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SETTING OF OPTIMUM SIGNAL TIMING USING VISSIM SOFTWARE TO IMPROVE THE EXISTING TRAFFIC OPERATING CONDITION OF T AND FOUR LEG INTERSECTION OF CHITTAGONG CITY

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ABSTRACT

Now a day's traffic congestion issues in Chittagong city is becoming worse day by day. This happens due to the slow-moving vehicles, occupied footpath, unauthorized car and bus/truck lay over, traditional traffic signal timings Government authorities are building flyovers to abate the intensity of congestion which is not always a great solution but cost a huge amount of money. Saturation flow in any intersection is huge to control with traditional traffic signal system. The aim of this paper is to assess and develop the traffic operations at the AK Khan (T) and Alongkar (four leg) intersection which are situate near the most congested portion of Chittagong city due to bus terminal area. Traffic count studies are conducted to determine the number, movement and classification of vehicles at an intersection. In this study, an improved traffic signal timings i.e. green time, amber time and red time have selected for continuous movement of vehicles through the intersection to ameliorate the situation of delays, average speed and queue length to do that videography survey has conducted at 15 minutes of intervals during estimated peak hour. In addition, geometric, traffic and signalized data were collected during peak time periods. In this study, we calculated the signal timings (Green time, Yellow time, Red time, Cycle time and Lost time) and it is optimized by VISSIM which is a traffic simulation software. Delay time and average speed are determined manually and compared after optimization in VISSIM. Another alternative solution is given i.e. construction of one through overpass for one direction (from AK Khan to Alongkar) for through vehicles to have more improved traffic condition. These solutions will be advantageous for the signalized intersections especially during rush hours, decreasing the travel cost, greenhouse gas emission & number of accidents, increasing the efficiency of the road network, improving traffic flow and traffic operations.

***Keywords**: VISSIM, Intersection, Chittagong, Optimization, Traffic Signal.*

1. INTRODUCTION

In Chittagong city of Bangladesh, congestion has been a serious problem for the past few years. With the rapidly growing population and consequent vehicle increment, the problem is worsening day by day. A modern city should have 25 percent of its total area devoted to road use but Bangladesh has only 7.5 percent, which is one of the main causes of traffic congestion (Shah, Rahman & Mamun, 2015). It is needed to improve traffic operating condition of the existing road networking by applying signal optimization technique, building new flyovers, mass rapid transit (MRT), bus rapid transit (BRT). But building these developments are time consuming and also needs huge fund. In this research, an attempt has been taken to improve the traffic operating condition of AK Khan to Alongkar road by setting appropriate signal timing at the intersections along this road which is not that expensive compared to building new flyover.

As AK Khan to Alongkar road is one of the major bus terminal area of Chittagong city which is directly connected with N1 highway, it is not possible to implement the appropriate signal timing and analyze the operation of complex transportation systems under congested conditions in this road practically. Therefore, in order to implement the appropriate signal timing, we use simulation software and the whole analyses are performed in VISSIM simulation software. The software allows us to test the impacts of changes before implementing in real life. Traffic simulation replicates the roadway existing travel pattern with least effort and greater accuracy and gives a way to perceive the situation clearly and devise our thoughts and analyze the operation of complex transportation systems under congested conditions in a more realistic way.

The main objective of the study is to improve the traffic operating condition of Alongkar to AK Khan intersection (i.e. T and 4-leg) by setting optimum signal timing at the intersections along this road. Other objectives are discussed below.

1. To evaluate the existing delay and capacity of the intersection.
2. To adjust the cycle length, timing (green time, amber time and red time) of intersections to reduce the delay and increase the average speed for different situation.

2. LITERATURE REVIEW

For any emergency situation, demand responsive and well-planned traffic signal system is needed for satisfactory management of traffic (Rahman, Mamun, Basit & Rahman, 2017). TRAMS (Transit Route Animation and Modeling by Simulation) can simulate light rail transit operations but not applicable for large volume of bus operation (Shah, Rahman & Mamun, 2015). CORSIM is able to simulate transit operations while considering car-following and lane- changing behavior (Shah, Rahman & Mamun, 2015).

TSIS-CORSIM is a microscopic traffic simulation software package for individual traffic signal set ups, highway, freeway, as well as combined signal, highway and freeway systems. CORSIM consists of an integrated set of two microscopic simulation models. These models represent the entire environment of the traffic.

VISSIM is a microscopic, time step and behavior-based simulation model developed to model urban traffic, public transport operations and flows of pedestrians. The program can analyze private and public transport operations under constraints such as lane configuration, vehicle composition, traffic signals, thus making it a useful tool for the evaluation of various alternatives based on transportation engineering and planning measures of effectiveness (Roy, Barua & Das, 2015). VISSIM can be applied as a useful tool in a variety of transportation problem settings. The simulation package VISSIM consists internally of two different parts, exchanging detector calls and signal status through an interface. The simulation generates an online visualization of traffic operations and offline the generation of output files gathering statistical data such as travel times and queue lengths (Uddin, Hasan, Rony, Alam, Ghosh & Zaman, 2019).

3. STUDY AREA AND DATA COLLECTION

A reconnaissance survey was done from 20 January to 26 January, 2019 to find out the position of building to setup the camera for the purpose of filming the traffic data. The peak hour of these intersections was 5:00 pm to 6:00 pm. Traffic volume data was recorded for 15-minute interval at 4:00 pm to 6:00 pm for the month of February and March, 2019 for both AK Khan and Alongkar intersection. A video graphic survey has been completed at AK Khan and Alongkar intersection. At AK Khan intersection there is no suitable elevated place for traffic survey and survey is conducted from at-grade condition. But there is an elevated place to count the vehicle movement at Alongkar intersection. Finally add them together to show the volume with percentage details in result and analysis section and converted the values into PCU/hr. A student version of VISSIM is available in Port City international University, Transportation Engineering Lab which is used as the micro simulation tool for calibration and validation of the model. Geometric data of the survey area were collected manually for the purpose of drawing links and connectors in VISSIM. AK Khan intersection and Alongkar intersection are shown in the figure 1.

a) AK Khan intersection (T-intersection)

b) Alongkar intersection (four leg intersection)

Figure 1: Selected intersection (a and b) for data collection.

Mobile phone and action camera used to collect the data. The video was then analyzed at a speed of one-eighth of the actual speed to enable recording and measurement of traffic volume data. Besides traffic volume several traffic parameters can be obtain from recorded film. This indirect data collection method is applicable when volume is high. A suitable elevated place is required for filming operation. Data cannot be used immediately after collection. This process is time consuming and tedious but calculation quality is good enough. We selected indirect data collection method as we can get correct and exact data by this method. Any kind of research work related to transportation, traffic volume or vehicular composition analysis is mandatory since variation of average speed of vehicle, overtaking maneuver, traffic congestion is directly related to the traffic volume.

4. DATA ANALYSIS AND RESULT

After collecting data, they were checked, verified, cleaned and finally edited. Table 1, 2 and figure 2 were prepared as required. Data from different videos were also analyzed and compared in the same way. Tabulated and presented data were scrutinized carefully and critically to interpret in an accurate and tidy format. Moreover, all traffic volume and speed data were examined in terms of the research objectives.

a)

b)

Figure: 2 Traffic volume and flow direction at Alongkar (a) and AK Khan (b) intersection

Table 1 and 2 showed that maximum traffic volume is found for through vehicle movement for all directions at both intersections except east bound vehicle movement at Alongkar intersection. There is no way for movement in east (through) direction and traffic volume is 0 for AK Khan intersection presented in table 2.

Table 1: Traffic Volume (PCU/hour) at Alongkar Intersection

(**East bond**)

Left turn	Through	Right turn
76	80	384

(**West bond**)

Left turn	Through	Right turn
32	48	24

(**South bond**)

Left turn	Through	Right turn
40	492	60

(**North bond**)

Left turn	Through	Right turn
280	464	36

Table 2: Traffic Volume (PCU/hour) Data at AK khan Intersection

(**East bond**)

Left turn	Through	Right turn
112	0	380

(**South bond**)

Left turn	Through	Right turn
0	308	100

(North bond)

Left turn	Through	Right turn
268	428	0

In this paper, a model of traffic flow on AK Khan and Alongkar intersection on Chittagong city by evaluating Passenger Car Unit (PCU) of different vehicle categories at different volume levels is developed by using the micro-simulation model, VISSIM. Simulation on VISSIM is shown in figure 3.

Figure 3: VISSIM Simulation Model of Alongkar Intersection

Table 3 represented the traffic parameters after traffic signal design manually at AK Khan and Alongkar intersection which is used to model in VISSIM.

Table 3: Parameters for AK Khan and Alongkar intersection from manual signal design

Parameters	**AK Khan Intersection**	**Alongkar Intersection**
Saturation Flow Rates (veh/hr/lane)	1125	1178
Yellow interval (sec)	2.4	2.4
Red interval (sec)	11.6	12.7
Effective green time (sec)	48.4	47.3
Lost time (sec)	14	16
Minimum Cycle length (sec)	37	42
Desirable Cycle length (sec)	54	70

Table 4 represented the delay time before and after signal timing optimization which is improving by 37.5 % and 35.71% for Alongkar and AK Khan intersection respectively.

Table 4: Comparison of delay time at Alongkar and AK Khan intersection

Delay Time	Alongkar intersection	AK Khan interesection
Manual signal design (sec)	16	14
VISSIM Signal Timing design (sec)	10	9

Table 5 represents the signal timings for manual signal design and optimized signal timing for the improvement through VISSIM.

Table 5: Manual and Optimized Signal Timing

Phase Name	Manual signal time (sec)			Improved signal time by VISSIM (sec)		
	Green	Amber	Red	Green	Amber	Red
Alongkar- Colonel Hut	82.8	22.8	75	126	12	66.6
GEC- AK Khan	85.2	19.2	66	129	9	32.4

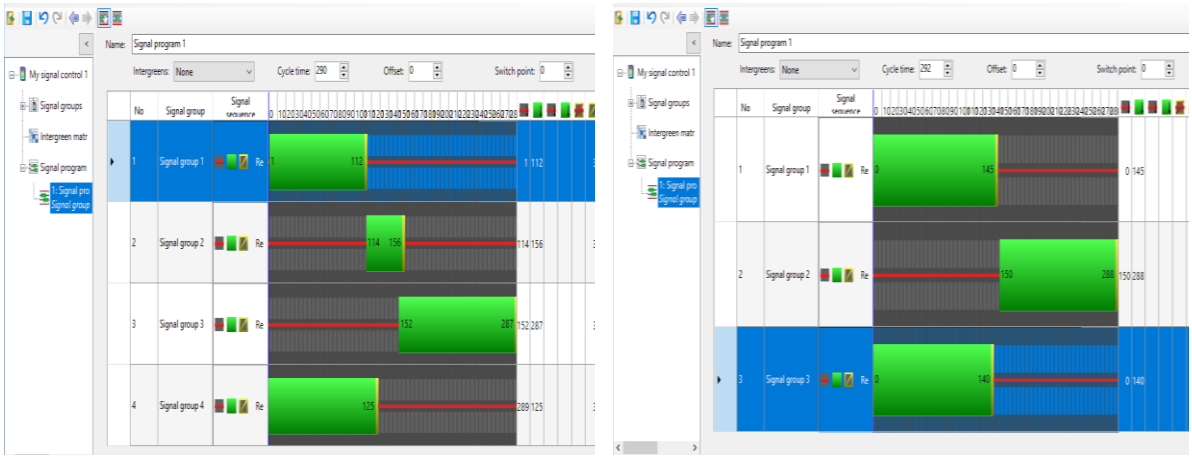

Figure: 4 Optimized signal timing for Alongkar and AK Khan Intersection.

Table 6 and 7 represented the average speed and delay of different intersections at different scenario described below.

- Existing condition represents the scenario of intersection without improvement.
- Scenario 1 is optimized signal timing at Alongkar intersection and
- Scenario 2 is constructing an overpass from AK Khan to Alongkar intersection for through vehicle movement. After that signal optimization is done again to observe the performance.

Figure 4 represents the optimum signal timing (Scenario 2) of both intersections.

Table 6: Comparative studies among different alternatives for Alongkar Intersection

	Average Speed (km/hr)	% Increase of average speed	Delay (sec)	% Decrease of delay
Existing Condition	19.95	N/A	18	N/A
Scenario 1	22.76	14.06%	14	22.22%
Scenario 2	37.42	87.57%	2	88.88%

From table 6 it was observed that Scenario 1 which means improvement through signal optimization only increases the average speed and delay by 22.76 % and 22.22 %. Overwhelming improvement observed for Alongkar intersection was observed in scenario 2 by constructing flyover from AK Khan to Alongkar for through vehicles i.e. 87.57% increase in average speed and 88.88% increase in delay compared to exiting situation.

From table 7 it was observed that Scenario 1 and 2 presents very similar improvement for AK Khan intersection as compared to Alongkar. Though scenario 2 shows maximum improvement for both intersections, in future it is recommended to build flyover to reduce the traffic congestion level and make the road operation more efficient.

Table 7: Comparative studies among different alternatives for AK Khan intersection

	Average Speed (km/hr)	**% Increase of average speed**	**Delay (sec)**	**% Decrease of Delay**
Existing Condition	19.35	N/A	21	N/A
Scenario 1	21.87	13.02%	16	23.81%
Scenario 2	36.11	86.61%	2	90.48%

Output of delay result from VISSIM was shown for existing and improves condition in table 8 and 9. It was observed for that the delay in the main road has been extravagantly improved after signal optimization. Though the number of vehicles passing and the number of passengers passing have increased but efficiency of intersection has improved i.e. reduced each person's average delay, average parking time per vehicle and average number of stops per vehicle.

Table 8: Status "delay" result output for AK Khan intersection

Existing Situation						
Time(s)	**Delay(s)**	**Stopd**	**Stops**	**#Veh**	**Pers.**	**#Pers**
Time: 600 sec	34	6.7	0.2	123	26	86
Improved Situation						
Time(s)	**Delay(s)**	**Stopd**	**Stops**	**#Veh**	**Pers.**	**#Pers**
Time: 600 sec	9	5.4	0.00	272	11	109

Table 9: Status "delay" result output for Alangkar intersection

Existing Situation						
Time(s)	**Delay(s)**	**Stopd**	**Stops**	**#Veh**	**Pers.**	**#Pers**
Time: 600 sec	36	6.8	0.22	132	27	92
Improved Situation						
Time(s)	**Delay(s)**	**Stopd**	**Stops**	**#Veh**	**Pers.**	**#Pers**
Time : 600 sec	10	5.48	0.00	266	10	118

Meaning of Symbols:
(1) "Stopd" is the average parking time per vehicle (unit: s);
(2) "Stops" is the average number of stops per vehicle;
(3) "# Veh" is the number of vehicles passing;
(4) "Pers." For each person's average delay (unit: s);
(5) "# Pers" is the number of passengers passing.

5. CONCLUSIONS

The results of the intersection analysis showed that the best alternative is constructing one overpass. Frequent bus stops, random pedestrian crossing, unauthorized parking and road side cart near intersection also initiate of construction flyovers to reduce the congestion at intersection. As during peak hour traffic volume is very high it is not possible to reduce the congestion by only signal timing optimization. But as temporary traffic measure it can be adopted to control the vehicle flow. Though there are some benefits are obtained by optimization of signal timing, but in future it is desirable to build a flyover from AK Khan to Alongkar direction to abate the intensity of vehicle on at grade level. As there is huge pedestrian activity at both 4- and T- intersection because of random and irregular crossing, it is also a reason which makes the road operation unsuccessful. Foot over bridge along with other small traffic engineering initiatives can improve the traffic operating condition of both intersections.

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