A PRESENTATION
OF
TRAFIC MANAGEMENT

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Traffic Management

***Abstract* — This paper aims to overcome traffic congestion caused by ineffective traffic management systems that are outdated and work on a predefined countdown. These traditional systems allot timings irrespective of the actual density in traffic on a specific road thereby causing large red light delays. The system we propose ensures traffic lights respond to real time values of traffic, thereby allowing proper management of time and resources. In order to do this we first calculate the density of traffic which is determined using a combination of ultrasonic sensors and image processing techniques. This information is processed by a Raspberry Pi, which in turn controls the traffic light indicators. In addition to that, the data that is collected is sent to the cloud, and can be used to monitor traffic flow at periodic intervals. In case of sensor system failure, the values stored in the cloud will also be useful in predicting the density of traffic based on long term periodic analysis.**

***Keywords*: Cloud, Image Processing, Raspberry Pi, Traffic Congestion, Ultrasonic Sensors.**

I. INTRODUCTION

In today's world where technology has transcended all barriers it has now become easy to solve most human problems and one of these problems include traffic congestion. Traffic congestion has increased drastically over the years and has had negative impacts that include road rage, accidents, air pollution, wastage of fuel and most importantly unnecessary delays. One of the many causes of traffic congestion is improper traffic management systems.

The first gas lit traffic light was invented in London in the 1860's to control traffic caused by horse carriages in the area and it was operated manually by police officers. Since then traffic lights have adapted so as to allow the smooth movement of traffic. The electric traffic light came soon after in the early 1900's, and this was later replaced by the automated traffic lights which are still used in a number of cities today. This system works like clockwork with the lights changing at regular intervals, but soon people realized that the system had a flaw. In many occasions vehicles had unnecessary waiting periods because the light would be red even when the opposite road was empty.

The main purpose of this paper is to introduce a system which will allot time to each road based on the amount of traffic[1]. The amount of traffic on a single lane is classified under three levels: low, medium and high. These levels are determined by the Raspberry Pi based on inputs received from the ultrasonic sensors and camera. Based on the level of traffic the Raspberry Pi then allots timings for a lane, and makes changes to the red, green and yellow indicators. In addition these values processed by the Raspberry Pi are sent to the cloud where they can be stored and accessed whenever required. Also, if the level of traffic indicated by the image processing techniques and ultrasonic sensors continuously differ then the previous values stored on the cloud can be used to determine the level of traffic for that specific time till the required repairs are made.

This traffic management system fulfills its duty by enabling the smooth movement of vehicles and it also has a fail-safe system which will prove useful in unexpected circumstances.

II. LITERATURE REVIEW

A number of papers have been published with an aim to overcome the disadvantages of the traditional traffic light system. The various methods use to find the density of traffic can be classified based on vehicle detectors such as piezoelectric sensors and Inductive Loops[2], Ultrasonic Sensors[3], Infrared Sensors[4] and sound Sensors[5], Acoustic Sensors[6], Video/ Image processing techniques[7]-[9], RF based detectors[10], Fuzzy Logic Systems[11] and systems based on cloud computing and IoT[12],[13].
This paper uses a combination of techniques so as to provide results that are more accurate.

III. METHODOLOGY

A. BLOCK DIAGRAM

The main components of traffic management system as shown in Fig 1 include a camera, the yellow, green and red indicators, the IOT platform for analytics - ThingSpeak and the ultrasonic sensors. The ultrasonic sensors and the camera serve as input devices, the indicators as output devices, and the Raspberry Pi as the edge device that is used to communicate with the cloud.

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

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.

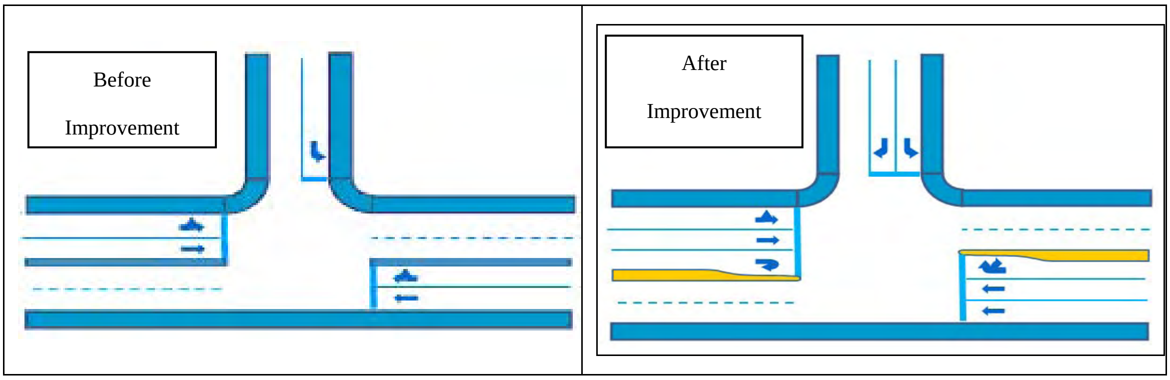


Figure 16.2-2 Type of Current U-turn Points

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.

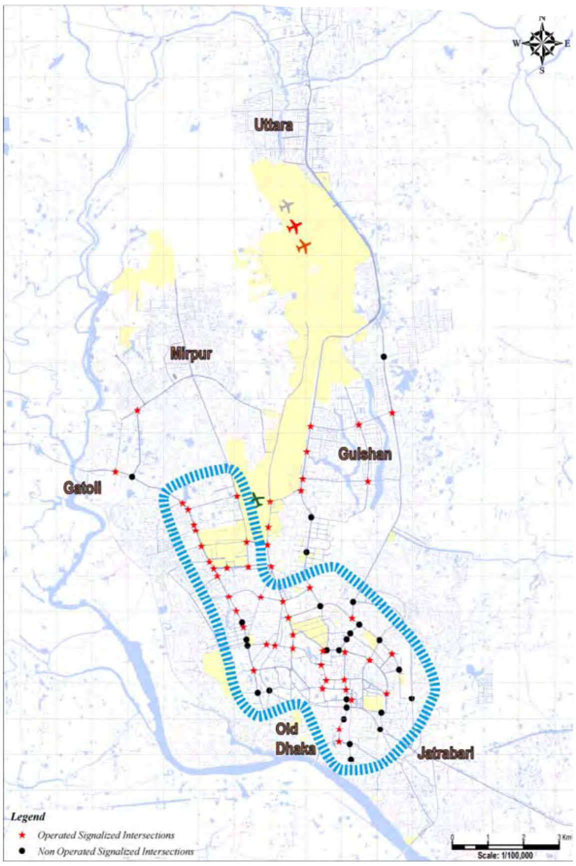


Figure 16.2-3 Proposed Area Traffic Signal Control Area

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.

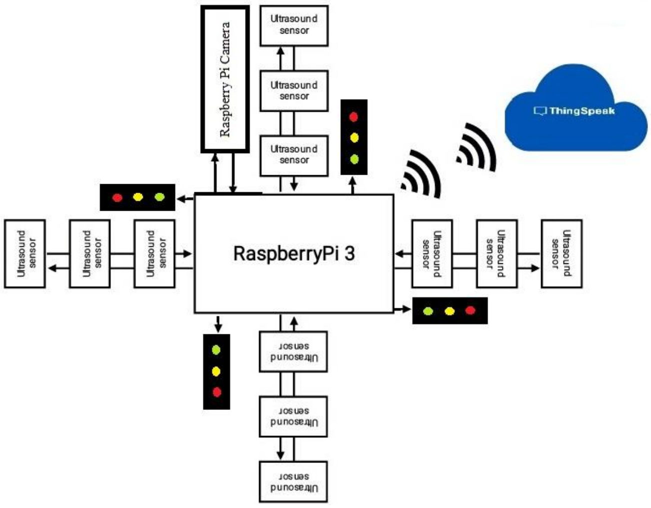


Fig. 1 Block diagram

WORKING:

The main purpose of the smart traffic managements system is to allot timings to a traffic signal based on the level of traffic on a lane. In order to calculate the level of traffic on each lane the road is divided into three equally spaced sections. These sections are labeled L0, L1, and L2 as shown in Fig 2.

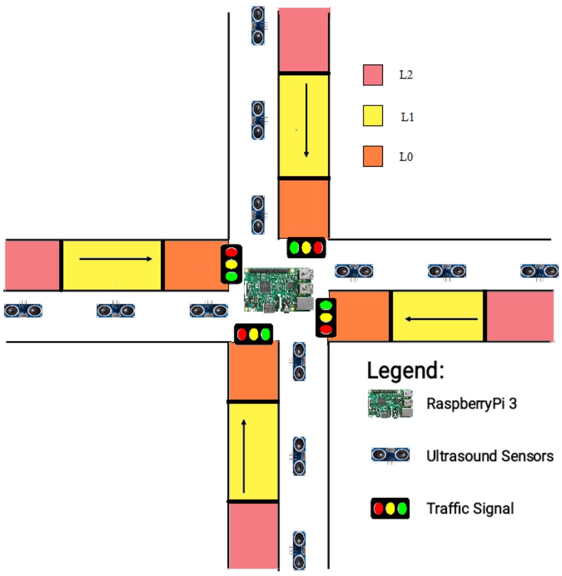


Fig. 2 Schematic diagram showing the different section L0, L1, and L2

Each section houses an ultrasonic sensor to determine if vehicles are present in that particular area. The ultrasonic determines the presence of an obstacle by finding the distance taken for a transmitted signal to be received. In addition a camera is placed at the junction who takes images of the lane at periodic intervals. Using image processing techniques, the image of an empty road is cropped into the three sections. The mean value of this empty road is compared against cropped images of the actual road to find the level of traffic in the area. Based on the vehicles present in a section the level of traffic is classified as low, medium and high as portrayed in the table below.

TABLE 1 TRAFFIC LEVELS BASED ON PRESENCE OF VEHICLES (P) IN VARIOUS SECTIONS

Level Of Traffic	**L0**	**L1**	**L2**
LOW LEVEL	p	x	x
	x	p	x
	x	x	p
MEDIUM LEVEL	p	p	x
	x	p	p
	p	x	p
HIGH LEVEL	p	p	p

The ultrasonic sensors and the results from the image processing techniques are sent to the Raspberry Pi and based on the inputs received the Pi calculates the level of traffic and accordingly allots the time to the traffic indicators. These values processed by the Raspberry Pi are further sent to the IOT platform (ThinkSpeak) where they can be stored in the form of a database useful for analyzing traffic density patterns in a particular area.

In addition, the Raspberry Pi compares the values provided by both the ultrasonic sensors and image processing results to make sure the level of traffic is the same in both the cases. If there appears to be a large variation in readings on multiple occasions then the values stored on ThinkSpeak provide sufficient data to run the traffic lights in the absence of the sensor system. This does not provide accurate results, but the timing allotted to the traffic lights are based on previous levels of traffic calculated over an extended period of time.

So saying the above mentioned system has a fail-safe system that can be used in case of failures too.

The results obtained are based on the prototype as shown in Fig.3 of a four way traffic junction. The ultrasonic sensors used in the prototype is the HC-SR04 as portrayed in Fig 3.1

Fig. 3 HC-SR04 ultrasonic sensor

These sensors can be used to determine the presence of an obstacle which in our case is vehicles. Each lane houses three sensors which are placed at equal distances and are positioned vertically at the divider. For the four roads a total of 12 ultrasonic sensors are used. These sensors are connected to the Raspberry Pi using jumper wires and the information collected by the sensors is processed by Raspberry Pi.

. The Raspberry Pi camera module portrayed in Fig 4 serves as to capture Real time traffic images. These images are

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.

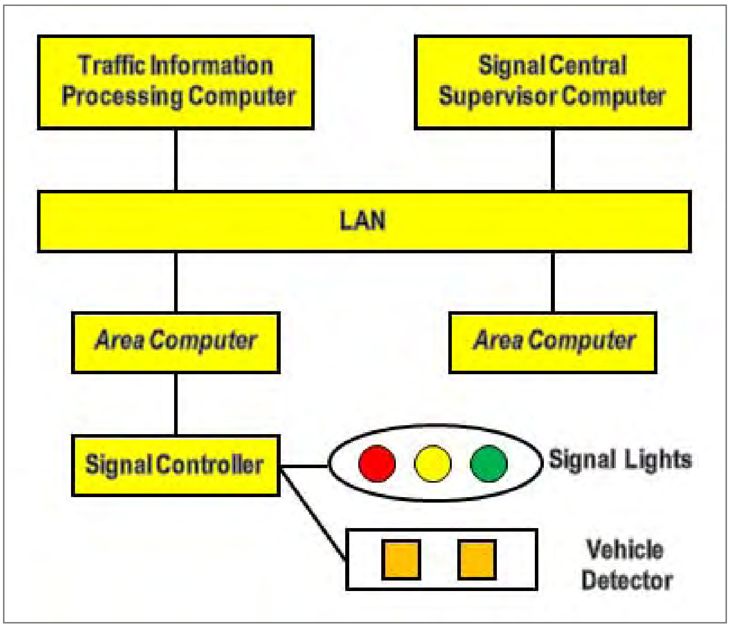


Figure 16.2-4 System Configuration

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.

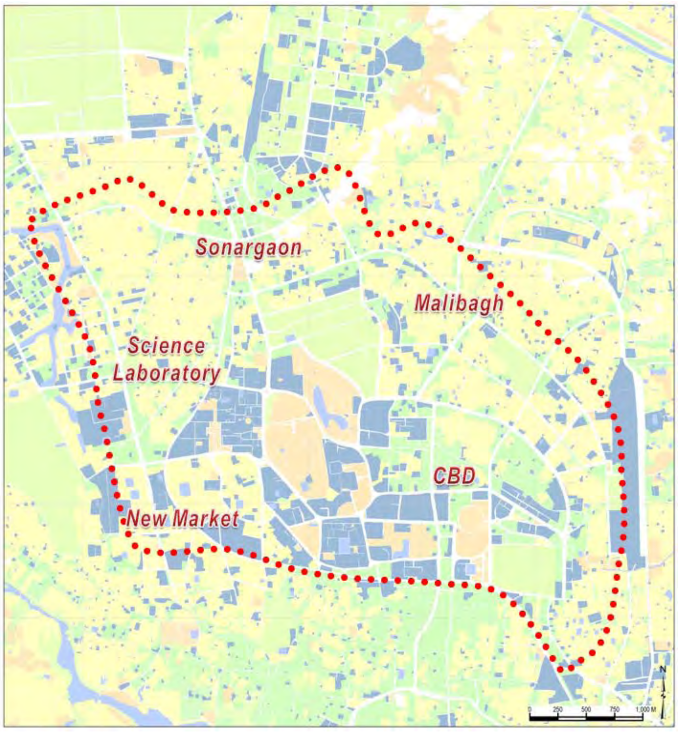


Figure 16.2-5 Parking Management Zone of CBD in Dhaka

(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

Source: Japan Traffic Safety Education Association

Figure 16.2-6 Example of Traffic Education Sample for Children

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.

processed using Python Image Library (PIL) and Numpy libraries-supporting large multidimensional arrays and matrices.

Fig. 4 Raspberry Pi Camera Module

The Pi then determines the level of traffic and allots timing to the traffic light indicators which are the red, yellow, and green LED's. Fig 5 shows the setup of the prototype housing the camera module, the Raspberry pi, the ultrasonic sensors and the traffic light indicators.

Fig. 5 Four way traffic junction prototype

Fig. 6 portrays how the ultrasonic sensors determine the level of traffic. As shown in the figure, the densities on Road 1,2,3,4 are respectively low, medium, no traffic and high. The corresponding values displayed on the python terminal confirm that the sensors read the same values.

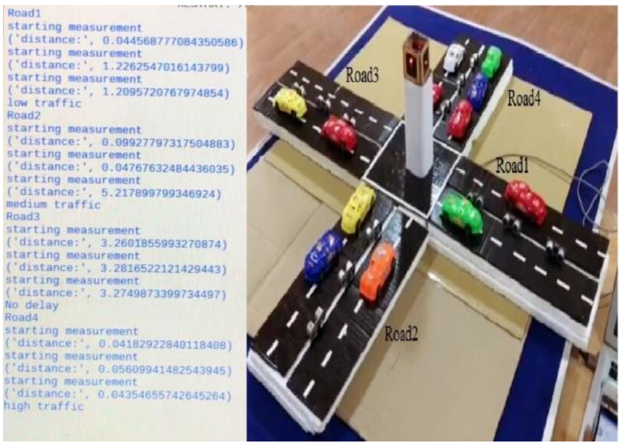


Fig. 6 Output at Python Terminal for the corresponding levels of traffic

Fig. 7 shows four different images captured by a camera with the corresponding output from the image processing algorithm.

Every time the Raspberry Pi finds the level of traffic it updates the values to ThinkSpeak. On the ThinkSpeak platform the values that are sent can be stored in the form of a graph as shown in Fig 8. Allowing the channel to be made public gives access to anyone who would like to view the level of traffic at a specific junction thereby enabling users to be well informed of the traffic density in a region.

In addition these values can be converted in the form of a database using the data export option, which will also serve as a source of information of traffic levels. This data can be made useful in case the sensor system fails by finding the average density of traffic at specific time slots.

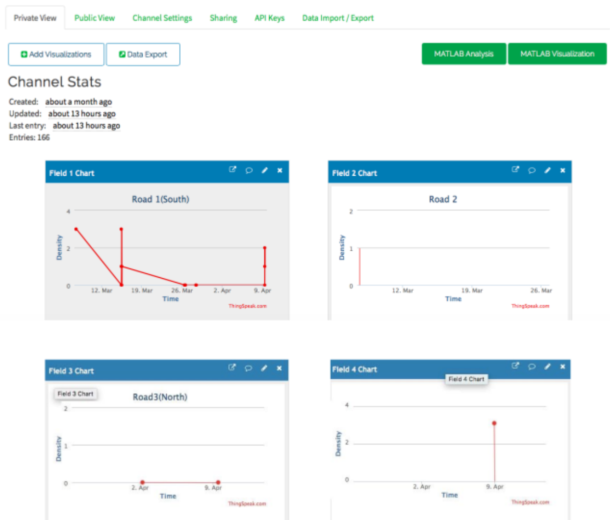


Fig. 8 Graphical representations of traffic levels on the ThinkSpeak platform

Therefore from the above results it can be inferred that together with the help of ultrasonic sensors and image processing techniques an approximate level of traffic can be found out that is equivalent to real time values of traffic. This information gathered can be used to assess and control the traffic lights in real time depending on actual densities of traffic. This will intern help in saving time and reducing the negative effects of traffic congestion.

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

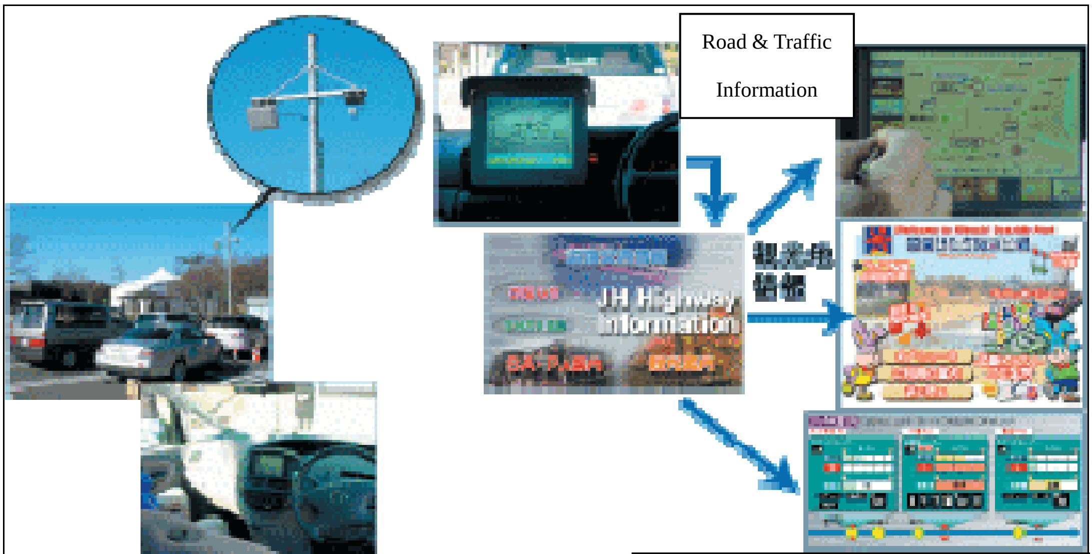
j) 3rd stage: Operational start-up of a concentrated-control advanced system.

(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.

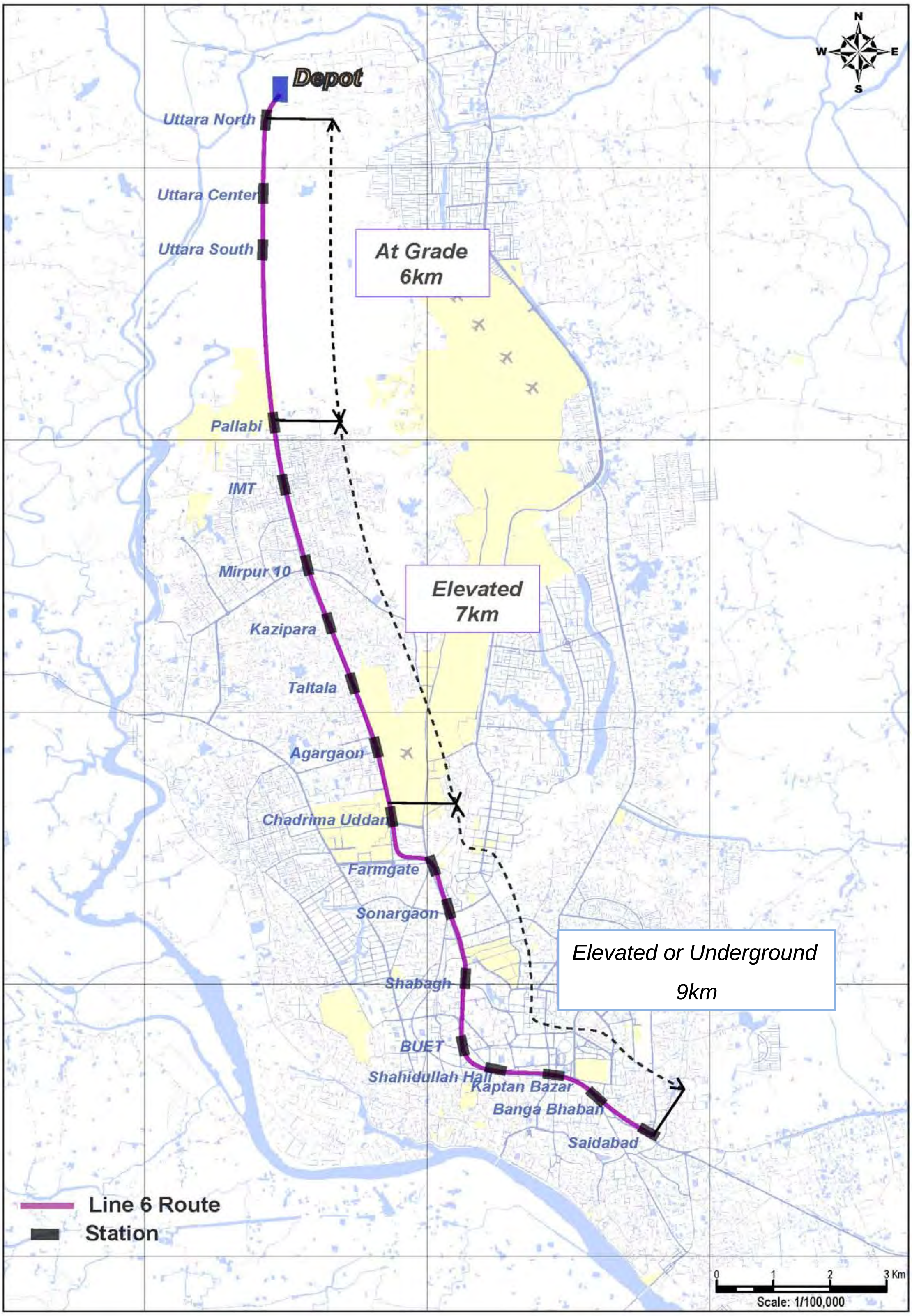


Figure 19.2-1 Line 6 Route and Structure (Base Case)

(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.

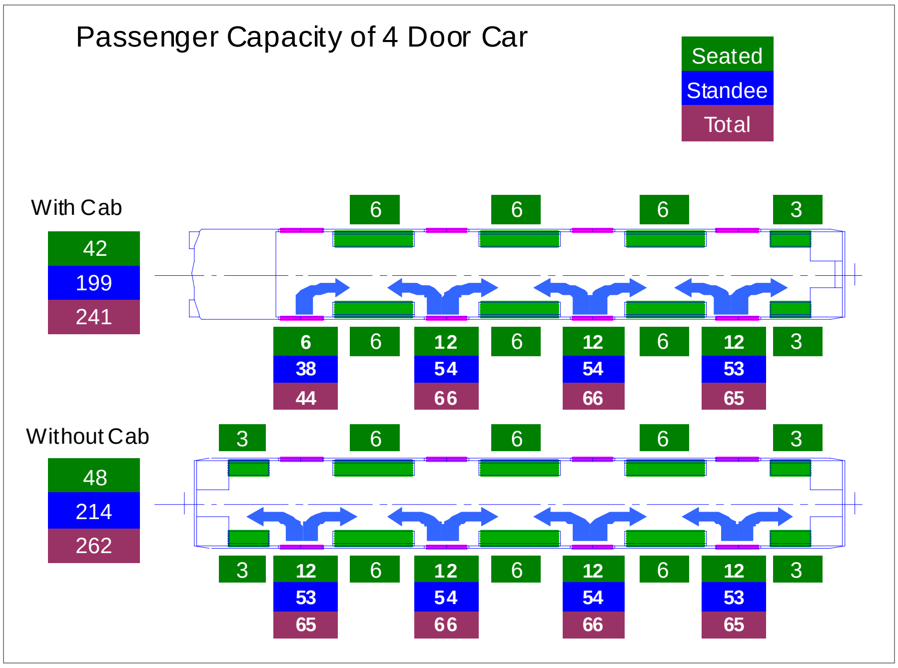


Figure 19.2-2 Seats Arrangement

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

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[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.*

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.

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

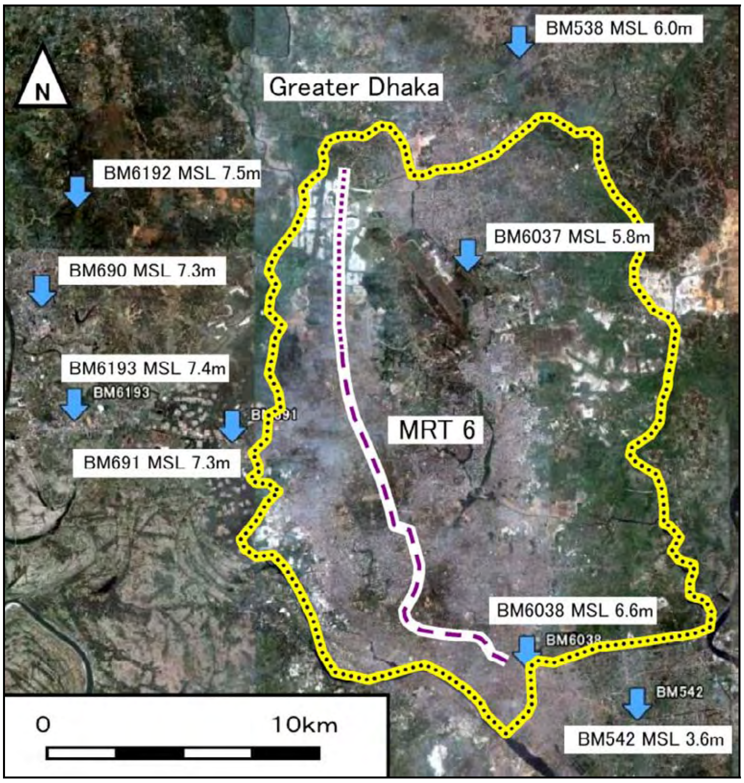

Figure 19.3-4 Flood Level in 1998

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.

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

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

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.

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.