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Present Scenario of Existing Intersection of Rajshahi City Corporation Area, Rajshahi, Bangladesh

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Abstract

The aim of this study was to assess the present scenario of the existing signalized intersection of Rajshahi City Corporation Area, Rajshahi, Bangladesh, and find optimum signal time using micro-simulation modeling. Among 16 existing signalized intersections of the Rajshahi City Corporation Area, three signalized intersections were selected: Bernalir Morr, Monichottor Morr, and Zero Point. The selected signalized intersections were four-leg intersections. A two-day traffic survey was done by video recording for each intersection. It was found that all the traffic signals at intersections were non-functional. At Bernalir Morr, rickshaws (33%) and E-bikes (33%) were found to be the maximum. However, at Monichottor Morr and Zero Point, rickshaws (47%) and E-bike (43%) dominated, respectively. Bernalir Morr & Monichottor Morr has a higher traffic volume on a weekday, but Zero Point has a higher traffic volume on weekends. From micro-simulation modeling, the optimum cycle time of Bernalir Morr, Monichottor Morr, and Zero point was 120, 90, and 60 sec respectively.

Keywords: Intersection, traffic survey, VISSIM, Rajshahi.

1 Introduction

Rajshahi Metropolitan City, another enormous, divided, and developing Bangladeshi city, exhibits a daily rise in population density. The city's maintenance and management processes are inadequate despite the current moderate state of condition of the transportation systems. (Hasan & Chowdhury, 2021). Metropolitan areas of developing nations like Bangladesh are highly concerned about the increase in vehicles brought on by the proportional increase in people and the quick development of modern society (Kafy et al., 2018). It is essential to ensure that roads link all the country's regions and that the transportation infrastructure is in outstanding physical condition because the development of any nation's road network directly affects that nation's economy (Joni & Hikmatt, 2018). Congestion is a form of issue that people deal with daily. The primary causes of this issue include unsignalized intersections, mixed vehicle types, lane limitations, damaged and narrow roadways, unplanned stops, speed discrepancies, and unnecessary U-turns (Islam & Ahmed, 2017). Signals are traffic control tools that ensure regular and safe flows on roads and at intersections. (Akmaz & Çelik, 2016). Two key traffic management and control goals at non-signalized intersections are travel efficiency and traffic safety. With the growing number of cars, traffic analysis at non-signalized junctions has always been challenging to do (James et al., 2021). Due to a lack of available land, many dense urban areas are currently experiencing pressure and issues with traffic congestion. The two main users of roads in traffic are vehicles and pedestrians (Gupta & Patel, 2014). Rajshahi City is called the "City of Education" (Saha & Sobhan, 2012). The highest traffic volume is auto rickshaws, and the lowest traffic volume is cars. In Rajshahi City, commercial vehicles are 63%, non-commercial vehicles are 37%, and the average annual growth rate for both categories together is 6.1% (Transport Situation in Rajshahi, n.d.). Rajshahi City Corporation encompasses a diverse and thriving urban area in northwest Bangladesh, celebrated for its cultural heritage, agricultural prominence, and educational institutions. In this paper, an assessment of the present scenario of the existing signalized intersection of Rajshahi City Corporation Area, Rajshahi, Bangladesh, has been done. Also, micro-simulation-based modeling was used to find optimum signal time as one of the frequently employed tools in the design of a road system is traffic modeling and simulation. Software created for traffic simulations is a crucial auxiliary tool in making decisions and selecting the best course of action. (Fabianova et al., 2019).

2 Methodology

Rajshahi City Corporation has 16 signalized intersections. Among them, three signalized intersections were selected. They are Bornalir Morr, Monichottor Morr, and Zero Point, as shown in Figure 1 and Table 1. For each intersection, a two days traffic survey was done by recording video using Samsung A51 and One plus 7t devices placed on the stand for one hour (10.00 -11.00 am) on a sunny day. Among the two days, one was collected on a weekday and another on a weekend. Each video was taken from different floors of adjacent buildings. The road width of each intersection was also recorded during the traffic survey. Different types of vehicles number were counted manually from the recorded video at BAUET premises. In order to calculate Bornalir Morr intersection, it is divided into a total of 16 sections. In order to count the number of vehicles, Moni Chatwar Road is separated into 11 sections. The zero point is calculated by dividing the road into 6 intersections. After calculating the sections, they were analyzed using Microsoft Office Excel 2016. For conducting micro-simulation modeling, VISSIM 2022 was used.

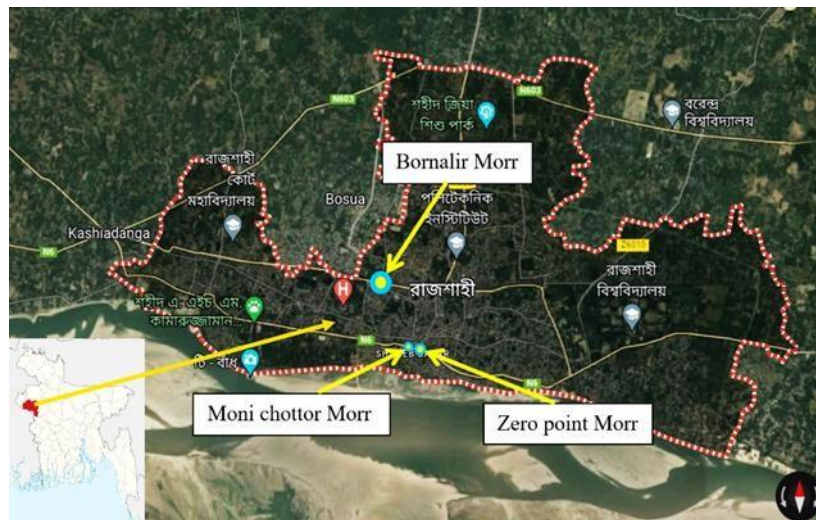


Figure 1: Rajshahi City Corporation (Extracted from Google map) Table 1: Details of the intersection point

| Intersection Name | Coordinate |
|-------------------|---------------------------|
| Bornalr Morr | 24°22'32.7"N 88°35'35.4"E |
| Monichottor Morr | 24°21'58.0"N 88°35'50.9"E |
| Zero Point Morr | 24°21'55.4"N 88°35'60.0"E |

3 Result and Discussion

3.1 Present Scenario of Road Intersections at Rajshahi City

The present scenario of selected signalized intersections is shown in Figure 2. All the intersections had link roads connected with various infrastructures, educational institutions, and shopping malls. All the traffic signals were found non-functional. Traffic sergeants manually control the traffic when they think it is needed.



Figure 2: Present scenario of selected existing intersection with traffic congestion (a) Bernalir Morr (b) Monichottor Morr (c) Zero Point

The reasons for the congestion problem are as follows:

- The foot overbridge is only at zero point; there is no foot overbridge at Monichottor Morr and Bornalir Morr Road. As a result, traffic congestion is created at the other two intersections as people pass through the road. People are crossing the road randomly at Monichottor Morr and Bornalir Morr Road, as shown in Figure 3.
- The footpath/walkway is occupied by various shops (temporary businesses). Due to these reasons, people come to buy them and cause traffic jams on the roads.
- Due to the high traffic volume on these routes, traffic lights were once used. However, they are now all non-functional. Excess traffic leads to traffic jams, resulting in longer travel time. The police use manual traffic signals to avoid extra travel time at specific hours.



Figure 3: People cross the road randomly.

- There are no separate roads for motorized (bus, truck, car, motorcycle, etc.) and non-motorized (bicycle,rickshaw) vehicles, which leads to the longer travel time of motorized vehicles.
- Vehicles parked on the roadside because no designated parking area was present.

3.2 Traffic Composition at Existing Intersection

The survey determined that light vehicles (such as E-rickshaws, E-bikes, and CNG motorcycles) make up most of the traffic in Rajshahi City. Light vehicles come in a wide variety and have varying overall sizes, powers, and speeds. At Bornalir Morr, rickshaws and E-bikes were found to dominate vehicles with a percentage of 33%, as shown in Figure 4 (a). At Monichottor Morr, rickshaws (47%) dominated vehicles, as shown in Figure 4 (b). However, Figure 4 (b) shows that E-bike (43%) was the dominating vehicle at Zero Point.

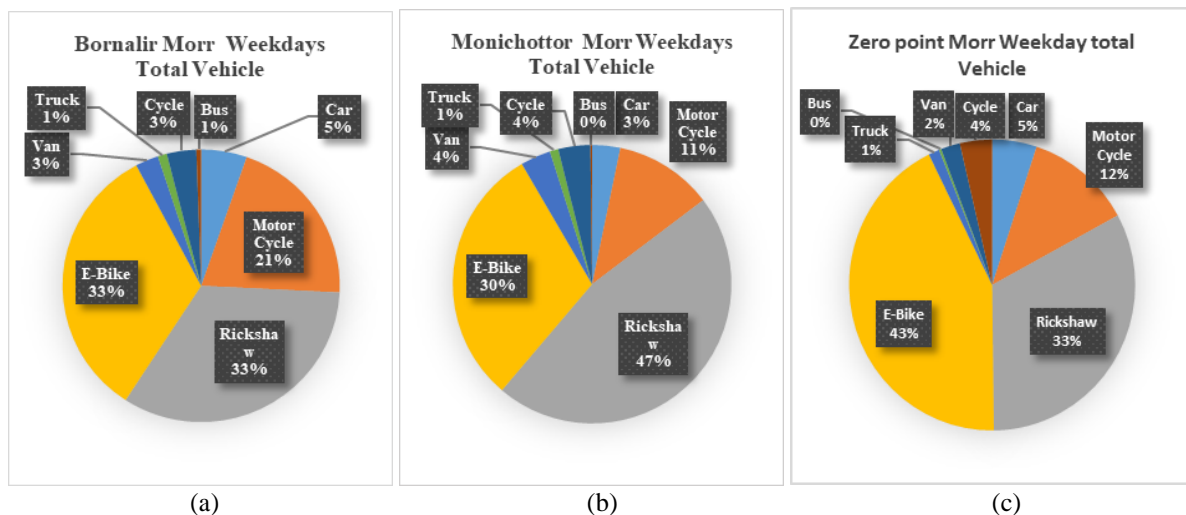


Figure 4: Traffic composition at (a) Bornalir More (b) Monichottor More (c) Zero Point

3.3 Traffic volume

Traffic volume changes over the weekdays and weekends in the three intersections of the Rajshahi City Corporation Area are shown in Figure 5. It was seen that Bornalir Morr & Monichottor Morr, reveals higher traffic flow on weekdays compared to weekends, which can be attributed to increased commuting and business activities during weekdays. On the other hand, higher traffic volume was found on the weekend at Zero Point because this intersection comprises different types of markets.

3.4 Micro-Simulation Model of Existing Intersection using VISSIM.

Micro-simulation modeling was carried out at Bernalir Morr, Monichottor & Zero Point intersections by VISSIM software to find out the optimum cycle time. The duration of green time, red time & amber time are shown in Figure 6. It was found that the optimum cycle time of Bernalir Morr, Monichottor Morr, and Zero point were 120, 90, and 60 sec respectively, as shown in Table 2.

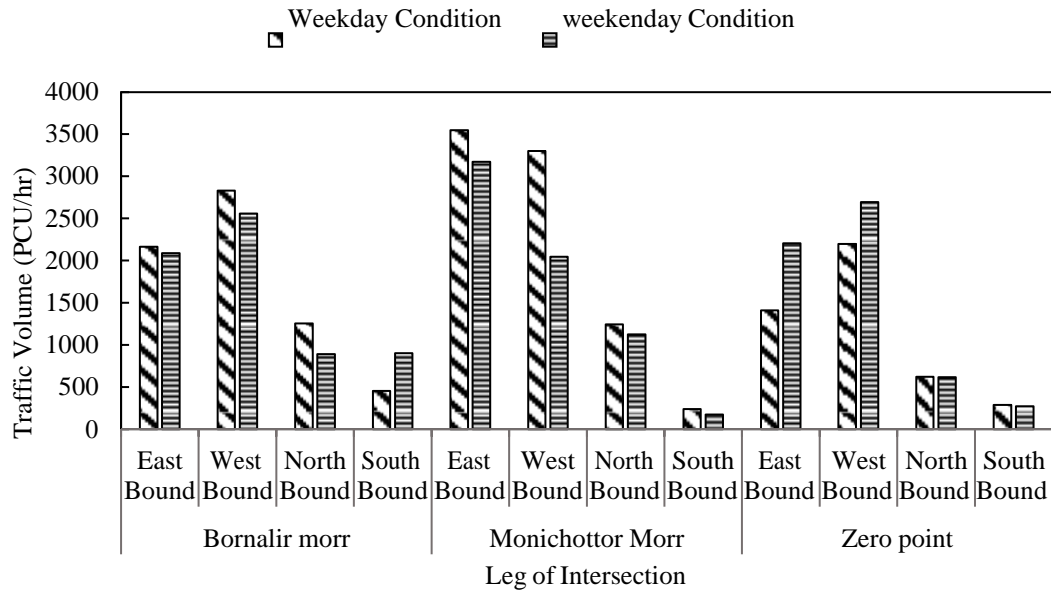


Figure 5: Traffic Volume

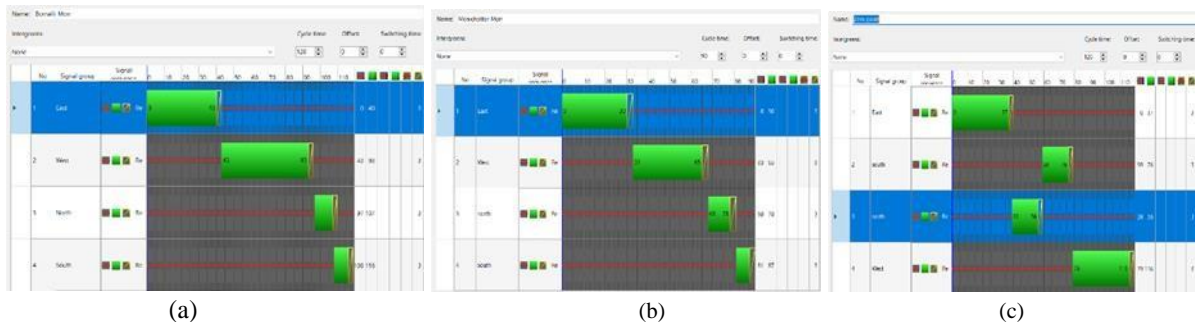


Figure 6: Simulation modeling (a) Bernalir Morr (b) Monichottor Morr (c) Zero Point

Table 2: Optimized Signal Time

| Number of Intersection | Phase | Traffic flow Direction | Green Time(s) | Amber Time(s) | Red Time(s) | Cycle Time(s) |
|------------------------|-------|------------------------|---------------|---------------|-------------|---------------|
| Bernalir morr | 1 | East | 40 | 3 | 77 | 120 |
| | 2 | West | 50 | | 73 | |
| | 3 | North | 10 | | 107 | |
| | 4 | South | 8 | | 109 | |
| Monichottor | 1 | East | 30 | 3 | 57 | 90 |
| | 2 | West | 32 | | 55 | |
| | 3 | North | 10 | | 77 | |
| | 4 | South | 6 | | 81 | |
| Zero point | 1 | East | 17 | 3 | 40 | 60 |
| | 2 | South | 6 | | 51 | |
| | 1 | West | 17 | | 40 | |
| | 2 | North | 8 | | 49 | |

3.5 The Intersection Model Was Developed

Figure 7 shows the signalized intersection model using PTV Visim software. The yellow marking of the signalized intersections indicated conflict zones. Traffic jams occur at marked intersections due to the heavy flow of vehicles. As a result, traffic takes more time, and accidents often occur. There is no roundabout or divider at the Bornalir Morr intersection. Dividers have been provided at Monichottor and Zero Point four-leg intersections so vehicles from South and East Roads cannot cross West and North Roads. The model was prepared for the normal movement of vehicles by removing the divider at Monichottor Morr and Zero Point Road so that vehicles from South and East Roads could cross West and North Roads.



Figure 7: Intersection model visualization at (a) Bornalir Morr (b) Monichottor (c) Zero Point

3.5 Level Of Service

The Highway Capacity Manual (HCM, 2010) defines six LOS for each facility type with analysis procedures. Letters designate each level, from A to F. With LOS A representing the best operating conditions and LOS F the worst. Each level of service represents a range of operating conditions and the driver's perception of those conditions. Safety is not included in the measures that establish service levels.

Table 3: Level of Service of The Study Area

| Name of Road | Name of Intersection | Intersection Delay | LOS | General operating conditions |
|---------------|----------------------|--------------------|-----|------------------------------|
| Bornalir Morr | East Road | 114 | F | Forced or breakdown flow |
| | West Road | 53 | D | Approaching unstable flow |
| | North Road | 9 | A | Free flow |
| | South Road | 32 | C | Stable flow |
| Monichottor | East Road | 34 | C | Stable flow |
| | West Road | 36 | D | Approaching unstable flow |
| | North Road | 46 | D | Approaching unstable flow |
| | South Road | 82 | F | Forced or breakdown flow |
| Zero Point | East Road | 125 | F | Forced or breakdown flow |
| | West Road | 80 | F | Forced or breakdown flow |
| | North Road | 116 | F | Forced or breakdown flow |
| | South Road | 78 | E | Unstable flow |

4 Conclusions

The study provides information on the present conditions of existing signalized intersections of the Rajshahi City Corporation Area, Rajshahi.

The findings of this study are as follows:

- All the traffic signals were found non-functional. The foot overbridge only be found at the Zero Point intersection. Vehicles were parked at the intersection, no separate lane was found for motorized vehicles, and shops occupied the footpath.
- At Bornalir Morr, rickshaws (33%) and E-bikes (33%) were found to be the maximum. However, at Monichottor Morr and Zero Point, rickshaws (47%) and E-bike (43%) were found to be dominating, respectively.
- At Bornalir Morr & Monichottor Morr has a higher traffic volume on a weekday, but Zero Point has a higher traffic volume on weekends.
- From micro-simulation modeling, the optimum cycle time of Bornalir Morr, Monichottor Morr, and Zero point were 120, 90, and 60 sec respectively.

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