Evaluation of bus rapid transit (BRT) in context of Bangladesh

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ABSTRACT: The work has been a little effort to the evaluation of bus rapid transit with other mass transit options to alleviate traffic congestion in Bangladesh; to examine whether BRT system will be effective enough to meet public transport existing and future demand in the major routes of Dhaka city and the suburbs of Dhaka; to present the propriety of proposed BRT (Uttara-Gazipur) and (Uttara-Old dhaka) corridor in urban area. The question survey conducted among bus passengers reveals that the majority of respondents (98%) considered the issues of the quality of the roads and the impact of flooding that damage the road from time to time and the travel time related to traffic congestion. As simultaneous boarding and alighting are not possible, the on-off time is higher than it should be actually. From the survey along the corridor it has been also estimated that the average stoppage time for non- scheduled bus ranges from 40-60 minutes. Travel time savings for BRT projects is 48.84% which is greater than various reported travel time savings over pre-BRT conditions in some city of the world. The time savings are greatest where the bus routes previously experienced major congestion. Pittsburg, for example, has reported travel time savings up to 5 minutes per mile during peak hours and here along the proposed corridor of Uttara to Gazipur travel time savings has been determined approximately 3.7 minutes per mile during peak hours. The speed of BRT is double compared to the existing bus which means per kilometer the BRT will save 2.6 minutes. So total cost of delay 79, 10,280 BDT/km/hr considering vehicle operating cost (VOC) and value of travel time (VOT). The purpose of this research is to focus on whether it will be feasible to initiate BRT in Dhaka road traffic. Moreover the corridor characteristics, existing roadway widths, condition, vehicular composition, land use pattern and obstacles along the selected corridor are shown to compare with the requirement of BRT. The research includes proposal of BRT road cross-section in existing row with the help of STP, possible station location and overall the prospect of replicating BRT systems within the settings of Dhaka city. The existing public transportation along the corridor is failing to satisfy passenger with its performance due to lack of reliability in service, travel time increase, poor condition of vehicle and roadway. The only tool to solve the problem is the introduction of BRT system along the corridor which has the potential to reduce travel time, reliability and comfort.

1 WHAT IS BUS RAPID TRANSIT (BRT)?

Bus Rapid Transit (BRT) is a very popular form of rapid transit implemented throughout the world. BRT uses separate transit-only roadways, called “Transitways” that transit vehicles use to operate at high speed, away from traffic congestion. BRT vehicles are state-of-the-art rubber-tired vehicles that can operate on and off the Transitway, using the regular street system to pick up passengers, and then travel at high speeds on the Transit way to major destinations. When operating on-street, BRT vehicles take advantage of transit priority measures already built, such as diamond lanes, transit signal priority lights, and the Graham Transit Mall. A recent Transportation Research Board study defines BRT as: "a flexible, rubber-tired form of rapid transit that combines stations, vehicles, services, running ways, and ITS [intelligent transportation system] elements into a fully integrated system with a strong image and identity." More generally, BRT includes at least some of the following elements, with the overall objective of reducing travel times. A number of transit routes use the Transitway, with buses entering/exiting at either end of the Transitway or at intermediate points. This permits

the operation of a very flexible route network, which minimizes the need to transfer, providing a one-seat trip for a majority of passengers.

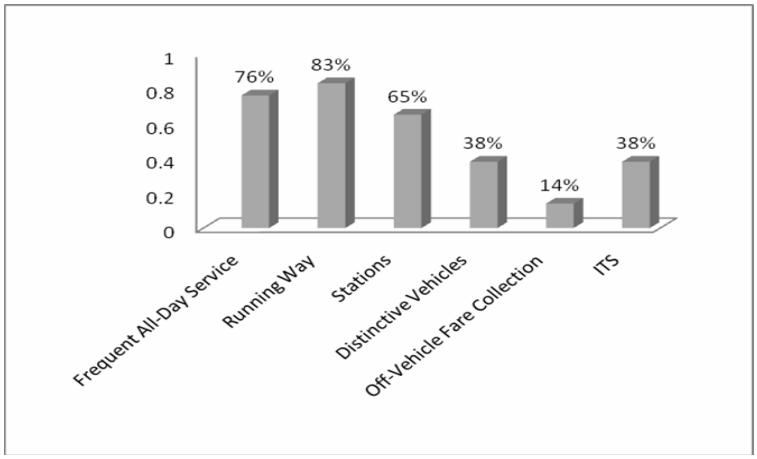

Figure 1. BRT system feature

BRT systems have the following features:

- Transitways – exclusive to transit for high-speed service
- High-frequency service throughout the day
- Rapid Transit Stations along the Transitway
- Modern state-of-the-art buses with air-conditioning and other passenger amenities
- Electronic real-time passenger information systems (such as GPS tracking, on-board "Next Stop" displays, and electronic bus departure displays)
- Traffic signal priority at intersections

Table 1 Comparison between mass transit system

Parameter	BRT	LRT
All operating and maintenance costs excluding depreciation and interest	(In $1992) $ 3- $3.5 per vehicle km for a bus based transitway	$3-$5 per vehicle km for light rail
Capital costs	Cost is 50% lower for a bus based transitway	Higher capital cost
Construction costs	(In $2004 M/km) At grade, $ 0.12 M/km with shared use of existing road, $1.1 M/km with widening of an existing road and $ 1.7 M/km in an exclusive corridor .	In contrast LRT under the same corridor context is respectively $3.6 M/km, $ 2.20 M/km and $ 2.12 M/km.
Track length	Bus based transitway system can be shorter in length	The length will be longer than BRT line
Operation flexibility	Permits far more flexible operation	Operation is flexible
Unit operating cost	Unit operating cost is less	The most cost effective LRT is 60-80% higher on unit operating costs than a bus based transitway
Construction period	Planning and construction time for BRT is 12-18 months.	Planning and construction time for Metro is 3-30 years.

On the above comparison it can be clearly said that BRT is the best suitable solution for reducing traffic congestion in Dhaka city as it has a large passenger capacity with low capital cost than other mass transit option shown in figure above.

2 EVALUATION OF BUS RAPID TRANSIT IN SOME ASIAN COUNTRIES

2.1 *Review of TRANSJAKARTA BRT*

Lessons from Jakarta System-

- The existing conventional bus of Dhaka with high floor and one door will not be suitable for BRT fleet as it will offer lower capacity.
- As acquisition of additional express lane would be difficult in Dhaka achievement of capacity in excess of 10000 pphpd through multidoor articulated bus would be a good idea.

2.2 *Review of Delhi BRT Initiative*

Lessons from Delhi BRT-

- Allowing other buses on BRT lane might not be a good idea as it can easily lead to chaotic situation.
- High quality low floor similar characteristics buses should be introduced preferably from the opening of the system.
- At-grade passenger crossing access to BRT system may not be safe enough in sub-continent situation.
- Preference should be given for grade separation of BRT system at traffic signals and long cycle time may result queuing of buses at signals.

3 WHY BUS IS NOT BECOMING POPULAR AS PUBLIC TRANSPORT IN BANGLADESH

The city's transport environment and system being predominantly road based with a substantial share of non-motorized transport: about a third of total trips use rickshaws and quarter is comprised of walk and bicycling among others. Buses and minibuses, the cheapest mode available as mass transit, are constrained by

1. Poor service condition
2. Long waiting
3. Delay on plying
4. Overloading and long walking distance from the residence/work place to bus stoppages.
5. The city's road space is limited, with few alternative connector roads, lacking of effective maintenance and management, most of it with geometrical conditions that make them not accessible to buses.
6. Most of signals are manually controlled and police have to control traffic, without properly coordinated automated systems.
7. With policy formation and control shared between government agencies poorly coordinated, there has been a lack of organized effort to handle the situation.
8. A highly fragmented bus industry, operated by a large number of very small individual operators, and a road network not properly maintained were insufficient to meet the demand for public transport.
9. Per capita income averages around US$ 550 per year and 30 percent of the population lives in miserable conditions, with very poor access to transport services.
10. Increasing road congestion affects buses even more than cars.
11. Buses accelerate more slowly and are less able to take advantages of gaps.
12. Buses operate to pre- determined route.
13. Decreased speed makes buses less attractive to passengers.
14. Unreliability of services resulting from traffic congestion.
15. Mixed traffic pattern affects bus operation.

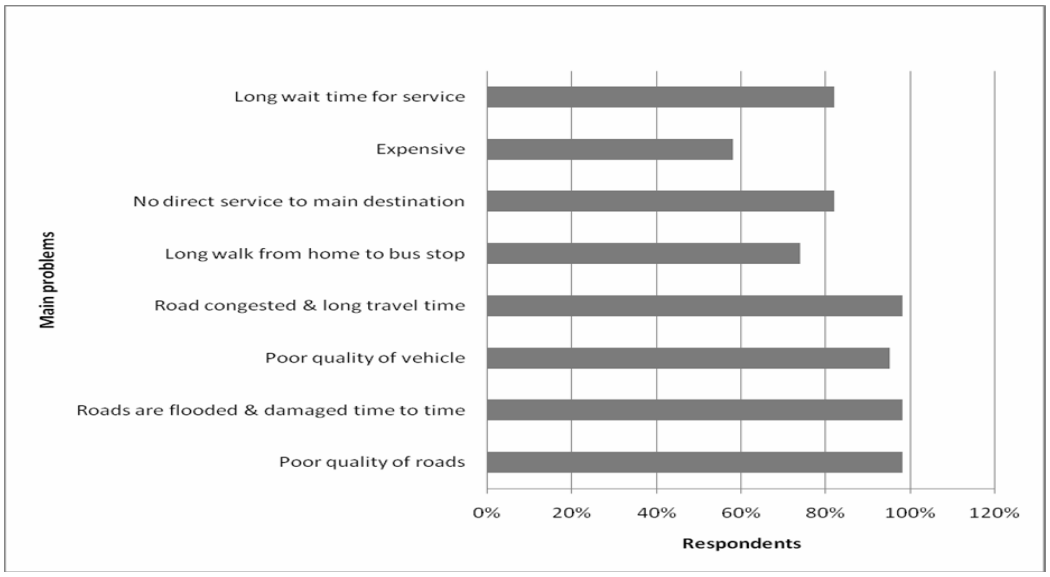

Figure 2. Main problems with the public transport

4 ANALYSIS OF PASSENGER RESPONSE SURVEY

The service characteristics which are responsible for the unpopularity of public transportation has been identified based on interview survey. The physical surveys have been conducted at different bus stops as well as at other locations along the survey route.

4.1 Respondent's characteristics

Most of the trip makers were from 18-40 years old. Among the respondents there were service holders, students and businessman. Trip purposes were mainly home and official.

4.2 Survey on Public Transport Opinion Results

The question survey conducted among bus passengers reveals that the majority of respondents (98%) considered the issues of the quality of the roads and the impact of flooding that damage the road from time to time and the travel time related to traffic congestion. The only issue to have divided opinion was that of the cost of public transport where 58% thought it is expensive compared to 42% that did not.

A number of factors contribute to the need for a comprehensive approach to improving public transport in Greater Dhaka.

5 RELIABILITY OF SERVICE

OBJECTIVE OF THE SURVEY **:**To find out the existing approximated travel time from AIRPORT-GAZIPUR by local bus service at peak office hour , the variation of travel time and reliability of service.

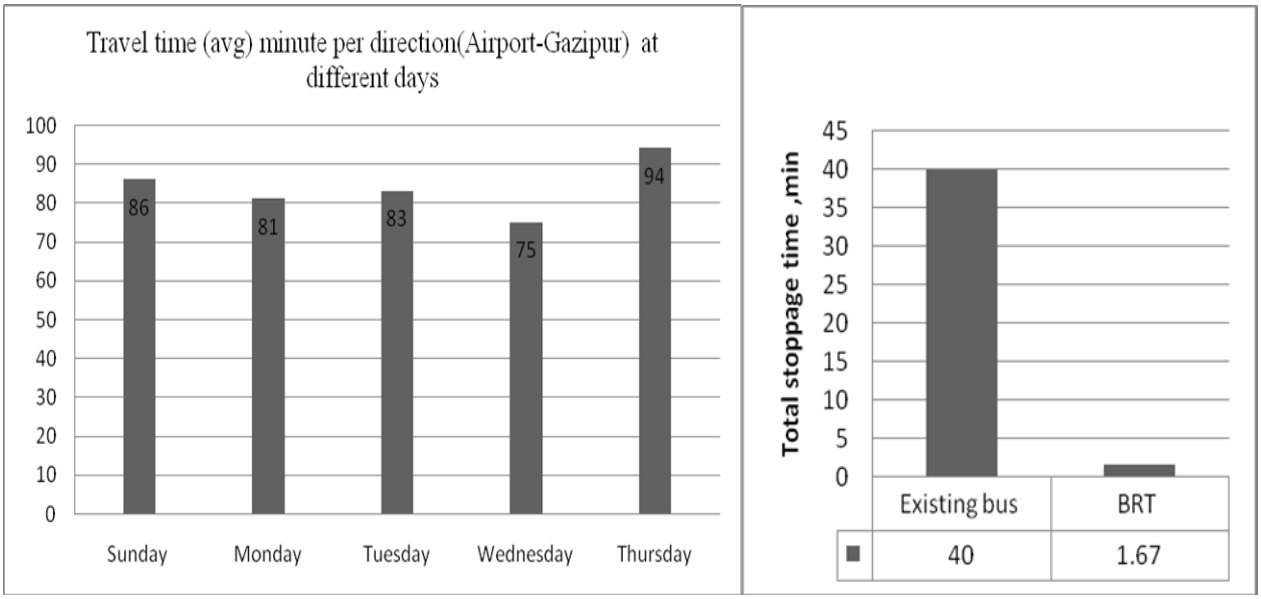

Figure 3. variation of travel time (in vehicle time) per direction along the corridor and total required stoppage time for existing bus and BRT

At Thursday travel time is maximum of 94 min as most of the people travel in this corridor in local bus service are workers of various institutions,offices, factories,agencies,garments etc. who comes for working purposes. Most of them stays in the centre of Dhaka city or nearby areas. The next higher time is taken on Sunday . Friday and Saturday takes less time to travel than other days as there are two important educational institutions at board bazaar which is being closed.Because of this time variation at different days, people find unreliability in local bus service and as a result private car occupancy is increasing along the corridor day by day.

6 LOSS OF TRAVEL TIME AT BUS STOPPAGE

It is shown that besides congestion ,one of the main causes of increasing travel time of local buses are crowded bus stoppages. Time also increases for boarding and alighting passengers and checking tickets by conductors awaiting passengers in the bus. Moreover, most of the buses have two doors; unfortunately none of these buses use the second door for boarding and alighting passengers. As simultaneous boarding and alighting are not possible, the on-off time is higher than it should be actually.

From the survey along the corridor, it has been also estimated that the average stoppage time for single decker in peak hour is 2 minute. So the average time spent in the 20 stoppages is 40 minutes for scheduled bus. For non- scheduled bus it ranges from 40-60 minutes. It is also evident that BRT system is 20 times faster than existing bus service.

7 LOSS OF TRAVEL TIME (IN-VEHICLE TIME)

The average time spent from Airport toGazipur is =86 min or 1 hour 26 min.
The total length from Airport to Gazipur through the proposed route is =18.2 kilometre.
So the operating speed of vehicle along the corridor is =12 km/hr.
If BRT is implemented on the proposed corridor, travel time will be from uttara to gazipur
Assuming average travel speed 25 kilometre/hour
=around 44 minutes.
Therefore the loss travel time or delay per trip per direction =(86-44)minutes =42 minutes
SO TIME SAVING /TRIP/DIRECTION = 42 MINUTES

8 TRAVEL TIME SAVINGS IN COMPARISON TO OTHER CITIES

Travel time savings for BRT projects is 48.84% which is greater than various reported travel time savings over pre-BRT conditions in some city illustrated in table:

Table 2: Examples of travel time savings in BRT projects

Los Angeles Metro Rapid Bus	23%-28%
Port Alegre	29%
Bogota	32%
Bus Tunnel-Seattle	33%
Proposed BRT corridor(Uttara-Gazipur)	48.84%

With respect to total BRT travel times, BRT projects with more exclusive running ways generally experienced the greatest time savings compared to the local bus route. Exclusive transit way projects operated at a travel time rate of 2 to 3.5 minutes per mile (between 17 and 30 miles per hour) . Arterial BRT projects in mixed flow traffic or designated lanes operated between 3.5 and 5 minutes per mile (between 12 and 17 miles per hour).The time savings are greatest where the bus routes previously experienced major congestion. Pittsburg,for example , has reported travel time savings up to *5 minutes per mile* during peak hours**.**And here along the proposed corridor of Uttara to Gazipur travel time savings has been determined approximately *3.7 minutes per mile* during peak hours.

9 DELAY COST ESTIMATION

Public bus is sample vehicle.
Expected speed of BRT is taken if BRT is implemented along the proposed corridor = 25km/hr
Operating travel speed along the corridor = 12 km/hr
Delay to pass 1 km = (1/12-1/25) hr
= 13/300 hr
=0.043 hr
So delay is 0.043 hr/km.
Estimation of VOT (value of travel time):
Assumed from monthly income of 4000 BDT and working hour 160 hour ,
The value of time = 4000/160 = 25 BDT/hr/person
Assuming 40 passenger in one bus = (25×40)
= 1000 BDT/hr
VOT for delay = (1000×0.043)
= 43 BDT/km-hr
Estimation of VOC (vehicle operating cost):
Assuming operating and maintenance cost of 1 bus as 100 BDT/hr
Bus passing in 1 hr = 200 (assumed approximately)
VOC for delay = (100×200×0.043)
= 860 BDT/km-hr
Total cost of delay = VOT + VOC
= (43+860) BDT/km/hr
= 903 BDT/km/hr
= 79,10,280 BDT/km/hr
So Total cost of delay = 79,10,280 BDT/km/hr

10 SPEED & CAPACITY

From the study of design of BRT buses , It is observed that the world's first city to use bi-articulated bus is Curitiba , Brazil that carry passenger up to 270 and it is more in double bi-articulated buses . Where the passenger carrying capacity in the local bus service that ply along the city road in our country is up to 60 passenger in single decker .

From the system performance of BRT it is observed that the average speed of BRT is 20 km/hr along the busway and 30 km/hr on the direct express routes (Curitiba , Brazil) . Where the operating bus speed that is existing along the road is 10-12 km/hr . Along the proposed corridor the operating speed of local bus is observed 12 km/hr and assuming the average speed if BRT is implemented is 25 km/hr the following graph is plotted :

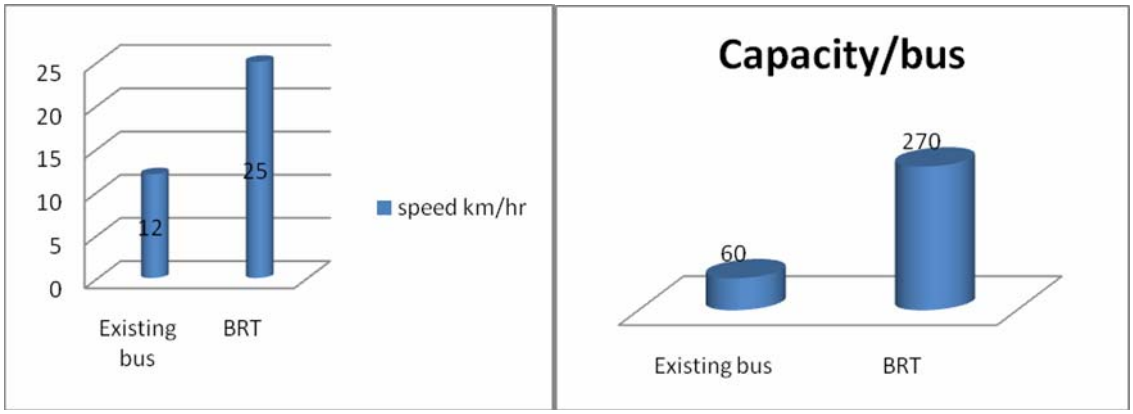

Figure 3: Capacity & speed per bus in Existing bus and BRT

From the figure it is observed that passenger capacity per bus of BRT is almost 4.5 times greater than the existing bus hence BRT will carry the passenger of equivalent five buses in a single time . So the road will be used more effectively. The speed of BRT is double compared to the existing bus which means per kilometer the BRT will save 2.6 minutes .

11 CONCLUSION

The three important parameter of judging the performance of public transportation is reliability , travel time and comfort .The existing public transportation along the corridor is failing to satisfy passenger with its performance due to lack of reliability in service , travel time increase , poor condition of vehicle and roadway as shown above .

The only tool to solve the problem is the introduction of BRT system along the corridor which has the potential to

- Reduce travel time
- Reliability
- comfort