CHAPTER 16: TRAFFIC MANAGEMENT PLAN

16.1 Proposed Traffic Management Policy and Measures

16.1.1 Issues and Problems regarding to Traffic Management Plan

Based on the analyses made, the following issues can be identified:

(1) Lack of Traffic Discipline

a) Buses stop near intersections and in all lanes just in front of intersection without any consideration of traffic flow. Buses stop in the middle of the road to pick up and drop passengers.

b) Motorized vehicles are parked along roads, even if parking is forbidden.

c) Waiting vehicles of right-turning traffic at intersections are spread into the straight traffic lane even in left-turning lane.

d) Many rickshaw pullers are not followed traffic rules.

(2) Poor Pedestrian Facilities

a) Pedestrians walk on the roadway because sidewalks are used by hawkers or illegal vehicle parking, if not scares. They always cross wide street everywhere and any time even if vehicle passing through.

b) Pedestrian are walking on the median and are hiding between trees in the middle of the roads.

c) In the roundabout, pedestrians are waking anywhere and any time when they want.

(3) Poor Traffic Operation

a) The traffic policemen are trying their best to direct traffic at intersections considering their intersections or upstream intersections. They direct traffic against traffic signals.

b) Police use wooden sticks which cannot be seen during darkness to direct traffic. Most of traffic policemen do not usually wear reflective jackets while on duty after sunset.

c) Many obstructions such as garbage, construction materials, etc are occupied in road spaces.

d) A few one way road systems are employed.

(4) Poor Traffic Management Facilities

a) Road markings are non-existent or out of paint. Lanes are not marked on the roadway. Very few road signs are installed even on the primary and secondary roads.

b) Channelization at intersections has not been installed at most intersections although there are available lands.

(5) Poor Traffic Signals

a) No vehicle drivers follow traffic signal, because the traffic policemen always control for traffic signal even during off-peak period.

b) Some of the traffic signals are malfunctioning.

(6) Poor Education for Drivers

People in Bangladesh do not follow traffic rules properly because most of drivers are not well trained. They are illiterate and got their licenses by bribery. Thus, they do not even know the traffic rules.

16.1.2 Traffic Management Policy and Measures

As mentioned above, the existing traffic congestion is largely caused by inadequate road usage due to a poor traffic management. An appropriate systematic traffic management system is essential for safety and smooth traffic flows on roads, making a maximum usage of road facilities to enlarge the current road capacities.

a) To achieve smooth traffic flow
b) To reduce traffic accidents, and
c) To create pedestrian –friendly facilities

Table 16.1-1 describes current problems and issues and its countermeasures. Some measures should be implemented in short term period and the others are needed in medium and long term period. These countermeasures can be summarized as follows;

1) Short Term Measure

a) Improvement of bottleneck intersections
b) Improvement at U-turn and right-turn points
c) Improvement of traffic signals
d) Improvement of parking system
e) Improvement of traffic safety facilities
f) Traffic safety campaign and education
g) Improvement measure for rickshaw traffic
h) Improvement of traffic operation
i) Strengthening traffic enforcement

j) Coordination between agencies

2) Medium and Long Term Measures

a) Traffic information system

b) Bus location information system

c) Electronic demand management system

d) Traffic demand management system

These countermeasures will be discussed below:

Table 16.1-1 Countermeasures for Immediate Action Plan

Current Problems	Issues	Countermeasures
1. Traffic Congestion at Signalized intersection	1. Engineering improvement of traffic signal control system and intersection 2. Engineering improvement of intersection 3. Traffic enforcement	1. Improvement of traffic signal control system 1) Traffic response system on near/over saturated condition 2) Synchronized system of traffic signal 2. Improvement at intersections 1) Road marking and signs 2) Geometric improvement of intersections 3. Traffic Enforcement for vehicles and crossing pedestrian
2. Traffic Conflict between Vehicles and Crossing of Pedestrian	1. Appropriate Pedestrian Safety Education Program 2. Improvement of Pedestrian Facilities	1. Improvement of Traffic Safety Facilities 1) Pedestrian crossing with traffic light 2) Scramble pedestrian crossing 3) Pedestrian bridge 2. Improvement of Traffic Safety Education System 1) Pedestrian safety education program 3. Strengthening traffic regulation enforcement
3. Traffic Conflict among Vehicles (Rickshaw)	1. Appropriate Rickshaw Puller Education Program	1. Improvement of Traffic Safety Education System 1) Appropriate rickshaw puller traffic safety education program 2. Extension of Rickshaw Free Road at Major Arterial Roads
4. Traffic Congestion of Buses near Bus Stops	1. Effective Traffic Education Program for Bus Driver 2. Safety Bus Stop Facilities for Passengers 3. Bus Priority System	1. Improvement of Bus Facilities 1) Appropriate bus shelters 2) Provision of bus bay 3) Provision of bus stops and bus information 2. Improvement of Traffic Education System 1) Bus driver education program
5. Traffic Congestion at non-signalized intersection or Roundabout	1. Installation of traffic Signals 2. Improvement of Intersections	1. Installation of Traffic Signal Control System 1) Installation of traffic signal 2. Improvement of Intersection 1) Geometric and channelization improvement at intersections 2) Reconstruction of roundabouts
6. Poor Traffic Operation	1. Improvement of traffic operation	1. Strengthening traffic police 1) Strengthening traffic police 2. Improvement of Traffic Operation System 1) Introduction of one-way system for district traffic

Current Problems	Issues	Countermeasures
		3. Monitoring of road asset usage 1) Establishment of road monitoring system 2) Expansion of monitoring personnel
7. Traffic Congestion by Richshaw	1. Rickshaw Issues	1. Review of role for Rickshaw 2. Expansion of Rickshaw Free Road 3. Control of rickshaw number
8. Traffic Congestion by on-street parking	1. Provision of Parking Spaces 2. Parking Policy	1. Improvement of Parking System 1) No parking area 2) Construction of off-street parking 2. Establishment of Parking Policy and Regulations 1) Establishment of parking improvement areas 2) Revision of building code 3. Enforcement of Illegal Parking Vehicles 1) Enforcement of illegal parking 2) Removal of left vehicles
9. Traffic Conflict of Vehicles at U-turn and Right-turn Points	1. Channelization Treatment	1. Geometric improvement at U-turn Point 1) Geometric improvement at U-Turn points 2) Provision of U-turn lane 2. Traffic Enforcement 1) No parking near U-turn points
10. Traffic Conflict near Schools and Shopping Centers	1. Provision of Parking Space	1. Improvement of Parking System 1) Provision of parking spaces 2) Traffic regulation
11. Traffic Accidents	1. Effective Traffic Safety Education Program 2. Improvement of Traffic Safety Facilities and Signs 3. Conduct of Traffic Campaign	1. Improvement of Traffic Safety Education 1) Traffic safety education to driver 2) Traffic safety education to peoples 2. Improvement of Traffic Safety Facilities 1) Traffic safety facilities 3. Conduct of Traffic Campaign 1) Traffic campaign
12. Traffic Accident at Black Spots	1. Improvement of Black Spot Points	1. Improvement of Black Spot 1) Improvement of block spot

Photo 16.1-1 (1) A Lot of Rickshaw waiting for Passengers near Bus Stops

Photo 16.1-1 (2) Not Effectively Working Signal System

Photo 16.1-1 (3) A Lot of Buses waiting at Bus Stops

Photo 16.1-1 (4) Obstructions left on Carriageway

Photo 16.1-1 (5) Street Stalls on Sidewalk at Busy Street

Photo 16.1-1(6) Narrow Sidewalk along Major Roads

16.2 Short-Term Plan for Immediate Actions

16.2.1 Bottleneck Intersection Improvement

Since there is no space in the built-up area of the study area, it is very difficult to widen existing and new roads. Accordingly, based on the major problem of current traffic bottlenecks caused by lack of traffic capacity, it is necessary to increase road traffic capacity through the maximum use of the existing road facilities. The measure should take into account the need to decrease delay time and long queue during peak hours. Therefore, an improvement of an intersection by introducing a widening plan at the approach of the intersection with channelization is necessary, in addition to the traffic signal control system, for mitigating traffic congestion.

(1) Widening Plan at Approach of Intersection

This plan covers the signalized intersections at the locations which, based on the analysis of the travel time and distance diagram in the travel time survey, were considered to be traffic bottlenecks. In this analysis, the bottleneck point in the context of traffic engineering is defined as follows:

a) Travel speed of less than 10km/h, and
b) Ratio of total stopping time to total travel time indicating a ratio of above 50%.

The travel speed less than 10 km/h is obtained from travel speed survey result mentioned in Chapter 4.

At bottlenecks where such parameters are exceeded, the approach will be widened and/or traffic lights system will be improved. In this section, the widening plan will be introduced. As an example, improvement plans are shown in Figure 16.2-1. The left lane of the widening plan is improved by shifting to the centerline or median, and the improvement of channeling is also required. In determining the locations for the widening plan at the approach of intersection, the criteria used was the same as for the improvement of the traffic control system, the location to be improved is also the same as for bottlenecks.

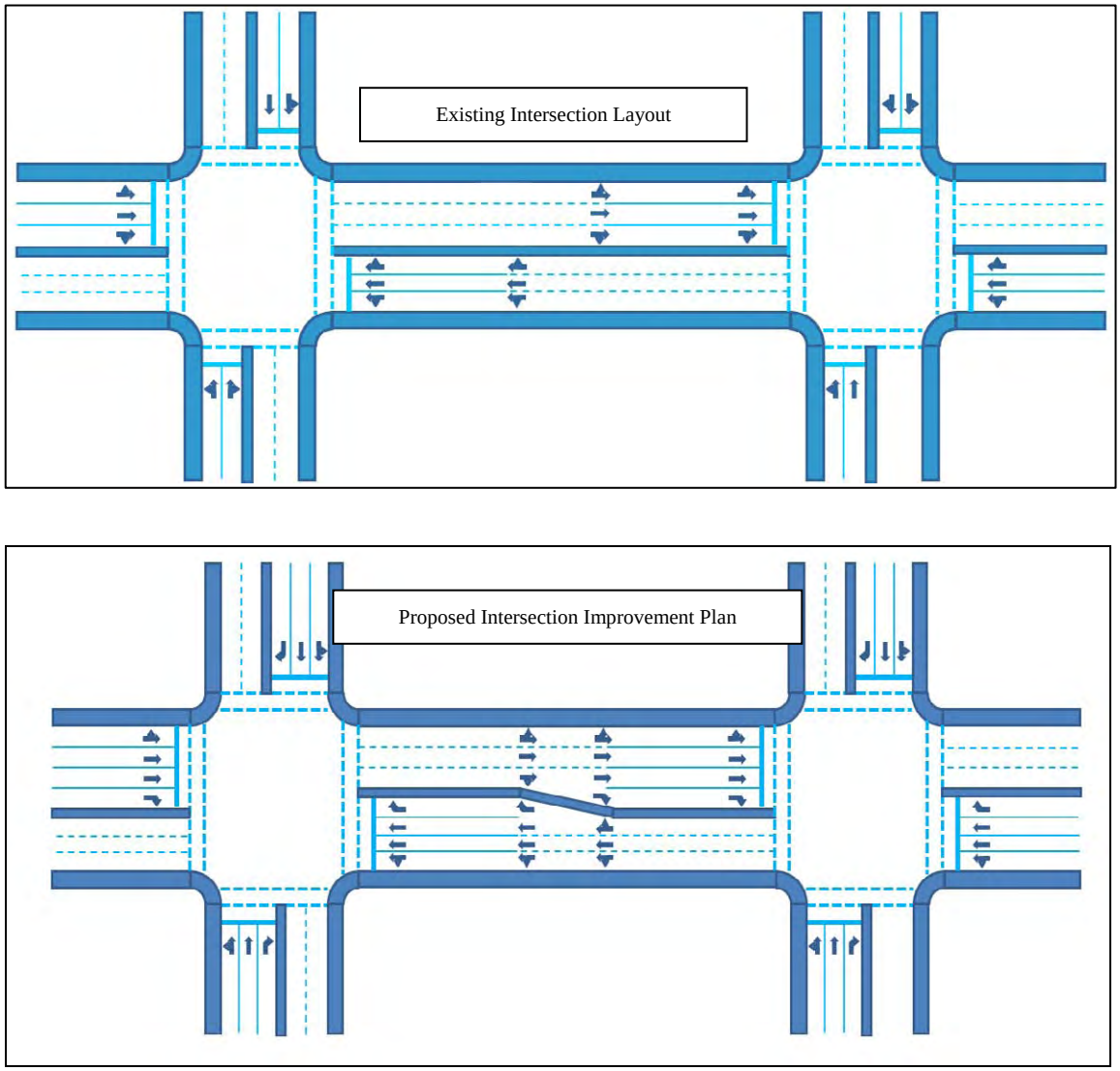


Figure 16.2-1 Intersection Improvement Plan

(2) Installation of Road Signs and Marking

In the intersection improvement, it is very important to install road sign and marking simultaneously. The road marking is a tool to provide guidance and information for drivers to drive safely and smoothly and for pedestrians to walk safely. It is recommended that road signs and makings shall be installed.

(3) Traffic Enforcement

As observing intersection of traffic movements at the intersections in Dhaka, traffic polices are greatly important roles to ensure safety and smooth traffic flow.

16.2.2 U-Turn and Right Turn Points at Mid-Block

Traffic congestion at U-turn and Right points is caused by conflicts between through traffic, right–turning traffic and U-turn traffic. It is, therefore, highly recommended that the

improvement of U-turn and right-turn point by geometric improvement and installation of new traffic signal lights at U-turn and right points should be considered in order to control both main traffic flow, right-turn flow and entering traffic flow. The plan proposes a standard design by type of U-turn and right-turn point.

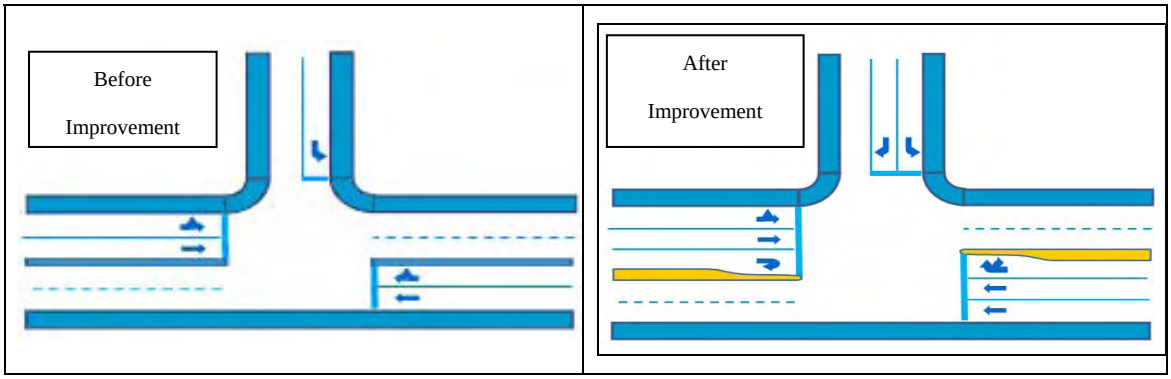


Figure 16.2-2 Type of Current U-turn Points

16.2.3 Traffic Response Signal Control System

In order to alleviate traffic congestion where there are near or over-saturated conditions, it is recommended to introduce a type of traffic response signal system. It is applicable for all traffic conditions, from under-saturation to over-saturation. As part of the advanced adopted traffic control system, this new signal control system was developed. The concept of control, system configuration and the effects of application are detailed below.

(1) Plan Locations

As shown in Figure 16.2-3, this plan will deal with the principal road network of signalized intersections, linked to key bottlenecks with near or over-saturated conditions following the analysis of the travel time survey. In determining the locations for the installation of traffic signal lights for the traffic response system, the following criteria were used:

Criteria for determining locations for installation of signal lights:

a) Traffic congestion sections indicating less than 10 km/h of average travel speed, normally identified as traffic congestion level in major cities in the world, due to long periods of waiting for traffic signal lights to change;
b) High ratio of total stopping time to total travel time:
c) Key bottlenecks bring about spill-back condition to downstream; and
d) Locations are located in the high principal road network in the action plan area.

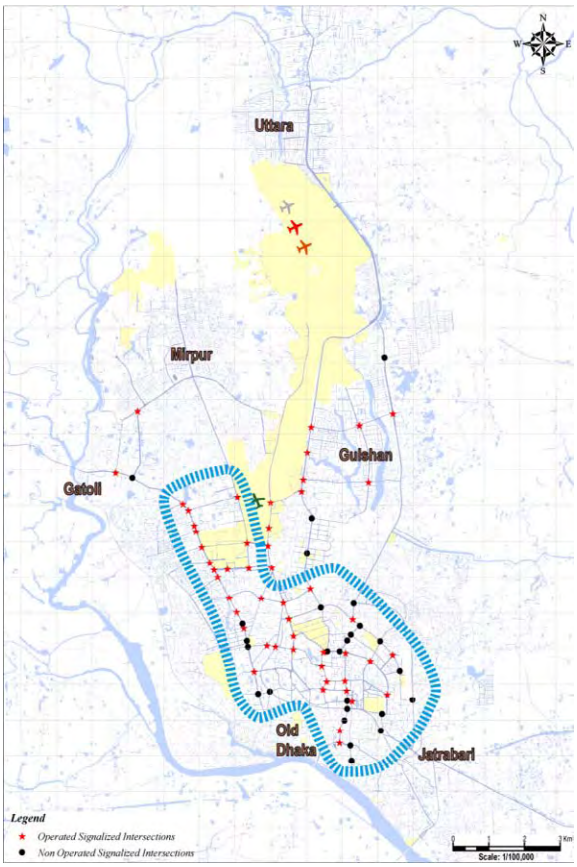


Figure 16.2-3 Proposed Area Traffic Signal Control Area

The intersections controlled by manual operation by the traffic police will be considered to be signalized intersections. Based on the foregoing consideration, the plan of the traffic response system covers the area bordered by Mirpur Road, Zehir Raihan Sharani, Bangladesh Railway and Pantha Path Roads. The total number of signalized intersections is 44 locations including 8 new signals.

(2) Concept of Real-time Control System

The concept of control is explained below.

a) When traffic demand is under-saturated, the aims of the system are not only to reduce delay and stops but also to make the traffic flow safe by moderating the speed of vehicles. It therefore uses a tool to set up an offset which corresponds to the cycle length and uses a pattern selection method for real-time offset control.

b) When traffic demand is nearly saturated, this system curbs congestion by improving the efficiency of green time at critical intersections and maximizing the traffic capacity. It is provided with a critical intersection control method (Congestion alleviation control) for achieving this. The congestion alleviation control directly calculates the split and cycle length every 5 minutes based on the queue and the traffic volumes calculated from vehicle detector information. This system also incorporates right turn vehicle actuation, which is run every second by a signal controller at each critical intersection.

c) When traffic demand is over-saturated, this system runs priority control for competing traffic flows at critical intersections. If congestion has exceeded a certain limit within a specific area such as the CBD of Dhaka, this system controls inflow to that area. Priority control is made possible by the congestion alleviation control function, and inflow control is provided by Intentional Priority Control.

(3) System Configuration and Summary of Functions

The system consists of sub-systems which are connected by means of an optical LAN and which share functions. As shown in Figure 16.2-4, the system consists of several Area Computers, a Traffic Information Processing Computer and a Signal Control Supervisor Computer.

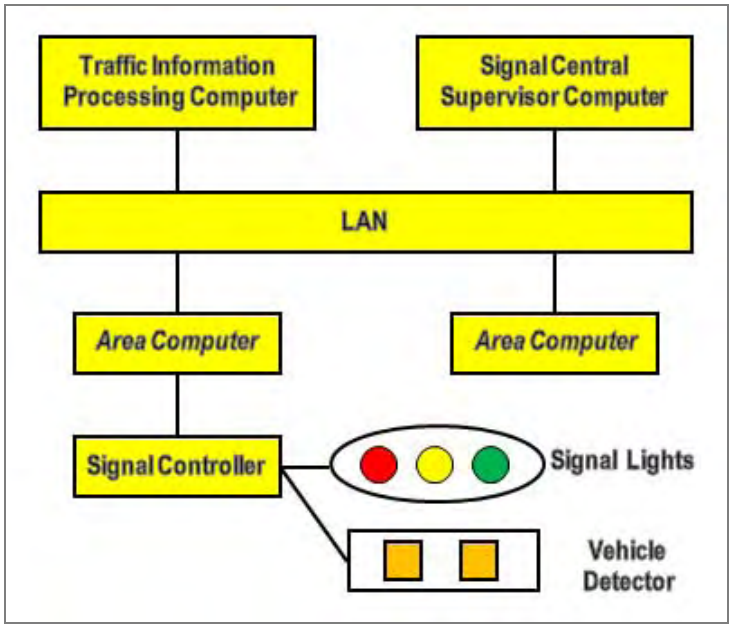


Figure 16.2-4 System Configuration

16.2.4 Improvement of Parking System

(1) General

The Study Area for the immediate action plan, in Dhaka CBD, is a densely built-up area that functions as a center of commercial and business activities. In the peak hour, all major roads in the area are congested due to the high concentration of commuters, and commercial and business activities. This congestion causes numerous problems, including the deterioration of the overall environment and commercial and business activities. Owing to the density of buildings in the area of the immediate action plan, it will be difficult to improve the road capacity to meet the demands of an ever increasing traffic volume of traffic despite unlimited investment in new road construction. Therefore, it is necessary start regulating the inflow of private vehicles by various traffic restrictions and increasing the use of public transport facilities. Unrestricted vehicle movement should be limited in the Dhaka CBD by means of

restraint by traffic control and by promotion of modal conversion from private vehicles use to public transportation use. It is, therefore, highly recommended that the parking system should be improved by introducing policy zoning for parking management. The main points of the recommendation are:

a) To ban on-street parking by zonal parking control in order to make more effective use of road capacity;
b) To manage parking duration on-street in order to increase the turnover rate;
c) To deter vehicles from long-term parking on-street by introducing a parking charge system in addition to the parking duration control; and
d) To develop off-street parking facilities with the proceeds from the parking charges.

In addition, the parking guidelines in construction of building that building owners should provide parking spaces that are applicable for building use and by total floor area shall be introduced in the plan.

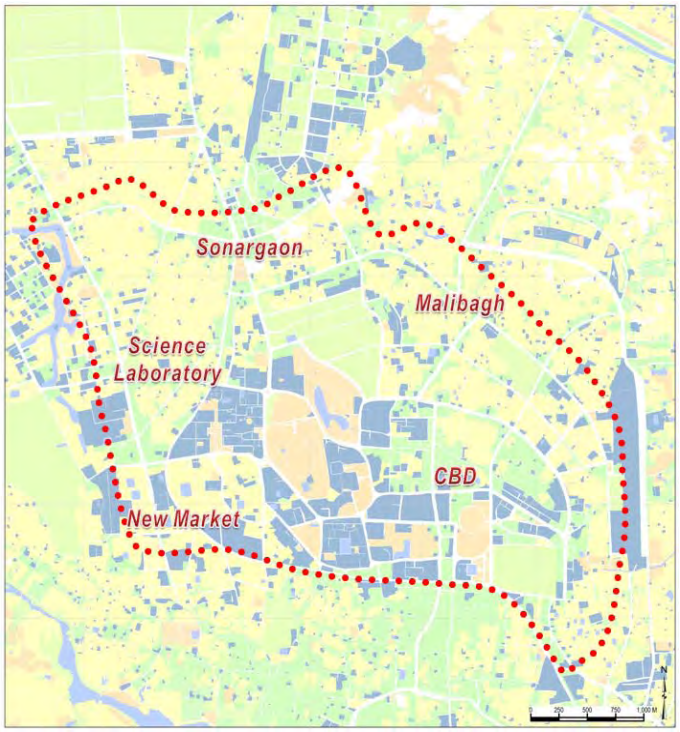


Figure 16.2-5 Parking Management Zone of CBD in Dhaka

(2) Locations for Parking Management System

Figure 16.2-5 shows the proposed area for the parking management system. With regard to on-street parking, Dhaka CBD has high parking demand, where on-street total parking occupancy during peak hours is very high. The parking purpose during the peak period is considered to be for commuting or business and shopping. With regard to the zonal share of building use, on-street parking management ought to be more strictly enforced for the area with

high parking occupancy and every effort should be taken to increase off-street parking.

(3) Area for Policy Zoning for Parking Management

The strictness of zonal parking management on street should be identified, based on the conditions of building use in the plan area. The policy zoning for parking management is effective for the traffic demand of commuting or business & shopping. The total building floor area is classified into four (4) categories of building use;

a) Residential,
b) Business & commercial, manufacture, public facility and education facility,
c) Mixed area residential & business, mixed area residential area & manufacture, and
d) Open-space & religious and others.

The generated and attracted traffic demand from/to building use of category 2) (Business & commercial, manufacture, public facility and education facility) are mostly considered to be for commuting or business & shopping. Figure 16.3.16 shows the distribution by the share of the total building floor area of category 2).

(4) Criteria for Parking Management Zone

Based on the foregoing situation, the parking management zone will be adopted at each zone listed below. In determining the area of the policy zoning for parking management, the following criteria are used. The areas of the policy zoning for parking management are defined as follows: Dhaka CBD is bordered by Mirpur Road Zehir Raihan Sharani, Bangladesh Railway and Pantha Path Roads.

Criteria for Determining the Area of the Parking Management Zone

a) Current high parking occupancy above 100% in midday peak hours
b) Share of total building floor area of category 2); Business & commercial, manufacture, public facility and education facility above 30%.

(5) Measure of Parking Management

The strictness of zonal parking management on-street was identified as being based on the category levels of the share of the total building floor area and the degree of parking occupancy. Such strictness of category levels was defined by two (2) types of parking management. Two kinds of prohibition measures may be recommended; one is the prohibition of on-street parking during 8:00-20:00 and the other is to charge all vehicles. These two ought to be applied at the same time within one system.

a) Prohibition of on-street parking during 8:00-20:00; and
b) Prohibition of on-street parking duration by introducing a parking charge system.

Under the recommended system every vehicle parked on a designated street must pay a certain amount of parking charge and cannot park continuously longer than three (3) hours at one time,

even by paying more.

16.2.5 Improvement of Traffic Safety Facilities

The traffic safety facilities are not sufficient in number, such as pedestrian crossings (including bridges), safety guard devices and traffic signs. Pedestrian behavior in the city is seen as lawless, in some cases, pedestrians cross streets in the middle section of roads (jay-walking), and they walk along vehicle lanes to shortcut their journey, whilst in bus waiting areas, pedestrians and passengers overflow onto vehicle lanes. Pedestrians in Egypt are generally low priority. It is observed that drivers generally pay little attention to pedestrians even when the pedestrians are using pedestrian crossings at intersections. This attitude must be changed, with pedestrian traffic considered as important as vehicular traffic through the provision of safe and convenient facilities and the according of sufficient priority to pedestrians on roads, including pedestrian education through campaigns. This section, in particular, discusses safety facilities for pedestrians in order to prevent traffic accidents involve to pedestrians, the objectives of development of pedestrian facilities in the CBD are:

a) To prevent “jay-walking” of pedestrians;
b) To ensure a safe pedestrian environment; and
c) To create “pedestrian-friendly” facilities.

(1) Plan Locations for Pedestrian Crossing

Pedestrian crossings with traffic light or scramble pedestrian crossings are highly recommended. In determining the locations for the installation of such safety facilities, the following criterion based on an analysis of the current situation was used:

Criteria for determining locations of pedestrian crossings with traffic lights or scramble pedestrian crossings:

a) Locations where both vehicles and pedestrian traffic intermingle to a high degree, and where there is a need to achieve a smooth and safe traffic flow; and
b) Traffic congestion sections indicating less than 10 km/h of average travel speed due to pedestrians crossing.

The main purposes of this are:

a) To raise the turnover rate in order to increase the parking capacity in the planned area;
b) To exclude long-stay vehicles, for instance vehicles that park throughout working time, in order to provide more opportunities to vehicles to park for shopping or business;
c) To promote the conversion from private mode to public mode; and
d) To increase funds to develop off-street parking facilities.

(2) Plan of Scramble Pedestrian Crossing

At principal road intersections with large volumes of pedestrians, where there are conflicts

between pedestrians and right-turning traffic, this leads to traffic accidents involving pedestrians. In order to reduce crossing times for pedestrians, by minimizing the carriageway crossing distance, and contributing to pedestrian safety, it is recommended that scramble pedestrian crossings should be installed at signalized intersections with high volumes of pedestrians crossing.

16.2.6 Traffic Safety Campaign and Education

It is necessary to introduce traffic safety education and traffic enforcement thoroughly to safeguard against increasing traffic accidents in DMA. The following are the proposed countermeasures for consideration to decrease traffic accidents based on the traffic characteristics and behavior in DMA.

(1) Introduction of System for Traffic Accident Data and Analysis

Currently, traffic accident data is collected manually and individually by traffic police. This is not an appropriate method to conduct traffic engineering analysis for formulating effective countermeasures to reduce traffic accidents. Therefore, it is necessary to introduce a system for integrating such processes as building a database on accidents, analyzing causes of accidents using analytical programs and examining suitable countermeasures in a unified way. The system gives priorities to identifying appropriate measures against locations of high traffic accidents.

(2) Implementation of Periodical Traffic Safety Campaign

Traffic safety campaign is one of the most effective countermeasures in reducing traffic accidents. Moreover, constant periodical implementation of these campaigns at a national, local and district level usually has a relatively greater impact on the public. The introduction of traffic safety education to the school curriculum is worth doing, as it is an experience the children could value over their entire life, positively influencing their behaviors future vehicle drivers. They could also exert a large influence over the traffic behavior of their family members. Examples of traffic safety education materials for children in Japan are shown in Figure 16.2-6.

Source: Japan Traffic Safety Education Association

Figure 16.2-6 Example of Traffic Education Sample for Children

16.2.7 Issue of Rickshaw

It is obvious that slow speeding Rickshaws are disturbing vehicle traffic flow mainly in CBD and Old Dhaka Area. At the same time, the mode of Rickshaw is widely accepted by thae Dhaka people. Observing past history of transport development in other mega cities in Asian counties, such slow vehicle traffic like Rickshaw has been selected out from the transport modes and exist only transport mode for tourists. Considering as such, number of Rickshaw should be decreased from present number. In this connection, it is recommended the following measures;

a) Registration of Rickshaw should be maintained at present level
b) Non licensed Rickshaw should be enforced to prohibit for its usage.
c) Rickshaw free road should be expanded to primary and secondary roads, especially DIT Road, etc.

16.2.8 Changes of Traffic Operation System as One-Way System

One of measures for achieving smooth traffic flow is to employ one-way system. To employ the one-way system is some conditions that are a) existence of parallel roads, b) detour distances being not long, etc. In the Dhaka context, it is rather difficult to adopt the one way system due to existence of Rickshaw. The Rickshaw pullers normally run through minimum distance roads so that those Rickshaw pullers do not sometimes follow the one-way streets. In order to achieve the smooth traffic, the employment of the one-way system is efficient measures. It is therefore recommended that the one-way system should be introduced at Banani, Gulshan 1 and 2, UTTRA areas.

16.2.9 Other Traffic Management Measures

In order to make maximum use of the road assets, the following measures should be introduced as;

a) Removal of obstructions of road spaces as construction materials, abandoned vehicles, garbage, etc.
b) Parking on the public buses and lagunas should be moved from road to public transport garages,

16.2.10 Strengthening the Traffic Enforcement by the Traffic Police

It is more effective to select certain regulations and enforce them at a selected time period, day of week etc. rather than try to enforce all the rules simultaneously. This method of selective enforcement makes a greater impression on drivers and is easier for the enforcement officers to perform their duties. In selecting the regulations to be enforced, violations or causes of traffic accidents that most frequently occur can be listed, based on analyses of traffic accidents, and then given a priority ranking. Those with high priority will then be selected for enforcement. The recommended areas for selective enforcement based on site observations and traffic accident data from traffic police are as follows:

a) Drunk-driving
b) Ignoring traffic signals
c) Illegal on-road stopping/parking at/near intersections, especially matatus
d) Pedestrians crossing the road without the Zebra or crosswalk marking

16.2.11 Coordination between Agencies

The traffic management activities are not implemented by the single ministry or authority. As seen in Table 16.2-1, there are many agencies are concerned to implement the traffic management measures. It is recommended that DTCB shall coordinate and assist each of ministries and agencies to be more effective to solve the bottlenecks of traffic management.

Table 16.2-1 Agencies Related to Traffic Management Activities

Issues		Countermeasures	DCC	DMP	MOE	DTCB
1	Traffic congestion at intersection (Key bottlenecks)	1 Improvement of geometic design of intersections	●			●
		2 Improvement of traffic signal control system	●			
		3 Improvement of traffic enforcement by traffic police		●		
2	Traffic congestion of Buses near Bus Stops	1 Improvement of Bus traffic displine program				●
		2 Improvement of traffic enforcement of discorderly Bus		●		
		3 Improvement of Bus facilities	●			
3	Improvement of traffic displine	1 Traffic education to Drivers, Rickshaw Puller, Pedestorian	●		●	●
		2 Traffic Enforcement		●		
4	Improvement of traffic management facilities	1 Improvement of road marking and signs	●			●
		2 Improvement of pedestorian facilities and sidewalk	●			
		3 Channelization of intersection	●			
5	Traffic Safety	1 Traffic safety campaign	●	●		●
		2 Traffic Enforcement		●		
6	Parking control	1 Traffic Enforcement by Traffic Police		●		●
		2 On street parking control, Introduction of toll parking facilities	●	●		
		3 development of off-street parking facility	●			

16.3 Medium and Long Term Plan

16.3.1 Traffic Information System

The medium and long-term plans related to traffic management are focused on the traffic information system and traffic control system from a medium and long-term perspective; the new system uses vehicles detectors which enable automatic and real-time collection of traffic information supplied to drivers through message sign boards.

(1) Concept for the Plan

The traffic information system should be installed stepwise, because the existing traffic signal control system must also continue to function. The system expansion should be done as follows:

a) Renewal for the functional upgrading of various traffic control installations of the control center and the local facilities of signal lights and traffic detectors.
b) Expansion of the traffic control area providing traffic signals at new intersections.
c) CCTV cameras should be installed at effective points, such as susceptible traffic congestion locations in order to expand traffic surveillance and to improve traffic control.
d) Expansion of the linear traffic-actuated control for each sub-area of the existing route.
e) Expansion of an area traffic control through the interconnection of sub-areas around the city center.
f) Improvement and expansion to achieve an advanced system which can control traffic quickly and in a timely manner, in response to real changes.
g) The system will be conceived with the improvement and expansion done in the following three stages:
h) 1st stage: installation of terminal equipment in the city center of each Governorate and

traffic signal local facilities, and individual linear controls and surveillance systems on major radial roads,

i) 2nd stage: improvement of traffic control operation transit to area traffic control, and

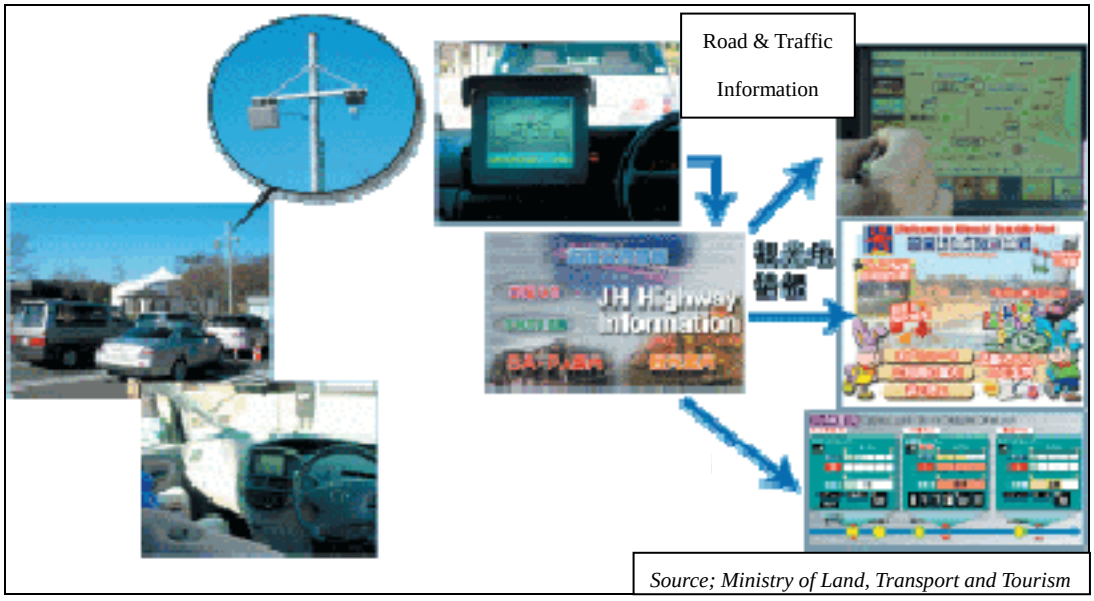
j) 3rd stage: Operational start-up of a concentrated-control advanced system.

(2) System Configuration

The system configuration is comprised of an information collection system, a data processing system and an information supply system.

(3) Traffic Information Supply Plan

It is proposed to install a system to supply information on road and traffic conditions, necessary for drivers, through a resident traffic manager, in addition to the traffic control system to control traffic signal lights. Figure 16.3-1 shows the relationship between the signal control system and the information system.



Source; Ministry of Land, Transport and Tourism

Figure 16.3-1 Relationship between Signal Control System and Information System

(4) Objectives for Supplying Road Traffic Information

By supplying emergency information such as accidents, abnormalities and traffic regulations, the following effects are aimed at:

a) Immediate notification of incidents to drivers;

b) Selection of routes, to prevent secondary congestion;

c) Traffic flows will be re-distributed as a result; and

d) Drivers can participate in the reduction of traffic problems by having such information and this will help to mitigate traffic congestion.

(5) Information Supply

The following information will be supplied:

a) Information concerning route prohibition;
b) Information on congestion and route guidance for detour;
c) Road and traffic regulations; and
d) Other public information.

(6) Location of information Indication Unit

The center will be housed in the traffic signal control center and the information indication units will be installed at major crossroads on arterial roads, as shown in Figure 16.3-1. The information supply system includes an exchange of road and traffic information between the proposed future urban expressway and the at-grade road network.

16.3.2 Bus Location Information System and Bus Priority Signal Control System

This section discusses the bus priority system for the medium and long terms by introducing the bus location information system and the bus priority signal control system at signalized intersection. This section introduces a brief description of these systems.

(1) Bus Location Information System

In terms of public transport, public transport service information such as time/fare table, route network, transfer points, operation schedule and bus location is considered to be important to the users. This information system does not alleviate traffic congestion directly, but indirectly by encouraging people to use public transport mode. To alleviate passenger discomfort caused by unpunctuality and to improve management of operation, the bus location information system enables individual display of the location of approaching buses at respective bus stops and integrated display of locations of all buses under operation at the control center. The system will enable public transport operators to manage and control their business operations effectively and efficiently. Furthermore, the system will alleviate users' frustration towards unreliable services by displaying relatively accurate bus arrival schedule at bus stops. The system, therefore, is expected to increase public mode users extensively. Figure 16.3-2 shows an information board of the system and a mechanism of the system.

Source; Ministry of Land, Transport and Tourism

Figure 16.3-2 Bus Location System

16.3.3 Electronic Demand Management Measures

The full-scale development of ITS will create the development of infrastructures, distribution of terminal equipment and diversification of applications. The information and functions for ITS services are roughly divided into nine (9) development areas such as advances in navigation systems, electronic toll collection system, assistance for safe driving system, optimization of traffic management system, increasing efficiency in road management system, support for public transport system, increasing efficiency in commercial vehicle operation system, support for emergency system, and support for emergency vehicle operations system. In terms of the electric demand management measures for the future, then advances in navigation system, the electronic toll collection system and the support for public transport system will helpfully reduce traffic congestion that causes a tremendous economic loss in monetary terms. This section introduces a brief description of such effective electric demand management measures.

(1) Advances in Navigation System

The advanced in navigation system is divided into two (2) users services as the provision of route guidance traffic information and the provision of destination-related information, and then into six (6) specific user services: 1) provision of route guidance information to drivers, 2) provision of information on other modes of transportation to drivers, 3) advanced provision of route guidance information, 4) advanced provision of information on other modes of transportation, 5) advanced provision of destination-related information, and 6) provision of destination-related information for drivers. Especially, in this specific user services, the description of services are shown below.

(2) Provision of Route Guidance Information to Drivers

a) Provide optimum route information;
b) Provide road traffic congestion;
c) Provide required travel time when congested; and

d) Guide along the selected route.

(3) Provision of Information on Other Modes of Transportation to Drivers

a) Provide information on other modes operations;
b) Provide information on parking availability; and
c) Provide information on availability of other public transportation service during emergency.

(4) Advanced Provision of Route Guidance Information

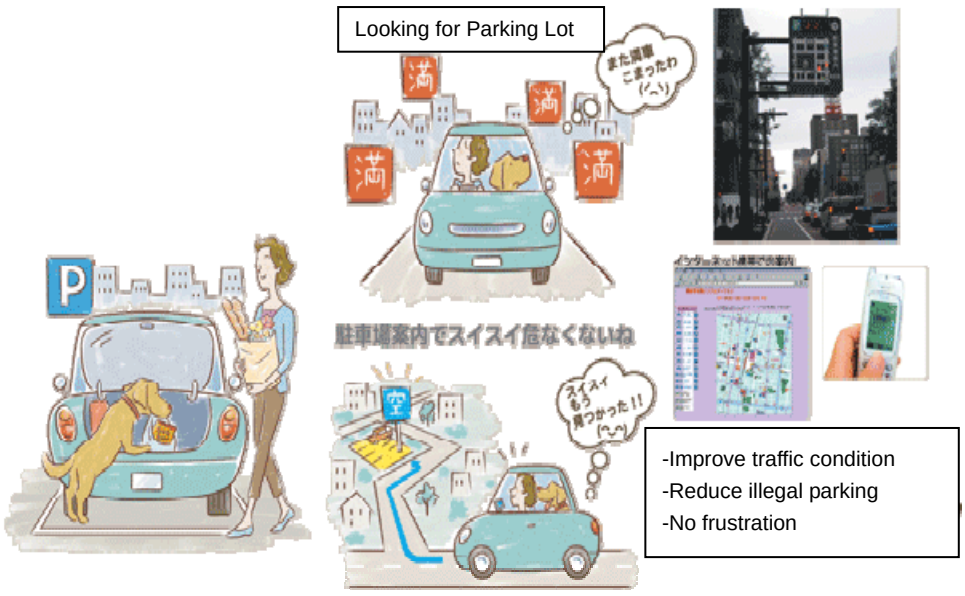
a) Provide optimum route information in advance; and
b) Provide road traffic information in advance.

(5) Advanced Provision of Information on Other Modes of Transportation

Provide information on other modes of transportation operations in advance; and • Provide information on parking availability in advance.

(6) Advanced Provision of Destination-related Information/, and Provision of Destination-related Information for Drivers.

Provide detailed information and reservation on destination facility and other in advance.



Source; Ministry of Land, Transport and Tourism

Figure 16.3-3 Parking Location System

16.4 Traffic Demand Management (TDM)

The gap between increasing transport demands and the capacity to accommodate the demands is hardly fulfilled only with physical development of infrastructures, because of serious constraints against funds, land space, time and technologies. Although the DHUTS Plan

addresses a massive amount of investments on structuring a transport network in the most effective and efficient manner, traffic congestion on roads will not be perfectly mitigated in the future, because traffic demands will be increasing faster and greater than capacity expansion by providing the physical infrastructures. Therefore, a vital policy must be addressed to manage and/or control the demand side, instead of concentrating only on the supply side. The transport demand is basically "derived" demand. It is rare that people travel only for a transport purpose. People travel, for instance to go to work, to school and/or to somewhere for recreation. The transport demand, therefore, is a demand of movement to attain some original purpose.

If many of those demands take place during a short period of time, the transport demand has a peak in consequence. In urban life, work starts in the morning, school begins in the morning. In the evening, work, school and major activities finish. The transport demand pattern for these activities, therefore, has peaks in the morning and evening as a result.

Transport Demand Management **(**TDM**)** is an idea to control transport demands mainly in the peak periods, because the peaks causes serious traffic congestion in urban areas, thereby producing economic losses in the society. Traffic congestion is often generated in specific time of day and in specific urban areas. The TDM aims at solving the traffic congestion, by leveling the peaks over time and space. Moreover, shifting use of people's transport modes from car to public transport is a significant aim of TDMs, because such a modal shift can increase the transport efficiency, or more people's travels with less vehicles, thereby yielding economic and environmental benefits in the society. Major tools of the TDM are summarized as follows:

(1) TDM Measures to Discourage Usage of Cars:

a) Pricing such as road pricing in CBD;
b) Surcharge tax on car ownership and car usage;
c) Enforcement such as traffic restriction by number plates of cars; and a "Three in One" policy that at least three passengers should be in one car;
d) Strict parking charge system in CBD or designated zone;

(2) TDM Measures to be Balanced Usage of Cars:

a) Staggered working hours;
b) Staggered working days;

(3) TDM Measures to Facilitate Usage of Public Transport:

a) Priority traffic treatments for public transport;
b) Common ticketing system among urban public transport;
c) Public cooperation, such as transport management association, staggered working hours, car-pool/van pool and so on.

It is noted that the above two types of measures are complementally effective to catalyze a

policy for people's modal shift to public transport. As a long-term TDM policy, one of notable measures is to guide the urbanization process towards more transit-driven urbanization that aims to develop urban centers in association with rail-based public transport system.

TDM 1: Introduction of a Common Ticketing System among Public Transport Modes; and
TDM-2: Introduction of a policy mix with a fuel tax increase and a parking charge system
Figure 16.4-1 shows the TDM concept.

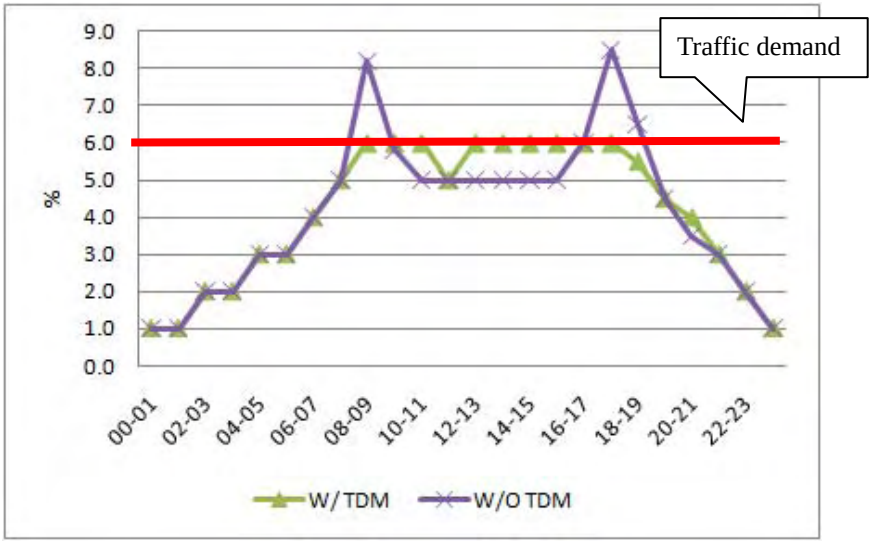


Figure 16.4-1 Concept of Traffic Demand Management

16.5 Preliminary Cost Estimates

This section deals with preliminary cost estimate for implementing the traffic management plan proposed by this Study. The rough cost of each countermeasure is estimated using the 2010 as the base years and under the following basic conditions.

(1) Stage Implementation Plan

Table 16.5-1 shows the proposed staging implementation plan based on the following factors;

- Urgency
- Maturity
- Project impact

(2) Preliminary Cost Estimate

Table 16.5-2 shows the total estimated project cost for each countermeasure under short term, medium term and long term periods by 2025. In the total cost, the road improvement costs are excluded. Personal costs for traffic education and enforcement are also excluded. This is due to personal cost being covered by operating expenditure.

(3) Project Impact Analysis

Project impact analysis of the traffic management measures is made and described in public experiment in Chapter 22.

Table 16.5-1 Phasing Implementation Plan

		Short Term (2010-2015)	Medium Term (2016-2020)	Long Term (2021-2025)
TM-1	Short Term Actions			
	1. Intersection Improvement	■		
	2. Parking System	■	■	
	3. Traffic Signal System	■	■	
	4. Traffic Safety Facilities	■		
	5. Traffic Safety Campaign	■	■	■
TM-2	Medium & Long Term Traffic Management Plan			
	1. Traffic Information System		■	■
	2. Bus Location System & Bus Priority Signal System		■	■
	3. Electronic Demand Management System		■	■
TM-3	Traffic Demand Management			
	1. Short Term Traffic Management	■		
	2. Medium & Long term Traffic Management		■	■

Source; JICA study Team

Table 16.5-2 Cost Estimate for Implementing Traffic Management Plan

		Unit	QTY	Cost (Million US$)	Short Term (2010-2015)	Medium Term (2016-2020)	Long Term (2021-2025)
TM-1	Short Term Actions						
	1. Intersection Improvement	No.	10	50.0	50.0		
	2. Parking System	No.	10	300.0	150.0	150.0	
	3. Traffic Signal System	No.	100	100.0	20.0	80.0	
	4. Traffic Safety Facilities	No.	200	50.0	25.0	25.0	
	5. Traffic Safety Campaign	yr,	16	16.0	6.0	5.0	5.0
TM-2	Medium & Long Term Traffic Management Plan						
	1. Traffic Information System	System	2	60.0		30.0	30.0
	2. Bus Location System & Bus Priority Signal System	System	2	60.0		30.0	30.0
	3. Electronic Demand Management System	System	1	30.0		30.0	
TM-3	Traffic Demand Management						
	1. Short Term Traffic Management	No.	1	5.0	5.0		
	2. Medium & Long term Traffic Management	System	2	60.0		30	30
Total				731.0	256.0	380.0	95.0

Source; JICA study Team

CHAPTER 17: INITIAL ENVIRONMENTAL EXAMINATION (IEE)

17.1 Procedure of IEE

Environmental and social impact which may be caused by a project must be assessed and examined from the earliest planning stage possible. Alternative proposals or minimization measures to prevent or reduce adverse impact must be examined and incorporated into the project plan. Hence, Initial Environmental Examination (IEE) is carried out as a part of the DHUTS. The scope of IEE is determined for different types of the DHUTS plans.

17.2 Environmental Legislation and Regulation in Bangladesh

17.2.1 The Bangladesh Environment Conservation Act

This Act is the basic environmental law in Bangladesh and provide for conservation of the environment, improvement of environmental standards and control and mitigation of environmental pollution. All the provisions are directed to protect the environment by any pollution and damage. This Act was established by the Department of Environment and empowers its Director General. According to this Act, an Environmental Clearance Certificate from the Director General must be issued before initiating any industrial activity or development project with negative environmental impacts. All projects and activates under the DHUTS need to comply with the provisions of this Act.

17.2.2 The Environment Conservation Rules

The Environment Conservation Rules, 1997 were issued as an enforcement law in exercise of the powers conferred by the Bangladesh Environment Conservation Act, 1995. These Rules provide for declaration of ecologically critical areas, classification of industries and development projects into 4 categories, procedures for issuing the Environmental Clearance Certificate and environmental standards.

According to these Rules, for the purpose of issuance of Environmental Clearance Certificate, the industrial units and development projects shall, in consideration of their site and impact on the environment, be classified into four categories: Green, Orange - A, Orange - B and Red. The Green categories are automatically granted the Clearance Certificate. The Orange categories must submit considerable further information and plans and may be subject to field inspection. The Orange-B categories must conduct an Initial Environmental Examination and prepare environmental management plans satisfactory to the Department. The Red categories must

conduct a detailed Environmental Impact Assessment and prepare environmental management plans.

Schedule 1 of the Rules provides classification of industrial units or projects based on its location and impact on environment. Orange-B category projects include "engineering works (up to 10 hundred thousand BDT capital.)", "construction, re-construction and extension of road (feeder road, local road)" and "construction, re-construction and extension of bridge (length below 100 meters)". Red category projects include "engineering works (capital above 10 hundred thousand BDT)", "construction, re-construction and expansion of road (regional, national and international)" and "construction, re-construction and expansion of bridge (length 100 meter and above)". The classification of traffic management plan is not stated in the Rules. Most of construction projects proposed in the DHUTS will be classified as Red categories.

17.2.3 Environmental Quality Standard

Environmental quality standards of air and noise were defined in "The Environment Conservation Rules, 1997". The air quality standards of 1997 were replaced by a new set in Statutory Regulatory Order No: 220-Law/2005. The SRO includes emission standards from several motor vehicles. These environmental standard levels are as follows:

Table 17.2-1 Standards for Air

Pollutant	Averaging Period	Bangladesh Standards
Carbon Monoxide (CO)	8-hour 1-hour	10 mg/m3 (9 ppm) 40 mg/m3 (35 ppm)
Lead (Pb)	Annual	0.5 µg/m3
Oxides of Nitrogen (NOx)	Annual	100 µg/m3 (0.053 ppm)
Suspended Particulate Matter (SPM)	8-hour	200 µg/m3
PM10	Annual 24-hour	50 µg/m3 150 µg/m3
PM2.5	Annual 24-hour	15 µg/m3 65 µg/m3
Ozone (O3)	1-hour 8-hour	235 µg/m3 (0.12 ppm) 157 µg/m3 (0.08 ppm)
Sulfur dioxide (SO2)	Annual 24-hour	80 µg/m3 (0.03 ppm) 365 µg/m3 (0.14 ppm)

Source: S. R. O. No: 220-Law/2005

Table 17.2-2 Standards for Sound

Category of areas	Standards determined at dBa unit	
	Day	Night
Silent zone	45	35
Residential area	50	40
Mixed area (mainly residential area, and also simultaneously used for commercial and industrial purposes)	60	50
Commercial area	70	60
Industrial area	75	70

1. *The time from 6 a.m. to 9 p.m. is counted as daytime.*
2. *The time from 9 p.m. to 6 a.m. is counted as night time.*
3. *Area up to a radius of 100 meters around hospitals or educational institutions or special institutions/ establishments identified/to be identified by the Government is designated as Silent Zones where use of horns of vehicles or other audio signals, and loudspeakers are prohibited.*

Source: The Environment Conservation Rules, 1997

17.2.4 Bangladesh Resettlement Policy

Bangladesh Resettlement Policy is based on:

a) Acquisition and Requisition of Immovable Property Ordinance of 1982 (ARIPO)
b) Cash Compensation by Law (CCL)
c) Land Acquisition Act 1994

Under these laws entitled are compensations to the formal titled owner for loss of land, houses and structures affected, loss of crops, trees and perennials and to sharecroppers, if applicable. The problems of present enforcement are:

a) No compensation is made for the people without formal title
b) The time when compensation paid is too slow, sometimes after the completion of the project, and
c) Too small amount is paid compared to the market value since the amount is predetermined based on the tax, paid for the assets to be acquired by the project, in previous years and people were used to report excessively small value to minimize tax.

Therefore, it is common practice in the international donors' project that the

a) Compensations are made to no titled people as well, in case they are regarded as equivalent as those with formal title, in if staying there long period peacefully without any claim/ dispute.
b) Compensation is made before relocation/ start of construction.
c) Compensation is made based on the actual market value able to purchase alternatives

Thus, necessary amount of compensations shall be made to all affected people, regardless of

titled or non-titled, except speculators and jumpers[1], so that they are able to regain their life and livelihood lost by the project. The government agency (usually Deputy Commissioner, DC) in charge of legal compensation pays the predetermined excessively small amount of compensation as specified in law only. Then the project executing agency shall pay the balance between the necessary amount and predetermined amount by Deputy Commissioner. Therefore, the affected people have to go to collect money to both Deputy Commissioner and executing agency.

17.2.5 JBIC Guidelines for Confirmation of Environmental and Social Considerations

Japan Bank for International Cooperation (JBIC) (Overseas economic cooperation section of JBIC was merged into JICA in October, 2008) established and made public "JBIC Guidelines for Confirmation of Environmental and Social Considerations" in 2002. The objective of the Guidelines is to encourage project proponents to implement appropriate environmental and social considerations in accordance with the Guidelines, by making clear its procedures (both before and after funding decisions are made), criteria for decision-making and requirements which projects subject to funding are to meet. In doing so, JBIC endeavors to ensure transparency, predictability and accountability in its confirmation of environmental and social considerations.

JICA will adopt new transport infrastructure projects to "New Guidelines for Environmental and Social Considerations" from July 2010[2].

17.3 Scoping for IEE

This environmental scoping is the first step to identify the environmental and social impacts of plans proposed by the DHUTS and means deciding whether the proposed plans is likely to have any impacts on the environment. The scope of IEE is prepared on the basis of the scoping results. The following tables summarize the scoping results of the DHUTS plans and show the expected possible adverse impacts and issues for the environmental and social considerations.

(1) Public Transport Development Plan

By this plan, Rickshaw pullers are affected and commercial/residential lands may be lost by the Passengers' Terminal Plan. Following indicates scoping results for Public Transport Development Plan.

[1] *Squatters who jump in the project site right before construction for the purpose to get compensation only*

[2] *http://www.jica.go.jp/english/operations/social_environmental/guideline/pdf/guideline100326.pdf*

Table 17.3-1 Scoping Result for Environmental and Social Considerations

Project Description Location: DMA Area Project Type: Rickshaw Plan. Passenger Terminal Plan		
Environmental Item 1)	Rating	Remarks
1. Air pollution	B	Pollution by exhaust gas and dust caused by construction works of new passenger terminal
2. Water pollution	B	Pollution of river and ground water by turbid water and spilling oil caused by construction works of new passenger terminal
3. Soil pollution	D	Little impacts on soil
4. Waste	B	Generation of construction waste caused by construction works of new passenger terminal. Increase in domestic waste from new passenger terminal
5. Noise and vibration	B	Generation of noise and vibration caused by construction works of new passenger terminal
6. Ground subsidence and soil erosion	D	No impacts on ground subsidence and soil erosion
7. Offensive odors	B	Bad smell of exhaust gas caused by construction works of new passenger terminal
8. Geographical features	D	No impacts on geographical features
9. Bottom sediment	D	No impacts on bottom sediment
10. Biota and ecosystem	D	Little impact on biota and ecosystem
11. Water usage	D	No impact
12. Accident	D	No impact
13. Global warming	C	Potential increase in greenhouse gas by increased vehicular traffic
14. Involuntary resettlement	A-B	Serious since loss of shelter is caused by land acquisition/prohibition of land occupation tentatively or permanently whichever
15. Local economy such as employment and livelihood etc.	A-B	Serious since loss of working place is caused by land acquisition/prohibition of land occupation tentatively or permanently whichever
16. Land use and utilization of local resources	B	Loss of agricultural land if any
17. Social institutions such as social infrastructure and local decision-making institutions	B	Confusion may be caused with local development planning section
18. Existing social infrastructures and services	B	Some infrastructures become tentatively unavailable during construction if any. Among all, road congestion can be serious
19. The poor, indigenous of ethnic people	B	Vulnerable will become poorer by loss of shelter/ working place
20. Misdistribution of benefit and damage	A-B	Non titled poor who does not get any compensation/ project benefit
21. Local conflict of interests	A-B	Conflict will be caused between displaced new comers and existing groups
22. Gender	B	Impoverishment makes gender gap wider
23. Children's rights	B	Impoverishment induces children's labour
24. Cultural heritage	C	Unknown since the location is not determined
25. Infectious diseases such as HIV/AIDS etc.	B	Impoverishment may force some mothers engaged in illegal business
26. Others	A-C	Impoverishment can induce human trafficking

Rating: A: Serious impact is expected. B: Some impact is expected.
C: Extent of impact is unknown. D: No impact is expected.

1) Reference: Japan International Cooperation Agency Guidelines for Environmental and Social Considerations (April 2004) "Appendix 3. Screening Format, Check Items"

Followings are supplementary descriptions about environmental impacts.

a) Improved traffic conditions may reduce air pollutant, noise, vibration and greenhouse gas as positive impact.

b) Generally, the compensation policy of Bangladesh is far from adequacy even if for titled and not at all for non-titled. Following are common social issues predicted for all type of projects hereafter.

c) The impact of loss of land for working places is serious since no proper compensation was made, with which able to purchase alternatives even if he has formal land title. If he doesn't have formal title, he wouldn't get any compensation.

d) Thus, impact to non-titled vulnerable group is critical. They may be just kicked out without compensation from the places of living and livelihood by the project. Among all, (1) shelters along road/railway side may have to move out, (2) makeshift shops along roads side may have to move out and (3) rickshaw pullers may lose their job.

e) As an conclusion, further impoverishment may force some of the Vulnerable group, especially "mothers" who are very keen to protect children for food and education, to be engaged in even if illegal economic activities such as prostitution/drug trafficking or to be a deceived/abducted migrant to overseas for money. Thus gender gaps are enlarged.

f) Serious conflict for territory may be caused between existing group who have been there long time and newly coming group who were forced to move by the project. For example, between resettled group and their receiving community, or between existing shopkeeper and displaced hawkers are such cases.

(2) Mass Rapid Transit Railway (MRT) Development Plan

This Study proposed three MRT lines as follows;

a) Line 4 is covering the eastern portion of Dhaka, starting from Uttara, north of Dhaka, through east of Zia International Airport, to Saidaba, south of Dhaka with a total length of 22 km. At-grade structure option is assumed inside Right of Way (ROW) of the existing Bangladesh Railway (BR) between UTTRA and Cantonment, while elevated structure option is assumed to be between Cantonment and Saidabad.

b) Line 5 is covering the center portion of Dhaka, and is a looped route passing Badra, Mirpur, Mohammadpur Tejgaonia and Badra again, with a total length of 22km. Due to the congested area along the corridor, elevated structure option is assumed to be all section.

c) Lone 6 is covering western half of DCC, with a total length of 22 km, from UTTRA phase 3 to Saidabad. At-grad structure option is assumed to be between UTTARA Phase 3 and

Pallabi while the elevated structure option is assumed to be the remaining section.

It is also assumed that width of ROW of the MRT line will be required to be 25 meters taking into account width of constructing stations. People to be displaced by land acquisition of 25 m width along the whole route is estimated at counting number of buildings using satellite images multiplied by the population densities[3]. In calculation, radius of the MRT route of each line is assumed to be 600 meters. Number of displaced people is calculated as follws;

	Proposed Length (km)	Number of displaced household	Number of displaced people	Location and characteristic of displaced people
Line 4	22	5,000	25,000	Illegal occupants inside ROW of railway
Line 5	22	2,090	10,450	Residents around proposed stations of central area
Line 6	22	970	4,900	Residents around stations of southern congested area

As shown in above Table, 4,900 to 25,000 people may be displaced by the construction MRT mainly due to the construction of stations except in Line 4 where people illegally construct their residence in side ROW of railways. Other than the locations of stations, number of displaced people is minimized using elevated type of railway. Among 3 MRT alternatives lines, Line 6 is considered to be environmentally most feasible, since the number of displaced people is the minimum.

The most serious issue to consider is impoverishment of displaced people without proper compensation can cause various social issues.

- ✓ Bus operators and drives may have to find another job if number of their users drastically decreased due to competition with MRT line while Rickshaw pullers may receive more job opportunities due to many customers.
- ✓ Serious traffic congestion can be caused for the construction of elevated lines during construction period. However, traffic congestion may be decreased after construction due to diversion form road traffic to railway traffic.
- ✓ Noise and vibration may be ignored during construction period.
- ✓ No natural reservation parks are located near the routes. Most of the trees to be affected /removed are very common species and artificially planted in the past, although some of them are a hundred years old and very tall, creating beautiful landscape, and are not

[3] In each building, 5 households with 5 persons per household are living respectively.

allowed to remove.

Thus, there are several environmental issues for the MRT alternatives, compared to other alternative such as BRT, especially during construction, in addition to the high initial cost. However once operated, the MRT is much cost effective as a total and far much environmentally feasible compared, without emissions such as from motorized vehicles. Thus as the sense of environment and social-economics, the MRT Line 6 is considered to be the most feasible alternative in all of the alternatives including BRT and improvement road network etc.

a) Scoping for Line 4 MRT

This is located inside the existing railway and the people to be displaced are illegal occupants of 5,000 families that are equivalent about 25,000 people.

Table 17.3-2 Scoping Result for Environmental and Social Considerations

Project Description Location: DCC Area Project Type: MRT Line No.4		
Environmental Item	Rating	Remarks
1. Air pollution	B	Pollution by exhaust gas and dust from construction works, Less total volume of pollutants by MRT operation than without plan
2. Water pollution	B	Pollution of river, pond and ground water by turbid water and spilling oil in construction phase
3. Soil pollution	D	Little impacts on soil
4. Waste	A	Generation of construction material waste, surplus soil and other general waste in construction phase
5. Noise and vibration	B	Generation of noise and vibration from construction machines and MRT operation of at grade and elevated structure option
6. Ground subsidence and soil erosion	B	Impact on groundwater in case of at grade and elevated structure option
7. Offensive odors	B	Bad smell of exhaust gas from construction machine operation
8. Geographical features	D	No impacts on geographical features
9. Bottom sediment	D	No impacts on bottom sediment
10. Biota and ecosystem	B	Impact on trees on roadside and center strip
11. Water usage	D	No impact
12. Accident	B	Construction workers accidents
13. Global warming	C	Generation of greenhouse gas from construction works, Less total volume of greenhouse gas by MRT operation than without plan
14. Involuntary resettlement	A	In the maximum, a total of 25,000 people may be displaced by the land acquisition in case of at grade and elevated structure option
15. Local economy such as employment and livelihood etc.	A	Serious since loss of working place is caused by land acquisition /prohibition of land occupation tentatively or permanently whichever

Project Description Location: DCC Area Project Type: MRT Line No.4		
Environmental Item	Rating	Remarks
16. Land use and utilization of local resources	D	No impact
17. Social institutions such as social infrastructure and local decision-making institutions	D	No impact
18. Existing social infrastructures and services	B	Some infrastructures become tentatively unavailable during construction if any.
19. The poor, indigenous of ethnic people	A	Vulnerable group will become poorer by loss of shelter/ working place
20. Misdistribution of benefit and damage	A	Non titled poor who does not get any compensation/ project benefit
21. Local conflict of interests	A	Conflict will be caused between displaced new comers and existing groups
22. Gender	B	Impoverishment makes gender gap wider
23. Children's rights	B	Impoverishment induces children's labour
24. Cultural heritage	C	Unknown since the location is not determined
25. Infectious diseases such as HIV/AIDS etc.	C	Impoverishment may force some mothers engaged in illegal business
26. Others	B	Impacts on hydrological situation of road drainage and flood pattern, Impacts on sunshine right in sides of elevated structures, Impoverishment induces human trafficking

Rating: A: Serious impact is expected. B: Some impact is expected.
C: Extent of impact is unknown. D: No impact is expected.

b) Scoping for Line 5 MRT

This is located at the central portion of residential/commercial areas. Many houses are densely built-up along the roads in this area in general. About 2,090 families (10,450 people) can be displaced at the time of construction of stations.

Table 17.3-3 Scoping Result for Environmental and Social Considerations

Project Description Location: DCC Area Project Type: MRT Line No.5		
Environmental Item	Rating	Remarks
1. Air pollution	B	Pollution by exhaust gas and dust from construction works, Less total volume of pollutants by MRT operation than without plan
2. Water pollution	B	Pollution of river, pond and ground water by turbid water and spilling oil in construction phase
3. Soil pollution	D	Little impacts on soil
4. Waste	A	Generation of construction material waste, surplus soil and other general waste in construction phase
5. Noise and vibration	B	Generation of noise and vibration from construction machines and MRT operation
6. Ground subsidence and soil erosion	B	Impact on groundwater, subsidence and surrounding elevated structures

Project Description Location: DCC Area Project Type: MRT Line No.5		
Environmental Item	Rating	Remarks
7. Offensive odors	B	Bad smell of exhaust gas from construction machine operation during construction
8. Geographical features	D	No impacts on geographical features
9. Bottom sediment	D	No impacts on bottom sediment
10. Biota and ecosystem	B	Impact on trees on roadside and center strip
11. Water usage	D	No impact
12. Accident	B	Construction workers accidents
13. Global warming	C	Generation of greenhouse gas from construction works, Less total volume of greenhouse gas by MRT operation than without plan
14. Involuntary resettlement	A	In the maximum, a total of 10,450 people can be displaced by the land acquisition in case of elevated structure option
15. Local economy such as employment and livelihood etc.	A	Serious since loss of working place is caused by land acquisition/prohibition of land occupation tentatively or permanently whichever
16. Land use and utilization of local resources	B	Loss of agricultural land if any
17. Social institutions such as social infrastructure and local decision-making institutions	B	Confusion may be caused with local development planning section
18. Existing social infrastructures and services	B	Some infrastructures become tentatively unavailable during construction if any. Among all, road congestion can be serious in construction phase
19. The poor, indigenous of ethnic people	B	Vulnerable group will become poorer by loss of shelter/ working place
20. Misdistribution of benefit and damage	B	Non titled poor who does not get any compensation/ project benefit
21. Local conflict of interests	B	Conflict will be caused between displaced new comers and existing groups
22. Gender	B	Impoverishment makes gender gap wider
23. Children's rights	B	Impoverishment induces children's labour
24. Cultural heritage	C	Unknown since the location is not determined
25. Infectious diseases such as HIV/AIDS etc.	C	Impoverishment may force some mothers engaged in illegal business
26. Others	B	Impacts on hydrological situation of road drainage and flood pattern, Impacts on sunshine right in sides of elevated structures, Impoverishment induces human trafficking

Rating: A: Serious impact is expected. B: Some impact is expected.
C: Extent of impact is unknown. D: No impact is expected.

c) Scoping for Line 6 MRT

For Line 6, the people to be displaced are the residents of about 970 families (4,900 people) near the proposed stations to be constructed in southern congested area. Northern portion of this route is not that congested, and location of stations will be chosen to minimize displacement of people.

Table 17.3-4 Scoping Result for Environmental and Social Considerations

Project Description Location: DCC Area Project Type: MRT No.6		
Environmental Item	Rating	Remarks
1. Air pollution	B	Pollution by exhaust gas and dust from construction works, Less total volume of pollutants by MRT operation than without plan
2. Water pollution	B	Pollution of river, pond and ground water by turbid water and spilling oil in construction phase
3. Soil pollution	D	Little impacts on soil
4. Waste	B	Generation of construction material waste, surplus soil and other general waste in construction phase
5. Noise and vibration	B	Generation of noise and vibration from construction machines and MRT operation
6. Ground subsidence and soil erosion	B	Impact on groundwater, subsidence and surrounding underground structures in construction phase
7. Offensive odors	B	Bad smell of exhaust gas from construction machine operation
8. Geographical features	D	No impacts on geographical features
9. Bottom sediment	D	No impacts on bottom sediment
10. Biota and ecosystem	B	Removal of very big and old trees in the government area shall be minimized, although they are very common species such as acacia, fig and mango only
11. Water usage	D	No impact
12. Accident	B	Construction workers accidents
13. Global warming	C	Generation of greenhouse gas from construction works, Less total volume of greenhouse gas by MRT operation than without plan
14. Involuntary resettlement	A	In the maximum, a total of 4,900 people can be displaced by the land acquisition in case of elevated structure plan
15. Local economy such as employment and livelihood etc.	B	Some impacts is expected since the route required some resettlement
16. Land use and utilization of local resources	B	Loss of agricultural land if any
17. Social institutions such as social infrastructure and local decision-making institutions	B	Confusion may be caused with local development planning section
18. Existing social infrastructures and services	B	Some infrastructures become tentatively unavailable during construction if any. Among all, road congestion can be serious in construction phase
19. The poor, indigenous of ethnic people	B	Vulnerable will become poorer by loss of shelter/ working place
20. Misdistribution of benefit and damage	B	Non titled poor who does not get any compensation/ project benefit
21. Local conflict of interests	B	Conflict will be caused between displaced new comers and existing groups
22. Gender	B	Impoverishment makes gender gap wider
23. Children's rights	B	Impoverishment induces children's labour
24. Cultural heritage	C	Unknown since the location is not determined
25. Infectious diseases such as HIV/AIDS etc.	C	Impoverishment may force some mothers engaged in illegal business

Project Description Location: DCC Area Project Type: MRT No.6		
Environmental Item	Rating	Remarks
26. Others	B	Impacts on hydrological situation of road drainage and flood pattern, Impacts on sunshine right in sides of elevated structures, Impoverishment induces human trafficking Landscape in this line shall be studied since historical buildings with beautiful old, tall trees are reserved here.

Rating: A: Serious impact is expected. B: Some impact is expected.
C: Extent of impact is unknown. D: No impact is expected.

(3) Proposed Road Development Plan

a) Road Network Development

Construction of new roads will acquire lands for economic activities and residence, resulting in causing serious social problems.

Table 17.3-5 Scoping Result for Environmental and Social Considerations

Project Description Location: DCC Area, DMA Area, RAJUK Area Project Type: Existing Road Improvement and New Road Construction		
Environmental Item	Rating	Remarks
1. Air pollution	B	Pollution by exhaust gas and dust from construction works and increased traffic vehicles
2. Water pollution	B	Pollution of river, pond and ground water by turbid water and spilling oil in construction phase
3. Soil pollution	D	Little impacts on soil
4. Waste	B	Generation of construction material waste, surplus soil and other general waste in construction phase
5. Noise and vibration	B	Generation of noise and vibration from construction machines and increased vehicle
6. Ground subsidence and soil erosion	C	Little impact on subsidence, Potential impact on soil erosion in river side area
7. Offensive odors	B	Bad smell of exhaust gas from construction machine operation
8. Geographical features	D	No impacts on geographical features
9. Bottom sediment	D	No impacts on bottom sediment
10. Biota and ecosystem	B	Loss of semi-natural vegetation and trees on roadside and center strip
11. Water usage	B	Use of irrigation water may be disturbed by construction new roads
12. Accident	D	No impact
13. Global warming	C	Potential increase in greenhouse gas by increased vehicles
14. Involuntary resettlement	A	Serious since loss of shelter is caused by land acquisition/prohibition of land occupation tentatively or permanently whichever
15. Local economy such as employment and livelihood etc.	B	Some impacts since loss of working place is caused by land acquisition/prohibition of land occupation tentatively or permanently whichever
16. Land use and utilization of local resources	B	Loss of agricultural land if any

Project Description Location: DCC Area, DMA Area, RAJUK Area Project Type: Existing Road Improvement and New Road Construction		
Environmental Item	Rating	Remarks
17. Social institutions such as social infrastructure and local decision-making institutions	B	Confusion may be caused with local development planning section
18. Existing social infrastructures and services	B	Some infrastructures become tentatively unavailable during construction if any. Among all, road congestion can be serious
19. The poor, indigenous of ethnic people	B	Vulnerable group will become poorer by loss of shelter/ working place
20. Misdistribution of benefit and damage	B	Non titled poor who does not get any compensation/ project benefit
21. Local conflict of interests	B	Conflict will be caused between displaced new comers and existing groups
22. Gender	B	Impoverishment makes gender gap wider
23. Children's rights	B	Impoverishment induces children's labour
24. Cultural heritage	C	Unknown since the location is not determined
25. Infectious diseases such as HIV/AIDS etc.	C	Impoverishment may force some mothers engaged in illegal business
26. Others	B-C	Impacts on hydrological situation of road drainage and flood pattern in low land, Impoverishment can induce human trafficking

Rating: A: Serious impact is expected. B: Some impact is expected.
C: Extent of impact is unknown. D: No impact is expected.

i. Because some of the construction sites are located in overcrowded urban area, the negative impacts during the construction phase will be serious.

ii. In case of new road construction in the superb, semi-natural vegetation will be lost.

iii. Serious social impacts are predicted as stated in Section 18.3(1).

b) Intersection Improvement (Flyover projects)

Construction of flyovers will acquire lands, at least during construction, for economic activities and residence, resulting in causing serious social problems.

Table 17.3-6 Scoping Result for Environmental and Social Considerations

Project Description Location: DCC Area Project Type: Flyover Construction Projects (5 site)		
Environmental Item	Rating	Remarks
1. Air pollution	B	Pollution by exhaust gas and dust from construction works and increased traffic vehicles
2. Water pollution	B	Pollution of river and ground water by turbid water and spilling oil in construction phase
3. Soil pollution	D	Little impacts on soil
4. Waste	B	Generation of construction material waste, surplus soil and other general waste in construction phase
5. Noise and vibration	B	Generation of noise and vibration from construction machines and increased vehicle
6. Ground subsidence and soil erosion	C	Potential impact on subsidence
7. Offensive odors	B	Bad smell of exhaust gas from construction machine operation

Project Description Location: DCC Area Project Type: Flyover Construction Projects (5 site)		
Environmental Item	Rating	Remarks
8. Geographical features	D	No impacts on geographical features
9. Bottom sediment	D	No impacts on bottom sediment
10. Biota and ecosystem	B	Loss of trees on roadside and center strip
11. Water usage	D	No impact
12. Accident	B	Accident while construction may caused
13. Global warming	C	Generation of greenhouse gas from construction works, Less total volume of greenhouse gas by improved traffic condition without projects
14. Involuntary resettlement	B	Serious or some impacts since loss of shelter is caused by land acquisition/prohibition of land occupation tentatively or permanently whichever
15. Local economy such as employment and livelihood etc.	B	Some impacts since loss of working place is caused by land acquisition/prohibition of land occupation tentatively or permanently whichever
16. Land use and utilization of local resources	B	Loss of agricultural land if any
17. Social institutions such as social infrastructure and local decision-making institutions	B	Confusion may be caused with local development planning section
18. Existing social infrastructures and services	B	Some infrastructures become tentatively unavailable during construction if any. Among all, road congestion can be serious
19. The poor, indigenous of ethnic people	B	Vulnerable group will become poorer by loss of shelter/ working place
20. Misdistribution of benefit and damage	B	Non titled poor who does not get any compensation/ project benefit
21. Local conflict of interests	B	Conflict will be caused between displaced new comers and existing groups
22. Gender	B	Impoverishment makes gender gap wider
23. Children's rights	B	Impoverishment induces children's labour
24. Cultural heritage	C	Unknown since the location is not determined
25. Infectious diseases such as HIV/AIDS etc.	C	Impoverishment may force some mothers engaged in illegal business
26. Others	B-C	Impacts on hydrological situation of road drainage, Impacts on sunshine right in sides of elevated structures, Impoverishment can induce human trafficking

Rating: A: Serious impact is expected. B: Some impact is expected.
C: Extent of impact is unknown .D: No impact is expected.

i. Because the construction sites are located in overcrowded urban area, the negative impacts during the construction phase will be serious.

ii. Serious social impacts are predicted as stated in Section 18.3(1).

c) Expressway Development Plan

Construction of expressways will acquire lands for economic activities and residence, resulting in causing serious social problems.

Table 17.3-7 Scoping Result for Environmental and Social Considerations

Project Description Location: DMA Area Project Type: Elevated Expressway Construction		
Environmental Item	Rating	Remarks
1. Air pollution	B	Pollution by exhaust gas and dust from construction works and increased traffic vehicles
2. Water pollution	B	Pollution of river and ground water by turbid water and spilling oil in construction phase
3. Soil pollution	D	Little impacts on soil
4. Waste	B	Generation of construction material waste, surplus soil and other general waste in construction phase
5. Noise and vibration	B	Generation of noise and vibration from construction machines and increased vehicle
6. Ground subsidence and soil erosion	C	Potential impact on subsidence
7. Offensive odors	B	Bad smell of exhaust gas from construction machine operation
8. Geographical features	D	No impacts on geographical features
9. Bottom sediment	D	No impacts on bottom sediment
10.Biota and ecosystem	B	Loss of trees on roadside and center strip
11. Water usage	D	No impact
12. Accident	B	Accident while construction may caused
13. Global warming	C	Generation of greenhouse gas from construction works, Less total volume of greenhouse gas by improved traffic condition without project
14. Involuntary resettlement	A-B	Serious or some impacts since loss of shelter is caused by land acquisition/prohibition of land occupation tentatively or permanently whichever
15. Local economy such as employment and livelihood etc.	B	Some imacts since loss of working place is caused by land acquisition/prohibition of land occupation tentatively or permanently whichever
16. Land use and utilization of local resources	B	Loss of agricultural land if any
17. Social institutions such as social infrastructure and local decision-making institutions	B	Confusion may be caused with local development planning section
18. Existing social infrastructures and services	A	Some infrastructures become tentatively unavailable during construction if any. Among all, road congestion can be serious
19. The poor, indigenous of ethnic people	A	Vulnerable will become poorer by loss of shelter/ working place
20. Misdistribution of benefit and damage	A	Non titled poor who does not get any compensation/ project benefit
21. Local conflict of interests	A	Conflict will be caused between displaced new comers and existing groups
22. Gender	A	Impoverishment makes gender gap wider
23. Children's rights	A	Impoverishment induces children's labour
24. Cultural heritage	C	Unknown since the location is not determined
25. Infectious diseases such as HIV/AIDS etc.	C	Impoverishment may force some mothers engaged in illegal business
26. Others	B-C	Impacts on hydrological situation of road drainage, Impacts on sunshine right in sides of elevated structures, Impoverishment can induce human trafficking

Rating: A: Serious impact is expected. B: Some impact is expected.
C: Extent of impact is unknown. D: No impact is expected.

i. Because the construction site is mainly located in overcrowded urban area, the negative impacts during the construction phase will be serious.
ii. Serious social impacts are predicted as stated in Section 18.3(1).

d) Eastern Fringe Road Plan

Construction/improvement of new road will acquire lands for economic activities and residence, resulting in causing serious social problems.

Table 17.3-8 Scoping Result for Environmental and Social Considerations

Project Description Location: DMA Area Project Type: New Road Construction		
Environmental Item	Rating	Remarks
1. Air pollution	B	Pollution by exhaust gas and dust from construction works and increased traffic vehicles
2. Water pollution	B	Pollution of river and ground water by turbid water and spilling oil in construction phase
3. Soil pollution	D	Little impacts on soil
4. Waste	B	Generation of construction material waste, surplus soil and other general waste in construction phase
5. Noise and vibration	B	Generation of noise and vibration from construction machines and increased vehicle
6. Ground subsidence and soil erosion	C	Potential impact on soil erosion in river side area
7. Offensive odors	B	Bad smell of exhaust gas from construction machine operation
8. Geographical features	D	No impacts on geographical features
9. Bottom sediment	D	No impacts on bottom sediment
10. Biota and ecosystem	B	Loss of semi-natural vegetation
11. Water usage	B	Use of irrigation water may be disturbed by construction new roads
12. Accident	D	No impact
13. Global warming	C	Potential increase in greenhouse gas by increased vehicles
14. Involuntary resettlement	A-B	Serious or some impacts since loss of shelter is caused by land acquisition/prohibition of land occupation tentatively or permanently whichever
15. Local economy such as employment and livelihood etc.	B	Some impacts since loss of working place is caused by land acquisition/prohibition of land occupation tentatively or permanently whichever
16. Land use and utilization of local resources	B	Loss of agricultural land if any
17. Social institutions such as social infrastructure and local decision-making institutions	B	Confusion may be caused with local development planning section
18. Existing social infrastructures and services	B	Some infrastructures become tentatively unavailable during construction if any.
19. The poor, indigenous of ethnic people	B	Vulnerable will become poorer by loss of shelter/ working place
20. Misdistribution of benefit and damage	A-B	Non titled poor who does not get any compensation/ project benefit
21. Local conflict of interests	A-B	Conflict will be caused between displaced new comers and existing groups
22. Gender	B	Impoverishment makes gender gap wider

Project Description Location: DMA Area Project Type: New Road Construction		
Environmental Item	Rating	Remarks
23. Children's rights	B	Impoverishment induces children's labour
24. Cultural heritage	C	Unknown since the location is not determined
25. Infectious diseases such as HIV/AIDS etc.	C	Impoverishment may force some mothers engaged in illegal business
26. Others	B-C	Impacts on hydrological situation of flood pattern in low land, Impoverishment can induce human trafficking

Rating: A: Serious impact is expected. B: Some impact is expected.
C: Extent of impact is unknown. D: No impact is expected.

i. The construction site is located in low land area, where has a function as retaining reservoir. Intercept of thy water flow by the road structure may cause change of the flood pattern.

ii. Semi-natural vegetation will be lost.

iii. Serious social impacts are predicted as stated in Section 18.3(1).

(4) Traffic Management Plans

Improvement of intersections will acquire lands for economic activities and residence, resulting in causing serious social problems.

Table 17.3-9 Scoping Result for Environmental and Social Considerations

Project Description Location: DMA Area Component of Plans: Improvement of Intersections, Parking System, Traffic Safety Facilities and Traffic Signal Control. Introduction of ITS System. Traffic Safety Education. Institutional Coordination		
Environmental Item	Rating	Remarks
1. Air pollution	D	No impacts on air pollution
2. Water pollution	D	No impacts on water pollution
3. Soil pollution	D	No impacts on soil pollution
4. Waste	D	No impacts on waste
5. Noise and vibration	D	No impacts on noise
6. Ground subsidence and soil erosion	D	No impacts on Ground subsidence and soil erosion
7. Offensive odors	D	No impacts on bottom sediment
8. Geographical features	D	No impacts on geographical features
9. Bottom sediment	D	No impacts on bottom sediment
10. Biota and ecosystem	D	No impacts on biota and ecosystem
11. Water usage	D	No impact
12. Accident	D	No impact
13. Global warming	D	No impacts on greenhouse gas
14. Involuntary resettlement	B-C	Serious if loss of shelter is caused by land acquisition/prohibition of land occupation tentatively or permanently whichever

Project Description Location: DMA Area Component of Plans: Improvement of Intersections, Parking System, Traffic Safety Facilities and Traffic Signal Control. Introduction of ITS System. Traffic Safety Education. Institutional Coordination		
Environmental Item	Rating	Remarks
15. Local economy such as employment and livelihood etc.	B-C	Serious if loss of working place is caused by land acquisition/prohibition of land occupation tentatively or permanently whichever
16. Land use and utilization of local resources	B-D	Loss of agricultural land if any
17. Social institutions such as social infrastructure and local decision-making institutions	B-D	Confusion may be caused with local development planning section
18. Existing social infrastructures and services	B-C	Some infrastructures become tentatively unavailable during construction if any. Among all, road congestion can be serious
19. The poor, indigenous of ethnic people	B-C	Venerable may become poorer by loss of shelter/ working place
20. Misdistribution of benefit and damage	B-C	Non titled poor who does not get any compensation/ project benefit
21. Local conflict of interests	B-C	Conflict will be caused between displaced new comers and existing groups
22. Gender	B-C	Impoverishment makes gender gap wider
23. Children's rights	B-C	Impoverishment induces children's labour
24. Cultural heritage	C	Unknown since the location is not determined
25. Infectious diseases such as HIV/AIDS etc.	B-C	Impoverishment may force some mothers engaged in illegal business
26. Others	B-C	Impoverishment can induce human trafficking

Rating: A: Serious impact is expected. B: Some impact is expected.
C: Extent of impact is unknown. D: No impact is expected.

i. Improved traffic conditions may reduce air pollutant, noise, vibration and greenhouse gas as positive impact.

ii. Serious social impacts are predicted as stated in Section 17.3(1).

17.4 Expected Environmental Impacts of the High Priority Plan

(1) MRT Line 6 Development Plan

The conceptual plan proposed in STP is 16 km in length from Plallabi to Saidabad Bus Station with 16 stations. The following alternatives will be considered in the next Feasibility Study stage.

Table 17.4-1 MRT Line 6 Conceptual Plan

	Alternatives	
Operational section	16 km (Plallabi - Saidabad Bus Station)	22 km (Uttara - Saidabad Bus Station)
Structure	All elevated or surface section	Elevated or surface section in northern part and elevated or underground section in southern part

(2) Construction Phase

Table 17.4-2 Expected Environmental Impacts and Mitigation Measures

Environmental Item	Environmental Impact	Mitigation Measure/ Environmental Monitoring Plan
Natural Environment/ Environmental Pollution		
Air pollution and Offensive odors	Convey of construction materials, heavy equipment operation and earthworks will generate harmful dust. Heavy equipment operation will also generate exhaust gas with pollutants and bad smell. The impact is more serious in residential or comitial area including Pallabi, Mirpur, Tejgaon and Saidabad. These dust and exhaust gas are unavoidable to some degree.	The contractor should keep their construction equipment proper condition to avoid the imperfect combustion. To reduce the dust, periodical water spray should be taken. If the residents and pedestrians complain about the dust and gas, the consultant of the supervision and the contractors should reconsider the construction technique.
Water pollution	Earthworks will generate turbid water. The turbid water is unavoidable to some degree. Spilling oil and petrol from construction equipment are water pollution sources.	The contractor should keep their construction equipment in proper condition to avoid accidental leaking of the oil and petrol. In construction works near water bodies such as Uttara – Pallabi and Taltala section, the consultant of supervision and contractor should monitor and control the turbid water as necessary.
Waste	The construction works will generate construction wastes such as surplus soil, fragments of construction materials and garbage from construction workers. In case of underground structure, the surplus soil will be enormous amount.	The contractor should consider the proper reuse and disposal plan, and manage the construction wastes. The consultant of supervision should monitor the waste disposal.
Noise and vibration	Heavy equipment operation and earthworks will generate noise and vibration. The impact is more serious in residential or educational area. These noise and vibration is unavoidable to some degree.	To mitigate the nuisance by noise and vibration, the consultant of the construction planning should consider the proper execution scheme. The construction works during night time should be avoided in residential or educational areas. The contractor should keep their construction equipment in proper condition. If the residents or college people complain about noise and vibration, the consultant of the supervision and the contractors should reconsider the construction technique.
Ground subsidence	In case of underground structure, construction works may have a serious impact on groundwater condition. Change of groundwater condition may cause ground subsidence and have an influence on basements of existing buildings.	In the planning stage, detailed geological and hydrological surveys should be conducted. The proper structure design and construction technique should be considered. The consultant of supervision and contractor should monitor the ground subsidence. If the ground subsidence occurs, the consultant of the supervision and the contractors should reconsider the construction technique

Environmental Item	Environmental Impact	Mitigation Measure/ Environmental Monitoring Plan
Biota and ecosystem	There are well-grown roadside trees including Bo tree, Rain tree and Flame tree along main roads especially in the southern section, which create the good scenery and shaded areas for rest. Most center strips of main roads are planted trees including Asoka and Sacred fig. The construction works in the roads will require felling the trees in the center strip. In case of elevated structure in park and university area in the southern section, cutting branches of the roadside trees will be required. In case of elevated structure around Baldha Garden, the dust, exhaust gas and decrease in sunlight may have an influence on the rare tree spices.	Study on the species and quantity of these trees subject to felling should be conducted. Compensatory planting or replanting should be conducted as necessary.
Global warming	The construction works will emit sizable greenhouse gases.	The balance of greenhouse gas between the emission volume in the construction phase and the reduction volume in the operation phase should be considered.
Social Environment		
Involuntary Resettlement	Resettlement of residents including titled and non-titled caused by land acquisition or prohibition of residing along railway/road.	Implement socio-economic survey and prepare proper Resettlement Action Plan (RAP) together with public consultation of affected people. External monitoring of resettlement activity by the third party and reporting of monitoring results to JICA is required. In the RAP, rehabilitation plan for affected people shall be included. Especially poor and vulnerable people, such as land occupants for residing/ business and rickshaw pullers, shall be properly consulted and job training/ micro credit shall be offered.
Local economy such as employment and livelihood etc.	Loss of access to business caused by land acquisition or prohibition of occupying railway/road sides.	
The poor, indigenous of ethnic people	Due to the insufficient compensation policy, not only these who have no title to be compensated but also those titled to be compensated can not enjoy enough money/ alternatives to restore/ regain the life/ livelihood that have been lost by the project. Thus, more or less of people affected by the project can be impoverished severely and various negative impacts can be caused, such as gender, HIV, children's labor and human trafficking.	
Gender		
Children's rights		
Infectious diseases such as HIV/AIDS etc.		
Human trafficking		
Existing social infrastructures and services	Serious traffic jam	To be established are proper traffic control and construction management including examination of designing and construction method.
Use of water	Use of irrigation water may be disturbed by the new road	Plan proper drainage system
Local conflict of interests	Conflict ma be caused between exiting group and resettled group for shelter and business issues.	Sufficient consultation together with both group shall be done beforehand.

(3) Operation Phase

Table 17.4-3 Expected Environmental Impacts and Mitigation Measures

Environmental Item	Environmental Impact	Mitigation Measure/ Environmental Monitoring Plan
Natural Environment/ Environmental Pollution		
Air pollution	The operation of MRT will improve congestion of roads along the MRT line and efficiency of mobility of the vehicles. Consequently, increase in air pollution in Dhaka city may be mitigated as a positive impact.	To identify the positive impact, the air quality along the MRT line should be monitored for long term.
Noise and vibration	The MRT operation will generate noise and vibration. The noise and vibration level is related to the structure, car type, distance from the carriageway and surrounding condition. Especially in zone surrounded by high buildings, the noise level will increase by echo effect.	In the planning stage, the countermeasures against noise and vibration should be conducted. The noise along the MRT line should be periodically monitored. If the noise level reaches a significant level such as exceeding environmental standard, the mitigation measures on noise control should be conducted.
Global warming	The MRT operation may reduce the total emission of greenhouse gas from transport sector in Dhaka city.	The balance of greenhouse gas between the emission volume in the construction phase and the reduction volume in the operation phase should be considered.
Hydrological situation	Uttara – Pallabi section is located through low land area, where has a function as retaining reservoir. Intercept of the water flow by the MRT structure may cause change of the flood pattern. In urban area, the MRT structure may have an influence on hydrological situation of road drainage.	In the planning stage, the detailed hydrological and drainage capacity survey should be conducted. The proper structure design should be considered.
Sunshine Right	In case of elevated structure in residential or urban area, decrease in sunlight may have an influence on the local residents.	In the planning stage, the proper structure design should be considered. Regulations on sunshine right have not been prepared yet in Bangladesh. However, if the residents complain about sunshine right, the mitigation measures including compensation should be considered.
Social Environment		
Local economy such as employment and livelihood etc.	Decrease of the number of customers for rickshaw pullers and roadside business.	RAPas stated inside Table 17.4-1(1) shall cover this issue.
Landscape	Elevated MRT may affect the landscape for historical/ national/ religious monuments.	Prepare montage photo/ sketches and implement random perception survey

(4) Moghbazar Flyover Project

The conceptual design is 1190 m in length, 14.5 m in width with 4 lanes.

a) Construction Phase

Table 17.4-4 Expected Environmental Impacts and Mitigation Measures

Environmental Item	Environmental Impact	Mitigation Measure/ Environmental Monitoring Plan
Natural Environment/ Environmental Pollution		
Air pollution and Offensive odors	Convey of construction materials, heavy equipment operation and earthworks will generate harmful dust. Heavy equipment operation will also generate exhaust gas with pollutants and bad smell. These dust and exhaust gas are unavoidable to some degree.	The contractor should keep their construction equipment proper condition to avoid the imperfect combustion. To reduce the dust, periodical water spray should be taken. If the residents and pedestrians complain about the dust and gas, the consultant of the supervision and the contractors should reconsider the construction technique.
Water pollution	Earthworks will generate turbid water. The turbid water is unavoidable to some degree. Spilling oil and petrol from construction equipment are water pollution sources.	The contractor should keep their construction equipment in proper condition to avoid accidental leaking of the oil and petrol.
Waste	The construction works will generate construction wastes such as surplus soil, fragments of construction materials and garbage from construction workers.	The contractor should consider the proper reuse and disposal plan, and manage the construction wastes. The consultant of supervision should monitor the waste disposal.
Noise and vibration	Heavy equipment operation and earthworks will generate noise and vibration. These noise and vibration is unavoidable to some degree.	To mitigate the nuisance by noise and vibration, the consultant of the construction planning should consider the proper execution scheme. The contractor should keep their construction equipment in proper condition. If the residents and pedestrians complain about noise and vibration, the consultant of the supervision and the contractors should reconsider the construction technique.
Ground subsidence	Construction works may have an impact on ground condition. Change of ground condition may cause ground subsidence and have an influence on basements of existing buildings.	In the planning stage, detailed geological surveys should be conducted. The proper structure design and construction technique should be considered.
Biota and ecosystem	Most center strip of the target road is planted trees including Asoka and Sacred fig. The construction works will require felling these trees.	Study on the species and quantity of these trees subject to felling should be conducted. Compensatory planting should be conducted as necessary.
Social Environment		
Same social impacts as of the case of "MRT Line 6 Development Plan" can be predicted		

b) Operation Phase

Table 17.4-5 Expected Environmental Impacts and Mitigation Measures

Environmental Item	Environmental Impact	Mitigation Measure/ Environmental Monitoring Plan
Natural Environment/ Environmental Pollution		
Air pollution	The exhaust gas from increased traffic may deteriorate the air pollution to a significant level.	Because pollutants in micro-environment such as the flyover site are different from those in local monitoring station, the air quality at the site should be periodically monitored. If the air pollution level exceeds significantly the environmental standard, the regulations on fuel quality, imported old cars and emission gas control should be prepared as necessary.
Noise and vibration	The level of the noise and vibration caused by increased traffic will increase. Especially in zone surrounded by high buildings such as Moghbazar intersection, the noise level will increase by echo effect.	In the planning stage, the countermeasures against noise and vibration should be conducted. The noise along the flyover should be periodically monitored. If the noise level reaches a significant level such as exceeding environmental standard, the mitigation measures on noise control should be conducted.
Hydrological situation	The flyover structure may have an influence on hydrological situation of road drainage.	In the planning stage, the drainage capacity survey should be conducted. The proper drainage design should be considered.
Sunshine Right	Decrease in sunlight caused by the flyover structure may have an influence on the local residents.	In the planning stage, the proper structure design should be considered. If the residents complain about sunshine right, the mitigation measures including compensation should be considered.
Social Environment		
Landscape	Elevated MRT may affect the landscape for historical/ national/ religious monuments.	Prepare montage photo/ sketches and implement random perception survey

17.5 Scope of EIA for the High Priority Plan

17.5.1 MRT Line 6 Development Plan

(1) Natural Environment

Air pollution, water pollution, construction waste, noise, vibration and ground subsidence caused by the plan implementation should be considered in the EIA including the prediction of impacts, mitigation measures, and monitoring and management plans in the feasibility study stage. Since there are many grown trees on road sides and center strip, a study on the species and quantity of these trees subject to felling should be carried out in the EIA. To identify greenhouse gas reduction effect, the balance of greenhouse gas between the emission volume in the construction phase and the reduction volume in operation phase should be also considered in the EIA.

(2) Social Environment

Following activities are required:

a) Socio-economic survey on the affected people
b) Public consultation including landscape issue
c) Preparing Resettlement Action Plan (RAP) in accordance with Resettlement Policy OP4.12, World Bank 2004 or equivalent.
d) External monitoring of resettlement activity including post-resettlement condition

17.5.2 Moghbazar Flyover Project

(1) Natural Environment

Air pollution, water pollution, construction waste, noise and vibration caused by the project implementation should be considered in the EIA including the prediction of impacts, mitigation measures, and monitoring and management plans in the feasibility study stage. Since there are many grown trees on the road center strip, a study on the species and quantity of these trees subject to felling should be carried out in the EIA.

(2) Social Environment

Studies as of MRT Line 6.

17.6 Public Participation

Public consultation was held on 1st February 2010 at BRAC center for the purpose to disseminate the project information to stakeholders. About 50 people from governmental/private sectors, research/educational institutions and media were participated and discussion was chaired by DTCB. Most of the participants expressed favor to the study approach/project, although some requested to implement careful environmental/ social impact assessment. Detail of the public consultation is presented in the appendix. In the future at the feasibility study stages, public consultation is required for individual project.

CHAPTER 18: EVALUATION OF DHUTS PLAN

18.1 Introduction

As the comprehensive urban transport master plan formulated with various project packages; such as public transport development plans, road network development plans, intermodal transport plans, traffic management plans, environment assessments, financing procurement plan, organization/institution plan, etc., should be evaluated from the integrated viewpoints, the economic and financial assessment is one of them that is examined in this chapter.

18.2 Outline of the Analysis

(1) Major purposes

Major purposes of the analysis in this chapter are as follows;

- To judge economic feasibilities of the proposed master plan, from economic viewpoint in general/regional economic aspects, as a whole,
- To clarify overall financial feasibilities from view points of financing for project implementation by availability of budget allocation/financial viability in each stage of the plan, and
- To assess financial feasibility of MRT Line No. 6 that is of the highest priority among many projects proposed in the master plan.

(2) Methodology

a) General

Economic evaluation is carried out through economic cash flow analysis based on 'benefit-cost' analysis, that is analyzed comparatively both of so called 'social benefits' derived by the project in the regional economy and 'social costs' necessary for the project implementation.

Above economic evaluation was conducted in terms of comparative analysis between benefits and costs. Benefits contain time saving benefit and vehicle cost saving benefit, while costs consist of construction cost and operation/maintenance cost. Indicator adopted here for economic evaluation is conventional "Economic Internal Rate of Return (EIRR)". Evaluation was conducted on the basis of transport demand forecast. Transport demand

forecast was conducted in such two cases that one case is “With” objective transport plans and the other case is “Without” them.

b) Objective Transport Plans

Objective transport plans to be evaluated in this chapter is (a) MRT Line 6 being selected through certain screening procedure discussed in chapter 14, (b) All transport plans proposed by The JICA Study Team including MRT Line6, 3 BRT lines, highway development plan, urban expressway.

c) Unit Cost

In the evaluation, some basic parameters were estimated such as (a) Travel Time Cost (TTC) and (b) Vehicle Operating Cost (VOC). The procedure and estimation results of these parameters are shown as follows:

i. Travel Time Cost (TTC)

TTC was estimated in terms of two kinds. The one is the cost per passenger, and the other is the cost per vehicle. The former value was applied to public transport evaluation while the latter cost was for road traffic, which was converted to passenger cars by utilizing of “Passenger Car equivalent Unit (PCU)”. The procedure for estimation of above two kinds of unit cost is given as follows:

- Passenger based TTC

In the study, travel time unit cost (BDT per one hour or one minute) was estimated in year of 2025. Estimation was conducted based on traditional income approach, in which travel time unit cost can be calculated in such a way that average monthly salary is simply divided by average working hours. Monthly salary is varying depending on income level, therefore the travel time unit cost is obviously different by each income group. We’ve taken into account of such income stratum which affect on the differentiation of travel time unit cost. As a result, travel time unit cost was estimated by each income level. Furthermore, in obtaining such unit cost in year of 2025, GDP growth rate was taken into account since average monthly salary is closely related to GDP. On the basis of above-mentioned ideas and procedures, passenger based travel time unit cost in year of 2025 was estimated as follows:

Table 18.2-1 Passenger Based Unit TTC

A: Income level [BDT/Month]	2009			2025			
	B:	C:	D:	E:	F:	G:	
	Monthly Income [BDT/Month]	Working Hour [hours/Month]	Unit TTC [BDT/hour]	Monthly Income [BDT/Month]	Working Hour [hours/Month]	Unit TTC	
						[BDT/hour]	[BDT/minute
LIG: 0-20,000	12,700	160	80	14,200	160	89	**1.48**
MIG: 20,000-50,000	30,900	160	193	34,800	160	217	**3.62**
HIG: 50,000-	93,400	160	584	119,300	160	746	**12.43**
Average	35,900	160	224	73,100	160	457	7.6116

Footnote: A: LIG, MIG and HIG stand for "Low/Medium/High Income Group" respectively.
B, C, F: Source of data is projected value drawn from *IMF, "IMF Report for the 2008 Article 4 Consultation Report", 2008*
D: Values were obtained through [B] divided by [C]
E: Projected value based on [B] by using of average GDP growth rate
G: Final results

- Vehicle based TTC

As for vehicle based TTC, existing survey outputs in Bangladesh is available. Road and Highway Department (RHD) opened the survey report to public in 2005, of which title is "RHD Road User Cost Annual Report for 2004 - 2005", 2005. According to the report, vehicle based travel time unit costs are estimated by each transport mode. However, the report was published in 2005. Therefore some calibration of the estimation is necessary in order to obtain the value available in corresponding year of 2025. One of methodologies for cost calibration is the application of adjustment factor taking account of GDP growth rate. The methodology was applied on the basis of such notion that travel time cost is closely related to user's income level which is connected to GDP growth rate. As a result, vehicle based travel time unit cost was estimated through review of the RHD report and calibration of the value on the report taking account of GDP growth rate, which was projected in the study. The travel time unit costs by each transport mode in the RHD report are as follows:

Table 18.2-2 Unit TTC for Each Transport Mode

	TTC per capita [BDT/hour]
Bus	17.6
Car	30.9
Auto-Rickshaw	16.4
Rickshaw	4.1

Footnote: estimation of value for Rickshaw is
for year of 2002, while other vehicles are for year of 2004
Source: *"RHD Road User Cost Annual Report for 2004 - 2005", 2005*

Above unit costs were converted to the unique passenger vehicle cost averaged by share of volume of each type of vehicle, which were forecasted trough the study. Furthermore, the value of RHD report were calibrated to the value for year of 2025 since they were

estimated in the past i.e., value for Rickshaw is for year 2002 while the other vehicle is for 2004. Converted and calibrated unit TTC is shown as follows:

Table 18.2-3 Vehicle Based Unit TTC

	A: Unit TTC [BDT/min. /person]	B: Occupancy [persons /vehicle]	C: PCU	D: Unit TTC [BDT/PCU]	E: Share of traffic volume
Rickshaw	0.383	2	0.4	1.91	0.43
Car	1.288	2.71	1	3.49	0.3
Bus	0.733	38.23	2	14.02	0.1
Auto-Rickshaw	0.683	2.42	0.7	2.36	0.18
F: Converted Unit TTC [BDT/Car]				**3.63**	

Footnote: A: The values were drawn from the RHD report, which were converted from original BD T/hour to BDT/minute.
B, C, E: The value was obtained through the JICA Study Team.
D: The value was converted [A] value to BDT/PCU.
A formula is: [A] times [B] divided by [C] times [GDP growth rate from 2002 or 2004 to 2025]
F: The value was averaged value of [D] by using of [E].
A formula is: Σ [[A] times [E]] divided by Σ [E]

ii. Vehicle Operating Cost (VOC)

After careful examination of VOC estimated by RHD, the JICA Study Team judges that VOC can be applicable for this study. It is therefore estimated on the basis of RHD report. The values on RHD report were for the year of 2004, therefore those values were calibrated taking into account of GDP growth rate to meet our study requirement. Also the unit VOC was converted to the value for unique passenger vehicle by using of PCU and traffic volume which was obtained through the study. The estimated values in the RHD report, which are the base value for our study are shown as follows:

Table 18.2-4 Unit VOC

Unit VOC [BDT/Vehicle*km]		
Bus	**Car**	**Auto-Rickshaw**
15.69	10.18	2.52

Footnote: Above values are for year of 2004
Source: *"RHD Road User Cost Annual Report for 2004 - 2005", 2005*

Above unit costs were converted to the unique passenger vehicle cost averaged by share of volume of each type of vehicle, which were forecasted trough the study. Furthermore, the values of RHD report were calibrated to the value for year of 2025 since they were estimated for year of 2004. Converted and calibrated unit VOC are shown as follows:

Table 18.2-5 Converted Unit VOC

	A: Unit VOC [BDT/Vehicle*km]	B: PCU	C: VOC [BDT/PCU]	D: Share of Traffic Volume
Bus	15.69	2	7.85	0.1
Car	10.18	1	10.18	0.3
Auto-Rickshaw	2.52	0.7	3.6	0.18
E: Converted Unit VOC [BDT/Car*km]		**19.25**		

Footnote: A: Values came from Table 19.3-4
B, D: Values were estimated through the study
E: The value was averaged value of [C] by using of [D].
A formula is: Σ[[C] times [D]] divided by Σ[D]

18.3 Results of the Evaluation

18.3.1 Evaluation of MRT Line 6

(1) User Benefit Estimate[1]

On the basis of unit TTC, unit VOC, as well as transport demand forecast, of which main outputs are the reduced time and vehicle running kilometer being expected by introducing MRT Line 6, economic evaluation of MRT Line 6 was conducted from the viewpoint of user benefit. Estimated time saving and vehicle kilometer saving being brought about by introduction of MRT Line 6 are shown in the following table. As seen in the table, time saving is expected to about 670 thousand hours per day, while vehicle kilometer saving is about 1.8 million vehicle kilometer per day.

Table 18.3-1 Saving Time and Vehicle Kilometer

Time Saving [hours/day]		
	MRT & BRT	118,700
	Cars	-785,000
Vehicle Kilometer Saving [Vehicle*Kilometer/day]		
	Cars	-1,787,600

Source: JICA Study Team

Above time saving value and vehicle kilometer saving value were converted to annual value, then those values were converted to monetary value through application of unit TTC and VOC, which were discussed in the previous part in this chapter. As a result, total economic effect on monetary basis was estimated as 370 million US dollars per year.

(2) Economic Internal Rate of Return (EIRR)

Based on the results of the user benefit estimate shown in the above section, and cost of MRT Line 6, which were specified in section 19.4 in chapter 19, introduction of MRT Line

[1] *User benefit is estimated on the basis of "total cost approach".*

6 was evaluated in terms of EIRR. As a result, Economic Internal Rate of Return was estimated as 25.7 %.

18.3.2 Evaluation of the Study Team Transport Master Plan

(1) User Benefit Estimate

As similarly done in the previous section, user benefit for introduction of all kinds of transport plans, which includes (a) three BRT Lines, (b) MRT Line 6 with upgraded BR line, (c) Highways and Urban Expressway, and (d) Road traffic management policy, proposed by The JICA Study Team was estimated. (Estimated costs with respect to these transport plans are specified in chapter 21.) Estimated time saving and vehicle kilometer saving being brought about by introduction of The JICA Study Team Transport Master Plan (the Master Plan) are shown in the following table. As seen in the table, time saving is expected to about 4,700 thousand hours per day, while vehicle kilometer saving is about 33.6 million vehicle kilometer per day.

Table 18.3-2 Saving Time and Vehicle Kilometer

Time Saving [hours/day]		
	MRT & BRT	580,500
	Cars	-5,274,800
	TOTAL	**-4,694,300**
Vehicle Kilometer Saving [Vehicle*Kilometer/day]		
	Cars	**-33,604,900**

Source: JICA Study Team

Above time saving value and vehicle kilometer saving value were converted to annual value, then those values were converted to monetary value through application of unit TTC and VOC. As a result, total economic effect on monetary basis was estimated as 1,309 million USD per year.

It is noted that saving in vehicle operating cost is huge amount of 1,250 million USD while saving of travel time cost is smaller amount of 59 million USD per year. This is largely due to mode change from vehicle traffic to MRT Line 6.

(2) Economic Internal Rate of Return (EIRR)

Based on the results of the user benefit estimate shown in the above section, and cost of the Master Plan, specified in Table 18.3-3, the Master Plan was evaluated in terms of EIRR. As a result, Economic Internal Rate of Return was estimated as 25.7 %.

In this computation, the following assumptions are made:

a) Project life of the DHUTS plan is 30 years from 2025
b) Taking into account opportunity capital rate in Bangladesh, a discount rate is assumed to be 12 % in case of computation of NPV and BC ratio
c) It is assumed that all construction costs will be invested in 2024 and while the same amount of benefits in 2025 will be generated during project life period.

Table 18.3-3 Results of the Economic Evaluation for the JICA Study Team Transport Master Plan

Items				Results
Project Cost [Million US$]	Total Costs (without discount)			7,491
		Construction Cost		4,755
			MRT (Line 6)	1,641
			BRT (Line 1, 2, 3)	591
			Road Development	1,596
			Traffic Management and other public transport	927
		Operation/Management Cost [for 30 years]		2,736
			MRT (Line 6)	902
			BRT (Line 1, 2, 3)	736
			Road Development	766
			Traffic Management	279
Benefits in 2025 [Million US $]	Total Benefit			1,309
		Saving in Time Cost		59
		Saving in Vehicle Operating Cost		1,250
Economic indicators	Benefit Present Value [for 30 years] [Million US$] *Discount rate is assumed to be 12 % p.a.			5,055
	EIRR [%]			25.7

Source: JICA Study Team

(3) Benefit Cost Ratio (BCR)

BCR was estimated for references. Under the assumption of some discount rate 4.0%, 10.0%, 12.0% and 25.7%, BCR was estimated raging from 1.00 to 3.57 shown in the following table.

Table 18.3-4 BCR for the JICA Study Team Transport Master Plan

Discount Rate [%]	BCR
4.0	3.57
10.0	2.18
12.0	2.23
25.7	1.00

Note; Project life is assumed to be 30 years

Table 18.3-5 Cost Benefit Stream

			Undiscounted Cost / Benefit					Discounted Cost / Benefit				
		Discount Rate	Construction Cost	Operation & Maitenance Cost	Cost Total	Benefit	Net Benefit	Construction Cost	Operation & Maitenance Cost	Cost Total	Benefit	Net Benefit
0	2024	1.000	4,755	0	4,755		-4,755	4,755	0	4,755	0	-4,755
1	2025	0.893	0	91	91	1,309	1,218	0	81	81	1,169	1,087
2	2026	0.797	0	91	91	1,309	1,218	0	73	73	1,044	971
3	2027	0.712	0	91	91	1,309	1,218	0	65	65	932	867
4	2028	0.636	0	91	91	1,309	1,218	0	58	58	832	774
5	2029	0.567	0	91	91	1,309	1,218	0	52	52	743	691
6	2030	0.507	0	91	91	1,309	1,218	0	46	46	663	617
7	2031	0.452	0	91	91	1,309	1,218	0	41	41	592	551
8	2032	0.404	0	91	91	1,309	1,218	0	37	37	529	492
9	2033	0.361	0	91	91	1,309	1,218	0	33	33	472	439
10	2034	0.322	0	91	91	1,309	1,218	0	29	29	421	392
11	2035	0.287	0	91	91	1,309	1,218	0	26	26	376	350
12	2036	0.257	0	91	91	1,309	1,218	0	23	23	336	313
13	2037	0.229	0	91	91	1,309	1,218	0	21	21	300	279
14	2038	0.205	0	91	91	1,309	1,218	0	19	19	268	249
15	2039	0.183	0	91	91	1,309	1,218	0	17	17	239	222
16	2040	0.163	0	91	91	1,309	1,218	0	15	15	214	199
17	2041	0.146	0	91	91	1,309	1,218	0	13	13	191	177
18	2042	0.130	0	91	91	1,309	1,218	0	12	12	170	158
19	2043	0.116	0	91	91	1,309	1,218	0	11	11	152	141
20	2044	0.104	0	91	91	1,309	1,218	0	9	9	136	126
21	2045	0.093	0	91	91	1,309	1,218	0	8	8	121	113
22	2046	0.083	0	91	91	1,309	1,218	0	8	8	108	101
23	2047	0.074	0	91	91	1,309	1,218	0	7	7	97	90
24	2048	0.066	0	91	91	1,309	1,218	0	6	6	86	80
25	2049	0.059	0	91	91	1,309	1,218	0	5	5	77	72
26	2050	0.053	0	91	91	1,309	1,218	0	5	5	69	64
27	2051	0.047	0	91	91	1,309	1,218	0	4	4	61	57
28	2052	0.042	0	91	91	1,309	1,218	0	4	4	55	51
29	2053	0.037	0	91	91	1,309	1,218	0	3	3	49	46
30	2054	0.033	0	91	91	1,309	1,218	0	3	3	44	41
Total			4,755	2,736	7,491	39,270	31,779	4,755	735	5,490	10,544	5,055

NPV	5,055
B/C Ratio	1.92
EIRR	25.7%

Notes; 1) Discount rate is assumed to be 12 % p.a.

2) Project life is assumed to be 30 years

CHAPTER 19: PRELIMINARY STUDY ON MRT LINE 6

19.1 Introduction

DHUTS proposed various types of Mass Transit System in Dhaka, which consists of rail based Mass Rapid Transit (MRT) and Bus Rapid Transit (BRT). In rail based MRT we identified five routs of which three lines are originally proposed by STP to be introduced by the year 2024. Other two MRT lines are proposed by DHUTS to be introduced by year 2050.

Among the MRT lines, we identified MRT line 6 as the highest priority in terms of passenger demand and effectiveness of overall transport network in Dhaka. Here in this chapter, preliminary engineering, technical and operational considerations are discussed to make/ facilitate basic framework for the development of MRT Line 6. Based on the framework, it is recommended to conduct further Feasibility Study (FS) in the later stage.

This Chapter discusses the following four subjects: (1) Preliminary engineering considerations on MRT Line 6, (2) Preliminary cost estimate and project implementation schedule and (3) Preliminary economic and financial analysis

19.2 Preliminary Engineering Study on MRT Line 6

19.2.1 Proposed Route

According to the STP proposal, the Line 6 connects between Pallabi in the north of the City and Saidabad in the south with the total length of 16 km. Taking into account future urbanization of Dhaka city, DHUTS recommended its extension from Pallabi to Uttara-3 area, where RAJUK has undertaken large housing developments. Total length of proposed Line 6 is 22 km from Uttara-3 to Saidabad including 6 km of extension. Thus the Line 6 has two terminals and 16 intermediate stations.

Most of the line 6 will be possible to be constructed by using existing road space. In our preliminary examination, most of the existing roads that the line 6 will run (i.e., Begun Rokeya Sharani, Khamabari Road, Airport Road, Sonargaon Road, Kataban Road, Kazi Nazul Islam Avenue, S. Kamruzzaman Sharani, and Hotkhola Road) have at least three lanes of carriage way and 2 m width of pedestrian pass in both directions and center divider. Therefore, it is possible to provide permanent way either in the center of existing road space or underground throughout the corridor between Pallabi to Saidabad. There is no existing road in the extension section from Pallabi to Uttara-3, and therefore, it is necessary to examine possible route in this section during the FS stage.

The possible alignment and structure are shown in Table 19.2-1. We identified that the entire route from Uttara-3 to Saidabad is divided into three sections, (1) grade separation, (2) elevated structure and (3) underground structure. According to STP, it is proposed to construct viaduct structure using center divider of the roads from Pallabi to Chandrima -Uddaan with the length of about 7 km and then, the permanent way goes down at Sher-e-Bangla Nagar and underground line reaches at Saidabad with about 9 km length. In our initial investigation, the transit section from viaduct to underground at Sher-e-Bangla Nagar seems to be technically possible but further detailed study will be necessary.

The section from Shonargaon to Saidabad is the most heavily congested area in the city with the concentration of office and commercial buildings as well as many government facilities. In this area, there are at least two alternatives of the route: one is the route running through Shonargaon Road, Kataban Road, Dhaka University, BUET, Kamruzzaman Sharani and reaching at Saidabad; and the other is the route running through Kazi Nazul Islam Avenue, Kamruzzaman Sharani and reaching at Saidabad. More detailed study of route selection in this area will be necessary during the FS stage.

19.2.2 Initial Operation Planning

Based on the future traffic demand forecast, the passenger of the MRT line 6 is estimated to be some 64,000 pph (passengers per hour) at peak hour in both directions in the year 2025. If around 70% of the passengers will go from the north to the south, i.e., from the areas of Uttara, Pallabi and Mirpur to downtown in the morning peak hour, it is estimated to be about 40,000 pph at peak hour in one direction in the year 2025. We use this figure for preliminary operational planning.

Basic assumptions made for the preparation of initial operation plan are summarized as follows:

a) Crash Load 250/㎡ (AW3)
b) Average Train Speed 32km/hr Max. Speed 80 km/hr
c) Commercial Length 22 km
d) Turn round time at both terminals 4 minuets
e) Stop time at Stations 40 seconds
f) All train runs through between two terminals. (No Express Service)
g) Train composition 10 cars
h) Number of Stations 16 (Station) + 2 (Terminal)

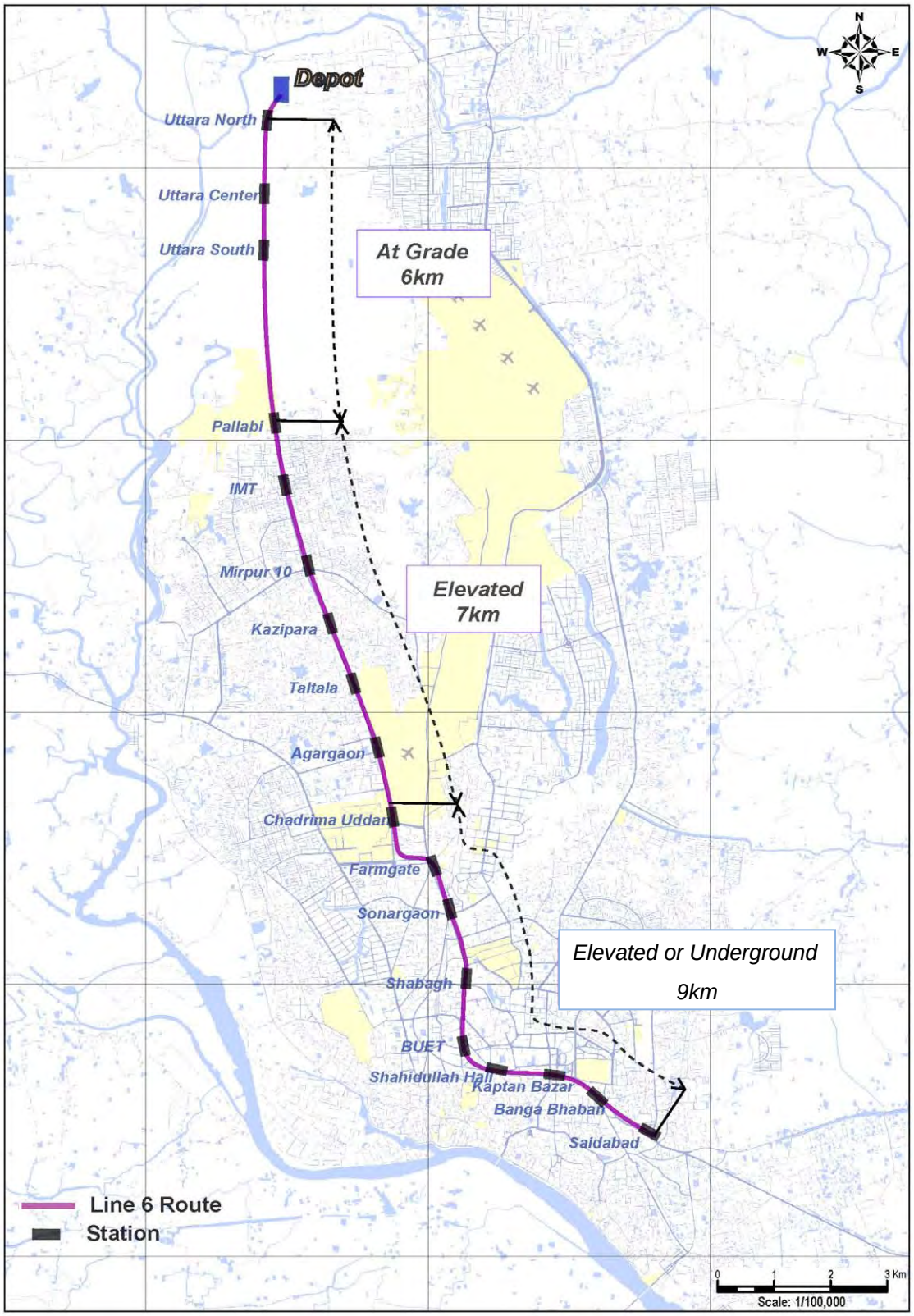


Figure 19.2-1 Line 6 Route and Structure (Base Case)

(1) Number of Car

Based on the estimation of the passenger of around 40,000 pph at peak hour in one direction, we calculated number of cars needed for the services. If we use the maximum capacity of 6 passengers per square meter at peak hour, one coach can carry about 250 passengers. Then, the train can carry 1,500 passengers in total when one train consists of 6 cars. This means that 27 train services at peak hour would be needed to carry 40,000 pph and it needs 2 minutes 12 second headway operation. We feel that it is quite difficult to keep this interval of train services in the initial stage. Therefore, if one train consists of 10 cars, one train can carry 2,500 passengers. In this case, 16 train services at per hour are required to carry 40,000 pph and it needs 3 minutes 45 second interval.

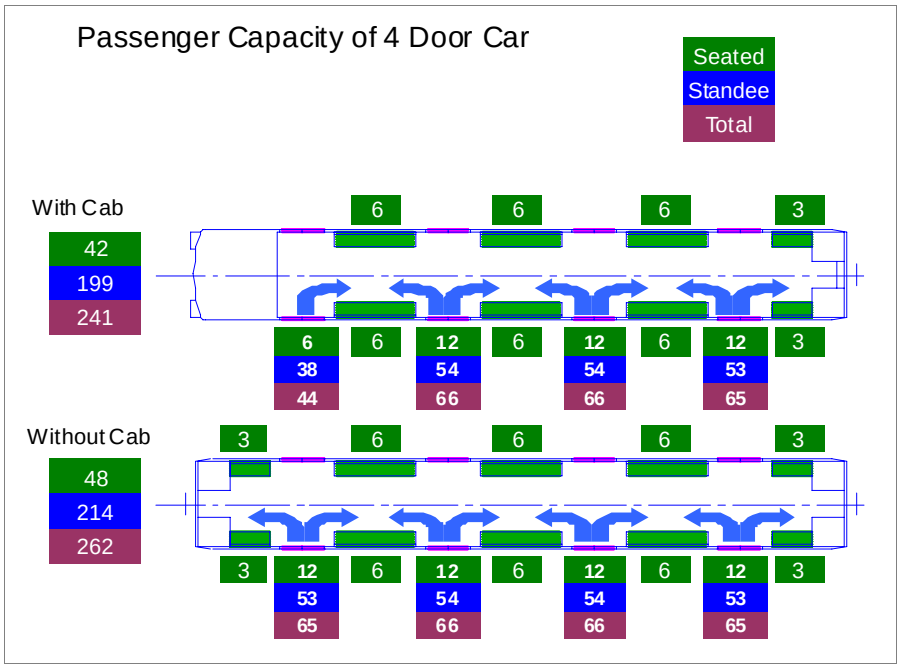


Figure 19.2-2 Seats Arrangement

If we assume the average train speed of 35 km/hr[1], it would take about 38 minutes from Uttara-3 terminal to Sadabad terminal (22 km/35 km/hr=0.628 hr= 37.7 minutes). In addition, turn back would be necessary at the terminals (we assume 4 minutes at each terminal), and one round trip of the train would requires a total of 83 minutes (37.7 minutes x 2 trips + 4 minutes x 2 times=83.4 minutes). Accordingly, it is required the total of 23 train services to carry 40,000 pph at peak hour (83.4 minutes/3.75 minutes interval= 22.2 trains). Taking into account additional trains needed for maintenance (3 trains), the total number of 26 trains or 260 EMUs is required. Based on this figure, the size of depot would be about 24 ha[2].

Of course, detailed operational plan should be studied in FS stage, but it is noted that estimation

[1] *Kolkata Metro with maximum speed is 85 km/hr, and design speed was 35 km.*

[2] *In the Kolkata METRO 16 Ha depot for 140 coaches will be constructed. 260 EMUs depot will required around 24 Ha land.*

of passenger volume is the most important factor to prepare train operation plan, EMU utilization plan, staff utilization plan and scale of depot and workshop.

(2) Train Operation Plan per Day

We propose that train service would be for 16 hours starting at 5:00 am and ending at 11 pm. The train operation plan has four patterns: off peak, morning peak, day time, evening peak

a) Off peak: 5:00 am – 7:00 am and 7:00 pm -11 pm for 6 hours, 6 trains per hour
b) Morning Peak: 7:00 am - 9:00 am for 2 hour, 16 trains per hour
c) Day Time: 9:00 am – 4:00 pm for 7 hours: 8 trains per hour
d) Evening Peak: 4:00 pm – 7:00 pm for 3 hours: 12 trains per hour

19.2.3 Initial Engineering Considerations

(1) Gauge

West Bangladesh Railway networks uses broad gauge, while the eastern part of the network uses meter gauge. We recommend standard gauge which has been used commonly in recent railway over the world. There are several advantages using standard gauge: i.e., railway modern technology can be used and possible to procure rolling stocks at reasonable price. Figure 19.2-3 shows International Union Railway (UIC) standard gauge construction envelopment.

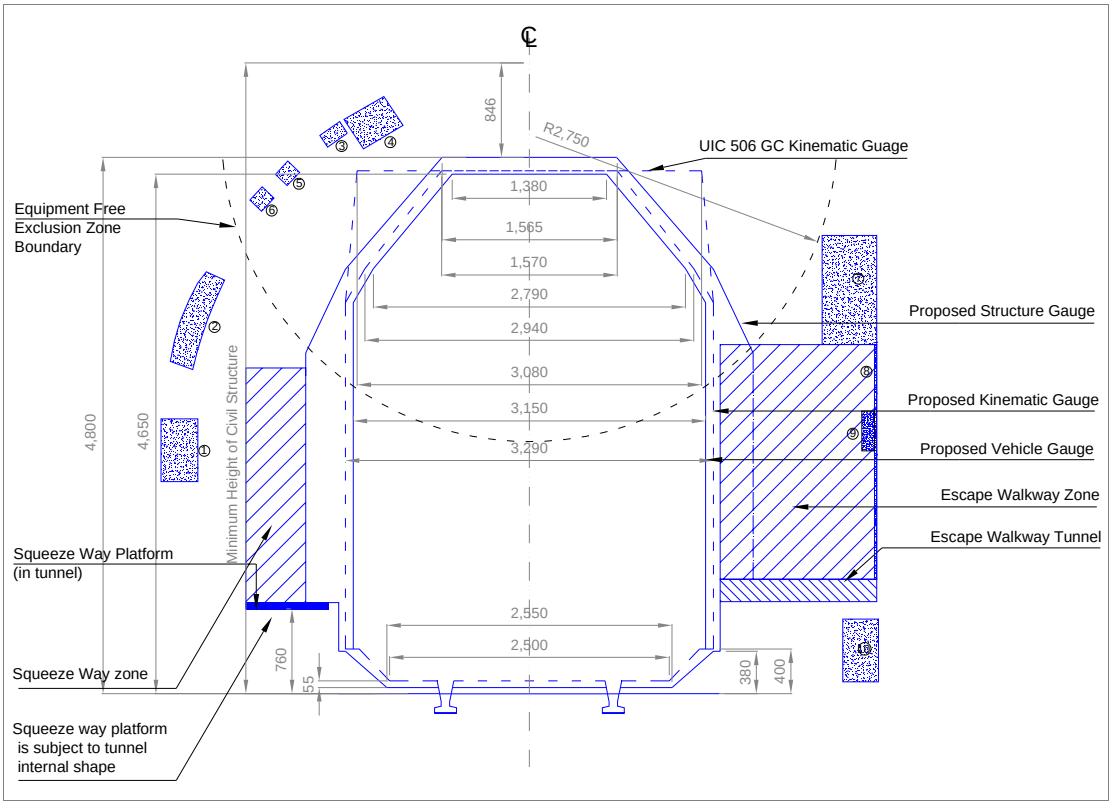


Figure 19.2-3 UIC Kinematic Gauge and Proposed Gauge

(2) Construction Method

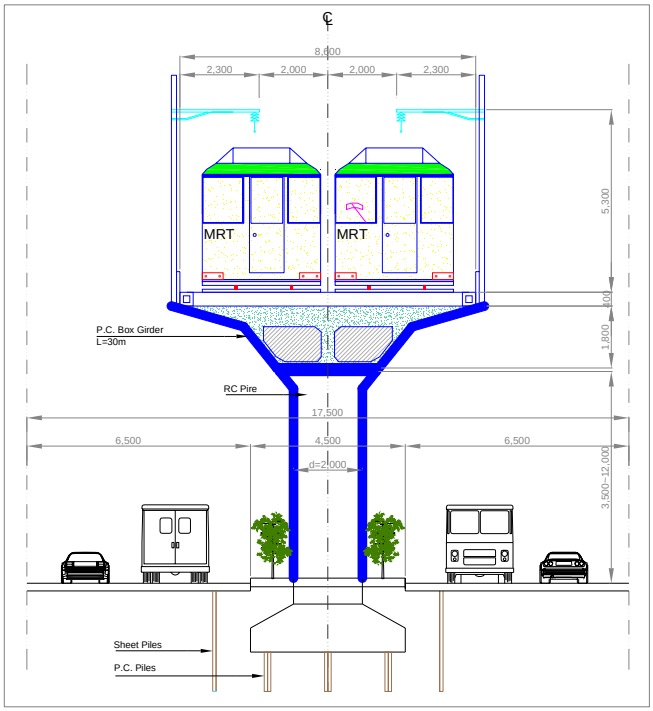


Figure 19.2-4 Typical Elevated Structure

Viaduct structure can be constructed at mid of road space using existing center dividers. Between stations some 2 m radius circle piers are built with pile foundations. Pile diameter and length will be determined in accordance with soil condition. Since permanent way is constructed on the road that has 3 lanes of carriage way and 2 m wide pedestrian path in one direction. If several measures are undertaken, such as removal of illegal parking cars and enforcement of rickshaw free zone, it will be possible to create the space for construction of permanent way on the center of the existing roads. Figure 19.2-4 shows Typical Elevated Structure.

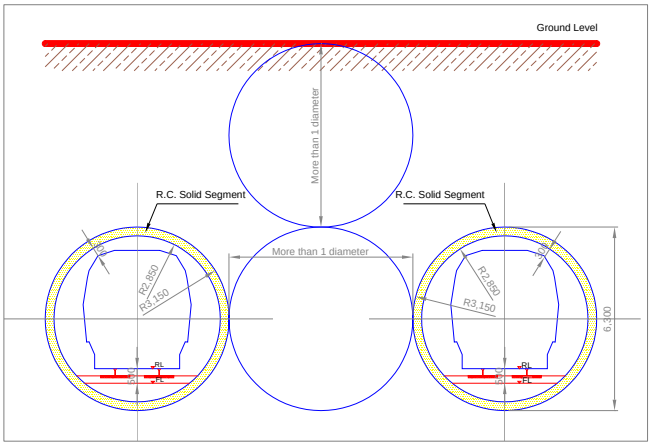


Figure 19.2-5 Typical Underground Structure

In the Old Dhaka area, STP proposed construction of underground permanent way. It is, however, needed to evaluate its economic feasibility during the FS stage, because huge amount of construction cost would be necessary for tunneling civil works. Figure 19.2-5 shows typical Twin Single Track Shield Tunnel. .

The transit system should be protected from flood. Underground station entrance is usually designed to protect flooding with a 100 years ratio. It is, however, quite difficult to stop rain water flowing and therefore, provision of big capacity of pump is inevitable in underground construction.

During construction period, traffic management is one of the major issues. In general, the construction of elevated station requires working space with minimum 8 m width. In addition to this, some space for construction of overhead pedestrian bridge is necessary. On the other hand, construction of underground station requires working space with minimum 21 m width and space for alternative routes of road transportation.

(3) Alignment

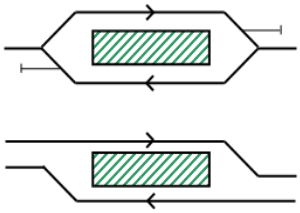
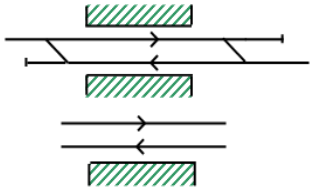
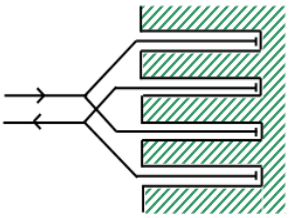
The vertical alignment shall be studied during the FS stage. As technical standard of railway construction, the maximum gradient of 35 ‰ is commonly used for EMU. But in recent technological development it may be possible to adopt 40 ‰ as the gradient. The height of permanent way will be determined by overhead pedestrian deck, power distribution line and telecommunication line. On the other hand, permanent way in underground section will be designed with the considerations of water supply system, sewage system etc. Prior to construction starting, it is necessary to examine the physical conditions and make design criteria. In Bangladesh, it might be useful to use the criteria of UIC, BR, EN, AREA or JRS. But in near future, MRT operation organization like DMTA should have own construction and maintenance standard.

In order to provide safe operation of the train, it is recommended that minimum curvature of alignment would be 600 m radius and 400 m radius in inevitable case. According to the proposed route, relatively small curvature is expected in the area of Old Dhaka, especially in the section between Dhaka University and BUET.

(4) Platform Arrangement and Track Layout

Table 19.2-1 shows types of platform, such as island platform, lateral platform and dead end platform. Generally speaking, lateral platform can keep straight track alignment, but it needs all the facilities and equipments in each platform. On the other hand, island platform is more efficient because it needs only one set of facilities and equipments. Island platform has, however, more curvatures at end of platforms, compared with lateral platform. In general practice, lateral platform is used in elevated section, while island platform is adopted in underground section, to minimize land acquisition.

Table 19.2-1 Comparison of Types of Platform

Island Type Platform	Lateral Type Platform	Dead End Type Platform
		
- Land width required is comparatively small, results in huge intial investment Cost - Passenger handling can be done on one plateform - In front and rear of platform, curvetures are inevitable - Passenger must cross at least one track - Future extension and expansion is difficult	- Platform expansion is easy - It is possible to keep tangent track - Where land price is high, adequate type - Passenger must select platform - Two sets of equipment is needed - Station Staff increase	- Applicable to intercity train operation - Big space is needed

The number of train services can be different in the sections between Pallabi - Saidabad and Pallabi - Uttara-3. This is because the expected passenger in the section between Pallabi - Saidabad is much bigger than those in the section between Pallabi - Uttara-3. This means that Pallabi Station would function as a major intermediate station. Figure 19.2-6 shows preliminary track layout plan. In this plan, Pallabi station has lateral platform with feeder line and there are emergency crossing lines at Shahindullah Hall and Kazipara stations. In order to reduce construction working space, all the underground stations are designed as one island platform. Further detailed study should be conducted during the FS stage.

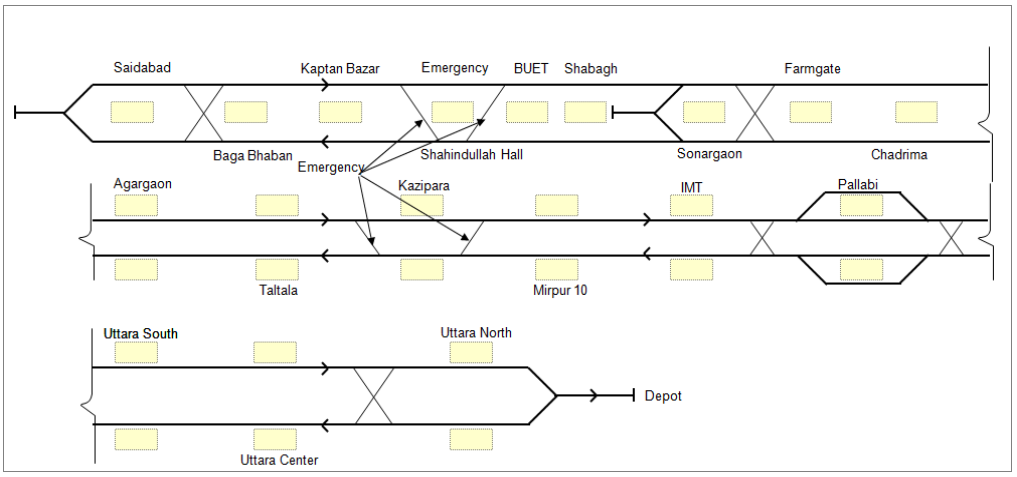


Figure 19.2-6 Track Layout Plan

(5) Station Design

Both elevated and underground stations have 2 levels, i.e., concourse level and platform level. Figure 19.2-7 & Figure 19.2-8 show typical cross section of elevated station and underground station, respectively. It is noted that entrance to underground station is designed to heighten up to high water level (HWL) + 1m in order to prevent the station from rain water encroachment. Flood protect door is also needed at the entrance of underground station.

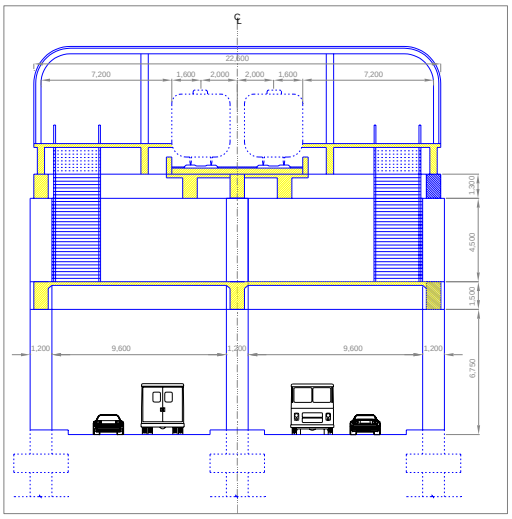


Figure 19.2-7 Typical Elevated Station

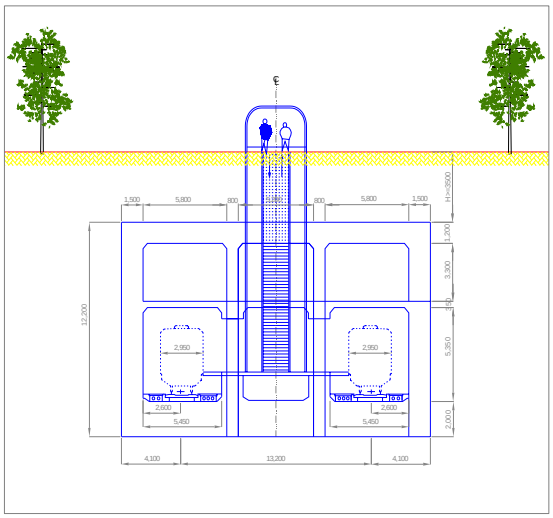


Figure 19.2-8 Typical Underground Station

Figure 19.2-9 shows proposed location of Saidabad underground terminal. The underground terminal needs the space of at least 32-33m width and 250 m long. It is important to implement the construction of Saidabad underground terminal keeping with the function of bus terminal on the surface.

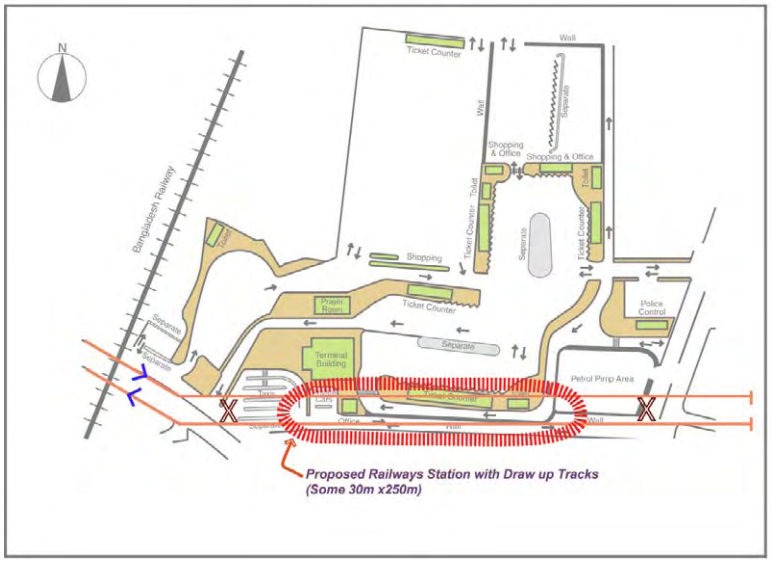


Figure 19.2-9 Proposed Location of Saidabad MRT Station

In recent Metro line, platform screen doors have been widely used to provide safety for passengers. The platform screen doors are also efficient to reduce energy costs for air-conditioning in underground stations. The screen doors must be wider than the train doors, and station names and light and chime indicators are displayed above the door. A safety feature of the doors is a device that will prevent the doors closing if something or someone is between the doors.

Figure 19.2-10 shows general layout plan of concourse and platform floor. At the border between paid and un-paid area fare collection gate will be provided. In many American and European countries fare collection gate of MTS uses turn-bar type of gate, while it is common to use contactless type fare collection system in many Asian countries. The turn-bar type of gate has capacity 40 peoples per minutes while contactless fare collection system has 60 – 70 passengers per minutes.

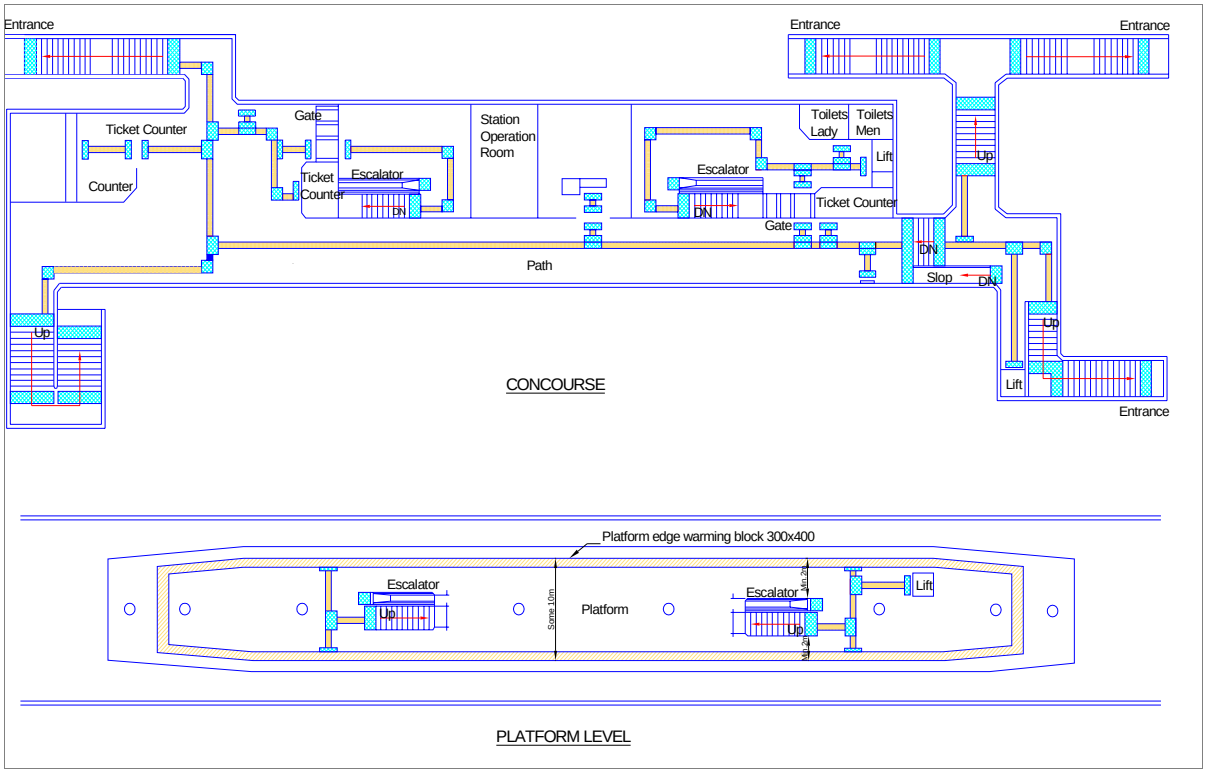


Figure 19.2-10 General Station Layout Plan

(6) Track System

We propose UIC 53 kg rail or equivalent for main line, and 40 kg rail for depot and its access track. With regard to switch and turnout, commercial track shall have #10 or higher degree while depot shall be constructed with #8. The position of Insulated Joint shall be coordinated Signalized System.

In order to provide passengers comfortable ride and to reduce the maintenance cost and noise from wheels, CWR (Continuous Welded Rail) shall be installed. Further at end position of CWR an EJ (Expansion Joint) will be provided. Standard Rail length is 25 m which will be welded to long rail and further CWR. Regarding welding methods, we propose Flush Butt Welding or equivalent, and avoid the Thermit Welding Method.

Rail fastening shall be direct elastic type which shall have enough capacity to bear lateral, longitudinal, vertical and roll-over forces. Taking into account future maintenance input, we propose Plinth Type Direct Fastening System or Ballastless Track. Special attention shall be paid at locations where is sensitive to noise and vibration like school, hospital, religious facility etc.

Within maintenance depot and its approach where there is no passenger, track shall be constructed on the cushion ballast without rail welding using fish plates in order to save construction cost. At present it becomes very difficult to obtain wooden sleeper, so as concrete sleepers and concrete bearers.

(7) E & M

Urban Transit System like rail-based MRT commonly uses EMU (Electrical Multiple Unit) which is superior in acceleration/deceleration, and it has advantage in energy effectiveness. We are concerned about shortage of electrical power supply in Dhaka. In order to carry out punctual and effective train operation, stable power supply is inevitable. Construction of own power station is one of the alternatives, but it would need a large amount of investment.

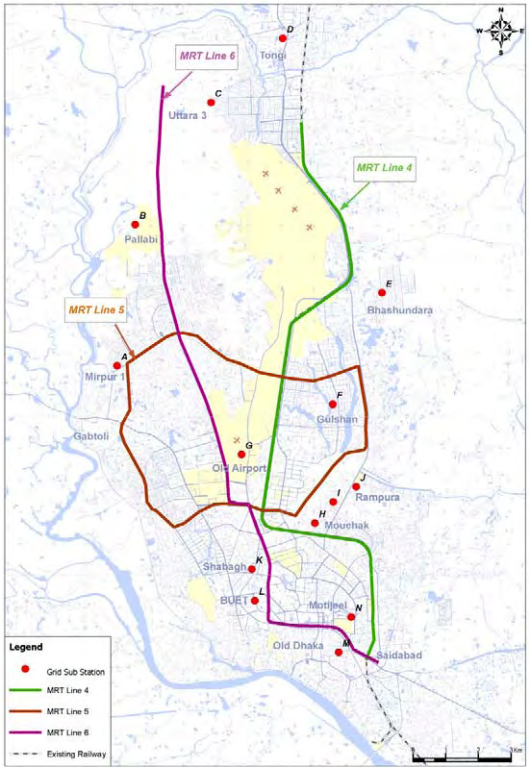


Figure 19.2-11 Grid Sub Stations

As normal practice, traction sub-stations shall be constructed at certain interval that if one sub-station drops other sub-station feed electrical power to continue the train services. Figure 19.2-11 shows grid sub-station which may feed electrical power to traction substation which can be arranged by expected MRT authority or concessioner. Expected level of power supply is 6500 kw which makes trains possible to run even one sub-station stops. In selecting currency, we recommend DC (Direct Carrent) instead of AC (Alternating Current), because the former has an advantage to cover power supply when other sub-station drops off. With this practice, it is not necessary to have own power station. Further investigation would be necessary, including capacity of each sub-station and location of sub-station.

Electrification method of either DC or AC will be determined during the Feasibility Study stage taking into account number and location of sub-stations. In general DC electrification requires more sub-station at the interval form 5 km to 10 km, while in AC electrification sub-station needs at the interval from 20 km to 30 km. DC electrification has advantage that it is comparatively easy to control train speed, and big power is available at initial stage of motor operation. AC electrification, on the other hand, has advantage of cost saving for construction of sub-station. Further attention shall be paid to EMI (Electro Magnetic Interface) which sometime effects on Signal system or public TV set.

In several cities the 3rd rail power supply system has been introduced with DC 750 voltage electrification. We are a little concerned to power shortage to meet with forecasted passenger. Furthermore, in depot and crossing special coverage to power receiving system will be necessary to protect labors or system from obstructs. Figure 19.2-12 shows 3rd rail system which is used in the Kolkata MRT. We here recommend Overhead Catenary System for collection propulsion power which can operate heavy train at reasonable speed.

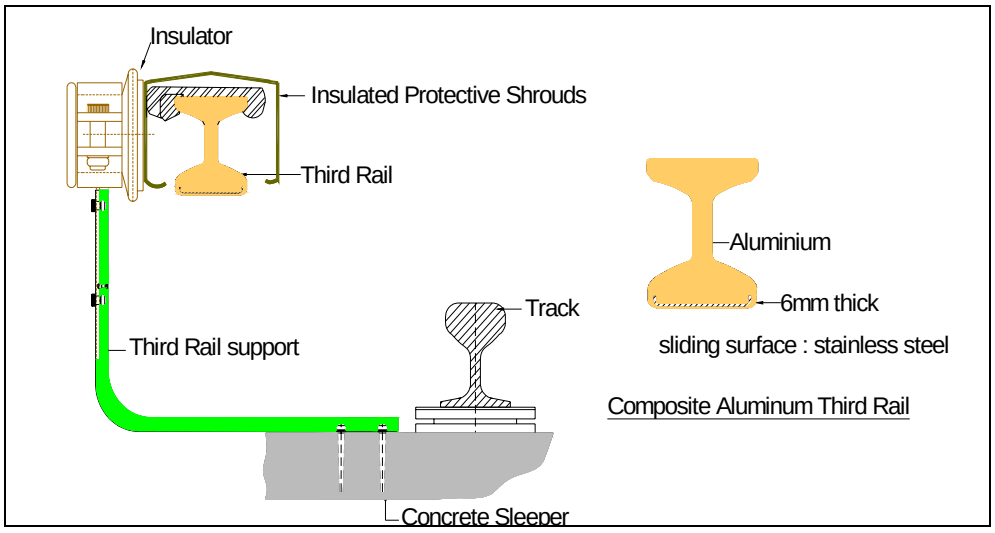


Figure 19.2-12 Third Rail Traction Power Supply

In order to avoid train collision and to keep safety and effective train operation, signalling system is very important and it will retrieve human-error. For these purposes, all trains should be controlled through OCC (Operation Control Center) by signalling such as ATO (Automatic Train Operation), ATP (Automatic Train Protection) and ATS (Automatic Train Supervision).

In order to operate trains safely and efficiently, the following telecommunications systems should be considered: (1) cable and transmission system, (2) provide automatic branch exchangers (PABX), (3) multifunctional telephone system (MTS) including commercial cellular telephone access, (4) time distribution and clock system, (5) closed circuit television system (CCTV), (6) public address system (PA), and (7) passenger information display (PID) system.

(8) Rolling Stock and Maintenance

Rolling Stock is major component of mass transit system. In general the passenger volume of more that 40,000 pph at peak hour requires rail-based Mass Rapid Transit (MRT) system. Typical train has maximum capacity of 250 persons per car. Procurement of rolling stock directly effects cash follow, and there are many unforeseen factors. At the initial phase, therefore, it is not necessary to buy 260 cars. We recommend that 130 cars, half of the cars based on the passengers estimation in 2025.

Major specifications of rolling stock are shown as follows:

Table 19.2-2 Major Specifications Rolling Stock

Gauge : 1435 mm	Size of a Car:20,900 mm (Same as Delhi Metro)
Traction: AC/DC Overhead Catenary (AC or DC will be made decision in FS)	
Train Composition: 10 cars	Wheel Diameter: 860 mm
Maximum Speed: 80 km/hr	Design Speed: 100 km/hr
Average Speed: 34 km/hr	
Weight: Tare Weight less 36 Ton (Same as Delhi METRO)	
Acceleration: 1.0 m/s/s	Deceleration: 1.3 m/s/s (Emergency)
Axle load:14 – 16 ton	Propulsion System: VVVF 3 phase drive
Train Motor Rating: 180 kw	Braking: Regenerative
Body: Lightweight stainless steel or Aluminum	Seating Arrangement: Longitudinal
Amenity: Air-conditioned	Train Control: ATO, ATP

Photo 19.2-1 Overview of Rolling Stock

Source: Tokyo Metro Co., LTD.

Depot is provided to utilize EMU. The functions of depot are: (1) Stabling, (2) Inspection, (3) Regular maintenance and (4) Repair and cleaning. Figure 19.2-13 shows typical work flow of regular maintenance cycle at depot.

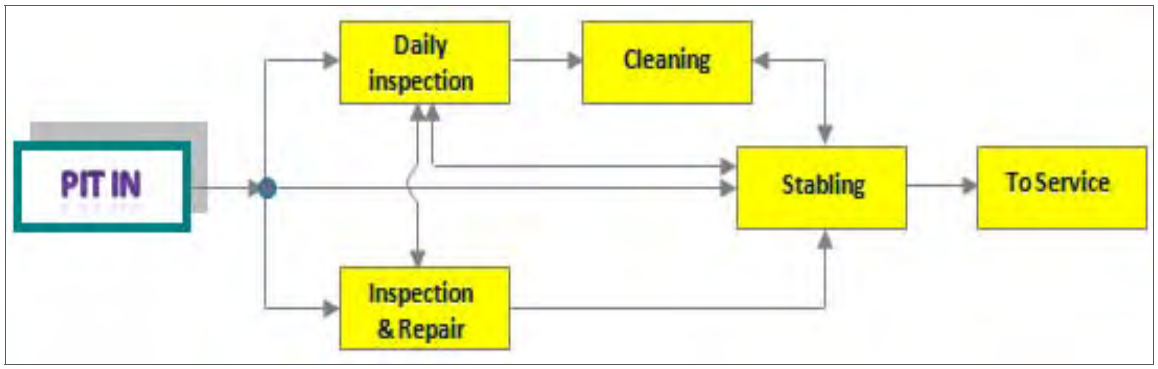


Figure 19.2-13 Work Flow of Regular Maintenance Cycle

Depot is made based on assumption that initial stage 130 rolling stocks. Thus, necessary stabling tracks are 7 lines. Length of track to be arranged at initial stage

a) Effective Length of Track 10cars x 22 m＝220 m
b) Test Track 600 m
c) Receiving/Dispatching Track 300m
d) Inspection Track 2 x 220 = 440m
e) Light Maintenance 1 x 220 = 220m

Figure 19.2-14 shows typical depot general layout.

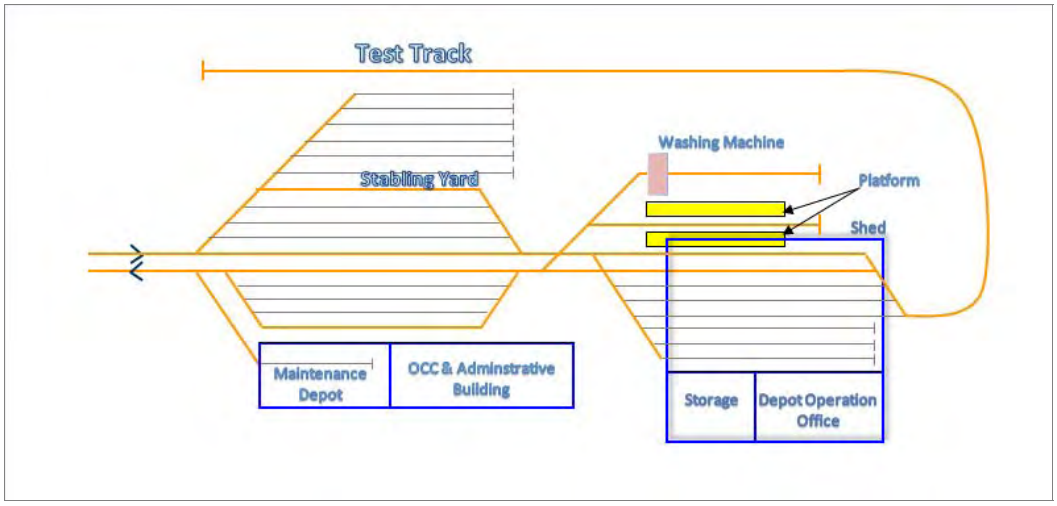


Figure 19.2-14 Typical Depot General Layout

(9) Training of Operational Staff

The mission of the MRT is to provide comfortable train services for passengers with stable, safe and punctual operation. In order to meet this mission, all facilities, such as rolling stocks, signal, telecommunications, station, etc., shall be maintained workable status. Prior to starting commercial operation of the MRT, operation organization has to establish operation/maintenance standards.

In addition to this, staff of operation organization must have adequate level of skills to operate

the MRT. The employees of operation organization should have appropriate training and education. Staff recruitment plan should be coordinated with training plan. In general new employ has to be in the class to learn operation regulation, emergency case, handling of passenger, driving techniques etc. Accordingly, it is required to recruit staff nearly one year before the operation. . Organization structure of MRT is discussed in Chapter 20 of this report.

In order to run the Enterprise, the fixed asset including employee should be minimum from the view point of "Company Operation". Therefore rolling stock cleaners, station building operation and maintenance, administration office cleaning or security guard-man etc., as much as possible should be out source. This out-sourcing philosophy is widely applied in Europe and North America. In introduction new METRO System for several years opportunity of repair/heavy maintenance for equipment will be small while aged equipment requests frequent maintenance. After opening commercial operation 5 year maintenance obligation should be added to procurement contract. If the supplier provides low quality goods, he may pay much money for maintenance work. In this contract it is possible to keep the goods at adequate quality level.

19.3 Proposed MRT Line 6 route and Flooding

19.3.1 Flooding along MRT Line 6 Route

This section shows conditions of the proposed route of MRT 6 under flooding.

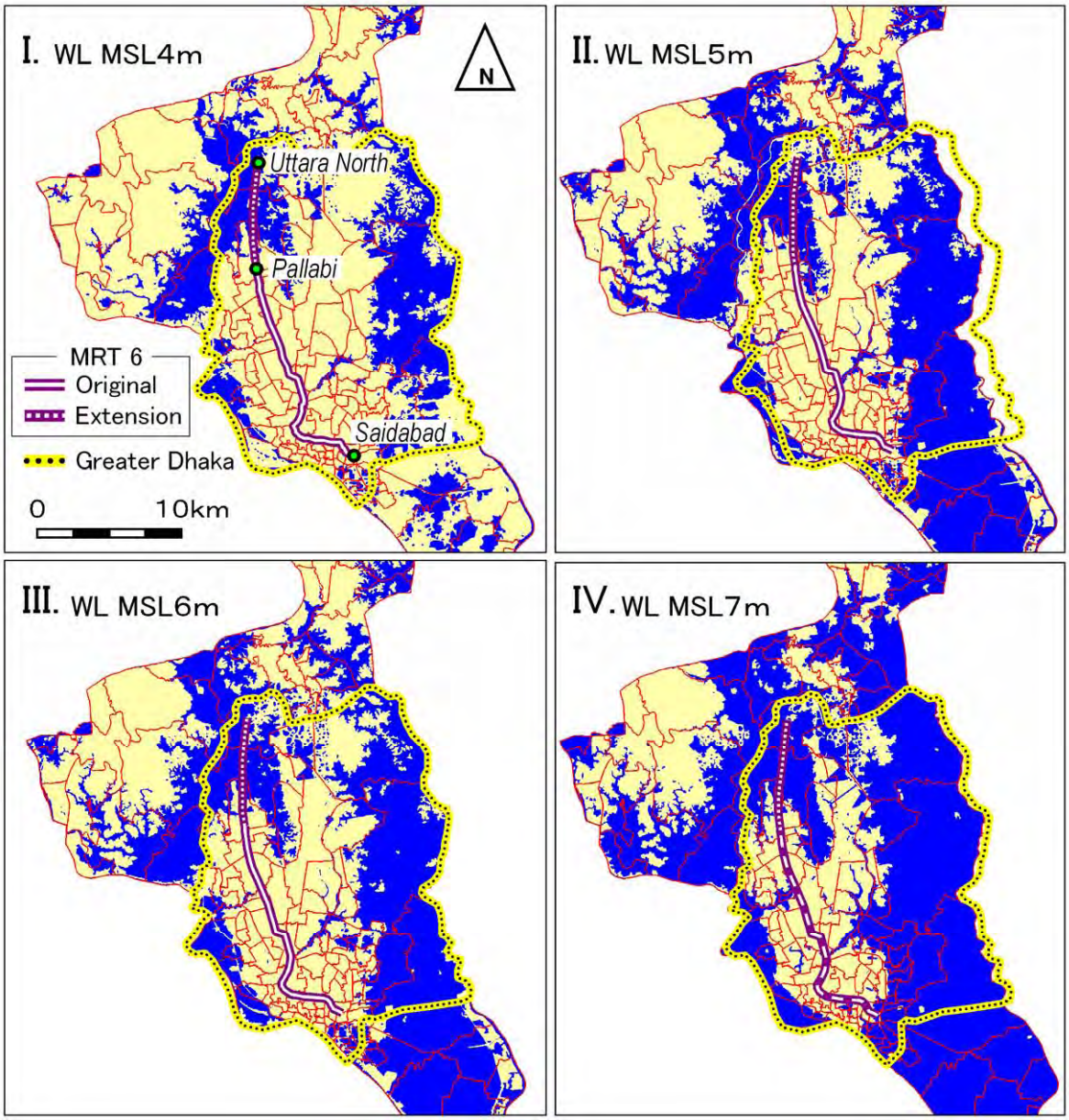


Figure 19.3-1 Proposed MRT 6 and Flooding

Source: The Study on Urban Information Management for Greater Dhaka City, August 2004, JICA

Flood conditions in the above Figure 19.3-1 were simulated under the study on Urban Information Management for Greater Dhaka City. Area with blue color of Figure 19.3-1 shows inundated area when flooding occur with the water level as indicated in the each figures. Ground elevation of the original MRT 6 alignment is above a water level of MSL 7m as shown in Figure 19.3-1 (IV). However, the ground elevation of the extension portion of MRT Line 6 is below a water level of MSL 4 m as shown Figure 19.3-1 (I). Design water level of the western drainage area was set at 4.0 m PWD (MSL 3.27 m*). Therefore, some protection measures are necessary to protect MRT facilities from landside water when the proposed MRT apply metro style.

*MSL+0.73m=PWD m

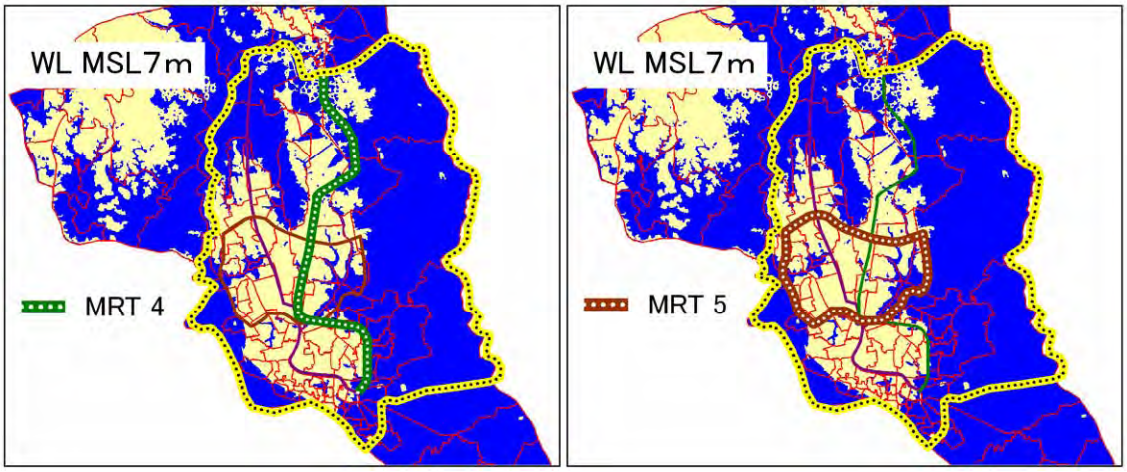


Figure 19.3-2 Proposed MRT Line 4&5 and Flooding

Source: The Study on Urban Information Management for Greater Dhaka City, August 2004, JICA

Proposed routes of MRT 4 & 5 are as shown in Figure 19.3-2. Section of MRT 4 & 5 below MSL 4 m is longer than that of MRT 6. From this point of view, with the same flood condition, MRT 6's route is slightly safer than that of MRT 4's and 5's.

As a reference, MRT 6 alignment with the proposed station and a profile of the original ground level are as shown in Figure 19.3-3.

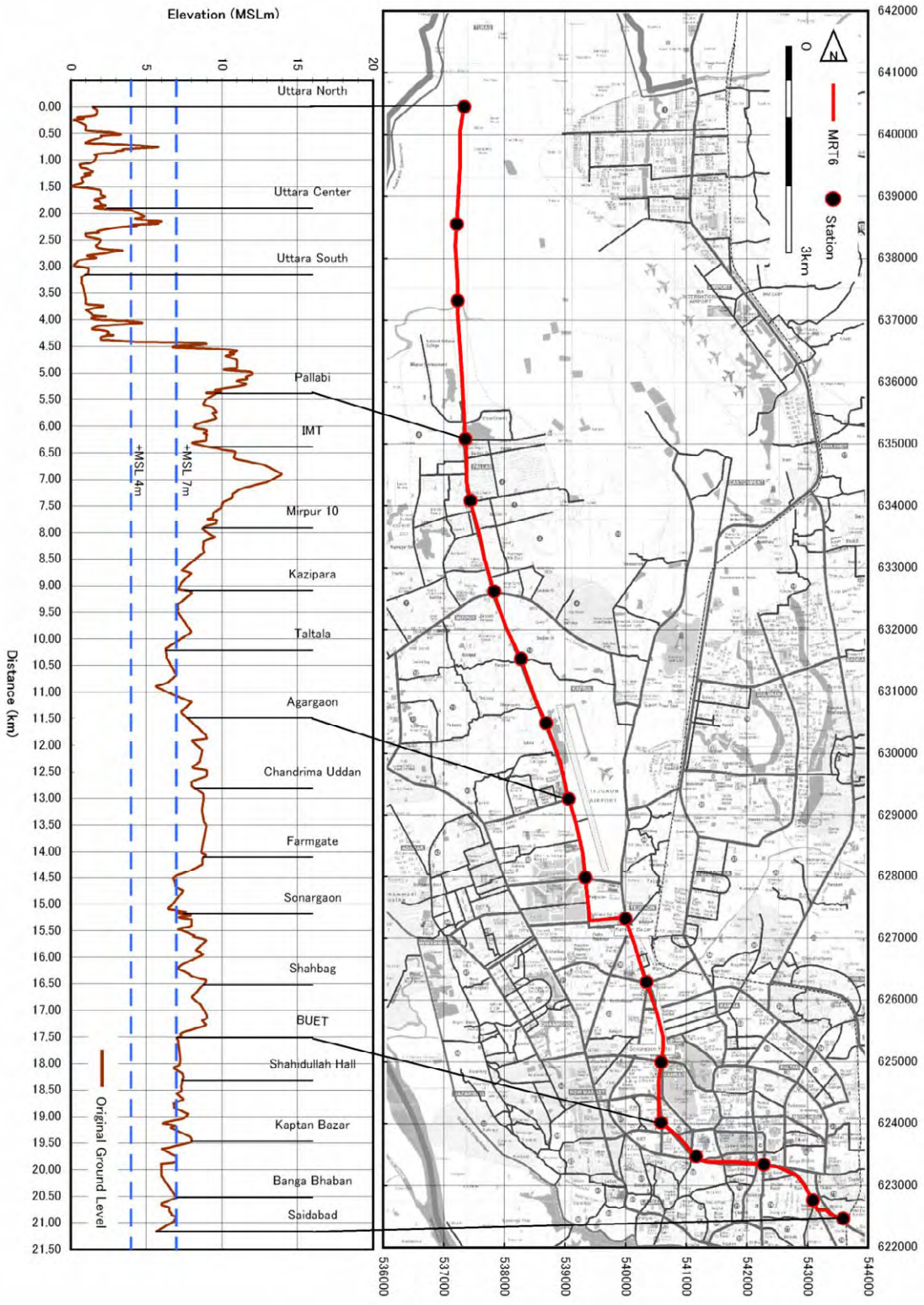


Figure 19.3-3 Plan and Profile of MRT Line 6

Note: Each MRT route and station in the above figures is a tentative proposal, not finalized yet under this study.

19.3.2 Flood Water Level in 1998

Flood water level in flood of 1998 was recorded under the study on Urban Information Management for Greater Dhaka City based on interview with vicinity people at the following Bench Mark position of Survey of Bangladesh (SOB) as shown in Table 19.3-1 and Figure 19.3-4.

Table 19.3-1 Flood Level in 1998

BM	Flood level in 1998 (MSL)	Coordinate (WGS84)
538	6.000	23 55'10"N,90 25'53"E
542	3.600	23 41'33"N,90 28'26"E
690	7.300	23 50'02"N,90 15'32"E
691	7.300	23 47'15"N,90 19'40"E
6192	7.500	23 52'05"N,90 16'18"E
6193	7.400	23 47'42"N,90 16'15"E
6037	5.800	23 50'46"N,90 24'46"E
6038	6.600	23 42'37"N,90 26'03"E

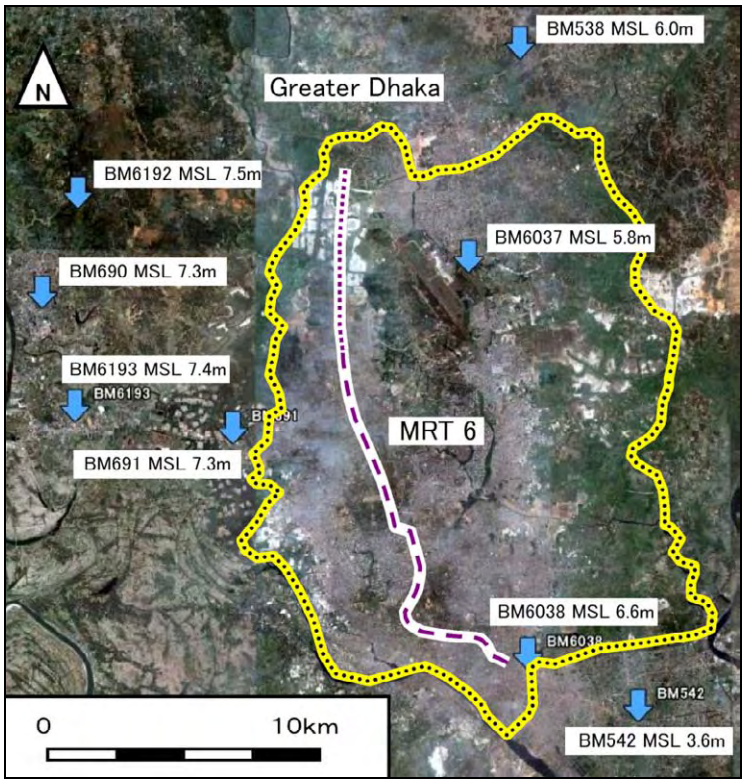


Figure 19.3-4 Flood Level in 1998

Source: The Study on Urban Information Management for Greater Dhaka City, August 2004, JICA

Maximum water level was recorded at MSL 6.6 m at BM.6038 in Greater Dhaka area. Therefore, flood water level of MSL 7 m will be used as a reference water level for feasibility study level design.

19.3.3 Comparison of Alternative Structures

Three different type of MRT structure are considered, such as elevated, at level and underground. Each type requires each flood counter measure and cost as shown in Figure 19.3-5.

	ELEVATED	AT LEVEL	UNDER GROUND
Type			
Flood Measures	None	Embankment	Watertight structure 24 hours pumping drainage Elevated entrance/exit
Cost	None	Low	High

Figure 19.3-5 MRT Type and Flood Countermeasure

19.4 Preliminary Estimation of Construction Cost and Implementation Schedule

19.4.1 Preliminary Cost Estimation

For the purpose of preliminary estimation of construction cost of MRT line 6, we referred to several examples of MRT[3] in other cities and countries. One of the most useful data for cost estimation in Dhaka MRT is the case of Kolkata METRO, which we found the data from Detailed Project Report in Kolkata METRO[4].

We made a preliminary cost estimation of MRT in the following 4 cases.

a) Case 1-1: Total length of 22 km from UTTARA 3 to Saidabad by the construction of at grade structure with 6 km, elevated structure with 7 km and underground structure with 9 km.
b) Case 1-2: Total length of 16 km from Pallabi to Saidabad by the construction of elevated structure with 7 km and underground structure with 9 km.
c) Case 2-1: Total length of 22 km from UTTARA 3 to Saidabad by the construction of at grade structure with 6 km and elevated structure with 16 km.
d) Case 2-2: Total length of 16 km from Pallabi to Saidabad by the construction of elevated structure with 16 km.

Table 19.4-1 shows the summary of construction cost of MRT line 6.

[3], *we referred to similar works, such as Kolkata METRO, Jakarta Depok Depot Construction Project, Delhi METRO Phase 1 & 2, Bangalore METRO, Sofia Subway Extension Project, and others*

[4] *It was prepared by Delhi Metro Rail Corporation (DMRC) on May 2005.*

Table 19.4-1 Comparison Table of Construction Cost

	Case 1		Case 2	
	1-1	1-2	2-1	2-1
Origin	UTTRA 3	Pallabi	UTTRA 3	Pallabi
Commercial Length (km)	22	16	22	16
Structure	With 9 km of underground section		Without Underground section	
Construction Cost (US$ Million)				
Civil/Archi	988	882	760	646
E& M System	326	199	326	191
Rolling Stock	165	165	195	165
Depot	48	47	48	47
Engineering	187	155	159	126
Contingency	87	72	74	59
Escalation	92	76	78	62
Total	1,893	1,597	1,641	1,295
Construction Cost (US$ Million per km)	86	100	75	81

19.4.2 Implementation Schedule

Tentative project implementation schedule is shown in Figure 19.4-1. In this figure the following assumption were made:

a) Project implementation body shall be established and detailed job description of each department in the implementation body shall be specified by the general consultant (GC).

b) The construction/installation contract shall be FIDIC type of design build method in order to avoid a long duration for detailed design. Accordingly, GC shall make tender drawings as preliminary design level, which makes bidders be possible to carry out basic design smoothly.

c) Land shall be ready to start civil work before issuance of notice to proceed (NTP), preferable before tender call.

d) Tender period for selection of construction contractors (civil contractor and E&M contractor) shall be needed 3-4 months as a minimum.

e) The civil contractors should allow the E&M contractor to access to the site at reasonable time. We think the timing is one and half year later from the NTP issuance.

f) Depot shall be ready when first rolling stock arrives. It shall be 2 years later after the NTP

issuance to depot contractor.

g) Before taking over all structures, track, E&M, OCC and rolling stock, they should pass individual test meeting with the employer's requirements. After the individual tests, integrated test of operation shall be carried out. This period needs around 6 months.

In our estimation, about 7 years are needed to start commercial operation of MRT after conclusion of loan agreement.

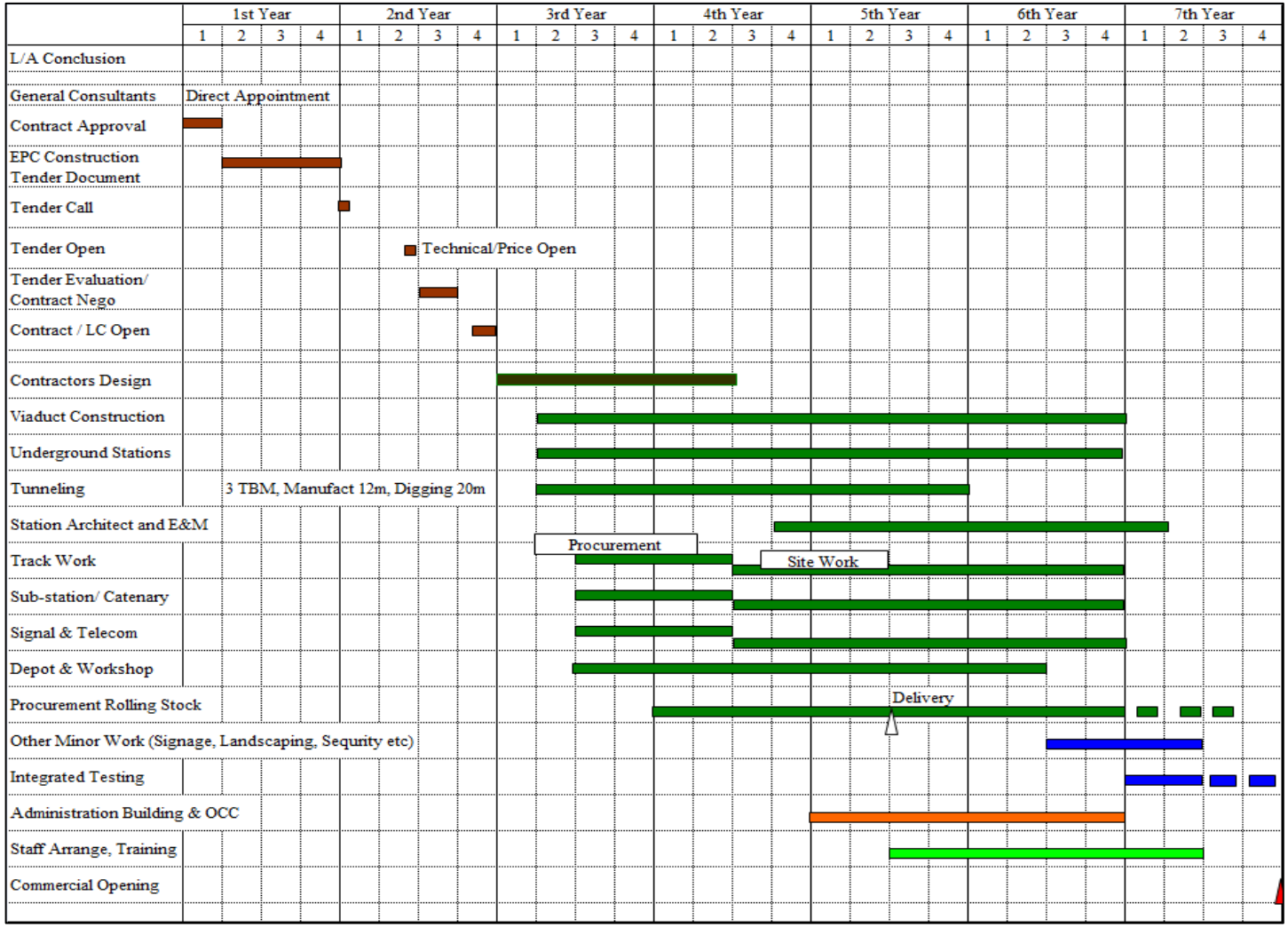


Figure 19.4-1 Implementation Program

Source: JICA Study Team

19.5 Financial Evaluation

Financial evaluation is examined based on the financial balance of 'profit-cost' cash flow for the project implementation and operation of proposed MRT Line 6, especially in the Case 2 that starts from UTTARA 3 to Saidabad without underground permanent way.

19.5.1 General

Financial analysis of the MRT project is carried out through the following work flow illustrated in Figure 19.5-1 . Major works are to prepare the input data of financial statements and necessary external variables such as investment and operation costs and revenues.

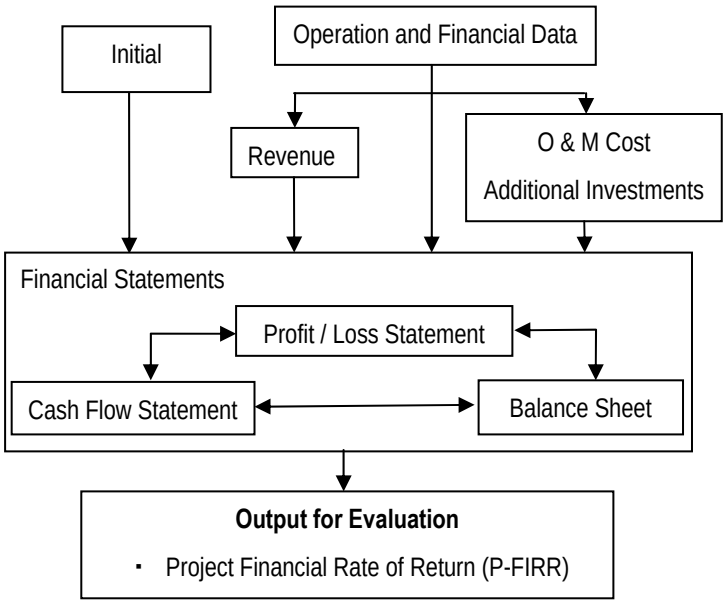


Figure 19.5-1 Framework of Financial Evaluation of MRT Project

Usually financial statements are composed of three formularies; 1) Profit-loss statement, 2) Cash flow statement and 3) Balance sheet.

a) Profit-loss statement: Descriptions of annual profit/loss to indicate the project performance, including the items of operating revenue, operating expenses, operating profit, non-operating revenue, non-operating expenses, net profit before taxes, and net profit.
b) Cash flow: Statements of cash in-flow and out-flow to estimate the annual surplus or deficit including loan and application of funds besides operating expenses; sources of funds, application of funds, and cash flow.
c) Balance sheet: Description of assets condition at the end of the fiscal year to indicate financial stability and soundness of the company; assets, liabilities, and capital or net worth.

19.5.2 Major Assumptions

(1) Real/Nominal Terms

There are two ways in financial analysis, 'in real terms' and 'in nominal terms'. In this analysis, the financial statements in real terms without inflation (in 2008-09 price) are used in order to examine the Financial Internal Rate of Return (FIRR).

(2) Evaluation Period

Evaluation periods of financial analysis depend on the characteristics and scale of the projects. such as 10 to 30 years. In the MRT project, we use the duration of 30 years for financial examination, because it requires long period for capital recovery due to large initial investment and/or long-term loan

(3) Operation and Maintenance System

In the case of MRT project, several alternatives of operation and maintenance system are considered in order to reduce the initial investment costs. They are: i) base case: independent construction and operation of whole MRT system, ii) case 1: rolling stocks are invested by separated body, iii) case 2: all infrastructures by separated body, iv) case 3: electricity & mechanical system separated and v) infrastructures and E&M systems separated.

(4) Necessary Funds

It is necessary to prepare a large amount of initial investment costs for MRT project. Therefore, we considered various funding sources, including foreign government official development loan. Availability of the loan will be examined in the next FS stage.

19.5.3 Investment and Operating Costs

The necessary investment costs of MRT Line 6 (case 2) are estimated with the time frame of 30 years, including preparation, construction and regular operations, as summarized in Table 19.5-1.

Table 19.5-1 Necessary Cost Flows of MRT Line 6

		Description	Investment Cost	O & M Cost	Additional Investment	Cost Total
1	2011	Design	37.21			37.21
2	2012	Design	9.30			9.30
3	2013	Construction	245.17			245.17
4	2014	Construction	408.38			408.38
5	2015	Construction	430.28			430.28
6	2016	Construction	408.25			408.25
7	2017	Test Run	102.25			102.25
8	2018	Operation		17.40		17.40
9	2019			17.43		17.43
10	2020			17.46		17.46
11	2021			17.59	75.00	92.59
12	2022			17.62		17.62
13	2023			28.42	60.00	88.42
14	2024			28.45		28.45
15	2025			28.76	60.00	88.76
16	2026			30.68		30.68
17	2027			30.72		30.72
18	2028			36.06		36.06
19	2029			36.10		36.10
20	2030			36.21		36.21
21	2031			36.25		36.25
22	2032			36.29		36.29
23	2033			36.33		36.33
24	2034			36.36		36.36
25	2035			36.40		36.40
26	2036			36.44		36.44
27	2037			36.48		36.48
28	2038			36.52		36.52
29	2039			36.57		36.57
30	2040			36.61		36.61
31	2041			36.99		36.99
32	2042			37.04		37.04
33	2043			37.09		37.09
34	2044			37.15		37.15
35	2045			37.20		37.20
36	2046			37.24		37.24
37	2047			37.28		37.28
Total			1640.84	967.14	195.00	2802.98

Source: JICA Study Team

It is estimated that initial investment costs account for US$ 1,641 million including all the necessary cost before the inauguration of its commercial operation in 2018. The cost includes survey/design, all infrastructure construction, E&M system installation and initial rolling stocks, etc. And another US$ 18 to 37 million is required for yearly operation and maintenance after 2018. Additional cost for supplemental rolling stocks are also required in accordance with increase of passengers demand. About 60% of the initial cost is used for infrastructures, 25% for E&M systems and 15% for rolling stocks.

19.5.4 Passenger Demand and Proceeds

Passenger demands for MRT Line 6 is estimated based on the future transport demand forecast in MDA at the year 2025, as shown in Table 19.5-2.

Table 19.5-2 Future Passenger Demands Forecast of MRT Line 6, in 2025

Section	UTTARA 3 – Pallabi – National Assembly – Saidabad (22 km)
No. of passengers per day	639,000
No. of pass.-km per day	4,673,740
Average pass. per km	212,000
Average trip length per pass.	7.31

Total revenue of MRT Line 6 is calculated based on the following assumption:

a) Unite fare: We use the fare of BDT 3.0/km as an affordable fare in Dhaka.
b) Fare revision: A premise of the unite fare revision with 10% increase in every 5 years is adopted in accordance with future inflation.
c) Increase ratios of passengers demand: 5% per year from inauguration to 2025, 3% per year after 2025.
d) Paid passenger ratio: Though it might be expected in future to apply some fare exemption/discount regulations for public transport users such as military men, police, pupils/students and handicapped, it is neglected in this stage because of the uncertainty.
e) Expansion from day to year volume: Considering the less traffic volume in weekends and national holidays comparing weekdays, the yearly volume is calculated as average daily volume multiplied by 330.

In addition to the revenue from service operation, some non-operational revenue are considered, such as advertisement, commercial utilization of available spaces and lands. It is assumed to be 15% of ticket revenues.

Finally the total yearly revenues of MRT Line 6 are estimated as US$ 49.1 million in 2018 and US$ 76.0 million in 2025 respectively.

19.5.5 Cash Flow and Accumulated Balance

Preliminary financial evaluation is examined in several alternative cases, because independent/full-scale operation cannot cope with successful financial results.

Four (4) alternative cases are assessed in addition to the base case:

a) Rolling stocks separated,
b) Infrastructures separated,
c) E & M separated, and
d) Infrastructures and E & M separated.

Each case of cash flow is examined through 30 years after the inauguration of commercial operation in 2018.

Since relatively difficult financial situations are expected, various premises for cost reduction are considered in this preliminary stage; e.g. necessary costs for survey and design at the beginning stage are exempted (might be done by grant base or design-built base) and also every taxes and duties are exempted and so on.

The results are tabulated in Table 19.5-3.

Table 19.5-3 Preliminary Financial Cash Flows of MRT Line 6

		Base Case				+20% Revenue		without Rolling Stock			without Infrastructure		without E&M		w.o Infra. and E&M	
	Year	Revised Cost	Revenue	Balance		Balance		Balance			Balance		Balance		Balance	
				Yearly	Accumulated	Yearly	Accumulated	Cost	Yearly	Accumulated	Yearly	Accumulated	Yearly	Accumulated	Yearly	Accumulated
	2011	0.00	0.00	0.00	0.00											
	2012	0.00	0.00	0.00	0.00											
	2013	245.17	0.00	-245.17	-245.17	-245.17	-245.17	208.40	-208.40	-208.40	-98.07	-147.10	-183.88	-183.88	-36.78	-36.78
	2014	408.38	0.00	-408.38	-653.56	-408.38	-653.56	347.13	-347.13	-555.52	-163.35	-310.46	-306.29	-490.17	-61.26	-98.03
	2015	430.28	0.00	-430.28	-1083.83	-430.28	-1083.83	365.73	-365.73	-921.26	-172.11	-482.57	-322.71	-812.87	-64.54	-162.57
	2016	408.25	0.00	-408.25	-1492.08	-408.25	-1492.08	347.01	-347.01	-1268.27	-163.30	-645.87	-306.19	-1119.06	-61.24	-223.81
	2017	102.25	0.00	-102.25	-1594.33	-102.25	-1594.33	86.91	-86.91	-1355.18	-40.90	-686.77	-76.69	-1195.75	-15.34	-239.15
1	**2018**	36.15	42.71	6.56	-1587.78	15.10	-1579.24	17.40	29.57	-1325.61	10.83	-675.94	10.83	-1184.92	10.83	-228.32
2	2019	36.18	44.84	8.66	-1579.12	17.63	-1561.61	17.43	31.89	-1293.72	13.14	-662.80	13.14	-1171.78	13.14	-215.18
3	2020	36.21	47.08	10.87	-1568.25	20.29	-1541.32	17.46	34.33	-1259.39	15.58	-647.22	15.58	-1156.20	15.58	-199.60
4	2021	36.34	49.44	13.10	-1555.15	22.98	-1518.34	17.59	36.79	-1222.59	18.04	-629.18	18.04	-1138.16	18.04	-181.56
5	2022	47.62	51.91	4.29	-1550.86	14.67	-1503.66	17.62	39.48	-1183.11	9.48	-619.70	9.48	-1128.68	9.48	-172.08
6	2023	58.42	54.50	-3.92	-1554.78	6.99	-1496.68	28.42	31.53	-1151.58	1.53	-618.16	1.53	-1127.14	1.53	-170.54
7	2024	58.45	57.23	-1.22	-1556.00	10.23	-1486.45	28.45	34.50	-1117.08	4.50	-613.66	4.50	-1122.64	4.50	-166.04
8	**2025**	58.76	66.10	7.34	-1548.66	20.56	-1465.89	28.76	43.95	-1073.13	13.95	-599.71	13.95	-1108.69	13.95	-152.09
9	2026	30.68	68.08	37.40	-1511.25	51.02	-1414.88	30.68	44.21	-1028.92	44.21	-555.50	44.21	-1064.48	44.21	-107.88
10	2027	30.72	70.13	39.41	-1471.84	53.44	-1361.44	30.72	46.42	-982.50	46.42	-509.08	46.42	-1018.06	46.42	-61.46
11	2028	36.06	72.23	36.16	-1435.68	50.61	-1310.83	36.06	43.39	-939.11	43.39	-465.69	43.39	-974.67	43.39	-18.07
12	2029	36.10	74.40	38.30	-1397.38	53.18	-1257.65	36.10	45.74	-893.38	45.74	-419.95	45.74	-928.93	45.74	27.67
13	2030	36.21	84.29	48.08	-1349.31	64.93	-1192.72	36.21	56.51	-836.87	56.51	-363.45	56.51	-872.43	56.51	84.17
14	2031	36.25	86.82	50.57	-1298.74	67.93	-1124.79	36.25	59.25	-777.62	59.25	-304.19	59.25	-813.18	59.25	143.42
15	2032	36.29	89.42	53.14	-1245.60	71.02	-1053.76	36.29	62.08	-715.54	62.08	-242.12	62.08	-751.10	62.08	205.50
16	2033	36.33	92.11	55.78	-1189.82	74.20	-979.56	36.33	64.99	-650.55	64.99	-177.12	64.99	-686.11	64.99	270.49
17	2034	36.36	94.87	58.51	-1131.31	77.48	-902.08	36.36	67.99	-582.55	67.99	-109.13	67.99	-618.11	67.99	338.49
18	2035	36.40	107.49	71.09	-1060.23	92.58	-809.50	36.40	81.83	-500.72	81.83	-27.30	81.83	-536.28	81.83	420.32
19	2036	36.44	110.71	74.27	-985.96	96.41	-713.08	36.44	85.34	-415.38	85.34	58.05	85.34	-450.94	85.34	505.66
20	2037	36.48	114.03	77.55	-908.40	100.36	-612.73	36.48	88.95	-326.42	88.95	147.00	88.95	-361.98	88.95	594.62
21	2038	36.52	117.45	80.93	-827.47	104.42	-508.31	36.52	92.68	-233.75	92.68	239.68	92.68	-269.31	92.68	687.29
22	2039	36.57	120.98	84.41	-743.06	108.61	-399.70	36.57	96.51	-137.24	96.51	336.19	96.51	-172.80	96.51	783.80
23	2040	36.61	137.07	100.46	-642.60	127.87	-271.83	36.61	114.17	-23.07	114.17	450.35	114.17	-58.63	114.17	897.97
24	2041	75.99	141.18	65.19	-577.41	93.43	-178.40	36.99	118.31	95.24	79.31	529.66	79.31	20.68	79.31	977.28
25	2042	95.54	145.42	49.88	-527.54	78.96	-99.44	37.04	122.92	218.15	64.42	594.08	64.42	85.10	64.42	1041.70
26	2043	95.59	149.78	54.19	-473.35	84.14	-15.30	37.09	127.66	345.82	69.16	663.24	69.16	154.26	69.16	1110.86
27	2044	76.15	154.27	78.13	-395.22	108.98	93.68	37.15	132.55	478.37	93.55	756.80	93.55	247.81	93.55	1204.41
28	2045	37.20	174.79	137.59	-257.64	172.55	266.23	37.20	155.07	633.44	155.07	911.86	155.07	402.88	155.07	1359.48
29	2046	37.25	180.03	142.78	-114.85	178.79	445.02	37.25	160.79	794.23	160.79	1072.65	160.79	563.67	160.79	1520.27
30	2047	37.30	185.43	148.13	33.28	185.22	630.24	37.30	166.68	960.90	166.68	1239.33	166.68	730.35	166.68	1686.95
Total		2951.51	2984.80	33.28		630.24	-29992.98	2322.37	960.90		1288.36		730.35		1686.95	
				FIRR(%)	0.09	FIRR(%)	1.49		FIRR(%)	2.54	FIRR(%)	5.20	FIRR(%)	2.13	FIRR(%)	10.83

Source: JICA Study Team

Table 19.5-4 Summary Results of Preliminary Financial Evaluation of MRT Line 6

Alternative Case			Initial Investment Cost (US$ Million)	FIRR (30 years)	Year, Accumulated Balance into Black
0	Base Case	Indipendent Construction & Operation	1,594.33	-	30 (2047)
1	+15% Revenue		1,594.33	-	28 (2045)
2	Case 1	Rolling Stock, Separeted	1,355.18	2.54%	24 (2041)
3	Case 2	Infrastructures, Separated	637.73	5.20%	19 (2036)
4	Case 3	E&M System, Separated	1,195.75	2.13%	24 (2041)
5	Case 4	Infrastructures and E&M System, Separated	239.15	10.83%	12 (2029)

19.5.6 Preliminary Results and Findings

Major findings are summarized as follows:

a) It is not financially feasible as an independent business without any subsidy from outside, because of the huge amount of initial investments comparing to the lower revenues based on passengers' fares. It shows very late years of accumulated balance into the black both in base case (30^{th} year) and +15% revenue case (28^{th} year).

b) In both cases of 'rolling stock separated' and 'E & M system separated', the FIRRs are still low level even though they are 2.1% and 2.5% respectively.

c) A rather favorable FIRR can be acquired in the case of 'infrastructure separated', which shows 5.2% of FIRR and accumulated balance become into the black after 19 years' operation.

d) Most desirable result is found in the case of 'infrastructure and E & M system separated'; it achieves 10.8% of FIRR. The accumulated balance become black in 2028, 12 years after the inauguration.

e) As the result of preliminary financial evaluation, further analysis should be examined from various points of view in order to improve its financial status, because MRT implementation is essential for future increasing urban traffic demands in DMA.