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An Assessment on Turning Restriction of Vehicle at Intersections in an Arterial Road

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Abstract –Urbanization and population growth accompanied by high travel demand increasing pressure on transportation system and creating traffic congestion. Mega cities with large population cannot cope with high traffic demand due to lack of finance and shortage of adequate land for construction of new roads. However, capacity of existing road can be many folded and performance of the arterials can be augmented through proper traffic management. In this study, we have discussed on a survey study conducted in Mirpur road of Dhaka city—which is one of the busiest arterial there. Grid lock Traffic jam is a common phenomenon and right turning vehicle at intersections worsen the situation. Restricting right turning vehicle in the intersections in lieu of allowing those vehicle to pass through the U-turn in the mid block section can resolve this problem feasibly. CORSIM simulation model is used for Mirpur road (Science Laboratory to Asad Gate). Through the sections of CORSIM simulation model is reviewed, selection of study area and roadway network performance are investigated. An idealistic model for Mirpur road is developed, calibrated and applied to analyze planning options.

Keywords – Traffic Congestion, Simulation, CORSIM, Traffic Management, arterials.

I.INTRODUCTION

Traffic congestion is one of the major problem in the densely populated cities around the world. Like other large populated cities; existing road cannot accommodate peak hour traffic rush and resulting recurrent traffic jam in Dhaka. In order to alleviate traffic congestion and improvement transportation system in Dhaka several studies were conducted by Dhaka Transport Coordination Board (DTCB) and Louis Berger Group. The study was focused predominantly on developing strategies for building new infrastructure, including rail transit, bus rapid transit, and highway development. [5] Implementing traffic management tool can improve the capacity of existing road network. Capacity of major arterial roads can be improved very easily with least cost. Mirpur road is a major arterial with number of busy intersections in Dhaka city. The scope of the study is to evaluate and find out some planning and management related measures, which can improve road network performance of the Mirpur Road. In this study, performance of Mirpur Road (Science Lab to Asad Gate) is evaluated based on delay and speed using CORSIM traffic simulation software firstly.

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After that, the network improvements are achieved by changing signal timing and turning movements, which are also tested in CORSIM.

II.TRAFFIC MANAGEMENT

Various countries and localities have several tools of urban traffic management and a range of applications have been developed over many years. Traffic signals, parking controls, pedestrian zones, public transport provision, freight provision and access controls are the typical management applications. Reducing congestion, increasing capacity of transport system, enhancing road safety and reducing traffic emissions are the advantages of these policies.

A. Planning and Policy Related Study -

Baquee (1979) studied on economy and engineering feasibility of the "Dhaka bypass" in 1968. In that study along with recommendations for design and construction of roads, some suggestions were made on traffic control and traffic management. Baquee (1979) conducted a study regarding traffic problem in Old Dhaka. He recommended some traffic management techniques to solve the problem; such as time restriction for the related vehicles, parking provisions improvement, one-way system, banning of selected vehicles from selected roads etc. [3] Alam (1992) performed a model based study on Dhaka city. He analyzed traffic optimization options by using traffic assignment model. With new perspective, the Dhaka Metropolitan Development Plan (DMDP, 1995-2015) was prepared for sustainable growth of Dhaka. [2] Recognizing the need for a sustainable increase in investment in Dhaka's transport sector, Government of Bangladesh with the help of World Bank (WB) approved a project named Dhaka Urban Transport Project (DUTP). DUTP is a technical assistance project for traffic management policy making in Dhaka. [5] Ahmed and Hoque (1988) discussed different aspect of failure of traffic management and administration of Dhaka City. It was found that existing transport facilities were not adequate to meet travel demand and mixed mode situation, which resulted in traffic congestion and danger. Suggestions for modifications of traffic management and policies had been made [1].

III. STUDY AREA

Mirpur road is one of the major and busiest arterial in Dhaka city, which is very poorly operated and managed. Although traffic signals are present, access and turning movement are not efficiently controlled. Roadside non motor activities are common scenarios. Therefore, traffic congestion is a regular feature in this road.

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A recent study reveals that the average speed at Mirpur road (a major arterial road) is 15 to 17 kilometer per hour during peak period. [6] In this investigation we show that the traffic condition at Mirpur road can be improved by setting appropriate signal timing and managing the turning movements at the intersections. The whole analysis is performed in CORSIM simulation software. The software allows us to test the impacts of changes before implementing in real life. The present traffic conditions of Mirpur road are shown in Figures 1.

Figure 1: Traffic Condition at Mirpur Road

IV. DATA COLLECTION

A. Reconnaissance Survey –

Reconnaissance survey is a preliminary survey for gathering information about the survey site before the final survey. The information obtained from the reconnaissance survey is mentioned below. As stated previously, Mirpur road is a very congested place. A long queue of traffic is a common scene almost all the time during the pick period. But the worst situation are seen (except any special occasion) in the weekend Thursday after the office time (4.00 pm to7.00 pm) and Sunday before the office time (7.00 am to 10.00 am). The flow of vehicles and pedestrians reach to its maximum of the day at that time. Weather condition is also found responsible for the maximum flow. Some useful information is also collected from traffic police.

B. Traffic Volume Survey –

After the reconnaissance survey it is found that Thursday (4.00 pm to 7.00 pm) or Sunday (7.00 am to 10.00 am) is the best time to obtain the maximum flow. It is very important to provide some general information for any kind of survey. For a traffic volume count survey, the general information may be consists of location of survey along with the point of data collection, date of survey, time of survey along with the time interval, weather condition of the survey place, method of counting, etc. Between manual and video recording counting method it is much preferable to use video recording method. In video recording method there is less chance for error and counts can be cross checked several times along with vehicle classification. The general information of the traffic survey area (Science lab to Asad gate) is provided in the Table I:

Table I: Details of Survey

Location of survey	Mirpur Road
Data collection points	12 locations. Science-lab, City College, Road no.-03 (Dhanmondi 3), Road no.-04 (Dhanmondi 4), Road no.-05 (Dhanmondi 5), Road no.-06 (Dhanmondi 6), Road no.-07 (Dhanmondi 7), Kolabagan (Road No-08), Panthopath, Road no.-27 (Dhanmondi 27), Manik Mia Avenue, Asad Gate
Date of survey	5 week days
Time of survey	8.00 am to 9.00 am 5.00 pm to 6.00 pm
Duration of survey	1 hour at a 15 min interval
Weather condition	Sunny (favorable)
Method of counting	Manual Counting and Video recording

The data collection points are shown in Figure 2.

Figure 2: Survey Points (Satellite View)

C. Traffic Volume Count –

Initially traffic was counted for four consecutive 15-minutes. Then the maximum volume for 15 minute is multiplied by 4 to obtain the max hourly volume (vph). Mathematically, Traffic Flow = max volume at a 15 min interval × 4 After analyzing all the traffic data of different survey dates as mentioned before, it is found that Thursday 5.00 to 5.15 pm is the time when the flow was the maximum. Therefore, in this study we use the traffic flow of that particular time for our simulation. We converted that survey volume data into PCU/Vehicle by multiplying by PCU factors as per Canadian Capacity Guide for Signalized Intersections (3rd Edition). [4]

D. Summary of Survey –

The summarized data of North bound traffic (Science Lab to Asad Gate) and South bound traffic (Asad Gate to Science Lab) at each survey point is provided with graphical comparison in Figure 3.

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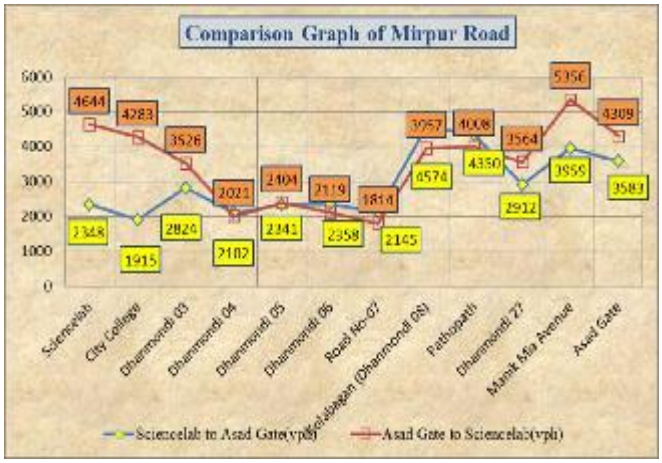

Figure 3: Graph Showing Directional Distribution of Traffic at Mirpur Road

V. CORSIM SIMULATION

CORSIM (CORridor SIMulation) is the most widely used microscopic traffic simulation program in U.S. and all over the world. The initial development of CORSIM logic started in early 1970s. It is a comprehensive microscopic traffic simulation, applicable to surface streets, freeways, and integrated networks with a complete selection of control devices (i.e., stop/yield sign, traffic signals, and ramp metering). [7] Though used by the FHWA for conducting research, these tools are sold to the public. It has become the standard and found thousands of applications in recent years. In addition to continuous enhancements to its logic, incomparable validation, verification, and calibration effort ensures that CORSIM results realistically reflect real world traffic flow. It simulates traffic and traffic control systems using commonly accepted vehicle and driver behavior models. CORSIM Version 5.0 is used for simulation in this study.

A. Network Representation –

In this research, Mirpur road (Sciencelab to Asad Gate) is analyzed. The length of the network and other measurement (i.e length, width, side-friction etc) are obtained from Google Earth and used to create a network in CORSIM. Scaling the bitmap is crucial to obtain accurate results. The data is obtained from the road survey. The second step in editing the surface link properties over the entire network is entering data such as the number of lanes data (acquired from Google Earth), and lane channelization (as observed from Google Earth). This part of the editing takes time depending upon the networks complexity and size. The lane channelization is also defined in the software. The next step is editing properties of intersections, such as nodes, turn moments (according to Google Maps), relative turn volume percentages data, lane alignment, turn movements, stop line and finally adjustment of turn alignment of the all links near the intersection. The red, yellow, and green times for each allowed movement on each approach in the pre-timed cycle for the intersection are incorporated in the model. Our CORSIM simulation network is comprised of 180 network links, 53 network Nodes and 31 dummy entry nodes for the origins of vehicle inputs. The CORSIM Network is shown in Figure 4.

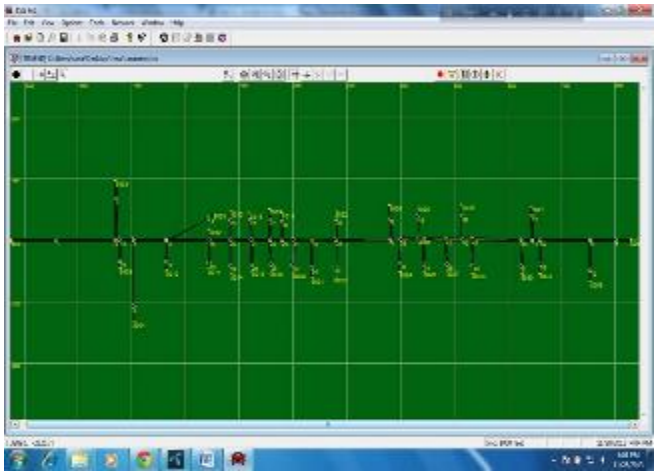

Figure 4: CORSIM Simulation Network

B. Calibration of Network –

We have calibrated the network model before using for final analysis. It is an essential part of any simulation. It is done in order to make sure that the model replicates the true scenario that exists in the field. In this work calibration was done mainly by comparing the outputs (e.g., volume, average speed, delay time) from the model with the field data obtained from the traffic volume survey. In order to do so, we have adjusted the CORSIM parameters: signal timing, speed limit, lane width etc. Adjustment was done until the outputs from the model matched with the field observations.

C. Network Analysis –

Existing Condition Simulation:

The calibrated network is simulated in CORSIM to determine the performance of the existing condition of Mirpur road. Performance measures of each link and the whole network are obtained after the simulation runs. From CORSIM simulation we got the outputs (i.e., move time, delay time, travel time, average speed etc.) for every individual link as well as for the whole network. However, for the performance evaluation of Mirpur road we have used only the delay time and average speed. It can be observed that delay time per vehicle is very high at many links with very low average speed. Heavy traffic congestions are found at Elephant road, City College, Dhanmondi 27, Manik Mia Avenue and Asad Gate intersections.

Improved Condition Simulation:

From the existing condition analysis we have found that there are heavy traffic flows in the five main intersections in Mirpur road within our study area. Therefore, a new improved model is developed in CORSIM with the same input of traffic volume, lane number, lane width and length data as used in existing network analysis. In order to improve the traffic condition of Mirpur road signal timing and turning movements are adjusted for those critical intersections. The following changes are made for the turning movements of the traffic:

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Elephant Road Intersection: At this intersection right turn have been made restricted from the Elephant road to Mirpur road and made all turns to left. Then a U-turn is designed at the middle of the New Market road median. Instead, drivers are instructed to "overshoot" the intersection, go through the U-turn lane, come back to the intersection from the opposite direction, and through.

City College Intersection: At this intersection right turn have been made restricted from the City College to Mirpur road and made all turns to left. Then a U-turn is designed at the middle of the City College to green direction lane median. Instead, drivers are instructed to "overshoot" the intersection, go through the U-turn lane, come back to the intersection from the opposite direction, and through.

Dhanmondi-27 Intersection: At this intersection right turn have been made restricted from Mirpur road to Dhanmondi-27 road and made all turns to through. Then a U-turn is designed at the middle of dhanmondi-27 to Panthopath direction lane median. Instead, drivers are instructed to "overshoot" the intersection, go through the U-turn lane, come back to the intersection from the opposite direction, and go left.

Manik Mia Intersection: At this intersection right turn have been made restricted from Mirpur road to Manik Mia Avenue and made all turns to through. Then a U-turn is designed at the middle of Manik Mia to Asad Gate direction lane median. Instead, drivers are instructed to "overshoot" the intersection, go through the U-turn lane, come back to the intersection from the opposite direction, and go left.

Asad Gate Intersection: At this intersection right turn have been made restricted from Mirpur road to Asad Avenue and made all turns to left. Then a U-turn is designed at the middle of Asad Gate lane to Mirpur direction lane median. Instead, drivers are instructed to "overshoot" the intersection, go through the U-turn lane, come back to the intersection from the opposite direction, and left.

After doing the above mentioned operational changes we have got the new model. The new model is shown in Figure 5.

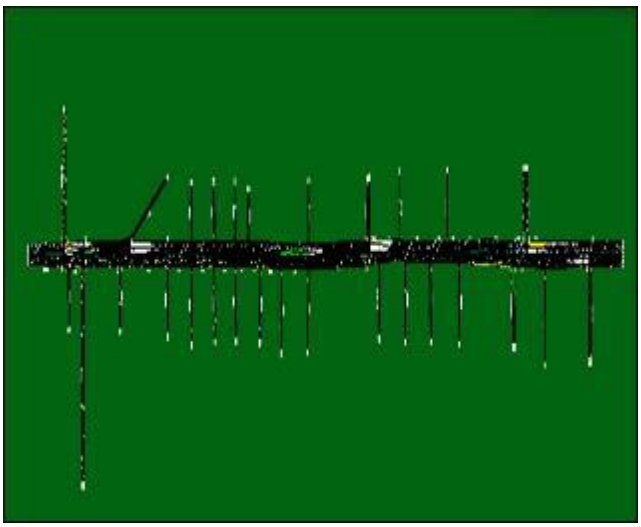

Figure 5: Improved Model in CORSIM

VI. COMPARISON OF EXISTING & IMPROVED CONDITION

Average speed and delay time are determined for both the present condition and improved condition of the network. In improved model, the average speeds are found higher and delay times are found lower than those of existing network. For the whole network, the average speed has increased and delay time has decreased after the improvements have been done.

Table II: Comparison of Performance Measures of the Whole Network.

Network-wide Average	Existing Condition	Improved Condition	% Improvement
Total Vehicle- Mile (VMT)	6290.29	11402.96	81.28%
Total time (Vehicle-Hours) (VHT)	1434.36	1293.51	9.82%
Total time (Minutes/Mile)	13.68	6.81	50.22%
Delay time (Vehicle-Hours)	1224.7	913.43	25.42%
Delay time (Minutes/Mile)	11.68	4.81	58.82%
Average Speed (MPH)	4.39	8.82	100.91%

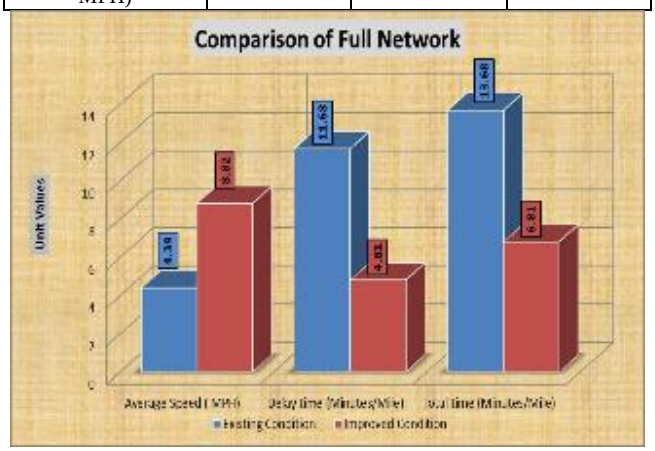

Figure 6: Comparison of Performance Measures of the Whole Network

It was found that along the Mirpur road many intersections are overly congested due to many reasons. Improvements in traffic condition could be achieved by changing signal timing and turning movements.

VII. CONCLUSION

Emphasizing on conventional traffic management tools can increase the capacities of existing road network. By using CORSIM simulation software we showed that traffic condition can be improved by setting appropriate signal timing and managing turning movements (i.e., banning right-turn, U-turn, etc). In our study Mirpur road (Science Lab to Asad gate) was modeled and simulated. First the existing condition was modeled in CORSIM and after the calibration with the field data performance measures (i.e., delay, average speed, etc.) were obtained.

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It was found that the traffic congestions were huge at every intersection. The conditions were worse at major five intersections (Science Lab, City College, Dhanmondi 27, Manik Mia Avenue and Asad Gate intersections) along this arterial within our study network. Therefore, we tried to increase the capacities of those intersections. In order to do so, signal timing was adjusted and some right turns were banned at those congested intersections, which were also tested in CORSIM. Satisfactory results were obtained as the average speed of the vehicles increased and delay time decreased for almost every link as well as for whole network. So it can be said that, by proper network design and effective traffic management we can lead to a safe, healthier and congestion free life.

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