have to ensure efficient implementation of soil disposal management plan.

d) Cutting Trees

Trees planted on the greenbelt and sidewalk along the road of each corridor should fell down during the construction period. In case of Red Line, the length of greenbelt is 11.2 km. In case Brown Line, it is 10.8 km. The number of trees cut down should be replanted upon completion of the construction works.

3) Operation and Maintenance Period

The positive/negative impact during operation and maintenance period is summarized in Table 9-3-3.

Table 9-3-3 Evaluation of Issues on SEA During Construction

Item \ Case	No Project	Green Line	Brown Line	Red Line	Yellow Line	Blue Line	KCR
a) Air Pollution	●●●	○○	○	○	○	○○	○○
	1	4	2	2	2	4	4
b) Noise and Vibration	●●●	○●	○●	○●	○	○●	○●
	1	1	1	1	2	1	1
c) GHG and Emission	●●●	○○○	○○	○○	○○	○○○	○○○
	1	5	4	4	3	5	5

Note: Upper line ●:Important but negative impact, ○: Positive impact; Lower line, 1-Smallest impacts 5: Largest Positive impact/Smallest negative impact, GHG denotes "Green House Gas"
Source: JICA Study Team

a) Air Pollution

Currently, NOx, CO and PM_{10} concentrations are higher than National Environmental Quality Standards along major roads. It is expected that emission of air pollutants will be reduced due to the modal shift of public transportation from the present passenger cars and buses to mass transit system.

The expected effect depends much on the amount by the reduction of present passenger cars and buses. In particular in Green Line and Blue Line, effect of the reduction of present passenger cars and buses will probably be noticeable. When Green Line and/or Blue Line are developed, which are major artillery railway system as mass transit system is developed, the direction of movement of the vehicles on the existing road along these corridors will be significantly reduce.

b) Noise and vibration

Noise level is higher than National Environmental Quality Standards along major roads. It is expected that ambient noise level will be reduced due to the modal shift of transportation from the present cars and buses to mass transit system. On the other hand, impacts of noise and vibration from mass transit system are expected to introduce to the local area.

In case of Green Line, Red Line and Blue Line, it is necessary to consider of vibration caused by the underground section of mass transit while there will be essentially no noise is emanated from the underground section.

c) Green House Gas (GHG)

It is expected that the GHG emission would be reduced due to the modal shift of transportation from the present passenger cars and buses to the new transportation system. It would be particularly effective on Blue Green and Blue Line based on the present statistics on the traffic volume shown in Karachi master Plan - 2020. However, the expected effect depends much on reduced number of cars and buses as a result of modal shift. When Green Line and/or Blue Line are developed, which are major

artillery railway system as mass transit system is developed, the direction of movement of the vehicles on the existing road along these corridors will be significantly reduce.

(4) Social Impact Analysis

1) General Characteristics of the Respondents of Each Corridor

Interview survey along each corridor of KTIP has been carried out and the numbers of respondent and their distribution are shown in Table 9-3-4. Randomly selected respondents are so happened to be more commercial oriented persons followed by the local households. This might be of the reason that the interview survey took place only on the area fronting the road subject to corridor development.

Table 9-3-4 Result of Interview Survey: Distribution of Respondents

Corridor	Green	Brown	Red	Yellow	Blue
No. of Respondents	351	317	302	332	381
1. Residential	19%	22%	9%	13%	8%
2. Commercial	81%	74%	78%	84%	89%
3. Residential plus Commercial	-	3%	8%	1%	2%
4. Industrial	-	1%	2%	0%	0%
5. Others	-	0%	3%	2%	1%
Total	100%	100%	100%	100%	100%

Source: JICA Study Team

Majority of them have been living for more than 15 years and they are interested in public transportation development as soon as possible. Their residential status, if they are with valid land title or not, have not been clearly established since more than 30 % of them do not respond to the question. However, those with land title are nearly 60% of the total number of respondents. Approximately 10 % of the respondents do not possess land title.

For the option of corridor development in the future as is shown in Table 9-3-5 to 9-3-6, majority of them are interested in using public transportation to commute to working places. In general more than half of the respondents of the total respondents are interested in their respective corridor developed with a combination of bus and railway services i.e it is their style of commuting to work places, rather than railway only or bus only.

Table 9-3-5 Result of Interview Survey: Use of Mass Transit System - Green Line

Destination	Future Options for the Proposed Public Transportation Network			Total
	Bus	Rail	Combination of both	
Workplace	16%	22%	46%	84%
Market (Large/Small)	2%	2%	6%	9%
School/Madrassa (Primary/Secondary)	0%	0%	0%	1%
College/University	0%	0%	1%	2%
Hospital/Clinic	0%	0%	0%	0%
Place of Worship	0%	0%	1%	1%
other	1%	0%	2%	3%
No Response	0%	0%	0%	0%
Total	19%	25%	57%	100%

Source: JICA Study Team

Table 9-3-6 Result of Interview Survey: Use of Mass Transit System - Brown Line

Destination	Future Options for the Proposed Public Transportation Network			Total
	Bus	Rail	Combination of both	
Workplace	15%	18%	45%	79%
Market (Large/Small)	4%	3%	9%	16%
School/Madrassa (Primary/Secondary)	1%	1%	0%	2%
College/University	1%	0%	0%	1%
Hospital/Clinic	0%	0%	0%	0%
Place of Worship	0%	0%	1%	1%
other	1%	0%	1%	2%
Total	22%	22%	56%	100%

Source: JICA Study Team

Table 9-3-7 Result of Interview Survey: Use of Mass Transit System - Red Line

Destination	Future Options for the Proposed Public Transportation Network			Total
	Bus	Rail	Combination of both	
Workplace	17%	29%	43%	90%
Market (Large/Small)	1%	1%	4%	7%
School/Madrassa (Primary/Secondary)	0%	0%	1%	1%
College/University	0%	0%	0%	1%
Hospital/Clinic	0%	0%	0%	1%
Total	19%	32%	49%	100%

Source: JICA Study Team

Table 9-3-8 Result of Interview Survey: Use of Mass Transit System - Yellow Line

Destination	Future Options for the Proposed Public Transportation Network			Total
	Bus	Rail	Combination of both	
Workplace	14%	23%	42%	78%
Market (Large/Small)	4%	4%	8%	17%
School/Madrassa (Primary/Secondary)	0%	0%	0%	0%
College/University	1%	0%	1%	2%
Hospital/Clinic	0%	0%	2%	2%
Place of Worship	0%	0%	0%	1%
Total	20%	27%	53%	100%

Source: JICA Study Team

Table 9-3-9 Result of Interview Survey: Use of Mass Transit System - Blue Line

Destination	Future Options for the Proposed Public Transportation Network			Total
	Bus	Rail	Combination of both	
Workplace	16%	29%	41%	87%
Market (Large/Small)	2%	3%	7%	12%
School/Madrassa (Primary/Secondary)	0%	0%	0%	1%
College/University	0%	0%	1%	1%
Hospital/Clinic	0%	0%	0%	0%
Total	18%	32%	50%	100%

Source: JICA Study Team

Income distribution of the respondents generally follow the trend of the above tables i.e. those of the income level between Rs. 10,000 and 30,000, that are accounted for more than

30 % of the total number of respondents, are showing their interest on the development of public transportation in combination of bus and railway as soon as possible.

2) Green Line

It is one of the three artillery lines generally running from north to south. Approximately 2/3 of the northern portion is running in the residential area whereas 1/3 in the southern portion runs in the commercial areas intermixed with residential area. The line ends at Guru Mandir, one of the largest commercial centers in Karachi, where the line joints to Red Line and Blue Line.

There are 31 commercial and residential, or a building with commercial purposes on its lower floors and residential purposes on the upper floors are affected by a number of stations planned to construct. Changing of the designing of station structures would make all of the "Would-be-affected" structures out of ROW.

3) Brown Line

It is one of the two circular lines generally running from northwest, bisecting three artillery lines to southeast of Karachi. It runs through residential and commercial areas alternately in the northwestern half and then runs through residential areas near industrial area before it reaches in the middle of Korangi industrial belt.

There are 27 commercial and residential, or a building with commercial purposes on its lower floors and residential purposes on the upper floors are affected by a number of stations planned to construct.

Particular attention should be paid to the area near Drigh Road Station of KCR where there are 23 residential structures and 4 squatter buildings would become subject to demolition. As a result approximately 91 households would be subject to resettlement. There will be no other way to change the alignment of Brown Line.

4) Red Line

Approximately 1/3 of the northeastern portion is running in the future residential area whereas 1/3 in the middle runs through educational and residential areas while southern portion runs in the commercial area. The line ends at Guru Mandir, one of the largest commercial centers in Karachi and joined to Green Line and Blue Line.

There are 9 commercial and residential, or a building with commercial purposes on its lower floors and residential purposes on the upper floors are affected by a number of stations planned to construct. Changing of the designing of station structures would make all of the "Would-be-affected" structures out of ROW.

5) Yellow Line

It is one of the two circular lines generally runs from east to west generally running in the south of Korangi industrial belt and ends at Central Business District (CBD). This line joins to KCR's Cantonment Station.

There are 26 commercial and residential, or a building with commercial purposes on its lower floors and residential purposes on the upper floors are affected by a number of stations planned to construct. Changing of the designing of station structures would make all of the "Would-be-affected" structures out of ROW.

6) Blue Line

It is one of the three artillery lines generally running from northeast to southwest. Its northeastern tip is in the future residential area. It then runs through residential area to Guru Mandir where it joins with Green Line and Red Line while it goes through a couple of commercial centres within the residential area. From Guru Mandir to Tower, this line goes through high-density commercial area of CBD.

At its southern end, national heritage building of Merewether Tower is affected by the # 1 station structures. The front yard of City Court, also one of the heritage buildings is affected by # 2 station structure. Thus mitigation measures for both heritage sites will have to be further necessary to elaborate.

There are 23 commercial and residential, or a building with commercial purposes on its lower floors and residential purposes on the upper floors are affected by a number of stations planned to construct. Changing of the designing of station structures would make all of the "Would-be-affected" structures out of ROW.

Traffic congestion in CBD, especially in the area around Tower during construction period would become the worst unless appropriate traffic management and diversion was made. If not the commercial operators including bus, taxi and rickshaw operators and the commuters to work would suffer severely.

(5) Summary of Scoring of Environmental Analysis

Based on the above analysis, SEA matrix has been elaborated as per Table 9-3-10 in order to provide general indicator of environmental impacts of each corridor for Master Plan.

Table 9-3-10 Evaluation on the Natural and Social Environment

a. Scoring Points

Item	Global Warming	Air Quality	Noise and Vibration	During Construction	Affected Structures/ Resettlement	Local Economic Activities	Transportation Vulnerables	Culture, History and Heritage	Total
Score / Corridor	3	3	1.5	1.5	8	5	4	4	30
1 No Project	0.00	0.00	0.00	1.50	8.00	3.00	0.80	4.00	17.30
2 Green	3.00	2.40	0.30	0.60	5.60	3.75	2.40	4.00	22.05
3 Brown	1.50	1.20	0.30	0.30	6.40	3.50	2.40	4.00	19.60
4 Red	2.25	1.20	0.30	0.60	7.60	3.50	2.40	4.00	21.85
5 Yellow	0.75	1.20	0.60	1.20	6.40	3.50	2.40	4.00	20.05
6 Blue	3.00	2.40	0.30	0.60	6.40	4.00	2.40	3.60	22.70
7 KCR	3.00	2.40	0.30	0.90	0.00	4.00	2.40	4.00	17.00
Total	13.50	10.80	2.10	5.70	40.40	25.25	15.20	27.60	-
Average	1.93	1.54	0.30	0.81	5.77	3.61	2.17	3.94	-

b. Indicator (Scoring Points/Average)

Item	Global Warming	Air Quality	Noise and Vibration	During Construction	Affected Structures/ Resettlement	Local Economic Activities	Transportation Vulnerables	Culture, History and Heritage	Average
1 No Project	0.00	0.00	0.00	1.85	1.39	0.83	0.37	1.02	0.68
2 Green	1.55	1.56	1.00	0.74	0.97	1.04	1.11	1.02	1.12
3 Brown	0.78	0.78	1.00	0.37	1.11	0.97	1.11	1.02	0.89
4 Red	1.17	0.78	1.00	0.74	1.32	0.97	1.11	1.02	1.01
5 Yellow	0.39	0.78	2.00	1.48	1.11	0.97	1.11	1.02	1.11
6 Blue	1.55	1.56	1.00	0.74	1.11	1.11	1.11	0.91	1.14
7 KCR	1.55	1.56	1.00	1.11	0.00	1.11	1.11	1.02	1.06
Total	6.99	7.02	7.00	7.03	7.01	7	7.03	7.03	-
Average	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	-

c. Overall Indicator (Indicator x Weight)

Item	Global Warming	Air Quality	Noise and Vibration	During Construction	Affected Structures/ Resettlement	Local Economic Activities	Transportation Vulnerables	Culture, History and Heritage	Overall Indicator for Evaluation
Weight (%) / Corridor	10%	10%	5%	5%	30%	10%	10%	20%	100%
1 No Project	0.00	0.00	0.00	0.09	0.42	0.08	0.04	0.20	0.83
2 Green	0.16	0.16	0.05	0.04	0.29	0.10	0.11	0.20	1.11
3 Brown	0.08	0.08	0.05	0.02	0.33	0.10	0.11	0.20	0.97
4 Red	0.12	0.08	0.05	0.04	0.40	0.10	0.11	0.20	1.10
5 Yellow	0.04	0.08	0.10	0.07	0.33	0.10	0.11	0.20	1.03
6 Blue	0.16	0.16	0.05	0.04	0.33	0.11	0.11	0.18	1.14
7 KCR	0.16	0.16	0.05	0.06	0.00	0.11	0.11	0.20	0.85
Total	0.72	0.72	0.35	0.36	2.1	0.7	0.7	1.38	-
Average	0.10	0.10	0.05	0.05	0.30	0.10	0.10	0.20	-

Source: JICA Study Team

(6) Opinions of Key Informants

A brief result of the key informant survey is shown in Table 9-3-11. Among key informants, Green Line and Blue Line are more popular than other corridors. Those who selected railway development, indicated in yellow in Table 9-3-6, eight of them selected Blue Line and six of them selected Green Line.

Those who selected bus development, indicated in grey in Table 9-3-11, six of them selected Green Line and four of them selected Green Line. Those who selected a combination of bus and railway development, six of them selected Green Line and eight of them selected Blue Line.

Table 9-3-11 Result of Key Informant Survey

No.	Preferred Corridor	Preferred Mode of Transportation	Preference of Corridor					Preference of Rail/Bus/Combination			Remarks
			Green	Brown	Red	Yellow	Blue	Rail	Bus	Comb.	
1	Blue	Bus	-	-	-	-	1	-	1	-	Gov./Semi-gov.
2	Green	Bus	1	-	-	-	-	-	1	-	Gov./Semi-gov.
3	Brown	-	-	1	-	-	-	-	-	-	Gov./Semi-gov.
4	Green	Rail	1	-	-	-	-	1	-	-	Gov./Semi-gov.
5	Red	Combination	-	-	1	-	-	-	-	1	Business
6	Blue	Combination	-	-	-	-	1	-	-	1	Business
7	Green	Bus	1	-	-	-	-	-	1	-	Business
8	Blue	Combination	-	-	-	-	1	-	-	1	Univ./NGO
9	Yellow	Bus	-	-	-	1	-	-	1	-	Univ./NGO
10	Blue	Rail	-	-	-	-	1	1	-	-	Univ./NGO
11	Blue	Rail	-	-	-	-	1	1	-	-	Univ./NGO
12	Blue	Bus	-	-	-	-	1	-	1	-	Univ./NGO
13	-	-	-	-	-	-	-	-	-	-	Univ./NGO
14	Red	Combination	-	-	1	-	-	-	-	1	Univ./NGO
15	Blue	-	-	-	-	-	1	-	-	-	Univ./NGO
16	Blue	Combination	-	-	-	-	1	-	-	1	Univ./NGO
17	Green	Bus	1	-	-	-	-	-	1	-	Gov./Semi-gov.
18	Green	Bus	1	-	-	-	-	-	-	-	Gov./Semi-gov.
19	Brown	Bus	-	1	-	-	-	-	-	-	Univ./NGO
20	-	-	-	-	-	-	-	-	-	-	Univ./NGO
21	Blue	Rail	-	-	-	-	1	1	-	-	
22	Green Red Blue	Combination of these corridors	1 - -	- - -	- 1 -	- - -	- - 1	1 - -	- - -	- - -	Business
23	Blue	Rail	-	-	-	-	1	1	-	-	Business
24	Blue	Bus	-	-	-	-	1	-	1	-	Business
25	Green	Combination	1	-	-	-	-	-	-	1	Business
26	-	-	-	-	-	-	-	-	-	-	Gov./Semi-gov.
27	Blue	Rail	-	-	-	-	1	1	-	-	Gov./Semi-gov.
28	Blue	Combination	-	-	-	-	1	-	-	1	Business
29	Green	Rail	1	-	-	-	-	1	-	-	Business
30	-	-	-	-	-	-	-	-	-	-	Univ./NGO
31	Blue	Bus	-	-	-	-	1	-	1	-	Business
32	Blue	Combination	-	-	-	-	1	-	-	1	Business
33	Blue	Combination	-	-	-	-	1	-	-	1	Business
34	Blue	Rail	-	-	-	-	1	1	-	-	Gov./Semi-gov.
35	Blue	Combination	-	-	-	-	1	-	-	1	Gov./Semi-gov.
36	Blue	Combination	-	-	-	-	1	-	-	1	Gov./Semi-gov.
37	Green	Bus	1	-	-	-	-	-	1	-	Gov./Semi-gov.
38	Green	Combination	1	-	-	-	-	-	-	1	Gov./Semi-gov.
39	Green	Combination	1	-	-	-	-	-	-	1	Business
40	Green	Bus	1	-	-	-	-	-	1	-	Business
41	Green	Combination	1	-	-	-	-	-	-	1	Business
42	Green	Combination	1	-	-	-	-	-	-	1	Business
43	Blue	Combination	-	-	-	-	1	-	-	1	Business
44	Green	Bus	1	-	-	-	-	-	1	-	Gov./Semi-gov.
45	Green	Combination	1	-	-	-	-	-	-	1	Univ./NGO
46	Green	Rail	1	-	-	-	-	1	-	-	Business
47	Green	Rail	1	-	-	-	-	1	-	-	Gov./Semi-gov.
48	Green	Rail	1	-	-	-	-	1	-	-	Gov./Semi-gov.
49	Green Yellow	Rail	1 -	- -	- -	- 1	- -	1 -	- -	- -	Gov./Semi-gov.
50	Green Red Yellow	Rail	1 - -	- - -	- 1 -	- - 1	- - -	1 - -	- - -	- - -	Business
		Total	21	2	4	3	21	14	11	17	-

Source： JICA Study Team

Those knowledgeable persons of the local universities and NGOs specialized in urban transportation/development experts, 13 of them replied, have different opinions in selecting corridors and mode of transportation. Out of 13 respondents, 9 of them gave clear answers for selection of a corridor and only 4 persons selected Blue Line and 2 of them replied for railway development. Others who selected Blue Line are either for bus development or a combination of bus and railway.

Those of knowledgeable persons who clearly selected corridors, two of them selected Blue Line but one prefers bus while the other is for railway. The person who selected Brown Line gave no clear answer for bus or railway development. The one selected Red Line is for a combination of bus and railway. However, those who did not select corridor or mode transportation indicates in their comments that "a system where passenger density per vehicle" should be developed. Others stated that "elevated rail (partly underground) with feeder services as a solution of main transport".

A large number of the key informants are concerned with which mass transit can become a target of terrorism. Thus security system development is very important for operation and maintenance. They also stated that political system has been barring the implementation of mass transit system in the past decades. They also stated that strong leadership with an appropriately set up solid and strong organization without corruption is the key to successful implementation of the project.

One stated that monthly pass should be made available for passengers while others contended that there is a significant lack of political will to implement public purpose project. Majority of them, however, stated that any form of mass transit public transportation system is acutely needed in Karachi. Details of stakeholder meeting result are shown in Appendix 5-2: Result of SOSE Survey.

(7) Opinions of the Participants of Stakeholder Meetings

There have been three times of stakeholder meetings held in March 2011 for hearing local opinions of the project. At the meeting, questionnaire survey was carried out if they prefer rail, bus or a combination of both. The result is shown in Table 9-3-12.

Table 9-3-12 Preference of Transportation Mode

	a. SHM 1		b. SHM 2		c. SHM 3	
Mode of Transport	No.	%	No.	%	No.	%
Bus	27	13.0	30	26.5	20	10.7
Rail	58	28.0	16	14.2	44	23.5
Combination of both	112	54.1	67	59.3	121	64.7
Not sure	10	4.8	-	.0	2	1.1
Total	207	100.0	113	100.0	187	100.0

Source: JICA Study Team

As is shown above, 59.4% in average of all the participants of 507 of three meetings stated that they are interested in public transportation system developed in a combination of bus and train. This is compared to the survey result of knowledgeable persons and that is quite similar.

As is shown in Table 9-3-13, the age of the majority of participants is less than 30 years of age. Female participation was approximately 10 % and more than half of them are living or running business for 20 years or longer in these corridor areas. Majority of participants is students and small business owners. Distribution of gender, distribution of occupation, and duration of residence of the participants are shown in Table 9-3-14 to 16 respectively.

Table 9-3-13 Age Distribution of Participants

	a. SHM 1		b. SHM 2		c. SHM 3	
Age Distribution	No.	%	No.	%	No.	%
19 - 20	41	19.8	12	10.6	56	29.9
21 - 22	50	24.2	24	21.2	39	20.9
23 - 25	33	15.9	30	26.5	27	14.4
26 - 30	17	8.2	12	10.6	33	17.6
31 - 40	26	12.6	15	13.3	15	8.0
41+	40	19.3	20	17.7	17	9.1
Total	207	100.0	113	100.0	187	100.0

Source: JICA Study Team

Table 9-3-14 Gender Distribution of Participants

	a. SHM 1		b. SHM 2		c. SHM 3	
Gender Distribution	No.	%	No.	%	No.	%
Male	179	86.5	99	87.6	177	94.7
Female	28	13.5	14	12.4	10	5.3
Total	207	100.0	113	100.0	187	100.0

Source: JICA Study Team

Table 9-3-15 Distribution of Occupation

	a. SHM 1		b. SHM 2		c. SHM 3	
Residential Period	No.	%	No.	%	No.	%
> 5 years	15	7.2	22	19.5	23	12.3
5-10 Years	20	9.7	21	18.6	16	8.6
10-15 years	26	12.6	7	6.2	12	6.4
15-20 years	31	15.0	8	7.1	31	16.6
20 Years <	115	55.6	55	48.7	105	56.1
Total	207	100.0	113	100.0	187	100.0

Source: JICA Study Team

Table 9-3-16 Duration of Residence

	a. SHM 1		b. SHM 2		c. SHM 3	
Residential Period	No.	%	No.	%	No.	%
Unskilled worker	8	3.9	-	-	-	-
Skilled worker / Technician	26	12.6	-	-	-	-
Shopkeeper / Business (Low Level)	9	4.3	2	1.8	1	.5
Business (High Level)	9	4.3	9	8.0	5	2.7
Student	81	39.1	42	37.2	69	36.9
Private service	34	16.4	32	28.3	74	39.6
Government service	12	5.8	7	6.2	8	4.3
Sector specialist	9	4.3	6	5.3	5	2.7
other	10	4.8	2	1.8	25	13.4
No response	9	4.3	13	11.5	-	-
Total	207	100.0	113	100.0	187	100.0

Source: JICA Study Team

Table 9-3-17 shows distribution of income level of the participants in relation to their preference to corridor development. It demonstrates that relatively low income participants are expressing their concern over a combination of railway and bus development.

Table 9-3-17 Participants' Opinion on the Development of KTIP and Their Income

a. SHM 1

Income	Bus		Rail		Combination		Not sure		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%
< 1,000	18	9	19	9	81	39	6	3	124	60
1,001 - 10,000	9	4	20	10	7	3	1	0	37	18
10,001 - 20,000	0	0	16	8	10	5	3	1	29	14
20,001 - 30,000	0	0	2	1	5	2	0	0	7	3
30,001 - 40,000	0	0	0	0	3	1	0	0	3	1
40,001 - 50,000	0	0	0	0	4	2	0	0	4	2
60,001 - 70,000	0	0	1	0	0	0	0	0	1	0
90,001 - 10,0000	0	0	0	0	1	0	0	0	1	0
20,0001 <	0	0	0	0	1	0	0	0	1	0
Total	27	13	58	28	112	54	10	5	207	100

b. SHM 2

Income	Bus		Rail		Combination		Not sure		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%
< 1,000	8	7	10	9	40	35	0	0	58	51
1,001 - 10,000	2	2	0	0	7	6	0	0	9	8
10,001 - 20,000	9	8	3	3	8	7	0	0	20	18
20,001 - 30,000	4	4	2	2	6	5	0	0	12	11
30,001 - 40,000	3	3	1	1	0	0	0	0	4	4
40,001 - 50,000	2	2	0	0	4	4	0	0	6	5
60,001 - 70,000	1	1	0	0	1	1	0	0	2	2
90,001 - 10,0000	0	0	0	0	1	1	0	0	1	1
20,0001 <	1	1	0	0	0	0	0	0	1	1
Total	30	27	16	14	67	59	0	0	113	100

c. SHM 3

Income	Bus		Rail		Combination		Not sure		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%
< 1,000	8	4	22	12	72	39	1	1	103	55
1,001 - 10,000	4	2	5	3	13	7	0	0	22	12
10,001 - 20,000	6	3	8	4	18	10	1	1	33	18
20,001 - 30,000	1	1	2	1	4	2	0	0	7	4
30,001 - 40,000	1	1	2	1	4	2	0	0	7	4
40,001 - 50,000	0	0	2	1	7	4	0	0	9	5
60,001 - 70,000	0	0	0	0	2	1	0	0	2	1
90,001 - 10,0000	0	0	1	1	0	0	0	0	1	1
20,0001 <	0	0	2	1	1	1	0	0	3	2
Total	20	11	44	24	121	65	2	1	187	100

Source: JICA Study Team

9.4 Selection of Feasibility Study Project

Since KCR forms the fundamental section for the circular and radial network in the mass transit system in Karachi, the priority has been given to the implementation of KCR. The feasibility study (F/S) of KCR has already been completed. The extension of KCR is also the priority project but it is proposed to conduct its F/S after the successful implementation of KCR.

In addition to KCR, Blue Line and Brown Line are proposed as rail-base transit system, formulating North East – South West route and North West – South East route in cross shape. The two lines are very important for the future transit network. However, JICA will not finance rail-base urban transport system other than KCR in the short-period (-2020) because the scale of KCR is very large. Therefore, these lines cannot be selected as the F/S project.

There are other reasons that these lines were not selected as the F/S project. The preliminary economic analysis shows that it is not the time to start the construction of the lines in view of the economic viability. In addition, the present institutional system, in which even the introduction of CNG buses on streets is taking time, is not capable to deal with urban rail system. The capacity of the organization should be developed in step-by step manner, and the experience of KCR will be fully utilized for the establishment of the proper authority in the future.

The JICA Study Team had several meetings with KMTC regarding the project for the F/S based on the policy about Japanese ODA to Pakistan in consultation with JICA. It was concluded that BRT routes of Green Line and Red Line would be the F/S projects. Although the JICA Study Team had been informed by KMTC that BRT would be financed by ADB, there has been no progress of BRT project by ADB, and the F/S by JICA would not cause any contradiction among the international agencies.

The reason of the selection of Green Line and Red Line among the six BRT routes in the master plan network is:

- **Green Line:** This is a high demand corridor toward the future development area in the north and mass transit system along this corridor would increase boarding to KCR.
- **Red Line:** This is also a high demand corridor, connecting Mazar Area, Civic Center and universities. This route can reach Mazar Area without difficult section and implementation would be easier than other lines. In the future, extension to Education City can be considered.
- **Yellow Line:** Demand is very high along this line. However, further study is required for this line about terminal point with KCR and the crossing of Malir River. In addition, under the present situation, it is difficult for international consultants to conduct a study along this corridor due to safety reason.
- **Aqua Line:** This line depends on the urban development of Hawaks Bay. Therefore, it should be studied in connection with the development.
- **Orange Line:** Demand is very high along this line. However, as same as Yellow Line, it is difficult for international consultants to conduct a study along this corridor because of unstable law and order situation.

Chapter 10 Project List for Possible JICA Assistance

10.1 Type of Possible JICA Assistance for KUTMP 2030

10.1.1 Type of JICA Assistance

Japan's ODA (Official Development Assistance) consists of bilateral aid, in which assistance is given directly to developing countries, and multilateral aid, which is provided through international organizations. JICA provides bilateral aid in three forms of Technical Cooperation, Japanese ODA Loans, and Grant Aid.

Technical Cooperation assists raising technology level and establishing the new system through human resource development and technology transfer. Grant aid assistance aims to provide finance as for public facility construction such as school and hospital, procurement of materials necessary for education and medical treatment, and disaster restoration. ODA Loan is an aid to extend funds necessary for development with low and long-term interest. Its scheme includes not only economic and social infrastructure implementation such as highway construction projects, but also software assistance like commodity loan.

10.1.2 JICA Assistance in Pakistan

Japanese government started providing ODA cooperation to Pakistan in 1960s. Since the latter of the 1990s, this cooperation has been focused on social sector, economic infrastructure, agriculture and the environment.

According to "Japan's Country Assistance Program for Pakistan", formulated in February 2005, Japan has established its medium- and long-term goal for this support as 'Construction and Development of a Sustainable Society.' Under this goal, following three directions has been set,

1. Ensuring human security and human development (mainly in the area of education and health),
2. Development of a sound market economy (agricultural sector, diversification of industries, economic infrastructure),
3. Achievement of balanced regional socio-economic development (enhance the economy in Karachi, development of Peshawar economic area, etc.).

Transportation facility plays a key role for economic development, and Karachi city is glaringly the biggest economic city in Pakistan. Thus, as Direction 2) and 3) saying, development of transportation infrastructure in Karachi city is one of the most essential issues in ODA program for Pakistan.

10.1.3 Proposed type of JICA Assistance for KUTMP 2030

The master plan period of KUTMP 2030 is approximately 20 years. JICA is expected to assist KUTMP 2030 in short-term, mid-term, and long-term.

Development of MRT systems accounts for a large portion of the investment in KUTMP 2030, and it is difficult to finance the proposed MRT systems by its domestic budget for Karachi. It is proposed to introduce loans from international development banks such as World Bank, ADB, JICA, and other banks for infrastructure development of MRT systems. JICA can assist the KUTP 2030 by providing loans to KCR. Considering the loan portfolio of JICA, providing loans to other MRT systems in parallel with KCR in short-term period would not be realistic. The future investment on other MRT corridors after the short-term period would be one of the candidate projects.

In addition to infrastructure development, institutional development is important in KUTUP 2030. CDGK has enough experiences in road development, but its capacity on mass transit development need international assistance. From this, technical cooperation to the institutional development by JICA is proposed. To enhance the capacity of implementation agency, trainings by JICA are also proposed.

10.2 Proposed List of JICA Assistance

10.2.1 ODA Loan

Mass transit development needs a large-scale financing in good condition. There is no mass transit project in KUTMP 2030 which can be commercially feasible – all projects need public support even in a Public-Private-Partnership scheme. KCR, MRT, and BRT in KUTMP 2030 are the candidate for ODA loan.

Road projects such as flyover construction, road widening, local road development and other minor projects play an important role in the transport sector although these projects are scattered over Karachi. These projects can be financed by the government budget, and the necessity of using ODA loan is small. On the other hand, an integrated approach is recommended for some road projects by packaging them. For example, signalling projects at intersections should be integrated as one package project. Road network development with adequate drainage system including rehabilitation in a specific area such as industrial zones and suburban development areas is also considered as one package project.

The following projects are the proposed projects in KUTMP 2030 for candidates of ODA loan. Note that this is only proposal in KTIP and does not mean the commitment from JICA.

- KCR (Circular route): short-term
- KCR (extension): mid-term
- BRT: mid-term
- MRT: long-term
- Expressway: mid-term
- Industrial Road Network short-term

10.2.2 Technical Cooperation

The following technical cooperation is proposed.

- Support for establishment of Karachi Mass Transit Authority (KMTA)
- Support for station plaza development
- Support for road planning using the demand forecast model developed in KTIP
- Support for capacity development of urban planning using GIS system

10.2.3 Training

The following trainings are proposed.

- Training of operation and maintenance