6.5 Depot Facility

According to the operation program of both corridors, there are three locations for depot facility identified by the government, and another section of this report should be more definitive about the information to refer. The same section describes the depot facility from the operation point of view so that this section particularly discusses more in architectural definition and program of depot facilities.

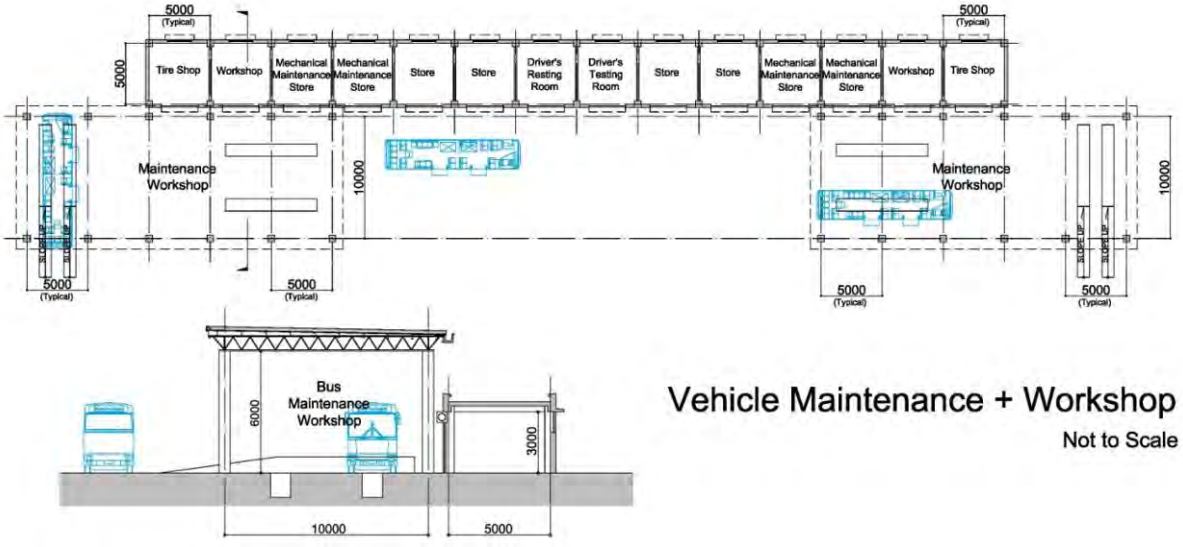
6.5.1 Size

Depot facility layout and size of the space are both calculated and designed on the basis of operation program and the number of vehicles. The size of depot land should accommodate efficiently and sufficiently for both maintenance as well as operation facilities required and a large number of vehicles which should be over two hundred in quantity for each corridor.

According to the projected quantity of vehicles for each corridor, ideal area size for one depot should be approximately 10 acre (4 hector). The area, however, may be reduced in smaller size if careful layout study and design are achieved in the definitive design stage. Where the depot land is smaller and split into several locations, the package of the facility and parking space shall be carefully analyzed in order to best design the function with operation program. For example, a main overnight parking space, if split, needs to be arranged with a drivers' accommodation, a mosque, security watch blocks and operators' secondary office blocks.

6.5.2 Facilities

Service facility should include major maintenance and minor maintenance workshops, fuel supply station, vehicle washing yard, tire stores and maintenance storages. Operation should require a depot administration office, operator's offices and a short term accommodation facility for drivers and mechanics including restrooms, canteen and short term bedding space because of projected operation hours.



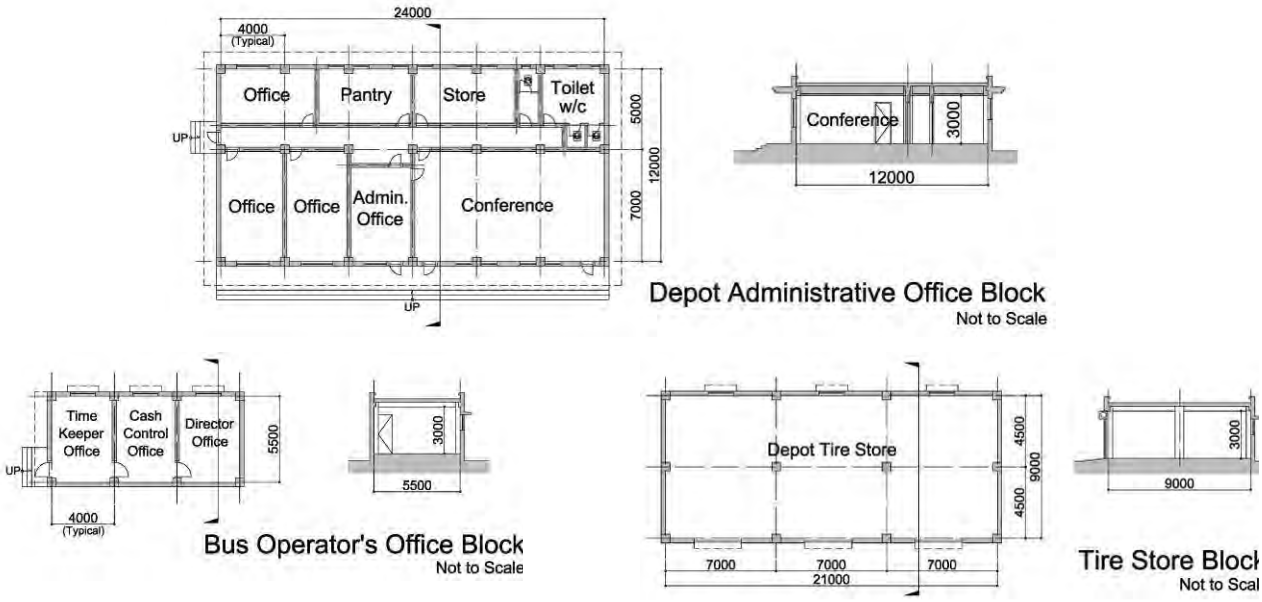
Source: Illustrated by JICA Study Team

Figure 6-5-1 Vehicle Maintenance and Workshop

Sewer system and drainage facility shall be prepared. Connection to public sewer system may be designed if there is nearby system existing to discharge waste water excluding oil mixed waste water from vehicle washing and workshops. Percolation pit may be considered for waste water discharge from the site into the earth if there is no public sewer system to connect. For toilet facility, a septic tank package installation may be considered from sanitary control point of view. In order to collect washing water for possible reuse or recycle, soiled washing water collection pit should be

prepared near vehicle washing facilities. Such system shall also include oil separation or collection system at depot site in order to ensure controlling oil mixed water under the environmental quality and impact management.

Administrative and operator offices may be air conditioned by split type equipment based on the operation requirement so that calculated power supply is necessary.

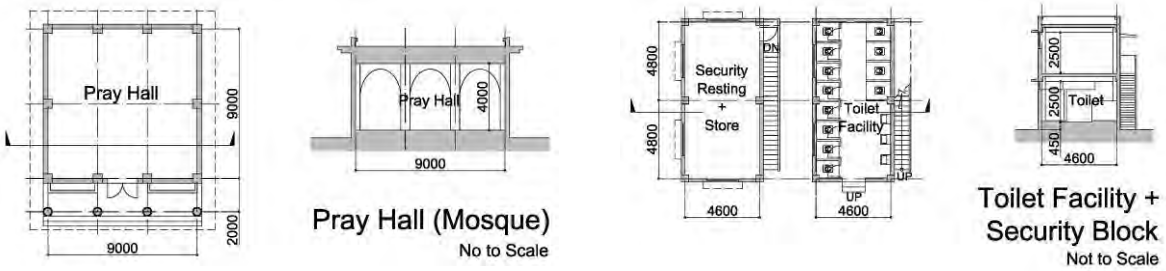


Source: Illustrated by JICA Study Team

Figure 6-5-2 Administrative Office, Operator's Office and Store Block

In addition to these, there should be a pray hall (mosque) and a security office as well as watch towers for security control required.

Typical depot facility block program and finish schedule are attached as appendix for reference. The final facility requirement shall be studied and finalized in connection with the government decision and consent.

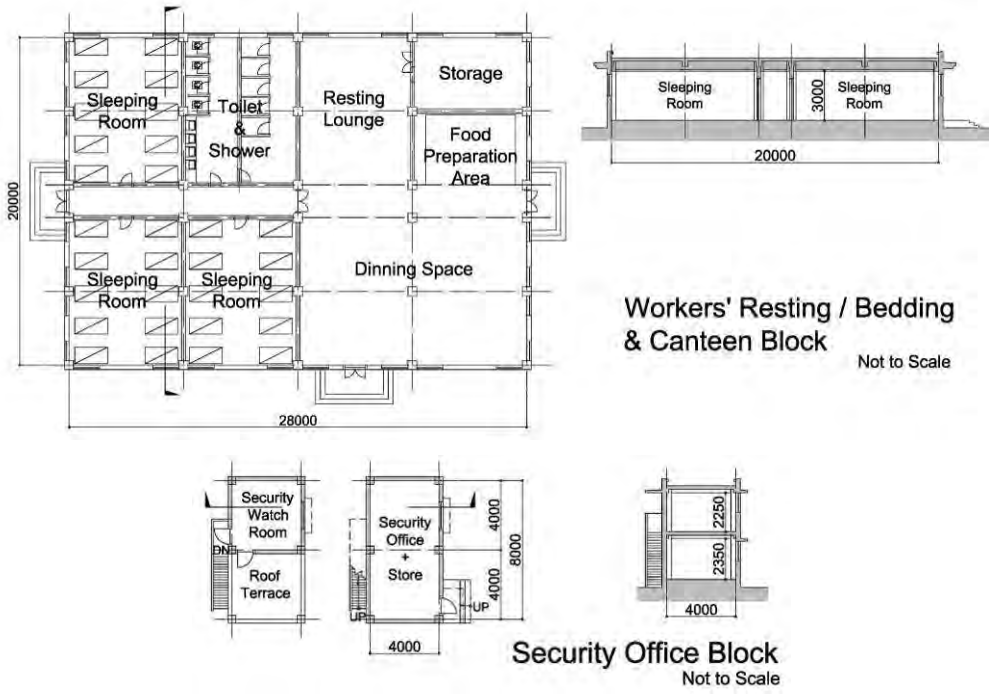


Source: Illustrated by JICA Study Team

Figure 6-5-3 Pray Hall (Mosque), Toilet Facility and Security Block

A Prayer Room (mosque) shall be provided in order to fulfill cultural requirement in this country, and the facility may be located nearby administrative zone and particularly driver/mechanic accommodation building. This is, however, not considering highly decorated or landmark type aesthetic approach for design, rather simple and minimum spatial program.

Driver/mechanic accommodation facility is to take care of not only drivers but also maintenance personnel who may need to stay overnight because of the operational needs and high level schedule management. A canteen for their daily food preparation, toilet, and minimum bathing facility may also be prepared. Because of overnight shift, there should be a need of bedding facility in a certain number of person even including operator if necessary.



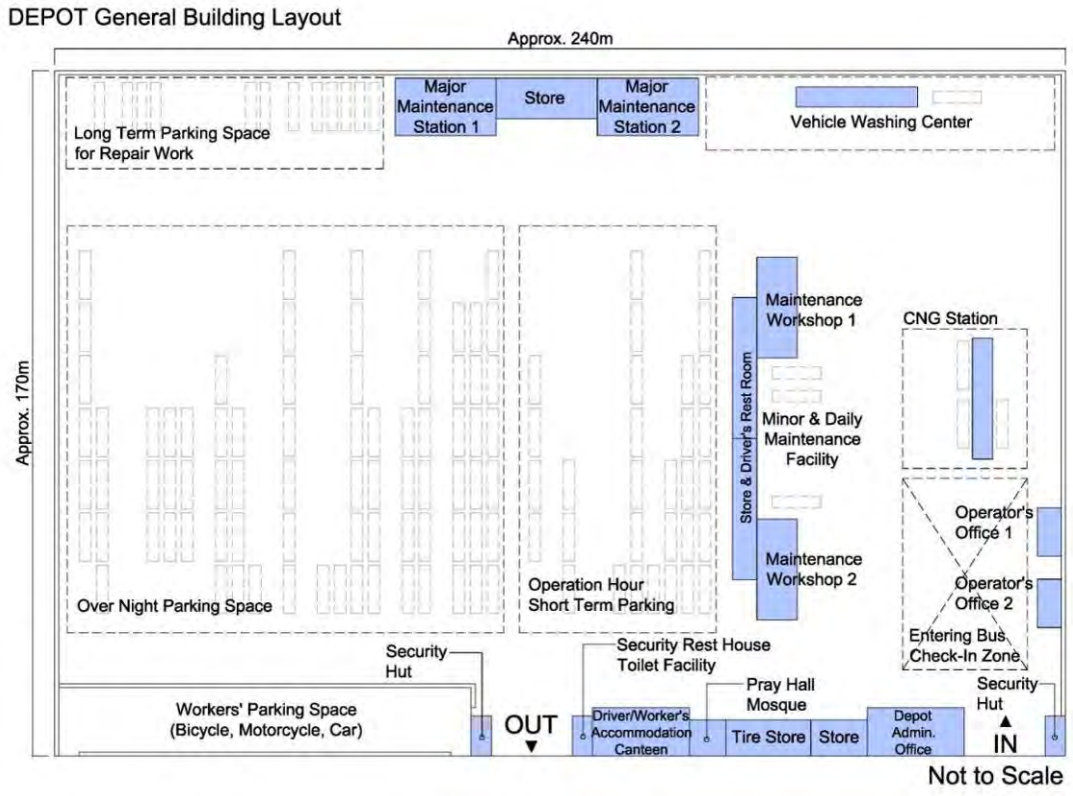
Source: Illustrated by JICA Study Team

Figure 6-5-4 Worker's Resting/Bedding & Canteen Block and Security Office Block

Many drivers, maintenance crews and operators may be commuting to the facility by their own motorcycles or bicycle, and some may drive cars to the depot. The facility may expect visitors and guests for any occasion. Thus, minimum yet sufficient parking spaces for these vehicles and bicycles shall be arranged within or adjacent location of the depot land for convenient and effective operation program.

6.5.3 Layout of Facility

The depot land will be divided into three major zones: vehicle parking area, maintenance area and administrative area. Parking section should be further subdivided into overnight parking, short term parking and long term parking for broken vehicles. Maintenance section should be arranged with vehicle check zone, fuel station, washing yard (maybe with automated washing machine), major and minor maintenance workshops and storage section. Administrative section should contain a depot administrative office, operator offices, storages, a toilet facility, a driver/mechanic accommodation facility including canteen, a Prayer hall and a security office and watch towers.



Source: Illustrated by JICA Study Team

Figure 6-5-5 Depot General Building Layout

Vehicle entry and exit should be effectively segregated with independent security control, and exit way from the main parking space should be close and possibly direct.

Vehicle driving pattern and procession shall be well planned based on the operation program so that the smooth flow of vehicles can be achieved without disturbance to maintenance activities.

Each entry and exit of depot compound should be gated with the security office or watch tower, and security guards should periodically check around the facilities as well as depot perimeter to maximize security of the depot.

6.6 Intermodal Transfer Facility

6.6.1 Bus Stop for Feeder/Existing Bus

The proposed BRT system is characterized as "Trunk and Feeder" system. The BRT buses run along major arterial roads only providing high frequency, high speed, and high capacity transport system, while the feeder services collect passengers from various areas in Karachi. Passengers need to transfer between feeder buses and the BRT buses at BRT stations. For convenient transfer between the two modes, bus bays of feeder buses should be properly constructed adjacent to the BRT stations.

(1) Selection of Bus Bays Locations

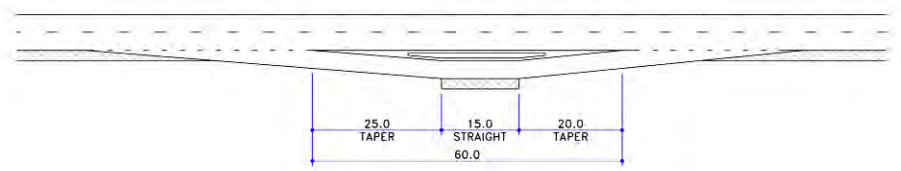
Intermodal facilities between BRT and feeder services should be located near intersections where feeder bus routes are crossing. Existing bus routes were considered as proper routes of the feeder services. Figure 6-6-1 shows candidate locations of the intermodal facilities together with existing bus network.

Source: Illustrated by JICA Study Team

Figure 6-6-1 Existing Feeder Bus Stop

The bus bays should be located out of mixed traffic lanes so that boarding and alighting of feeder buses does not affect the traffic of other vehicles. A bus bay area needs stopping area, tapers (entrance and exit), and deceleration and acceleration lanes, and a shelter (or benches). Figure 6-6-2 shows the layout plan of the bus bays.

Locations of the bus bays were selected from the candidate locations in Figure 6-6-1 by assessing whether the location has enough space for the development of a bus bay using the topographic survey data.



Source: Illustrated by JICA Study Team

Figure 6-6-2 Layout Plan of Bus Bay

Table 6-6-1 shows the selected locations of the bus bays.

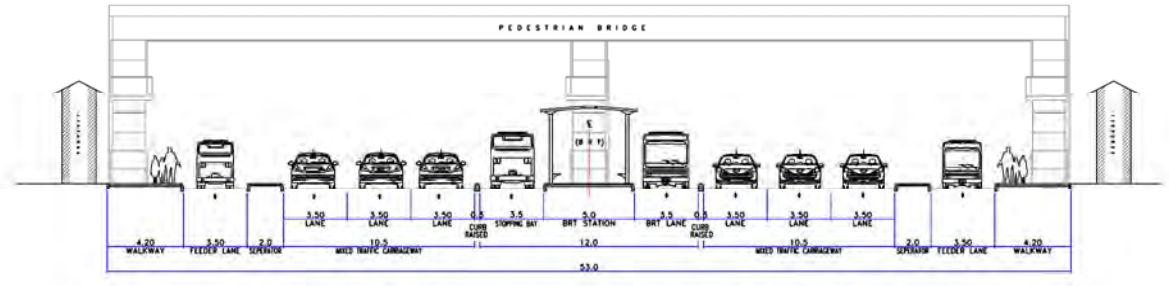
Table 6-6-1 Proposed Location of Bus Bay

Km	Station No.	Installation Location
Green Line		
6+000	G-04	Separation Band Traffic Island
6+450	G-05	Separation Band Side Walk
7+590	G-06	Separation Band Side Walk
9+660	G-09	Traffic Island
12+880	G-13	Traffic Island
15+200	G-16	Separating Band
18+850	G-21	Existing Bus Terminal
20+250	G-22	Separating Band
Red Line		
2+340	P-3a	Open Space
2+200	R-04	Sidewalk
4+400	R-06	Sidewalk
7+720 7+840	G-06	Traffic Island Sidewalk
9+100	R-09	Sidewalk Open Space
14+150 +150	R-15	Open Space
20+300	R-17a	Proposed Depot Area

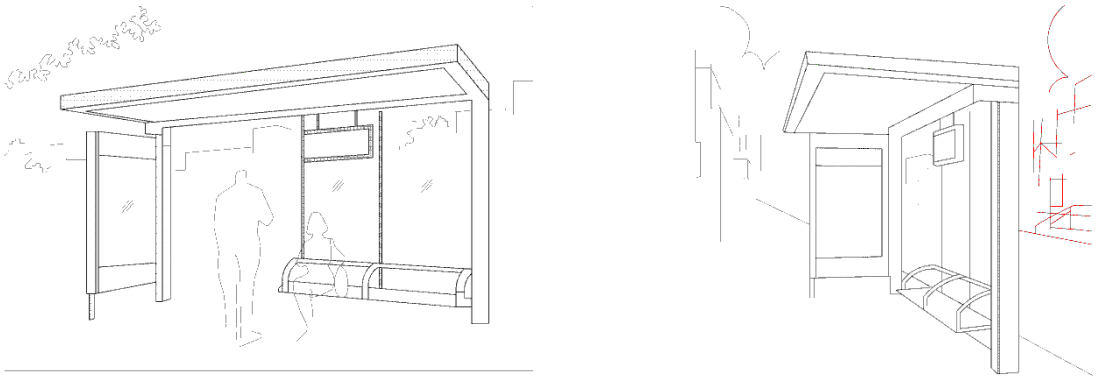
Source: JICA Study Team

(2) Concept Plan for Feeder/Existing Bus Station

According to the infrastructure design in this study, the BRT station is located on the center of the street. The passengers will access from BRT station to the feeder/existing bus station with pedestrian deck. The bus stop will be located near the entrance of the pedestrian deck extended from BRT station to side strip. The design of cross section and bus stop for feeder/existing bus is described as bellow.



Cross Section



Feeder Bus Stop Design

Source: Illustrated by JICA Study Team

Figure 6-6-3 Concept plan for Feeder/Existing Bus Station

6.6.2 Transfers between BRT and KCR

There are two transfer points between KCR and BRT as:

- Gulushan-e-Iqbal Flyover Area, and
- North Nazimabad Flyover Area

(1) Gulushan-e-Iqbal Flyover Area

The area around Gulushan-e-Iqbal Flyover and NIPA intersection will be a major transfer point when KCR and BRT are developed. NIPA intersection is a very busy transfer point of existing buses along Universtity Road and Rashid Minhas Road. A KCR station is planned to be located near the intersection.

1) KCR and BRT

Pedestrian decks cannot be constructed between BRT and KCR stations at this place because there is no space between the existing flyover and the building along the Rashid Minhas Road. Therefore, intermodal access between BRT and KCR should be provided by improving the pedestrian walk way.

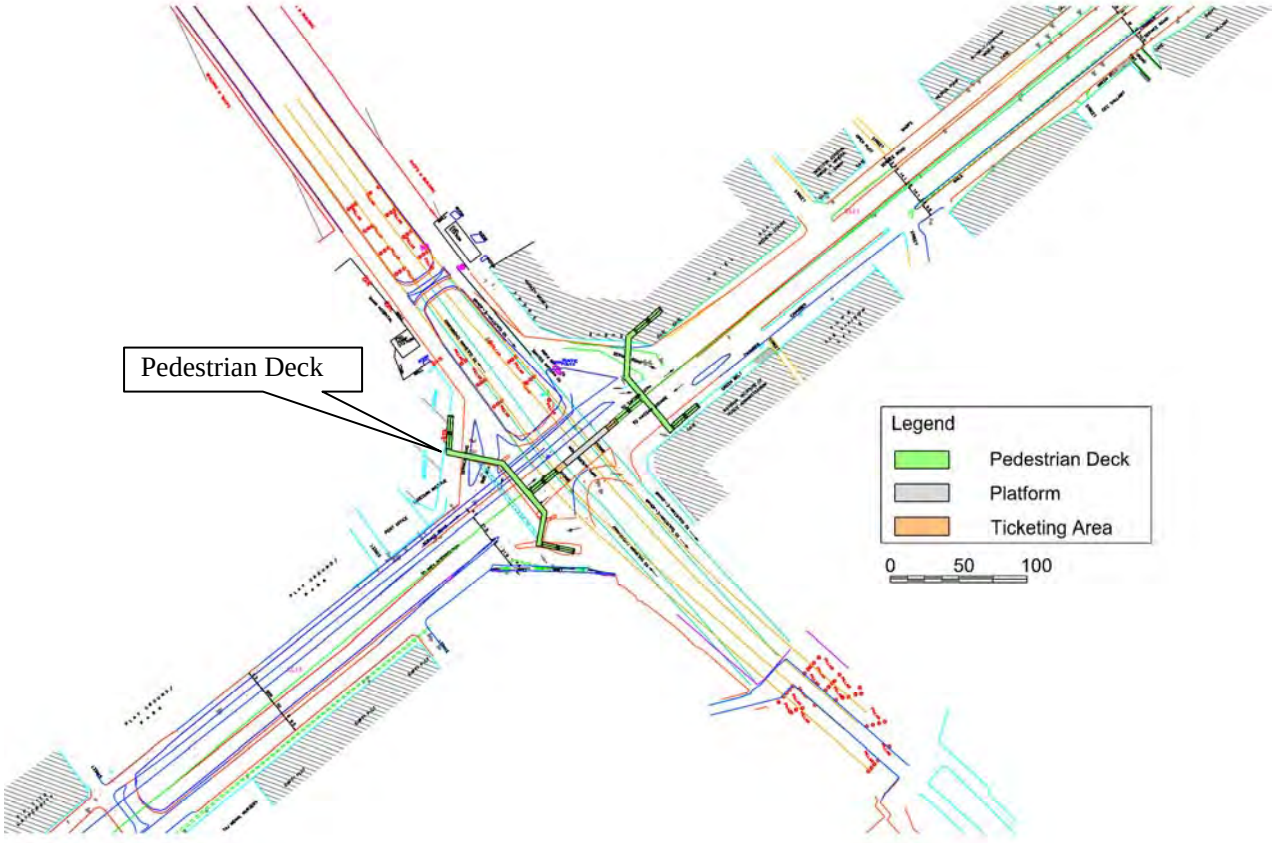
2) BRT and Feeder Transport

There are four bus stops around the Gulushan-e-Iqbal Flyover as shown in Figure 6-6-4. These bus stops are concentrated at each corner of the intersection between Rashid Minhas Road and University Road.

The BRT station will be connected to these bus stops by pedestrian decks as shown in Figure 6-6-5.

Source: Photo by JICA Study Team

Figure 6-6-4 Existing Feeder Bus Stop around Gulushan-e-Iqbal Flyover



Source: Illustrated by JICA Study Team

Figure 6-6-5 Pedestrian Deck Connection between BRT Station and Feeder Bus Stop

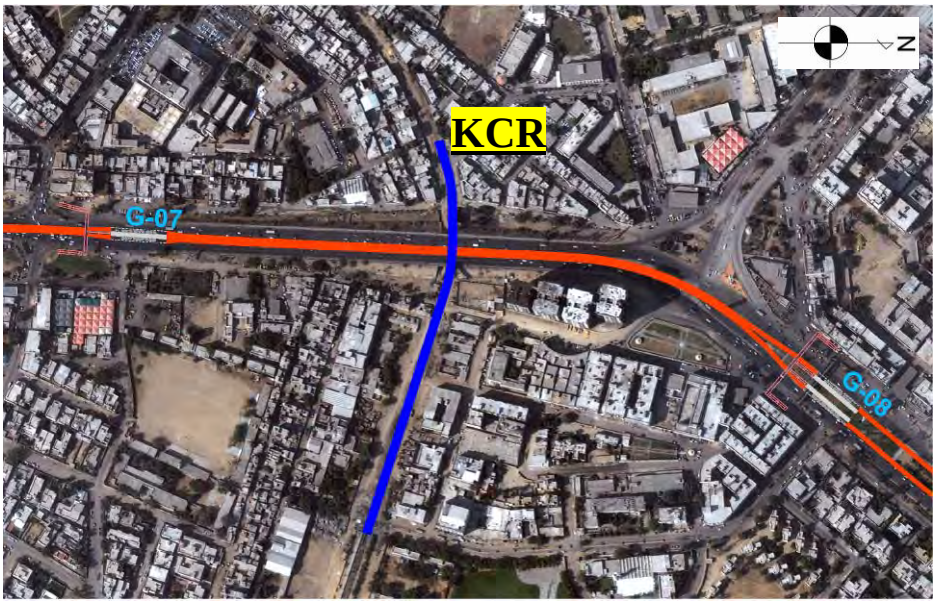
(2) North Nazimabad Flyover Area

1) Present Condition

North Nazimabad Flyover is located near A.O. Clock Tower. The KCR track runs under the flyover. There are many existing bus routes from New Karachi, North Nazimabad, and Orangi. A KCR station, North Nazimabad Sation, will be located near the flyover. The busway of Green Line is planned to be located in the center of the flyover.

There is space in front of North Nazimabad Station, which is once used as a station plaza. After the termination of the operation of KCR, the access road to this staion plaza is lost due to development as a residential area. It is desirable that BRT station is directly connected to the station plaza. However, it will require access road development including resettlement, and it would be difficult. Construction of the BRT station on the flyover will enable direct connection between BRT and KCR stations but there is no space available for the station on the flyover.

North Nazimabad Flyover
Photo: JICA Study Team



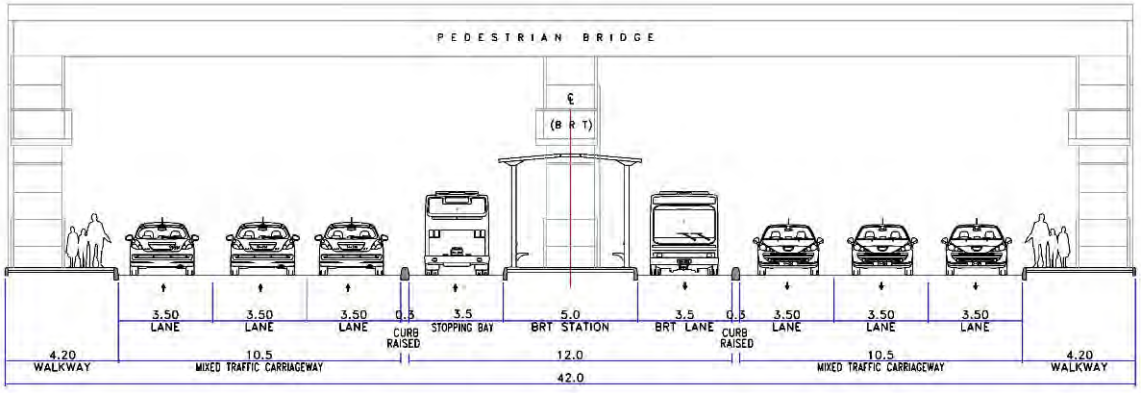
Source: Illustrated by JICA Study Team

Figure 6-6-6 North Nazimabad Flyover

2) Intermodal Connection

KMTC proposed demolishing the flyover and constructing KCR as elevated structure to KUTC (Letter No. 63-1/KMTC/KUTC-KCR/2012/10). If KCR is elevated over the crossing road, the transfer between KCR and BRT will be more convenient.

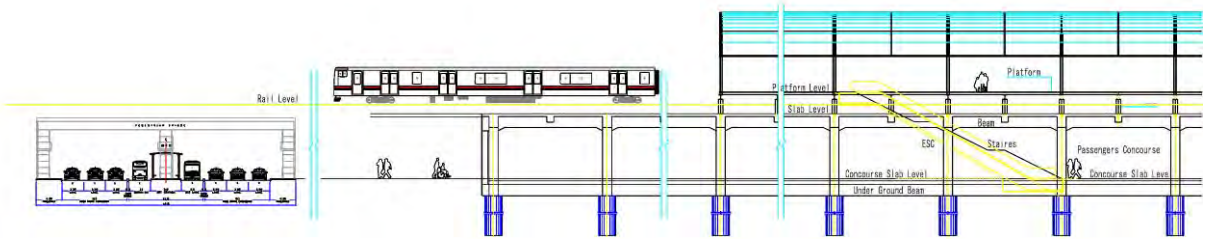
Figure 6-6-7 shows the cross section design of Green Line at-grade under the elevated KCR.



Source: Illustrated by JICA Study Team

Figure 6-6-7 Cross Section of Station under KCR

Figure 6-6-8 shows the connection between the BRT station and KCR station. Although the transfer needs three vertical movements (BRT station -(1)- Pesdestrian Deck -(2)- Ground -(3)- KCR platform), the distance between two stations is shorter, and pedestrian route is more convenient compared to the plan when the flyover is reconstructed over the KCR line.



Source: Illustrated by JICA Study Team

Figure 6-6-8 Conection of BRT Station and KCR Station

The interspace under the railway pier will be open space, and the access road along the railway track will be constructed as a dedicated walkway from BRT to KCR. This open space can be exploited for commercial use.

Figure 6-6-9 shows an example of commercial use under the viaduct of Hinode Station of Keikyu Corporation in Japan. There are a lot of cases of utilization of parking lots for cars or bicycles because such facilities use only a narrow space between piers. The area under the elevated structure can provide small-scale spaces for locally-based activities without large-scale development.

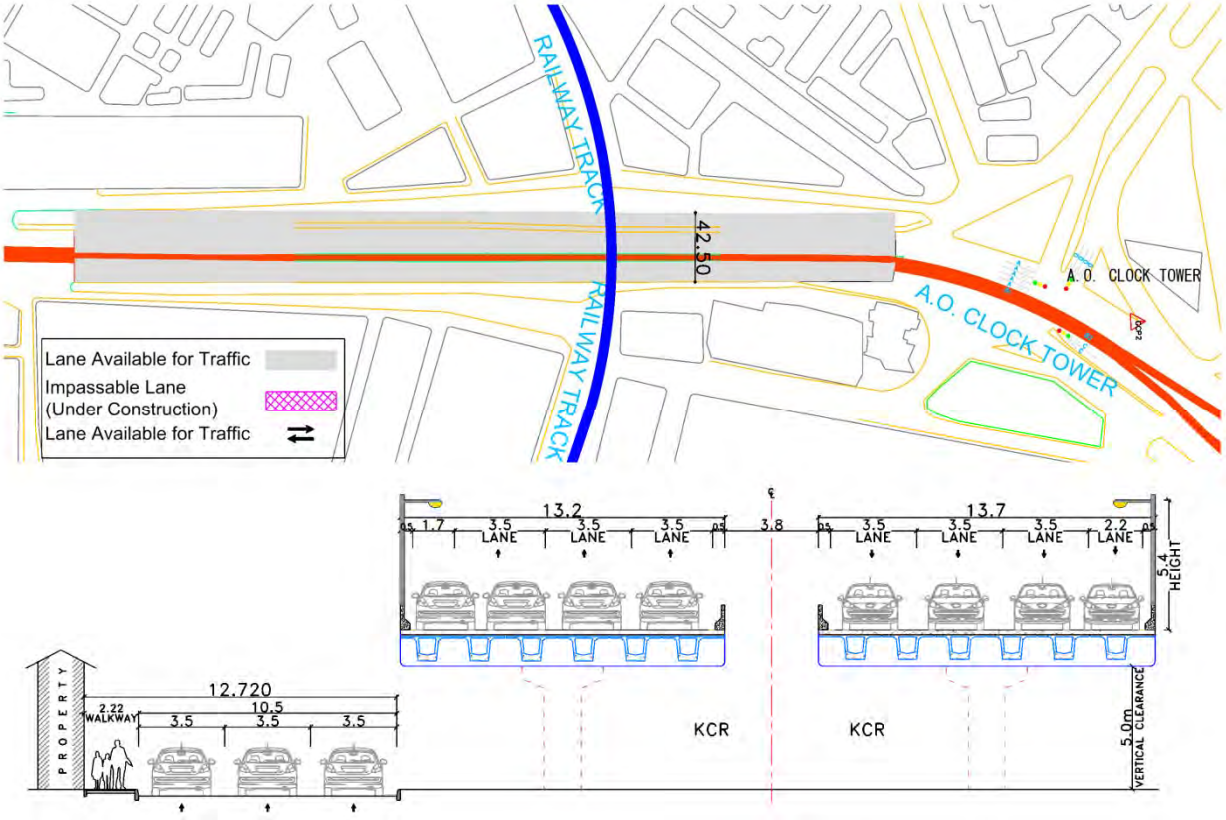
Although the distance between KCR and BRT stations will be as long as 200m even if the flyover is demolished, the commercial use under the structure can reduce psychological distance.

Source: Website of Ministry of Land, Infrastructure, Transport and Truism (URL; http://www.mlit.go.jp/)

Figure 6-6-9 Case Example of Commercial Use under Viaduct

3) Method of Flyover Removal

Since the traffic on the flyover is heavy, and Shahra-e-Sher-Shar-Suri Road is the one of the most important arterial roads, negative impact on the traffic during the removal work should be minimized.



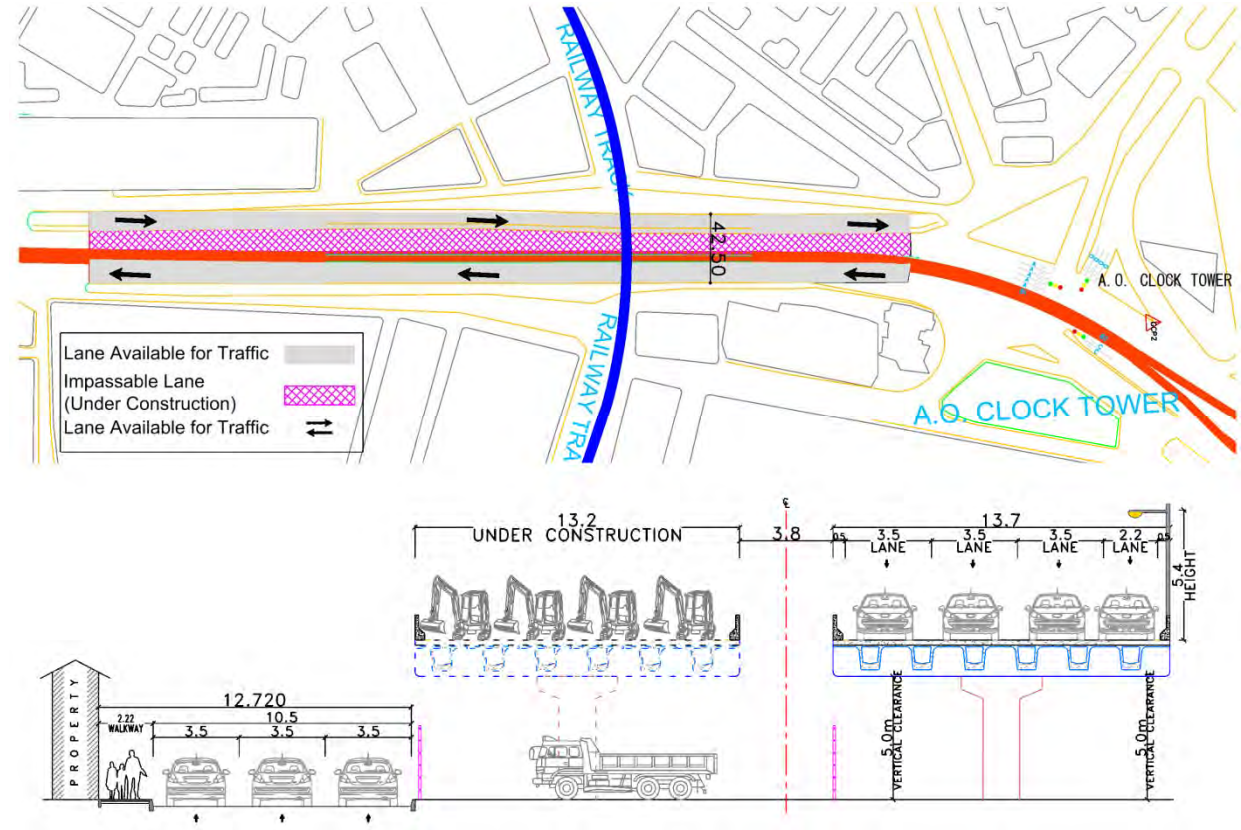
Source: JICA Study Team

Figure 6-6-10 Present Condition of North Nazimabad Flyover

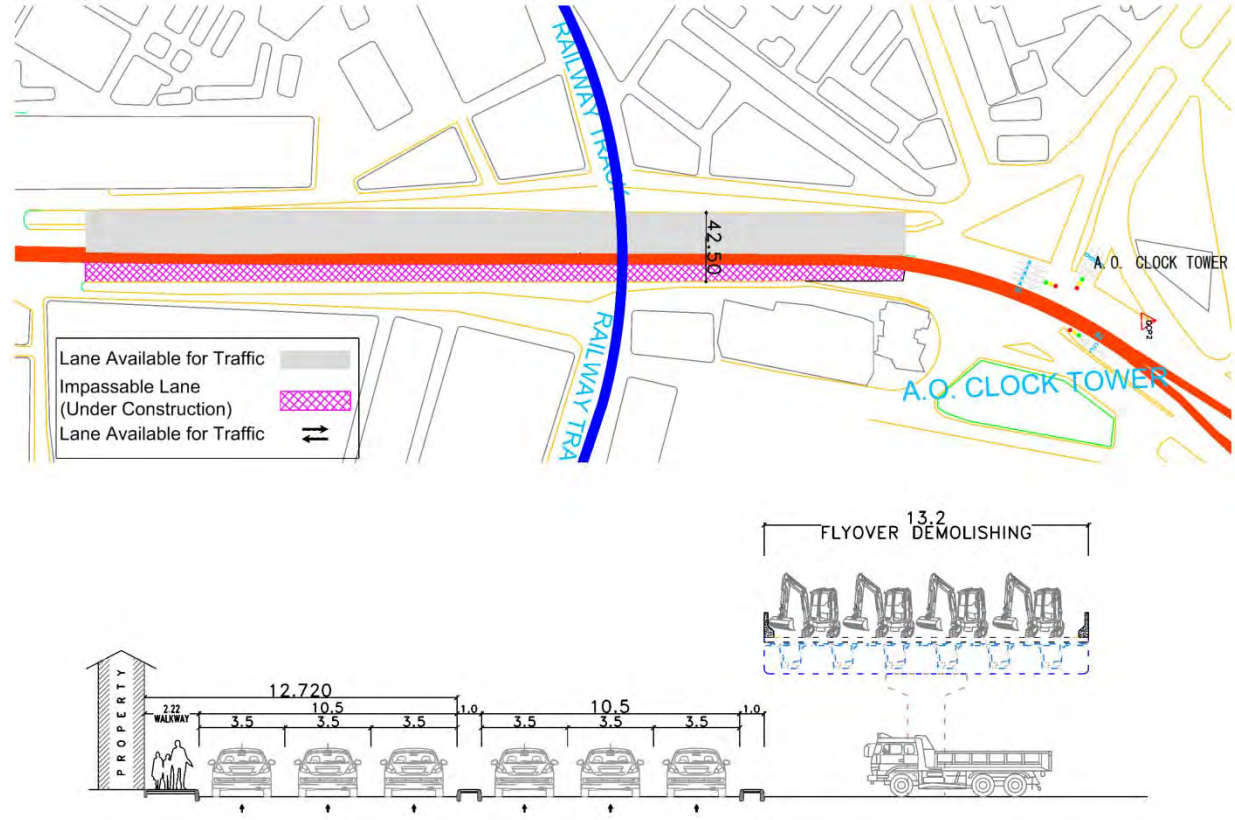
The construction work is illustrated in Figure 6-6-10. The top figure shows the present cross section of the flyover. The width of the road is 42.5m including a service road on the west side of the flyover. Sine the flyover consists of two independent structures, it is possible to demolish the flyover in different stages.

First, the service road will be converted to a temporary road for the northbound traffic. The southbound traffic will continue to use the present flyover. The west side of the flyover will be removed, and at-grade road will be constructed.

Secondly, the flyover on the east side will be closed. The northbound traffic will still use the temporary road, while the southbound traffic will use the constructed at-grade road on the east of the temporary road. After the flyover on the east side is removed, the busway and the BRT station will be constructed.



Stage 1: Removal of Western Flyover



Stage 2: Removal of East Flyover

Source: JICA Study Team

Figure 6-6-11 Method of Demolishment of Existing Flyover

6.7 BRT Infrastructure Construction Cost Estimation

6.7.1 Scope of Cost Estimation

This cost estimation was carried out based on the following scope:

- The BRT infrastructure cost to be estimated in this paragraph is defined as an initial capital cost covering all the necessary costs to construct a complete infrastructural facility of BRT system, excepting procurement costs of the bus fleet with spare parts that are separately estimated in another paragraph of this report.
- The infrastructure construction cost is to be estimated at the price of the project inaugural year of December 2011, which was predetermined for project economic valuation. Also, the cost estimation does not include any contingency reserves for project management cost, transaction tax, price escalation, and consulting service fee.

6.7.2 Estimation Methodology

(1) Costing Items

Costing items for the infrastructure construction cost were defined using examples from the BRT Planning Guide 2007[1], and which should include the following work categories:

- Runway and Station Infrastructure (construction of BRT busway)
- Integration Infrastructure (related infrastructural construction associated with BRT such as road, intersection, pedestrian bridge, etc.)
- Fare System and ITS (fare vending/collection and intelligent transportation systems for BRT operation)
- Other Infrastructure (terminal, depot, control center etc.)
- Relocation Public Utilities (power pylons on a segment of BRT corridor)
- Property Acquisition (mainly for installation of pedestrian bridge ramps)

(2) Collection and Processing of Cost Data

1) Infrastructural costs

Most of infrastructural cost data were collected from the CDGK's past projects, and such projects included road rehabilitation, overpass and underpass construction, intersection improvement, pedestrian bridge installation, and bus-stop installation. Where there is a lack of cost information from CDGK's past projects, the cost data from NHA (National Highway Authority) of Pakistan and those from BRT Planning Guide 2007 were supplementarily used.

Corresponding to the costing items selected, relevant construction costs and quantities were sought out from the past project documents to obtain unit costs and quantities with respect to the cost items. In this case, quantities were expressed by linear or areal unit for simplification of project quantity description.

Price escalations were applied to the unit costs to estimate the unit costs as of December 2011. The price escalation rates were calculated from the Wholesale Price Index (WPI) as shown in Table 6-7-1.

Finally, various unit costs acquired through the above process were combined into more aggregated cost units, such as BRT runway per kilometer, station per number by types, land acquisition per square meter, etc.

[1] Bus Rapid Transit - Planning Guide 2007, Institute for Transportation & Development Policy, USA

Table 6-7-1 Whole Sales Price Index (WPI)

Year	Whole Sales Price Index (WPI)
2007-08	100.00
2008-09	118.96
2009-10	135.40
2010-11	164.16
2011-12	176.01

Source: Cost Escalation Rate Monthly Review on Price Indices, October and December, 2011 (Base 2007-08) Government of Pakistan, Statistic Division, Federal Bureau of Statistics

2) Relocation public utilities and property acquisition costs

These costs information was collected by Pakistani staff through telephone asking to KESC (Karachi Electric Supply Corporation), CDGK's land department, and some real estate offices.

3) Fare system and ITS costs

The following systems were proposed for cost estimation:

- Fare payment medium to use magnetic strip vending machines in addition to coin and token system per station, and
- Bus operation control system with GPS technology.

Since the systems proposed above have not been planned in detail, the costs thereof were estimated in a lump sum referring to the sample costs suggested in the BRT Planning Guide 2007.

(3) Estimated Unit Prices

The estimated unit prices are shown in Table 6-7-2 – Table 6-7-4

Table 6-7-2 Estimation of Unit Costs per Km (1)

Cost Data No.		Base Cost (PKR)	Quantity per Km or per Station: Length (m)	Width (m)	Nos	Quantity	Cost per Km or per Station (PKR)	Specification Assumed	Data Source
Busway Infrastructure									
Runway and Station Construction									
1	At-Grade Runway	4,100 /sq.m	1,000	8.75	1	8,750	35,880,000 /km	Concrete pavement 30 cm assumed	CDGK
2	Elevated Runway Viaduct	79,000 /sq.m	1,000	8.25	1	8,250	651,750,000 /km	Concrete bridge with precast girders	CDGK
3	Elevated Runway Viaduct (U-turn lane ; Single la	79,000 /sq.m	1,000	6.80	1	6,800	537,200,000 /km	Concrete bridge with precast girders	CDGK
4	Elevated Runway Viaduct (Platform)	79,000 /sq.m	1,000	7.40	1	7,400	584,600,000 /km	Concrete bridge with precast girders	CDGK
5	Ramp (Elavated to At-grade : Retaining Wall)	27,000 /sq.m	1,000	8.25	1	8,250	222,750,000 /km	Retaining Wall Structure	CDGK
6	Elevated Station Platform	55,000 /sq.m	56	6.10	1	340	18,700,000 /station	Platform Length 56 m x 6.1 m, 70 % of elevated runway	CDGK
7	Elevated Station Platform (Terminal)	55,000 /sq.m	100	8.00	1	800	44,000,000 /station	Platform Length 100 m x 8 m, 70 % of elevated runway	CDGK
8	Asphalt Pavement on Existing Bridge Deck	1,300 /sq.m	1,000	8.75	1	8,750	11,380,000 /km		NHA
9	Asphalt Pavement on Elevated Runway	1,300 /sq.m	1,000	8.25	1	8,250	10,730,000 /km		NHA
Lane Separators and Markings									
10	Separator Bars	1,610 /m	1,000		1	1,000	1,610,000 /km	Single both on at-grade and elevated runways	CDGK
11	Separator Blocks	830 /m	1,000		2	2,000	1,660,000 /km	Double on at-grade runway	CDGK
12	Lane Marking	740 /sq.m	1,000	0.20	4	800	590,000 /km	2 lines per BRT lane	CDGK
Meadian Tree Planting									
13	High-quality (1tree/10m + sculptures)	4,500,000 /km					4,500,000 /km		BRT Guide
Runway Lighting									
14	Electrical Lighting	208,600 /no.					6,950,000 /km	Lighting pole 30 m interval assumed	CDGK
Station Facilities									
Station Platform with Architecture									
15	Split Plantform	27,910 /sq.m	56	4.00	2	450	12,560,000 /station		StudyTeam
16	Double Platform	27,910 /sq.m	56	4.00	1	220	6,140,000 /station		StudyTeam
17	Landscape Platform	27,910 /sq.m	56	10.30	1	580	16,190,000 /station		StudyTeam
18	Elevated Double Platform	27,910 /sq.m	56	4.00	1	220	6,140,000 /station		StudyTeam
Other Station Facilities									
19	Sliding Doors at Boarding Interface	3,600,000 /station				1	3,600,000 /station		BRT Guide
20	Station Identification-Sign Post and Information E	340,000 /station				1	340,000 /station		BRT Guide
21	Information Kiosks	2,700,000 /station				1	2,700,000 /station		BRT Guide
22	Emergency Callbox	140,000 /station				1	140,000 /station		BRT Guide
23	Security Cameras CCTV	396,552 /station				2	790,000 /station		CDGK

Note: Sources are shown in the table

Table 6-7-3 Estimation of Unit Costs per Km (2)

Cost Data No.		Base Cost (PKR)	Quantity per Km or per Station Length (m)	Width (m)	Nos	Quantity	Cost per Km or per Station (PKR)	Specification Assumed	Data Source
Integration Infrastructure									
Pedestrian Access to Station									
24	At-Grade Crosswalk with Signal	1,800,000 /station			1	1	1,800,000 /station	4 m wide zebra crossing	BRT Guide
25	Pedestrian Bridge Deck	62,234 /sq.m	1	1.00	1	1	60,000 /sq.m	3 m wide 46 m long	StudyTeam
26	Ramp (At-grade station)	9,273,707 /nos	1	1.00	1	1	9,270,000 /nos		StudyTeam
27	Ramp (Elevated station)	12,070,690 /nos	1	1.00	1	1	12,070,000 /nos		StudyTeam
28	Stair Case	48,000 /sq.m	16	2.00	1	32	1,540,000 /nos		StudyTeam
Existing Road Interface									
29	Road Shift in the section with Pylon	4,200 /sq.m	1,000	7.00	1	7,000	29,400,000 /km		CDGK
30	Major Intersection Improvement with Signal	4,200 /sq.m	100	50.00	1	5,000	28,200,000 /intersection	Change intersection traffic operation	CDGK
31	Medium Intersection Improvement with Signal	4,200 /sq.m	40	40.00	1	1,600	13,920,000 /intersection	Change intersection traffic operation	CDGK
32	Minor Intersection Improvement with Signal	4,200 /sq.m	40	10.00	1	400	5,280,000 /intersection	Maintain intersection traffic operation	CDGK
33	Median Strip for Elevated Runway Columns	3,100 /sq.m	1,000	3.00	1	3,000	9,300,000 /km	3 m wide median strip for viaduct columns	CDGK
Fare and ITS									
Fare Collection Readers									
34	Magnetic Strip System (4 readers/station)	630,000 /station			1	1	630,000 /station		BRT Guide
Fare Collection Turnstiles									
35	Rotating Turnstile (4 No./station)	630,000 /No.			1	1	630,000 /station		BRT Guide
Fare Registering Unit/Vending Machine									
36	Magnetic Strip System	900,000 /machine			1	1	900,000 /station		BRT Guide
Fare Media									
37	Magnetic Strip Cards	5 /card			500,000	500,000	2,500,000 /station		BRT Guide
Fare System Software									
38	Magnetic System	27,000,000 /software			1	1	27,000,000 /Project		BRT Guide
Inteligent Transportation Systems (ITS)									
39	Green Light Phase Extension for BRT	1,800,000 /No.			1	1	1,800,000 /intersection		BRT Guide
40	Real-Time Infromation Displays	675,000 /station			1	1	680,000 /station		BRT Guide
Other Infrastructure Cost Items									
Control Centre (incl. software)									
63	Control centre physical construction	30,000 /sq.m	30	30.00	1	900	27,000,000 /Project		Hearing
65	GPS system (equipment and software)	90,000,000 /No.			1	1	90,000,000 /Project		BRT Guide
Terminals and Depots									
67	Depot	55,900,000 /No.			1	1	56,000,000 /Corridor	280x200 m	CDGK
68	Accessway to Depot	4,800 /sq.m	1,000	8.75	1	8,750	42,000,000 /km	Concrete Pavement 30 cm	CDGK

Note: Sources are shown in the table

Table 6-7-4 Base Cost Estimation

Work Type a	Data Source b	Cost Data Cost (Rp) c	Quantity d	UnitCost (Rp) e	DataYear f	GST	Escalation g	Unit Cost Dec 2011 (Rp) h	Specification
Cement Concrete Pavement	CDGK road rehabilitation project, from Shahrah-e-Noor Jehan to Ziauddin hospital								
	Eng. Estimate	49,172,165	3,308 cu.m	4,460 /sq.m	2010	16%	1.07	4,100 /sq.m	0.30 m Incl demolish and new construction
			14864.62	4,459			1.07	4,100	
Asphalt Pavement on Bridge	NHA Construction Price 2009								
Asphalt Pavement		10,060	0.10 cu.m	1,010 /sq.m					10 cm Class B
Prime coat		75	1.00 sq.m	80 /sq.m					
Scarification		50	1.00 sq.m	50 /sq.m					
				1,140 /sq.m	2009	16%	1.30	1,300 /sq.m	
Road Rehabilitation with Asphalt Pavement	CDGK interchange construction project, University Rd and Johar/Abulhassa Isphahani Rd								
	Eng. Estimate	53,084,920	16,000 sq.m	3,320 /sq.m	2008	16%	1.48	4,200 /sq.m	10 cm Asphalt thickness
	Eng. Estimate	33,278,788	12,000 sq.m	2,770 /sq.m	2008	16%	1.48	3,500 /sq.m	10 cm Incl drainage
Sidewalk/Median Construction	CDGK interchange construction project, University Rd and Johar/Abulhassa Isphahani Rd								
	Eng. Estimate	6,025,478	2,500 sq.m	2,410 /sq.m	2008	16%	1.48	3,100 /sq.m	6 cm concrete paver
	Eng. Estimate	3,998,351	2,500 sq.m	1,600 /sq.m	2008	16%	1.48	2,000 /sq.m	6 cm Incl demolish and new construction
Flyover Bridge	CDGK interchange construction project, University Rd and Johar/Abulhassa Isphahani Rd								
	Bridge Section 1	136,469,736	2,205 sq.m	61,900 /sq.m	2008	16%	1.48	79,000 /sq.m	10.5 m wide 210m long
	Bridge Section 2	63,656,780	1,040 sq.m	61,200 /sq.m	2008	16%	1.48	78,000 /sq.m	6.5 m wide 160 m long
	Ramp 1	44,820,518	2,100 sq.m	21,300 /sq.m	2008	16%	1.48	27,000 /sq.m	10.5 m wide 200m long
	Ramp 2	29,851,345	1,625 sq.m	18,400 /sq.m	2008	16%	1.48	23,000 /sq.m	6.5 m wide 160 m long
Underpass	CDGK underpass construction project, IBN-E-SINA Rd at Nazimabad Chowrangi No.2								
	Eng. Estimate	289,034,910	1 no.	289,030,000 /no.	2008	16%	1.48	368,800,000 /no.	4 lanes, inclu.civil and drainage works
Pedestrian Bridge including 2 staircases	CDGK pedestrian bridge construction project, Soharab Goth near Asif Square								
	Contract Price		Surface area	Assume					Incl. 2 staircases.
Main Truss		19,278,000	113 sq.m	170,900 /sq.m	2009	16%	1.30	192,000 /sq.m	Asume cost ratio 1:4
Staircases		2,263,000	53 sq.m	42,700 /sq.m	2009	16%	1.30	48,000 /sq.m	
Total		21,559,465	166 sq.m						
Electrical/Lighting	CDGK interchange construction project, University Rd and Johar/Abulhassa Isphahani Rd								
	Eng. Estimate	9,994,925	65 no.	153,770 /no.	2008	16%	1.48	196,200 /no.	per lighting pole
	Eng. Estimate	5,885,540	36 no.	163,490 /no.	2008	16%	1.48	208,600 /no.	Incl all lighting fixture and wiring
CCTV Installation on Intersection	CDGK upgradition of 40 signal intersections by installation of demand response system								
	Contract	1,828,450	4 no.	457,100	2011	16%	1.00	390,000 /intersection	4 cameras per intersection
Lane Marking	CDGK Transport & Communication Dept.								
	CDGK Price List	370,200	465 sq.m	800 /sq.m	2010	16%	1.07	740 /sq.m	2 mm thick 20 cm wide
Cat Eyes Stud	CDGK Transport & Communication Dept.								
	CDGK Price List	436	1 no.	1,740 /m	2010	16%	1.07	1,610 /m	4 no./m assumed
Kerb Concrete	CDGK Transport & Communication Dept.								
	CDGK Price List	166	1 ft	540 /m	2010	16%	1.07	830 /m	30x15cm convert to 30x25 cm Class B
Station Platform with Architecture	Study Team Estimate								
Single Face Plantform		7,252,700	1 no.	32,380 /sq.m	2012	16%	1.00	27,910 /sq.m	4 m wi 40 m long
Double Face Plantform		3,689,432	1 no.	16,470 /sq.m	2012	16%	1.00	14,200 /sq.m	4 m wi 40 m long

Note: Sources are shown in the table

(4) Estimation Result

The result of cost estimation for BRT infrastructures is tabulated below, with items considered for the estimation and unit price of each item calculated based on the methodologies described above.

Table 6-7-5 Estimated Construction Cost

Item	Amount LC (PKR)	Amount FC (JPY)	Unit	Green Line		Red Line	
				Quantity	Amount LC (PKR)	Quantity	Amount LC (PKR)
Runway Infrastructure							
AT-Grade Runway	39,740	-	/km	21.0	835,000	22.6	900,000
AT-Grade Runway on Existing Flyover/Bridge	13,580	-	/km	1.1	15,000	0.2	3,000
Elevated Runway Viaduct	673,980	-	/km	0.0	0	0.7	499,000
Elevated Runway Viaduct (U-turn: Single Lane)	550,130	-	/km	0.0	0	0.4	204,000
Elevated Runway Viaduct (Platform)	597,530	-	/km	0.0	0	0.2	90,000
Ramp (Embankment)	235,680	-	/km	0.0	0	0.1	19,000
Station Infrastructure							
AT-Grade Station Split Type	12,560	-	/station	5.0	63,000	0.0	0
AT-Grade Station Double Face	6,140	-	/station	14.0	86,000	24.0	147,000
AT-Grade Station Landscape	16,190	-	/station	8.0	130,000	0.0	0
Elevated Station Platform	24,840	-	/station	0.0	0	2.0	50,000
Electrical Lighting	6,950	-	/km	21.1	147,000	24.4	170,000
Integration Infrastructure							
At-Grade Crosswalk with Signal	1,800	-	/station	0.0	0	2.0	4,000
Pedestrian Bridge	60	-	/sqm	5,844	351,000	3,807	228,000
Access Ramp (At-grade)	9,270	-	/ No.	87.0	806,000	63.0	584,000
Access Ramp (Elevated)	12,070	-	/ No.	0.0	0	6.0	72,000
Staircase	1,540	-	/ No.	6.0	9,000	15.0	23,000
Road Shift along the section with Pylon	31,060	-	/km	7.2	224,000	2.2	68,000
Major Intersection Improvement with Signal	28,200	-	/ No.	1.0	28,000	0.0	0
Medium Intersection Improvement with Signal	13,920	-	/ No.	3.0	42,000	1.0	14,000
Minor Intersection Improvement with Signal	5,280	-	/ No.	5.0	26,000	4.0	21,000
Landscaping	4,500	-	/km	21.1	95,000	24.4	110,000
Fare and ITS							
Fare and ITS	1,068	6,000	/station	27.0	219,000	26.0	211,000
Green Light Phase Extension for BRT	1,800	-	/ No.	9.0	16,200	5.0	9,000
Other Infrastructure							
Depot Facility	56,000	-	/No.	1.0	56,000	1.0	56,000
Depot Civil Works	4	-	/sqm	49,400	203,000	27,600	113,000
Accessway to Depot	45,860	-	/km	0.9	39,000	0.9	41,000
GPS system (control center, equipment and software)	11,700	134,000	/Line	1.0	166,000	1.0	166,000

Source: JICA Study Team

Chapter 7 Environment and Social Considerations

7.1 Screening and Categorization of the Project

Category A projects defined by the JICA Guidelines generally include i) vital sectors, such as transportation, having sensitive characteristics, or ii) projects located in or around sensitive areas. Moreover, a project causing large-scale involuntary resettlement is classified under Category A project. A project is classified as Category B if potential adverse impacts on the environmental and society are less adverse than those of Category A projects.

As above there is a possibility that the Karachi Transportation Improvement Project (KTIP) could be classified as a Category B project since it is proposed to take place along the centre of the existing wide roads in the already developed area of Karachi and therefore there will be no involuntary resettlement involved in the project area.

According to Pakistan Environmental Protection Agency Regulation, 2000, a proponent of a project falling in any category listed in Schedule II shall file an EIA with the Federal Agency. Since the listed projects are generally major national projects and that they cause potential effect on a large number of people.

The KTIP Project is expected to be classified in the “Federal or Provincial highways or major roads (except maintenance, rebuilding or reconstruction of existing roads) with total cost of Rs. 50 million and above” in Schedule II. The Project needs to proceed into the official procedure for EIA approval prescribed in Pakistan legislation. Therefore, it is suggested that KMC, as the project proponent, should follow the necessary steps on the EIA before implementation of the project.

7.2 Scoping of the Environmental Impacts

Potential impacts on the natural and social environment during the pre-construction, construction and operation stages of the Project have been initially identified using the environmental scoping list and matrices. The results are shown in Table 7-2-1.

Table 7-2-1 Preliminary Scoping of Environmental and Social Impacts

Item	Pre-Construction / Construction Stage	Operation Stage	Description
Pollution control			
1. Air pollution	B-	B+	Some negative impacts on air quality are expected due to operation of heavy equipment/ vehicles as well as traffic jam incidental to construction works, although the expected impacts will be temporary during the construction stage It is expected that emission of air pollutants will be reduced due to the modal shifting of transportation from passenger cars/ buses to the new transportation system.
2. Water pollution	C-	D	Some impacts on water quality would be caused by the turbid water generated from construction yards of digging works, although the expected impacts will be temporary during construction stage. The facilities associated to the new transportation system will be operated according to the Pakistan regulations related to managing the Waste or effluent. Therefore, it is not expected to bring about the serious impacts on water quality in operation stage.
3. Soil Contamination	C-	D	There are no project components or activities, which cause the soil pollution. However, in case that the soil at the construction sites is already contaminated by other reasons, the construction activity of the Project may cause the negative impacts.

Item	Pre-Construction / Construction Stage	Operation Stage	Description
4. Solid Waste and/or Industrial Discharge	B-	D	It is expected that the Project will generate the construction waste in the construction stage. The solid waste from the facilities associated to the new transportation system will be managed according to the Pakistan regulations and guidelines concerned, then it is not expected to cause the serious impacts.
5. Noise and vibration	B-	B+	Some impacts of noise and vibration are expected due to the operation of the heavy equipment/vehicles, although the expected impacts will be temporary during the construction stage. It is expected that emission of noise and vibration will be reduced due to the modal shifting of transportation from passenger cars/buses to the new transportation system.
6. Ground subsidence	D	D	There are no project components or activities that may cause the negative impacts on the ground subsidence since there is no underground section..
7. Odor	D	D	There are no project components or activities that may cause the offensive odor.
8. Bottom sediment	D	D	There are no project components or activities that may cause the negative impacts on the water bottom/sediment to which aquatic life depends.
Natural Environment			
9. Geographical Conditions and Geological Conditions	D	D	Since the alignment of corridor is made along the existing trunk roads, it is not expected that the Project will bring about the significant change or impacts on geographical and geological conditions
10. Soil Erosion	D	D	Since the alignment of corridor is made along the existing trunk roads, it is not expected that the Project will cause soil erosion.
11. Flora	B-	D	There is a possibility of clearing a large number of trees on the road center's green-belt as well as the sidewalk where the stations and equipment for new transportation system are constructed.
12. Fauna	D	D	Negative impacts are not expected on the faunal ecology and biodiversity to be protected, since the most of the Project alignment is designed in developed urban area and out of protected areas.
13. Ground Water	D	D	There is no project component or activity, which would cause the significant change or impacts on the ground water in and around the Project area.
14. Water Body (River, Lakes, etc.)	D	D	There is no project component or activity, which would cause the significant change or impacts on hydrological conditions in and around the Project area.
15. Coastal Environment	D	D	There is no effect on the coastal environment in and around the Project area.
16. Oceanographic	D	D	There is no project component or activity, which would cause the significant change or impacts on Oceanographic conditions in and around the Project area.
17. Natural/Ecological Reserves and Sanctuaries	D	D	Negative impacts are not expected, since the Project alignment is designed in developed urban area and out of the ecological reserves and sanctuaries.
Social Environment			

Item	Pre-Construction / Construction Stage	Operation Stage	Description
18.Involuntary Resettlement	D	D	BRT system is proposed to take place along the centre of the existing wide roads in the already developed area of Karachi and therefore there will be no involuntary resettlement involved in the project area.
19 Local economies (employment, livelihood, etc.)	B+	B+	Some positive effect on the local economy is expected because of possible increment of business/ employment opportunity generated by the project implementation. During operation stage, convenience of passenger of new transportation system would improve commercial activities or commuting to work of the local population along the corridors. Although there are 36 of kiosks on the sidewalk where the pedestrian bridges for the S-21 station of Red Line is planned to construct are subject to relocation, there is no kiosk owner who loses his/her business or those who do not have places to re-establish their present business as they are allowed to move to near-by sidewalk or market place at their own discretion without any extra cost.
20. Water right	D	D	No impact on water use or water right is expected due to the project implementation.
21. Land use and utilization of local resources	D	C-	Since the alignment of corridor is made along the existing trunk roads, extent of changing the land use condition during the construction stage is expected to be negligible. There is no project component or activity which would cause the change of land use condition in operation stages. However, it would be undeniable to cause the land use change secondarily due to the operation of new stations. Negative extent of the secondary change of land use would be necessary to be examined further.
22. Social institutions and community	D	D	Since the alignment of corridor is made along the existing trunk roads, no significant part of the local community would be divided by the Project.
23. Existing social infrastructures and services	B-	B+	Some negative impacts on the existing traffic conditions are expected due to the traffic jam caused by the construction activities, although the expected impacts will be temporary during the construction stage. It is expected to improve the regional infrastructure through the project developing convenient transportation mode during the operation stage.
24. Poor, indigenous, or ethnic people	D	D	Since the alignment of corridor is made along the existing trunk roads, there is no project component or activity which would cause negative impacts additionally.
25.Misdistribution of benefits and damages	C-	C-	The feeling of inequality among the stakeholders might cause anxiety since those in the vicinity of stations would receive benefit from the Project than others Practically inequality among the stakeholders should take place since those in the vicinity of stations would receive benefit from the Project and the others away from the station areas would bear negative feeling on the Project.
26. Local conflicts of interest	C-	C-	It might be expected that inequality among stakeholder and misdistribution of benefit/ damage would cause the local conflict of interest unless the adequate public consultation is not arranged.
27. Gender and	D	D	Since the alignment of corridor is made along the existing trunk

Item	Pre-Construction / Construction Stage	Operation Stage	Description
Children's rights			roads, there is no project component or activity which would cause negative impacts additionally.
28. Cultural heritage	D	D	Since the alignment of corridor is made along the existing trunk roads, there are no project components or activities that may cause the negative impacts on effect on Cultural heritage.
29.Landscape	D	C+/-	There is a possibility of the part elevating section in center of Karachi city though the alignment of corridor is made along the existing trunk roads. As a result of the construction of this corridor, limited area of urban land use and the landscape should be changed to a limited extent.
30. Infectious diseases such as HIV/AIDS	B-	D	During construction, increments of risks are probably expected on infectious diseases among the construction workforce.
31. Public Hygiene	B-	D	During construction, sanitary condition will be deteriorated for wastewater, dust, solid waste from the construction sites.
32. Working conditions (including occupational safety)	B-	B-	Increment of the risks on traffic safety is expected due to the operation of heavy equipment and heavy vehicles during the construction stage. Increment of the risks on traffic safety is expected due to the new traffic services in the operation stage.
Others			
33. Accident and Hazard	B-	D	There is a possibility of accident hazard due to operation of the construction heavy vehicles, though the project is not special method of construction and traffic system.
34. Local Climate	D	D	It is not expected that the Project will cause the significant change on the regional meteorological condition.
35. Global warming	B-	B+	The possibility of increased Greenhouse Gas (GHG) emission is expected due to the operation of heavy vehicles as well as traffic jam incidental to the construction works, although the expected probability will be temporary during the construction stage. It is expected that the GHG emission would be reduced due to the modal shifting of transportation from passenger cars/ buses to the new transportation system.

Note: * Regarding the impacts on "Gender" and "Children's Right", might be related to all criteria of Social Environment.
Rating

A+/-: Significant positive / negative impact is expected.

B+/-: Positive / negative impact is expected to some extent.

C+/-: Extent of positive / negative impact is unknown. (A further examination is needed, and the impact could be clarified as the study progress)

D: No impact is expected

Overall rating: Highest rate among the rating of relevant project activities for negative and positive ratings is considered as the overall rating of the Project as a whole i.e. even only one "A-" is included in the above scoping matrix, overall rating of the project in terms of the environmental assessment becomes "A-".

Reference: Appendix 5 of JICA Guidelines for Environmental and Social considerations (April 2010)

Source: JICA Study Team for KTIP

7.3 Preliminary Environmental Impact Assessment

7.3.1 BRT-Green Line

During the Feasibility Study stage, potential impacts on the natural and social environment during the pre-construction, construction and operation stages of the Project of BRT-Green Linehas been identified using the environmental scoping list and matrices. The results are shown in Table 7-3-1.

Key areas of concern on the natural environment is felling of trees planted on the road center's green belt and sidewalks. During the early stage of the project study, at the time of initial environmental examination, all of the trees within the project implementation area are subject to felling. Later, the project design has been so changed that the trees are fell down in the areas where bus stations are constructed. Project design also considered to construct all of its facilities within the publicly owned land area i.e. No involuntary resettlement is involved in the implementation of BRT-Green Line.

Table 7-3-1 Environmental Scoping Matrix for BRT-Green Line

				Project-related Activities							
				Pre-Construction Stage		Construction Stage				Operation Stage**	
	No.	Likely Impacts	Overall Rating	Land acquisition	Change of land use plan, control of various activities by regulations for the construction	Land clearing / tree cutting	Operation of construction equipment and vehicles	Construction of exclusive lane, station, pedestrian bridges and other related facilities	Traffic restriction in construction area	Operation of Buses	Appearance / occupancy of lane and related facilities
Pollution	1	Air pollution	B+/-	D	D	D	B-	B-	B-	B+	D
	2	Water pollution	C-	D	D	D	D	C-	D	D	D
	3	Soil contamination	C-	D	D	D	D	C-	D	D	D
	4	Solid Waste and/or Industrial Discharge	B-	D	D	B-	D	B-	D	D	D
	5	Noise and vibration	B+/-	D	D	D	B-	B-	B-	B+	D
	6	Ground subsidence	D	D	D	D	D	D	D	D	D
	7	Odor	D	D	D	D	D	D	D	D	D
	8	Bottom sediment	D	D	D	D	D	D	D	D	D
Natural Environment	9	Geographical Conditions and Geological Conditions	D	D	D	D	D	D	D	D	D
	10	Soil Erosion	D	D	D	D	D	D	D	D	D
	11	Flora	B-	D	D	B-	D	D	D	D	D
	12	Fauna	D	D	D	D	D	D	D	D	D
	13	Ground Water	D	D	D	D	D	D	D	D	D
	14	Water Body (River, Lakes, etc.)	D	D	D	D	D	D	D	D	D
	15	Coastal Environment	D	D	D	D	D	D	D	D	D
	16	Oceanographic	D	D	D	D	D	D	D	D	D
	17	Natural/Ecological Reserves and Sanctuaries	D	D	D	D	D	D	D	D	D
Social Environment*	18	Involuntary Resettlement	D	D	D	D	D	D	D	D	D
	19	Local economies (employment, livelihood, etc.)	B+	D	D	D	B+	B+	D	B+	D
	20	Water right	D	D	D	D	D	D	D	D	D
	21	Land use and utilization of local resources	C-	D	D	D	D	D	D	D	C-
	22	Social institutions and community	D	D	D	D	D	D	D	D	D
	23	Existing social infrastructures and	B+/-	D	D	D	D	D	B-	B+	D

	No.	Likely Impacts	Overall Rating	Project-related Activities							
				Pre-Construction Stage		Construction Stage				Operation Stage**	
				Land acquisition	Change of land use plan, control of various activities by regulations for the construction	Land clearing / tree cutting	Operation of construction equipment and vehicles	Construction of exclusive lane, station, pedestrian bridges and other related facilities	Traffic restriction in construction area	Operation of Buses	Appearance / occupancy of lane and related facilities
		services									
	24	Poor, indigenous, or ethnic people	D	D	D	D	D	D	D	D	D
	25	Misdistribution of benefits and damages	C-	D	C-	D	D	D	D	D	C-
	26	Local conflicts of interest	C-	D	C-	D	D	D	D	D	C-
	27	Gender and Children's rights	D	D	D	D	D	D	D	D	D
	28	Cultural heritage	D	D	D	D	D	D	D	D	D
	29	Landscape	C+/-	D	D	D	D	D	D	D	C+/-
	30	Infectious diseases such as HIV/AIDS	B-	D	D	D	B-	B-	D	D	D
	31	Public Hygiene	B-	D	D	D	B-	B-	D	D	D
	32	Working conditions (including occupational safety)	B-	D	D	B-	B-	B-	D	B-	D
Others	33	Accident and Hazard	B-	D	D	B-	D	D	D	D	D
	34	Local Climate	D	D	D	D	D	D	D	D	D
	35	Global warming	B+/-	D	D	B-	B-	B-	B-	B+	D

Note: * Regarding the impacts on "Gender" and "Children's Right", might be related to all criteria of Social Environment.
Rating

A+/-: Significant positive / negative impact is expected.

B+/-: Positive / negative impact is expected to some extent.

C+/-: Extent of positive / negative impact is unknown. (A further examination is needed, and the impact could be clarified as the study progress)

D: No impact is expected

Overall rating: Highest rate among the rating of relevant project activities for negative and positive ratings is considered as the overall rating of the Project as a whole i.e. even only one "A-" is included in the above scoping matrix, overall rating of the project in terms of the environmental assessment becomes "A-".

Reference: Appendix 5 of JICA Guidelines for Environmental and Social considerations (April 2010)

Source: JICA Study Team for KTIP

7.3.2 BRT-Red Line

During the Feasibility Study stage, potential impacts on the natural and social environment during the pre-construction, construction and operation stages of the Project of BRT-Red Line has been identified using the environmental scoping list and matrices. The results are shown in Table 7-3-2.

Key areas of concern on the natural environment is felling of trees planted on the road center's green belt and sidewalks. During the early stage of the project study, at the time of initial environmental examination, all of the trees within the project implementation area are subject to felling. Later, the project design has been so changed that the trees are fell down in the area where bus stations are constructed. Project design also considered to construct all of its facilities within the publicly owned land area i.e. No involuntary resettlement is involved in the implementation of BRT-Red Line.

Table 7-3-2 Environmental Scoping Matrix for BRT-Red Line

	No.	Likely Impacts	Overall Rating	Project-related Activities							
				Pre-Construction Stage		Construction Stage				Operation Stage**	
				Land acquisition	Change of land use plan, control of various activities by regulations for the construction	Land clearing / tree cutting	Operation of construction equipment and vehicles	Construction of exclusive lane, station, pedestrian bridges and other related facilities	Traffic restriction in construction area	Operation of Buses	Appearance / occupancy of lane and related facilities
Pollution	1	Air pollution	B+/-	D	D	D	B-	B-	B-	B+	D
	2	Water pollution	C-	D	D	D	D	C-	D	D	D
	3	Soil contamination	C-	D	D	D	D	C-	D	D	D
	4	Solid Waste and/or Industrial Discharge	B-	D	D	B-	D	B-	D	D	D
	5	Noise and vibration	B+/-	D	D	D	B-	B-	B-	B+	D
	6	Ground subsidence	D	D	D	D	D	D	D	D	D
	7	Odor	D	D	D	D	D	D	D	D	D
	8	Bottom sediment	D	D	D	D	D	D	D	D	D
Natural Environment	9	Geographical Conditions and Geological Conditions	D	D	D	D	D	D	D	D	D
	10	Soil Erosion	D	D	D	D	D	D	D	D	D
	11	Flora	B-	D	D	B-	D	D	D	D	D
	12	Fauna	D	D	D	D	D	D	D	D	D
	13	Ground Water	D	D	D	D	D	D	D	D	D
	14	Water Body (River, Lakes, etc.)	D	D	D	D	D	D	D	D	D
	15	Coastal Environment	D	D	D	D	D	D	D	D	D
	16	Oceanographic	D	D	D	D	D	D	D	D	D
	17	Natural/Ecological Reserves and Sanctuaries	D	D	D	D	D	D	D	D	D
Social Environment*	18	Involuntary Resettlement	D	D	D	D	D	D	D	D	D
	19	Local economies (employment, livelihood, etc.)	B+	D	D	D	B+	B+	D	B+	D
	20	Water right	D	D	D	D	D	D	D	D	D
	21	Land use and utilization of local resources	C-	D	D	D	D	D	D	D	C-
	22	Social institutions and community	D	D	D	D	D	D	D	D	D
	23	Existing social infrastructures and services	B+/-	D	D	D	D	D	B-	B+	D
	24	Poor, indigenous, or ethnic people	D	D	D	D	D	D	D	D	D
	25	Misdistribution of benefits and damages	C-	D	C-	D	D	D	D	D	C-
	26	Local conflicts of interest	C-	D	C-	D	D	D	D	D	C-
	27	Gender and Children's rights	D	D	D	D	D	D	D	D	D
	28	Cultural heritage	D	D	D	D	D	D	D	D	D
	29	Landscape	C+/-	D	D	D	D	D	D	D	C+/-

	No.	Likely Impacts	Overall Rating	Project-related Activities							
				Pre-Construction Stage		Construction Stage				Operation Stage**	
				Land acquisition	Change of land use plan, control of various activities by regulations for the construction	Land clearing / tree cutting	Operation of construction equipment and vehicles	Construction of exclusive lane, station, pedestrian bridges and other related facilities	Traffic restriction in construction area	Operation of Buses	Appearance / occupancy of lane and related facilities
Social Environment	30	Infectious diseases such as HIV/AIDS	B-	D	D	D	B-	B-	D	D	D
	31	Public Hygiene	B-	D	D	D	B-	B-	D	D	D
	32	Working conditions (including occupational safety)	B-	D	D	B-	B-	B-	D	B-	D
Others	33	Accident and Hazard	B-	D	D	B-	D	D	D	D	D
	34	Local Climate	D	D	D	D	D	D	D	D	D
	35	Global warming	B+/-	D	D	B-	B-	B-	B-	B+	D

Note: * Regarding the impacts on "Gender" and "Children's Right", might be related to all criteria of Social Environment.
Rating

A+/-: Significant positive / negative impact is expected.

B+/-: Positive / negative impact is expected to some extent.

C+/-: Extent of positive / negative impact is unknown. (A further examination is needed, and the impact could be clarified as the study progress)

D: No impact is expected

Overall rating: Highest rate among the rating of relevant project activities for negative and positive ratings is considered as the overall rating of the Project as a whole i.e. even only one "A-" is included in the above scoping matrix, overall rating of the project in terms of the environmental assessment becomes "A-".

Reference: Appendix 5 of JICA Guidelines for Environmental and Social considerations (April 2010)

Source: JICA Study Team for KTIP

7.4 Implementation of EIA Study

7.4.1 Selection of Local Consultant

Selection of the local consultant for EIA study for KTIP Project took place in Karachi, Pakistan in December 2011 in accordance with the JICA's Guidelines for the procurement of the subcontractor 2006. As a result, EMC based in Karachi, Pakistan has been awarded for the EIA Study package of KTIP Project. EIA study has been conducted between January 2012 to April 2012 in accordance with Pakistan's guidelines for EIA study as well JICA guidelines for the Environment and Social Consideration as per the conditions of the contract for EIA study.

7.4.2 Contents of EIA Study

Contents of EIA Study are as follows:

- Study/survey for obtaining baseline data on the natural and social environment;
- Examination of alternative KTIP plans and their impacts on the environment;
- Analysis of the Environmental Impacts caused by the Project ;
- Elaboration of the Environmental Mitigation Measures;
- Elaboration of the Environmental Management and Monitoring Plans;
- Holding Stakeholder Meetings for Dissemination of information of the Project as well as to Input of the opinions of the stakeholders; and

- Elaboration of EIA Report in the form acceptable to Pakistan's Environmental Protection Agency for KMC to obtain "No Objection Certificate (NOC)".

Focal areas to be addressed in EIA Study are shown in Table 7-4-1.

Table 7-4-1 List of Study for EIA

Category	Items of Study	
Pollution Control	Air Pollution Water Pollution Soil Contamination	Noise and Vibration Solid Waste and/or Industrial Discharge
Natural Environment	Floral Ecology	
Social Environment	Local Economies (Employment, livelihood, etc.) Land use & utilization of local resources Existing social infrastructures & services Misdistribution of benefits & damages Local conflicts of interest	Landscape Infectious diseases such as HIV/AIDS Public Hygiene Working conditions (including occupational safety)
Others	Global warming	

7.4.3 Methodology of EIA Study

(1) Primary Data Collection

1) Physico-chemical Survey

Primary surveys are conducted for soil, groundwater, air, noise and vibration along the project area as a part of the study of pollution control parameters of the environment in the study area.

2) Biological Survey

For floral environment, using the direct counting method for all of the tree species affected by the Project has been conducted for assessing the impacts on bio-diversity within the study area.

For the faunal environment, secondary data gathering and interviewing of key-informants within the project area are conducted in order to identify faunal species affected by the Project.

3) Stakeholder Meeting and Hearing Survey

During the EIA study period, stakeholder meetings are held as follows:

a. Initial Stakeholder Meeting
   - One at appropriate location in each of Green and Red Line for the purpose of information dissemination on the outline of the project

b. Second Stakeholder Meeting
   - At the location of initial stakeholder meeting on the Green and Red Line for information dissemination of the result of EIA Study

Hearing of the local opinion on the Project as a result of stakeholder meeting held two times during the study period, as well as to hear from the local people running small business that are directly affected by the Project are carried out in order to obtain primary data by the opinion survey as a part of socio-economic baseline data.

(2) Secondary Data Collection

Secondary data collection based on the published data on land use, socio-economics, demography, legal aspects related to EIA study are carried out throughout the study period. Sources of secondary data will be any form of data sets, reports, papers and publications put out by the central and local governments, central and local educational institutions, international donor organizations including JST's master plan study results, and international and domestic NGOs reports relevant to the Project.

(3) Impact Analysis using Matrix System

Scoping is a tool which gives direction for selection of impacts due to the project activities on the environment. As a part of the study, scoping exercise was conducted selecting various types of impacts which can accrue due the Project as per Section 7.2. Based on the project features, site conditions, and the environmental conditions on site, various parameters to be covered as a part of EIA study are selected for further in-depth analysis and that the results are presented in a matrix of environmental impacts.

7.5 Review of Institutional and Legal Framework

7.5.1 Legal Framework for EIA

During EIA study, the laws, regulations and guidelines related to the environmental and social considerations in Pakistan are reviewed. Major laws, regulations and guideline directly governing the EIA study for the Project are listed as follows:

- Pakistan Environment Protection Ordinance (PEPO), 1983;
- Pakistan Environmental Protection Act (PEPA), 1997;
- National Environmental Policy 2005;
- Guidelines for the Preparation and Review of Environmental Reports (1997);
- Guidelines for Public Consultation (1997);
- Sector Guidelines for Preparation of Environmental Reports;
- Pak-EPA (Review of IEE and EIA) Regulations, 2000;
- National Resettlement Policy (2002);
- Project Implementation and Resettlement of Affected Persons Ordinance 2001;
- The Sindh Katchi Abadis Act, 1987; and
- Sindh Public Procurement Rules 2010

In 1983, Pakistan Environment Protection Ordinance (PEPO) was passed as the first substantive policy on the environment in Pakistan. This highlighted the need to have a framework of environmental laws in Pakistan in order to address emerging national issues. PEPO had three goals for the country's environmental protection effort, which are conservation of natural resources, promotion of sustainable development, and improvement of efficiency in the use and management of resources. Fourteen program areas were targeted for priority implementation, including energy efficiency improvements, renewable resource development/ deployment, pollution prevention/reduction, waste management, institutional support of common resources, and integration of population and environmental programs. It is unfortunate that PEPO has remained largely unimplemented.

The Pakistan Environmental Protection Act (PEPA) was enacted on 6th December 1997, repealing the PEPO of 1983. The PEPA of 1997 provides the framework for implementation of National Conservation Strategy (NCS), Establishment of Provincial Sustainable Development Funds, Protection and Conservation of Species, Conservation of Renewable Resources, Establishment of Environmental Tribunals as well as the appointment of Environmental Magistrates, and Framework for Initial Environmental Examination (IEE) and Environmental Impact Assessment (EIA).

National Environmental Policy 2005 provides an overarching framework for addressing the environmental issues facing Pakistan. This provides broad guidelines to the Federal Government, Provincial Government, Federally Administrated Territories and Local Government for addressing environmental concerns and ensuring effective management of their environmental resources.

Sindh Public Procurement Rules 2010 provides rules of purchasing goods and services within Sindh Province of Pakistan. It states, in the Article5 "Conflict with International and Inter-Governmental Agreements" as follows.

> *In the event that these rules are inconsistent with, or in conflict with, any obligation or commitment of Government arising out of an international treaty or an agreement with a foreign country or countries, or any international financial institution, the provisions of such international treaty or agreement shall override the provisions of these Rules to the extent of that inconsistency or conflict as the case may be.*

7.5.2 National Environmental Quality Standards

National Environmental Quality Standards (NEQS) were first promulgated in 1993 and were amended in 1995 and 2000. The following standards are specified:

- Ambient Air;
- Allowable concentration of pollutions in gaseous emissions from industrial sources;
- Motor vehicle exhaust and noise; and
- Allowable concentration of pollutions in Municipal and liquid industrial effluents and industrial gaseous emissions.

(1) Air quality

Table 7-5-1 shows national environmental quality standard for ambient air.

Table 7-5-1 National Environmental Quality Standard for Ambient Air

Pollutant	Time-weighted average	Concentration in Ambient Air		Method of measurement
		Effective from 1st July, 2010	Effective from 1st January, 2013	
Sulfur Dioxide (SO_2)	Annual Average*	80μg/m^3	80μg/m^3	Ultraviolet Fluorescence Method
	24 hours**	120μg/m^3	120μg/m^3	
Oxides of Nitrogen as (NO)	Annual Average*	40μg/m^3	40μg/m^3	Gas Phase Chemiluminescence
	24 hours**	40μg/m^3	40μg/m^3	
Oxides of Nitrogen as (NO_2)	Annual Average*	40μg/m^3	40μg/m^3	Gas Phase Chemiluminescence
	24 hours**	80μg/m^3	80μg/m^3	
O_3	1 hour	180μg/m^3	130μg/m^3	Non dispersive UV absorption méthode
Suspended Particulate Matter (SPM)	Annual Average*	400μg/m^3	360μg/m^3	High volume Sampling, (Average flow rate not less than 1.1m^3/minute)
	24 hours**	550μg/m^3	500μg/m^3	
Respirable Particulate Matter (PM_{10})	Annual Average*	200μg/m^3	120μg/m^3	B Ray absorption method
	24 hours**	250μg/m^3	150μg/m^3	
Resipirable Particulate Matter ($PM_{2.5}$)	Annual Average*	25μg/m^3	15μg/m^3	B Ray absorption method
	24 hours**	40μg/m^3	35μg/m^3	
	1 hour	25μg/m^3	15μg/m^3	
Lead (Pb)	Annual	1.5μg/m^3	1μg/m^3	ASS Method after

Pollutant	Time-weighted average	Concentration in Ambient Air		Method of measurement
		Effective from 1st July, 2010	Effective from 1st January, 2013	
	Average*			sampling using EPM 2000 or equivalent Filter paper
	24 hours**	2μg/m^3	1.5μg/m^3	
Carbon Monoxide (CO)	8hours**	5mg/m^3	5mg/m^3	Non Dispersive Infra Red (NDIR) method
	1hours	10mg/m^3	10mg/m^3	
*Annual arithmetic mean of minimum 104 measurements in a year taken twice a week 24 hourly at uniform interval. **24 hourly / 8 hourly values should be met 98% of the in a year. 2% of the time, it may exceed but not on two consecutive days.				

Source: Advertisement regarding public opinion/comments on national standards for ambient air (PEPA)

(2) Noise

Table 7-5-2 shows the standards for motor vehicle noise.

Table 7-5-2 The Motor Vehicle Ordinance (1965) and Roles (1969)

Parameter	Standards (maximum permissible limit)	Measuring method
Noise	85dB(A)	Sound-meter at 7.5meter from the source

Source: Statutory Notification, SRO-7-2(KE)/2009, dated May 16, 2009, Ministry of Environment, Government of Pakistan.

Table 7-5-3 shows the proposed national environmental quality standard for noise.

Table 7-5-3 Proposed National Environmental Quality Standard for Noise

S. No.	Category of Area / Zone	Effective from 1st January, 2009		Effective from 1st January, 2010	
		Limit it in dB(A) Leq*			
		Day Time	Night Time	Day Time	Night Time
1	Residential area (A)	65	50	55	45
2	Commercial area (B)	70	60	65	55
3	Industrial area (C)	80	75	75	65
4	Silence Zone (D)	55	45	50	45

Note: 1 Day time hours: 6.00 a. m to 10.00 p. m
2 Night time hours: 10.00 p. m to 6.00p. m
3 Silence zone; Zone which are declared as such by competent authority. An area comprising not less than 100 meters around hospitals, educational institutions and courts.
4 Mixed categories of areas may be declared as one of the four above-mentioned categories by the competent authority.
*dB(A)Leq Time weighted average of the level of sound in decibels on scale A which is relatable to human hearing.

Source: Advertisement regarding public opinion/comments on national standards for noise (Pak-EPA)

(3) Water quality

The national environmental quality standards for municipal and liquid industrial effluents has been established for the control of the pollution and gone through modifications since 1993 as Statutory Notification by the Ministry of Environment, Local Government and Rural Development, Pakistan. The Standards limit the concentration of a number of quality parameters for discharge into the national waters as shown Table 7-5-4.

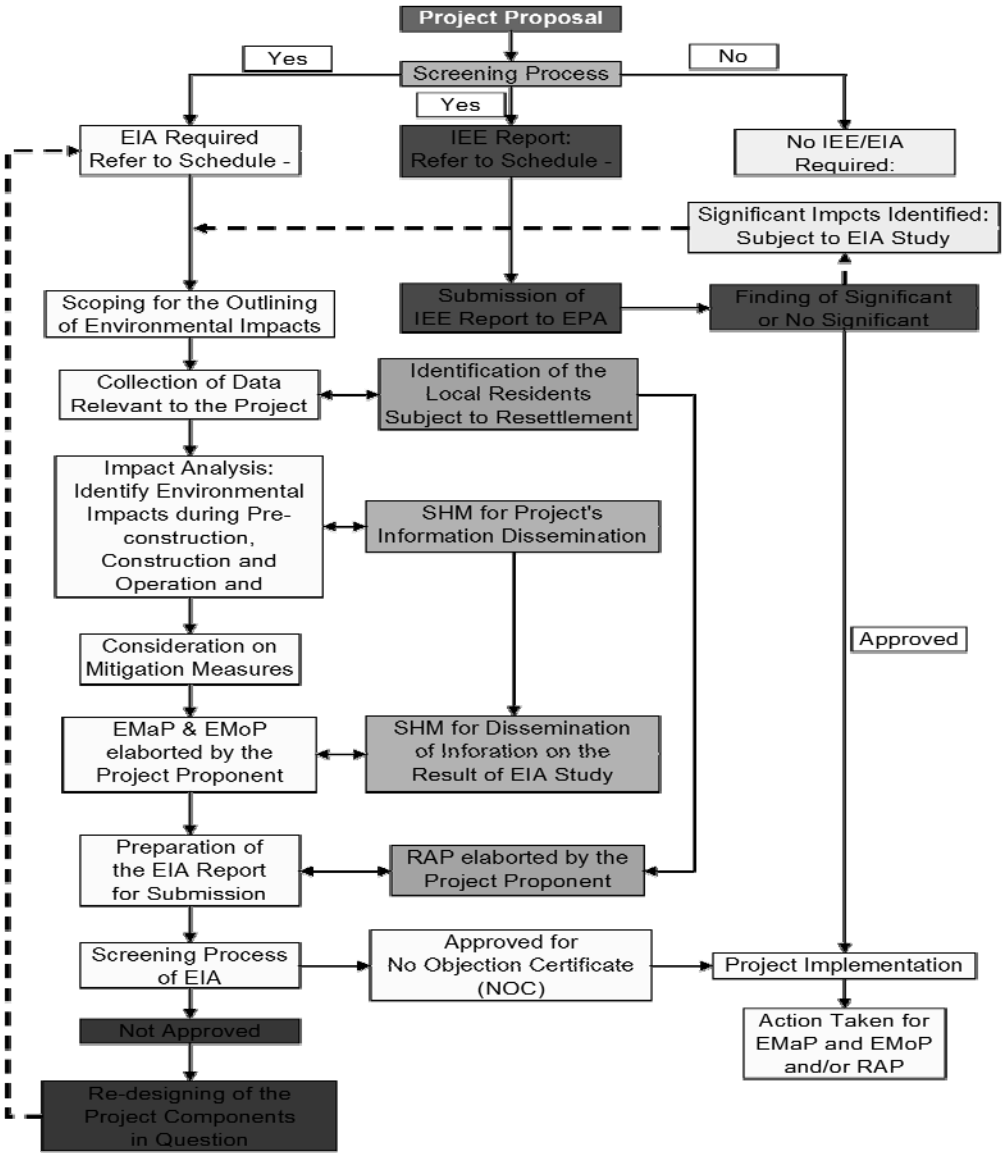
Table 7-5-4 NEQS for Municipal and Liquid Industrial Effluents

S. No.	Parameter	Inland Waters	Sewage Treatment	Sea Waters	Unit
1	Temperature or Temp. increase	<3	<3	<3	^oC
2	pH value (H^+)	6-9	6-9	6-9	
3	Biological Oxygen Demand $(BOD)_5$ at 20 ^oC	80	250	80	mg/l
4	Chemical Oxygen Demand $(COD)_{Cr}$	150	400	400	mg/l
5	Total Suspended Solids (TSS)	200	400	200	mg/l
6	Total Dissolved Solids (TDS)	3500	3500	3500	mg/l
7	Oil and Grease	10	10	10	mg/l
8	Phenolic Compounds (as Phenol)	0.1	0.3	0.3	mg/l
9	Chloride (as Cl^-)	1000	1000	SC	mg/l
10	Fluoride (as F^-)	10	10	10	mg/l
11	Cyanide (as CN^-)total	1.0	1.0	1.0	mg/l
12	An-ionic detergents (as MBAS)	20	20	20	mg/l
13	Sulphate(SO_4^{2-})	600	1000	SC	mg/l
14	Sulphide(S^{2-})	1.0	1.0	1.0	mg/l
15	Ammonia (NH_3)	40	40	40	mg/l
16	Pesticides	0.15	0.15	0.15	mg/l
17	Cadmium	0.1	0.1	0.1	mg/l
18	Chromium (trivalent and hexavalent)	1.0	1.0	1.0	mg/l
19	Copper	1.0	1.0	1.0	mg/l
20	Lead	0.5	0.5	0.5	mg/l
21	Mercury	0.01	0.01	0.01	mg/l
22	Selenium	0.5	0.5	0.5	mg/l
23	Nickel	1.0	1.0	1.0	mg/l
24	Silver	1.0	1.0	1.0	mg/l
25	Total toxic metals	2.0	2.0	2.0	mg/l
26	Zinc	5.0	5.0	5.0	mg/l
27	Arsenic	1.0	1.0	1.0	mg/l
28	Barium	1.5	1.5	1.5	mg/l
29	Iron	8.0	8.0	8.0	mg/l
30	Manganese	1.5	1.5	1.5	mg/l
31	Boron	6.0	6.0	6.0	mg/l
32	Chlorine	1.0	1.0	1.0	mg/l

Source: Statutory Notification, SRO-549(1)/2000, dated August 10, 2000, Ministry of Environment, Local Government and Rural Development, Government of Pakistan.

7.5.3 Environmental Impact Assessment

Environmental issues and their control in Pakistan are in general, governed by PEPA. The act defines the terms of environmental issues including the way of EIA study to be conducted. The act makes it mandatory for the project proponents to carry out IEE or EIA of development projects and incorporate environmental impact mitigation measures as part of the project planning. Figure 7-5-1 shows the EIA process in Pakistan.



Source: Modified by JST based on "Faisal Aslam: ENVIRONMENTAL IMPACT ASSESSMENTIN PAKISTAN – OVERVIEW, IMPLEMENTATION AND EFFECTIVNESS, 2006

Figure 7-5-1 EIA Process in Pakistan

"Pakistan EPA (Review of IEE and EIA) Regulations, 2000" defines and regulates the procedure of IEE and EIA for projects implemented within the borders of Pakistan. Especially, schedule-II in this regulation defines projects requiring EIA study as follows:

> *The Projects in schedule-II are generally major Projects and have the potential to affect a large number of people. They also include Projects in environmentally sensitive areas. The impact of such Projects may be irreversible and could lead to significant changes in land use and the social, physical and biological environment.*

7.5.4 Social Environment

(1) Resettlement Policy

The laws and regulations regarding Resettlement Action Plan (RAP) in Pakistan are provided in National Resettlement Policy (2002). It is not only covering the affected persons (APs) subject to resettlement but also to ensure an equitable and uniform treatment of resettlement issues. This

policy defines objectives of policy as follows:

- Avoid or minimize adverse social impacts in a project wherever possible and where adverse impacts cannot be avoided, the mitigation measures and resettlement activities should be conceived and executed as development programs and the affected persons be provided opportunity to share the project benefits;
- APs be provided with sufficient compensation and assistance for lost assets, that will assist them to improve or at least restore their living standards, income earning or production capacity to the pre-project level;
- Provide a development opportunity to all vulnerable groups. The vulnerable populations should receive special assistance to bring them at least to a minimum living standard at par with the pre-project level; and
- All population adversely affected by the project, should be eligible for sharing the social and economic benefits, envisaged after completion of the project.

"National Resettlement Policy (2002)" is further supplemented by "Project Implementation and Resettlement of the Affected Persons Ordinance, 2002" that has to be adopted by state and local governments. This ordinance provides a comprehensive and detailed procedures and definitions for land acquisition and resettlement of the Affected Persons (APs).

(2) Policy on the Public Consultation

Pakistan Environmental Protection Agency has put out "Guidelines for Public Consultation" in October 1997 and it defines "Objectives of consultation" as follows:

Public involvement is a feature of environmental assessment and can lead to better and more acceptable decision-making. It can be time consuming and demanding, yet without it, proposals are seldom soundly based, and there is likely to be antagonism from affected people, Public involvement, undertaken in a positive manner and supported by a real desire to use the information gained to improve the proposal, will lead to better outcomes, and lay the basis for ongoing positive relationships between the participants. The objectives of public involvement include:

a) Informing the stakeholders about what is proposed;
b) Providing an opportunity for those otherwise unrepresented to present their views and values, therefore allowing mere sensitive consideration of mitigation measures and trade-offs;
c) Providing those involved with planning the proposal with an opportunity to ensure that the benefits of the proposal are maximized and that no major impacts have been overlooked;
d) Providing an opportunity for the public to influence project design in a positive manner;
e) Obtaining local and traditional knowledge (corrective and creative), before decision making;
f) Increasing public confidence in the proponent, reviewers and decision-makers;
g) Providing better transparency and accountability in decision making;
h) Reducing conflict through the early identification of contentious issues, and working through these to find acceptable solutions;
i) Increasing a sense of ownership of the proposal in the minds of the stakeholders; and
j) Developing proposals which are truly sustainable.

As above, Guidelines for Public Consultation introduces effective ways to inform contents of the Project to the general public during the planning stage and that eventually consensus building toward the implementation of project is reached.

Incorporating public involvement into the stages of environmental assessment is explained in the guidelines that public consultation meeting has to be carried out after the works on "developing options, and assessing and mitigating impacts" for comments and assessment.

7.5.5 JICA Guidelines for Environmental and Social Considerations

JICA Guidelines for Environmental and Social Considerations (hereinafter referred to as "JICA Guideline") is commonly applied to JICA's internationally funded projects for overseas economic cooperation. In order to contribute to sustainable development in developing countries, JICA confirms according to the guidelines that the project proponents are undertaking appropriate study on the environmental and social considerations through various measures so as to prevent or minimize impacts on the natural and social environment as project is implemented.

According to the JICA Guideline, "Environmental and Social Considerations Studies" means studies including socio-economic and natural environment baseline surveys, predicting and evaluating adverse impacts and likely impacts that projects are to cause on the environment and local society, and mitigation measures to avoid and minimize these impacts. The items that require investigating natural social environment are as follows:

- Natural environment in general
- Habitat of wildlife
- Resettlement
- Living and livelihood
- Heritage
- Landscape
- Ethnic minorities and indigenous peoples
- Working conditions (including occupational safety)

In addition, it is mandatory according to JICA Guidelines to investigate the following:

- Air quality
- Water quality
- Solid Waste and/or Industrial Discharge Management
- Soil Pollution
- Noise and vibration
- Subsidence
- Odor
- Sediment
- Protected areas
- Ecosystem
- Hydrology
- Topography and geology
- Management of abandoned sites

The impacts caused by the Project on these environmental parameters should be examined and prediction should be made for before during and after the implementation of the Project on the basis of intensity, irreversibility, and cumulative effects on the existing environment.

7.5.6 World Bank Operational Policies

In conjunction with JICA Guidelines, the World Bank Operational Manual BP 4.01 to BP 4.12, January 1999 will have to be used in reference to JICA Guidelines where necessary. General provisions of these operational manuals are essentially the same in its philosophy as provided in JICA Guidelines. However, in the case of resettlement compensation, these operational policies are more stringent in terms of the way APs are compensated against the loss of their property and working opportunities as well as the existing life style.

7.5.7 Other Guidelines on the Environmental and Social Considerations

Other guideline essential to refer to out are listed up as follows:

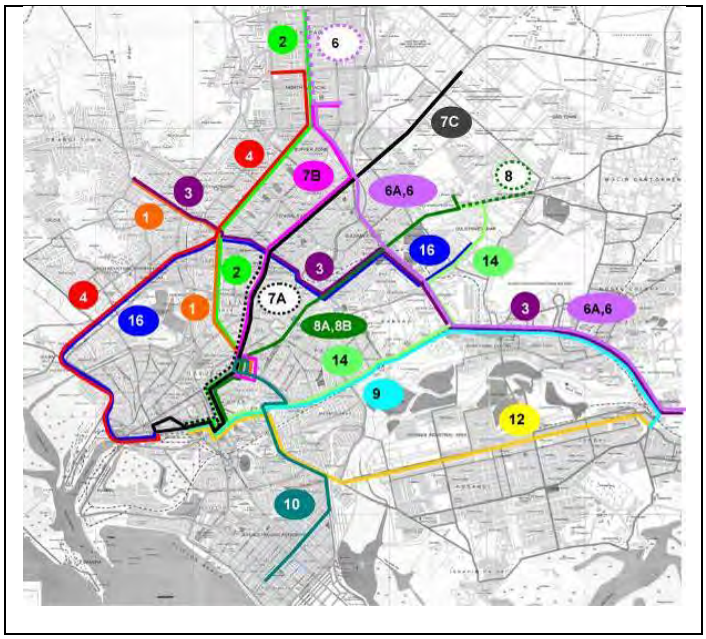
1) EIA for Development Countries in Asia, ADB, December 1997;
2) Handbook on Resettlement: A Guide to Good Practice, ADB, 1998;
3) Safeguard Policy Statement, ADB, June 2009.

The above guidelines are in general the same in its philosophy as provided in the World Bank Operational Manual BP 4.01 to BP 4.12.

7.6 Comparison of Alternative Scenarios

7.6.1 Master Plan's Optional Scenario Analysis

During the Master Plan study period, there have been a number of scenarios developed in order to carry out studies on comparison of various alternatives including "Do-nothing Scenario". As a result, a combination of MRT and BRT as per Figure 7-6-1 and Table 7-6-1 have become the most viable combination of options for the urban transportation development scenario in Karachi.



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

Figure 7-6-1 Concept of Karachi Urban Transportation Network

Table 7-6-1 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	12.7 km	25
Red Line	BRT	19.2 km	38
Orange Line	BRT	3.9 km	8
Purple Line	BRT	9.7 km	19
Aqua Line	BRT	11.8 km	24

Source: JICA Study Team

As a result of the analysis, the following is noted:

1) "Do-nothing" scenario simply cannot cater for transportation at any time in the future of the ever-increasing urban population and the current business development trend of Karachi;

2) Holistic approach of the urban transportation development scheme with the development of KCR at its core as precondition should be the most viable option;

3) Road development per se will remarkably improve along major corridor. However, serious traffic congestion should linger over decades;

4) KCR developed as MRT will improve the road traffic in CBD to some extent. However, road traffic congestion will still remain especially for radial directions;

5) Construction of a number of LRT in place of MRT or BRT will not be efficient in terms of cost vs. effectiveness in terms of revenue and cost of the operation and maintenance;

6) Development of elevated LRT or MRT causes a large number of resettlement as well as to cause direct impacts on national heritage sites in CBD area;

7) Developing one or two MRT lines per se would not be able to cater for the future demand of Karachi urban setting;

8) BRT network per se will not be the solution for the ever-increasing traffic demand in the future because of its capacity and impact on road traffic while cost implication could be viable to some extent. Thus the best option for the future mass transit network in Karachi should therefore be considered a mixture of MRT and BRT networks; and

9) The target of mass transit development should be the middle income people, who are using motorcycles as transport mode.

7.6.2 Selection of Corridor(s) for Feasibility Study

Based on the conclusions of Master Plan study on the analysis of alternative study, further selection process for the most viable and acutely necessary transportation corridor(s) took place in order to carry out feasibility study. As a result, the following is considered:

1) KMC originally intended to carry out BRT system based on ADB's study result i.e. JICA Study Team might be in need of studying one of the MRT plan;

2) Within the list of Table 7-6-1, Blue and Brown as MRT corridors have been considered appropriate to carry out followed by Red, Green and Yellow as BRT corridors;

3) During the stakeholder meetings held in March 2011, participants made a demand on bus route in preference to LRT or MRT;

4) Blue Line as MRT corridor is in need of 8 km long underground section in order to clear the geographical as well as geometrical difficulties i.e. the cost of construction will become as large as railway system like KCR; and

5) Brown Line would be much better if it was implemented after the completion of Blue Line in terms of transportation functionality.

As a result, conclusion was made that the Green and Red Line should be selected for feasibility study in view of them viable to implement as soon as possible.

7.6.3 Analysis of the Alternatives for Feasibility Study

(1) Do nothing Scenario vs. Other BRT Development

Analysis of alternatives for feasibility study is broadly divided into "Do it" or "Do nothing" since any BRT development brings positive effects on the socio-economic environment of Karachi as a whole.
"Do-Nothing" is a scenario analysed during the Master Plan study. It means that the improvement of only the existing bus services should takes place with the current plan of road system improvement. In case no action on the public transport is taken in the future, as has been in the past 20 years, the number of buses would not increase even if traffic demand increases. The following is thus noted:

1) It is obvious that most of the roads in Karachi will suffer from traffic saturation;

2) Population growth in Karachi is multiplied by 1.67 times from 2010 to 2030;

3) Forecasted eeconomic growth will increases the trip rate of urban transportation;

4) Forecasted increase in car ownership should further increases the trip rate and road spaces relatively decreases; and

5) Expansion of urbanized areas should increase the trip length by a factor of 1.64 times from 2010 to 2030.

As a result there will be more deterioration takes place on the bus services as well as the road conditions. Thus "Do-nothing" scenario will further causes modal shift to motorcycle and private cars for further increase of the road traffic. This scenario should lead to the chaotic urban transportation in Karachi in the near future.

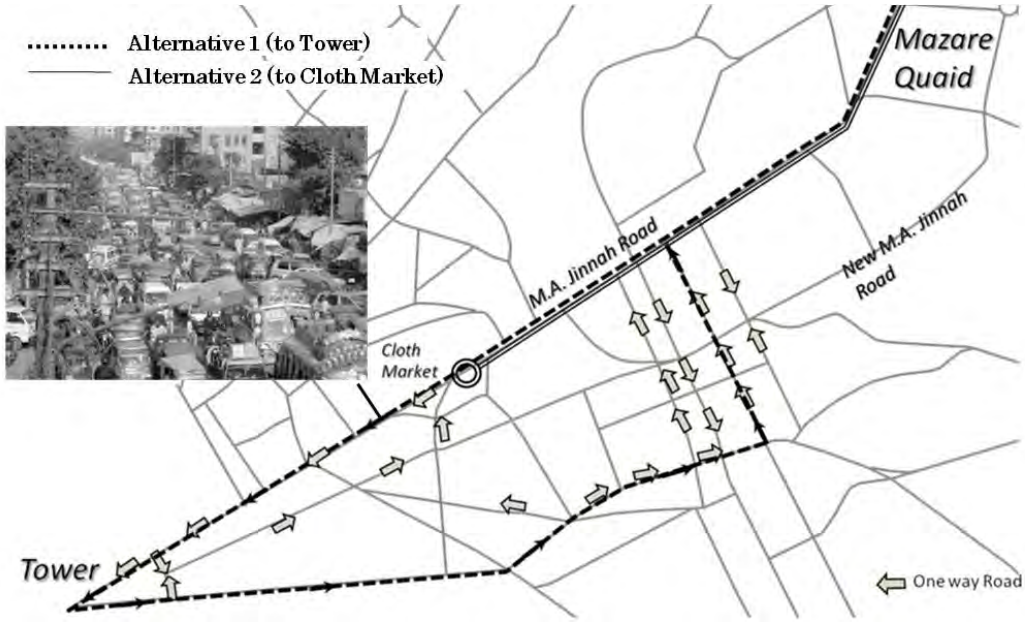
(2) Green Line Development Scenario

Green Line shown in No.2 of Figure 7-6-1 is now Green Line in the Feasibility Study with a few modification made on the southern end of the line. There is no alternative route for Green Line because there is no alternative parallel road along the corridor. It was originally intended to stop as Gur Mandir. However, its southern end has been extended to Jahangir Park where the buses are returning on the loop while there is a strong desire to extend it to Tower area.

The issue of the selection of end point of Green Line as 1) there is a strong requirement of its extension to Tower and 2) it should stop at Jahangir Park. The characteristics of current conditions of M. A. Jinnah Road are observed as follows:

- The width of M. A. Jinnah Road between Tower and Cloth Market, one way section, is generally narrower than the necessary width of bus station section;
- The existing traffic congestion in one way section around this area is very high, since this is very busy commercial area and sophisticated urban construction scheme is necessary; and

In the contexts as above, two alternative plans are prepared for the end point of Green Line as per Figure 7-6-2.



Source: JICA Study Team

Figure 7-6-2 Examination of the end point in CBD for Green Line

- Alternative 1: This route is planned along one way section of approximately 2.6 km to Tower from Jahangir Park. A detour route from Tower to M.A. Jinnah Road with a total length of approximately 5.5 km will have to be provided; and
- Alternative 2: This route is planned to stop at Jahangir Park/Cloth Market. U-turn loop is planned at Jahangir Park/Cloth Market area.

The environmental examination of the end point of Green Line is summarized as follows:

Table 7-6-2 Analysis from Environmental and Social Viewpoints on Green Line

Items	Environmental Impacts
Environmental pollution	- When Green Line is designed to construct on the ground level to Tower from Jahangir Park, there is a possibility of high traffic congestion during not only construction period but also operation period. - In case of elevated/underground system was constructed to the one way section, traffic congestion due to construction work will be severe. - Impacts of air pollution and noise on the surrounding areas due to the construction works/traffic congestion will be higher in case of Alternative 1 for end point of BRT, compared with the case of Alternative 2.
Social Environment	- The case of one way section construction activities would induce the higher probability of causing the land acquisition and resettlement for the area of station facilities. This is compared to the case of two way direction section which would have to double the socio-economic impacts.

Source: JICA Study Team

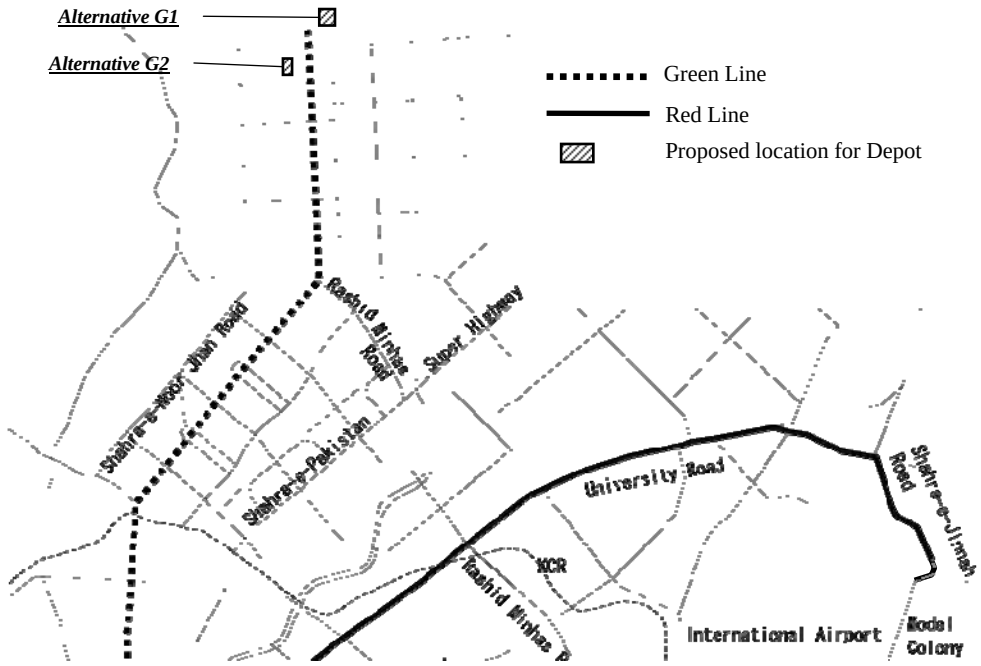
As a result, based on the above analysis, Alternative 2 has been selected in terms of environmental aspect.

There is an alternative plan of the depot as follows.

Table 7-6-3 Alternative plan of the BRT depot for Green Line

Alternative	Ownership	Remark	Area
G1	Governmental Land	There is a parking space of the CNG Bus Project and vacant land.	51,400 ㎡
G2	Governmental Land	There is a depot of the CNG Bus Project. The access road from BRT line to this area is narrow road.	16,000 ㎡

Source: JICA Study Team



Source: JICA Study Team

Figure 7-6-3 Location of Depot for Green Line

This line serves for the workforce going to the northern industrial area of Karachi as well as those of work force commuting to the commercial areas along the corridor and to CBD. Green Line development involves relatively large number of trees fell down. It is the only significant

environmental impacts on the natural environment caused by the Green Line development.

The same way as is explained in the case of Red Line development, Green Line alone functions very well as the line contributes commuting workforce to north as well as to south i.e. socio-economically viable option contributing to the shortage of urban transportation in Karachi. On the other hand, this line alone should create inequality in terms of socio-economic conditions along the Green Line in preference to other areas in Karachi.

Green Line has been selected to construct on the existing major road for passenger convenience for transfer and the conditions of the existing road structures. It is expected to cause minimum negative social impact such as the resettlement and land acquisition does not get involved in the plan. It is proposed to construct along M. A. Jinnah Road.

From the natural environmental view points, only the negative impact of Green Line development is the felling of trees planted on the road side and the road center's green belt.

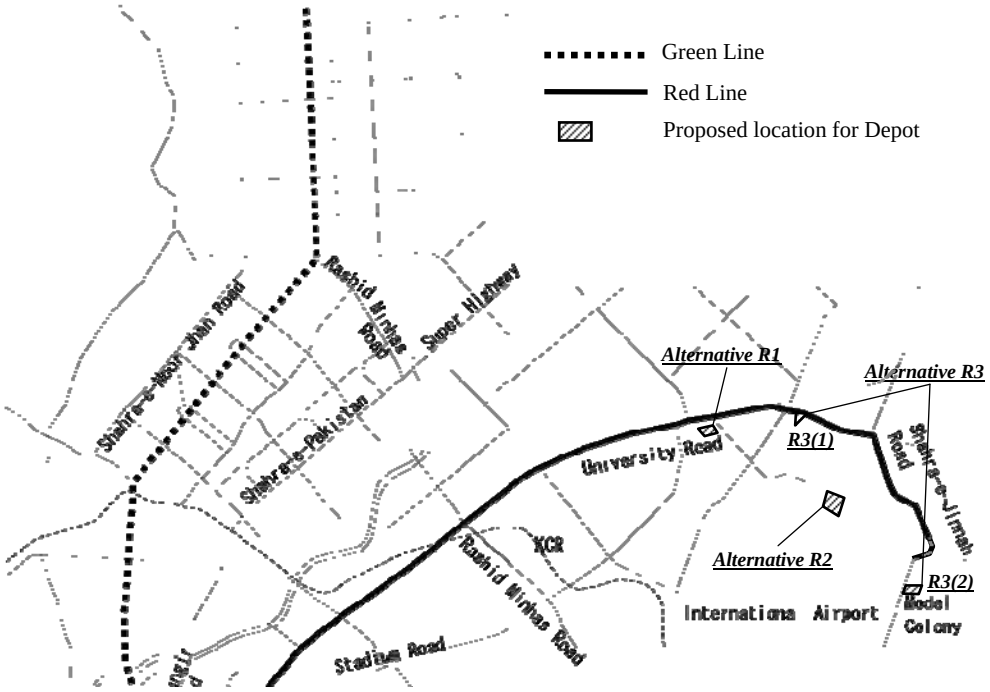
(3) Red Line Development Scenario

There is no alternative route for Red Line because there is no alternative parallel road along the corridor. There are depots located in the vicinity of Red Line, and the alternative plan of the depot is as follows:

Table 7-6-4 Alternative plan of the BRT depot for Red Line

Alternative	Ownership	Remark	Area
R1	Ranger Land	This area has already been occupied by Pakistan Ranger.	33,800 m^2
R2	Private Land	This area is vacant land	24,000 m^2
R3	Governmental Land	These areas are vacant land	(1) 17,500 m^2 (2) 12,100 m^2

Source: JICA Study Team



Source: JICA Study Team

Figure 7-6-4 Location of Alternative Depot for Red Line

In case of Red line, three locations are proposed. Alternative R1 is currently occupied by Pakistan

rangers, where was selected as a depot in the "Confirmatory Green Route Study for Karachi". The area appears to be difficult to build as a depot in this area because of the function of ranger occupied area cannot be shifted from this area to other areas. Alternative R2 is in the north of the Jinnah Airport. This area is not exactly along Red Line. Compensation for land acquisition is necessary for this depot. Although there is no resettlement, a patch of private land as Alternative R3 has two separate locations. Thus Alternative R3 has been selected.

Green Line shown in No 8 of Figure 7-6-1 is now Red Line in the Feasibility Study with a few modifications made on the starting of its western end and the ending point of its eastern end. Its eastern end has been extended to Malir Cantonment where a relatively large scale housing development is taking place i.e. this line should function to feed the workforce that are building up in the eastern side of Karachi. Thus socio-economically, this line will contribute positive impacts along the corridor.

The Red Line development alone can function very well as the line mainly feed work force from the eastern Karachi to the central Karachi. On the other hand, since the corridor goes through higher education area of Karachi, Red Line corridor development alone cannot contribute to the sectors of commerce and industry i.e. inequality in development of urban transportation in terms of socio-economic conditions along the Red Line corridor might be created in preference to other areas in Karachi.

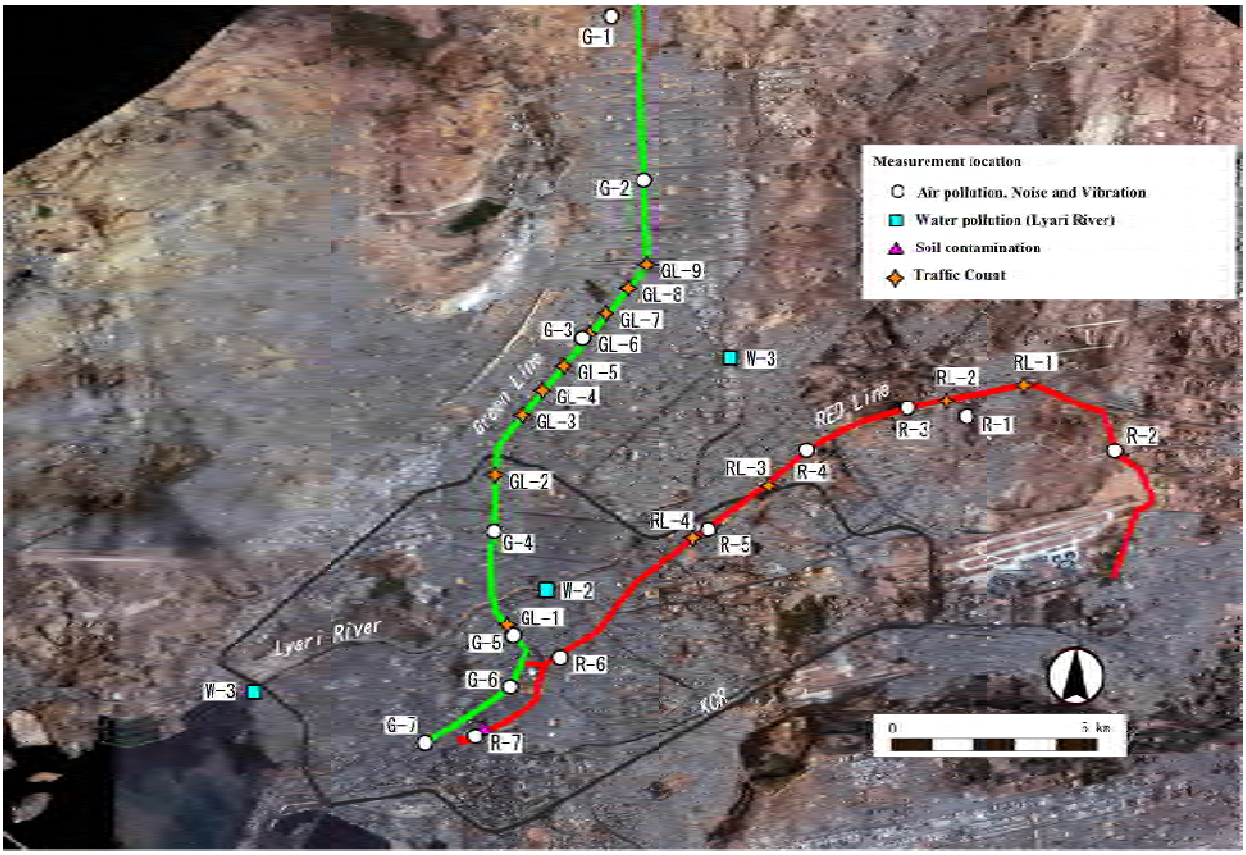
(4) A Combination of Green Line and Red Line Development Scenario

As explained in the section (2) and (3) as above, relatively wide "Area Development" in urban transportation could be achieved rather than "Linier Development" of urban transportation. Thus, in view of the developing much positive impacts on socio-economic environment, a combination of two is considered as viable option.

Not only a combination of Green Line and Red Line, but any other combination BRT line development should remain essentially the same in terms of the environmental impacts caused by the project to the natural and socio-economic environment. Thus the most effective development option of Green Line and Red Line is considered appropriate in view of the environmental impacts caused by the Project.

7.7 Result of Field Survey on the Environment Affected by the Project

Measurement location of field survey is shown in Figure 7-7-1.



Source: JICA Study Team

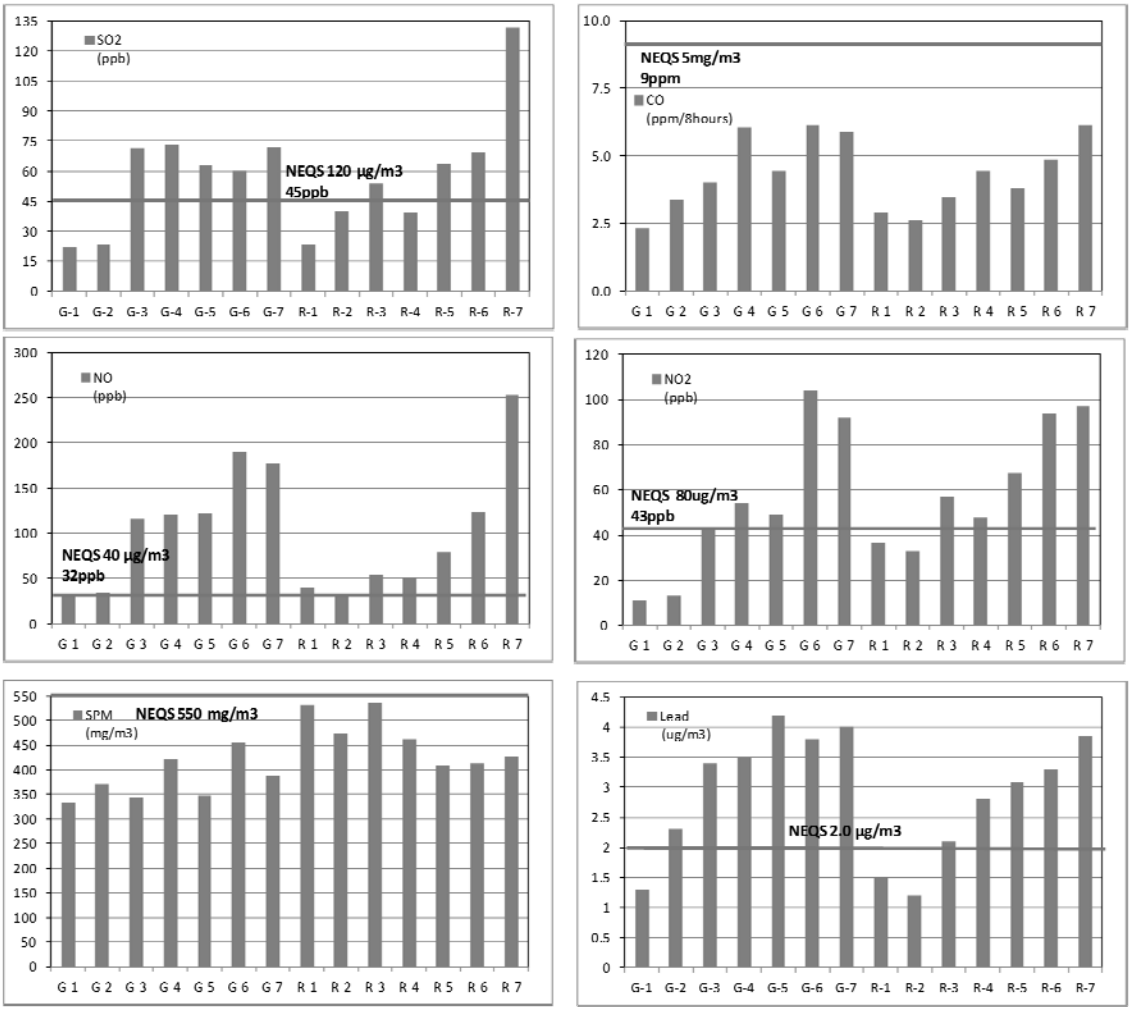
Figure 7-7-1 Measurement location of EIA field survey

7.7.1 Pollution Control

(1) Air pollution

The results of field measurement of air quality along the project route are shown in Figure 7-7-2. The problem of air pollution is more acute in highly business congested area of green and red line where movement of air is minimal. Measurements of NO, and NO_2 at central area of Karachi (R-6, 7, G-6, 7) are particularly higher than the recommended standard by NEQS. This reflects that heavy traffic movement on these intersections in addition to outdated vehicles resulting in emission of lead.

According to the report of Vehicular Emission Control Programme (VECOP) by The Sindh Environmental Protection Agency, regular monitoring and inspection was started from January 2010 and during the last 18 months, about 11,384 vehicles of all categories have been inspected and tested for their emission levels. Out of them, about 3,503 did not comply with the NEQS for vehicles and 1,947 were challenged by the traffic police for violation of the standards.



Source: JICA Study Team

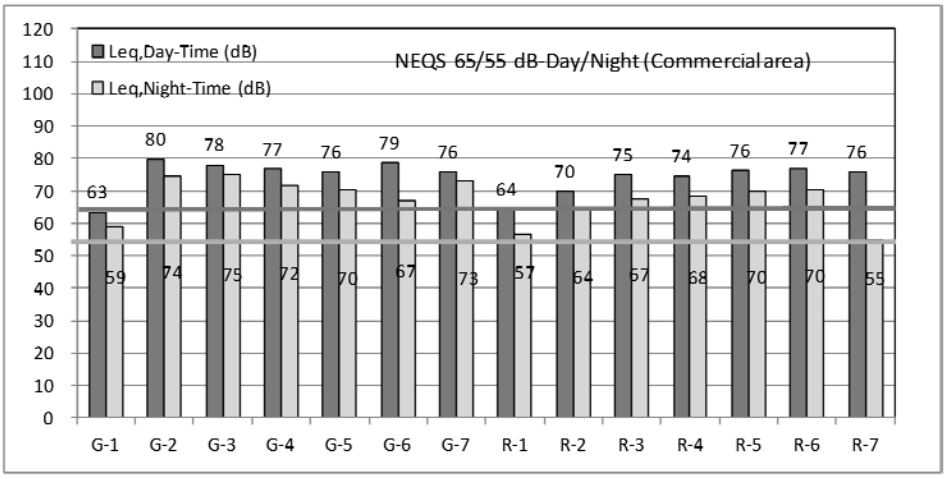
Figure 7-7-2 Result of Field Measurement on Air Quality

(2) Noise and Vibration

The results of field measurement of noise and vibration level along the project route are shown in Figure 7-7-3 and Figure 7-7-4.

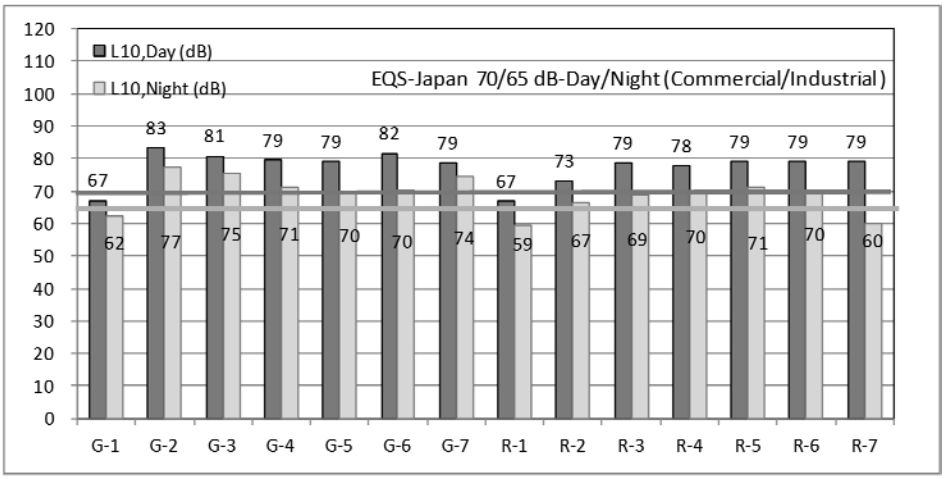
The noise level of all locations except CNG green bus terminal Surjani town (G-1) and Ranger area (R-1) is high as compared to NEQS noise level for commercial area. Regarding the vibration level, all locations except G-1 and R-1 is also higher as compared to Request Limits for Motor Vehicle Vibration in Japan.

G-1 and R-1 is located in the residential area. Other survey points are located along the major corridor. Noise/vibration level during night time at R-7 was very low, since traffic density decreased.



Note: Day time hours: 6.00 a. m to 10.00 p. m, Night time hours: 10.00 p. m to 6.00p. m
Source :JICA Study Team

Figure 7-7-3 Result of field measurement of Noise Level



Note: Day time hours: 7.00 a. m to 10.00 p. m, Night time hours: 10.00 p. m to 7.00p. m
QES-Japan: Request Limits for Motor Vehicle Vibration in Japan
Source: JICA Study Team

Figure 7-7-4 Result of Field Measurement of Vibration Level

(3) Water Quality

According to the water quality survey in Lyari River during two seasons, the effluent stream appears to be viably stabilized in terms of many parameters including DO, BOD, COD, S^{2-}, Nitrogen Ammonia, Detergents and Phenolic compounds etc. Average character of stream during dry and wet season is not showing a viable difference with respect to many of its criteria parameters. Average figures of TDS, Electric Conductivity, PH, Temperature, Chloride and DO were found in very close proximity. The stream chemical character remained almost un-altered during wet and dry season. Average figures of following parameters are exceeding NEQS defined limits:

- Biological oxygen demand (BOD) average figures are 95 and 138mg/l for wet and dry season respectively; both figures are exceeding NEQS figure of 80mg/l.
- Total suspended solids (TSS) average figures are 273 and 138mg/l for wet and dry season respectively, the figure of dry season is less than NEQS figure of 200mg/l.
- Sulphide average figures are 14 and 16mg/l for wet and dry season respectively, both of these figures are exceeding NEQS figure of 1mg/l

(4) Soil Quality

Soil quality measurement was conducted at three locations around digging area for structure on Red Line (R-7) New M.A. Jinnah Road. Three soil samples have been analyzed in laboratory for soil quality of the project area. All samples are low as compared to National Environment Standards for Soil Contamination in Japan as per Table 7-7-1.

Table 7-7-1 Soil Quality Measurement and the Analytical Result

	Compound	LOR	Unit	Sample1	Sample2	Sample3	EQS Ministry of Environment Government of Japan	
							Soil Leachate Standard (Risk for ingestion from ground water etc.)	Soil Concentration Standard (Risk for direct ingestion)
1	pH	0.1	pH	9.9	9.1	9.6	-	
2	Moisture Content	0.1	%	9.1	10.6	2.4	-	
3	Antimony (Sb)	1	mg/kg	<1	<1	<1		
4	Arsenic (As)	1	mg/kg	11	12	5	0.01 mg/l	15 mg/kg
5	Beryllium (Be)	0.5	mg/kg	0.5	0.6	<0.5		
6	Cadmium (Cd)	0.2	mg/kg	<0.2	<0.2	<0.2	0.01 mg/l	150 mg/kg
7	Chromium (Cr)	1	mg/kg	34	41	15	0.05 mg/l	250 mg/kg
8	Copper (Cu)	1	mg/kg	16	16	8		125 mg/kg
9	Lead (Pb)	1	mg/kg	9	8	6	0.01 mg/l	150 mg/kg
10	Nickel (Ni)	1	mg/kg	33	42	8		
11	Selenium (Se)	1	mg/kg	<1	<1	<1	0.01 mg/l	150 mg/kg
12	Silver (Ag)	0.1	mg/kg	<0.1	<0.1	<0.1		
13	Thallium(Tl)	0.5	mg/kg	<0.5	<0.5	<0.5		
14	Zinc (Zn)	1	mg/kg	36	37	21		
15	Mercury (Hg)	0.05	mg/kg	<0.05	<0.05	<0.05	0.0005 mg/l	150 mg/kg
16	Benzene	0.1	mg/kg	<0.1	<0.1	<0.1	0.01 mg/l	
17	1.1.1-Trichloroethane	0.2	mg/kg	<0.2	<0.2	<0.2	1 mg/l	
18	1.1-Dichloropropylene	0.2	mg/kg	<0.2	<0.2	<0.2		
19	Carbon Tetrachloride	0.2	mg/kg	<0.2	<0.2	<0.2	0.002 mg/l	
20	1.2-Dichloroethane	0.2	mg/kg	<0.2	<0.2	<0.2	0.004 mg/l	
21	1.1.2-Trichloroethane	0.2	mg/kg	<0.2	<0.2	<0.2	0.006 mg/l	
22	Simazine	0.05	mg/kg	<0.05	<0.05	<0.05	0.003 mg/l	

Source: JICA Study Team

(5) Traffic Survey

The results of field measurement of traffic count are shown in Table 7-7-2. Traffic Count Survey was conducted for 14 hours (7:00-21:00) on a weekday (Monday-Thursday). The objective of the Traffic Count Survey is to obtain traffic volume data by direction (left, right, and straight) by approach at major intersections along Green and Red Lines.

Table 7-7-2 Result of Traffic Count

Location	Cars/Jeeps/ Taxis/Vans	Motor cycles & Scooters	Auto Rickshaws	Motorcycle Rickshaws	Pickups	Mini Buses & Coaches	Large Buses	Rigid Trucks & Trailors	Total
GL-1; U-turn of Business Recorder Road (near Fatima Bai Hospital)									
From Guru Madir	9,517	25,628	7,873	20	1,483	360	442	258	45,581
From Garden	1,844	1,783	1,792	3	288	66	10	20	5,806
From Lasbella	9,588	27,364	7,857	22	1,028	371	463	191	46,884
From Patel Para	584	1,244	1,629	1	254	6	5	3	3,726
Total	**21,533**	**56,019**	**19,151**	**46**	**305**	**803**	**920**	**472**	**101,997**
GL-2; Nazimabad No.7									
From Nazimabad Underpass	18,008	48,007	7,986	55	3,483	957	727	987	80,210
From Abbasi Shaheed Hospital	4,704	11,321	3,929	736	646	536	94	70	22,036
From Matric Board Office	16,710	50,543	7,229	91	2,805	789	811	874	79,852
From Nazimabad No. 4	2,840	4,588	2,188	706	656	95	8	34	11,115
Total	**42,262**	**114,459**	**21,332**	**1,588**	**7,590**	**2,377**	**1,640**	**1,965**	**193,213**
GL-3: U-turn between KDA Chowrangi and Hyderi Market									
From KDA	19,779	32,915	7,189	29	3,094	1,118	642	746	65,512
From Hyderi Market	257,237	42,296	10,362	29	3,530	1,270	689	871	84,284
Total	**45,016**	**75,211**	**17,551**	**58**	**6,624**	**2,388**	**1,331**	**1,617**	**149,796**
GL-4: U-turn between Hyderi Market and Five Star Chowrangi									
From Hyderi Market	24,120	38,809	7,365	29	5,003	995	585	847	77,753
From Five Star Chowrangi	23,070	35,036	8,073	38	2,828	1,192	566	995	71,798
Total	**47,190**	**73,845**	**15,438**	**67**	**7,831**	**2,187**	**1,151**	**1,842**	**149,551**
GL-5:U-turn between Five Star Chowrangi and New Hyderi Market									
From Five Star Chowrangi	19,352	50,318	7,277	26	3,153	1,190	603	974	82,893
From New Hyderi Market	20,852	54,628	8,153	36	2,930	2,089	504	1,007	90,199
Total	**40,204**	**104,946**	**15,430**	**62**	**6,083**	**3,279**	**1,107**	**1,981**	**173,092**
GL-6:U-turn between New Hyderi Market and Sakhi Hassan Chowrangi									
From New Hyderi Market	15,834	46,533	7,643	54	3,130	1,113	601	908	75,816
From Sakhi Hasam	15,773	52,626	7,715	33	2,960	1,300	579	702	81,696
Total	**31,607**	**99,159**	**15,358**	**87**	**6,090**	**2,421**	**1,180**	**1,610**	**157,512**
GL-7:U-turn in front of Haroon Shopping Center									
From Sakhi Hasan Chowrangi	14,401	41,076	4,633	71	2,841	1,310	480	929	65,741
From Nagan Chowrangi	15,668	52,540	6,227	124	3,410	1,412	591	971	80,943
Total	**30,069**	**93,616**	**10,860**	**195**	**6,251**	**2,722**	**1,071**	**1,900**	**146,684**
GL-8:U-turn between Haroon Shopping Center and Nagan Chowrangi									
From Haroon Shopping Centre	14,038	42,040	6,886	85	3,069	1,253	630	981	68,982
From Nagan Chowrangi	14,409	46,062	6,222	361	3,461	1,539	653	948	73,655
Total	**28,447**	**88,102**	**13,108**	**446**	**6,530**	**2,792**	**1,283**	**1,929**	**142,637**
GL-9:Nagan Chowrangi									
From Sohrab Goth	13,276	23,176	4,856	546	2,598	1,356	286	885	46,979
From Sakhi Hasan	14,053	41,774	6,641	401	2,777	1,226	531	994	68,397
From Anda Morr	1,092	2,215	597	4	251	30	17	21	4,227
From UP Morr	18,487	69,914	10,174	900	2,923	1,558	546	1,097	105,599
From Godhra	712	877	184	6	112	81	81	37	2,090
Total	**47,620**	**137,956**	**22,452**	**1,857**	**8,661**	**4,251**	**1,461**	**3,034**	**227,292**
RL-1; Safura Chowk									
From Karachi University	7,450	5,240	874	838	578	801	82	299	16,162
From Kiran Hospital	3,259	2,183	406	213	238	478	8	136	6,921
From Saadi Road	3,511	2,912	285	144	304	129	64	180	7,529
From Malir Cantt	4,346	4,437	483	203	439	329	50	292	10,579
Total	**18,566**	**14,772**	**2,048**	**1,398**	**1,559**	**1,737**	**204**	**907**	**41,191**
RL-2; Intersection of Road from Kamran Chowrangi (Gulistan-e-Jauhar) & University									
From Karachi University	10,295	10,082	1,747	904	979	974	117	150	25,248
From Kamran Chowrangi	6,778	4,232	947	1,073	272	166	29	193	13,690
From Safoora Chowrangi	16,685	15,266	3,169	1,400	1,115	1,174	103	383	39,295
Total	**33,758**	**29,580**	**5,863**	**3,377**	**2,366**	**2,314**	**249**	**726**	**78,233**
RL-3; NIPA. Chowrangi									
From Johar Chowrangi	23,718	25,003	4,543	45	1,883	1,504	181	1,040	57,917
From Civic Centre	26,386	16,481	4,979	1,083	1,317	3,344	383	490	54,463
From Gulshan	31,362	31,188	6,206	424	2,730	2,498	303	1,090	75,801
From Karachi University	33,804	25,168	5,754	260	1,395	2,577	347	489	72,139
Total	**115,270**	**97,840**	**21,482**	**4,157**	**7,325**	**9,923**	**1,214**	**3,109**	**260,320**
RL-4; U-turn between Bait-ul-Mukkarram Masjid and PIA Garden									
From PIA Garden	29,370	35,523	7,823	353	2,002	1,873	300	419	77,663
From Bait-ul-Mukkarram	37,445	31,294	6,912	280	1,753	2,040	284	432	80,440
Total	**66,815**	**66,817**	**14,735**	**633**	**3,755**	**3,913**	**584**	**851**	**158,103**

Source: JICA Study Team

7.7.2 Biological Environment

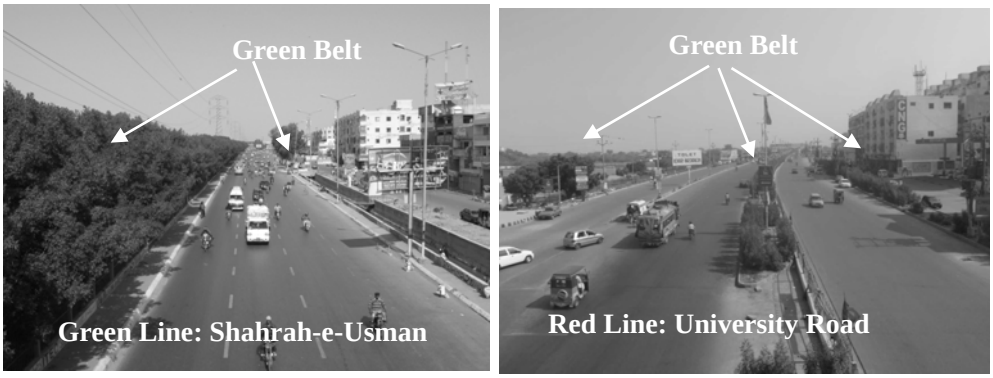
(1) Flora

As many as 72 species of plants have been recorded from the project area of Green and Red line. The plant species subject to fell down are *Conocarpus*, *Eucalyptus* and *Lignum species*. There are a number of medicinal plants such as *Azadirachta indica*, *Aerva* javanica, *Calotropis procera*, *Cassia fistula*, *Fagonia indica*, *Melia azidarach*, Morinaga oleifera, *Ricinus communis*, and *Tecomela undulata*. There are shade trees commonly found in the project area such as *Albizzia procera*, *Azadirachta indica*, *Eucalyptus citriodora*, *Fiscus bengalensis*, *Fiscus religiosa*, *Melia azidaroch*, *Pithcellobium dulce*, *Tamarindus indica* and *Zizyphus nummularia*. Fruit trees are also affected such as Mango, Jaman, Naryal, Badam, Jangal jalebi, Imli, Lahsora, Gondni, Ber, Date palm, and Amla. Four *Tecomella Undulata* in total have been identified as endangered species on the right lane of Red Line between Malir Cantt. to Safoorah Chowrangi. Total number of tree counted on both corridors is shown in the Table 7-7-3.

Table 7-7-3 Result of Tree Counting along the Corridors

BRT	Number of Trees			Total
	Left Lane	Median Lane	Right Lane	
Green Line	1,701	13,456	1,480	16,637
Red Line	1,504	9,662	4,632	15,798
Sub-total	3,205	23,118	6,112	32,435

Source: JICA Study Team



Source: JICA Study Team

Figure 7-7-5 Typical Cross Sections Showing Tree Counting Areas

The dominant plant species are obviously *Conocarpus*, *Eucalyptus* and *Lignum species*. The flora included some medicinal plants such as *Azadirachta indica, Aerva javanica, Calotropis procera, Cassia fistula, Fagonia indica, Melia azidarach, Morinaga oleifera, Ricinus communis, and Tecomela undulata.* The shade trees were also commonly found such as *Albizzia procera, Azadirachta indica, Eucalyptus citriodora, Fiscus bengalensis, Fiscus religiosa, Melia azidaroch, Pithcellobium dulce, Tamarindus indica and Zizyphus nummularia.*

The fruit trees included Mango, Jaman, Naryal, Badam, Jangal jalebi, Imli, Lahsora, Gondni, Ber, Date palm, and Amla.

(2) Fauna

As regards the fauna, 16 species of animals were recorded comprising of 4 species of mammals, 10 species of birds and 3 species of reptiles. All of them are common species whose inhabitants are in industrial area Karachi.

7.7.3 Socio-economic Environment

(1) Framework of Socio-economic Impact Assessment

1) Identification of Adverse Impacts

Emphasis has been given to identifying and mitigating adverse impacts to the socio-economic conditions of the project area generally following the existing road. These impacts should be specified and reported for each of Green Line and Red Line. Particular attention has been given to highlighting adverse impacts on people who are sensitive or vulnerable strata. Classification is based on the age, gender, ethnicity, caste, poverty or other factors.

2) Method of Predicting Socio-economic Impact Assessment

Method for predicting socio-economic impacts varies from one project to the other depending on the combination of the nature of project and the existing natural and social conditions. In general the Project takes place on the major roads of Karachi where major characteristic is a heavily populated urban setting. Thus a combination of the following methods will have to be used:

a) Trend extrapolations: projecting current trends, such as population change or employment, into the future (with or without modifying the rate of change);
b) Population multipliers: extrapolated increases in population size are coefficients for the change in other variables, such as employment and demand for housing, infrastructure or services;
c) Consultation to urban development experts: use of expert knowledge such as researchers, professional consultants, local authorities, or knowledgeable citizens on the urban planning and/or urban transportation development;
d) Scenario development: exercises to develop "Do-nothing" and other alternatives or preferred future urban transportation development of Karachi as a Pakistan's largest city. A number of sscenarios have to be developed to compare different outcomes; and
e) Comparative studies: examining how an affected community has responded to change in the past, or the impact on other communities that have undergone a similar action.

(2) Socio-economic Conditions of the Area along Green Line

1) Socio-economic Characteristics of the Green Line Corridor

Based on the baseline survey, the following tables illustrate general characteristics of the Green Line Corridor. Table 7-7-4 illustrates the result of socio-economic survey on the population fronting the road subject to BRT development for Green Line. As is shown approximately 81 percent of respondents of the survey is engaged in commercial activities and most of them are non-residents, while 16.5% respondents are residents. This is compared to the general characteristics of each township that the Green Line goes through as is expressed in the following section.

Table 7-7-4 General Distribution of Respondents

Type of Structure	No.	Percentage
Residential	58.0	16.5%
Commercial	284.0	80.9%
Residential Cum Commercial	3.0	0.3%
Others	6.0	1.7%
No Response	2	0.5%
Total	351	100%

Source: JICA Study Team for KTIP.

Table 7-7-5 illustrates details of respondents engaged in commercial activities. Among the respondents engaged in commercial activities, 82% are retail shop owners, managers, helpers; service providers (telecommunication, internet, cable TV, etc.), 13% respondents are providing recreational/catering services while the rest are engaged in academic institutions, health service institutions and similar activities in the commercial sector.

Table 7-7-5 Activity-wise Distribution of Commercial Respondents

Type of activity	No.	Percentage
Retailer/Service Provider	235	81.7%
Eateries/Recreational	36	12.7%
Others (Medical Facilities/Academic Institutions etc)	16	5.6%
Total	287	100%

Source: JICA Study Team for KTIP.

Table 7-7-6 illustrates details of residents in terms of their mode of living. Among the respondents, 24% of the live in apartments and also 24 % of the residents live in multi-story houses, while 19 respondents live in single story house and approximately 33 % of the live in flats. In broad generalization, most of the respondents living in single-story and multi-story houses are relatively well-off residents followed by those of middle to low income families living in apartment complex and flats.

Table 7-7-6 Resident-wise Distribution of Respondents by Type of Structure

Type of structure	No.	Percentage
Single-story house	11	18.97%
Multi-story house	15	24.14%
Flat	20	32.76%
Apartment Complex	15	24.14%
Total	61	100%

Source: JICA Study Team for KTIP.

2) Townships along Green Line Corridor

Green Line of BRT goes through the following townships from north to south. Characteristics of each township that the Green Line goes through are briefly described as follows:

a) North Karachi Township

Major land use coving approximately 60% of the township is predominantly urban residential area recently developed for ever increasing population in Karachi. North Karachi is a supplier as well as recipient of work force to and fro the adjacent UC's/Towns including North Karachi Industrial Area. In general there are lower middle to low income families occupy the area. Industrial covers approximately 10 % of the total land area.

b) North Nazimabad Township

Major land use of the township is relatively old but well developed residential area which covers 70 % of the total land area. This township is well planned and compact in respect of infrastructure facility development. The area is a supplier of high level as well as middle level work force to the adjacent North Karachi Industrial Area. Relatively small scale commercial activities are concentrating in the area along major roads.

c) Liaquatabad Township

Major land use is residential and covers around 70% of the urbanized area. The population density is very high with middle class to lower middle class income families. Commercial areas are concentrating along the major road in the south of township.

d) Jamshed Township

Major land use is predominantly urbanized residential area and it covers approximately 70% of the total land area. There is a mixture of high to upper middle income families as well as middle to lower income families. There is approximately 30 % of residential area formed by kachi abadi, or squatter settlement. Heavy concentration of commercial activities along the major road is observed.

e) Saddar Township

Saddar is commercial and administration hub of Karachi city. Major portion of the area is predominantly commercial and Central Business District (CBD) of Karachi City occupies most part of the township. CBD plays a major role of the financial and commercial centre in Pakistan. The main financing function such as national bank, stock market and headquarters of major enterprise are located in CBD. Most of federal and provincial offices are also located in this township.

(3) Socio-economic Conditions of the Area along Red Line Corridor

1) General Socio-economic Characteristics of the Red Line Corridor

Based on the baseline survey, the following tables illustrate broadly generalized characteristics of the Red Line Corridor. Table 7-7-7 illustrates the result of socio-economic survey on the population fronting the road subject to BRT development for Red Line. As is show, 78 percent of respondents of the survey are engaged in commercial activities and most of them are non-residents while 17 percent in total of the respondents are residents. This is compared to the general characteristics of each township that the Red Line goes through as expressed in the following section.

Table 7-7-7 General Distribution of Respondents

Type of Structure	No.	Percentage
Residential	26	9%
Commercial	237	78%
Residential Cum Commercial	24	8%
Others	7	2%
No Response	8	3%
Total	302	100%

Source: JICA Study Team for KTIP.

Table 7-7-8 illustrates economic activities along the Red Line. Among the respondents engaged in commercial activities in the corridor, 95.4 percent are retail shop owners, managers, helpers; service providers (telecommunication, internet, TV cable), followed by 3.4 percent of recreational/catering services and others counting for 1.3 percent engaged in academic institutions, health service institutions and similar activities.

Table 7-7-8 Activity-wise Distribution of Commercial Respondents

Type of activity	No.	Percentage
Retailer/Service Provider	249	95.36%
Eateries/Recreational	9	3.38%
Others (Medical Facilities/Academic Institutions, etc.)	3	1.27%
Total	261	100%

Source: JICA Study Team for KTIP.

Table 7-7-9 illustrates residents living in various type of housing. Among the respondents, 62 percent live in apartments followed by 27 percent of them living in flat, 11.5 percent of them living in single-story house. Thus general picture of the corridor is that there are no relatively well-off families living in multi-story building followed by middle to low income families living in apartment complex and single-story houses.

Table 7-7-9 Residents-wise Distribution of Respondents by Type of Structure

Type of structure	No.	Percentage
Single-story house	6	11.54%
Multi-story house	0	0%
Flat	13	26.92%
Apartment Complex	31	61.54%
Total	50	100%

Source: JICA Study Team for KTIP.

2) Townships along the Red Line Corridor

Red Line goes through the following townships generally from east to west. Characteristics of each township that the Red Line goes through are briefly described as follows:

a) Malir Township

The area is predominantly residential. While in general western half of the township covers residential area, eastern half of it is rural setting and 20 % of the township is covered by agricultural area.

b) Malir Cantonment

Malir Cantonement is a largest military training and residential area in Karachi. Relatively wide area of the cantonment is not occupied.

c) Gulshan-e-Iqbal Township

This township is predominantly residential and it covers 40 % of the total land area. This township also houses most of the large scale educational facilities including Karachi University.

d) Jamshed Township

As described in the Section 7.8.2, Major land use is urbanized residential area and it covers approximately 70% of the total land area. However, approximately 30 % of residential area is formed by kachi abadi, or squatter settlement. Heavy concentration of commercial activities along the major road is observed.

e) Saddar Township

As described in the Section 7.8.2, Saddar is commercial and administration hub of Karachi city. Major portion of the area is predominantly commercial and Central Business District (CBD) of Karachi City occupies most part of the township. CBD plays a major role of the financial and commercial centre in Pakistan. The main financing function such as national bank, stock market and headquarters of major enterprise are located in CBD. Most of federal and provincial offices are also located in this township.

7.8 Stakeholder Meeting

7.8.1 Outline of Stakeholder meeting

Two rounds of consultation meetings were carried out as shown Table 7-8-1. Detail of stakeholder meeting is shown in Appendix.

The stakeholders meetings were arranged at one location each on the two corridors on date that was advertised in the press and by invitation extended to all major stakeholders.

Objectives of Stakeholder Meeting are defined as follows:

1) To disseminate information on the outline of the development plans for Karachi Transportation Improvement Project (KTIP) for concerned citizens;

2) Provide information on environmental and social benefit of the project;

3) To offer opportunities to vice the concerns of the stakeholders regarding the project during the planning stage;

4) Dissemination of information on the project in respect to the alignment, schedules and plan;

5) To consult with stakeholders on draft environmental scoping and draft TOR for EIA Study during primary stakeholder meeting; and

6) To disclose all main findings from Draft Environmental Impact Assessment (EIA) study during secondary stakeholder meeting

Table 7-8-1: Outlines of Stakeholder Meetings

Stage	Main Contents	Venue	Date/Time	Number of participants
Scoping Stage	-Outline of the Project. -Sharing and discussing the draft scoping. -Methodology for EIA study and issues to be considered in the study.	Taimuria Library (Green Line Corridor)	31st January 2012	109
		NED University (Red Line Corridor)	8th February 2012	90
Disclosure of Findings from Draft Final Report	-Outline of the Project. -Sharing and discussing the draft EIA.	Largess Restaurant (Green Line Corridor)	27th April 2012	87
		Hotel Ramada Plaza (Red Line Corridor)	28th April 2012	102

Source: JICA Study Team

7.8.2 Initial Stakeholder Meeting

During initial stakeholder meeting, the presentation was focus on the project outline, environmental baseline, the scope of EIA and mode of operation of the BRT system.

Question and Answer was followed by questionnaire to obtain feedback on the status of the transportation system and the likely improvement that the participants would foresee incase the BRT system is introduced. All the participants were requested to responds to the set of questions laid down in the questionnaire.

(1) Green Line

The main comments from participants of initial stakeholder meeting on Green Line are summarized as follows:

1) The project should be seriously and actively implemented for solving the problem of urban transportation system in Karachi;

2) The fares should be affordable to the general public of the Karachi especially it can be easily accessible to the poor sector of the society;

3) The project will have to be able to minimize the traffic congestion faced during the peak hours;

4) Traffic accidents will have to be reduced by the accomplishment of this project;

5) Special arrangements should be made for the facilitation of disabled-persons in the transport project;

6) Project will have to provide instant transport service by accommodating a massive population of Karachi at one time from one place to another; and

7) Project will have to provide a provision of stations on particular locations without disturbing any business/residential or institutional activity.

(2) Red Line

The main comments from participants of initial stakeholder meeting on Red Line are summarized as follows:

1) Earlier implementation is the key to the success of this ambitious project;
2) Current political, social and economic situation of the country is the main factor which hinders the development of an efficient BRT system in the city;
3) JICA guidelines and other international standards regarding occupational, health and safety should be considered before implementation of the project;
4) Proposed BRT system should provide feeder service to the Karachi Circular Railway and both systems should be interlinked to each other;
5) All concerned parties like Bus Associations etc. should be taken on board and their participation should be made necessary for the smooth implementation of the proposed project;
6) The fares should be affordable to the general public of the Karachi, especially it can be easily accessible to the poor sector of the society;
7) The project should minimize the current level of traffic congestion;
8) The BRT line should be made available for ambulances in time of emergency; and
9) Traffic accidents should be reduced by the accomplishment of this project.

(3) Questionnaire Survey

1) Green Line

The Table 7-8-1 to 2 shows the result of the initial stakeholder meeting on Green Line of BRT. For the purpose of opinion polls, a survey form distributed to the participants for opinion survey. It is designed to obtain comprehensive feedback of the participants in terms of the importance, what they understand the problems, hurdles and comments on the Project. Among 109 participants, there have been 55 valid answers.

Table 7-8-1 Assessment of Stakeholders feedback - Green Line

S.No	Questions	No. of Respondents				Percentage (%) of Respondents			
		Positive Views	Negative Views	Others	Total	Positive Views	Negative Views	Others	Total
1	I am satisfied/not satisfied with the performance of current transport system	1	54	0	55	2%	98%	0	100%
2	After implementation of Bus Rapid Transit (BRT) in Karachi; congestion of Roads will increase/decrease.	14	37	4	55	25%	67%	8%	100%
3	(a)Presently I travel through Bus/Car/Motorcycle to reach my work place.(b) I would prefer /not prefer BRT in future for travel	47	8	0	55	85%	15%	0	100%
4	BRT will improve/not improve social life, environmental condition and economic activities in city	53	2	0	55	96%	4%	0	100%
5	There are technical hurdles/no hurdles in the implementation of BRT on Redline and Greenline	32	23	0	55	585	42%	0	100%

Source: JICA Study Team for KTIP

Among them 98 % of respondents are not satisfied with the performance of current transport system and just 2% of them are satisfied i.e. majority of the stakeholders understand the importance of this project.

On the other hand increases or decreases the congestion of the roads, only 25 % of the total number of respondents thinks that our at present roads are already congested and 67 % of the stakeholders says that there will be no congestion as the majority of people prefer traveling by BRT.

Among the respondents 85 % are willing to travel in BRT because it is expected to be cheap, comfortable and reliable. The rest of people are willing to travel by private transport.

As an overall rating, 96 % are in favor of socio-economic and environmental conditions that will be improved by the project and the rest of people had opposite opinion.

There are issues of technical hurdles in the project implementation and 58 % of the total respondents saying that there will be hurdles to clear because of transport mafia, land mafia, political pressure from various political parties. The rest of 42 % are thinking that there will be no technical hurdle.

Table 7-8-2 Travelling Mode-Green Line

S.No	Travelling Mode	No of Respondent	Percentage of Respondents
1	Bus	10	18%
2	Car	15	27%
3	Motorcycle	3	5%
4	Car & Motorcycle or both	4	7%
5	No Response	23	43%
	Total	55	100%

Source: JICA Study Team for KTIP

On the other hand current traveling mode of the stakeholder's responses have had shown different points of view in respect of travelling routes. Because some of them are using buses and rest of them are traveling by private vehicles, as the above table indicates 18% of the stakeholders that are travelling by local public transport are contending that it is insufficient and fewer numbers of buses are running in this route of Green Line. This view if reflected by the others using their private cars and motor cycles or both, which is accounted for 36 % of the total number of respondents.

Some of the local residents have to change different points to reach their destination if buses are used. Therefore, 5 % of the total number of respondents use motorcycles as it is cheaper and less time consuming then local transport while 7% of the total number of respondents travel by private cars and motorcycles exchanging one to the other because the bus stations are far from their residence.

2) Red Line

The Table 7-8-3 and 4 shows the result of the initial stakeholder meeting of the Red Line. For the purpose of opinion polls, a survey form distributed to the participants for opinion survey. It is designed to obtain comprehensive feedback of the participants in terms of the importance, what they understand the problems, hurdles and comments on the Project. While there have been 90 participants, 49 of them returned valid answers.

Among them, 96 % of respondents are not satisfied with the performance of current transport system and 4% are satisfied. It would mean that the majority of stakeholders understand the importance of this project.

For the question on the increase or decrease the congestion of the roads in the future with the Project, only 29 % of the total number of respondents thinks that the roads in Karachi would become congested while 71% of the total number of respondents thinks there will be no congestion after the implementation of the Project because the majority of people prefer traveling through BRT.

Among the respondents, 71 % are willing to travel in BRT because it is cheap, comfortable and reliable and the rest of people willing to travel by private transport.

Over all 82 % are in favor of this project because socio-economic and environmental condition will be improved by this project. However, many thinks that there are issues of technical hurdles regarding the implementation of the project as 65 % of the total respondents saying that there will be transport mafia, land mafia and political pressure in time of the implementation of the Project. There are 29 % of the total number of respondents that they think there will be no technical hurdles while the 6 % are not confirm either it would be completed or not. In conclusions, the majority of people appreciated and supported the Project.

Table 7-8-3 Assessment of Stakeholders feedback for - Red Line

S.No	Questions	No of Respondents				Percentage (%) of Respondents			
		Positive Views	Negative Views	Others	Total	Positive Views	Negative Views	Others	Total
1	Iam satisfied/not satisfied with the performance of the current transport system	2	47	0	49	4%	96%	0%	100%
2	After implementation of Bus Rapid Transit (BRT) in Karachi; Congestion of Roads will increase/decrease	14	35	0	49	29%	71%	0%	100%
3	.(a) presently I travel through Bus/Car/Motorcycle to reach my work place. (b) I would prefer/not prefer BRT in future for travel.	35	14	0	49	71%	29%	0%	100%
4	BRT will improve/not improve social life, environmental condition and economic activities in city	40	9	0	49	82%	18%	0%	100%
5	There are technical hurdles/no hurdles in the implementation of BRT on Redline and Green line	32	14	3	49	65%	29%	6%	100%

Source: JICA Study Team for KTIP

Current traveling modes of the respondents have been different from the respondents of Green Line corridor. Some of the respondents in Red Line corridor are using buses and rest prefers traveling by private vehicles. The Table 7-8-10 indicates the proportion of traveling modes of the respondents in Red Line corridor.

Among the respondents, 45 % of them travel by local public transport while there is insufficient and less number of buses run on this route. This implies that there are relatively low income families living in this area. For the private car users, there has been 35 % of the total number of respondents and 10 % of others use motor cycles. A combination of car and motor cycle riding respondents has amounted for 8 % because the bus stations are far from their place.

Table 7-8-4 Travelling Mode-Red Line

S.No	Travelling Mode	No of Respondent	Percentage % of Respondents
1	Bus	22	45%
2	Car	17	35%
3	Motorcycle	5	10%
4	Car & Motorcycle both	4	8%
5	No Response	1	2%
	Total	49	100%

Source: JICA Study Team for KTIP

3) Conclusions

For those using car, motorcycle or a combination of two are amounted for 39 % of the total number of respondents in Green Line and that of in Red Line is amounted for 53 %. These people are considered as potential BRT commuters. If included those using buses, 57 % of the respondents in Green Line and 98 % of the respondents on Red Line would become potential commuters of BRT.

Further, if those who did not respond to the survey in Green Line were included, provided that those were one way or other commuting to work, although some may own small business within the local area, the great majority of the local residents would become potential user of BRT.

7.8.3 Second Stakeholder Meeting

Outline of the stakeholder meeting was shown as Teble7-8-1. During secondary stakeholder meeting, all main finding from draft environment Impact Assessment study were disclosed. Presentation was focus on the project details, environmental baseline, screening of potential environmental impacts and proposed mitigation measurements.

(1) Green line

The main suggestion/comments from participants of secondary stakeholder meeting on Green Line are summarized as follows:

1) Exclusive lanes for BRT from Nazimabad to Business Recorder Road may disturb the traffic in the mixed lanes because the RoW in these areas is already narrow.
2) The road width should be carefully studied along the corridor and BRT design should be made accordingly to avoid disturbance to the residential and commercial areas.
3) Boarding and alighting timings at stations should be carefully studied.
4) Engines should be well designed and equipped with such technologies that may control emissions.
5) The observation was with regard to the boarding and alighting facility for old age people.
6) The question was with regard to the benefits and security measures for females in BRT system
7) Public awareness campaign about BRT should be accelerated and rules and regulations should be made effective;

(2) Red line

The main suggestion/comments from participants of secondary stakeholder meeting on Red Line are summarized as follows:

1) Public Toilets should be provided at all stations;
2) Separate compartments should be provided for women;
3) Prepaid card system may be introduced for passengers using BRT;
4) The question was with regard to the provisions of the labor laws and international standards on occupational health, safety and environment, the criteria for operators, sudden incident, the project implementation period and so on.

7.9 Environmental Impacts Caused by the Project and The Mitigation Measures

7.9.1 Pollution Control

(1) Air pollution

1) Construction stage

During construction stage, dust sources from the construction site of BRT are likely to create significant impacts. The worst effects are likely to be in the most constricted areas such as the construction works of elevated sections, around the station locations and depot areas. Vehicles carrying construction material are expected to result in increased SPM levels adjacent to the haul roads. Such construction activities can be of potentially hazardous if construction vehicles

concentrate and pass through residential areas. At the construction yard, the dust levels are also expected to increase due to loading and unloading of construction materials. Also, there will be slight increase in concentration of NOx and CO due to the increased general vehicular traffic as the existing road width is cut down to the construction yard. The impacts of such activities would, however, be temporary and restricted to the construction phase which runs for 3-4 years only. The impacts will be confined within the project boundary and is expected to be negligible outside the project boundaries in general.

In order to mitigate the impact of air pollution and dust from construction equipment and activities, preparation of adequate mitigation measures such as water sprinkler, periodical inspection of air quality and maintenance of the construction machinery and vehicles are importation. It is also important to carry out training of the technicians and the operators of the construction machinery and drivers of the construction vehicles. Air quality monitoring in the project site during construction phase is need of the important tools in order to feed back actions to be taken for mitigation measures.

2) Operation stage

The BRT system of Green Line and Red Line are designed to run within the existing median of major roads on paved surfaces. Thus no significant traffic air pollution along the corridors should be caused. It is expected that emission of air pollutants will be reduced due to the modal shifting of transportation from passenger cars/ buses to the new transportation system.

Other hands, in accordance with BRT operation start, emissions of air pollution from BRT vehicles will be generated around the depot areas proposed in vacant land currently.

In order to mitigate the impact of air pollution around the depot area, traffic control person should be placed at the gate of the depot to evade traffic congestion like bottle neck and keep smooth traffic flow. And BRT vehicle drivers should be trained on safety and low-speed operation in accessing the depot through residential area.

3) Prediction of the changes of NOx Intensity by the Implementation of BRT

Based on traffic demand forecasting, changes of the air quality by the implementation of BRT is predicted to some extent. Appropriate method of measurement for air quality is still being in the stage of trial and error in Pakistan. The exhaust unit volume of vehicles on air quality factors is not ensured yet for the prospect of air quality in the surrounding areas of the Project. In addition, it is difficult to obtain adequate long term meteorological data for in each forecasting point that are set out along the project area for air quality survey. Therefore, application of Atmospheric Dispersion Model (Plume-Puff Model, etc.) as popularly applied elsewhere in other countries is not so easy to apply in the case of Project.

Thus JICA Study Team proposes the mathematical method in estimating the exhaust coefficient of the total NOx volume emanated from BRT lines. The effect of proposed project is evaluated by comparing the NOx volumes of both “with” and “without” project. The forecast of summary of road traffic volume is shown in Table 7-9-1. Unit volume of exhaust gas are shown in Table 7-9-2. The flow of the mathematical method for the NOx volume forecast is shown in Figure 7-9-1.

Table 7-9-1 Forecast of Summary of Road Traffic

Green Line

Section		Length	2020 Road Traffic (KCR + Green Line + Red Line)				2020 Road Traffic (Only KCR)			
			M/C	Car	Bus	BRT	M/C	Car	Bus	BRT
Cloth Market	Garden Road	0.88	72,000	35,000	4,500	1,632	88,000	45,000	6,000	0
Garden Road	Shahra-e-Quaideen	1.30	104,000	60,000	6,000	1,632	120,000	74,000	8,500	0
Shahra-e-Quaideen	Gurmandir	0.94	116,000	65,000	6,000	1,632	128,000	83,000	8,500	0
Gurmandir	Lasbela	1.08	84,000	67,000	4,000	1,632	96,000	84,000	6,000	0
Lasbela	Nazimabad No.1 Chowrangi	1.65	108,000	73,000	5,500	1,632	128,000	88,000	8,000	0
Nazimabad No.1 Chowrangi	Board Office	3.53	152,000	86,000	8,000	1,632	172,000	98,000	11,000	0
Board Office	Nagan Chowrangi	4.82	116,000	73,000	5,500	1,455	112,000	71,000	8,500	0
Nagan Chowrangi	New Karachi	4.00	116,000	77,000	6,000	1,200	120,000	76,000	9,000	0
New Karachi	Surujani Chowrangi	5.61	116,000	77,000	6,000	840	120,000	76,000	9,000	0

Red Line

Section		Length	2020 Road Traffic (KCR + Green Line + Red Line)				2020 Road Traffic (Only KCR)			
			M/C	Car	Bus	BRT	M/C	Car	Bus	BRT
M.A. Jinnah Road	Jail Chowrangi	2.11	44,000	29,000	4,000	1,632	60,000	44,000	6,000	0
Jail Chowrangi	Hasan Square Roundabout	2.45	68,000	48,000	4,500	1,632	92,000	66,000	7,000	0
Hasan Square Roundabout	NIPA Chowrangi	3.07	96,000	71,000	5,500	1,632	120,000	89,000	7,000	0
NIPA Chowrangi	Safari Flyover	1.63	72,000	61,000	5,000	1,632	96,000	77,000	6,500	0
Safari Flyover	NED	0.97	84,000	74,000	8,000	1,632	100,000	87,000	11,000	0
NED	Safura Circle	4.00	84,000	74,000	8,000	1,089	100,000	87,000	11,000	0
Safura Circle	Malir Cant Check Post	2.16	60,000	65,000	5,000	1,089	72,000	82,000	6,000	0
Malir Cant Check Post	Model Colony	4.08	72,000	59,000	5,000	1,089	76,000	60,000	5,500	0

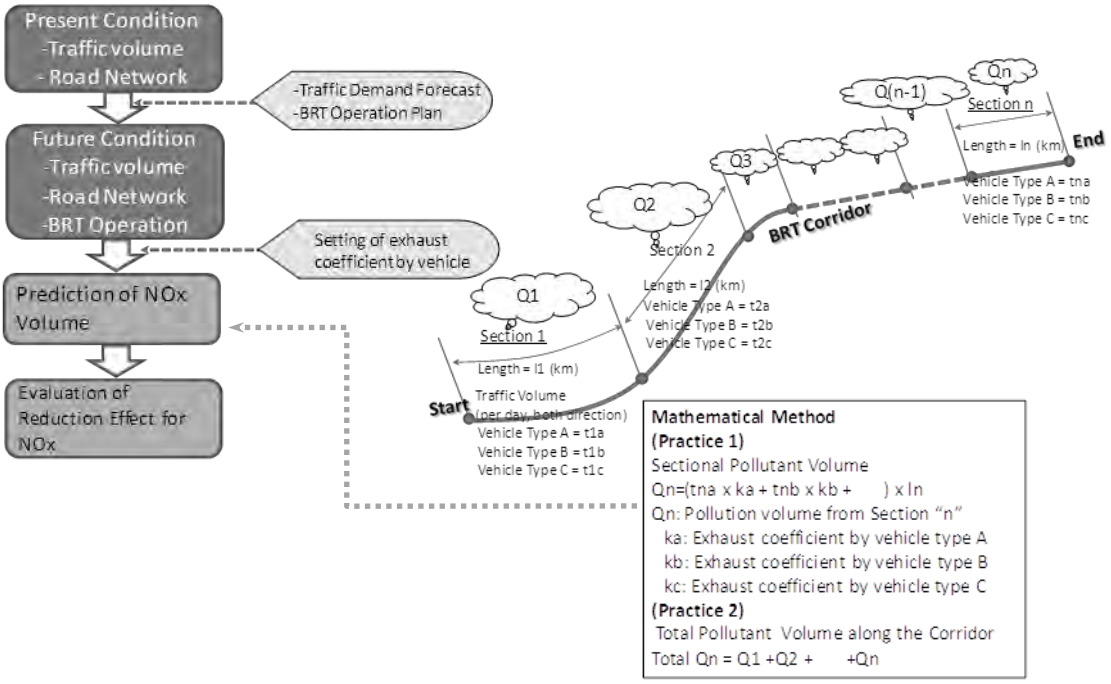
Note 1: Figures are the number of vehicles per day for both directions
Note 2: Estimated by the Demand Forecast Model in KTIP
Note 3: M/C = Motorcycle

Source: The Study for KTIP

Table 7-9-2 Unit Volume of Exhaust Gas

Vehicle Type	NOx (g/km)	Fuel type
Motor Cycle	0.20*	Gasoline
Car	1.10*	Gasoline
Bus	14.90*	Diesel Oil
BRT Vehicle	11.175**	CNG

Source: *Pakistan GHG Source and sink coefficient 1997 Asia Least-Cost Greenhouse Gas Abatement Study (ALGAS)
**Pakistan GHG Source and sink coefficient 1997 ALGAS and CNG Bus Emissions Roadmap: from Euro III to Euro VI, International Council on Clean Transportation 2010)



Source: JICA Study Team

Figure 7-9-1 Prediction Flows in NOx Volumes

It is expected that the exhaust pollution gas is reduced approximately 14% by modal shift due to the implementation of BRT as shown Table 7-9-3.

Table 7-9-3 Reduction Ratio in Air Quality

BRT	Forecast of NOx volume along the BRT line :Q (g/day)		Reduction due to the implementation (%)
	With the BRT Project Road Traffic (KCR + Green Line + Red Line)	Without the BRT Project Road Traffic (Only KCR)	
	Q_w	Q_{wo}	$(Q_{wo}-Q_w)/Q_{wo}$
Green Line	4,981	5,782	13.9%
Red Line	8,684	10,073	13.8%
Total	13,665	15,855	13.8%

Source: JICA Study Team

(2) Noise and Vibration

1) Construction stage

During construction stage, the construction activities would generate significant amount of noise and vibrations. However, these increased noise levels from the present conditions will prevail only during the construction stage.

In order to mitigate the impacts of noise and vibrations from construction equipment, the contractors should prepare the adequate mitigation measures such as regular maintenance of the construction machinery and equipment. It is also important to carry out training of the technicians and the operators of the construction machinery and drivers of the vehicles. Use of portable noise barriers and implementation of regular monitoring should also be periodically carried out.

Construction plants and machinery with high intensity of noise and vibration will be allowed to operate during specified/designated time of the day. In case it is necessary to take construction activities in night shift in order to catch up with the required construction schedule, permissions from local authorities should be obtained.

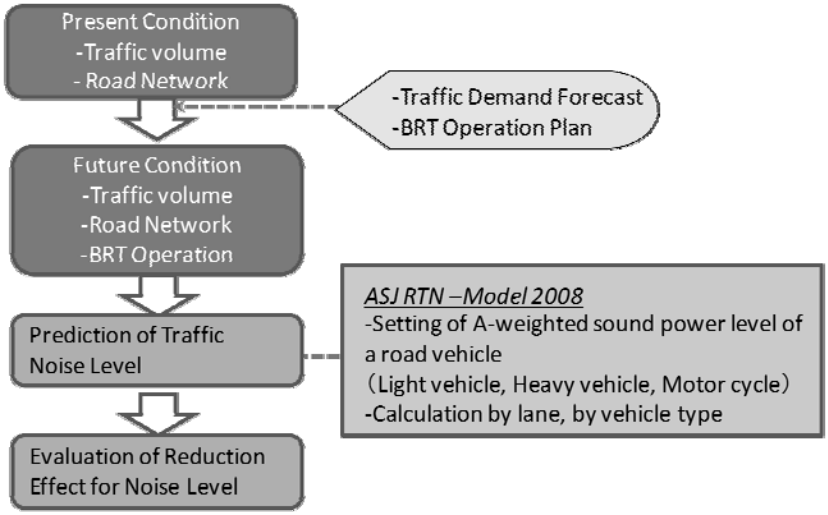
2) Operation stage

During operation stage, the BRT system of Green and Red Line are designed to run within the existing median of major roads on paved surfaces. Therefore additional significant traffic noise and vibration to the present traffic should not be generated.

3) Prediction of the Change of the Traffic Noise Level by the Implementation of BRT

Based on the traffic demand forecasting, prediction of the change of the traffic noise level as a result of the implementation of BRT is expected to take place. In general noise and vibration will be reduced due to the modal shift of transportation from passenger cars/buses to the new transportation system of BRT.

For prediction of the changes of the level of noise, there is no appropriate method has not yet been established officially in Pakistan. The noise source level of vehicles in Pakistan has also not ensured to date. In addition, there is no scientific establishment of the noise source in each forecasting point set out for the Project. Therefore, in respect of grasping the traffic noise improvement by the modal shift of transportation from present to BRT system, JICA Study Team proposes that the power level using the simulation method of the Acoustic Society of Japan (ASJ RTN-Model 2008) is applied with the existing model volume for calculation of the traffic noise level changes. Five points along the Green/Red line are selected as prediction locations, where there was the same section of field survey points. The flow of the mathematical method for the traffic noise level forecast is shown in Figure 7-9-2.



Source: JICA Study Team

Figure 7-9-2 Prediction Flows in Traffic Noise Level

BRT operation plan and traffic demand forecast are same as the prediction for NOx. The result of the noise level forecast is shown in Table 7-9-4. It is expected that the traffic noise level is reduced up to approximately 2.1 % by modal shift due to the implementation of BRT.

Table 7-9-4 Reduction Ratio in Noise Level

BRT	Location	Traffic Noise Level				Reduction rate (%)	
		With the BRT Project Road Traffic (KCR + Green Line + Red Line)		Without the BRT Project Road Traffic (Only KCR)			
		NL_w		NL_{wo}		$(NL_{wo}-NL_w)/NL_{wo}$	
		Day	Night	Day	Night	Day	Night
G-3	Shahrah-e-Shershah Suri Opposite Farooq-e-Azam Mosque, North Nazimabad	73.9	67.8	73.9	67.8	0.0%	0.0%
G-4	Nawab Sadiq Ali Khan Road, Munnu Bhai Park, Pedestrian Bridge, Nazimabad No.1	81.3	74.4	81.9	74.9	0.7%	0.7%
G-5	Business Recorder Road Opposite Subhani Mosque	79.1	73.6	79.9	74.3	1.0%	0.9%
G-6	M.A.Jinnah Road Numaish Intersection near Rangers	77.6	73.7	78.3	74.4	0.9%	0.9%
G-7	M.A.Jinnah Road Opposite Radio Pakistan near Sabri KMC Orangzeb Market	79.3	74.1	80.1	74.9	1.0%	1.1%
R-3	University Road Opposite Sheikh Zayed Islamic Centre	79.6	72.2	80.3	72.9	0.9%	1.0%
R-4	University Road Opposite Chiniot School near Safari Park	76.9	70.5	77.9	71.4	1.3%	1.3%
R-5	Bait-ul- Mukkarran University Road	80.0	73.3	80.9	74.2	1.1%	1.2%
R-6	University Road near Car Dealers, Dawood Engg. College	76.1	68.3	77.4	69.4	1.7%	1.6%
R-7*	New M.A. Jinnah Road End Point, Opposite Church at Abdullah Haroon Road	78.7	70.0	80.2	71.5	1.9%	2.1%

Note: Day time: Day time hours: 6.00 a. m to 10.00 p. m, Night time hours: 10.00 p. m to 6.00p. m
*Noise level was simulated in consideration of the elevated structure of BRT.

Source:JICA Study Team

(3) Water Pollution

1) Construction stage

Construction activities of the Project would cause minor impacts on hydrology and ground water quality of the project area as a whole unless otherwise the case that the construction chemicals seep through the ground.

The majority of the road construction works are designed to take place within the existing median of major roads on paved surfaces and therefore soil erosion and sedimentation should not take place at all.

The impact of storm water runoff might on the other hand become very significant for operation and maintenance of the Project during rainy season as low-lying area's water ponding should hamper the bus operation for several days.

2) Operation stage

During operation phase, to prevent surface and ground water contamination on account of oil/grease etc., leak proof containers should be used for storage and transportation of oil/grease used for construction plants and machinery. The floors of oil/grease handling area should be kept effectively impervious. Any wash off from the oil/grease handling area or workshop should be drained through impervious drains and effluent should be treated appropriately before releasing it.

(4) Solid waste and Land Contamination

1) Construction stage

Solid waste is mainly generated from the construction debris and the packaging material as well as some from human activity i.e. workers at construction site. The entire solid waste generated

at the construction site should be recyclable except for the food waste which is perhaps considered to be a major issue in regard to contamination from non-construction waste. However the amount of food waste could be negligible in comparison to the total solid waste generated during the construction phase.

Appropriate solid management program should be planned at the time of the commencement of construction works. Description in the contract documents the safe disposal mainly through recycling process would provide a viable solution against land contamination that could otherwise be caused by solid waste disposal during the construction phase. Excavated soil and other construction debris should be checked for containing any harmful materials before disposal.

2) Operation stage

During operation stage, there is a possibility of generation of the waste solid from the depot due to the repair /maintenance of the BRT vehicles. These waste materials are expected to be treated by the special contracts for services of waste collection/recycling/ sewage treatment and reuse.

(5) Overall Impact Assessment

Identification of Impacts and proposed mitigation measurement are summarized in Table 7-9-5.

Table 7-9-5 Identification of Impacts and Mitigation Measurement for Pollution Control

S. No	Environmental Attributes	Aspect	Potential of Impact	Proposed Mitigation Measures
Pre-Construction Phase				
1	Physical Impacts	- Designing and planning works will be implemented during pre-construction stage.	- No significant impacts	-
Construction Phase				
1.	Ambient Air Quality	- Dust emissions from site preparation, excavation, material handling & other construction activities at site.	- Minor and short term negative impact around site - No negative impact outside site.	- Regular water sprinkling on the exposed surfaces to reduce dust emission - Proper maintenance of all equipment at regular intervals
2.	Noise & Vibration	- Noise & Vibration generated from construction activities, operation of construction machinery, equipment and their movement	- Short term negative impact around site - Noise and vibration generation sources confined within the construction site. - No significant negative impact on ambient noise levels outside site.	- Regularly maintenance of construction machinery and vehicles, with particular attention to silencers and mufflers in order to keep construction noise levels to minimum level. - Carry out training of the technicians and the operators of the construction machinery and drivers of the vehicles - Notify the local people in case of plants and machinery with high intensity of noise and vibration are used. - Permissions from local authorities should be obtained in case of night time activities.
3.	Water Quality	- Surface runoff from project site (particularly during the rainy season) might be of an obstacle to the operation and maintenance of the Project - Oil/fuel & waste spills from construction area due to the	- No significant negative impact.	- Construction methods and techniques and disposal of waste water need to be designed for proper drainage and control of discharge (i.e. local drainage, oil and grease traps) - Avoid excavation during rainy

S. No	Environmental Attributes	Aspect	Potential of Impact	Proposed Mitigation Measures
		repairing and maintenance works of equipment/ vehicles on site - Improper debris disposal - Discharge of sewage from labor camp.		season.
4.	Solid waste	- Disposal of excavated soil, construction debris and other waste including domestic waste which can cause soil contamination and other health & safety issues - Disposal of solid waste from labor camp	- Minor negative impact	- Proper solid waste management program should be designed and executed for the construction and operation phases of the Project as integrated in the EMP. - The entire solid waste generated at the construction site and camp site is recyclable but for the food waste.
5.	Soils contaminant	- Construction and excavation activity leading to topsoil removal & erosion.	- Minor and short term negative impacts	-
Operation Phase				
1	Ambient Air Quality	- Particulate and gaseous emissions from vehicle movement	- Minor negative impact inside premises with no impact outside. Limited alongside the routes	- Vehicle Emission Control - Driver training on safety
2	Noise	- Noise from vehicle movement	- No significant impact at sensitive receptors.	-
3	Water quality	- Oil/fuel and waste spills. - Discharge of contaminated water - Spillage of oil and grease from the vehicles and wastewater generated from on-site activities such as vehicles washing, workshop etc.	- No significant adverse impact. - No wastewater discharge to the nearby water sources.	- Wastewater treatment/pits at depots should be installed to mitigate the impact.
4	Solid waste	- Disposal of repaired parts and tires	- No remarkable negative impact	- Contracts for services of waste collection/recycling/ sewage treatment and reuse shall be formulated
5	Soil contamination	- Accidental fuel and material spills	- No negative impact	- Proper waste management plan and spill response plan should be implemented

Source: JICA Study Team

7.9.2 Natural Environment

(1) Flora

There are several locations where there are trees present in the median of the both BRT corridors. As many as 72 species of plants were recorded during roadside trees measurement on green and red line. The total of tree count on the median of both corridors is found to be 23,118. The dominant plant species are obviously *Conocarpus, Eucalyptus* and *Lignum* species.

There are at least 9,020 trees on Red Line and 4,145 trees on the Green Line. This number relates to trees that are on the median and the same will have to be removed to yield to BRT-RoW where road width is narrow along the Green Line and Red Line corridors as well as the station sites. Among affected trees, approximately 70-80% of the trees are maturing while 20-30 % are mature. Tentative cost of removal of trees /Plants as well as re-plantation is estimated Rs. 500/Tree.

Soft landscaping should be installed in the median under the elevated sections to improve the appearance of the completed works. Other opportunity spaces should be sought by KMC to re-plant trees as near the locations of the felled tree as possible (e.g. Depot, non-affected major roads). The contracts drawn up by KMC for the BRT should require that wherever possible the trees are transplanted for use elsewhere in the project (e.g. amenity areas at intersections). The cut wood shall

not be burned on site. All stumps and surplus vegetation shall be disposed of at landfill via routes or other destinations as designated and instructed by KMC.

(2) Fauna

No significant impact is likely to register as there is no considerable fauna in the project area particularly along the green and red line. The project area does not have wetlands also the sections passing across rivers and water bodies are not directly affecting the associated ecosystems particularly the movement and feeding / breeding grounds of migratory birds.

(3) Topography & Geology

During the construction phase the chances of severe impacts are less because the existing site is fairly leveled. Considering the region is flat with no deposits of minerals on site leading to loss of revenue. The development is planned according to the international standards for earthquake protection. Hence the impacts will be minor and not noteworthy.

(4) Soil Erosion and Sedimentation

The majority of the road works proposed are designed to be within the existing median of major roads on paved surfaces and therefore soil erosion and sedimentation should not be a significant impact.

Identification of Impacts and proposed mitigation measurement are summarized in Table 7-9-6.

Table 7-9-6 Impacts and Proposed Mitigation Measures for the Natural Environment

S. No	Environmental Attributes	Aspect	Potential of Impact	Proposed Mitigation Measures
Pre-Construction Phase				
1.	Flora & Fauna	- Habitat disturbance during construction activity.	- Minor negative impacts on short term	- Scores of cutting trees during construction should be minimized.
Construction Phase				
1.	Flora & Fauna	- Habitat disturbance during construction activity.	- There are affected trees on the median on the BRT corridors.	- It is required to adopt appropriate techniques while undertaking construction activities to minimize ecological disturbances - Re-plant - Appropriate compensatory plantation should be carried out around the station or depot, if possible.
2.	Topography & Geology	- Site development	- No significant impacts	-
3.	Soil erosion	- Run off	- No significant impacts	-
Operation Phase				
1.	Flora & Fauna	- flora & fauna	- Land use change	- When trees are planted as compensation during construction, appropriate maintenance should be carried out.

Source: JICA Study Team for KTIP

7.9.3 Socio-economic Environment

(1) Pre-construction and Construction Period

1) Kiosks Subject to Relocation

As is shown in Figure 7-9-3, there are 36 of kiosks on the sidewalk where the pedestrian bridges for the S-21 station of Red Line is planned to construct are subject to relocation. They have been notified informally as a part of pre-construction information. They will be further notified officially in writing prior to the commencement of the construction works.

These kiosks are allowed to put up in the present location on the basis of CDGK's permission under various regulations including "Karachi Building Town Planning Regulations, 2002" that requires a payment of Rp.1,000/month per kiosk. Thus during the construction period, their location of business are newly assigned by KMC, which issues official letter to each kiosk owners 15 days before the commencement of the Project.

The structures of these kiosks are temporarily constructed. Each kiosk is consisting of four bamboo poles and a sheet of fabric with a moveable table for vending various good such as fruits, vegetables, household goods, etc.

Relocation works of these kiosks are carried out by the owners of these kiosks themselves without incurring any extra cost for relocation. There is no kiosk owner who loses his/her business or those who do not have places to re-establish their present business as they are allowed to move to near-by sidewalk or market place at their own discretion without any extra cost.

Source: JICA Study Team for KTIP

Figure 7-9-3 Kiosks Subject to Relocation

2) Traffic Disruption

The proposed Green and Red Line BRT corridors will be constructed on the existing road with live traffic. Construction activities along these routes are likely to cause hindrance to the general road traffic depending on the construction practice. A temporary traffic management plan therefore will have to be developed and submitted by the contractor at least one month before commencement of construction works. The main objectives of the plan are to maximize the safety of the general public and the workforce of the Project. The plan should also pay attention to maintain traffic flow as much free as possible.

The temporary transport management plan should include but not limited to the consideration of the following:

- Maximize the availability of traffic flow in the traffic diversion sections and minimize the traffic flow passing through the works site;
- Seek road closures and the necessary government/police orders in order to minimize traffic congestion;

- Establish acceptable working hours and constraints at the work site;
- Establish traffic flow so as to delay the peak hours of traffic congestion;
- Co-ordination with other planned road and street works as well as building works;
- Traffic signs and warning instructions for the information of other road traffic are displayed at sites and along the proposed routes;
- As measures to mitigate the impacts to the general public, period of construction and area/location of construction site should be informed to the general public. Specifically important is to notify the local residents adjacent to the planned depot where the local houses are exposed to the construction works. Notify the timing of construction works intended to carry out at each depot and explain construction method and machinery intended to use. Monitor the noise and vibration at the construction location of each depot. Accept complaints of the local people and carry out mitigation measures considered important to mitigate the impacts;
- Any closure of the roads and deviations should be informed clearly through standard signs and displays;
- Discuss with KMC for its role on the inspection and monitoring; and
- Establish accident management system for the duration of construction works.

The plan will have to be reviewed by KMC for approval. Resources from the contractor, KMC, the Consultants and the traffic police will have to be provided as per the plan made before the commencement of construction works.

3) Job Opportunities

The local people would obtain job opportunities related to the construction works of BRT. Jobs would be created for unskilled, semi-skilled as well as skilled laborers, for which local population would be given preference. Expenditure incurred by those employed at the project will boost further local economy to some extent. Thus, the project is expected to contribute to the overall development of the area.

4) Working Conditions, Infection diseases, Public Hygiene, Accident and Hazard

The health and comfort aspects are the major environmental issues that need to be taken into consideration at the construction stage of the project. Health of the workforce and of the residents in the surrounding area may be affected to some extent from emissions of dust, noise and construction debris. The construction activity itself is a nuisance and must be mitigated to the level of tolerance.

Based on observations that an adequate level of sophistication of health and safety is applied in local construction practices, it can be assumed that the chances of serious injury or accident during the construction activities on the Green Line and Red Line corridors will be above the level of expectation. The health and safety aspects will have to be strengthened nevertheless by training on Occupational Health and Safety besides fire fighting.

Mitigation Measures are following:

- The campsite will be equipped with provision of safe drinking water, waste disposal facilities and first aid box as well as an ambulance to deal with cases of emergency.
- The workforce will also be given access to a doctor for routine checks and medical examinations if necessary.
- In order to maintain adequate hygienic and sanitary conditions at the construction site temporary toilets will be provided.
- The workforce shall be properly informed of the potential risks and hazards associated with their jobs, which might impact on their health and safety.

- All workers shall be provided with information which allows them to assess a risk in simple terms.
- Health education including vulnerability to sexually transmitted infections including HIV shall be provided.
- Disciplined behavior on the part of the workforce shall be made a condition for continued engagement at the site.
- The safe disposal of solid waste will be outsourced to a contractor.

(2) Operation and Maintenance Period

There are a number of minor items that might otherwise cause relatively positive impacts to the general public as follows:

a) Increase of job opportunities

Activities during the operation and maintenance period would contribute to local economy by providing job opportunities. These benefits will definitely increase the socio-economic status of the project area. Hence the overall impact will bring the positive change.

b) Improvement of Infrastructure Facilities

The development of project will also create or improve the amenities/services like road, communication, health, education, and other aspect of the urban setting.

c) Wider Economic Growth

The proposed project will increase the economic activities along the Green and Red Line corridors, creating avenues for direct/indirect employment in the post-project period. There would be a wider economic impact in terms of generating opportunities for other business related to commerce and industry in general.

d) Improvement of Road Transportation

During the operation and maintenance period, the local road will likely be improved without any obstructions. As more commuters are diverted to BRT, the traffic conditions will improve due to reduction in traffic flow, which further suggests improved air quality and general, environmental conditions associated with vehicular traffic along the Green and Red corridors.

e) Reduced Health Risk and Accidental Hazards

The construction of separate BRT lane will greatly reduce the accidents associated with the roads. While ensuring maximum operational safety of BRT lines, it suggests that road accidents are minimized. Health risks due to vehicular/exhaust emissions experienced in congested traffic conditions are likely to be avoided by the commuters travelling on BRT.

f) Creation of Depot

Depot is to maintain maintenance services of bus i.e. use of water for washing buses and maintenance works using mechanical tools as well as to run engines after repairing works. These activities should cause ambient noise newly introduced to the depot areas where there was none. Thus monitoring ambient noise around the local residential areas should be carried out. It is also important to accept complaints from the local residents and carry out mitigation measures as required.

7.10 Environmental Management and Monitoring Plan

7.10.1 Establishment of KTIP-EMS

Creation of an Environmental Management Unit within the organization of Karachi Metropolitan Corporation (KMC) is one of the pre-requisite of Japanese loan agreement. Thus KMC is requested to establish Environmental Management System, for now it is preliminarily termed as KTIP-EMS, within its organization. As is shown in Figure 7-10-1, KTIP-EMS is to provide systematic and continuous support committed to the implementation of Environmental Management and Monitoring Plan for the Project. Role of KTIP-EMS should include the following:

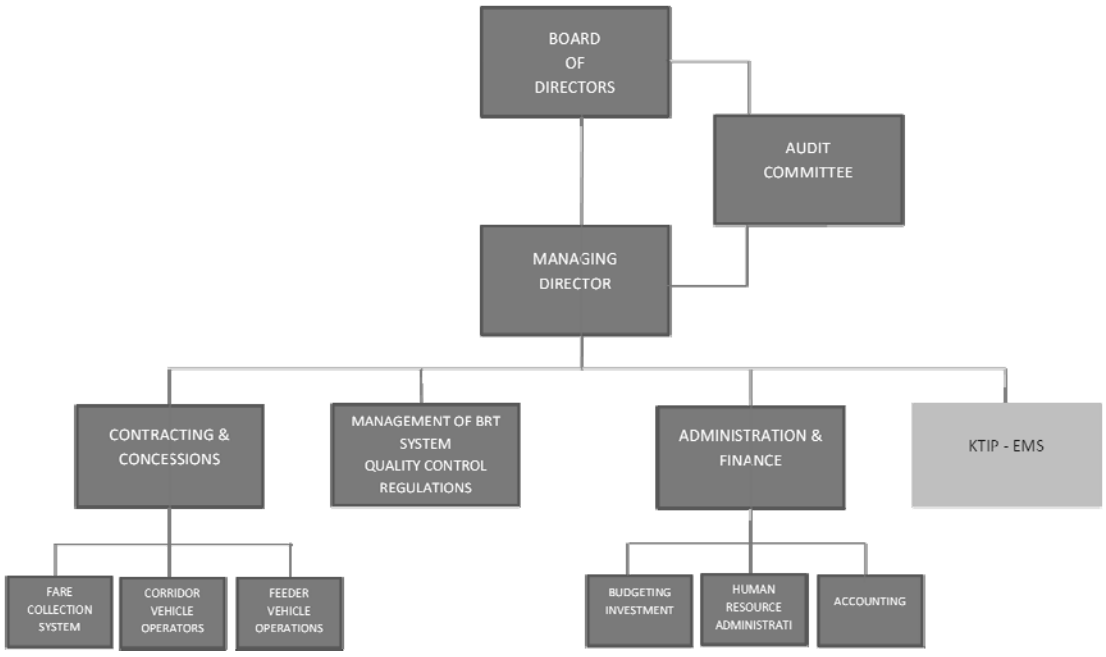
a) Environmental Management;

b) Environmental Monitoring;

c) Personnel Training;

d) Regular Environmental Audits & Corrective Action; and

e) Documentation of the standardized operation procedures, Environmental Management and Monitoring Plans & other relevant records.



Source: EMS, "EIA Study for KTIP"

Figure 7-10-1 Organization of KTIP-EMS

7.10.2 Functions of KTIP-EMS

(1) Responsibility of KTIP-EMS

KTIP-EMS will take overall responsibility for the actions required to implement for environmental management, monitoring and implementation of mitigation measures which was summarized in Table 7-9-5 and 7-9-6. Detail of their function should be included but not limited to the following:

a) Establish and maintain procedures to identify the environmental issues pertaining to the activities of BRT Green and Red Line and the services that the project office controls;

b) Monitoring the progress of the proposed management plans and actions to be taken for the project. KTIP-EMS as an organization within KMC will have to be headed by a qualified environmental engineer. Other members of the unit include but not limited to environmental scientists for the natural and social environment, environmental chemists, industrial safety officers and field survey operators;

c) Overseeing the environmental performance of the facilities, installations, construction sites along BRT corridors at regular interval to demonstrate compliance with existing National Environmental Quality Standards and guidelines;

d) Oversee the environmental performance in a manner that their operation as well as maintenance will neither degrade the environment along BRT corridors nor its macro environment;

e) KTIP-EMS manages facilities such as ISO 9000 certified Quality Control Laboratory (QCL) for all environmental sampling related to the Project. It will also arrange specialists or laboratories to perform the monitoring works within the parameters specified by NEQS, or as advised by EPA Sindh as well as the requirement made by World Bank Guidelines;

f) Follow the environmental management practices adopted by ISO 14,000 certified organizations and also support in the elaboration to safeguard the environment along BRT corridors of Green and Red Line;

g) KTIP-EMS will ensure that the characteristics of the significant impacts that are considered off-course of the environmental objectives that the project elaborates to maintain, and will keep information up-to-date and disclose it to the general public;

h) KTIP-EMS establishes and maintains procedures to identify and have access to legal requirements that are applicable to the environmental quality of the project activities and services including grievance redress system. While establishing and reviewing the environmental objectives of the Project, it observes legal and other requirements, significant environmental features, technological options and its financial, operational and business requirements in order to obtain the views of stakeholders;

i) KTIP-EMS establishes and maintains documented environmental objectives and targets within its organizational set up;

j) KTIP-EMS maintains a database and its own archives in order to keep abreast of modern environmental legislation, emission norms that are now technologically-specific that there are their own limits and standards; and

k) Comply with all the existing environment-related laws and regulations, guidelines and other requirements, including safety regulations, applicable to different systems and products of the Project.

National legislation and environmental guidelines on specific emission limits have not been set out in many cases in Pakistan. World Bank Guidelines are widely used as the minimum norm if the host country does not have its own specific legislation. KTIP-EMS will therefore have to follow the World Bank Guidelines until such time that the regulation on the technologically-specific limits, closely corresponding to national and provincial as well as the actual conditions become available. Detail of environmental management plan and environmental monitoring plan will be prepared in EIA report in accordance with Pakistan's regulation and examined by Pakistan Environmental Protection Agency.

(2) Proposed staff organization of KTIP-EMS

In the context of the implementation arrangement for mitigation measures and monitoring, human resources are also proposed to be arranged to fulfill the functional requirements. Specific responsibilities of the EHS Manager, Safety manager, Chief/site coordinator are detailed below.

1) EHS Manager

- ✓ Managerial and technical supervision of all EHS unit's activities
- ✓ Liaise with the top management of Karachi Bus Rapid Transit Corporation (KBRT) on matters concerning the environment
- ✓ Be fully conversant with the EIA of the project, the conditions of the approval of EIA, and all relevant environmental legislations.
- ✓ Conduct audits to ensure compliance to the EMP.
- ✓ Prevent actions that will harm or may cause harm to the environment, and take steps to prevent pollution on the site.

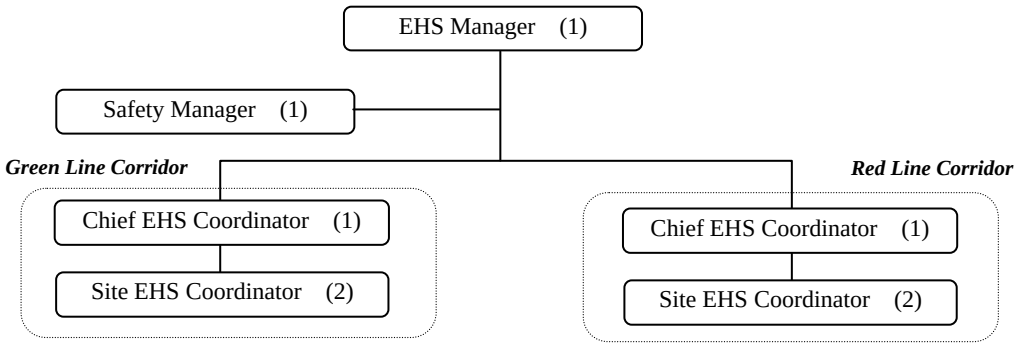
2) Safety Manager

- ✓ Identify road safety deficiencies at various stages in the development of the Project.
- ✓ Critically examine all aspects of the project which may have adverse safety implications, considering carefully the needs of all road users.
- ✓ The Safety Report shall specifically describe the safety deficiencies, potential or real, which have been identified along with the relevant references to accepted standards, practices and highway safety principles.

3) Chief/Site EHS Coordinator

- ✓ Be fully conversant with the EIA and conditions of its approval.
- ✓ Be fully conversant with the EMP.
- ✓ Be fully conversant with all relevant environmental legislation, policies and procedures, and ensure compliance with these.
- ✓ Undertake regular and comprehensive inspection of the site and surrounding areas in order to monitor compliance with the EMP.
- ✓ Take appropriate action if the specifications contained in the EMP are not followed.
- ✓ Monitor and verify that environmental impacts are kept to a minimum, as far as possible.
- ✓ Ensure that activities on site comply with all relevant environmental legislation.
- ✓ Compile progress reports on regular basis for submission to the EHS Manager, including a final post construction audit.

Figure 7-10-2 shows the proposed staff organization of KTIP-EHS



Source: JICA Study Team

Figure 7-10-2 Proposed Staff Organization of KTIP-EHS

Table 7-10-1 shows the proposed outline of human resource requirements, including qualification standard, major job description expected.

Table 7-10-1 Proposed Function of KTIP-EHS

Human resources	Numbers	Qualification and job description
EHS Manager	1	-Bachelor of science, experiences more than ten years in HSE field, preferably. -Managerial and technical supervision of all EHS unit's activities
Safety Manager	1	-Bachelor of science, experiences more than five years in HSE field, preferably. - Identify road safety deficiencies at various stages
Chief EHS Coordinator	2 (one person per one corridor)	-Bachelor of science, experiences more than ten years in specific field, preferably. -Technical supervision and performing the actions.
Site EHS Coordinator	4 (two person per one corridor)	-Middle technical education -Technical application and performing the actions.

Source: JICA Study Team

7.10.3 Environmental Monitoring Plan

Environmental Monitoring Plan should be an integral part of a good environment management in every stage of the project implementation. The main purposes of the Environmental Monitoring Plan are to provide a continuous feedback to the project implementation as well as to the operation and maintenance so as to identify actual or potential successes/problems of the Project. It is also designed to take action in timely manner in terms of the environmental management activities of the project as a whole. The results of monitoring should be examined from the viewpoints of evaluating the effectiveness of the impacts mitigation measures and other efforts of the project. Contents of the environmental monitoring during the construction and operation period shall include environmental impacts associated with water, air, noise, land including wastewater, solid waste generation and socioeconomic such as land acquisition, demolition and resettlement, economic development triggered by the BRT, etc.

Contents of monitoring shall include all direct and indirect impacts generated during the construction period and the operation period. These issues may be eased or nipped at root as much as possible through environmental control measures and environmental monitoring process.

The program on observing air, noise and vibration environment is conducted at locations of the stations as specified by the project plan. Following arrangements will also be ensured and monitored by Contoractor/Independent Monitoring Consultant appointed by KMC

Table 7-10-2 shows suggested environmental monitoring plan.

Table 7-10-2 Suggested Environmental Monitoring Plan

	Monitoring Item	Monitoring Parameter	Monitoring Frequency/Duration	Monitoring location	Unit Cost
Construction Stage					
I	Noise Monitoring	L_{eq} (dB(A))	2 time / month, 16 hours / day.	Stations/ Depot/ Residential areas Sensitive areas	Rs. 25,000/sample
II	Vibration Monitoring	L_p (dB)	2 time / month, 16 hours / day.	Stations/ Depot/ Residential areas Sensitive areas	Rs. 25,000/sample
III	Air Quality Monitoring	CO, SO_2, NO, NO_2, dust and microclimate parameters	Measuring twice a month, 6 samples at one location.	Stations / Depot / intersections	Rs. 40,000/sample

	Monitoring Item	Monitoring Parameter	Monitoring Frequency/Duration	Monitoring location	Unit Cost
IV	Water Quality Monitoring	TSS, TDS, pH, Temperature, BOD, COD, Metals, Sulphates, Carbonates, Oil and Grease, Anionic Detergents	Once fortnightly for surface and groundwater. Grabs Sampling to be done once at each identified location.	Surface water bodies / lagoons / ponds, etc. in proximity to construction sites	Rs. 25,000/sample
V	Land Contamination Monitoring	Alkalinity, Salinity, pH, Electrical Conductivity	Once fortnightly for surface and sub-surface samples. Sampling to be done grab once at each identified location	Exposed surfaces in and around areas in proximity to construction sites particularly at stations & depot. Subsurface sampling in areas around piling, excavation, quarrying and batching plants.	Rs. 40,000/sample
VI	Mitigation Measures	All Treatment Works	Continuous	Environmental Mitigation measures during Constructions	N/A
VII	Site Restoration	Restoring the sites to finished project sites without unnecessary delays.	After completion of each section	Construction Sites	N/A
VIII	Social Aspects	-The new employment opportunity on KTIP operation will be created for them with suitable training. -Communicable Diseases Prevention Program will be prepared for construction workers or residents near the construction sites -Cultural and Archaeological Site	Continuous	KTIP-RoW	N/A
IX	Occupational Health Monitoring	-Safety of workers and general public also checking unauthorized access. -Protective gear and safety. -Basic training of personnel in health and safety and responding to emergencies.	Half Yearly	KTIP-RoW	N/A
Operation Stage					
I	Noise Monitoring	L_{eq} (dB(A))	Measuring 1 time per quarter during the first 12 months, 24hours / day,	Stations/ Depot/ Residential areas / Sensitive areas	Rs. 25,000/sample
II	Vibration Monitoring	L_p (dB)	Measuring 1 time per quarter during the first 12 months, 24 hours / day.	Stations/ Depot/ Residential areas Sensitive areas	Rs. 25,000/sample
III	Air Quality Monitoring	CO, SO_2, NO, NO_2, dust and microclimate parameters	Measuring 1 time per quarter during the first 12 months, 6 samples at one location.	Stations / Depot / intersections	Rs. 40,000/sample

	Monitoring Item	Monitoring Parameter	Monitoring Frequency/Duration	Monitoring location	Unit Cost
IV	Water Quality Monitoring	TSS, TDS, pH, Temperature, Oil & Grease, Anionic Detergents.	Measuring 1 time per quarter during the first 12 months	Surface water bodies / lagoons / ponds, wells etc. in proximity to depot.	Rs. 25,000/sample

Source: JICA Study Team

7.11 Draft Environmental Checklist

During the feasibility study period of the Project, various environmental and social parameters have been examined through EIA study. The key points obtained in the course of environmental and social considerations studies for the Project should be summarized and compiled in a form of check list for the Environmental Monitoring Pan. A format of the "Environmental Checklists, No. 7 for Road Construction Project", defined in JICA Guidelines for Confirmation of Environmental and Social Considerations (April, 2010) is suggested to use as Environmental Checklist as is shown in Table 7-11-1.

Table 7-11-1 Draft Environmental Checklist of JICA Guidelines

Category	Environmental Item	Main Check Items	Yes: Y No: N	Sample Writing on the Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
1. Permits and Explanation	(1) EIA and Environmental Permits	(a) Have EIA reports been already prepared in official process?	N	(a) According to Pakistan law, the Project is required to proceed into the official procedure for EIA approval. Draft EIA report is under preparation as of May, 2012.
		(b) Have EIA reports been approved by authorities of the host country's government?	N	(b) EIA report has not been submitted to Sindh Environmental Protection Agency (SEPA) as of May, 2012. Draft EIA report is scheduled to be submitted to SEPA in June, 2012.
		(c) Have EIA reports been unconditionally approved? If conditions are imposed on the approval of EIA reports, are the conditions satisfied?	N	(c) Ditto
		(d) In addition to the above approvals, have other required environmental permits been obtained from the appropriate regulatory authorities of the host country's government?	N	(d) There is no additional environmental approval to be obtained by the project proponent.
	(2) Explanation to the Local stakeholders	(a) Have contents of the project and the potential impacts been adequately explained to the Local stakeholders based on appropriate procedures, including information disclosure? Is understanding obtained from the Local stakeholders?	Y	(a) Information disclosure to public at the draft EIA report stage was arranged through the 2nd stakeholder meeting held on 27th April 2012 for Green line and on 28the April 2012, and potential impacts with proposed mitigation measures ware explained with plain expression.
		(b) Have the comment from the stakeholders (such as local residents) been reflected to the project design?	Y	(b) Various opinions and suggestions were exchanged at the primary and secondary stakeholder meeting. Comments raised at the meeting were integrated in the final EIA reports as well as project design accordingly.
	(3) Examination of Alternatives	(a) Have alternative plans of the project been examined with social and environmental considerations?	Y	(a) As for route selection, environmental and social aspects such as land acquisition and resettlement have been examined as well as technical and economic aspects. During Master Plan Stage, Mass Transit System including BRT will be proposed trunk lines with considering of ROW and no-resettlement. Some alternative mass transit system/route is examined, and the Green line and Red line is selected. During Feasibility Study Stage, Alternative plan of the BRT Depot location and the end of point in center business district for green line have been examined with social and environmental considerations..

Category	Environmental Item	Main Check Items	Yes: Y No: N	Sample Writing on the Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
2. Pollution Control	(1) Air Quality	(a) Is there a possibility that air pollutants emitted from the project related sources, such as vehicles traffic will affect ambient air quality? Does ambient air quality comply with the country's air quality standards? Are any mitigating measures taken?	Y/N	(a) According to the air quality survey, SO_2, SPM, NO, NO_2 and Lead level along the major corridor are higher than the recommended standard by NEQS. The purpose of the BRT project is improvement of the current traffic problem in Karachi. Thus, implementation of the BRT project is most effective mitigation measurement. It is expected that the concentration of NOx is reduced approximately 14 % by modal shift of transportation from passenger cars/ buses to the new transportation system.
		(b) Where industrial areas already exist near the route, is there a possibility that the project will make air pollution worse?	N	(b) Ditto
	(2) Water Quality	(a) Is there a possibility that soil runoff from the bare lands resulting from earthmoving activities, such as cutting and filling will cause water quality degradation in downstream water areas?	N	(a) There is no possibility of soil run off because the BRT line will be based on existing road.
		(b) Is there a possibility that surface runoff from roads will contaminate water sources, such as groundwater?	N	(b) There is no underground section and no activities in the water bodies in the Project. Therefore there is no possibility of water contamination.
		(c) Do effluents from various facilities, such as parking areas/service areas comply with the country's effluent standards and ambient water quality standards? Is there a possibility that the effluents will cause areas not to comply with the country's ambient water quality standards?	Y	(c) The effluent from Depot/parking area will not be treated appropriately before releasing it.
	(3) Wastes	(a) Are wastes generated from the project facilities, such as parking areas/service areas, properly treated and disposed of in accordance with the country's regulations?	Y	(a) There is a possibility of generation of the waste solid from the depot due to the repair /maintenance of the BRT vehicles. These waste materials are expected to be treated by the special contracts for services of waste collection/recycling/ sewage treatment and reuse.

Category	Environmental Item	Main Check Items	Yes: Y No: N	Sample Writing on the Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
	(4) Noise and Vibration	(a) Do noise and vibrations from the vehicle and train traffic comply with the country's standards?	N	(a) The noise level of all locations except CNG green bus terminal Surjani town (G-1) and Ranger area (R-1) is high as compared to NEQS noise level for commercial area. G-1 and R-1 is located in the residential area. Other survey points are located along the major corridor. The purpose of the BRT project is improvement of the current traffic problem in Karachi. Thus, implementation of the BRT project is most effective mitigation measurement.It is expected that the traffic noise level is reduced up to approximately 2.1 % by modal shift due to the implementation of the BRT project. Regarding vibration, there is no standard in Pakistan. All locations except G-1 and R-1 are also higher as compared to Request Limits for Motor Vehicle Vibration in Japan for commercial area. The configuration of the measurement of vibration level is similar to noise level. Therefore, improvement by BRT is expected of the vibration as well as noise.
3. Natural Environ-ment	(1) Protected Areas	(a) Is the project site located in protected areas designated by the country's laws or international treaties and conventions? Is there a possibility that the project will affect the protected areas?	N	(a) The Project area does not include protected areas, and does not locate close to protected area. There is no possibility to affect the protected area due to Project.
	(2) Ecosystem	(a) Does the project site encompass primeval forests, tropical rain forests, ecologically valuable habitats (e.g., coral reefs, mangroves, or tidal flats)?	N	(a) The Project area is located in metropolitan city with highly urbanization. Therefore, there are no issues on ecosystem to be cautioned.
		(b) Does the project site encompass the protected habitats of endangered species designated by the country's laws or international treaties and conventions?	N	(b) Ditto
		(c) If significant ecological impacts are anticipated, are adequate protection measures taken to reduce the impacts on the ecosystem?	N	(c) Ditto
		(d) Are adequate protection measures taken to prevent impacts, such as disruption of migration routes, habitat fragmentation, and traffic accident of wildlife and livestock?	N	(d) Ditto

Category	Environmental Item	Main Check Items	Yes: Y No: N	Sample Writing on the Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
		(e) Is there a possibility that installation of roads will cause impacts, such as destruction of forest, poaching, desertification, reduction in wetland areas, and disturbance of ecosystems due to introduction of exotic (nonnative invasive) species and pests? Are adequate measures for preventing such impacts considered?	Y	(e) There are several locations where there are trees present in the median of the both BRT corridors. As many as 72 species of plants were recorded during roadside trees measurement on Green and Red Line. The total of tree count on the median of both corridors is found to be 23,118. There are at least 9,020 trees on Red Line and 4,145 trees on the Green Line. During construction the vegetation present on the median lane will be removed on the areas where the bus station will be constructed. In order to mitigate the felling of trees by the Project, modification location/area should be reviewed at sites with considering of minimizing before construction and the affected trees should be re-planted to the other spaces (e.g. Depot, on the center of the non-affected roads)
		(f) In cases the project site is located at undeveloped areas, is there a possibility that the new development will result in extensive loss of natural environments?	N	(f) Same as (a)
	(3) Hydrology	(a) Is there a possibility that alteration of topographic features and installation of structures, such as tunnels will adversely affect surface water and groundwater flows?	N	(a) There is no tunnel section in the Project. Therefore, there are no significant issues on hydrology to be cautioned.
	(4) Topography and Geology	(a) Is there any soft ground on the route that may cause slope failures or landslides? Are adequate measures considered to prevent slope failures or landslides, where needed?	N	(a) Green and Red Line alignment will pass along the existing trunk line and there is no tunnel section. Therefore, there are no significant issues on topography and geology to be cautioned.
		(b) Is there a possibility that civil works, such as cutting and filling will cause slope failures or landslides? Are adequate measures considered to prevent slope failures or landslides?	N	(b) Green and Red Line alignment will pass along the existing trunk line level, no cutting and filling section. A part of red line, near the Leagal Chownk, is proposed the elevated section. Therefore, there is no possibility of slope failures or landslides.
		(c) Is there a possibility that soil runoff will result from cut and fill areas, waste soil disposal sites, and borrow sites? Are adequate measures taken to prevent soil runoff?	N	(c) The surface areas where cut and cover method will be applied are limited to the stations' construction and elevated section. Therefore, the possibility of soil runoff due to construction work will be negligible.
4. Social Environment	(1) Resettlement	(a) Is there any involuntary resettlement caused by project implementation? If involuntary resettlement is caused, are there any efforts made to minimize the impacts caused by the resettlement?	N	(a) There is no involuntary resettlement, although 36 kiosks along the Red line have to change to near-by area as the Project is implemented.

Category	Environmental Item	Main Check Items	Yes: Y No: N	Sample Writing on the Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
		(b) Have there been adequate explanations on compensation and resettlement assistance given to affected people prior to resettlement?	N	(b) Replacement cost for 36 kiosks is not incurred, because these kiosks are allowed to put up in the present location on the basis of CDGK's permission under various regulations including "Karachi Building Town Planning Regulations 2002". The structures of these kiosks are temporarily constructed. Each kiosk is consisting of four bamboo poles and a sheet with a moveable table.
		(c) Is there any resettlement plan, including compensation with full replacement costs, restoration of livelihoods and living standards developed based on socio-economic studies on resettlement?	N	(c) No resettlement plan was made.
		(d) Are the compensations going to be paid prior to the resettlement?	-	(d) N/A
		(e) Are the compensation policies prepared in document?	-	(e) N/A
		(f) Does the resettlement plan pay particular attention to vulnerable groups or people, including women, children, the elderly, people below the poverty line, ethnic minorities, and indigenous peoples?	-	(f) N/A
		(g) Are agreements with the affected people obtained prior to resettlement?	-	(g) N/A
		(h) Is there organizational framework established to properly implement resettlement? Are the capacity and budget secured to implement the plan?	-	(h) N/A
		(i) Are there any plans developed to monitor the impacts of resettlement?	-	(i) N/A
		(j) Is the grievance redress mechanism established?	-	(j) N/A
	(2) Living Conditions and Livelihood	(a) Where roads are newly constructed, is there a possibility that the project affected the existing means of transportation and the associated workers? Is there a possibility that the project will cause significant impacts, such as extensive alteration of existing land uses, changes in sources of livelihood, or unemployment? Are adequate measures considered for preventing these impacts?	N	(a) There is a lot of Mini-Bus route or transportation means including rickshaw, which basically consist the feeder line network. Meanwhile, the BRT line is proposed in the trunk line and long distance. There is a different objective between two transportation means.

Category	Environmental Item	Main Check Items	Yes: Y No: N	Sample Writing on the Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
		(b) Is there any possibility that the project will adversely affect the living conditions of the inhabitants other than the target population? Are adequate measures considered to reduce the impacts, if necessary?	N	(b) Although there are 36 of kiosks on the sidewalk where the pedestrian bridges for the S-21 station of Red Line is planned to construct are subject to relocation, there is no kiosk owner who loses his/her business or those who do not have places to re-establish their present business as they are allowed to move to near-by sidewalk or market place at their own discretion without any extra cost.
		(c) Is there any possibility that diseases, including infectious diseases, such as HIV will be brought due to immigration of workers associated with the project? Are adequate considerations given to public health, if necessary?	Y	(c) In the case where contractor(s) workers' camps are established, the health care system including prevention of communicable diseases will be planned such as preventing diseases, providing first aid treatment for onsite injuries and providing healthcare services to the workforce.
		(d) Is there any possibility that the project will adversely affect road traffic in the surrounding areas (e.g., increase of traffic congestion and traffic accidents)?	Y	(d) There is a possibility that traffic congestion due to installing the new transportation system. The traffic police will be adequated arranged.
		(e) Is there any possibility that roads will impede the movement of inhabitants?	N	(e) The related structures on the road are stations and elevated piers. Regarding of stations, there is no possibility to impede the movement of inhabitation because stations are proposed within the center diviver area. Regarding of piers, necessary efforts to minimize the impacts due to obstruction have been made in the Project design to keep existing traffic lanes during elevated section
		(f) Is there any possibility that structures associated with roads (such as bridges) will cause a sun shading and radio interference?	N	(f) BRT Structures such as stations and pedestrian bridge are proposed in the center of the Major roads, on the existing ground level. In this case, there is no sun shading and radio interference. In case of elevated section near the Legal Chowk, elevated section is proposed limited, not residential and designed in the center of the road which is standard road structure in Urban area of Karachi. The most of shade of structure is expected within the ROW. Therefore, sun shading and radio interference might be negligible.
	(3) Cultural Heritage Area	(a) Is there a possibility that the project will damage the local archeological, historical, cultural, and religious heritage? Are adequate measures considered to protect these sites in accordance with the country's laws?	N	(a) BRT line is proposed within the existing road, no new modification/expanding road. Therefore, the new /additional damage to the Heritage along the existing road will be negligible.

Category	Environmental Item	Main Check Items	Yes: Y No: N	Sample Writing on the Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
	(4) Landscape	(a) Is there a possibility that the project will adversely affect the local landscape? Are necessary measures taken?	N	(b) As a result of the construction of bus stops and elevated section likely to cause the change of the local landscape. But, limited area of urban land use and the landscape should be changed to a limited extent.
	(5) Ethnic Minorities and Indigenous Peoples	(a) Are considerations given to reduce impacts on the culture and lifestyle of ethnic minorities and indigenous peoples?	N	(a) There is no ethnic minority and indigenous people in the project area.
		(b) Are all of the rights of ethnic minorities and indigenous peoples in relation to land and resources to be respected?	-	(b) N/A
	(6) Working Conditions	(a) Is the project proponent not violating any laws and ordinances associated with the working conditions of the country which the project proponent should observe in the project?	N	(a) The Project proponent will fulfill the requirements to protect working conditions according to the Labors laws.
		(b) Are tangible safety considerations in place for individuals involved in the project, such as the installation of safety equipment which prevents industrial accidents, and management of hazardous materials?	Y	(b) Safety considerations to prevent the injuries and accidents to individuals, such as first-aid kit, Personal Protective Equipment (PPE) , secure tamper-proof fence, security lighting, regular security patrols , etc.
		(c) Are intangible measures being planned and implemented for individuals involved in the project, such as the establishment of a safety and health program, and safety training (including traffic safety and public health) for workers etc.?	N/Y	(c) Safety and health program are not prepared concretely at this stage, but the proposed organization Set-Up for KTIP-EMS will ensure the health, safety and security issues.
		(d) Are appropriate measures being taken to ensure that security guards involved in the project not violate safety of other individuals involved, or local residents?	Y	(d) Traffic police for BRT will be arranged appropriately.

Category	Environmental Item	Main Check Items	Yes: Y No: N	Sample Writing on the Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
5 Others	(1) Impacts during Construction	(a) Are adequate measures considered to reduce impacts during construction (e.g., noise, vibrations, turbid water, dust, exhaust gases, and wastes)?	Y	(a) Adequate measures will be planned and provided to mitigate the negative impacts of environmental pollution during construction stage as described follows: i. Noise and vibration: planning the deliberate and efficient equipment use, regular maintenance of construction machines; ii. Turbid water: Avoid excavation during monsoon season; iii. Dust, exhaust gases: Regular water sprinkling, regular maintenance of equipment and trucks; iv. Wastes: A designated solid waste disposal site should be secured away from human settlements. In addition, a disposal site should be away from water streams and any archaeological and historical monuments.
		(b) If construction activities adversely affect the natural environment (ecosystem), are adequate measures considered to reduce impacts?	N	(b) No significant impact is likely to register as there is no considerable fauna in the project area particularly along the Green and Red Line. The project area does not have wetlands also the sections passing across rivers and water bodies are not directly affecting the associated ecosystems particularly the movement and feeding / breeding grounds of migratory birds.
		(c) If construction activities adversely affect the social environment, are adequate measures considered to reduce impacts?	Y	(c) Adequate measures such as temporary traffic management plan will be planned and provided to reduce the negative impacts to the social environment during construction stage.
	(2) Monitoring	(a) Does the proponent develop and implement monitoring program for the environmental items that are considered to have potential impacts?	Y	(a) Environmental monitoring plan will be proposed for pre-construction, construction and O&M stages of the Project, based on the impact prediction and mitigation measures proposed in the Draft EIA report.
		(b) What are the items, methods and frequencies of the monitoring program?	Y	(b) Items, methods and frequencies of the monitoring will be expected to be mentioned in environmental monitoring plan in the Draft EIA report.
		(c) Does the proponent establish an adequate monitoring framework (organization, personnel, equipment, and adequate budget to sustain the monitoring framework)?	Y	(c) Institutional arrangement to carry out the mitigation measurement and monitoring is proposed.
		(d) Are any regulatory requirements pertaining to the monitoring report system identified, such as the format and frequency of reports from the proponent to the regulatory authorities?	N	(d) There is no regulatory requirement in Pakistan such as reporting system of monitoring results.

Category	Environmental Item	Main Check Items	Yes: Y No: N	Sample Writing on the Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
6 Note	(1) Reference to Checklist of Other Sectors	(a) Where necessary, pertinent items described in the Forestry Projects checklist should also be checked (e.g., projects including large areas of deforestation).	N	(a) There is a possibility of clearing the man-made greenbelt of the road, because Green and Red Line alignment will pass along the existing trunk line. However, the developing area is only proposed station area in the ROW.
		(b) Where necessary, pertinent items described in the Power Transmission and Distribution Lines checklist should also be checked (e.g., projects including installation of power transmission lines and/or electric distribution facilities).	N	(b) There is no relevant item such as power plant or distribution.
	(2) Note on Using Environmental Checklist	(a) If necessary, the impacts to transboundary or global issues should be confirmed, if necessary (e.g., the project includes factors that may cause problems, such as transboundary waste treatment, acid rain, destruction of the ozone layer, or global warming).	N	(a) Although, there is a possibility of increased GHG emission due to the operation of heavy vehicles as well as traffic jams incidental to the construction works, this impact will be temporary. On the other hand, it is expected that the GHG emission will be reduced due to the modal shift of transportation from public people vehicle to the BRT.

Note:

1) Regarding the term “Country’s Standards” mentioned in the above table, in the event that environmental standards in the country where the project is located diverge significantly from international standards, appropriate environmental considerations are required to be made. In cases where local environmental regulations are yet to be established in some areas, considerations should be made based on comparisons with appropriate standards of other countries (including Japan's experience).
2) Environmental checklist provides general environmental items to be checked. It may be necessary to add or delete an item taking into account the characteristics of the project and the particular circumstances of the country and locality in which it is located.

Source: JICA Study Team

Chapter 8 Project Impact

8.1 Operation and Effect Indicators

Operation indicators and effect indicators will be identified to monitor the level of utilization of BRT infrastructure and rolling stock and their effects. Indicators that can show the utilization and effects concisely and are easy to be aggregated or estimated were selected. Table 8-1-1 shows the operation and effect indicators. As the BRT system is a new mode of transport in Karachi, the "Effect Indicators" are minimal, because no comparison with the existing situation is expected. So, most of the indicators are related to operation indicators which exhibit target values based on the development plan. The indicator A, D, I, and J are most important for evaluating the project after the commencement of the operation.

Table 8-1-1 Operation and Effect Indicators

Category	Indicator		Description	Unit	Target Values after 2 years of Operation
Operation Indicator	A	Transport volume	Daily boarding passengers	Person	700,000
	B	Transport volume by bus stop	Daily passengers by bus stop	Person	8,750
	C	Transport volume (vehicle - km)	Daily vehicle-km	Vehicle-km	146,820
	D	Number of bus services	Number of bus services per day	Number of service	4,241
	E	Transport efficiency	A / D	Person /Service	165
	F	Transport efficiency	A / number of employees	Person	265
	G	Annual average number of operated vehicles per day	Annual average number of operated vehicles per day	Vehicles	344
	H	Annual average number of operational (available) vehicles per day	Annual average number of operational (available) vehicles per day	Vehicles	405
	I	Vehicle operation rate	(G / H) x 100	%	80 - 90 %
	J	Vehicle availability	(H / total number of vehicles) x 100	%	80 - 90 %
Effect Indicator	A	Transport volume	Daily boarding passengers	Person	700,000
	K	Travel speed performance	Travel speed / planned speed (27.4km/h)	%	80 - 90 %

Source: JICA Study Team

8.2 Analysis of Environmental Improvement

8.2.1 Air quality

It is expected that NOx volume of exhaust gas is reduced approximately 26% by modal shift of transportation from passenger cars/ buses to the BRT system. Prediction procedure is described in Chapter 7.4.6. Improvement by BRT is expected of not only NOx but also other exhaust gas such as SO_2, SPM.

8.2.2 Noise and Vibration

It is expected that the traffic noise level is reduced approximately 0.1% to 2.1 % by modal shift of transportation from passenger cars/ buses to the BRT system. Prediction procedure is described in Chapter 7.4.6.

The field measurement shape of the vibration level is similar to noise level, since major influential factor is traffic density along the major road. Therefore, improvement by BRT is expected of the vibration as well as noise.

8.2.3 Green House Gas

The JICA Study Team proposes the mathematical method in estimating the improvement of the total CO_2 volume from the BRT corridors in respect of the modal shifting of transportation from passenger cars/ buses to the new transportation system. The effect of the Project is evaluated by comparing the CO_2 volumes of both cases (with and without-project). The exhaust coefficient of small and large vehicles is shown Table 8-2-1. The flow of the mathematical method for the CO_2 volume forecast is same as prediction flows in NOx volumes (see Figure 7.6.4). BRT operation plan and traffic demand forecast are same as the prediction for NOx (see Figure 7.6.3).

Table 8-2-1 Exhaust Coefficient of CO_2

Vehicle Type	CO_2 (g/km)*	Fuel type
Motor Cycle	116.10	Gasoline
Car	210.70	Gasoline
Bus	245.5	Diesel Oil
BRT Vehicle	239.5	CNG

Source: *2010 guidelines to Defra/DECC's GHG Conversion Factors for Company Reporting, 2010 Department for Environment, Food and Rural Affairs (Defra)

It is expected that the total emission factor for CO_2 is reduced approximately 12 % in respect of the modal shifting of transportation from passenger cars/ buses to the new transportation system.

Table 8-2-2 Reduction Ratio in GHG (CO_2)

BRT	Forecast of CO_2 volume along the BRT line (g/day)		Reduction rate (%)
	With the BRT Project Road Traffic (KCR + Green Line + Red Line)	Without the BRT Project Road Traffic (Only KCR)	
	GHG_w	**GHG_{wo}**	**$(GHG_{wo}-GHG_w)/GHG_{wo}$**
Green Line	689,120	802,531	14.1%
Red Line	270,251	292,469	7.6%
Total	959,370	1,095,000	12.4%

Source: JICA Study Team

Reduction in vehicle emission is one of the most expected outcomes about environmental

improvement by introduction of a mass transit system. The impact can be estimated form the result of with-without analysis in economic evaluation by applying unit vehicle emission of each system.

8.3 Qualitative and Quantitative Check

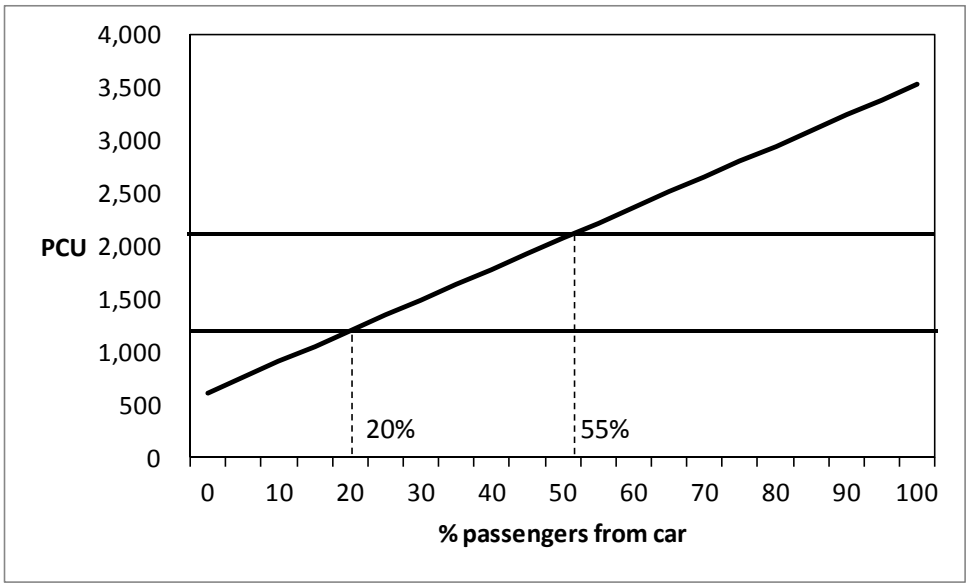
8.3.1 Quantitative Impact

There are some measurable impacts by the BRT project such as reduction in travel time, reduction in vehicle operating cost, and reduction in vehicle emission. There will be negative traffic impact because the project will use existing lanes of the corridors.

(1) Traffic Impact

The capacity of the proposed BRT system is 12,000 passengers per hour per direction, which is equivalent to 343 minibuses (35 passengers per minibus) or 686 passenger car units (PCUs). In case that the capacity of a lane of a road is less than 686 PCUs, converting the lane to the BRT lane will increase the road capacity. Generally, the capacity of a lane is 2,200 PCUs if there is no intersection, and converting such lane to the BRT lane will reduce the road capacity. However, if all BRT passengers are from car users, 3,530 PCUs will be removed from the road, which will increase the road capacity in any case. Figure 8-3-1 shows the reduction in PCUs by the percentage of BRT passengers who are shifted from cars. In case that 55% of BRT passengers are from cars, conversion of a traffic lane to a BRT lane will not decrease the road capacity because it will reduce 2,200 PCUs from the traffic lane. The capacity of a lane of urban roads is less than the lane capacity of 2,200 PCUs due to red time at intersections. Assuming the green time is 60% of a signal cycle, the capacity is approximately 1,200 PCUs per lane. In this case, if the passengers from cars account for 20% of the BRT passengers, the reduction in road capacity can be compensated by the reduction in road traffic.

However, most BRT passengers are expected to be those shifted from buses. Therefore, the reduction in road capacity will be larger than the reduction in road traffic, which will increase volume to capacity ratio of the road.



Source: JICA Study Team

Figure 8-3-1 Equivalent PCUs of a BRT lane by % of Car Users

(2) Travel Time Reduction of Bus Passengers

Presently, the average speed of a minibus is approximately 17km/h in Karachi[1]. It is expected that the BRT system will be operated at an average speed of 25 km/h. This will reduce the travel time of bus passengers.

(3) Reduction in Vehicle Operating Cost

Introduction of large buses for the BRT system will reduce the number of buses, which will save fuel consumption and vehicle operating costs.

(4) Environmental Impact

As discussed in 8.2, the BRT system will improve environment.

8.3.2 Qualitative Impact

The following impacts are expected by the BRT project, although measuring the impacts in numeric units are difficult.

(1) Improvement of City's Image

Megacities in the world have introduced mass transit system including BRT systems in recent years, which have impressed the world that the cities are economically growing. Mass transit system in these cities became a symbol of the steady growth of the city. BRT system with modern type vehicles will improve the image of Karachi.

(2) Increase in Women's Trip

Presently, the trip rate of women in Karachi is very low because of the social and cultural background. However, poor transport system is also one of the reason. BRT system will provide safer transport system than existing minibuses. The project will encourage women to make more trips to participate social activities.

(3) Crime Reduction

BRT system will ensure transparent fare collection by installing ticket gates and monitoring cameras to avoid free riders. Cameras will be also installed at major intersections to monitor the operation of BRT buses. The presence of security cameras can reduce crime in the city. Lighting at stations will also contribute to reduce crime in night time.

(4) Pedestrian Safety

Pedestrian bridges will be constructed to access BRT stations. People can use the pedestrian bridges even if they do not use BRT. The new pedestrian bridges will increase the number of crossing points along the corridors, which encourage people to use the bridges instead of crossing roads of heavy traffic. It is expected that traffic accident on road involving crossing pedestrian and cars will decrease.

(5) City Development

Development in Gadap Town is one of the important land use development. Since the BRT corridor connect the north of New Karachi to the center of the city, urban development in the north area will be promoted.

[1] Confirmatory Green Routes Study for Karachi, 2010, Exponent Engineers

8.4 Economic Evaluation

8.4.1 Methodology

The BRT project will bring about positive benefits to Karachi, while it will consume national resources to some extents. The project should be evaluated by comparing its economic benefit and economic cost in view of the country's economy.

The major economic benefits of the project are: (1) travel time saving, (2) vehicle operating cost (VOC) saving, (3) reduction in vehicle emission, and (4) indirect benefit such as comfort ride on modern buses from stressful minibuses and improvement of the city's image. The BRT project involves negative benefits for car uses from the reduction in the number of lanes and signalling control. The negative benefits were deducted from travel time saving.

Travel time savings and VOC savings were estimated as economic benefit of the project and Economic Internal Rate of Return (EIRR) was calculated. The indirect benefit was not taken into account because it is difficult to value such benefit. The evaluation period will be 20 years considering the project life of BRT.

"With" and "Without" analysis is the basis of the economic evaluation.

8.4.2 Project Cost

The project cost was estimated as Rs. 21.5 billion in total at 2011 prices (Chapter 10). In economic evaluations, price escalation and transfer items such as tax and subsidy should be excluded. The project cost does not include opportunity cost of carriageways and medians of roads which will be consumed for BRT lanes. The cost of carriageways is considered as the negative benefit of road users by the reduction in travel speed. Median spaces of roads are reserved for the future development of infrastructure. However, it is considered that the median spaces will remain in the future without producing economic benefit if it is not used for BRT this time. Therefore, these costs can be excluded from the economic cost.

Shadow wage rate to adjust unskilled labour cost is not applied because unemployment rate of Sindh is not so high (5.25% in urban area of Sindh, 2008-09, Pakistan Bureau of Statistics) to consider the real cost of unskilled labours.

The economic cost of the initial investment was estimated as Rs. 14,961 million.

Table 8-4-1 Estimation of Economic Cost

Item		Rs. Million
Grand Total	(a)	21,469
VAT	(b)	2,854
Import TAX	(c)	244
Price Escalation (Construction)	(d)	2,856
Price Escalation (Consultant)	(e)	110
Interest during construction	(f)	444
Economic Cost	(a)-(b)-(c)-(d)-(e)	14,961
	Green Line	7,431
	Red Line	7,842

Source: JICA Study Team

The above cost includes purchase cost of new vehicles (Rs. 4,397 million). The useful life of the buses is assumed as 10 years. Purchase cost also arises in "without" case. The cost of a new minibus is not available because new minibuses have not been produced for years. Instead, old minibuses have been rehabilitated. Generally, a full renewal is necessary for a minibus every five year at the cost of approximately Rs. 1 million. New vehicle cost in "without" case is assumed as 0.25 million per bus every year. The average travel distance of a minibus is

approximately 177.5km per day because the average route length of minibuses is 35.5km and a minibus can serve 2.5 round trips in average per day. Assuming 330 days per year as a conversion factor from day to year, total distance was calculated as 58,575 km. From this, the cost was estimated as Rs. 4.268 per km.

8.4.3 Operation and Maintenance (O&M) Cost

O&M cost of "With Case" is estimated in Chapter 9. In O&M costs, vehicle operation cost and vehicle maintenance cost are analyzed in the next subsection. Personnel cost, administrative cost, and infrastructure maintenance cost are considered as O&M cost for the economic analysis. The estimated O&M cost is Rs. 919.9 million per year.

In addition to maintenance cost of "with case", infrastructure cost in "without" case should be considered because the maintenance of existing lanes for BRT will not be necessary. The cost was estimated as Rs. 265.8 million per year which was the same cost as estimated for "without" case.

Table 8-4-2 O&M Cost for Economic Evaluation

Unit: Rs. Million per year

Corridor	Personnel Cost	Administrative Cost	Infrastructure Maintenance Cost	Total (with)	Infra-structure (without)	(with) - (without)
Green Line	209.5	44.8	197.5	451.8	41.7	410.1
Red Line	217.9	46.0	212.7	476.7	45.0	431.7
Both Lines	428.2	90.9	410.2	928.5	86.7	841.8

Source: JICA Study Team

Driver cost is included in the personnel cost. In "without" case, a driver and a conductor are necessary for a minibus operation per day with a daily salary of approximately Rs. 600 for each. From this, the driver cost in "without" case was estimated as Rs. 6.76 per vehicle-kilometre.

Cost of maintenance and repair staff is also included in the personnel cost of "with case". The same cost was not considered in "without" case because statistical information was not available. However, the personnel cost of maintenance and repair staff of minibuses is very small and ignoring this cost of minibus results in safer side evaluation.

8.4.4 Vehicle Operating Cost

(1) Component of VOC

In usual economic evaluation of a transport project, VOC consists of 1) depreciation of car, 2) fuel consumption cost, 3) lubricant cost, 4) driver's cost, 5) maintenance worker's cost, 6) spare tyre cost, and 7) spare parts cost. In this analysis, depreciation cost is already included in the initial investment cost as vehicle purchase cost. In addition, drivers and maintenance workers costs are considered in O&M cost.

(2) Fuel Consumption

Fuel consumption rate of buses varies with passenger loading, speed, acceleration, etc. The average fuel consumption rate of BRT buses was assumed as 2.9 km per litter based on information from a bus manufacture in Karachi. To assume the average fuel consumption rate of minibuses, a fuel consumption survey was conducted on 16th and 23rd January 2012 for CNG and diesel, respectively. It was calculated that a CNG minibus can run 3.49km per kg while a diesel minibus can run 2.63 km per litter.

Table 8-4-3 Fuel Consumption Survey

	CNG	Diesel
Survey Date	16th January 2012	23rd January 2012
Distance (km)	42.7	31.6
Fuel Filled	12.25 kg	12.02 litter
Fuel Consumption Rate	3.49 km/kg	2.63 km/ L

Source: JICA Study Team

(3) Fuel Price

Fuel price in Karachi easily fluctuates with domestic demand and supply gap, exchange rates, international market price, political incidents, and so on. Table 8-4-4 shows the unit price of CNG and diesel in Karachi in 2011-12. Since the market price includes the sales tax (16%), the economic price should be calculated by dividing the market price by 1.16. Since the base year of the project cost estimation is 2011, Rs. 94.16 was used for the economic evaluation.

Table 8-4-4 Fuel Price

Year	Month	CNG (Rs. /kg)	Diesel (Rs. /litter)
2011	April	55.78	93.30
	May	59.57	97.31
	June	N.A.	94.11
	July	63.11	92.10
	August	66.00	92.10
	September	N.A.	93.19
	October	N.A.	94.16
	November	N.A.	94.16
	December	69.62	98.81
2012	January	69.62	98.82
	February	70.15	103.46
	March	70.15	103.46

Source: Market price in Karachi

Passenger-km was calculated from the demand forecast (Chapter 3). A passenger occupancy rate, the number of on-board passengers per bus, varies depending on routes and time. The occupancy rate of minibuses is approximately 30-40 according to surveys[2]. Vehicle-km in without case was estimated assuming that the average occupancy rate of 35 passengers per bus, while that of with case was estimated from the rate of 60 passengers per bus.

Table 8-4-5 Vehicle-km and Fuel Saving (Daily)

		2010	2020	2030	Unit
Passenger-km	A	5,516	11,356	9,560	000
Vehicle-km (Without)	B	157.6	324.4	273.1	000
Fuel Consumption (Without)	C	59.9	123.4	103.9	000
Vehicle-km (With)	D	91.9	189.3	159.3	000
Fuel Consumption (With)	E	31.7	65.3	54.9	000
Fuel Saving (C- E)	F	28.2	58.1	48.9	000
Fuel Cost Saving	G	2,291	4,716	3,970	000
Green Line		1,420	2,145	2,157	
Red Line		871	2,571	1,813	

Source: JICA Study Team

[2] Confirmatory Green Route Study for Karachi (2010), Screen Line Survey in KTIP (2010)

(4) Other Minibus Cost

Renewal and personnel costs were estimated for "without" case as a part of VOC because the same cost in "with" case was included in the initial investment cost and O&M cost but they were not considered in "without" case.

Table 8-4-6 Other Minibus Cost Saving (Daily)

		2010	2020	2030	Unit
Vehicle-km Saving	A	157.6	324.4	273.1	000
Renewal Cost	B	673	1,385	1,166	000
Personnel Cost	C	621	1,279	1,077	000
B + C	D	1,294	2,664	2,243	000
Green Line		802	1,212	1,219	
Red Line		492	1,452	1,024	

Source: JICA Study Team

(5) VOC Saving of Motorcycle

The shift from motorcycles to the BRT system will reduce the VOC of motorcycles. The major VOC of a motorcycle is fuel consumption and capital cost. Fuel consumption rate was assumed as 40km per litter. Petrol price was approximately Rs 100 in 2011. The economic cost of the fuel consumption of a motorcycle was calculated at Rs. 2.16 (= Rs. 100/1.16 /40). The capital cost per kilometre was estimated at R 1.2 based on the assumption that the price of a motorcycle was Rs. 60,000 and the distance of the life is 50,000 km. VOC was calculated as Rs. 3.46/km.

Table 8-4-7 VOC Saving of Motorcycles

		2010	2020	2030	Unit
Passenger-km	(a)	416.3	600.7	584.4	000/day
Vehicle-km	(b) = (a) / 1.2	346.9	500.6	487.0	000/day
VOC Reduction (Rs.)	(c) = (b) * 5.5	1,908	2,753	2,679	Rs. 000/day
		591	853	830	Rs. Million/year
	Green Line	345	532	581	
	Red Line	246	322	249	

Source: JICA Study Team

(6) VOC Saving of Car

VOC saving of cars by shifting to the BRT system was estimated as same method as that of motorcycles. VOC was estimated as Rs. 8.8/km based on the assumption of follows: 1) fuel consumption rate = 18km/L, 2) price = Rs. 800,000, and 3) car mileage life = 200,000 km. Since there are various types of passenger cars with different prices, lower fuel consumption, lower price and longer distance of life were assumed for safe side estimation.

Table 8-4-8 VOC Saving of Cars

		2010	2020	2030	Unit
Passenger-km	(a)	0.5	662.1	278.7	000/day
Vehicle-km	(b) = (a) / 3.4	0.1	194.7	82.0	000/day
VOC Reduction (Rs.)	(c) = (b) * 8.8	1	1,714	721	Rs. 000/day
		0	531	224	Rs. Million/year
	Green Line	0	291	157	
	Red Line	0	240	136	

Source: JICA Study Team

8.4.5 Travel Time Cost

(1) Value of Time

Value of time for motorcycle and bus passengers was estimated as Rs. 49.65 per hour, while that of car passengers was Rs. 110 (Refer to VOL-1 Chapter 9).

(2) Time Cost Saving of BRT Passengers

The average travel time of minibuses is approximately 17km/h in Karachi. The travel speed of BRT is expected to be 25km/h in average. Passenger-hour was estimated by dividing passenger-km by the speeds, and the time cost saving was estimated by multiplying the estimated passenger-hour by the value of time.

Table 8-4-9 Passenger-Hour and Time Cost Saving (Daily)

		2010	2020	2030	Unit
Passenger-km	A	5,516	11,356	9,560	000
Passenger-hour (Without)	B	324.5	668.0	562.3	000
Passenger-hour (With)	C	220.6	454.2	382.4	000
B - C	D	103.8	213.8	179.9	000
Time Cost Saving	E	5,155	10,613	8,934	Rs. 000
Green Line		3,196	4,827	4,855	
Red Line		1,959	5,786	4,080	

Source: JICA Study Team

(3) Speed Reduction of Cars by BRT Lanes

The number of lanes of carriageway for cars will be reduced by BRT where the width of median is not wide enough for BRT lanes, which will reduce the capacity of road and increase the travel time.

The changes in the travel time in terms of passenger-hours can be calculated from the result data of the demand forecast in JICA STRADA format. However, the difference between “with” and “without” case is very small compared to the total passenger hours on entire transport network in Karachi. With the small % (0.01% of motorcycle and 0.09% of car), the difference is within the error range of the demand forecast model. There is another problem to evaluate the speed reduction. The speed-flow relations applied in the demand forecast model in KTIP is based on daily traffic, which means that the calculated speed does not necessarily represent the peak hour speed. From this, the result file of the demand forecast was not used to estimate the increase in travel time.

Table 8-4-10 Passenger-Hour Saving using Result File of JICA STRADA

		Motorcycle	Car	Bus
With Case	A	9,801,405	21,450,568	31,086,200
Without Case	B	9,910,401	21,472,658	31,847,253
Saving	C=B-A	108,996	22,090	761,053
%	C/A	0.10%	2.4%	-1.7%

Source: JICA Study Team

In this economic evaluation, a different approach, which is simpler than using traffic assignment, was applied. Peak hour speed along the project corridors was assumed to reduce by 25% in “with” case, and the affected traffic in peak hours was assumed as 50% of daily traffic.

In case that a BRT lane carries 12,000 passengers per hour, 686 PCUs will move to the BRT lane on the assumption of 35 passengers per bus and 2 PCU of a bus if only bus passengers shifts to BRT. The result of the demand forecast showed that motorcycle and car users accounted for

approximately 8 and 7%, respectively. In this case, the reduction of PCU is calculated as 1,020 PCUs on the assumption of vehicle occupancy rate of 1.2 (motorcycle) and 3.4 (car), and PCU of 0.25 (motorcycle) and 1.0 (car).

Travel time in relation with road capacity is explained by some formulas such as the BPR[3] function. The formula of the function is shown below.

$$T_f = T_0\left(1 + \alpha\left[\frac{V}{C}\right]^{\beta}\right)$$

Where,

T_f	: Travel time
T_0	: Travel time of free flow situation
V	: Traffic volume
C	: Capacity
α, $\boldsymbol{\beta}$	: Parameters

Figure 8-4-1 shows the curve of BRT function in case of 4-lane and 3-lane per direction when T_0 = 1. The assumption of this curve is the capacity of 2,000 vehicles per lane, α = 0.71, and β = 2.1. The difference of travel time differs by traffic volume.

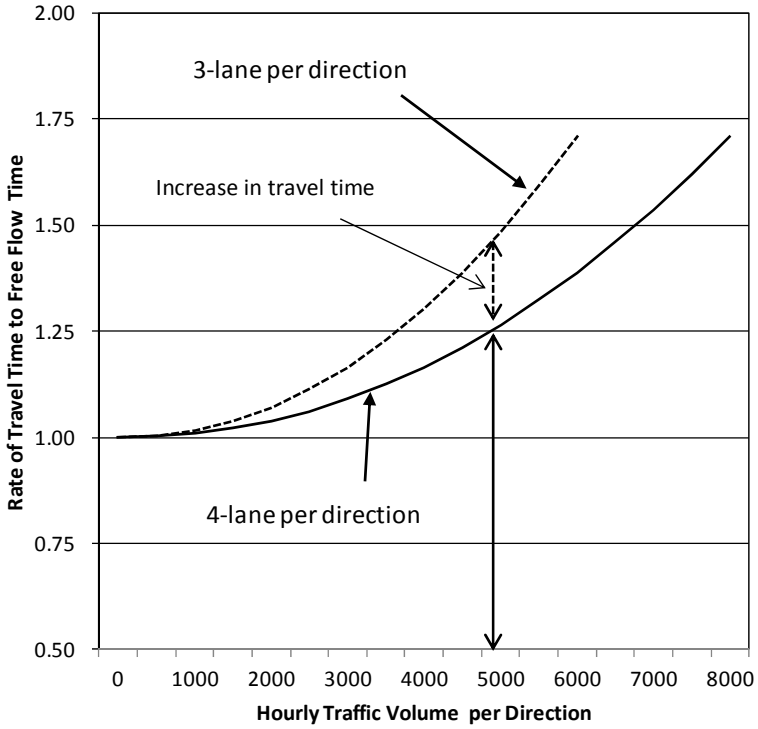


Figure 8-4-1 Comparison of Travel Time by BRT function

The demand forecast showed that volume to capacity ratio (V/C) of most sections along the project corridors would be more than 1, ranging 1 to 1.5 in the future. Table 8-4-11 shows the impact of lane reduction on a road whose V/C is 1 using BRT function under simple assumptions. Converting a lane to a BRT lane increases travel time by 3% (4-lane to 3-lane) or 5% (3-lane to 2-lane).

[3] Bureau of Public Roads

Table 8-4-11 Impact Analysis of Lane Reduction by BRT function

$\alpha = 0.83, \beta = 2.7$

	From 4-lane to 3-lane		From 3-lane to 2-lane	
	4-lane	3-lane	3-lane	2-lane
Capacity	2,200*4*0.5=4,400	2,200*3*0.5=3,300	2,200*3*0.5=3,300	2,200*2*0.5=3,300
Volume	4,400 (V/C=1)	4,400-1,020=3,380	3,300 (V/C=1)	3,300-1,020 = 2,280
T_f / T_0	1.83 (A)	1.89 (B)	1.83 (A)	1.91 (B)
B/A	1.03		1.05	

Source: JICA Study Team

The average speed in peak hours along the corridors is assumed as 33km/h based on the travel speed survey in 2010 (KTIP). In case of BRT, this average speed is assumed to reduce to 29.7 km/h (90%). Increase in vehicle-hour was calculated from vehicle-km as follows:

Increase in vehicle-hour = vehicle-km * (1/29.7 – 1/33).

Table 8-4-12 shows the result of the calculation. The economic loss for car and motorcycle passengers by reducing the lane was estimated as Rs. 461 million per year, in which Green Line and Red Lines accounted for Rs. 316 million and Rs. 145 million, respectively.

Table 8-4-12 Time Cost by Lane Reduction

Unit: 000

	2010		2020		2030	
	Motorcycle	Car	Motorcycle	Car	Motorcycle	Car
Vehicle-km	1,467	829	2,890	1,899	2,689	1,748
Vehicle-hour Increase	2.5	1.4	4.9	3.2	4.5	2.9
Passenger-hour Increase *1	3.0	4.7	5.8	10.9	5.4	10.0
Time Cost (Rs.000) *2	147	522	290	1,196	270	1,101
(total)	669		1,486		1,371	
Year (Rs. million)	207		461		425	

*1) passenger occupancy rate of motorcycle = 1.5, car = 3.4
*2) value of time of motorcycle = Rs. 49.7, car = Rs. 110
Source: JICA Study Team

(4) Delay at Intersections of Cars

The project will change the Signal Free Corridor to a signalized road for BRT operation, which will cause a delay at signalized intersections. Delay at an intersection depends on the capacity and traffic volume. Relation of delay and traffic flow is roughly described as follows.

Table 8-4-13 Relation of Delay and Traffic Flow

Level of Service	Average Control Delay (sec/veh)	General Description
A	- 10	Free flow
B	10 – 20	Reasonably free flow
C	20 – 35	Stable flow
D	35 – 55	Approaching unstable flow
E	55 – 80	Unstable flow
F	80 –	Forced or breakdown flow

Level of service (LOS) of a signalized intersection is a rank defined in the Highway Capacity Manual (USA)

The average delay per vehicle at an intersection is assumed as 40 seconds considering that it is expected that intersections of the corridors would remain congested in the future due to increase in traffic volume but the delay would be tolerable because of traffic improvement by new roads, KCR, and BRT. In this project, four (4) roundabouts will be signalized. With high demand

along the corridors, these roundabouts should be signalized in the future even if the BRT project is not implemented. Therefore, the delay at signalized intersections along the corridors was not evaluated in the economic analysis.

On the other hand, this project will signalize U-turns along the corridors. The delay at the new signalized U-turns was calculated by multiplying the number of vehicles using the U-turns by 40 seconds. Table 8-4-14 shows the result of the calculation. The economic loss by signalization of U-turns was estimated as Rs. 151 million per year, in which Green and Red Lines accounted for Rs. 113 million and Rs. 334 million , respectively.

Table 8-4-14 Delay at U-turn

	Motorcycle	Car	Bus	Truck	Total
No. of vehicles	61,179	81,464	3,144	663	
Occupancy rate	1.5	3.4	38.8	1.5	
No. of passengers	91,769	276,978	121,987	995	
Dely (hours)	1,020	3,078	1,355	11	
Value of Time (Rs./hour)	49.7	110	49.7	110	
Loss of delay per day (Rs.)	50,677	338,528	67,364	1,216	457,784
per year (Rs. million)	16.7	111.7	22.2	0.4	151.1

Source: JICA Study Team

8.4.6 Benefit and Cost Flow

It was assumed that the construction period is three years from 2017 and the service of BRT will start in 2020. The cost allocation was based on the analysis of Chapter 10. Table 8-4-15 shows the flow of benefit and cost. In the previous sections, the master plan network was assumed for the estimation of benefits and cost in 2030. Since the difference of benefits and costs between 2020 and 2030 was small and there would be uncertainness about the master plan project, these values were fixed at the same values in 2020.

Economic Internal Rate of Return (EIRR) was calculated as 26.0%. Net present value (NPV) at 12% discount rate was calculated as Rs. 8.4 billion. The result shows that this project would be economically feasible.

The difference of cost-benefit performance between Green Line and Red Line is very small. EIRR of each corridor was calculated as 24.4% for Green Line and 26.2% for Red Line.

Table 8-4-15 Benefit and Cost Flow of Economic Evaluation

Unit: Rs. Million

Year	Investment Cost	O&M	Travel Time			VOC Saving	Benefit	Benefit - Cost
			Bus	M/C & Car	Total			
	(a)	(b)	(c)	(d)	(e)=(c)+(d)	(f)	(g)=(e)+(f)	(g)-(c)-(d)
2012								0
2013	0							0
2014	200							-200
2015	305							-305
2016	112							-112
2017	4,624							-4,624
2018	4,866							-4,866
2019	4,880							-4,880
2020		654	3,290	-599	2,691	3,490	6,181	5,527
2021		654	3,290	-599	2,691	3,490	6,181	5,527
2022		654	3,290	-599	2,691	3,490	6,181	5,527
2023		654	3,290	-599	2,691	3,490	6,181	5,527
2024		654	3,290	-599	2,691	3,490	6,181	5,527
2025		654	3,290	-599	2,691	3,490	6,181	5,527
2026		654	3,290	-599	2,691	3,490	6,181	5,527
2027		654	3,290	-599	2,691	3,490	6,181	5,527
2028		654	3,290	-599	2,691	3,490	6,181	5,527
2029	5,024	654	3,290	-599	2,691	3,490	6,181	503
2030		654	3,290	-599	2,691	3,490	6,181	5,527
2031		654	3,290	-599	2,691	3,490	6,181	5,527
2032		654	3,290	-599	2,691	3,490	6,181	5,527
2033		654	3,290	-599	2,691	3,490	6,181	5,527
2034		654	3,290	-599	2,691	3,490	6,181	5,527
2035		654	3,290	-599	2,691	3,490	6,181	5,527
2036		654	3,290	-599	2,691	3,490	6,181	5,527
2037		654	3,290	-599	2,691	3,490	6,181	5,527
2038		654	3,290	-599	2,691	3,490	6,181	5,527
2039		654	3,290	-599	2,691	3,490	6,181	5,527
2040	-1,700							1,700

Source: JICA Study Team

Table 8-4-16 Benefit and Cost Flow of Green and Red Line

Green Line Unit: Rs. Million

Year	Investment Cost	O&M	Travel Time			VOC Saving	Benefit	Benefit - Cost
			Bus	M/C & Car	Total			
	(a)	(b)	(c)	(d)	(e)=(c)+(d)	(f)	(g)=(e)+(f)	(g)-(c)-(d)
2012								0
2013	0							0
2014	105							-105
2015	196							-196
2016	77							-77
2017	2,262							-2,262
2018	2,390							-2,390
2019	2,399							-2,399
2020		410	1,496	-351	1,145	1,757	2,902	2,492
2021		410	1,496	-351	1,145	1,757	2,902	2,492
2022		410	1,496	-351	1,145	1,757	2,902	2,492
2023		410	1,496	-351	1,145	1,757	2,902	2,492
2024		410	1,496	-351	1,145	1,757	2,902	2,492
2025		410	1,496	-351	1,145	1,757	2,902	2,492
2026		410	1,496	-351	1,145	1,757	2,902	2,492
2027		410	1,496	-351	1,145	1,757	2,902	2,492
2028		410	1,496	-351	1,145	1,757	2,902	2,492
2029	2,482	410	1,496	-351	1,145	1,757	2,902	10
2030		410	1,496	-351	1,145	1,757	2,902	2,492
2031		410	1,496	-351	1,145	1,757	2,902	2,492
2032		410	1,496	-351	1,145	1,757	2,902	2,492
2033		410	1,496	-351	1,145	1,757	2,902	2,492
2034		410	1,496	-351	1,145	1,757	2,902	2,492
2035		410	1,496	-351	1,145	1,757	2,902	2,492
2036		410	1,496	-351	1,145	1,757	2,902	2,492
2037		410	1,496	-351	1,145	1,757	2,902	2,492
2038		410	1,496	-351	1,145	1,757	2,902	2,492
2039		410	1,496	-351	1,145	1,757	2,902	2,492
2040	-495							495

Red Line Unit: Rs. Million

Year	Investment Cost	O&M	Travel Time			VOC Saving	Benefit	Benefit - Cost
			Bus	M/C & Car	Total			
	(a)	(b)	(c)	(d)	(e)=(c)+(d)	(f)	(g)=(e)+(f)	(g)-(c)-(d)
2012								0
2013	0							0
2014	100							-100
2015	194							-194
2016	83							-83
2017	2,409							-2,409
2018	2,528							-2,528
2019	2,529							-2,529
2020		432	1,794	-248	1,546	1,733	3,278	2,847
2021		432	1,794	-248	1,546	1,733	3,278	2,847
2022		432	1,794	-248	1,546	1,733	3,278	2,847
2023		432	1,794	-248	1,546	1,733	3,278	2,847
2024		432	1,794	-248	1,546	1,733	3,278	2,847
2025		432	1,794	-248	1,546	1,733	3,278	2,847
2026		432	1,794	-248	1,546	1,733	3,278	2,847
2027		432	1,794	-248	1,546	1,733	3,278	2,847
2028		432	1,794	-248	1,546	1,733	3,278	2,847
2029	2,541	432	1,794	-248	1,546	1,733	3,278	305
2030		432	1,794	-248	1,546	1,733	3,278	2,847
2031		432	1,794	-248	1,546	1,733	3,278	2,847
2032		432	1,794	-248	1,546	1,733	3,278	2,847
2033		432	1,794	-248	1,546	1,733	3,278	2,847
2034		432	1,794	-248	1,546	1,733	3,278	2,847
2035		432	1,794	-248	1,546	1,733	3,278	2,847
2036		432	1,794	-248	1,546	1,733	3,278	2,847
2037		432	1,794	-248	1,546	1,733	3,278	2,847
2038		432	1,794	-248	1,546	1,733	3,278	2,847
2039		432	1,794	-248	1,546	1,733	3,278	2,847
2040	-530							530

Source: JICA Study Team

8.4.7 Sensitivity Analysis

To evaluate the calculated EIRR in view of uncertainty of benefit and cost, a sensitivity analysis was conducted by changing input values such as cost and benefit. Table 8-4-17 shows the result. The result shows that the project will be economically feasible even if the cost is high by 20% or the benefit is low by 20%.

Even in the case that the cost is 20% high and benefit is 20% low, EIRR will be still high at 16.5%. This means that the project feasibility would be stable enough against cost and benefit risks.

Table 8-4-17 Sensitivity Analysis of EIRR

Base case	+20% in Cost	-20% in Benefit	+20% in Cost & -20% in Benefit
26.0%	21.5%	20.6%	16.5%

Source: JICA Study Team

8.5 Financial Analysis

Financial analysis is used to assess the financial viability of projects by comparing cost and revenue. In this section, the financial viability of the BRT project itself was analysed. The financial viability to each entity such as operators, authorities, investors, and stakeholders is not analysed. The financial analysis evaluates the return of the project for an assumed entity who finance all the cost of the project by own money.

8.5.1 Capital Investment Cost

The estimated cost was used for the financial analysis. Although financing cost differs by financial scheme, the cost in case of using Japanese Yen Loan was included in the project cost. The interest during construction is also included for safer side analysis. On the other hand, price escalation should be excluded the financial analysis.

The capital investment cost excluding price escalation was estimated as Rs. 18,502 million in which construction and rolling stock accounted for Rs. 12,424 and Rs. 6,079, respectively. The cost of Green and Red Lines was estimated as follows:

Table 8-5-1 Capital Investment Cost for Financial Analysis

Unit: Rs. Million

	Construction	Rolling stock	Total
Green Line	5,994	3,004	8,998
Red Line	6,430	3,075	9,505
Both Lines	12,424	6,079	18,502

Source: JICA Study Team (Chapter 10)

8.5.2 O&M Cost

Operation and maintenance (O&M) cost was estimated as Rs. 2,766 million per year (Chapter 9) in total. For O&M cost of Green and Red lines, common costs were allocated to two lines based on the route length, calculated as Rs. 1,363 million and Rs. 1,410, respectively.

8.5.3 Revenue

Ridership was assumed as 700,000 passengers boarding per day based on the demand forecast. The fare of Rs. 20 was used for the revenue projection. It was assumed that the revenue would be the same during the evaluation period considering that the demand of the BRT lines would be stable if other mass transit system in the master plan is implemented. The revenue of Green and Red Lines were estimated from the proportion of the number of passengers boarding. The proportion of Green and Red Line was calculated as 48.8% and 51.2%, respectively.

8.5.4 Cash Flow Analysis

The operation was assumed to start in 2020 and the period of 20 years was applied for the cash flow analysis. Financial Internal Rate of Return (FIRR) was calculated as 4.3% as shown in Table 8-5-2. The result shows that the return of the project is smaller than market interest rate. Therefore, this project is not commercially viable. Table 8-5-3 shows cash flow tables of Green Line and Red Line. FIRR of Green and Red Lines was calculated as 4.1% and 4.4%, respectively.

Table 8-5-2 Cash Flow Analysis

Unit: Rs. Million

Year	Construction (a)	Rolling stock (b)	Capital Cost (c) =(a)+(b)	O&M (d)	Revenue Fare (e)	Non-fare (f)	Total (g)	Cash Flow (g)-(c)-(d)
2012								
2013								0
2014	218	0	218					-218
2015	335	0	335					-335
2016	125	0	125					-125
2017	3,547	2,026	5,573					-5,573
2018	4,075	2,026	6,102					-6,102
2019	4,349	2,026	6,375					-6,375
2020	0	0	0	2,766	4,340	116	4,456	1,690
2021				2,766	4,340	116	4,456	1,690
2022				2,766	4,340	116	4,456	1,690
2023				2,766	4,340	116	4,456	1,690
2024				2,766	4,340	116	4,456	1,690
2025				2,766	4,340	116	4,456	1,690
2026				2,766	4,340	116	4,456	1,690
2027				2,766	4,340	116	4,456	1,690
2028				2,766	4,340	116	4,456	1,690
2029		6,079	6,079	2,766	4,340	116	4,456	-4,389
2030				2,766	4,340	116	4,456	1,690
2031				2,766	4,340	116	4,456	1,690
2032				2,766	4,340	116	4,456	1,690
2033				2,766	4,340	116	4,456	1,690
2034	1,503		1,503	2,766	4,340	116	4,456	187
2035				2,766	4,340	116	4,456	1,690
2036				2,766	4,340	116	4,456	1,690
2037				2,766	4,340	116	4,456	1,690
2038				2,766	4,340	116	4,456	1,690
2039				2,766	4,340	116	4,456	1,690
2040	-1,053		-1,053					1,053

Source: JICA Study Team

Table 8-5-3 Cash Flow Analysis by Corridor

Green Line Unit: Rs. Million

Year	Construction (a)	Rolling stock (b)	Capital Cost (c) =(a)+(b)	O&M (d)	Revenue Fare (e)	Non-fare (f)	Total (g)	Cash Flow (g)-(c)-(d)
2012								
2013								0
2014	106	0	106					-106
2015	180	0	180					-180
2016	60	0	60					-60
2017	1,726	1,001	2,727					-2,727
2018	1,930	1,001	2,932					-2,932
2019	1,993	1,001	2,994					-2,994
2020				1,363	2,118	106	2,224	860
2021				1,363	2,118	106	2,224	860
2022				1,363	2,118	106	2,224	860
2023				1,363	2,118	106	2,224	860
2024				1,363	2,118	106	2,224	860
2025				1,363	2,118	106	2,224	860
2026				1,363	2,118	106	2,224	860
2027				1,363	2,118	106	2,224	860
2028				1,363	2,118	106	2,224	860
2029		3,004	3,004	1,363	2,118	106	2,224	-2,143
2030				1,363	2,118	106	2,224	860
2031				1,363	2,118	106	2,224	860
2032				1,363	2,118	106	2,224	860
2033				1,363	2,118	106	2,224	860
2034	762		762	1,363	2,118	106	2,224	99
2035				1,363	2,118	106	2,224	860
2036				1,363	2,118	106	2,224	860
2037				1,363	2,118	106	2,224	860
2038				1,363	2,118	106	2,224	860
2039				1,363	2,118	106	2,224	860
2040	-530		-530					530

Red Line Unit: Rs. Million

Year	Construction (a)	Rolling stock (b)	Capital Cost (c) =(a)+(b)	O&M (d)	Revenue Fare (e)	Non-fare (f)	Total (g)	Cash Flow (g)-(c)-(d)
2012								
2013								0
2014	107	0	107					-107
2015	182	0	182					-182
2016	61	0	61					-61
2017	1,876	1,025	2,901					-2,901
2018	2,069	1,025	3,094					-3,094
2019	2,135	1,025	3,160					-3,160
2020				1,410	2,222	111	2,333	923
2021				1,410	2,222	111	2,333	923
2022				1,410	2,222	111	2,333	923
2023				1,410	2,222	111	2,333	923
2024				1,410	2,222	111	2,333	923
2025				1,410	2,222	111	2,333	923
2026				1,410	2,222	111	2,333	923
2027				1,410	2,222	111	2,333	923
2028				1,410	2,222	111	2,333	923
2029		3,075	3,075	1,410	2,222	111	2,333	-2,152
2030				1,410	2,222	111	2,333	923
2031				1,410	2,222	111	2,333	923
2032				1,410	2,222	111	2,333	923
2033				1,410	2,222	111	2,333	923
2034	741		741	1,410	2,222	111	2,333	183
2035				1,410	2,222	111	2,333	923
2036				1,410	2,222	111	2,333	923
2037				1,410	2,222	111	2,333	923
2038				1,410	2,222	111	2,333	923
2039				1,410	2,222	111	2,333	923
2040	-520		-520					520

Source: JICA Study Team

8.5.5 Sensitivity Analysis

FIRR was calculated in case of 10% increase in the capital investment cost, 10% decrease in revenue, and 10% increase in O&M cost, as shown in Table 8-5-4.

The result shows that the financial status would not be stable. Especially, revenue risk and O&M cost risk is very high due to the relatively high O&M cost. To reduce the risk, it would be necessary to increase the number of passengers for the opposite traffic of the peak direction. Presently, the peak direction is from the suburban to the centre in the morning peak and the centre to the suburban in the evening peak. Commercial and business area is recommended in the suburban area development.

Table 8-5-4 Sensitivity Analysis of FIRR

Base case	Capital Investment	Revenue	O&M
	+10%	-10%	+10%
4.3 %	3.1 %	1.3 %	1.1 %

Source: JICA Study Team

Chapter 9 Operation & Maintenance Plan

9.1 Operation and Maintenance Cost

9.1.1 Overview

Operation and maintenance costs are the costs, which are necessary for the BRT service provision, such as personnel, fuel, inspection and fixing buses, insurance and so on. The Study Team estimated the costs according to the following categories.

- Personnel cost
- Vehicle operating cost
- Vehicle maintenance cost
- Vehicle insurance cost
- Other administrative cost
- Maintenance cost of infrastructure

It should be noted that operation and maintenance costs were estimated based on the "principal of conservation" to secure financial soundness.

9.1.2 Personnel cost

Personnel cost of the BRT system was estimated by the proposed organizational framework, which is mentioned in section 10.1 "Institutional Arrangement". It was proposed that Karachi Bus Rapid Transit Corporation (KBRTC) plays a role as a PPP corporation, which is to be established by the public sector and the private sector, to manage the system by contracting out necessary works to private companies. Proposed private companies are assumed as the two bus operation companies, in which one companies are responsible for each line, and one fare collecting company. Table 9-1-1 shows assumed personnel cost of the BRT system.

Table 9-1-1 Monthly Personnel Cost of BRT System

Occupation Category Company		KBRTC		Operation Companies (2)		Fare Collection Company	
Occupation	Monthly Personnel Cost (Rs)	Number of Staffs	Monthly Personnel Cost (Rs)	Number of Staffs	Monthly Personnel Cost (Rs)	Number of Staffs	Monthly Personnel Cost (Rs)
President	300,000	1	300,000	2	600,000	1	300,000
Director	100,000	2	200,000	8	800,000	2	200,000
Administrative Staff	12,000	10	120,000	130	1,560,183	27	328,282
Drivers	14,000	0	0	1,033	14,464,707	0	0
Mechanic	25,000	0	0	284	7,109,896	0	0
Station staff	10,000	0	0	426	4,255,900	0	0
Security staff	10,000	0	0	284	2,837,267		
Ticketing staff	10,000	0	0	0	0	426	4,255,900
Total	-	13	620,000	2,167	31,627,952	456	5,084,182

Source: JICA Study Team

Major role of the KBRTC is considered as monitoring function to secure safe and efficient operation of the operating companies as well as a role of the fare revenue management, which will be transferred by the fare collection company. Therefore, expected number of staffs is considered as small as 13 staffs.

The two BRT operation companies would be considered to have a lot of staffs, such as management,

drivers, mechanics, security staffs and station staffs. Total number of the staffs of the two operating companies would amount to more than two thousand.

Table 9-1-2 summarizes the roles and duties of the expected staffs.

Table 9-1-2 Roles and Duties of Expected Staffs

Occupation	Roles and Duties
President	Represents a company and responsible for the management.
Director	Manages section(s) to assist the president.
Administrative Staff	Works for the administration of the company to assist the management.
Drivers	Drive the BRT vehicles safely and efficiently.
Mechanics	Keep the BRT vehicles in good condition for the safe operation.
Station staff	Works for safety of passengers and assist for safe operation of the BRT.
Security staffs	Keep the BRT area be secured from any dangers from criminals and terrorists.
Ticketing staff	Ticket sales and controlling the automatic entrance gate.

Source: JICA Study Team

Numbers of drivers and mechanics were estimated by assuming 2.0 and 0.5 persons per one vehicle respectively. In addition to these, a conversion factor of 1.34 was applied, which represents working days per year and spare ratio (10 %) of the staffs. The calculations were based on the following formulas.

No. of drivers = 2.0 (per vehicle) * 386 (operating vehicles) * (365/300) * 1.1

No. of mechanics = 0.5 (per vehicle) * 425 (total vehicles) * (365/300) * 1.1

Majority of the fare collection company are deemed as the ticketing staffs. Total number of the company staffs was estimated as 456.

As the BRT system is expected to be operated everyday all through the year, the number of staffs at the site such as drivers, station staffs, mechanics and ticket sales staffs are increased by assuming 300 working days and 10% spare staffs to the total in the same manner as the drivers and the mechanics.

Monthly personnel cost by occupation was estimated based on the current prevailing rates in the transport sector in Karachi.

9.1.3 Vehicle operation cost

The vehicle operation cost is a representative “variable” cost of the BRT system, which varies in proportion to operated distances of the BRT vehicles. The vehicle operation cost includes fuel, lubricant, tyre and filter costs in this study. The vehicle operation cost was estimated based on future total annual BRT vehicle-km by assuming specification of the BRT vehicle such as fuel type (CNG), daily service hours, operating speed and so on. Fuel consumption rate, useful life, of tyre and others are assumed properly in this calculation. The cost was estimated at the constant price of December 2011. Table 9-1-3 shows the vehicle operating cost per one vehicle-km.

Table 9-1-3 Estimated Vehicle Operation Cost per vehicle-km (Rp)

Category	Cost
Fuel	25.24
Lubricant	0.98
Filters	1.26
Tyre	1.53
Total	29.01

Source: JICA Study Team based on information provided by Hinopak Motors Limited.

Annual vehicle operating cost was estimated as much as Rp 1,556.0 million.

9.1.4 Vehicle maintenance cost

Vehicle maintenance cost of the BRT system was estimated based on maintenance scheme, which stipulates timing of change and overhaul by part in terms of operated distance and/or period of operation. The maintenance cost of BRT vehicle is estimated as Rs 1,756,529 for 500,000km operation according to Hinopak Motors Limited. Therefore, unit maintenance cost per vehicle-km was estimated to be Rs.3.51. Annual vehicle maintenance cost total was calculated as Rp 188.2 million.

9.1.5 Vehicle Insurance Cost

The vehicle insurance cost was estimated with due consideration to the current insurance payment by the KMC for the CNG bus project and Wright (2007). The insurance cost was finally assumed as 2 % of vehicle purchasing cost per annum. Annual insurance payment was calculated to be Rp 102.0 million.

9.1.6 Other administrative cost

It would be practical and conservative to admit the “unpredictable cost” for the implementation of future projects. The Study Team assumed the unpredictable cost as “other administrative cost” and appropriated Rp 91.8 million per year, which is 4 % of the sum of personnel cost, vehicle operation cost, vehicle maintenance cost and vehicle insurance cost. The “4%” was derived from past experience of KMC as well as foreign experiences mentioned in Wright et al (2007).

The other administrative cost is considered to include office expenditures, telephone charges, utility costs, repair costs and contingency.

9.1.7 Maintenance Cost for Infrastructure

The BRT system infrastructure cost consists of carriageway/station infrastructure, integration infrastructure with the inclusion of pedestrian bridges and intersection improvement, fare collection and ITS systems, other infrastructure and property acquisition as explained earlier. The annual maintenance cost for the infrastructure was assumed as 5 % of total investment cost, based on past experiences of the Study Team.

Table 9-1-4 shows a summary table of the O& M cost of the BRT system.

Table 9-1-4 Summary of O & M Cost

O & M Cost	Rs million per year
1. Personnel Cost	448.0
2. Vehicle Operation Cost	1,556.0
3. Vehicle Maintenance Cost	188.2
4. Vehicle Insurance Cost	102.0
5. Other Administrative Cost	91.8
6. Maintenance Cost of Infrastructure	400.7
Total	2,786.7

Source: JICA Study Team

9.2 Financial Analysis

9.2.1 Overview

(1) Objectives of the financial planning

The objective of the financial planning is to obtain feasible options for the implementation of the BRT project by evaluating financial feasibility of the project under various potential options, which could be applied by changing conditions such as magnitude of equity investment, government subsidy, fare levels and so on.

The BRT system of Karachi is planned as a public transport service consisting of the KBRTC, two operating companies and a fare collecting company as mentioned in the previous section. In this section, the project feasibility in terms of financial viability was analysed as a whole project, which covers the above all concerned organizations. No company based financial analyses were conducted because scale and responsibility of the potential companies would change as possible scenario changes. However, the Study Team examined realistic assumptions regarding number of employees, number of vehicles, potential operation and maintenance costs and other necessary concerns based on the technical requirements and the structural conditions of the KBRTC.

(2) Assumptions

1) Pricing date

The pricing date of the financial planning was assumed as of December 2011.

2) Foreign exchange rate

Foreign exchange rates in Dec. 2011(average monthly rate) were adopted as below based on "Statistical Bulletin – February 2012" by the State Bank of Pakistan.

US$1.00 = Rs89.340

JPY1.00 = Rs1.148

3) Project life

Thirty (30) years of the project life after the opening of the BRT system to the public was adopted for the evaluation. The project life was determined according to the repayment schedule of the expected foreign loan.

4) Construction period and the opening year

As mentioned in the Chapter 5, the L/A is assumed to be signed in 2013. After detail design/ tendering process and three-year construction period, the BRT system will be completed in the end of 2019. Since the BRT system is a completely new system to Karachi and highly trained stuffs are crucial to operate the system safely, the opening time of the system was assumed as in the middle of 2020, which is after six month training period of the completion to secure reliable and safe operation of the system.

5) Ridership

Ridership of the BRT system was estimated as 700,000 per day by the Study Team. Although the number is a bit bigger than the system transport capacity, the Study Team considered the number as realistic. The ridership is assumed to stay same level during the project life period.

9.2.2 Capital Cost

(1) Initial investment cost

The total initial investment cost is estimated as Rs 17,234 million, which includes the training cost (Rs 80 million: refer to 10.6 Capacity Development Programme) for the staffs of the BRT companies. Pure project cost is estimated as Rs 17,154 million as summarized in Table 9-2-1.

The cost is shown in 2011 constant price[1].

Table 9-2-1 Initial Investment Cost of the BRT System

(Unit: Rs million in 2011 constant price)

Item		FC	LC	Total
A. ELIGIBLE PORTION				
I	Procurement / Construction	4,120	8,911	13,031
	Civil Works	0	6,531	6,531
	Facilities	373	82	455
	Depot & Workshop	472	556	1,028
	Vehicle	3,079	1,318	4,397
	Physical contingency	196	424	621
II	Consulting services	369	500	869
	Base cost	351	476	827
	Physical contingency	17	24	41
Total (I + II)		4,489	9,410	13,900
B. NON ELIGIBLE PORTION				
a	Administration cost	0	695	695
b	VAT	0	2,335	2,335
c	Import Tax	0	224	224
Total (a+b+c)		0	3,255	3,255
TOTAL (A+B)		4,489	12,665	17,154

Source: JICA Study Team

(2) Additional investment cost

No additional investment cost was appropriated, because number of passengers is estimated same as the opening year during the project life period.

(3) Re-investment cost

Table 9-2-2 shows the useful lives of the invested assets for the BRT project.

Table 9-2-2 Useful Life by Asset

Depreciable Asset	Years
Carriageway (at grade)	50
Carriageway (viaduct)	50
Pedestrian Bridge (concrete/steel)	50
Station and Station Building	50
Office Building	50
Machinery (workshop machinery)	15
Bus Vehicle	10

Source: JICA Study Team

Invested assets, which have less useful life than 30 years of the project life, should be re-invested before the useful life is expired. Machinery and BRT bus vehicles are re-invested as shown in Table 9-2-3. The costs in the table are converted by 1.38261 against the original investment cost to include physical contingency, consulting services, VAT, administration and import tax to the re-investment cost.

[1] This project cost excludes the price escalation for the purpose of the financial analysis. The project cost including the price escalation is shown in Table 10-2-5, 10-2-6, and 10-2-7.

Table 9-2-3 Re-investment Cost by Year

(Unit: Rs million)

Asset	10 Years after Opening			15 Years after Opening			20 Years after Opening		
	FC	LC	Total	FC	LC	Total	FC	LC	Total
Facilities	-	-	-	515.7	113.1	628.8	-	-	-
Equipment at Depot	-	-	-	652.6	221.5	874.1	-	-	-
BRT Vehicle	4,257.2	1,821.6	6,078.8	-	-	-	4,257.2	1,821.6	6,078.8
Total	4,257.2	1,821.6	6,078.8	1,168.3	334.6	1,502.9	4,257.2	1,821.6	6,078.8

Note: Opening year is assumed as 2020 in the cost estimates.
Source: JICA Study Team

(4) Residual value

Thirty year period of the project life is defined only for the financial analysis. The BRT system lasts even after the period. Therefore, the remained value of the invested assets, which have longer useful lives than the project life, is appropriated as residual value at the last year of the project life. The residual value of the project is calculated as Rs 3,831.0 million, which is the sum of assets with 50 years useful life in Table 9-2-2.

9.2.3 Depreciation

Depreciation cost was appropriated according to the useful life table in Table 9-2-2. The cost is shown in Table 9-2-4 by asset.

Table 9-2-4 Depreciation Cost by Asset

Asset	Rs million per year
1. Civil Works	180.6
2. Facilities	41.9
3. Depot & Workshop	
Equipment	58.3
Civil Works	11.0
4. Vehicle	607.9
Total	899.6

Source: JICA Study Team

9.2.4 Revenue

(1) Fare Revenue

Fare system was assumed as a flat system. The BRT passengers are expected to pay Rs 20 per ride. Number of passenger is estimated as 700,000 per day as mentioned earlier. Therefore, fare revenue of the BRT system is expected to reach to Rs 4,340.0 million per year. The fare revenue stays at the same level during the project life because the number of passengers is nearly full capacity of the BRT system.

(2) Other Revenue

Currently, CDGK is running CNG buses as the CNG Bus Pilot Project. Buses are carrying ads all over their exteriors. Revenue by the ads is Rs 25,000 per vehicle per month according to officers at the depot. Total number of vehicles is planned as 425. Expected revenue will be more than Rs 127.5 million per year. Advertising revenue is also expected at bus stops. There is no information on the revenue at bus stops so far. Therefore, the Study Team assumed that other revenue would be 5% of the fare revenue in total, referring to the existing BRT companies reports.

9.2.5 Cash Flow Analysis

Two types of cash flow analysis were conducted. One is Base Case, where no price escalation was considered, while the other is Price Escalation Case, where prices were assumed to increase by 1.6 % and 4.4 % per annum for foreign currency portion and local currency portion, respectively.

(1) Base Case

The calculation sheets are shown in Table 9-2-5 – 9-2-6. The conditions of the calculation and the major indices are shown below.

Case:	Base Case	Pricing Year	2011		
Construction Cost Change	1.00	Government Subsidy (%)		Long Term Loan	
Revenue Change	1.00	Infration (%)		Interest Rate (%) for the Loan	1.4
Equity	0.20	Foreign	0.0	for Consultant Fee	0.01
Other Revenue	0.05	Local	0.0	Total Period (years)	30
				Grace Period (years)	10
Net Present Value (Rp.million)	-2,881.3	Corporate Tax (%)	35.0	Short Term Loan	
Hurdle Rate (%)	14.0			Interest Rate (%)	14.0
FIRR (%)	5.4	ROE(%)	24.7	Period (year)	1

1) Financial Internal Rate of Return (FIRR)

The FIRR of the project was calculated as 5.4%. The FIRR is positive, but the rate is considered low compared to the hurdle rate of Pakistan, which is setup as 14.0% referring to the current prevailing interest rate in the country. However, the FIRR of ROE (Return on Equity) showed an attractive value of 24.8%. It is considered that the foreign soft loan contributed to the high value considerably.

2) Profit and Loss

Regarding the profit and loss, the project shows a very good performance. The BRT system appropriates operating profit from the next year of the commercial operation, except for the first year of year 9, when the training program takes place for 6 month and the revenue operation is assumed only six months.

3) Cash Flow & Net Cash Flow

The cash flow also shows a stable situation, although some negative values are seen for the years when re-investments are required.

The net cash flow, which shows the actual cash reserve of the project, exhibits good performance as well, except for the year of year 9 when the training scheme takes place. The project needs some extra cash of Rs 83.1 million through the domestic monetary market at a very high interest rate. However, as the accumulated net cash flow shows, cash reserve of the project is affordable to pay for the huge re-investments in future years. The future cash reserve is considered sufficient.

4) Other Indicators

The Debt Service Coverage Ratio (DSCR) indicates affordability of interest payment and repayment of the principal. The indicator shows high enough value through the project life, except for the years of the re-investment. Affordability of the project seems high enough.

The operating ratio indicates profitability of the project, by calculating ratio of sum of O & M cost and depreciation cost against the operating revenue. If the value is less than 100, the project is considered profitable.

5) Sensitivity Tests

Sensitivity tests were conducted in terms of the cost overrun by 20% and the reduction of demand by 20%.

Reduction of demand case showed critical results. The operating profit of the project becomes negative through the project life years continuously. The FIRR shows a negative

value. The BRT system would never produce operating profit in any future years. The project would be financed by the depreciation cost. It means that the future re-investment would be impossible. In fact, the net cash flow shows a negative value in year 9, the first year of the BRT opening. The project would depend on the short term loan in the domestic market with the high interest rate. The project would not be sustainable forever, if the government will not subsidize the KBRTC.

A case of the cost overrun by 20% also means the end of the project. Although the project generates operating profit during the whole project life, the cash shortage also needs to be financed by borrowing money from the domestic monetary market. It means the project would pay a huge amount of interest for the short term loan. The short term loan balance starts to increase from the first year of the project to cancel the overrun. The project would not be feasible without some measures such as government subsidy to the interest payment for the short term loan.

The Study Team examined a case where the foreign soft loan were given to the increased investment cost in the above cost overrun case, The shortage of cash was improved remarkably in the short term. However, re-investment cost of the BRT vehicle in year 28 cancelled the positive cash flow. The short term loan increases every year continuously to the end of the project life. Some measures should be taken to sustain the BRT operation.

(2) Price Escalation Case

In this price escalation case, it was assumed that price escalation rates for foreign and local currency portions were applied not only to necessary costs but also to revenue of the BRT system. Therefore, following cost/revenue items are different from the Base Case.

- Revenue: increases as the same rate of the price escalation rate of the local portion.
- Initial investment cost, re-investment cost, operation and maintenance cost: increases by separate price escalation rates for foreign and local currency portion.
- Depreciation cost: appropriated based on the prices of purchased year. Therefore, the depreciation cost increases after the re-investment.

The calculation sheets are shown in Table 9-2-7 – 9-2-8. The conditions of the calculation and the major indices are shown below.

Case:	Price Escalation	Pricing Year	2011		
Construction Cost Change	1.00	Government Subsidy (%)		Long Term Loan	
Revenue Change	1.00	Infration (%)		Interest Rate (%) for the Loan	1.4
Equity	0.20	Foreign	1.6	for Consultant Fee	0.01
Other Revenue	0.05	Local	4.4	Total Period (years)	30
				Grace Period (years)	10
Net Present Value (Rp.million)	-	Corporate Tax (%)	35.0	Short Term Loan	
Hurdle Rate (%)	14.0			Interest Rate (%)	14.0
FIRR (%)	14.3	ROE(%)	38.4	Period (year)	1

1) Financial Internal Rate of Return (FIRR)

The FIRR of the project was calculated as 14.3% in the price escalation case for reference. The calculated rate exceeded the hurdle rate of 14.0%. However, it should be noted that the value changes as the assumed inflation rate changes. So, it is considered that the FIRR of the constant price case should be referred to evaluate the investment profitability with other projects.

2) Profit and Loss

Regarding the profit and loss, the project shows a very good performance. The BRT system appropriates operating profit from the next year of the commercial operation, except for the first year of year 9, when the training program takes place for 6 month and the revenue operation is assumed only six months as same as the Base Case. The operating profit increases year by year because the fare revenue increases every year by the assumed inflation rate.

3) Cash Flow & Net Cash Flow

The cash flow also shows a stable situation, although some negative values are seen for the years when re-investments are required as same as the Base Case.

The net cash flow, which shows the actual cash reserve of the project, exhibits good performance as well, except for the year of year 9 when the training scheme takes place. The project needs some extra cash of Rs 194.4 million through the domestic monetary market at a very high interest rate. However, as the accumulated net cash flow shows, cash reserve of the project is affordable to pay for the huge re-investments in future years. The future cash reserve is considered sufficient.

4) Other Indicators

The Debt Service Coverage Ratio (DSCR) indicates affordability of interest payment and repayment of the principal. The indicator shows high enough value through the project life, except for the years of the re-investment. Affordability of the project seems high enough. The indicator showed better values than the Base Case.

The operating ratio indicates profitability of the project, by calculating ratio of sum of O & M cost and depreciation cost against the operating revenue. If the value is less than 100, the project is considered profitable. This value was also better than the Base Case.

5) Sensitivity Tests

Sensitivity tests were conducted in terms of the cost overrun by 20% and the reduction of demand by 20%.

Reduction of demand case did not showed critical results which is completely different from the Base Case. The operating profit of the project becomes negative only the first year of operation. The accumulated deficit turns to positive in year 14. The net cash flow also showed positive during all the project life years, except for the re-investment years.

A case of the cost overrun by 20%, however, means the end of the project as same as the Base Case. Although the project generates operating profit during the whole project life, the cash shortage also needs to be financed by borrowing money from the domestic monetary market. It means the project would pay a huge amount of interest for the short term loan. The short term loan balance starts to increase from the first year of the project to cancel the overrun. The project would not be feasible without some measures such as government subsidy to the interest payment for the short term loan.

The Study Team examined a case where the foreign soft loan were given to the increased investment cost in the above cost overrun case as same as the Base Case, The shortage of cash was improved remarkably and the improvement continues to the end of the project life. This is different from the Base Case. The soft foreign loan is considered a key to cancel the cost overrun.

9.2.6 Conclusion of the Financial Analysis

The Study Team concludes the BRT system project is financially viable. However, it should be clearly noted that the likely cost overrun and the reduction of demand would destroy the feasibility of the project. Cost overrun should be restrained and any demand increase strategies should be executed by every conceivable means. In addition to the above, a countermeasure to the cost overrun by the foreign soft loan is considered very effective. This kind of countermeasures should be arranged properly to run the BRT system project successfully.

Table 9-2-5 Proforma Cash Flow Statement of Base Case (1)

Item \ Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Profit & Loss																			
Operating Revenue							2,170.0	4,340.0	4,340.0	4,340.0	4,340.0	4,340.0	4,340.0	4,340.0	4,340.0	4,340.0	4,340.0	4,340.0	4,340.0
Operation & Maintenance							2,786.8	2,786.8	2,786.8	2,786.8	2,786.8	2,786.8	2,786.8	2,786.8	2,786.8	2,786.8	2,786.8	2,786.8	2,786.8
Depreciation							899.6	899.6	899.6	899.6	899.6	899.6	899.6	899.6	899.6	899.6	899.6	899.6	899.6
Operating Profit							-1,516.4	653.6	653.6	653.6	653.6	653.6	653.6	653.6	653.6	653.6	653.6	653.6	653.6
Other Revenue							108.5	217.0	217.0	217.0	217.0	217.0	217.0	217.0	217.0	217.0	217.0	217.0	217.0
Government Subsidy																			
Interest Expense	0.0	0.0	0.0	0.0	0.0	0.0	187.6	208.3	187.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Short Term Loan	0.0	0.0	0.0	0.0	0.0	0.0	0.0	20.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Long Term Loan	0.0	0.0	0.0	0.0	0.0	0.0	187.6	187.6	187.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Net Profit	0.0	0.0	0.0	0.0	0.0	0.0	-1,595.6	662.3	682.9	870.6	870.6	870.6	870.6	870.6	870.6	870.6	870.6	870.6	870.6
Corporate Tax	0.0	0.0	0.0	0.0	0.0	0.0	0.0	231.8	239.0	304.7	304.7	304.7	304.7	304.7	304.7	304.7	304.7	304.7	304.7
Profit After Tax	0.0	0.0	0.0	0.0	0.0	0.0	-1,595.6	430.5	443.9	565.9	565.9	565.9	565.9	565.9	565.9	565.9	565.9	565.9	565.9
Accumulated Profit	0.0	0.0	0.0	0.0	0.0	0.0	-1,595.6	-1,165.1	-721.2	-155.3	410.6	976.5	1,542.3	2,108.2	2,674.1	3,240.0	3,805.8	4,371.7	4,937.6
Financial Cash Flow																			
Cash In	0.0	0.0	0.0	0.0	0.0	0.0	-508.3	1,770.2	1,770.2	1,770.2	1,770.2	1,770.2	1,770.2	1,770.2	1,770.2	1,770.2	1,770.2	1,770.2	1,770.2
Operating Profit			0.0	0.0	0.0	0.0	-1,516.4	653.6	653.6	653.6	653.6	653.6	653.6	653.6	653.6	653.6	653.6	653.6	653.6
Other Revenue			0.0	0.0	0.0	0.0	108.5	217.0	217.0	217.0	217.0	217.0	217.0	217.0	217.0	217.0	217.0	217.0	217.0
Depreciation			0.0	0.0	0.0	0.0	899.6	899.6	899.6	899.6	899.6	899.6	899.6	899.6	899.6	899.6	899.6	899.6	899.6
Cash Out	235.0	337.0	109.0	5,318.0	5,580.0	5,655.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6,078.8	0.0	0.0	0.0
Investment	235.0	337.0	109.0	5,318.0	5,580.0	5,655.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6,078.8	0.0	0.0	0.0
Initial Investment	235.0	337.0	109.0	5,318.0	5,580.0	5,655.4													
Re-investment																6,078.8			
Additional Investment																			
Residual Value																			
Cash Flow (FIRR: ROE)	-47.0	-67.4	-21.8	-1,063.6	-1,116.0	-1,131.1	-508.3	1,770.2	1,770.2	1,770.2	1,770.2	1,770.2	1,770.2	1,770.2	1,770.2	-4,308.6	1,770.2	1,770.2	1,770.2
Cash Flow (FIRR: ROI)	-235.0	-337.0	-109.0	-5,318.0	-5,580.0	-5,655.4	-508.3	1,770.2	1,770.2	1,770.2	1,770.2	1,770.2	1,770.2	1,770.2	1,770.2	-4,308.6	1,770.2	1,770.2	1,770.2

Item \ Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Financial Program																			
Source	237.0	352.4	124.8	5,448.6	5,772.0	5,848.1	-508.3	1,770.2	1,770.2	1,770.2	1,770.2	1,770.2	1,770.2	1,770.2	1,770.2	1,770.2	1,770.2	1,770.2	1,770.2
Long Term Loan	190.0	285.0	103.0	4,385.0	4,656.0	4,717.0													
Operating Profit	0.0	0.0	0.0	0.0	0.0	0.0	-1,516.4	653.6	653.6	653.6	653.6	653.6	653.6	653.6	653.6	653.6	653.6	653.6	653.6
Depreciation	0.0	0.0	0.0	0.0	0.0	0.0	899.6	899.6	899.6	899.6	899.6	899.6	899.6	899.6	899.6	899.6	899.6	899.6	899.6
Other Revenue	0.0	0.0	0.0	0.0	0.0	0.0	108.5	217.0	217.0	217.0	217.0	217.0	217.0	217.0	217.0	217.0	217.0	217.0	217.0
Government Subsidy	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Equity	47.0	67.4	21.8	1,063.6	1,116.0	1,131.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Use	235.0	337.0	109.0	5,318.0	5,580.0	5,655.4	187.6	587.5	426.7	1,104.6	1,104.6	1,104.6	1,104.6	1,104.6	1,104.6	7,183.4	1,104.6	1,104.6	1,104.6
Investment	235.0	337.0	109.0	5,318.0	5,580.0	5,655.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6,078.8	0.0	0.0	0.0
Principal Repayment	0.0	0.0	0.0	0.0	0.0	0.0	0.0	147.5	0.0	799.9	799.9	799.9	799.9	799.9	799.9	799.9	799.9	799.9	799.9
Long Term	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	799.9	799.9	799.9	799.9	799.9	799.9	799.9	799.9	799.9	799.9
Short Term	0.0	0.0	0.0	0.0	0.0	0.0	0.0	147.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Interest Expense	0.0	0.0	0.0	0.0	0.0	0.0	187.6	208.3	187.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Long Term	0.0	0.0	0.0	0.0	0.0	0.0	187.6	187.6	187.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Short Term	0.0	0.0	0.0	0.0	0.0	0.0	0.0	20.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Corporate Tax	0.0	0.0	0.0	0.0	0.0	0.0	0.0	231.8	239.0	304.7	304.7	304.7	304.7	304.7	304.7	304.7	304.7	304.7	304.7
Net Cash Flow	2.0	15.4	15.8	130.6	192.0	192.7	-695.9	1,182.7	1,343.5	665.6	665.6	665.6	665.6	665.6	665.6	-5,413.2	665.6	665.6	665.6
Accumulated Net Cash Flow	2.0	17.4	33.2	163.8	355.8	548.5	-147.5	1,035.2	2,378.7	3,044.3	3,710.0	4,375.6	5,041.2	5,706.8	6,372.4	959.2	1,624.8	2,290.5	2,956.1
Short Term Loan		0.0	0.0	0.0	0.0	0.0	147.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cash Flow in Present Value	-139.1	-175.0	-49.7	-2,125.3	-1,956.1	-1,739.1	-137.1	418.9	367.4	322.3	282.7	248.0	217.5	190.8	167.4	-357.4	128.8	113.0	99.1
DSCR							-2.71	4.98	9.43	2.21	2.21	2.21	2.21	2.21	2.21	-5.39	2.21	2.21	2.21
Operating Ratio							169.9	84.9	84.9	84.9	84.9	84.9	84.9	84.9	84.9	84.9	84.9	84.9	84.9

Source: JICA Study Team (The first year is assumed as 2014 in the cost estimates)

Table 9-2-6 Proforma Cash Flow Statement of Base Case (2)

Item \ Year	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	Total
Profit & Loss																		
Operating Revenue	4,340.0	4,340.0	4,340.0	4,340.0	4,340.0	4,340.0	4,340.0	4,340.0	4,340.0	4,340.0	4,340.0	4,340.0	4,340.0	4,340.0	4,340.0	4,340.0	4,340.0	128,030.0
Operation & Maintenance	2,786.8	2,786.8	2,786.8	2,786.8	2,786.8	2,786.8	2,786.8	2,786.8	2,786.8	2,786.8	2,786.8	2,786.8	2,786.8	2,786.8	2,786.8	2,786.8	2,786.8	83,604.0
Depreciation	899.6	899.6	899.6	899.6	899.6	899.6	899.6	899.6	899.6	899.6	899.6	899.6	899.6	899.6	899.6	899.6	899.6	26,988.8
Operating Profit	653.6	653.6	653.6	653.6	653.6	653.6	653.6	653.6	653.6	653.6	653.6	653.6	653.6	653.6	653.6	653.6	653.6	17,437.2
Other Revenue	217.0	217.0	217.0	217.0	217.0	217.0	217.0	217.0	217.0	217.0	217.0	217.0	217.0	217.0	217.0	217.0	217.0	6,401.5
Government Subsidy																		
Interest Expense	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	583.6
Short Term Loan	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	20.6
Long Term Loan	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	562.9
Net Profit	870.6	870.6	870.6	870.6	870.6	870.6	870.6	870.6	870.6	870.6	870.6	870.6	870.6	870.6	870.6	870.6	870.6	23,255.2
Corporate Tax	304.7	304.7	304.7	304.7	304.7	304.7	304.7	304.7	304.7	304.7	304.7	304.7	304.7	304.7	304.7	304.7	304.7	8,697.8
Profit After Tax	565.9	565.9	565.9	565.9	565.9	565.9	565.9	565.9	565.9	565.9	565.9	565.9	565.9	565.9	565.9	565.9	565.9	14,557.4
Accumulated Profit	5,503.4	6,069.3	6,635.2	7,201.1	7,766.9	8,332.8	8,898.7	9,464.6	10,030.4	10,596.3	11,162.2	11,728.1	12,293.9	12,859.8	13,425.7	13,991.5	14,557.4	190,947.0
Financial Cash Flow																		
Cash In	1,770.2	1,770.2	1,770.2	1,770.2	1,770.2	1,770.2	1,770.2	1,770.2	1,770.2	1,770.2	1,770.2	1,770.2	1,770.2	1,770.2	1,770.2	1,770.2	1,770.2	50,827.5
Operating Profit	653.6	653.6	653.6	653.6	653.6	653.6	653.6	653.6	653.6	653.6	653.6	653.6	653.6	653.6	653.6	653.6	653.6	17,437.2
Other Revenue	217.0	217.0	217.0	217.0	217.0	217.0	217.0	217.0	217.0	217.0	217.0	217.0	217.0	217.0	217.0	217.0	217.0	6,401.5
Depreciation	899.6	899.6	899.6	899.6	899.6	899.6	899.6	899.6	899.6	899.6	899.6	899.6	899.6	899.6	899.6	899.6	899.6	26,988.8
Cash Out	0.0	1,502.9	0.0	0.0	0.0	0.0	6,078.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-3,831.0	27,063.9
Investment	0.0	1,502.9	0.0	0.0	0.0	0.0	6,078.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	30,894.9
Initial Investment																		17,234.4
Re-investment		1,502.9					6,078.8											13,660.5
Additional Investment																		0.0
Residual Value																	3,831.0	3,831.0
Cash Flow (FIRR: ROE)	1,770.2	267.3	1,770.2	1,770.2	1,770.2	1,770.2	-4,308.6	1,770.2	1,770.2	1,770.2	1,770.2	1,770.2	1,770.2	1,770.2	1,770.2	1,770.2	5,601.2	37,551.1
Cash Flow (FIRR: ROI)	1,770.2	267.3	1,770.2	1,770.2	1,770.2	1,770.2	-4,308.6	1,770.2	1,770.2	1,770.2	1,770.2	1,770.2	1,770.2	1,770.2	1,770.2	1,770.2	5,601.2	23,763.6

Item \ Year	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	Total
Financial Program																		
Source	1,770.2	1,770.2	1,770.2	1,770.2	1,770.2	1,770.2	1,770.2	1,770.2	1,770.2	1,770.2	1,770.2	1,770.2	1,770.2	1,770.2	1,770.2	1,770.2	1,770.2	68,610.4
Long Term Loan																		14,336.0
Operating Profit	653.6	653.6	653.6	653.6	653.6	653.6	653.6	653.6	653.6	653.6	653.6	653.6	653.6	653.6	653.6	653.6	653.6	17,437.2
Depreciation	899.6	899.6	899.6	899.6	899.6	899.6	899.6	899.6	899.6	899.6	899.6	899.6	899.6	899.6	899.6	899.6	899.6	26,988.8
Other Revenue	217.0	217.0	217.0	217.0	217.0	217.0	217.0	217.0	217.0	217.0	217.0	217.0	217.0	217.0	217.0	217.0	217.0	6,401.5
Government Subsidy	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Equity	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3,446.9
Use	1,104.6	2,607.5	1,104.6	1,104.6	1,104.6	1,104.6	7,183.4	1,104.6	1,104.6	1,104.6	704.6	304.7	304.7	304.7	304.7	304.7	304.7	56,721.3
Investment	0.0	1,502.9	0.0	0.0	0.0	0.0	6,078.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	30,894.9
Principal Repayment	799.9	799.9	799.9	799.9	799.9	799.9	799.9	799.9	799.9	799.9	399.9	0.0	0.0	0.0	0.0	0.0	0.0	16,545.1
Long Term	799.9	799.9	799.9	799.9	799.9	799.9	799.9	799.9	799.9	799.9	399.9	0.0	0.0	0.0	0.0	0.0	0.0	16,397.7
Short Term	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	147.5
Interest Expense	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	583.6
Long Term	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	562.9
Short Term	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	20.6
Corporate Tax	304.7	304.7	304.7	304.7	304.7	304.7	304.7	304.7	304.7	304.7	304.7	304.7	304.7	304.7	304.7	304.7	304.7	8,697.8
Net Cash Flow	665.6	-837.3	665.6	665.6	665.6	665.6	-5,413.2	665.6	665.6	665.6	1,065.6	1,465.5	1,465.5	1,465.5	1,465.5	1,465.5	1,465.5	11,889.1
Accumulated Net Cash Flow	3,621.7	2,784.4	3,450.0	4,115.6	4,781.2	5,446.8	33.7	699.3	1,364.9	2,030.5	3,096.1	4,561.6	6,027.1	7,492.6	8,958.1	10,423.6	11,889.1	
Short Term Loan	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Cash Flow in Present Value	86.9	11.5	66.9	58.7	51.5	45.2	-96.4	34.7	30.5	26.7	23.5	20.6	18.0	15.8	13.9	12.2	33.8	-3,668.9
DSCR	2.21	0.33	2.21	2.21	2.21	2.21	-5.39	2.21	2.21	2.21	4.43	-	-	-	-	-	-	
Operating Ratio	84.9	84.9	84.9	84.9	84.9	84.9	84.9	84.9	84.9	84.9	84.9	84.9	84.9	84.9	84.9	84.9	84.9	

Source: JICA Study Team (The first year is assumed as 2014 in the cost estimates)

Table 9-2-7 Proforma Cash Flow Statement of Price Escalation Case (1)

Item \ Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Profit & Loss																			
Operating Revenue							3,062.4	6,394.3	6,675.7	6,969.4	7,276.1	7,596.2	7,930.4	8,279.4	8,643.7	9,024.0	9,421.0	9,835.6	10,268.3
Operation & Maintenance							3,451.7	3,548.1	3,647.9	3,751.2	3,858.1	3,968.7	4,083.3	4,202.0	4,324.9	4,452.2	4,584.2	4,720.9	4,862.6
Depreciation							1,130.7	1,130.7	1,130.7	1,130.7	1,130.7	1,130.7	1,130.7	1,130.7	1,130.7	1,326.6	1,326.6	1,326.6	1,326.6
Operating Profit							-1,520.0	1,715.5	1,897.1	2,087.5	2,287.3	2,496.8	2,716.4	2,946.7	3,188.1	3,245.1	3,510.3	3,788.1	4,079.2
Other Revenue							153.1	319.7	333.8	348.5	363.8	379.8	396.5	414.0	432.2	451.2	471.1	491.8	513.4
Government Subsidy																			
Interest Expense	0.0	0.0	0.0	0.0	0.0	0.0	230.7	258.0	230.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Short Term Loan	0.0	0.0	0.0	0.0	0.0	0.0	0.0	27.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Long Term Loan	0.0	0.0	0.0	0.0	0.0	0.0	230.7	230.7	230.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Net Profit	0.0	0.0	0.0	0.0	0.0	0.0	-1,597.6	1,777.3	2,000.1	2,436.0	2,651.1	2,876.6	3,112.9	3,360.7	3,620.3	3,696.3	3,981.3	4,279.9	4,592.6
Corporate Tax	0.0	0.0	0.0	0.0	0.0	0.0	0.0	622.0	700.0	852.6	927.9	1,006.8	1,089.5	1,176.2	1,267.1	1,293.7	1,393.5	1,498.0	1,607.4
Profit After Tax	0.0	0.0	0.0	0.0	0.0	0.0	-1,597.6	1,155.2	1,300.1	1,583.4	1,723.2	1,869.8	2,023.4	2,184.4	2,353.2	2,402.6	2,587.9	2,781.9	2,985.2
Accumulated Profit	0.0	0.0	0.0	0.0	0.0	0.0	-1,597.6	-442.4	857.7	2,441.1	4,164.3	6,034.1	8,057.5	10,242.0	12,595.1	14,997.8	17,585.6	20,367.5	23,352.7
Financial Cash Flow																			
Cash In	0.0	0.0	0.0	0.0	0.0	0.0	-236.2	3,165.9	3,361.5	3,566.7	3,781.8	4,007.3	4,243.6	4,491.3	4,750.9	5,022.9	5,307.9	5,606.5	5,919.2
Operating Profit			0.0	0.0	0.0	0.0	-1,520.0	1,715.5	1,897.1	2,087.5	2,287.3	2,496.8	2,716.4	2,946.7	3,188.1	3,245.1	3,510.3	3,788.1	4,079.2
Other Revenue			0.0	0.0	0.0	0.0	153.1	319.7	333.8	348.5	363.8	379.8	396.5	414.0	432.2	451.2	471.1	491.8	513.4
Depreciation			0.0	0.0	0.0	0.0	1,130.7	1,130.7	1,130.7	1,130.7	1,130.7	1,130.7	1,130.7	1,130.7	1,130.7	1,326.6	1,326.6	1,326.6	1,326.6
Cash Out	250.0	385.0	144.0	6,399.0	7,005.0	7,408.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9,363.5	0.0	0.0	0.0
Investment	250.0	385.0	144.0	6,399.0	7,005.0	7,408.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9,363.5	0.0	0.0	0.0
Initial Investment	250.0	385.0	144.0	6,399.0	7,005.0	7,408.8													
Re-investment																9,363.5			
Additional Investment																			
Residual Value																			
Cash Flow (FIRR: ROE)	-50.0	-77.0	-28.8	-1,279.8	-1,401.0	-1,481.8	-236.2	3,165.9	3,361.5	3,566.7	3,781.8	4,007.3	4,243.6	4,491.3	4,750.9	-4,340.6	5,307.9	5,606.5	5,919.2
Cash Flow (FIRR: ROI)	-250.0	-385.0	-144.0	-6,399.0	-7,005.0	-7,408.8	-236.2	3,165.9	3,361.5	3,566.7	3,781.8	4,007.3	4,243.6	4,491.3	4,750.9	-4,340.6	5,307.9	5,606.5	5,919.2

Item \ Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Financial Program																			
Source	252.0	390.0	148.8	6,489.8	7,116.0	7,467.8	-236.2	3,165.9	3,361.5	3,566.7	3,781.8	4,007.3	4,243.6	4,491.3	4,750.9	5,022.9	5,307.9	5,606.5	5,919.2
Long Term Loan	202.0	313.0	120.0	5,210.0	5,715.0	5,986.0													
Operating Profit	0.0	0.0	0.0	0.0	0.0	0.0	-1,520.0	1,715.5	1,897.1	2,087.5	2,287.3	2,496.8	2,716.4	2,946.7	3,188.1	3,245.1	3,510.3	3,788.1	4,079.2
Depreciation	0.0	0.0	0.0	0.0	0.0	0.0	1,130.7	1,130.7	1,130.7	1,130.7	1,130.7	1,130.7	1,130.7	1,130.7	1,130.7	1,326.6	1,326.6	1,326.6	1,326.6
Other Revenue	0.0	0.0	0.0	0.0	0.0	0.0	153.1	319.7	333.8	348.5	363.8	379.8	396.5	414.0	432.2	451.2	471.1	491.8	513.4
Government Subsidy	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Equity	50.0	77.0	28.8	1,279.8	1,401.0	1,481.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Use	250.0	385.0	144.0	6,399.0	7,005.0	7,408.8	230.7	1,074.4	930.8	1,832.2	1,907.5	1,986.4	2,069.1	2,155.8	2,246.7	11,636.8	2,373.0	2,477.5	2,587.0
Investment	250.0	385.0	144.0	6,399.0	7,005.0	7,408.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9,363.5	0.0	0.0	0.0
Principal Repayment	0.0	0.0	0.0	0.0	0.0	0.0	0.0	194.4	0.0	979.6	979.6	979.6	979.6	979.6	979.6	979.6	979.6	979.6	979.6
Long Term	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	979.6	979.6	979.6	979.6	979.6	979.6	979.6	979.6	979.6	979.6
Short Term	0.0	0.0	0.0	0.0	0.0	0.0	0.0	194.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Interest Expense	0.0	0.0	0.0	0.0	0.0	0.0	230.7	258.0	230.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Long Term	0.0	0.0	0.0	0.0	0.0	0.0	230.7	230.7	230.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Short Term	0.0	0.0	0.0	0.0	0.0	0.0	0.0	27.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Corporate Tax	0.0	0.0	0.0	0.0	0.0	0.0	0.0	622.0	700.0	852.6	927.9	1,006.8	1,089.5	1,176.2	1,267.1	1,293.7	1,393.5	1,498.0	1,607.4
Net Cash Flow	2.0	5.0	4.8	90.8	111.0	58.9	-466.9	2,091.5	2,430.8	1,734.5	1,874.3	2,020.9	2,174.5	2,335.5	2,504.3	-6,613.9	2,934.9	3,128.9	3,332.2
Accumulated Net Cash Flow	2.0	7.0	11.8	102.6	213.6	272.5	-194.4	1,897.1	4,327.9	6,062.4	7,936.7	9,957.6	12,132.1	14,467.6	16,971.9	10,358.0	13,292.9	16,421.8	19,754.0
Short Term Loan		0.0	0.0	0.0	0.0	0.0	194.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cash Flow in Present Value	-148.0	-200.0	-65.6	-2,557.3	-2,455.7	-2,278.3	-63.7	749.1	697.7	649.4	604.0	561.4	521.5	484.2	449.3	-360.0	386.2	357.8	331.4
DSCR							-1.02	7.00	14.57	3.64	3.86	4.09	4.33	4.58	4.85	-4.43	5.42	5.72	6.04
Operating Ratio							149.6	73.2	71.6	70.0	68.6	67.1	65.7	64.4	63.1	64.0	62.7	61.5	60.3

Source: JICA Study Team (The first year is assumed as 2014 in the cost estimates)

Table 9-2-8 Proforma Cash Flow Statement of Price Escalation Case (2)

Item \ Year	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	Total
Profit & Loss																		
Operating Revenue	10,720.1	11,191.8	11,684.3	12,198.4	12,735.1	13,295.4	13,880.4	14,491.2	15,128.8	15,794.5	16,489.4	17,214.9	17,972.4	18,763.2	19,588.8	20,450.7	21,350.5	364,326.3
Operation & Maintenance	5,009.4	5,161.7	5,319.6	5,483.3	5,653.0	5,829.1	6,011.8	6,201.4	6,398.1	6,602.2	6,814.0	7,034.0	7,262.3	7,499.4	7,745.6	8,001.2	8,266.8	163,748.6
Depreciation	1,326.6	1,374.6	1,374.6	1,374.6	1,374.6	1,374.6	1,674.4	1,674.4	1,674.4	1,674.4	1,674.4	1,674.4	1,674.4	1,674.4	1,674.4	1,674.4	1,674.4	42,100.6
Operating Profit	4,384.1	4,655.5	4,990.1	5,340.5	5,707.4	6,091.7	6,194.2	6,615.4	7,056.3	7,517.9	8,001.0	8,506.6	9,035.7	9,589.4	10,168.8	10,775.0	11,409.3	158,477.0
Other Revenue	536.0	559.6	584.2	609.9	636.8	664.8	694.0	724.6	756.4	789.7	824.5	860.7	898.6	938.2	979.4	1,022.5	1,067.5	18,216.3
Government Subsidy																		
Interest Expense	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	719.4
Short Term Loan	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	27.2
Long Term Loan	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	692.2
Net Profit	4,920.1	5,215.1	5,574.3	5,950.4	6,344.2	6,756.4	6,888.2	7,340.0	7,812.8	8,307.6	8,825.4	9,367.3	9,934.3	10,527.6	11,148.3	11,797.6	12,476.8	175,973.9
Corporate Tax	1,722.0	1,825.3	1,951.0	2,082.6	2,220.5	2,364.8	2,410.9	2,569.0	2,734.5	2,907.7	3,088.9	3,278.6	3,477.0	3,684.7	3,901.9	4,129.2	4,366.9	62,150.0
Profit After Tax	3,198.1	3,389.8	3,623.3	3,867.8	4,123.7	4,391.7	4,477.4	4,771.0	5,078.3	5,399.9	5,736.5	6,088.8	6,457.3	6,842.9	7,246.4	7,668.4	8,109.9	113,823.9
Accumulated Profit	26,550.8	29,940.6	33,563.9	37,431.6	41,555.3	45,947.0	50,424.4	55,195.4	60,273.7	65,673.6	71,410.1	77,498.9	83,956.2	90,799.1	98,045.5	105,713.9	113,823.9	1,206,459.4
Financial Cash Flow																		
Cash In	6,246.7	6,589.7	6,948.9	7,325.0	7,718.8	8,131.1	8,562.6	9,014.4	9,487.2	9,982.0	10,499.8	11,041.7	11,608.7	12,202.0	12,822.7	13,472.0	14,151.2	218,794.0
Operating Profit	4,384.1	4,655.5	4,990.1	5,340.5	5,707.4	6,091.7	6,194.2	6,615.4	7,056.3	7,517.9	8,001.0	8,506.6	9,035.7	9,589.4	10,168.8	10,775.0	11,409.3	158,477.0
Other Revenue	536.0	559.6	584.2	609.9	636.8	664.8	694.0	724.6	756.4	789.7	824.5	860.7	898.6	938.2	979.4	1,022.5	1,067.5	18,216.3
Depreciation	1,326.6	1,374.6	1,374.6	1,374.6	1,374.6	1,374.6	1,674.4	1,674.4	1,674.4	1,674.4	1,674.4	1,674.4	1,674.4	1,674.4	1,674.4	1,674.4	1,674.4	42,100.6
Cash Out	0.0	2,519.4	0.0	0.0	0.0	0.0	12,361.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-3,831.0	42,004.9
Investment	0.0	2,519.4	0.0	0.0	0.0	0.0	12,361.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	45,835.9
Initial Investment																		21,591.8
Re-investment		2,519.4					12,361.1											24,244.0
Additional Investment																		0.0
Residual Value																	3,831.0	3,831.0
Cash Flow (FIRR: ROE)	6,246.7	4,070.3	6,948.9	7,325.0	7,718.8	8,131.1	-3,798.4	9,014.4	9,487.2	9,982.0	10,499.8	11,041.7	11,608.7	12,202.0	12,822.7	13,472.0	17,982.2	194,062.6
Cash Flow (FIRR: ROI)	6,246.7	4,070.3	6,948.9	7,325.0	7,718.8	8,131.1	-3,798.4	9,014.4	9,487.2	9,982.0	10,499.8	11,041.7	11,608.7	12,202.0	12,822.7	13,472.0	17,982.2	176,789.1

Item \ Year	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	Total
Financial Program																		
Source	6,246.7	6,589.7	6,948.9	7,325.0	7,718.8	8,131.1	8,562.6	9,014.4	9,487.2	9,982.0	10,499.8	11,041.7	11,608.7	12,202.0	12,822.7	13,472.0	14,151.2	240,658.4
Long Term Loan																		17,546.0
Operating Profit	4,384.1	4,655.5	4,990.1	5,340.5	5,707.4	6,091.7	6,194.2	6,615.4	7,056.3	7,517.9	8,001.0	8,506.6	9,035.7	9,589.4	10,168.8	10,775.0	11,409.3	158,477.0
Depreciation	1,326.6	1,374.6	1,374.6	1,374.6	1,374.6	1,374.6	1,674.4	1,674.4	1,674.4	1,674.4	1,674.4	1,674.4	1,674.4	1,674.4	1,674.4	1,674.4	1,674.4	42,100.6
Other Revenue	536.0	559.6	584.2	609.9	636.8	664.8	694.0	724.6	756.4	789.7	824.5	860.7	898.6	938.2	979.4	1,022.5	1,067.5	18,216.3
Government Subsidy	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Equity	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4,318.4
Use	2,701.6	5,324.3	2,930.6	3,062.2	3,200.0	3,344.3	15,751.5	3,548.6	3,714.0	3,887.2	3,578.7	3,278.6	3,477.0	3,684.7	3,901.9	4,129.2	4,366.9	128,981.0
Investment	0.0	2,519.4	0.0	0.0	0.0	0.0	12,361.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	45,835.9
Principal Repayment	979.6	979.6	979.6	979.6	979.6	979.6	979.6	979.6	979.6	979.6	489.8	0.0	0.0	0.0	0.0	0.0	0.0	20,275.7
Long Term	979.6	979.6	979.6	979.6	979.6	979.6	979.6	979.6	979.6	979.6	489.8	0.0	0.0	0.0	0.0	0.0	0.0	20,081.3
Short Term	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	194.4
Interest Expense	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	719.4
Long Term	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	692.2
Short Term	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	27.2
Corporate Tax	1,722.0	1,825.3	1,951.0	2,082.6	2,220.5	2,364.8	2,410.9	2,569.0	2,734.5	2,907.7	3,088.9	3,278.6	3,477.0	3,684.7	3,901.9	4,129.2	4,366.9	62,150.0
Net Cash Flow	3,545.1	1,265.4	4,018.3	4,262.8	4,518.8	4,786.8	-7,188.9	5,465.8	5,773.1	6,094.8	6,921.2	7,763.2	8,131.7	8,517.3	8,920.8	9,342.8	9,784.3	111,677.3
Accumulated Net Cash Flow	23,299.1	24,564.5	28,582.9	32,845.7	37,364.5	42,151.3	34,962.4	40,428.2	46,201.3	52,296.1	59,217.2	66,980.4	75,112.1	83,629.4	92,550.2	101,893.0	111,677.3	
Short Term Loan	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Cash Flow in Present Value	306.8	175.4	262.6	242.8	224.5	207.4	-85.0	176.9	163.3	150.8	139.1	128.3	118.3	109.1	100.6	92.7	108.5	285.5
DSCR	6.38	4.16	7.09	7.48	7.88	8.30	-3.88	9.20	9.69	10.19	21.44	-	-	-	-	-	-	
Operating Ratio	59.1	58.4	57.3	56.2	55.2	54.2	55.4	54.3	53.4	52.4	51.5	50.6	49.7	48.9	48.1	47.3	46.6	

Source: JICA Study Team (The first year is assumed as 2014 in the cost estimates)

Chapter 10 Implementation Framework

10.1 Institutional Arrangement

10.1.1 Institutional Structure

(1) Basic Concept

BRT is a technology choice to be implemented and managed by an organization that can be a focused specialized agency to a large transport department that oversees all forms of public and private transport systems. These institutions can be either highly autonomous from the local government or closely controlled by elected officials and civil servants. The responsible level of government for a control is, in some instances, by provincial governments or even federal ministries. The institutional oversight of a BRT system can be implemented through existing agencies or a newly created organization. Curitiba, Brazil and TransMilenio, Colombia, are public organizations created by a municipal law while Metrovia of Guayaquil, Ecuador is a NGO. All of these institutions successfully operate their respective BRT systems. Transport for London (TfL) manages the operations of London bus system, London underground system, light rail lines, traffic management and taxi regulation. TfL was created as a Public-Private Partnerships (PPP) company in 1998 in order to secure a long-term investment in London transport infrastructure. Today, there are over 40 institutions in six continents implementing and managing BRT operations. Curitiba and TransMilenio are smaller organizations with focused mandate. They are public corporations reporting to the mayors of their respective cities through their board of directors. These new public transport systems represent a fresh opportunity to establish an effective institutional structure for the entire transport sector. After all, establishment of a sustainable and effective institution for a BRT system is a political process and unlikely to be achieved without political skill of the project sponsor. The quality and safety of Karachi bus services are inferior, and public acceptability of urban transportation will only be achieved if bus services are drastically improved and all other mass transit systems are implemented and operated to an acceptable standard. Furthermore, to facilitate the increasing number of commuters in Karachi a mass transit network consisting of BRT, LRT, Metro and any other modes of public transport systems need to be developed and put in operation within a reasonable time. In designing the institutional structure for a BRT or any other mode of MRT system for Karachi, it is necessary to envision an overall institutional oversight structure. Karachi BRT System is one of the transport agencies to be established under the CDGK overall oversight regulatory structure. The institution, regardless of shapes and forms, must secure required funds for the development and maintenance of infrastructure and vehicle operations, and it is likely that the large portion of these finds come from public sector since private sector funding is difficult. Under the current political and economic environment of Pakistan, it is unlikely that a BRT can be implemented and managed by private sector financing alone under any project financing scheme. To create incentives for the private sector to operate in the public interest GOS and CDGK need to work on the policy decisions by the highest level of public officials and effective regulations. It will take a new form of Public-Private Partnerships in which the public agency (CDGK) takes full responsibility of the construction, regeneration, improvement and maintenance of infrastructure (i.e., dedicated corridors, stations, terminals, depots, pedestrian bridges, etc). GOS has promulgated Sindh Public-Private Partnership Ordinance 2009 aimed at, amongst others, expanding transport infrastructure services and improving their reliability and quality. This legislation provides a legal framework for participation of private entities in public transport development in Karachi.

(2) Establishment of New Institution

After the careful analysis of institutional set up of mass transit administration in Karachi and in consultation with various public and private organizations including Karachi Mass Transit Cell (KMTC), Transport and Communication Department (TCD), Works and Services Department of CDGK and Public-Private Partnerships (PPP), a unit of Finance Department, GOS, a concept for the new institution was developed.

The new institution shall be a public corporation, and its stakeholders will be public sector (51%), and private sector (49%). The new institution will be tentatively called as the "Karachi Bus Rapid Transit Corporation (KBRTC)". In order to create a new institution for a mass transit system from scratch, it is the first thing to make it sure that there is a political will and financial and human resources to set up and operate the institution. Operations of public transportation system either by public or private sector or both are usually running in deficit requiring government subsidies in a large scale. The BRT system's sustainability depends as much on the system's "software" (the regulatory and business structure) as it does on the "hardware" (vehicles, stations, terminus, and other infrastructure). The new institution must operate as a commercial and business entity. It is designed to secure long-term investments from public and private sector and leverage local, provincial, central government funds as well as private funds, maximize the level of private sector investment over the long terms in Karachi BRT system. The KBRTC's initial institutional structure is a public company, but it is a dynamic form of "corporatization" which is a final form of institution in the privatization process. KBRTC is designed to be 100% private within next several years. Meanwhile, the new institution must create an environment to utilize the efficiencies, innovativeness, flexibility and speed of the private sector to provide better infrastructure and service at an optimal cost. In other words, attempting to plan an institutional structure it is necessary to maximize private sector participation in the BRT operations and infrastructure development within a Public-Private Partnerships framework (e.g. private sector finances vehicles and fare collection equipment).

As mentioned earlier, there are other institutional options available including a transportation authority and SPC (special purpose company- a PPP company), etc. A transportation authority is usually an organization with wide oversight on all public transport activities. A state or city owned monopoly is low cost-effective due to confused corporate objectives (services or profits?), low, sporadic or inappropriate investment resulting in poor services and large subsidy requirement. What is needed for the implementation and management of Karachi BRT is a focused business-oriented organization that is able to perform a balancing act of corporate objectives. The SPC is a PPP company created to engage in the financing, development, operation and maintenance of BRT system under a concession agreement. Under the current domestic and international market conditions, it is unlikely that a private company or consortium is capable to implement and manage the BRT system alone.

(3) Regulatory Structure

BRT corridors will be taken out from CDGK regulatory control and placed under the KBRTC's control. KBRTC would be running the BRT system independently, and it will manage the BRT Corridor vehicle operations through the concessions with private sector vehicle operators and, in later stage, feeder vehicles operators. It will control and administer revenues through independent concession for fares collection system. Handling the revenue is the key of the whole operation of BRT system. An independent fare collection process means that none of the vehicle operators have any relationship to handling the fares. Furthermore, through the use of real-time sharing of fare information, all parties have an open and transparent view on revenues, creating an environment of confidence in the system. CDGK is the regulatory authority of Karachi public transport system and owner of system assets. Furthermore, CDGK would have overall responsibility to deliver services to the traveling customer and for overall safety of the Karachi public transport systems. CDGK will finance, develop, and maintain through competitive bidding corridors, stations, terminals, depots, pedestrian bridges, and other

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. Responsibilities for mass transit, major road transport, traffic management and infrastructure development are currently shared among three departments of CDGK: Karachi Mass Transit Cell (KMTC), Transport & Communications Department (TCD), and Works & Services Department. KBRTC will play the leading role in the implementation and management of the BRT system. KMTC will focus on the transport policy, planning and setting standards for Karachi MRT system in collaboration with TCD and Master Plan Department of CDGK. TCD, on the other hand, regulates traffic and transport of the City. The Works and Services Department will through competitive bidding develop and maintain required infrastructure for BRT system operations in close consultation and coordination with KBRTC.

(4) Business Structure

There is a growing consensus over the form of the best practice business structure through the experience in Bogota, Curitiba and Guayaquil. While each city will likely have its own unique conditions that will ultimately determine the actual form of the business structure, based on the experiences to date, there are many common features that can lead to an effective structure. In each of these successful cases, there has been the basic formula of private sector competition within a publicly controlled system. In Bogota, TransMilenio, a public company holds overall responsibility for system management and quality control. Private sector concessions are used to deliver all other aspects of the system including fare collection and bus operations and maintenance. The vehicles and even fare collection equipment are purchased by the private sectors firms. TransMilenio and the municipal government are able to leverage private sector investment and defer large portion of the financial risks while retaining overall control on the shape of the system. Furthermore, the independent concession for fare collection helps ensure the system's revenue are properly controlled and administered. Generally, each corridor will host plural operators. However, none will have an inceptive to operate in an overly-competitive manner on the corridors as each operator is making its revenues from the vehicle-kilometers traveled rather than from the number of passengers collected. The feeder services can be particularly important in terms of finding a place for many existing operators in the new system. These contracts are tendered separately from the Corridor operators.

10.1.2 KBRTC

(1) Organization

Based on the institutional, regulatory and business principles KBRTC will be established as an overall lead body invested with the legal powers for establishing and implementing BRT policy. It will be the implementation agency for Karachi BRT system. KBRTC will be a public company, registered with Securities Exchange Commission of Pakistan (SECP) with the following shareholders: CDGK (41%), Government of Sindh (10%) and Private Sector (49%). It will serve as a regulatory authority for planning, implementing and managing BRT system of Karachi. The company's Board of Directors has the following structure: Administrator/Mayor (Nazim) Karachi, Chairman, Secretary of Finance, GOS(Member) and two members from CDGK viz EDO Transport & Communications and Director Genera, Karachi Mass Transit Cell (KMTC). The Board will also have two (2) members from the public traffic and transport control agencies, three (3) members from NGO and Managing Director, KBRTC as Secretary to the Board. KBRTC reports to the Chairman through its board of directors. The management of KBRTC consists of Managing Director who is supported by three (3) Deputies.

(2) KBRTC Board of Directors,

- Administrator /Mayor (Nazim) Karachi (Chairman)
- Secretary of Finance, GOS (Member)

- EDO, Transport & Communications, CDGK (Member)
- Director General, Karachi Mass Transit Cell, CDGK (Member)
- Deputy Inspector General (DIG), Karachi Traffic (Member)
- Representative of District Regional Transport Authority (DRTA) (Member)
- Representative of Karachi Public Transport Society (Member)
- Representative of the Chartered Institute of Transport (Member)
- Representative of Association of Road Users of Pakistan (Member)
- Managing Director, KBRTC as Secretary to the Board

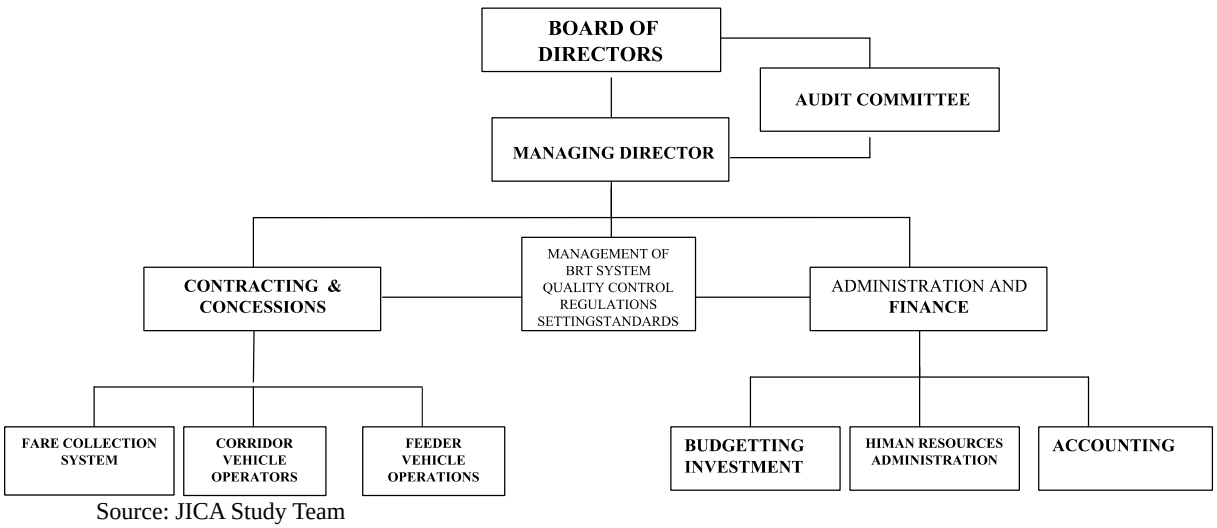
(3) Powers and Rights of KBRTC

KBRTC will be invested with the legal powers for the management of the BRT system operation. It will have exclusive rights for the following activities:

- Receive investments from public and private sectors.
- Exclusive right to regulate BRT Corridors.
- Regulate vehicle operation on BRT corridors
- Collect fares from BRT vehicles
- Set standards for fares and service parameters
- Quality control of BRT system operations
- Safety and security of BRT corridors and vehicle operation
- Enter performance contracts with the vehicle operators
- Enter independent concessions for fare collection system.

(4) Duties and Responsibilities of KBRTC

- Policy Making and Setting Standards
- Regulate BRT Corridors
- Planning and Design of BRT Corridors, stations and pedestrian bridges, etc.
- Management of concession for fee collection, accounting and distribution
- Quality control of BRT System operations
- Management of performance contracts with vehicle operators
- Marketing



Source: JICA Study Team

Figure 10-1-1 Organizational Structure of KBRTC

(5) Legal Framework of KBRTC

- Singh public-Private Partnership Ordinance, 2009
- Motor Vehicle Rules, 1969
- Motor Vehicle Ordinance, 1965

10.1.3 Transit Authority

Presently, Karachi Mass Transit Cell (KMTC), Karachi Municipal Corporation (KMC) is responsible for planning and regulation of mass transit development in Karachi. However, the present organization does not have enough power, human resources, and budget. Since the Karachi BRT is only a part of corridors, it is necessary to strengthen the organizational structure. For this, Establishment of Karachi Mass Transit Authority is proposed as well as a new law namely, Mass Transit Authority Act. Laws and regulations relating to mass transit development will be compiled into the act, and legal power and responsibilities will be given to the new authority. The authority will have the power to establish public corporations for public transport services such as BRT and MRT.

10.2 Project Scope

The silent feature of the project is summarized as follows.

	Green Line	Red Line	Total
Route Length (km) (elevated section)	21.1 (0.0)	24.4 (1.1)	45.5 (1.1)
No. of stations (elevated station)	28 (0)	26 (2)	54
No. of Depots	1	1	2
No. of Workshops	-	-	1
No. of vehicles	210	215	425
Vehicle type	12m in length, right door, high floor bus (See Chapter 5 for the details)		
Ticketing system	Pre-boarding ticket collection		

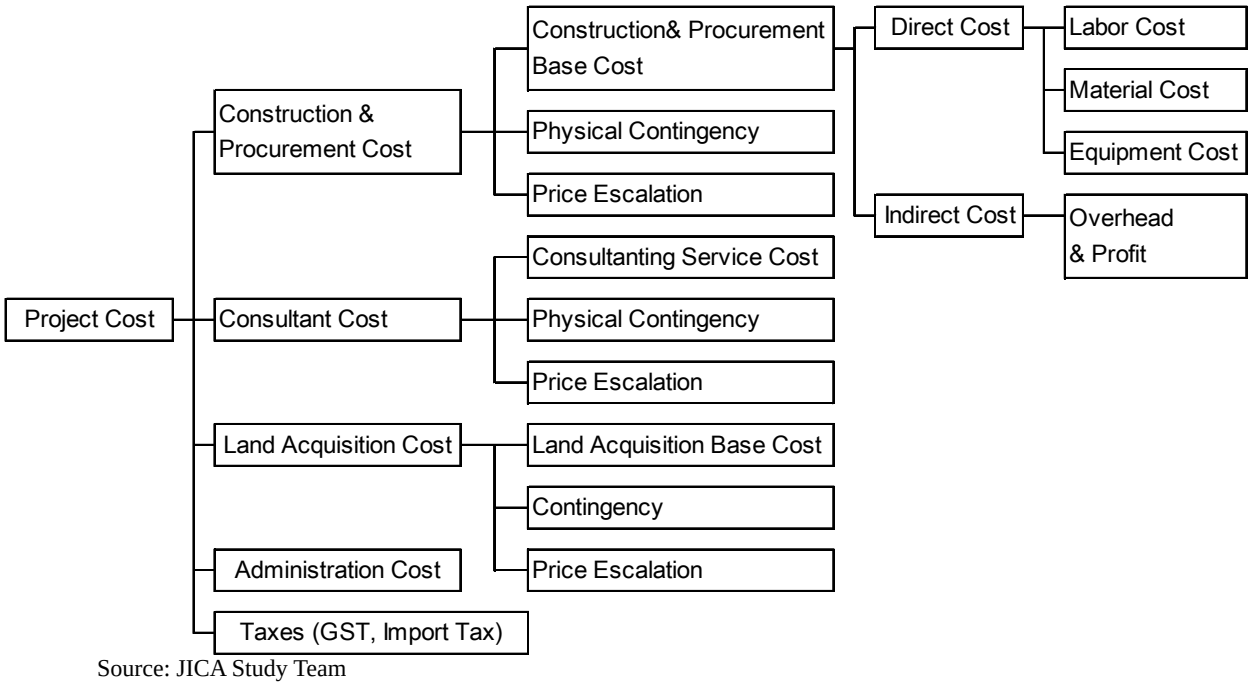
The contents of the project are:

- Construction of busways in the median of the existing roads
- Construction of two depots and a workshop
- Procurement of 425 vehicles and maintenance facilities

10.3 Project Cost Estimates

10.3.1 Components of the Project Cost Estimate

The project cost consists of components such as construction cost, consultant cost, and taxes etc, which are summarized in the following figure. In addition to these items categorized as initial cost, operation & management cost (O&M cost) shall also be considered as part of project cost that will continuously accrue after the commencement of BRT operation. Details of O&M cost has been explained in the previous chapter.



Source: JICA Study Team

Figure 10-3-1 Components of Project Cost (Initial Cost)

10.3.2 Conditions of the Project Cost Estimate

The conditions for the project cost estimate are enumerated as follows,

(1) Base Year

The base year of the project cost estimate is set in 2011. The cost information obtained through the past projects in different years before 2011 have been adjusted in the way price escalation in each year is considered.

(2) Currency

The project cost is estimated both in foreign and local currencies.

For the civil works, all of the costs have been estimated in local currency (PKR), since there will be no special construction method and techniques required, and all the materials, labour, equipment can be locally procured.

On the other hand, some of the equipment, devises and machineries, which are at present not available in Pakistan and to be imported from foreign countries or to be manufactured on CKD basis, have been estimated in foreign currency (Japanese Yen).

(3) Exchange Rate

The official exchange rate of December, 2011 (average monthly rate), issued by State Bank of Pakistan[1] is used in this project cost estimate. The exchange rate between currencies used is as follows;

US$ =Rp 89.340
JPY = Rp 1.148

The exchange rate of the final month of the base year 2011 (base year) is applied for the estimate. It is noted that the exchange rate above is for the purpose of the project cost estimate

[1] Statistical Bulletin: http://www.sbp.org.pk/reports/stat_reviews/Bulletin/2012/Feb/index.htm

and is different from the one for currency conversion purpose (the latest exchange rate provided by JICA is not used for project cost estimate purpose since the base year is set in 2011.).

(4) Construction Cost

Construction cost was estimated based on the preliminary engineering design and has been described earlier in chapter 6 of this report.

It should be noted that, as a business custom of Pakistan, unit prices include GST (Goods and Service Tax), overhead and contractor's profits, and they are not shown individually on the bill of quantities. Thus, the GST-equivalent amount is excluded from the unit prices which JICA Study Team collected through CDGK and separately considered and calculated in the cost estimate. Since the base year of the cost estimate is set in 2011, unit prices from past projects before 2011 have been corrected by considering price escalation rate of past year[1].

In addition to the items necessary for BRT systems following items are also considered in the cost estimate as part of civil works.

1) Traffic Management Cost

The BRT bus lanes, stations and access ways will be constructed on the existing road structures, footpath and centre medians – these areas are already serving as part of public transportation system. Since the proposed BRT routes run along the major public roads of Karachi, it is understood that, in principal, construction works of BRT be executed in such a way that civil works do not interrupt existing road capacity. For this reason, it is supposed that traffic management including temporary road diversion works is necessary during the construction period, and such costs have been considered in addition to the construction cost.

2) Relocations of Public Utilities

Usually, many public utilities are buried under the existing roads, such as water supply pipes, electricity cables, sewage conduits, etc. Even though the original ground in Karachi is expected to be hard and deep excavation will not be required for at-grade section, some of the utilities lying under the ground with a thin earth covering of less than 30 cm should be relocated before the commencement of civil works (the following photo shows the case example of utility buried under the ground with thin earth covering). In general, these works are carried out under the responsibility of the implementation agency, before the commencement of civil works. However, as is often the case, contractors may execute temporary protection/ support works for minor utilities under their responsibilities, with approval of related utility companies. Such costs have also been considered in the cost estimate.

Existing Public Utility under the Ground in Karachi (Photo: JICA Study Team)

(5) Procurement Cost

Procurement cost, in a broad sense, means everything to be procured under the project scheme, including procurement of consultants, contractors, materials and equipment etc, however, "procurement cost" under this clause describes major products and equipment, which are usually not classified as construction cost but rather as procurement cost, as the majority of the cost of the item is the product cost itself.

[1] Wholesale Price Index (WPI) of 2007 to 20010 is used as a price escalation rate for each year.
Indexhttp://www.pbs.gov.pk/sites/default/files/price_statistics/monthly_price_indices/mpi12/cpi_review_december_2011.pdf

Bus cost, station facility cost, workshop equipment and products of operation system are categorized as procurement cost.

Since these items are not very common in Pakistan, it is expected most of the products will be imported or locally assembled using imported parts (for buses). For these reasons, estimation for procurement cost was made based on the market price and cost information from similar projects in past, or if not, general cost data from "BRT Bus Rapid Transit Planning Guide" (June, 2007) by ITDP were used.

(6) Consultant Cost

Consulting service cost consists of direct employment cost (remuneration cost) and indirect cost. The direct employment cost is estimated based on the number of experts required in each of the project stage. The consultant services in this project are supposed to be carried out in two stages: engineering services that cover detailed design, tender document preparation and tender assistance; and construction supervision. Indirect cost such as transportation fee, survey cost and other expenses are also estimated individually.

The billing rates of consultants and support staff are listed in Table 10-3-1.

Table 10-3-1 Billing Rate of Consultants

	Foreign Currency (JPY)	Local Currency (Rp.)
Pro-A (International Consultant)	2,591,000	-
Pro-B (Local Consultant)	-	500,000
Supporting Staff	-	100,000

Source: JICA Study Team

The scope of consulting services of the project in each project stage is enumerated as follows;

1) Engineering Service (E/S or D/D)

- Detail Design (alignment, station layout, vehicles etc)
- Preliminary construction plan, construction schedule
- Preliminary construction cost estimate
- Preparation of tender documents (drawings, general and technical specification etc.)

2) Tender Assistance (T/A)

- Assistance for invitation of the tender (including PQ)
- Assistance for evaluation of the tender
- Assistance for negotiation of the contract with the tenderers

3) Construction Supervision (S/V)

- Construction supervision (quality, schedule and safety management etc.)
- Inspection for the civil, architecture works at the necessary stage, delivery inspection for buses and other facilities
- Cost management
- Stakeholder coordination
- Preparation of manuals for operation, management and maintenance

(7) Physical Contingency

This item is to cover the cost which may be incurred unexpectedly and was unforeseeable. It is set 5% of construction & procurement base cost and consulting service cost.

(8) Price escalation

Price escalation is set 1.6 % per year for foreign currency, and 4.4% per year for local currency. The amount of price escalation is accumulated every year on the base cost of construction and procurement cost, and consultant cost from 2012.

(9) Administration cost

5% of construction and procurement cost and consulting service cost, including contingency and price escalation.

(10) Land Acquisition Cost

Land acquisition is not expected in this project.

(11) Interest Rate during Construction

Conditions of yen loan[1] are applied for interest rate during construction.

- Construction Cost: 1.4 %
- Consulting Service: 0.01%

(12) General Sales Tax (GST)

16 % of General Sales Tax (GST), often called Value Added Tax (VAT) or Goods and Services Tax in other countries, is levied on goods and services to be procured both locally and multilaterally.

(13) Import Tax

The rate of import tax varies widely by import products in Pakistan, ranging from 0 to 35%. The possible items subject to import tax in this project are listed in Table 10-3-2 below with rates[2] and estimated amounts (the amounts shown in the Table below are for foreign currency portion only);

Table 10-3-2 Import Tax Rate

Item	Taxation rate	Estimated Amount (million JPY)
Vehicle (Bus)	0%	3,231
Workshop Equipment	5-35%	146
GPS System[*1]	5-20%	212
Fare Collection System and ITS[*2]	0%	333

Source: JICA Study Team

From the table above, the amount of bus procurement has the biggest impact on the total import tax amount, however, import tax for CNG buses are exempted in accordance with the customs act of Pakistan as described earlier in Chapter 5 of this report.

For workshop equipment, since various items as listed in Table 10-3-2 are subject to import tax, the taxation rate varies depending on the item (5-35%). GPS system, supposedly categorized as apparatus for the transmission or reception of data, will also be imported and taxed with the rate of 5 to 20 %. And, most of the items for automatic fare collection system could also be exempted if the products are imported under the category of “Automatic data processing machines”. However, in this stage where detail specification of the possible import item is yet to be determined, it is impractical to elaborate the total amount of import tax.

[1] http://www.jica.go.jp/english/operations/schemes/oda_loans/standard/index.html
[2] “Pakistan Customs Tariff(2009-2010)” www.pakcustoms.org/pakistan_customs_tariff/

In addition to the above, it should be mentioned that, in Pakistan, all the import items procured under public transportation infrastructure project can be exempted if it is approved by the central government (in most cases it is approved).

Even though there may be such a case that all the import products will be exempted, minimum tax rate of customs tariff, 5%, is applied as a tentative figure.

(14) Commitment Charge

Commitment charge of 0.1% per year of construction and procurement cost and consultant service cost is considered.

(15) Implementation Schedule

The implementation schedule on which the project cost estimate is based is as shown in the section 10.4.

10.3.3 Result of Project Cost Estimate

(1) Construction and Procurement Base Cost

The total amount of construction and procurement base cost is shown in the table below in local currencies,

Table 10-3-3 Construction and Procurement Cost for Green Line and Red Line

Item	Green Line (mil PKR)	Red Line (mil PKR)	Total (mil PKR)
Civil Works	**3,062**	**3,469**	**6,531**
Road Construction (incl intersection improvement)	**1,411**	**2,100**	**3,514**
Road works	1,073	971	2,044
Flyover	0	811	811
Other works	338	319	657
Station Construction (incl pedestrian access)	**1,444**	**1,105**	**2,549**
Station construction	278	197	476
Access way (Pedestrian bridge, stairs etc)	1,166	908	2,073
Traffic Diversion	**143**	**160**	**303**
Public Utilities Relocations	**64**	**104**	**168**
Facilities (Fare Collection system & ITS)	**235**	**220**	**455**
Depot & Workshop	**558**	**470**	**1,028**
Depot architecture & facilities (incl OCC,& GSP)	222	222	444
Workshop equipment	94	94	188
Depot Civil works	242	154	396
Vehicle	**2,173**	**2,224**	**4,397**
Grand Total	**6,028**	**6,383**	**12,411**

Source: JICA Study Team

Vehicle procurement cost on each line is calculated by multiplying the unit cost by the number of required vehicles as shown in table below.

Table 10-3-4 Vehicle Procurement Cost

	Unit Cost (per vehicle)	Green Line	Red Line	Total (Green + Red)
No. of Vehicle	-	210	215	425
F/C (mil PKR)	7.2	1,521	1,558	3,079
L/C (mil PKR)	3.1	651	667	1,318
Total (mil PKR)	10.3	2,172	2,224	4,397

Source: JICA Study Team

(2) Results of the Project Cost Estimate

Based on the conditions mentioned earlier, disbursement schedule and construction and procurement cost, the project cost has been estimated for the following three cases; a) Total Project Cost (Green Line & Red Line), b) Green Line only, c) Red Line only.

1) Total Project Cost (Green Line & Red Line)

Project cost for both lines (Green and Red) is summarized in the table below.

Table 10-3-5 Project Cost Estimate (Initial Cost) for both Lines (Green & Red)

Item		Total		
		FC (mil JPY)	LC (mil PKR)	Total (mil JPY)
A. ELIGIBLE PORTION				
I) Procurement / Construction		3,903	11,549	13,962
	Civil Works	0	6,531	5,689
	Facilities	325	82	396
	Depot & Workshop	411	556	895
	Vehicle	2,682	1,318	3,830
	Base cost	3,418	8,487	10,810
	Price escalation	299	2,512	2,487
	Physical contingency	186	550	665
II) Consulting services		339	570	836
	Base cost	306	452	700
	Price escalation	17	91	96
	Physical contingency	16	27	40
Total (I + II)		4,242	12,119	14,798
B. NON ELIGIBLE PORTION				
c	Administration cost	0	849	740
d	VAT	0	2,854	2,486
e	Import Tax	0	244	212
Total (a+b+c)		0	3,947	3,438
TOTAL (A+B)		4,242	16,066	18,236
C. Interest during Construction		388	0	388
	Interest during Construction(Const.)	387	0	387
	Interest during Construction (Consul.)	0	0	0
D. Commitment Charge		76	0	76
GRAND TOTAL (A+B+C+D)		4,706	16,066	18,700

Source: JICA Study Team

2) Project Cost for Green Line & Red Line

The project cost for Green Line and Red Line is summarized in Table 10-3-6 and Table 10-3-7, respectively.

Table 10-3-6 Project Cost Estimate (Initial Cost) for Green Line

Item		Total		
		FC (mil JPY)	LC (mil PKR)	Total (mil JPY)
A. ELIGIBLE PORTION				
I) Procurement / Construction		1,937	5,552	6,773
	Civil Works	0	3,062	2,667
	Facilities	166	45	205
	Depot & Workshop	206	322	486
	Vehicle	1,325	651	1,892
	Base cost	1,696	4,080	5,250
	Price escalation	148	1,208	1,201
	Physical contingency	92	264	323
II) Consulting services		170	283	416
	Base cost	153	224	348
	Price escalation	9	45	48
	Physical contingency	8	13	20
Total (I +II)		2,107	5,835	7,188
B. NON ELIGIBLE PORTION				
a	Administration cost	0	413	359
b	VAT	0	1,387	1,208
c	Import Tax	0	121	105
Total (a+b+c)		0	1,920	1,672
TOTAL (A+B)		2,107	7,755	8,861
C. Interest during Construction		188	0	188
	Interest during Construction(Const.)	188	0	188
	Interest during Construction (Consul.)	0	0	0
D. Commitment Charge		37	0	37
GRAND TOTAL (A+B+C+D)		2,331	7,755	9,086

Source: JICA Study Team

Table 10-3-7 Project Cost Estimate (Initial Cost) for Red Line

Item		Total		
		FC (mil JPY)	LC (mil PKR)	Total (mil JPY)
A. ELIGIBLE PORTION				
I) Procurement / Construction		1,966	5,997	7,189
	Civil Works	0	3,469	3,022
	Facilities	159	37	191
	Depot & Workshop	206	235	410
	Vehicle	1,357	667	1,937
	Base cost	1,722	4,407	5,560
	Price escalation	151	1,304	1,287
	Physical contingency	94	286	342
II) Consulting services		170	288	420
	Base cost	153	228	352
	Price escalation	9	46	49
	Physical contingency	8	14	20
Total (I + II)		2,136	6,285	7,610
B. NON ELIGIBLE PORTION				
a	Administration cost	0	437	380
b	VAT	0	1,468	1,278
c	Import Tax	0	123	107
Total (a+b+c)		0	2,027	1,766
TOTAL (A+B)		2,136	8,312	9,376
C. Interest during Construction		200	0	200
	Interest during Construction(Const.)	200	0	200
	Interest during Construction (Consul.)	0	0	0
D. Commitment Charge		39	0	39
GRAND TOTAL (A+B+C+D)		2,374	8,312	9,614

Source: JICA Study Team

(3) Comparison of the Cost Estimate

The outline of each option (route length, nos of stations), the estimated construction and procurement cost (including contingency and price escalation) and unit price per kilometer are summarized in the table below.

Table 10-3-8 Cost Comparison by Line

	Route Length (km)	Nos of Stations (nos)	Project Cost (mil JPY)	Unit Price /km (mil JPY)
Green Line & Red Line	45.5	54	13,962	307
Green Line	21.1 (0.0)	28 (0)	6,773	321
Red Line	24.4 (1.1)	26 (2)	7,189	295

*() : length/ numbers of elevated structure.
Source: JICA Study Team

Although there are some elevated structure sections in Red Line, which is more than fifteen times as high as the cost of at-grade runway, the comparison shows that the unit price of Green Line – no elevated structure – is slightly higher than that of Red Line. Part of this is because the frequency of station of Green line is more than that of Red Line; one station in every 750m in Green Line, and in every 940m in Red Line. And part of this is because the existing road width along Green Line is much wider than that of Red Line, causing the total length of pedestrian bridge over existing road nearly 1.5 times longer than that of Red Line. Since the pedestrian bridge is expected to be constructed mostly with steel material, this is one of the reasons for increasing the construction cost of Green Line.

(4) Comparison of Infrastructure cost with other BRT Projects in the world

According to the “Bus Rapid Transit Planning Guide (2007)” by ITDP, the principal factors to determine the actual infrastructure cost of BRT include;

- Number of exclusive lanes;
- Materials utilized in the construction of the lanes (asphalt or concrete);
- Expected system capacity, and thus the capacity and size of stations, terminals and depots;
- Amount of property expropriation required.

It also provides a list of well-known BRT systems all over the world, with their technical and financial outlines. From this list, figures of infrastructure cost and actual peak ridership (PHPDT) of BRT system in developing countries are extracted and summarized in the table below;

Table 10-3-9 Infrastructure cost and PHPDT of BRT System in Developing Countries

Country	City (Route Name)	Total Infrastructure Cost (mil US$ per km)	PHPDT (Peak Hour Ridership)
Indonesia	Jakarta	1.00	3,600
South Korea	Seoul	1.20	12,000
Taiwan	Taipei	0.35	9,500
Colombia	Bogota Phase 1	5.30	45,000
	Bogota Phase 2	13.30	45,000
	Pereira (Megabus)	1.70	6,900
Brazil	Curitiba	3.55	20,000
	Golania	1.30	11,500
	Sao Paulo	12.00	34,900
	Porto Alegre	1.20	28,000
Equador	Guayaquil (metrovia)	1.40	5,400
	Quito (Trole)	5.10	9,600
	Quito (Ecovia)	0.59	6,400
	Quito (Central Norte)	1.40	6,400
Mexico	Leon (Optibus)	1.00	2,900
	Mexico City (Metrobus)	1.50	8,500
China	Beijing	4.68	8,000
	Hangzhou	0.45	1,500
	Kunming	0.75	6,300

Source: Bus Rapid Transit Planning Guide (2007)" by ITDP

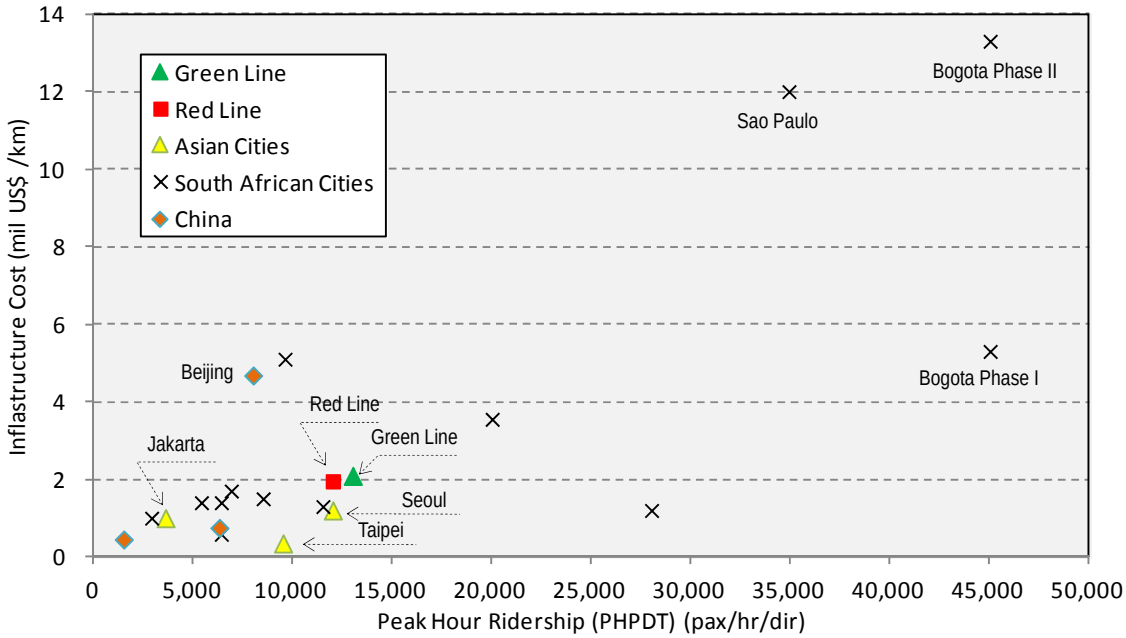
The infrastructure cost of Green Line and Red Line is shown in the table below together with estimated PHPDT of each line. With reference to the definition of the infrastructure cost above, vehicle cost has been excluded from the procurement and construction cost of each line.

Table 10-3-10 Infrastructure Cost and PHPDT of Green and Red Line

Line	Total Infrastructure Cost (mil US$ per km)	PHPDT (Peak Hour Ridership)
Green Line	2.04	13,000
Red Line	1.91	12,000

Source: JICA Study Team

The figure shows that BRT system that carries more passengers tends to be costly, although there is a case that shows successful BRT system can be developed less than 0.5 million US$ per kilometer. It highly depends on complexity and sophistication of the system, however, from the figure, it can be said that the infrastructure cost for Green Line and Red Line falls within the range of cost-demand relation of world BRT systems.



Source: Illustrated by JICA Study Team based on Bus Rapid Transit Planning Guide (2007)" by ITDP

Figure 10-3-2 Comparison of Infrastructure Cost and PHPDT with other BRT Projects

10.4 Construction Plan

Construction works for Green and Red Line will not require any special technologies and methodologies since it is just a simple road construction project in terms of construction works. However, some of the section may require special considerations as the construction works will be executed in the city centre with the existing traffic in service. In this section of Chapter 10, a few sections where there may possibly be difficulties in construction works, thus may need traffic management during and after construction are briefly described.

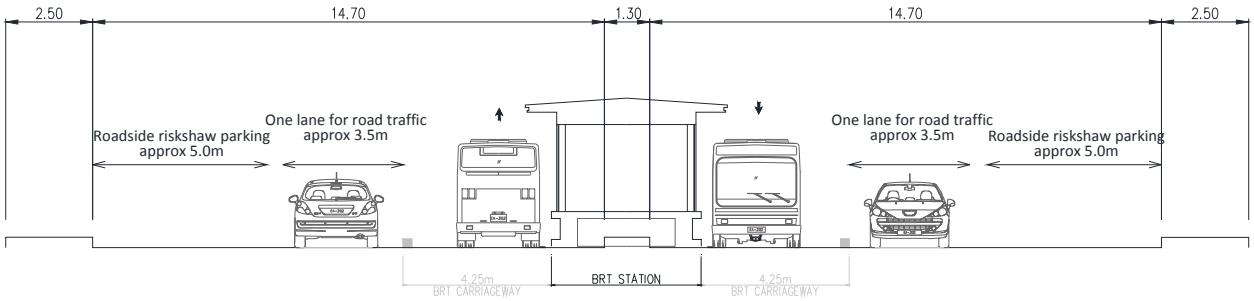
(1) Rickshaw Street

Right before Green Line crosses over Lyari River, there is an area where goes by the local name of "Patel Para". In this area, on both side of the street stand an array of rickshaw shops, selling new and used rickshaw, equipment and accessories for rickshaw. Since one lane, in some sections more than two, is always occupied as a showcase of rickshaw, repair shop and etc, in spite of relatively wide width of the road itself, the traffic lanes that can be used for public transportation is limited, which is causing sever and chronic traffic congestion along this street. If the current condition continues after and during the construction works, there will be only one traffic lane that can be used for public transportation. Therefore, it is vital to remove those who unlawfully occupy roadside public space for their business before the commencement of construction works.

Source: JICA Study Team

Figure 10-4-1 Location of "Patel Para"

Photo: JICA Study Team



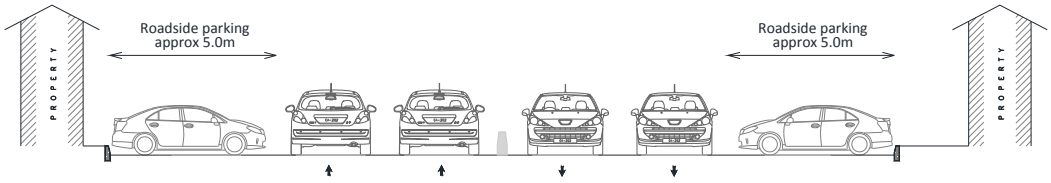
Source: JICA Study Team

Figure 10-4-2 Section along Patel Para Area with Bus Stop

(2) Elevated Structure Section

After construction works are complete, some of the spaces under flyover structure can be used for road traffic though piers and buffer zones occupy certain area and cannot be used for public road (Figure 10-4-4). However, during the construction works, especially when excavation, piling and foundation works are carried out, certain width of existing road have to be taken for construction works (Figure 10-4-5). In the proposed elevated section where busy shopping area is concentrated, especially near Empress Market, many private cars are parked on roadside, though legally not allowed, as if there were a tacit agreement that everybody knows about it. The traffic control on the illegal roadside parking is not managed at all by any authorities including traffic police.

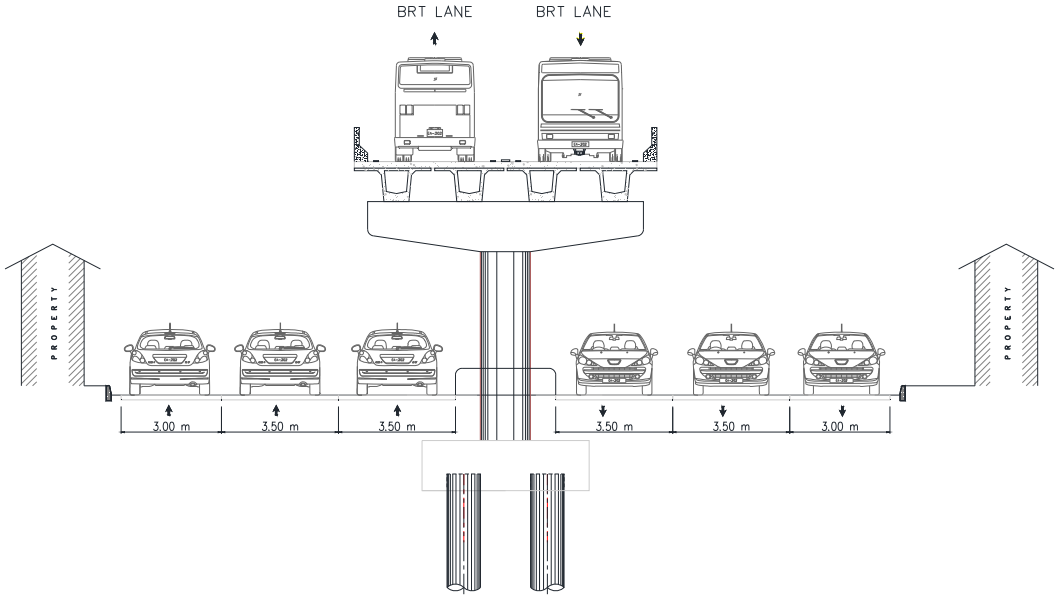
Considering the fact that traffic lanes for public transportation will be reduced after the commencement of construction works, in order to sustain current traffic, traffic lane currently used as parking space has to be restored its original function as a public road to accommodate traffic demand.



Source: JICA Study Team

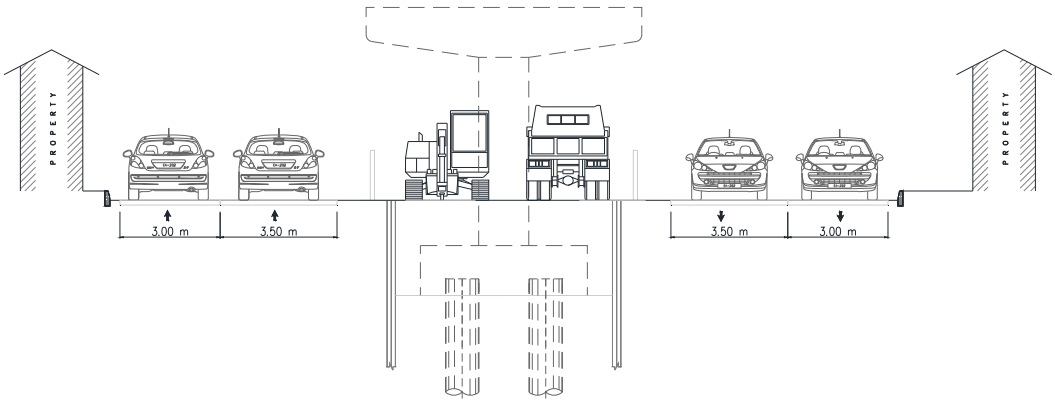
Figure 10-4-3 Existing Condition of Preedy Road

Public Roadside used as Parking Space on Preedy Street (Photo: JICA Study Team)



Source: JICA Study Team

Figure 10-4-4 Future Condition without Roadside Parking Space



Source: JICA Study Team

Figure 10-4-5 Future Condition during Construction Works without Roadside Parking Space

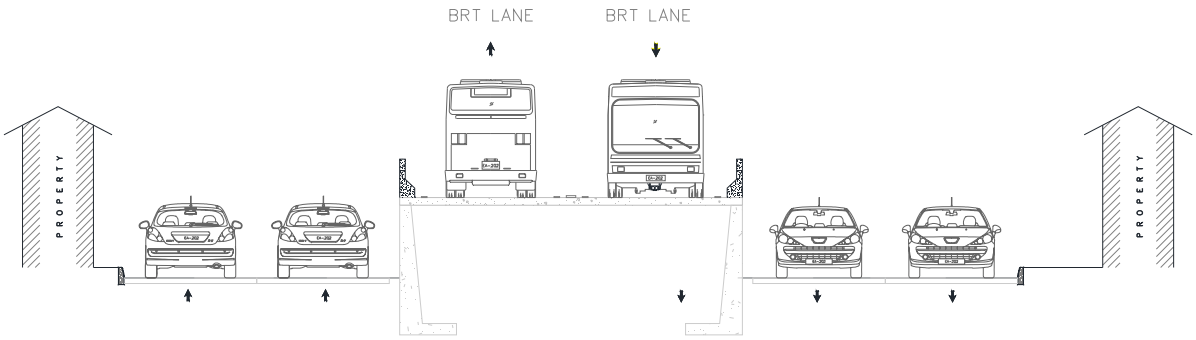
(3) Transition Section (Ramp) on Green Line

The transition section from elevated structure to at-grade structure will be located where there stands CDGK's parking building now. On the north side of proposed ramp section along New M.A Jinnah Road, there are many street stalls selling local fruits occupying one whole lane out of three carriageways (refer to the photo next page). Since road width will be for sure reduced after construction of ramp structure is complete as shown in Figure 10-4-7, all the carriage way must be used for public purpose, not private business purpose, in order to sustain existing traffic volume.

Source: JICA Study Team

Figure 10-4-6 Ramp Section on Red Line

Street Stalls on Roadside
Photo: JICA Study Team



Source: JICA Study Team

Figure 10-4-7 Future Condition of Ramp Section without Street Stalls

10.5 Financing

10.5.1 Private Sector Involvement

There seem little cases that huge investment to the transport sector by the private sector in Pakistan, currently. As a recent example, one case could be mentioned that the M/S Four Brothers invested Rs. 225 million to the high speed railway service (Pak Business Express). However, the BRT system needs Rs 5.1 billion including VAT only for vehicle acquisition. The necessary investment is more than 20 times bigger than the high speed railway service business.

The BRT system is also a completely new system to Karachi, and no one knows whether it would be successful or not. Therefore, it seems unrealistic that the private sector would be confident to invest a huge amount of capital for the BRT system in Karachi.

The Study Team considers that it will be realistic to develop the whole BRT system by the public sector in terms of investment and that the private sector operates and maintain the BRT system through concession contract.

It should be noted that private sector involvement should be open to foreign private companies too, because local private companies have no experience of the new BRT system. If an experienced foreign private operator or a joint venture with local companies is awarded the bidding, some amount of the investment cost would be saved in some extent.

10.5.2 Equity

In the case of Karachi Circular Railway development, the equity investment was planned as only 3.7% of the total investment cost according to JICA 2009. Most portion of the project was planned to be financed by the foreign loan. The total cost of the project was estimated as huge as Rs 160 billion. The equity investment was planned as Rs 5.9 billion only, the ratio to the total investment was as small as 3.7%.

The total investment cost of the BRT system was estimated as Rs 17.2 billion. The Study Team considers that the equity investment could be Rs 3.4 billion, which is equivalent to 20% of the total investment. The KBRTC owns all assets of the BRT system in this case.

There would be another option that the public sector would ask to the private sector to share the KBRTC equity investment for some portion. The public sector would be able to reduce financial expenditure if the private sector would respond to the invitation. Potential equity share of the private sector would be less than 50% of the total equity.

10.5.3 Loans

Two types of loans were considered. One is the JICA loan, which is very soft loan for the project, for the long term loan, the other is a short term loan available in the domestic market to cope with potential cash shortage. The conditions of the loans are summarized below.

JICA Loan

Interest Rate: 1.4% per annum
(0.01% per annum for consulting service)
Repayment period: 30 years (including grace period of 10 years)

Short Term Loan

Interest Rate: 14.0% per annum
Repayment period: 1 year

The condition of the short term loan was derived from the prevailing interest rate in Pakistan.

It should be mentioned that the JICA loan would not be applied to land acquisition,

administration cost of the local government and tax payment. Applicable JICA loan amounts to 80% of the total investment cost. Therefore, 20% of equity investment to the total project cost is considered reasonable.

Interest during construction

Interest during construction was included in the JICA loan and was repaid together with the loan under the condition of the loan. Therefore, no interest payment was appropriated during the construction period in the cash flow.

Commitment Charge

Commitment charge was included in the JICA loan and repaid as same as the interest during construction.

10.6 Implementation Schedule

10.6.1 Conservative Schedule

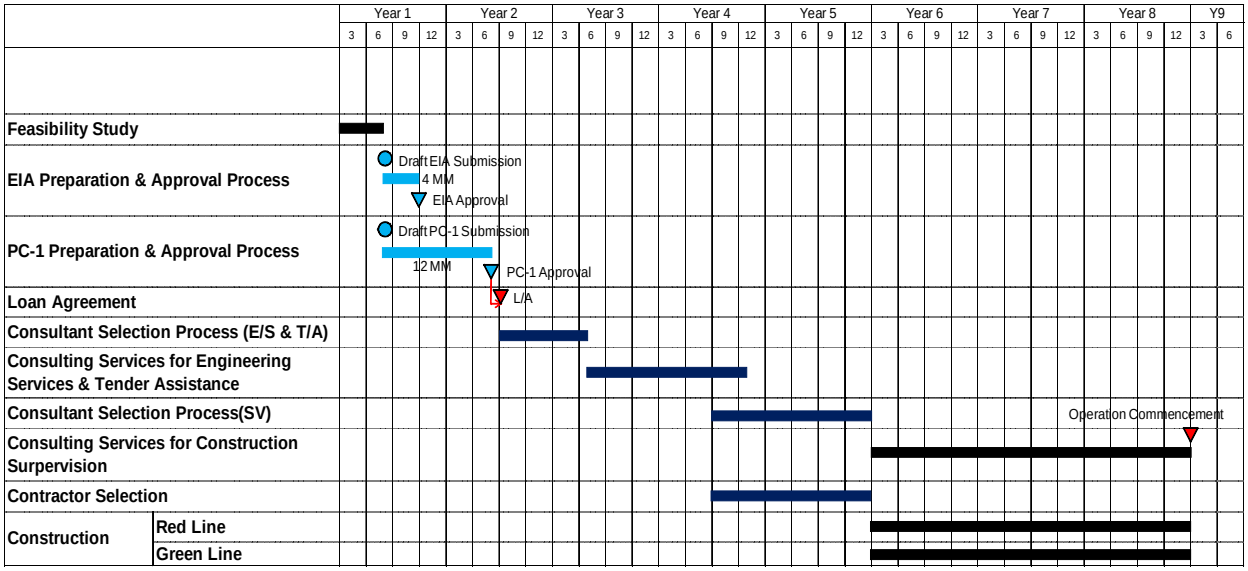
Figure 10-5-1 shows the project implementation schedule for Karachi BRT Project. In order to meet the schedule, the events listed below are required to be made in Pakistan before the project is materialized, following this Feasibility Study.

- EIA approval in Pakistan
- PC-1 approval in Pakistan

EIA approval in Pakistan usually takes four (4) months after a draft EIA report is submitted to the relevant authority of the central government of Pakistan. The approval of PC-1, a document to be submitted to Planning Commission of Pakistan for budged allocation, takes approximately twelve (12) months after submission. However, the duration of EIA and PC-1 approval procedure in Pakistan is varied depending on the project.

It should be noted that this implementation schedule is based on the case that the initial investment cost of the project will be partially or fully funded by Japanese yen loan. And thus, the Loan Agreement (hereinafter referred to as L/A) between Pakistan and Japanese government will be one of the major milestones to be made. Although L/A can be signed by both governments only after the project is officially approved in borrower country, it is proposed that the procedure for JICA's appraisal of the project can be put forward in parallel with PC-1 approval process in Pakistan, so that L/A can be signed right after the PC-1 is approved. This is necessary for this project to be implemented earlier since early realization is one of the key advantages of BRT introduction. It is understood that this scheme can be made possible considering the fact that the Japanese government is presently promoting to accelerate yen loan procedures to materialize the development project at an earlier date.

After the project is materialized, the critical path for the project completion (construction completion) widely relies on the procurement scheme of consultants and contractors. The procurement scheme for the project is described later in the following section.



Source: JICA Study Team

Figure 10-6-1 Implementation schedule

10.6.2 Issues on the Implementation Schedule

There might be some difficulties in implementation of the project to meet the schedule proposed in this study. The following describes possible issues on the implementation schedule.

a. Unclearness of the implementation agency for the project can be one of the critical issues.

b. Development of laws & regulations for BRT system can also be a problem which might disturb the project implementation.

c. Financial arrangement between central government of Pakistan and local government (KMA) may have to be made in order to fix the financial sharing of the development loan from international lending agency. The consensus building on this agreement may take longer than expected, depending on the borrower country's business custom and the speed of political decision makings.

10.7 Procurement

10.7.1 Package for Consulting Services

Procurement scheme for the project, which under this section means procurement of consultants and contractors, is based on the typical procurement scheme for, in this case, yen loan project. The services that consultants provide for this kind of project involve the following items (tasks of each service is also described together);

- Basic Design
  Alignment, Location of stations, Outline specification of infrastructure and buses,
- Detail Design
  Structural design for civil works and station architect works etc, detailed specification of infrastructure and buses,
- Tender Document Preparations
  Preparation of tender documents including all drawings and specifications etc,
- Tender Assistance
  Assistance for tender process including PQ (Pre-qualification), tender evaluation and negotiation etc,

- Construction Supervision
  Supervision of contractor's construction works in all aspects,

It is proposed that the consulting services for this project are divided into two stages, where basic design, detail design, tender document preparation and tender assistance are packaged together. The scope of consulting services in each stage of the project is described in section 10.3.2.

10.7.2 Procurement for Consultants and Contractors

(1) Procurement of consultants

The activities to procure consultants usually include the following,

- Preparation of PQ (Pre-Qualification) shortlist
- Tender process (for the consultant to prepare proposal)
- Tender evaluation
- Contract negotiation
- Approval of JICA

(2) Procurement of Contractor

The activities to procure contractors for construction works and procurement of facilities and vehicles include the following,

- PQ process (including PQ evaluation, and JICA's approval)
- Tender process (for the contractor to prepare their bid and proposal)
- Tender evaluation
- Contract negotiation
- Concurrence of JICA
- Approval of JICA

10.7.3 Packaging for Construction Contract

The policy of the contract packaging for the construction and procurement works are described as follows;

- Since the international competitive bidding is expected for this project, it is supposed that relatively large contractors who can take a certain level of risks will be participating the bidding. For such contractors, the more the contract amount becomes, the more attractive the contract will be. And furthermore, fewer number of contract package usually contributes to economize administration cost, contractor's overhead cost and so on. Therefore, in order to promote and attract as many competitive contractors as possible, the amount of one contract shall be set as large as possible.
- It is considered necessary to separate the contract package for vehicle procurement as one single package, since the nature of the work is obviously different from other works such as civil works. In order to guarantee the quality of vehicle, it is proposed that the contract for procurement of vehicles shall be given to the contractor specialized for such procurement works and familiar with the vehicle manufacturing.

Considering the above, there are two possible options for packaging as shown in Figure 10-7-1.

		Civil Works		Vehicle
		Green Line	Red Line	
Total Cost		10,810		
OPTION 1				
	Cost	6,980		3,830
	%	65%		35%
OPTION 2				
	Cost	3,357	3,623	3,830
	%	31%	34%	35%

Source: JICA Study Team

Figure 10-7-1 Packaging Option

Option 1 : one package for Green and Red Line, and one package for vehicle procurement,

Option 2 : separate contract package for Green Line and Red Line, one package for vehicle procurement

Although there are two options as above, option 2 is proposed considering the case where the employer does not want to put all risks in one basket. It also can be said that option 2 is preferable since it shares almost equal amount in each package.

10.8 Capacity Development Programme

As an urban transport system, major advantages of the BRT system, which is being to be introduced to Karachi, are high transport capacity and relatively high transport speed. To attain these advantages, the new BRT system should be operated in high service frequency, 3 bus services per one minute per direction for example, on segregated carriageway, which is dedicated to the BRT vehicles only as mentioned in the previous chapters of the study.

Bus service operation is planned to be given to private sector operators as explained in the previous section. Number of operators is assumed as four, as two operators each for Green and Red lines. However, it is deemed that presumable local bus operators have never experienced to operate the so frequent bus services in the past, because the BRT system is the first introduction to Pakistan. So much frequent service would certainly affect transport safety of the service although necessary infrastructure would be fully provided. Therefore, operators and concerned authorities should put first priority on the traffic/transport safety, when introducing the BRT system to Karachi.

The Study Team considers that staffs, such as drivers, and supervisors of the operators should be well trained for the new system operation before the opening of commercial operation. Trainings for maintenance staffs are also considered necessary, because the BRT system would not be operated safely without appropriate maintenance of vehicles, carriageway and other facilities.

The Study Team proposes the training program as mentioned below.

Objectives of Training would be;

- Securing Traffic Safety;
- Efficient Operation & Maintenance; and,
- Modern Management.

The "Modern Management" is not mentioned above related to the safe operation though, the Study Team considers it would be strongly necessary to ascertain effective and efficient management for the successful introduction of the BRT system to Pakistan, because this is the first time and it is very much important for future expansion of the system to all over Pakistan to mitigate various urban transport issues.

The training of the staffs and management of the BRT operator would be done by experienced staff teams organized by experienced operators in foreign countries, which have extensive and successful BRT networks. The training teams would consist of three members of management, driving (including safety), and maintenance. The training program would be roughly considered to start from six month before the commercial operation, when the BRT system is completed, and continue until just before the opening. It is proposed that the training program would be included as one of the conditions of the concession contract between the KBRTC and successful operators. Estimated cost of the training program for the trainers are Rp 80.4 million (US$900,000) for the six months training period, by assuming the monthly cost of one trainer is US$25,000 and that two teams consisting of 3 trainers each would be 36 man-month in total.

10.9 Possible Assistance Services for Operation and Maintenance

Since there is no precedent for such a public transport system as this BRT project in Karachi, in addition to the training programme described in the previous section, it may be necessary to provide assistance services for operation and maintenance (O&M) to implement and manage this project successfully. The assistance services, which are considered necessary and may be requested by Pakistan Government, are enumerated as follows;

- Preparation of rules and regulations on BRT operation
- Technical assistance for the operator tendering
- Support of public consultations
- In-house consulting to the implementation agency

The number of required experts for each assistance services and their cost are preliminarily calculated and listed in the following tables. The same billing rates shown in Table 10-3-1 are used in this estimate. Direct costs such as airfare, allowances and vehicle rental fee, etc are set 20 % of total remuneration cost with reference to the conditions applied to the cost estimate for the consulting services of the project.

Table 10-9-1 Cost estimation for Preparation of rules and regulations on BRT operation

(Unit: thousand JPY)

Position	M/M	Unit Cost	Cost
Remuneration of Professionals			
· Project Manager (International)	10	2,591	25,910
· Project Coordinator (Local)	12	436	5,226
· Legal specialist (Local)	12	436	5,226
· Bus operation specialist (International)	6	2,591	15,546
· Driver's training specialist	6	436	2,613
· Support staff (Local)	36	87	3,136
Subtotal(1)			57,657
20% of (1) for direct costs			11,531
Grand Total			69,188

Source: JICA Study Team

Table 10-9-2 Cost estimation for Technical assistance for the operator tendering

(Unit: thousand JPY)

Position	M/M	Unit Cost	Cost
Remuneration of Professionals			
· Project Manager (International)	10	2,591	25,910
· Project Coordinator (Local)	12	436	5,226
· Legal specialist (Local)	12	436	5,226
· Bus operation specialist (International)	6	2,591	15,546
· Document Specialist (International)	6	2,591	15,546
· Support staff (Local)	36	87	3,136
Subtotal (1)			70,590
20% of (1) for direct costs			14,118
Grand Total			84,708

Source: JICA Study Team

Table 10-9-3 Cost Estimation for Support of public consultations

(Unit: thousand JPY)

Position	M/M	Unit Cost	Cost
Remuneration of Professionals			
· Project Manager (International)	6	2,591	15,546
· Project Coordinator (Local)	12	436	5,226
· Social environment specialist (International)	12	2,591	31,092
· Social environment specialist (Local)	12	436	5,226
· Support staff (Local)	36	87	3,136
Subtotal(1)			60,226
20% of (1) for direct costs			12,045
Grand Total			72,271

Source: JICA Study Team

Table 10.9-3 Cost Estimation for In-house consulting to the implementation agency

(Unit: thousand JPY)

Position	M/M	Unit Cost	Cost
Remuneration of Professionals			
· BRT Specialist (International)	24	2,591	62,184
Subtotal (1)			62,184
20% of (1) for direct costs			12,437
Grand Total			74,621

Source: JICA Study Team

In total, approximately 30.1 million JPY is supposed to be required for the operation and maintenance assistance services for the BRT project.

Chapter 11 Conclusion and Recommendation

11.1 Conclusion

11.1.1 Master Plan

A person trip survey including interview to 40,000 households was conducted in 2010, and a traffic demand forecast model was developed. The master plan was formulated for the year 2020 and 2030 based on the demand forecast.

(1) Insufficient Transport System for Future Demand

Population of Karachi is 18.9 million in 2010, which is expected to increase 10 million in the next 10 years and reach 27.6 million in 2020 and 31.6 million in 2030. The land use plan assumes that these residents will be accommodated in the suburban areas such as Gadap, Bin Qasim, and Keamari. The number of trips was estimated 19.9 million in 2010, 29.0 in 2020, and 33.3 million in 2030. The large scale increase in population in these towns will increase traffic volume in Karachi because travel distance will become longer. The demand analysis shows that the present transport network can not deal with the future transport demand.

(2) Need Road Development

Road network is a fundamental infrastructure for the successful development in the suburban area such as Gadap, Bin Qasim, and Keamari Towns. Demand forecast analysis shows that road development is very important to meet the traffic demand in the future. In a technical aspect of the demand forecast, it is difficult to estimate the traffic volume on the assumption that there would be no road development in the future. Road development is more important than mass transit development. The master plan includes road development in a total length of 288 km

(3) Need Mass Transit Development

The demand analysis shows that road development in the master plan is not enough to reduce the projected traffic congestion in Karachi. In order to improve the traffic situation in the future, it is necessary to construct mass transit system. Karachi Circular Railway (KCR) will contribute to provide better transport in the center of the city, but it is proposed that the line should be extended to east because the future demand in Bin Qasim is expected to be very high. The demand analysis shows that the traffic demand will be high not only radial directions including Tower – Super Highway, but also the corridor along Rashid Minhas Road. Railway systems are proposed for the two corridors.

(4) Cost Efficient Development

It is necessary to compromise between the fully developed transport system and the available budget. Considering the city's budget including the provincial and federal subsidy, railway construction, in addition to KCR, will be difficult, and two more lines would be the maximum investment on the railway system in the next 20 years. In the master plan, BRT system is proposed instead of the railway system except for two corridors even if traffic demand is high enough to justify railway system due to the budget constraints and implementation period. 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.

(5) Naming of Mass Transit Corridors

In the existing plan, mass transit corridors are named as Corridor-1, 2, and so on as well as BRT corridors 1, 2, 3, etc. This causes confusion of corridor identification in planning. For better understanding of mass transit corridors, color names are given to each corridor such as Green, Blue, Red, Brown, Yellow, Purple, Aqua, Orange, and Silver.

11.1.2 Feasibility Study

Green Line (M. A. Jinnah Road - Business Recorder Road – Nawab Sadiq Ali Khan Road – Khyaban-e-Sher Shah Suri Road - Shahrah-e-Usman Road – Chaudry Fazal Ellahi Road) and Red Line (Shahrah-e-Liaquat Road – Pready Street – New M.A. Jinnah Road - University Road) are studied in the Feasibility Study Stage.

(1) Demand

Passenger demand is higher than the system capacity. Generally, a standard BRT system can carry 10,000 – 20,000 passengers per hour per direction, but the passenger demand for mass transit system along the corridors exceeds the capacity. Therefore, traffic demand is estimated under the capacity constraints. The total number of passengers of Green Line and Red Line is expected as 700,000 passengers per day.

(2) BRT Type

A typical style of BRT is proposed: a dedicated busway in the median of the roads, median stations, right door buses, and pre-boarding ticket system. This system has a number of advantages over other types such as direct services and on-board fare collection. After the discussion about the availability of the median of narrow roads, it was concluded that dedicated lanes can be constructed up to the CBD area which enabled to apply this system.

(3) BRT Route

There are narrow sections along the corridors such as Nawab Sadiq Ali Khan Road, Business Recorder Road, and New M.A. Jinnah Road. The roadsides of these roads are occupied by sanitary market, rickshaw market, and car market, respectively. For BRT construction, it is necessary to remove these markets from roadsides, and it seemed to be difficult. However, KMTC ensured that eliminating illegal parking along the roadsides is possible if public transport system can be improved. M.A. Jinnah Road is very busy road and narrow. It was concluded that the construction of BRT lanes between Tower and Cloth Market is almost impossible. Since the introduction of BRT in CBD area is very important, it is proposed to use existing park (Municipal Park) near Cloth Market as a terminal point of Green Line. On the other hand, KMTC proposed elevated structure near Empress Market. From this, Regal Chowk is planned as the terminal point of Red Line.

(4) Introduction of Large Buses to BRT system

Standard large buses in the length of 12m are introduced for the BRT system. Generally, successful BRT systems in the world use articulated buses to increase the capacity. On the other hand, the available space is limited in CBD area in Karachi, and it was found that the introduction of articulated buses along M.A. Jinnah Road and Shahrah-e-Liaquat Road would be impossible. The capacity of local manufactures is also considered for the type of the BRT vehicle.

(5) Multiple Stopping Bays

Since the width of roads along the corridors is not wide enough in the central area, passing lanes at stations are not proposed. Without a passing lane, the capacity of the BRT becomes smaller than usual full scale BRT systems with a passing lane. In order to avoid occurring queues at stations, three stopping bays for each direction is planned.

(6) Institutional Setup

For the successful operation of a BRT system, the system should be profitable and subsidy free. The new institution is proposed as a public corporation, namely, Karachi Bus Rapid Transit Corporation (KBRTC). A common business structure of BRT in the world is proposed. Private operators are given concession to operate buses along the corridors. The fare is collected by a fare collection company and becomes the revenue of KBRTC. The private operators are responsible of operation costs and receive contract amount based on the performance.

(7) Economic Benefit

The BRT project will bring about economic benefit such as travel time reduction for BRT passengers, vehicle operating cost reduction, and vehicle emission reduction. On the other hand, the project will cause negative impact on road traffic. Since existing bus passengers will use the BRT, and the system will reach its capacity by them, shift from car users to BRT system will not be large enough to compensate the reduction in the number of lanes. However, the total economic benefit is positive, and the Economic Internal Rate of Return (EIRR) is calculated as 26.6%, which shows that the project is economically feasible.

(8) Necessary Actions by KMC

The following actions should be taken by KMC for the implementation of the project.

- Finalization of EIA report based on the draft EIA and its approval
- Finalization of PC-1 based on the draft PC-1 and its approval
- Clearance of encroachments along the project corridors
- Consensus building on the traffic plan (changing the policy of the Signal Free Corridor)
- Notification of the right-of-way (ROW) along the corridors
- Agreement with KUTC on the removal of North Nazimabad Flyover

11.2 Recommendation

(1) Monitoring of Urban Development

Since the master plan depends on the future land use plan, it is necessary to monitor urban developments in Karachi, especially in Bin Qasim and Gadap Town. If the development in Bin Qasim delays, it will affect the traffic demand of KCR. If the development along Super Highway does not take place, the plan of Blue Line should be reconsidered. The next national population census will be the best timing to review the socio-economic framework in the master plan.

(2) Preparation of a New Law

Mass transit system can be developed under the present laws and regulations in Pakistan. However, there is a risk that exclusive use of lanes of roads by a private company will cause legal problem even if it is authorized by public sector. In order to promote mass transit

development, it is proposed to establish a new law which deals with mass transit system instead of amending relevant chapters of various laws and regulations.

(3) KCR Project

Maj Arshad Bridge, crossing over KCR line near North Nazimabad Station, is old and need to be reconstructed. The KCR project was planned on the assumption that the bridge would exist or would be reconstructed as the same type. However, it is recommended that KCR should be elevated so that connection between Green Line and KCR become easier. The close coordination of KUTC and KMTC is strongly recommended.

(4) CNG Green Bus Project

The BRT project will cause negative impacts on traffic although it will bring about the positive impact on bus passengers at the same time. It is necessary to demonstrate how modern public transport is nice for people in Karachi. CNG Green Bus Project will give a good impression to the public for the next BRT project.

(5) Feasibility Study of Blue Line and Brown Line

The two railway lines (Blue and Brown) are proposed as mid-term projects in the master plan. However, the implementation of a railway project takes time, and it is recommended to start a feasibility study for these lines within several years.

(6) Redevelopment in CBD

Narrow roads and streets in the central area are the major issue in the transport in Karachi. Since buildings in the area are old, and redevelopment will be taken place in the future. It is recommended to widen roads and streets during the redevelopment time. Jahangir Road is one of the roads which should be widened.

(7) Stakeholder Consultation on Busway along Bottleneck Sections

The BRT project will use the center lanes of roads as the dedicated lanes for BRT vehicles, which reduces the number of lanes for other vehicles. Meanwhile, there are three sections where commercial activity on roadsides is so high that goods and parking cars occupy the travel lanes to the extent that only one lane can be used in peak hours. The three bottleneck sections are: 1) Rickshaw market on Business Recorder Road, 2) Sanitary market on Nawab Sadiq Ali Khan Road, and 3) Car dealers market on New M.A. Jinnah Road near Jail Road. Construction of the busway along the sections will block lanes for other general vehicles. It is one of the most important issues for the project to remove such encroachment from the travel lanes. Since the clearance of the roadside activity involves a large number of stakeholders, dialogue between them and KMC is very important for the project implementation. It is recommended that stakeholder consultation on this matter should be held.