APPLICATION OF SMART TRAFFIC MANAGEMENT WITHIN CHATTOGRAM METROPOLITAN CITY

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ABSTRACT

Chattogram is the second biggest city of Bangladesh and also the biggest port city of the country. This city plays an important role in the international business of export & import. Therefore the government of Bangladesh has declared the city as the commercial capital of Bangladesh. On the other hand, Chattogram is one of the fastest growing cities of Bangladesh and the conventional way of traffic management is failing to handle this massive growth. A large number of working hours are wasted each day in Chattogram as a result of traffic congestion. This huge setback in economy demands a better traffic management system. Hence, an initiative was taken for the application of "Smart Traffic Management (STM)" which contemplates on management of non-mechanized & mechanized vehicle movement at road, minimization of traffic congestions at junction providing proper intersection design & traffic signal, on street traffic management for parking, dropping and stoppage to increase road efficiency, preventing traffic rules violation through multifunctional automated traffic enforcement system (mates). This study adopted an on-site survey strategy to collect data by questionnaires, performing volume count surveys, topography surveys, drone surveys at a major intersection and analyzing the data to determine intersection capacity to install a proper Smart Traffic Management system. From the study, New Market junction's capacity was found to be almost doubled than the current traffic volume but traffic jam in this junction is a regular event. This must be due to the poor traffic management and based on this study, a pilot project was granted permission to run in a less busy intersection, Kazir Dewri to achieve a sustainable and affordable traffic management.

Keywords: *Chattogram, traffic congestion, smart traffic management, intersections, mates*

1. INTRODUCTION

Roadway is the primary mode of transportation in Chattogram. Public transports like bus, tempo, human haulers and private transports like cars & motorcycles as well as CNG & rickshaw acting as taxi rounds up the trips made in Chattogram metro area. With the extensive population growth, the highways have become saturated with traffic. The Chittagong Development Authority (CDA) has implemented several effective transportation initiatives, such as broad roadways, link roads, flyovers, expressways, etc. (Chittagong Development Authority, 2023) to reduce traffic congestion in Chattogram, in response to the city's population growth, which has increased by approximately 58.79% in the last 23 years (World Population Prospects, 2022). But a properly planned traffic management system is still missing.

Figure 1 shows the mode split of all passenger trips. Bus, human hauler and tempo carries majority of the trips. The average speed by mode shown in Table 1 where it is evident that Chattogram has low average speed of modes indicating the severity of traffic congestion. Low average speed of traffic inevitably deals a negative impact on economy. Psychological impacts of traffic congestion among the city dwellers are also immense (Fattah et al., 2022). According to World Bank, 16 lakh working hours are being wasted each day in Chattogram.

In general, a Volume Capacity Ratio (VCR) less than 0.85 suggests that there is sufficient capacity, and that significant queues and delays are not anticipated for vehicles (National Research Council (U.S.). Transportation Research Board, 2010). All the major intersection's (VCR) is equal to or less than 0.61, which strongly justifies the application of STM in Chattogram metro area (Chittagong Strategic Urban Transport Master Plan, 2018).

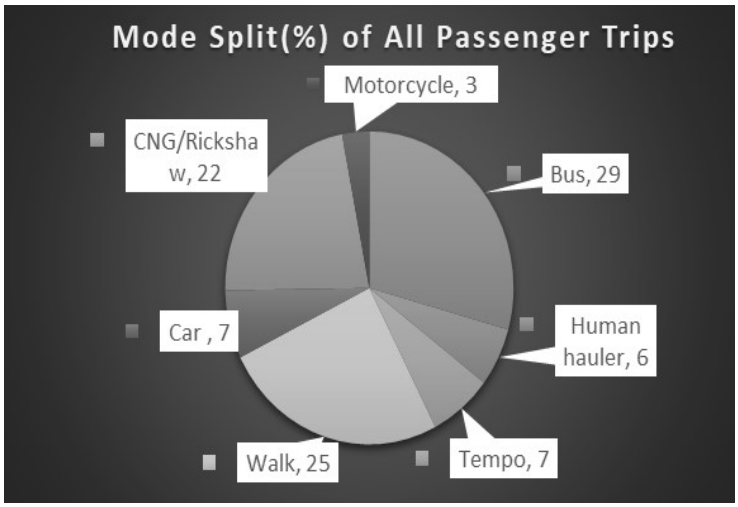


Figure 1: Mode split of all passenger trips (Chittagong Strategic Urban Transport Master Plan, 2018)

Table 1: Average speed by mode (Kph) (Chittagong Strategic Urban Transport Master Plan, 2018)

Mode	AM	PM
Car	18.3	10.7
Truck	20.8	15.0
CNG	16.0	11.7
Bus	13.9	10.3
Tempo	16.2	12.7
Human Hauler	15.4	12.5
Rickshaw	9.1	8.2

One of the major problems of intersection is merging of vehicle paths which leads to chaotic road use and can be solved via channelizing. Channelizing approach focuses on separation of manoeuvre areas, control of manoeuvre angle, control of speed, blockage of prohibited movements, and segregation of non-homogeneous flows.

2. OBJECTIVES

Based on some major causes of traffic congestion such as insufficient road network, absence of separated lane for fast and slow moving vehicle, chaotic lane use pattern, absence of proper intersection and no traffic management system, the four prime objectives of the study are as follows:

- To manage non mechanized & mechanized vehicle movement at road.
- To minimized the traffic congestions at junction providing proper intersection design & traffic signal.
- To manage on street traffic for parking, dropping and stoppage to increase road efficiency.
- To prevent traffic rules violation through multifunctional automated traffic enforcement system (mates).

3. METHODOLOGY

For this study, volumetric and geometric data of one specific junction (New Market) which is one of the busiest among the 53 major intersections in the city was collected. Figure 2 shows the locations of 53 major junctions. Volumetric survey was done by video-graph. Topography and drone surveys were done to have proper intersection dimensions and accurate locations of roadside structures. Physical survey by questionnaires was carried out to determine road side condition i.e. hawkers, parking space, footpath, drainage system etc. By using the data collected from the New Market junction survey, capacity vs current traffic volume analysis was done. Channelizing approach, U-turn, U-loop flyover- these three approaches are popular for intersection design. In STM system channelizing approach has been adopted.

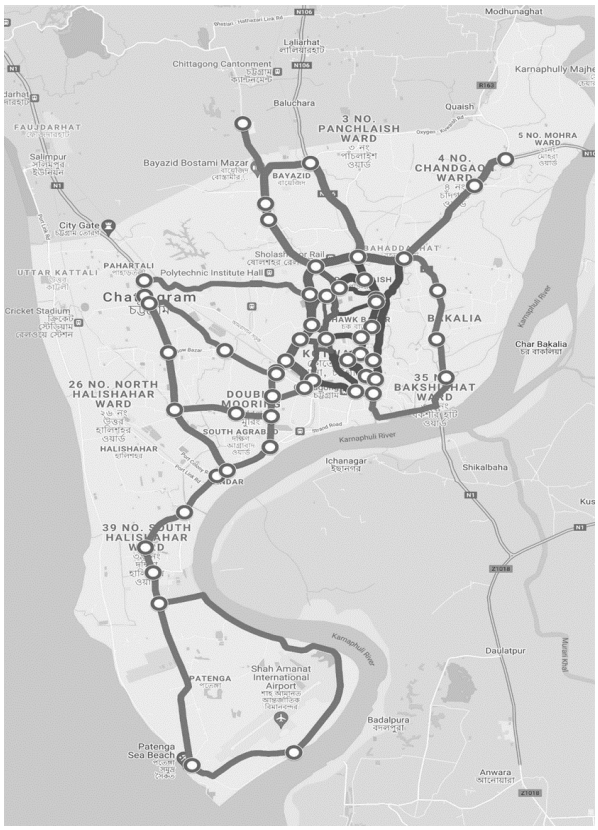


Figure 2: 53 major intersections

4. DATA ANALYSIS

Among 53 major junctions, one of the busiest junctions is New Market consists of Amtol road (6 lane 2 way), Kotowali road (4 lane 2 way), City College road (4 lane 2way), and Station road (6 lane 2 way). At 4 PM to 8 PM (PM peak) volumetric survey was performed for every hour. Data collected on PM peak hour as PM peak usually higher than AM peak. Table 2 represents the data acquired from the survey.

Table 2: Classified counts PCU (all modes) at PM peak (4pm-8pm)

Path	Left	Straight	Right	Total
Amtol road to junction (6 lane 2 way)	1022	723	260	2005
Kotowali to junction (4 lane 2 way)	408	1192	233	1833
City College to junction (4 lane 2way)	609	1385	137	2131
Station to junction (6 lane 2 way)	751	1035	355	2141

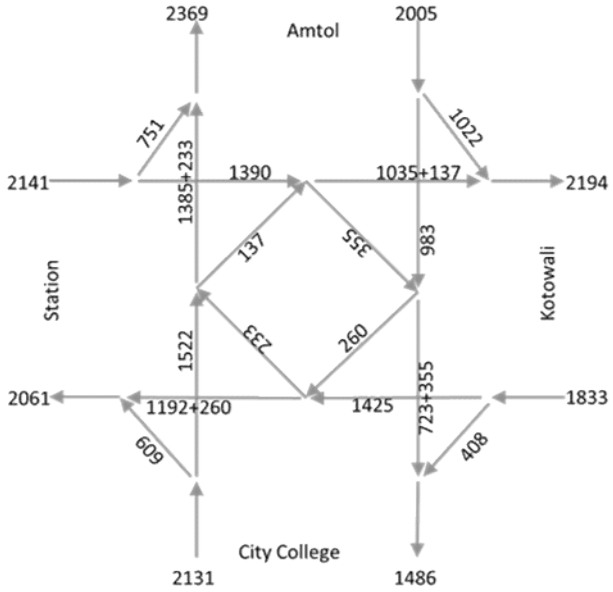


Figure 3: Detailed traffic flow (PCU) at New Market intersection

Calculating current traffic flow (PCU) at rotary from Figure 2.

Table 3: Rotary at Station road to Amtol/Juble road approach:

Path	PCU/hr
From Station road	2141
From City College road(straight and right turning	1522
From Kotowali road(right turning)	233
Total	3896

Similarly,
From the rotary at Kotowali road to City College road approach current vehicle flow is 3171 PCU/hr.
From the rotary at City College road to Station road approach current vehicle flow is 3816 PCU/hr.

From the rotary at Amtol road to Kotowali road approach current vehicle flow is 3532 PCU/hr.

Practical Capacity of rotary (Station road to Amtol road approach),
Weaving length, L = 41.84m
Width of entry, e_1= 10.67m
Width of exit, e_2= 31.63m
Non-weaving width, e = $(e_1+e_2)/2$ = 21.15m
Weaving width, w= $((e_1+e_2)/2)$ +3.5= 24.65m

e/w = 0.86
w/L= 0.59
The maximum weaving occurs in this junction, $p = \frac{b+c}{a+b+c+d}$

$$= \frac{1390+(1385+233)}{751+1390+(1385+233)+137}$$
$$= 0.77$$

Where, (from Figure 2)
a= 751 PCU/hr
b= 1390 PCU/hr
c= 1385+233 PCU/hr
d= 137 PCU/hr

And the practical capacity of the rotary, $Q_p = \frac{280w\left(1+\frac{e}{w}\right)(1-\frac{p}{3})}{(1+\frac{w}{L})}$

$$= \frac{280+24.65(1+0.86)(1-0.26)}{1+0.59}$$
$$= 8074 \text{ PCU/hr}$$

Similarly,
Practical capacity of the rotary at,
Kotowali road to City College road approach is 6360 PCU/hr.
City College road to Station road approach is 6260 PCU/hr.
Amtol road to Kotowali road approach is 6162 PCU/hr.

Table 4: Volume Capacity Ratio (VCR)

Road Approach	**Current Traffic Volume at PM peak(PCU/hr)**	**Capacity(PCU/hr)**	**VCR**
To Juble road	3896	8074	0.483
To Kotowali	3532	6162	0.573
To City College	3171	6360	0.499
To station Road	3816	6260	0.610

Following figure 4 depicts the roadside conditions obtained by field questionnaire survey and the results are disturbing as the roadside buildings with parking facilities are almost nonexistent. Centre of attraction at this junction is New Market and New Market itself doesn't have any parking facilities. Amount of unauthorized hawkers on roadside and on footpath are also high with the maximum number of 598 at New Market to Amtol bus Stand approach. Though numbers of hawkers at New Market to City College approach seem to be low, the road width is approximately 8.20m which is the lowest among the rest of the approach of this junction and without any parking facilities.

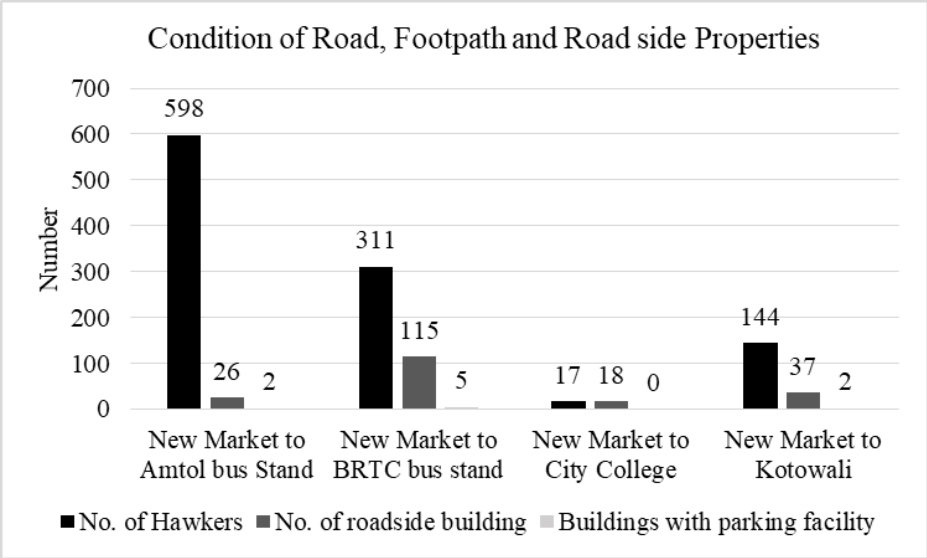


Figure 4: Condition of road, footpath and road side properties

5. INSTALLATION OF STM

As it is evident that the capacity of the road is higher than the current traffic volume, a Smart Traffic Management System consisting of the following three phases could be adapted to mitigate the traffic congestion.

In phase one, STM system focuses on proper intersection design consisting of lane marking, lane separation point, zebra crossing and left lane fencing and on street parking management. Lane marking will be done for channelizing approach and lane separation point will be installed at a distance from the junction to help segregating left, straight and right turning mechanized and non-mechanized vehicles. Zebra crossing will be at the entry of the junction for pedestrians to cross the road safely and left fencing to keep the left lane flowing throughout the day where necessary. As most road side building doesn't have enough parking space, on street parking management is very important. On street parking will be at a distance from junction and will specifically be marked. Dropping zone, which is also at a distance from junction, will be dedicated for passenger dropping and loading.

Phase one is designed in a way to maximize road and junction capacity. It helps to keep the junction free of unwanted and non-regulated congestion even when the traffic signal is not available.

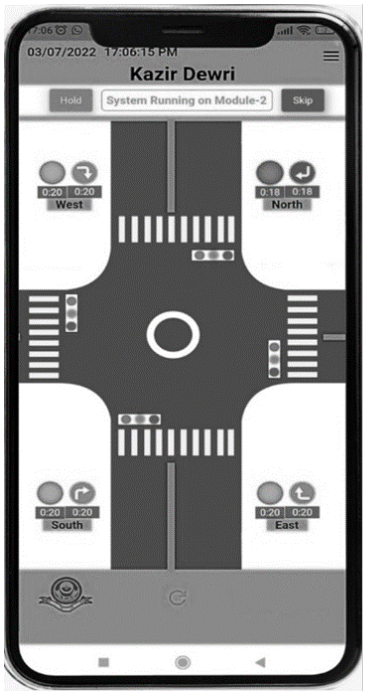
Phase two emphasizes on development of semi-automated signal light which includes providing auto signal lights for vehicles, providing signal for pedestrians, integrating the signalling system with a software which will enable the option to set multiple timers and control the traffic from the traffic control room.

Phase three will introduce multifunctional automated traffic enforcement system (Mates). Its main objective is to monitor the traffic, recognize types of vehicles and license plates, to detect most of the traffic violations under any weather and light conditions and regardless of the traffic intensity, to gather and process data, to produce reports to the relevant authority and sending a notice of violation directly to the registered owner of the vehicle. Apart from detecting various traffic violations like red light, stop line, speed limit, standing or stopping, turning, railroad crossings, unauthorized entering or manoeuvring in junction, the system can also detect overloaded vehicles, overtaking ban violation, driving in the sidewalk or footpath even road markings violation.

All three phases are dependent on each other as phase two won't be functional without the completion of phase one and phase three won't be functional without the completion of phase one and two.

6. ADAPTATION OF STM

An initiative is taken by Mass RnD which seeks to do different types of research work for affordable & sustainable urban development, a concern of Mass Group, Chattogram, to run a pilot project primarily at Kazir Dewri intersection by the approval of Chattogram City Corporation and Chattogram Metropolitan Police authorities as Kazir Dewri is less busy than the New Market intersection and installation is economically more feasible. STM system consists of three phases and phase one has already been completed at Kazir Dewri and phase two is in progress. In phase two, poles for signal lights and development of a software named E-Traffic to integrate the signalling process are already completed. Following figure 5 illustrates the interface of the software for controlling traffic signals.



Slot	Start Time	End Time
Time Slot 1	07:30	09:30
Time Slot 2	09:30	12:30
Time Slot 3	12:30	17:00
Time Slot 4	17:00	18:00
Time Slot 5	18:00	21:30
Time Slot 6	21:30	22:00
Time Slot 7	22:00	10:30
Time Slot 8	10:30	07:30

Figure 5: Software Interface

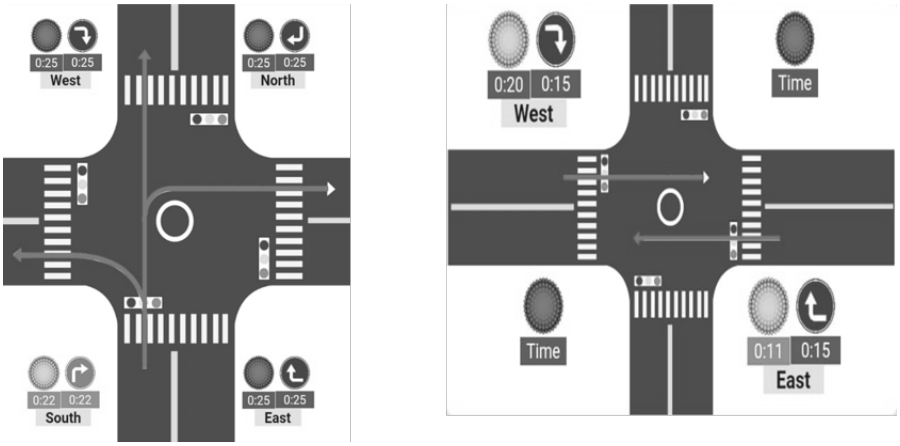


Figure 6: Signal Control Process

Figure 6 illustrates the signal control process. For straight moving vehicles, two signals will remain be opened and other two signals will remain be closed and also for straight, left and right moving vehicles three signals will remain be closed and one signal will remain be opened which can be controlled manually and automatically.

7. RESULTS AND DISCUSSION

The transportation system of Chattogram mainly consists of roadway, railway, waterway & airway. Roadway is the most common mode of transportation that is frequently used by people. Public Transport (PT) caters for half of all passenger trips in Chattogram. The most important PT modes are the bus, tempo and human-hauler which operate along fixed routes licensed by BRTA. Rickshaws and CNGs (auto-rickshaws) are plentiful across the city. They provide taxi services across the city. Often these rides are shared, sometimes between family and friends, but also with strangers.

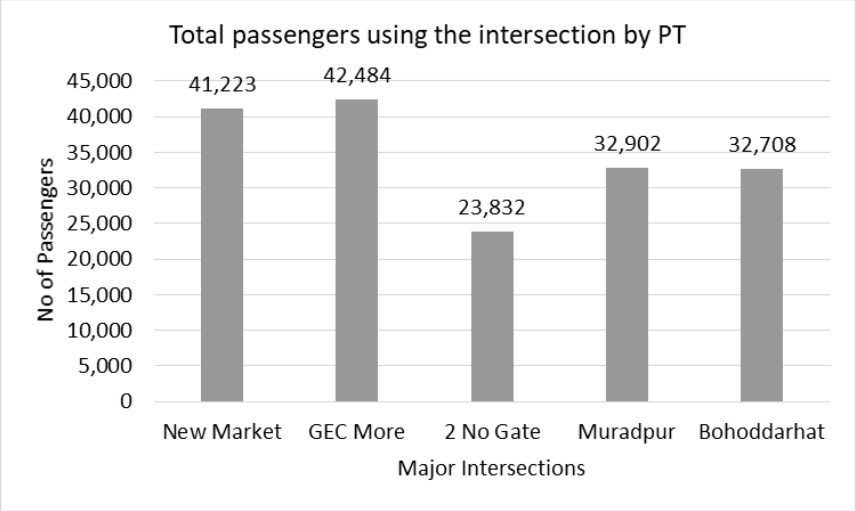


Figure 6: Total passengers using major intersections

Figure 6 shows that huge number of passengers are using these intersections by public transports but the problem is there have no zone for picking up or dropping off passengers leading into never ending chaos in the intersection.

Table 05: Summary

Capacity of Junction	Current Traffic Volume	On Street Parking	Availability of Footpath	Picking and Dropping zone
Adequate	Comfortable	Chaotic	Not satisfactory	Unmarked and chaotic

This study assessed the capacity of junction, current traffic volume, conditions of road, footpath and road side properties. By analysing the data it is found that the current traffic volume is within the capacity of junction. Table 4 shows that VCR is within comfortable range. But New Market junction faces severe congestion every day. Which means the road space isn't being used efficiently. In Figure 4 we see that huge numbers of hawkers are occupying the road and footpath space. 25% of all trips in Chattogram are made by foot and if footpath isn't available, people walks on road and road space gets thinner. Same goes for unauthorized parking and stoppage of vehicles. In short, even after having adequate road space congestion becomes inevitable.

8. CONCLUSIONS

A serious issue like traffic congestion in Chattogram metropolitan city demands immediate attention and sustainable solution. And successful completion of installation of STM not only offers the solution as in solving the current traffic issues like congested intersection, chaotic PT, passenger and pedestrian activities but also lays out the foundation to adapt or introduce new cutting edge technologies like Internet of Things (IOT) for further improvement of traffic management system.

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