PREPARATION OF CONGESTION INDEX OF TWO MAJOR ARTERIALS OF DHAKA CITY BASED ON FLOATING CAR METHOD-AN EFFECTIVE TOOL FOR TRANSPORTATION PLANNING

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ABSTRACT

For effective transportation planning and management, determination of congestion index based on real time traffic information is very effective. This paper is objected to extract traffic information and asses the congestion level of two major arterials of Dhaka City which are Mirpur Arterial and Shahbag - Kuril Arterial based on floating car method equipped with Global Positioning System (GPS) and prepare a congestion index and present it in a Global Information System (GIS) Map which is likely to serve as an effective source of transportation information. The data collection was done for 4 consecutive weeks at different hours of the day mostly at the morning and evening peak and based on the collected data, traffic parameters were computed. From the study, it is found that Mirpur Arterial provides higher level of Service in terms of Avg. Travel Speed, Travel Rate, Avg. Delay Rate, Avg. Relative Delay Rate and Avg. Delay Ratio. Moreover, the arterials more congested at the regions nearer the Central Business District than the outskirt regions. The lateral access roads have also worsened the condition to a great extent. Unplanned growing of Dhaka city with improper planning of road network and land use is also another big problem. Based on the study provision of proper frontage road along Mirpur Arterial, proper off street parking facilities, bus industry consolidation and development of mass transit is recommended.

KEY WORDS: Probe Vehicle, GPS, GIS, Congestion Index, Lateral Access Roads

1.0 INTRODUCTION

Dhaka city is overburdened with acute traffic congestion and immediate steps are expected to ease up the situation. Though various long term and short term measures are often being taken, expected outcome could never be achieved as most of them are based on improper planning and adoption of inefficient and unsuitable measures. The absence of reliable data and improper planning based mostly on common sense rather than engineering judgment is the main reason of this condition. Therefore, this research work is a need to assess congestion levels based on some established measure of effectiveness from an engineering point of view .That is why this paper is objected to prepare a congestion index based on traffic information derived of two Major Arterials of Dhaka City e.g. The Mirpur Arterial and The Arterial from Shahbag to Kuril Rail Crossing. The methodology used for extracting the traffic

information is the globally accepted probe vehicle method equipped with GPS. GPS technology offers a low capital cost and a low data collection cost combined with high location accuracy. Global positioning system (GPS) also provides real-time spatial and time measurements of a location. The derived congestion index is then presented in a GIS map in order to better understanding of the scenario which is expected to serve as an effective tool for the transportation planners.

2.0 OBJECTIVE

The objectives of this study are:

I. To extract useful traffic information of two major arterials of Dhaka city. The information to be derived are

i.   Travel Speed

ii. Travel Time

iii. Travel Rate

iv. Delay Ratio

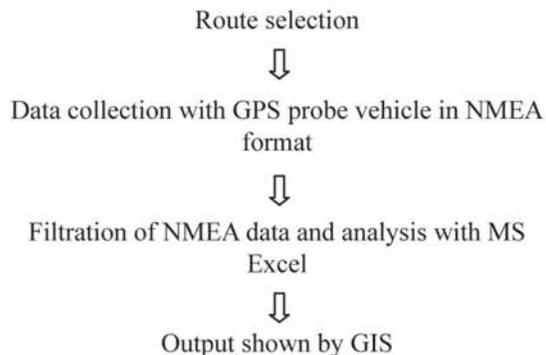v.   Actual Delay

vi. Relative Delay Ratio

II. Comparison between the two arterials in terms of the measured parameters

III. To prepare a congestion index based on this information.

IV. Summarizing the Congestion Index in a GIS Map.

3.0 METHODOLOGY

Two urban arterials in Dhaka City from i.e. The Mirpur arterial from Azimpur to Mirpur Technical (7.35 km approx.) and Shahbag Intersection to Kuril Rail Crossing (12.24 km approx.) is selected as the study route. The total route was divided into number of segments mostly based on intersections for the accuracy of the analysis and prediction of road performance as well as assessing the contributing factors behind congestion on different locations. A Toyota private car was equipped with a GPS receiver (Model: U-BLOX ANTARIS AEK-4H) connected with a portable computer. This was used as the probe vehicle to collect necessary information and data to extract required traffic information. Data was collected in the weekdays of 4 consecutive weeks and the collected data was then analysed and required traffic information was derived. The road network performance was done mainly based on the average speed of the vehicle. The output of the study was then presented by GIS (ArcGIS 9.2 version) by using coloured polygon features. Total methodology has been shown below with a flow diagram.

Route selection

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Data collection with GPS probe vehicle in NMEA format

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Filtration of NMEA data and analysis with MS Excel

⇩

Output shown by GIS

4.0 DATA COLLECTION

The data was collected in the week days of 4 consecutive weeks. Data collection was mostly done in the Morning and Evening Peak to evaluate the road network performance in the most extreme circumstances. Amongst them only $GPRMC (Recommended minimum specific GPS/Transit data) format data was used to extract travel speed, travel time, local coordinates. The data was then filtered and aggregated to derive necessary traffic information.

5.0 STANDARD FOR EVALUATING CONGESTION STATE

Considering the heterogeneity of vehicle and heavy population and traffic density in Dhaka Arterials some standards speed limits and travel rate are considered based on earlier studies and urban travel standards which are more representative and applicable for an arterial of a heavily crowded city like Dhaka.

Table 1: Congestion Standards

Travel speed K(mph)	Travel Rate (min/km)	Congestion State
>35	<1.72	None
25~35	1.72~2.4	Low
15~25	2.4~4	Medium
7.5~15	4~8	High
<7.5	>8	Very High

Source: Dr. Md. Mizanur Rahman et al (2012); "TRAFFIC INFORMATION DERIVING USING GPS PROBE VEHICLE DATA INTEGRATED WITH GIS"; International Conference on Sustainable Development, KUET.

6.0 ILLUSTRATIONS

6.1 Derived Traffic Parameters for Mirpur Arterial

The derived traffic parameters of for Shahbag intersection to Hazrat Shahjalal International Airport is provided at Table 3.1

Table 2.1: Traffic Parameters for Mirpur Arterial

Segment Name	Length (km)	Speed (km/hr)	Delay Rate (min/Km)	Travel Rate (min/km)
Technical More to Shyamoli	1.58	21.35	1.10	2.81
Shyamoli to Sishu Mela	0.24	11.76	3.39	5.10
Shishu Mela to Gana Bhaban	1.09	17.49	1.72	3.43
Gana Bhaban to Asad Gate	0.49	19.35	1.39	3.10

Table 2.1: Traffic Parameters for Mirpur Arterial (Contd.)

Segment Name	Length (km)	Speed (km/hr)	Delay Rate (min/Km)	Travel Rate (min/km)
Asad Gate to Manik Mia Avenue	0.26	12.76	2.99	4.70
Manik Mia Avenue to Dhanmondi Road #27	0.2	12.24	3.19	4.90
Dhanmondi Road #27 to Pantha Path	0.65	12	3.29	5.00
Pantha Path to City College	1.41	13.95	2.59	4.30
City College to Nilkhet More	0.81	16.12	2.01	3.72
Nilkhet More to Azimpur	0.62	12.24	3.19	4.90

Source: On field Data Collection in August, 2011

## 6.2 Derived Traffic Parameters for Shahbag Intersection to Kuril Rail Crossing

The derived traffic parameters of for Shahbag intersection to Hazrat Shahjalal International is provided at Table 4.1

Table 3.1: Traffic Parameters for Shahbag to Kuril rail Crossing

| Segment Name	Length (km)	Speed (km/hr)	Delay Rate (min/km)	Travel Rate (min/km)
Shahbag to Hotel Ruposhi Bangla	0.25	6.48	7.55	9.26
Hotel Ruposhi Bangla to Banglamotor Intersection	0.51	7.52	6.27	7.98
Banglamotor intersection to Karwan Bazar	0.44	7.94	5.84	7.56
Karwan Bazar to Farmgate	0.93	11.59	3.46	5.18
Farmgate to Bijoy Sarani	0.77	8.55	5.30	7.01
Bijoy Sarani to Jahangir Gate	1.25	11.41	3.54	5.26
Jahangir Gate to Setu Bhaban	1.43	22.93	0.90	2.62
Setu Bhaban to AIUB	3.37	25.14	0.67	2.39
AIU to Army Stadium	1.28	12.43	3.11	4.83
Army Stadium to Kuril	2.41	15.91	2.06	3.77

Source: On field Data Collection in August, 2011

7.0 COMPARISON BETWEEN THE TWO ARTERIALS IN TERMS OF THE MEASURED PARAMETERS
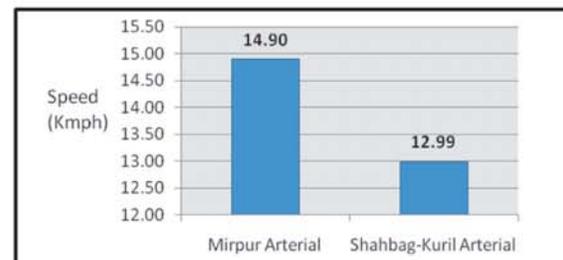
Figure 1: Comparison between Mirpur Arterial and Shahbag- Kuril Arterial in terms of Avg. speed
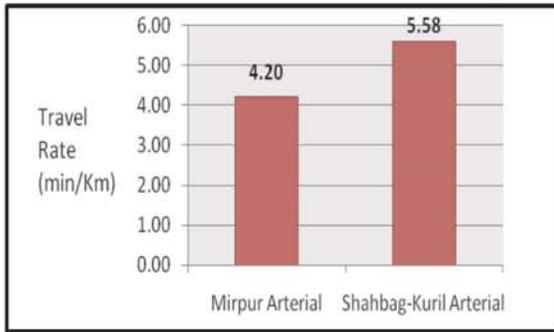
Figure 2: Comparison between Mirpur Arterial and Shahbag- Kuril Arterial in terms of Avg. Travel Rate
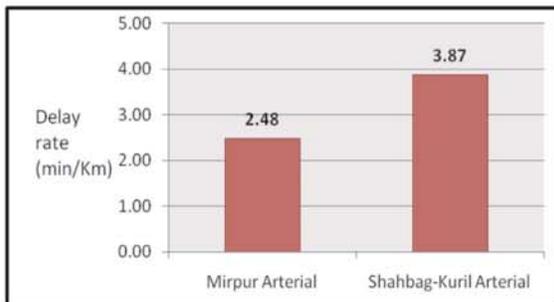
Figure 3: Comparison between Mirpur Arterial and Shahbag- Kuril Arterial in terms of Avg. Delay Rate

8.0 RESULT AND SUMMARY OF THE FINDINGS

1) The Mirpur Arterial provides a higher level of service than the Shahbag-Kuril Arterial in terms of Avg. Travel Speed, Travel Rate, Avg. Delay Rate, Avg. Relative Delay Rate and Avg. Delay Ratio.

2) Though the study shows a higher total Free Flow Travel Time in Shahbag-Kuril Arterial than Mirpur Arterial, the study route of Shahbag Arterialis nearly almost nearly twice than the Mirpur Arterial. So we can say both the arterials present similar Free Flow Travel Time.

3) Both the arterials are less congested at the outskirt regions from the Central Business District (CBD) and more congested near the CBD.

4) Congestion is most severe at the zones where the Arterials are connected with numerous lateral access roads and less severe where lateral access roads are less.

5) Both the study routes do not provide the expected Level of Service (LOS) of an Arterial because they are overburdened with local traffics from the poorly planned access roads.
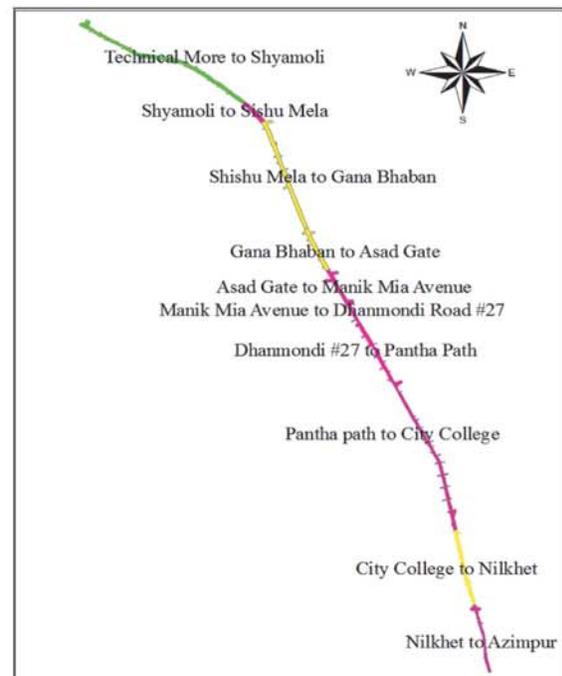
6) In case of Mirpur Arterial, most severe congestion occurs between City College to Asad Gate due to adjacent grid pattern local road network having there connection with the arterial.

7) In case of Shahbag- Kuril Arterial, though local traffic volume is less due to restrictive measures on some local NMT (Non motorized Traffic) vehicles, overall traffic volume is significantly high as it is the central arterial of the city and mostly commercial land use at the surroundings.

9.0 PRESENTATION OF OVERALL CONGESTION STATE BY GEOGRAPHIC INFORMATION SYSTEM (GIS)

Legend

Very High Congested Condition (Speed < 7.5 kmph)

High Congested Condition (Speed 7.5 to 15 kmph)

Moderately Congested Condition (Speed 15 to 25 kmph)

Low Congested Condition (Speed 25 to 35 kmph)

Congestion Free Condition (Speed > 35 kmph)

Figure 4: Overall congestion map of Mirpur Arterial
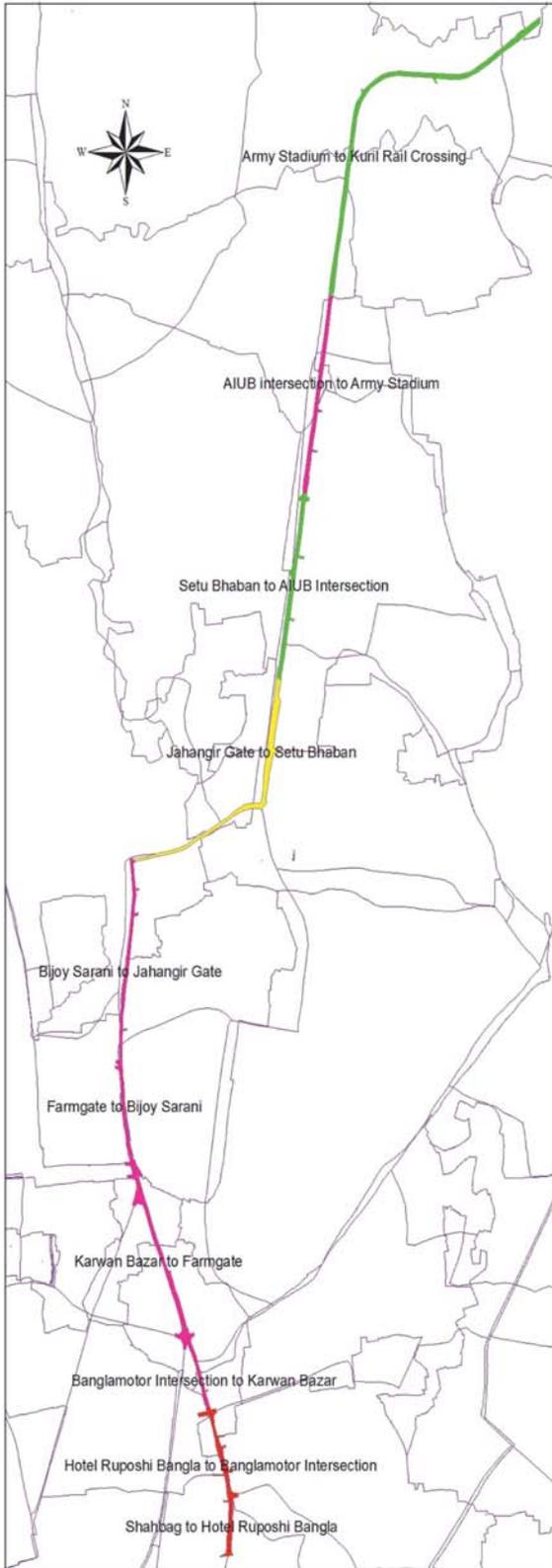
Figure 5: Overall congestion map of Shahbag-Kuril Arterial

10.0   RECOMMENDATIONS

1) In case of Mirpur Arterial, the adjacent grid pattern local road network is developed improperly having their connection directly with the arterial instead of having a frontage road. And the study shows a detrimental effect of the local traffics on the arterial. So appropriate measures is necessary to restrict the local traffic to have their access on the arterial in the most severely congested zones.

2) A significant portion of the carriageway width remains occupied by the randomly parked vehicles causing a detrimental effect on the Level of Service of the arterials. So immediate off-street parking facilities are needed to be developed and laws of keeping sufficient parking facilities in side each multistoried building adjacent the arterial are needed to be strictly implemented.

3) Pedestrian walkway facilities should be properly maintained and random crossing of roads by the pedestrians should be restricted strictly because it interrupts the traffic flow to a great extent and also causes safety hazards.

4) At the Shahbag -kuril Arterial, grade separation at the Mohakhli Rail Crossing has brought the congestion to a moderate state (according to this study). Two more grade separation works are undergoing i.e. an overpass at the Banani Rail crossing and an Interchange at Kuril Rail Crossing. But it is recommended that adequate compensatory road space should be allotted to avoid interruption of the traffic flow.

5) Some intersection treatment like widening , exclusive left turning lane is likely to develop the condition at Karwan Bazar Intersection and Bangla Motor Intersection.

6) Alternative transportation mode like BRT, Metro Rail and existing rail way should be developed for long-term solution of the problem. Because due to improper planning of the land use and road network as well as huge population, only demand management and temporary restrictive measures is not good enough anymore to solve the problem.

11.0   CONCLUSION

Transportation data are related with spatial information. For collecting accurate data GPS was

used & for storing & manipulating data GIS was used widely. This was done in this study that has been described already. One second accuracy was maintained by Antaris 4H GPS with proper altitude, global direction and vehicle speed. With that reasonable accurate data average speed, free flow time, actual delay, travel rate, delay rate, relative delay rate, delay ratio has been computed. After completing analysis total result has been shown by GIS (ArcGIS 9.2 version) by using colored polygon features. Based on the collected data and further analysis it is found that the central arterial that is Shahbag- kuril is more congested than the Mirpur Arterial. The majority of congestion in Mirpur Arterial is concentrated within Panthopath to Manikmia Avenue which is overburdened with lots of access roads directly without frontage road. The Shahbag-Kuril arterial is severely congested within Shahbag to Bijoy Sarani because of too closely spaced junctions and high traffic flow. The study shows the Mohakhali Overpass has lessened the traffic congestion because of the railway crossing at Mohakhali. From this study, it is believed that the Banani Overpass , Mirpur Trumpet Interchange as well as the Kuril pattern less Interchange is going to be effective to lessen the congestion while going towards Uttara. But a reverse effect is anticipated while coming towards Shahbag because of accumulated large queue of vehicles not being able to get discharged at the intersections after Jahangir Gate. That is why, frontage road along the arterial for low speed local traffic, bus industry consolidation and suitable mass transit options such as MRT and BRT is recommended to be implemented.

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