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# Evaluation of Bus Rapid Transit in Bangladesh and Recommendation for Improvements

**Arifa Sultana, Saad Muhammad Zakaria Rafe, Tasnim Shoily Deepi**

***Abstract*: Bangladesh is one of the most populated countries in the world. Like other developing countries, Bangladeshi people are also facing many transportation problems due to the increased population. The government of Bangladesh is planning to implement Bus Rapid Transit (BRT) system, Mass Rapid Transit, Expressways etc. A research was undertaken to evaluate the proposed BRT in Bangladesh. It will be built along the 42 km route stretching between Shibbari to Jhilmil in Dhaka. Another 36 km line will be constructed on the capital's eastern edge, according to the Revised Strategic Transport Plan (RSTP). It is known as "Dhaka Rapid." It will be implemented in two parts: from Gazipur to Dhaka airport (20 km) and from the airport to Keraniganj (22 km). The main focus of the research is the 22km BRT route which is from airport to keraniganj because it is a critical route. The research covers the traffic volume study of the route along with the short discussion of the BRT project in Bangladesh (cost of the project, features of buses, stations, lines etc). Although BRT can be a successful bus operation system, the implementation of this system in Dhaka city will offer a number of challenges which is the main focus of this research. Land acquisition and consolidation of the existing bus operators on the BRT corridor or convincing them to terminate their bus service and operations on the mixed traffic lanes along the corridor are the major challenges. Besides expecting that it will be an efficient, reliable, safe and affordable yet sustainable mass transit bus operation in Dhaka city and improve the existing traffic condition and bring sustainable development in the transportation system. This research will be helpful for the improvement of the BRT system in Bangladesh.***

***Key words*: Bus Rapid Transit, Evaluate, Dhaka Rapid, Implementation, Sustainable.**

## I. INTRODUCTION

Dhaka is not only the capital but also the center of culture, politics, and economy of Bangladesh. This growing city has an area of 306.38 square kilometers, which makes it the largest urban and metropolitan area. Its current population is over 17 million with a population density of 47,400 people per square kilometer (Amin, 2018) [3]. This densely populated city has a road network of about 3,000 kilometers with only 400 kilometers of footpaths which is disgracefully overcrowded and inadequate as well. Thus, the transportation inside Dhaka, the most important issue faced by the city has reached the crisis level (Rahman, 2010) [11]. To solve this problem, BRT has been proposed which will be constructed from Shibbari to Jhilmil (42km). It will be implemented in two parts: from Gazipur to Dhaka airport (20km); and from the airport to Keraniganj (22km) (Mamun, 2017) [9]. BRT is a high-quality bus-based public transport system that provides fast, comfortable, and cost-effective services at metro-level capacities (ITDP, 2016) [6]. It consists of dedicated lanes, with busways and iconic stations typically aligned to the center of the road, off-board fare collection, and fast and frequent operations. It is quite similar to the metro system or light rail system. BRT aims to combine the capacity and speed of a metro with the flexibility, lower cost, and simplicity of a bus system. With the right features, BRT is able to avoid the causes of delay that typically slow regular bus services, like being stuck in traffic and queuing to pay on board. The concept of the BRT system is not a recent concept. Around the world, cities are looking for reliable ways to reach the destination quickly, efficiently, and safely. Many other major cities in the world have BRT systems including Delhi, Bangkok, Jakarta, and Shanghai. BRT projects are cheaper than building new flyovers or highways with little scope for congestion as other vehicles. Commuters can catch BRT buses from dedicated stations by paying in advance through smart cards. BRT is already widely implemented in both the developed and developing countries. It took place in a Brazilian city, Curitiba in the middle of the 1970s. It was developed by Jaime Lerner, former Mayor. It was called as a 'surface metro'. Bogota's Trans Milenio System was developed in the late 90s. It has a network of 112 km. It was developed under the leadership of Enrique Penalosa, former Mayor, and now a worldwide ambassador of sustainable urban transport (CAI-Asia, 2010) [4]. Currently, there are 186 cities in 41 countries with BRT systems or corridors, serving almost 32 million passengers every day (Global BRT Database, 2014) [5]. The initial success of BRT is really high. Bogota's BRT system is one of the most successful BRT systems. Some Asian cities have also converted their transportation systems into the BRT system. Since then, BRT systems rapidly advanced. BRT cities in Asia can be divided into two categories– cities with a BRT system and cities that want to have a BRT system. Currently, there are over 80 BRT systems in development in Asia. Recently the government of Bangladesh has proposed the BRT system in Dhaka city to cope up with the transportation needs of increasing population and traffic congestion. BRT improves quality of life in cities (King, 2013) [7].

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***** Correspondence Author (s)
**Arifa Sultana***, Department of Civil Engineering, Ahsanullah University of Science and Technology, Dhaka, Bangladesh.
**Saad Muhammad Zakaria Rafe**, Department of Civil Engineering, Ahsanullah University of Science and Technology, Dhaka, Bangladesh.
**Tasnim Shoily Deepi**, Department of Civil Engineering, Ahsanullah University of Science and Technology, Dhaka, Bangladesh.

## II. THEORY

Dhaka is not only the capital but also the center of culture, politics, and economy of Bangladesh. Being one of the least motorized cities around the world, Dhaka, on the contrary, has a very high volume of non-motorized vehicles which also makes it one of the most congested and crowded cities of the world. So, BRT is implementing to solve this problem. According to [8] Mahmud & Anwar (2014) the descriptions of all BRT lines are given below.

**BRT Line-1:** This BRT line is planned to serve the eastern corridor between Uttara and Saidabad Bus Terminal. The main route is based on Pragati Sarani and DIT Road.

**BRT Line-2:** This BRT line is planned to serve the western corridor and runs between Gabtali and Saidabad Terminal. Primarily it is based on Mirpur Road and then crosses over to Zahir Raihan Sharani Road.

**BRT Line-3:** This BRT line is planned to serve the central corridor and runs between the International Airport and the Old City. Primarily it is based on Airport Road, Shaheed Tazuddin Road and the Ramna Area.

### A. Cost of BRT

According to [10] PMCCB (2013), total project investment cost will be around USD 255 million. The government of Bangladesh (GoB) and Asia Development Bank (ADB) will finance the project together with the French Development Agency (AFD) and the Global Environment Fund (GEF). The government of Bangladesh will be financing USD 45 million, which is 17.56% of the project cost and this will be used for taxes and duties, land acquisition and resettlement, and a small part of civil and administrative costs. ADB will provide a loan worth USD 160 million or 62.7% of the project cost, which will finance large civil works, administrative costs, consulting services, advocacy etc. AFD will finance USD 45 million, which is 17.94% of the total cost for civil work and GEF will fund USD 4.6 million, 1.8% of the project cost for Intelligent Transport System (ITS) and efficient lighting facilities.

### B. Features of BRT Line

The construction of BRT line -3 includes the following features considering Urban transport Corridor Restructuring as stated in [10] PMCCB (2013):

1) A 20-kilometer route designed following international best practices and quality standards.
2) 1 segregates lane per direction from km. 0 (Gazipur terminal) to km. 12.5
3) segregated lanes per direction from km. 12.5 to km. 20 (Airport);
4) A 4.5-kilometer elevated section in Tongi from km. 12.5 to km. 17 (House building to Deoara);
5) 7 additional flyovers at main junctions;
6) BRT lanes constructed with reinforced concrete pavements;
7) 31 closed stations located at the center of the corridor with 3 access at-grade and 28 underpasses (among which 8 are with elevators)
8) 1 terminal and 1 depot near Gazipur railway station.
9) Two lanes for both motorized and non-motorized vehicles and one NMT lane per direction and sidewalks along either side of BRT;
10) High capacity drainage system along the restructured corridor
11) 155 access feeder roads improved in favor of Non-Motorized Traffic (NMT) of a distance of 100 meters from the corridor.

There are also some municipal infrastructure improvements to be included.

1) Repair of approximately 56 km of feeder roads:
2) Tongi Municipality – 70 schemes with a total length of 22.837 km.
3) Tongi to Gazipur – 66 schemes with a total length of 30 km.
4) Gazipur Municipality – 5 schemes with a total length of 3.510 km.
5) 2 pilot pedestrian–friendly schemes in Shahajalal Avenue and Hospital Road.
6) Identification, land acquisition and design of 10 local markets.
7) Approximately 3 km of drainage works.
8) Provision of vehicle and equipment for traffic management.
9) Identification and preparation of resettlement sites to receive displaced persons.

### C. Features of Buses

A number of 120 articulated electric buses will be provided. Formerly 50 articulated buses were allotted for the project. The 18-meter long buses with 3 passenger doors immediately in front of each axle will be large enough to carry 140 people (Alam, 2013) [1]. As per [10] PMCCB (2013), buses will be equipped with Global Positioning System (GPS) and General Packet Radio Service (GPRS) modules linked to a central Operational Control Centre. The doors of the buses will be located on the right side of the bus. Hi-capacity buses will include special seats for women, elderly and handicapped people. LED panels will announce the approaching next stations, time and the weather outside. On board systems will be installed for possible communication between the bus and the control center, where vehicle position will be monitored using GPS. Low sulphur diesel and Compressed Natural gas (CNG) will be used as fuel of BRT buses. In future Hybrid and Electric bus will be introduced. A bus depot is being constructed for buses. Bus entry to and exit from the depot will be controlled with a gated office. One way the circulation of buses shall be designed for safety within the depot. Proper internal circulation and parking spaces for buses shall be designed to be free from pedestrian's movement and as per the appropriate international standard.

**Figure 01: BRT Bus Depot [2]**


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### D. Fare Collection System

As stated in [10] PMCCB (2013), fare collection systems will be done conventionally also there would be an electronic fare collection system. The BRT system will also use Automatic Vehicle Location (AVL) system to provide real-time passenger information of the real-time location of BRT buses. BRT line-3 will be equipped with both modern and conventional ticketing and fare collection systems. Smartcard tickets would possibly be issued which will be known as RapidPass. Mobile phone technology would possibly be used for ticketing besides paper tickets.

### E. BRT Stations

Prioritizing comfort, safety, efficiency and easy access for people of all ages, BRT stations have been designed as a cube with universal accessibility features. According to [10] PMCCB 2013, a combination of materials, such as reinforced cement concrete, stainless Prioritizing comfort, safety, efficiency and easy access for people of all ages, BRT stations have been designed as a cube with universal accessibility features. A combination of materials, such as reinforced cement concrete, stainless steel, polycarbonate etc. would be used to provide a modern appearance. Stations will be constructed both at grade and at underground for better accessibility. Stations will have large openings, proper drainage system and complete protection from the weather. Electronically operated doors will ensure a clear view of the surroundings and proper entrance and exit of passengers. There will be proper facilities for specially-abled persons. There will be three different types of stations.

1) **Type A Stations:** This type of station has been planned for 3 stations between Joydebpur Chowrasta and Gazipur Terminal. Its dimension is 25 meters x 3 meters.
2) **Type B stations**: This type of stations have been planned for 13 stations. Its dimension is 60 meters x Staggered (3+3) = 6 meters.
3) **Type C stations:** This type of stations have been planned for 15 stations. Its dimension is 100 meters x Staggered (3+3) = 6 meters.

### F. Construction of Flyovers and Improvement of Junctions

For the improvement of mobility and maintaining the scheduled frequency of BRT buses for reduced congestion, existing junctions and intersections will be improved. Seven new flyovers will be constructed and five at-grade junctions would possibly be improved at Joydebpur-Chowrasta, Station road Ashulia Road, Sonargaon Road, and Jasumuddin. Moreover. The feeder roads will be improved along with 155 feeder roads for improved accessibility. BRT stations are located in the center of the corridor. To gain access to the stations, escalators, underpasses or at-grade crossings have been considered for passengers. The stations are to be closed to prevent unauthorized entry to the BRT system. The floor of the Bus and the BRT station should be at the same level for quick and easy boarding and alighting. Closed Circuit Television (CCTV) for security along with architecturally designed stations will be other attractions of the system. Ensuring efficient operation and management of the BRT system, buses will be equipped with Global Positioning System (GPS) and General Packet Radio Services (GPRS) modules linked to a central Operational control center to be provided in the offices of the SPO. For safe and driving or movement street lighting will be provided.

## III. THE STUDY AREA

Vogra intersection is one of the most crucial intersections in Dhaka-Mymensingh highway. This is the crossing point for vehicles traveling to Rajshahi, Tangail, Mymensingh, Narayangonj. Highway N105 crosses this intersection. N105 highway is known as Dhaka city Bypass which connect Dhaka-Sylhet route with Dhaka-Joydebpur road. Both of this highway is the crucial part of Bangladesh's highway transportation system. Mini Bus, CNG, Laguna are the main public transportation system here. Vogra intersection has a lot of pressure during peak hours. As the Vogra intersection is the most critical location, the traffic volume study is done for this intersection.

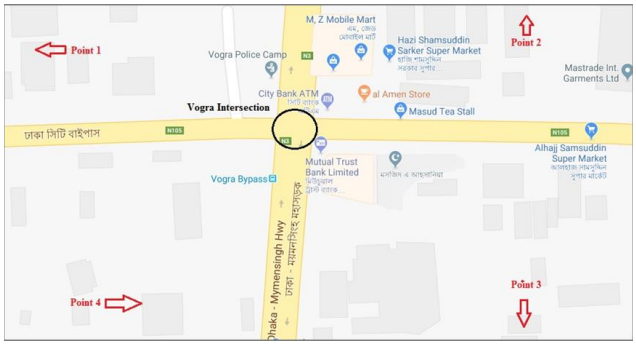


**Figure 02: Survey Area (Google Map)**

Point 1: From Narayanganj to Rajshahi
Point 2: From Hazrat Shahjalal International Airport to Gazipur
Point 3: From Gazipur to Hazrat Shahjalal International Airport
Point 4: From Rajshahi to Narayanganj

## IV. METHODOLOGY

Two ways are available for conducting traffic volume counts. These are:
a. Manual Counting Method: Vehicles are counted manually in this method. Two methods are followed in manual counting, which are (1) Direct method, (2) Indirect method.
b. Automatic Counting Method: In this method no human involvement is necessary. As no human is required it quite suitable for continuous count and used as permanent counting station. For this research Manual counting method was used.

## V. CALCULATION

**Table 01: Vehicle Volume at Vogra Intersection**

| Vehicle Type | Point 1 | Point 2 | Point 3 | Point 4 |
|---|---|---|---|---|
| Bus | 159 | 101 | 99 | 219 |
| Truck | 55 | 33 | 69 | 40 |
| Small Truck | 8 | 7 | 15 | 2 |
| Car | 139 | 147 | 114 | 190 |
| CNG | 10 | 20 | 11 | 28 |
| Total | 371 | 308 | 308 | 479 |


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The volume was counted by direct method. Even though this method is not very practiced nowadays, for faster data accessibility and learning purposes this method is quite useful.

1. Sample calculation for Vehicle Composition:

$$\text{Vehicle Composition} = \frac{\text{Number of each vehicle}}{\text{Total vehicle}} * 100$$

$$\text{For Point 1(Bus)} = \frac{159}{371} * 100 = 42.85\%$$

2. Sample calculation for Service Flow Rate:

$$\text{Service Flow Rate} = \frac{\text{Maximum hourly rate}}{\text{Number of segment of a lane}}$$

$$\text{For Point 1} = \frac{1609}{1} = 1609 \text{ PCU/hr}$$

3. Sample calculation for Directional Distribution:

$$\text{For Point 1} = \frac{\text{Volume of Point 1}}{\text{Volume of Point 1 and 4}} * 100$$

(Point 1 & 4 same lane)

$$\text{DDF For Point 1} = \frac{371}{371 + 479} * 100 = 43.65\%$$

## VI. RESULT

Tables showing vehicle composition, service flow rate, directional distribution, peak hour factor, ADT and AADT for Vogra intersection are given below which indicate the effectiveness of implementing Bus Rapid Transit in Bangladesh

**Table 02: Vehicle Composition at Vogra Intersection**

| Vehicle Type | Point 1 Vehicle Percentage (%) | Point 2 Vehicle Percentage (%) | Point 3 Vehicle Percentage (%) | Point 4 Vehicle Percentage (%) |
|---|---|---|---|---|
| Bus | 42.85 | 32.79 | 32.14 | 45.72 |
| Truck | 14.82 | 10.71 | 22.40 | 8.35 |
| Small Truck | 2.15 | 2.27 | 4.87 | 0.41 |
| Car | 37.46 | 47.72 | 37.01 | 39.66 |
| CNG | 2.69 | 6.49 | 3.57 | 5.84 |

**Table 03: Service Flow Rate at Vogra Intersection**

| Location | Service Flow Rate (PCU/hr.) |
|---|---|
| Point 1 | 1609 |
| Point 2 | 1156 |
| Point 3 | 1313 |
| Point 4 | 1984 |

**Table 04: Directional Distribution at Vogra Intersection**

| Location | Directional Distribution |
|---|---|
| Point 1 | 43.65% |
| Point 2 | 50% |
| Point 3 | 50% |
| Point 4 | 56.35% |

## V. DISCUSSION ON RESULT

Vehicle composition shows that most of the vehicles in the traffic stream are heavy vehicles. Both the percentage of bus and truck are quite high. Large bus and truck are seen very frequently at this hour but small and medium trucks are not visible at that quantity. Non-motorized vehicles are not seen much at the time of counting. The route Narayanganj to Rajshahi is a highway. The location is the industrial area. So, it is very natural to see heavy vehicles. People can travel from Narayanganj to Rajshahi by buses. That's why buses were seen fully occupied. The quantity of buses is high at this route because it is the Dhaka city bypass route. People go outside of the city and travel to North Bengal cities. It is the only route through which people can go outside of the city. The imported things like vegetables, fruits, crops also come to Dhaka through this route. Exportation of materials from inside of the city is another important use of this route.The maximum hourly rate of a roadway section during a given period under prevailing roadway condition is service flow rate. The maximum number of the vehicle is observed at location point 4(Rajshahi to Narayanganj) which is 1984 PCU/hr. That means most of the vehicles are coming to Narayanganj due to the working purpose or any other purpose. The number of vehicles for other locations are less than location point 4. The minimum value is found at location 2 which is 1156 PCU/hr. That means people are traveling less from Airport to Gazipur relative to other routes.It is seen that the directional distribution is same in both directions (50% in Hazrat Shahjalal International Airport to Gazipur & 50% in Gazipur to Hazrat Shahjalal International Airport which is in the ratio of 1:1. So, it can be said that the geometric design of the road is almost adequate for present traffic. The directional distribution for point 1(Narayanganj to Rajshahi) is 44% and for point 4 (Rajshahi to Narayanganj) is 56%. It indicates that the major percentage of flow is towards Narayanganj. That means people coming from North Bengal to Narayanganj. Narayanganj is the city where has a great source of employment. So, this situation justifies the current condition of the surveyed location.

## VI. CONCLUSION AND RECOMMENDATION

BRT is expected to improve the existing traffic condition and bring sustainable development in transportation system along the corridor. It is also expected that it will be an efficient, reliable, safe and affordable. As a large number of passengers would use the BRT system, a large portion of the traffic volume would be reduced from the existing lanes and it will ensure smooth traffic flow in normal vehicle lanes and reduce traffic congestions at the intersections along the BRT corridor. It should have minimum bus fare so that passengers of every occupation can afford the service. It is expected to reduce travel time and increase cost-efficiency, level of service and right of way of the corridor.


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Even though BRT is one of the smartest solutions for the existing traffic condition, this project might face many difficulties to result in a successful operation. As two lanes from the existing roadway will be reconstructed as the dedicated BRT lane, the right of way for other vehicles might decrease. Interchange of modes after walking out of the BRT stations might be difficult. As this BRT system has elevated sections, there is a chance of the occurrence of diverging and merging conflicts among other vehicles (normal lane vehicles) at the beginning and end of the elevated sections.
The suggestions for the betterment of the proposed BRT are recommended below.

1) An elevated expressway should be constructed on Dhaka City bypass road. BRT route along this way could provide a fast transportation system for long route passenger. Merging the proposed BRT flyover with the expressway at Vogra south will improve the intersection performance.
2) Bus reform can be considered outside the BRT corridor.
3) BRT buses will stop at the stations. After arriving at the station, people have to use feeder service to reach their destination. So, to reach the destination, improvement of the feeder service is very necessary. Minibus, Laguna, CNG or Rickshaw etc. can be used for the feeder service.
4) Most of the long-route buses travel over the proposed BRT route. After the initiation of BRT, the long route buses along with the local buses are going to travel on the normal traffic lane. This will reduce the level of service of the normal traffic lane and this will create congestion. It would be efficient if the long route bus terminal was situated near Gazipur Chowrasta.
5) The proposed BRT route will pass through N3 road beside the Bishya Ijtema field. But during Bishya Ijtema, the load of traffic increases which demands more facility of road. A BRT route along Tongi bypass road (R303) and West Abdullahpur road (N302) could have helped with the increase pressure due to “Bishya Ijtema”.

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## AUTHORS PROFILE

**Arifa Sultana,** Department of Civil Engineering, Ahsanullah University of Science and Technology, Dhaka, Bangladesh. Got Dean Award from Ahsanullah University of Science and Technology.

**Saad Muhammad Zakaria Rafe,** Department of Civil Engineering, Ahsanullah University of Science and Technology, Dhaka, Bangladesh.

**Tasnim Shoily Deepi,** Department of Civil Engineering, Ahsanullah University of Science and Technology, Dhaka, Bangladesh.