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Performance Evaluation of Articulated Bus as a Mode of Public Transport of Dhaka: A Case Study of Gazipur to Gabtoli Route

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Abstract

Dhaka, as a city of a developing country, is struggling to improve and enhance existing transit services at a low cost. The Articulated Bus Service is a newly introduced public transport mode in the transportation system of Dhaka city. Although a total of only 25 articulated buses operate from Gazipur and Gabtoli route, it is important to assess the role of the articulated bus services in order to justify the continuation of such services as well as considering the possible expansion to meet the popular demand for such services. The paper aims to evaluate the quality of service provision and examine the overall prospect of the articulated bus service in Dhaka. A passengers' attitude survey was carried out about the overall performance of BRTC's articulated bus and privately operated single decker bus services. Several service performance indicators were used to measure the performance and quality of these two bus modes considering the users' point of view. It was revealed that overall performance of articulated buses was better than single decker bus services. The Articulated Bus Service shows huge potential in enhancing the transportation condition of Dhaka city through contribution to reducing congestion, environmental pollution, unreliability, delay and providing better services at reasonable fares.

Introduction

The demographic trends of the last decades in Dhaka have resulted in rapid population growth and are expected to continue in the coming decades. The impact of such rapid growth has major consequences on the ability of the transport sector to provide mobility for all the people those are settled in Dhaka to take the advantage of employment, education, health and social opportunities. Dhaka is perhaps the only city of its size without a well-organized, properly scheduled bus system or any type of mass rapid transit system. The deteriorating traffic conditions are causing increasing delays and worsening air pollution, and seriously compromise the ability of the transport sector to serve and sustain economic growth and quality of life. The deficiencies in the city's transport systems have affected its economic and social performance. From a recent study of Roads and Highway Department (RHD), it has been found that annual loss caused by traffic congestions in Dhaka city is around Tk.200 billion where due to delay time on the streets accounts for nearly Tk 120 billion, Tk 40 billion in the area of trade and export, Tk 25 billion for environmental causes and the rest of the amount for the medical and other purposes. About 3.2 million business hours are lost due to traffic congestion every day (Mian, 2013). Transportation has not been planned or developed to meet the

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needs of the growing city population and the related problems have not been managed properly. To overcome the existing problems of transportation of Dhaka city, an efficient transport system should be developed. The role of an efficient transport and communication system is extremely critical for the socio economic progress of a country.

Public transport services are provided by commuter rail, minibuses, high quality bus service, taxis, auto-tempo, and auto-rickshaw. Only buses (single and double decker), minibuses, articulated buses and commuter rails are the cheapest modes available as mass transit among the public transport. However, road design, traffic flow, infrastructure or establishment cost and time are the considering factor for the selection of public transport. By restricting small occupancy vehicles and private cars and introducing large size buses, the cheapest form of public transport in Dhaka city in terms of affordable fare can be provided and thus possibly could solve both the congestion and travel problem of the cities. Keeping this notion in mind, articulated bus was officially launched in Dhaka in 2013 with a fleet of 10 buses serving Gazipur-Motijheel route (FE Report, 2013). Later in 2015, in total 45 articulated buses were running through Dhaka (BRTC, 2015). Since this bus service is a comparatively newer one plying on the roads of Dhaka, it is high time to investigate the performance level of this service for reducing the present level of traffic congestion and improving the public transport of Dhaka. The aim of the study is to evaluate the performance of the articulated bus services in Dhaka as a mode of public transport. To fulfill the aim, the operational and service performance of articulated bus services were investigated; the problems of this bus services were indentified and later recommendations were suggested to improve the articulated bus service of Gazipur to Gabtoli route.

This paper consists of six sections. Following the introduction, the second section portrays the existing condition of public transport of Dhaka. Third section presents the conceptual framework and research design for evaluating the performance of the articulated bus service. Fourth section depicts the findings about resource efficiency, resource effectiveness and service effectiveness. Fifth section identifies the problems of the articulated bus services, which is followed by the recommendations and conclusion.

Existing Condition of Public Transport of Dhaka

The transportation system of Dhaka is predominantly road based. Dhaka's road network is nearly 3,000 km (of which 200 km are primary) with few alternative connector roads. Only 7% of total land space is devoted to the roadway and transport facilities. Approximately 400 km of footpaths are available for pedestrians of which 40% are being occupied illegally by vendors and others (Rahman, 2008). Being a road based passenger transport system, the transport sector of Dhaka city is a combination of both motorized (viz. single decker bus, double decker bus, minibus, microbus, car, jeep, auto-rickshaw, tempo, maxi-hauler, motorcycle, etc.) and non-motorized transport (viz. rickshaw, rickshaw van, bicycle, push cart, etc.) with bus as the lone mode of mass transit. However, in fact, buses are inadequate both in number and quality to cater to the transportation needs of the metropolis. Different modes of transport of Dhaka are presented in Table 1. They often use the same road space which results in a high level of operational disorder and significantly diminishes the efficiency and effectiveness of the existing transport services. Traffic movements at intersections are mostly operated

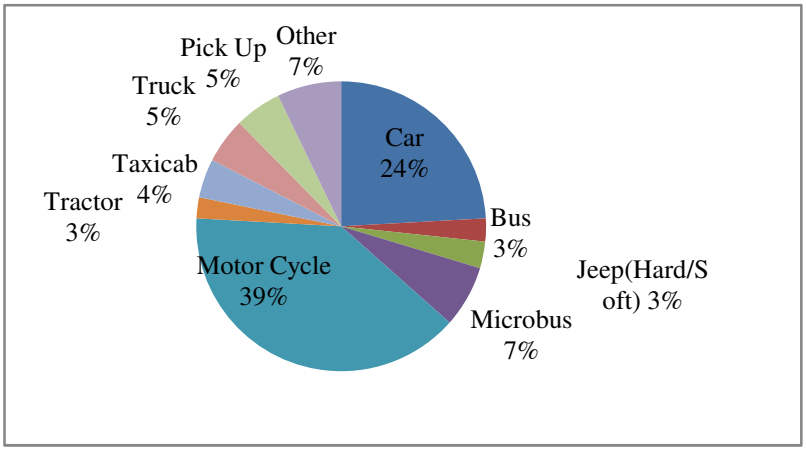
manually by traffic police, even though all large intersections (a total of 70) are equipped with traffic lights and signal controllers.

Table 1: Different modes of transport of Dhaka

	Mode	Description	Example
Group 1	Transit	Generally operate on fixed routes with relatively high capacity and services but differ from vehicles to vehicles	Articulated bus, single and double decker bus and mini bus etc.
Group 2	Para transit	Route is flexible and the capacity and service category of the vehicles are relatively low	Rickshaw, taxi, auto-rickshaw, tempo etc.
Group 3	Private	Most flexible one with the lowest capacity	Bicycle, motorcycle, car etc.

Source: Authors, 2015

Bangladesh Road Transport Authority (BRTA) data as presented in Figure 1 also shows that there are 39 percent of motor cycles in the vehicle mix, followed by passenger cars (24%), jeep and micro-bus (10%), bus (3%), taxi (4%), pick-up (5%) and truck (5%). In addition to these motorized vehicles there are over 500,000 rickshaws plying their trade in the streets of Dhaka (DTCB, 2005). Considering Figure 1 and Table 3, it can be found that on one hand car contributes one of the major portion in total vehicle composition 24% while modal share of car is only 5.1%.On the other hand, bus is only 3% of total vehicle but modal share of bus is around 29% which is comparatively higher than other passenger carrying vehicle. Buses and minibuses, the cheapest and only public transport system, have not been able to increase their share and cater to the demand because of service deficiencies (ADB, 2011).



Source: BRTA, 2014

Figure 1: Motorized vehicle composition in Dhaka, 2014

The present bus services provide inefficient, unproductive and unsafe level of services. Long waiting, delay in starting, overloading, discomfort and long walking distance from the residence or work place to bus stoppage are some of the obvious problems that are confronted by the users in their daily life. In peak hour's bus conductor very often load and unload in unspecified stops. It is a common practice in rush hours to deny access to the old, women, and children passengers, because this group has a tendency to avoid fighting during boarding and alighting (Rahman, 2008).

Table 3: Modal Share in Dhaka city

Vehicle	**Modal Share**
Public Bus	28.30%
Private Bus	1.80%
Car	5.10%
Rickshaw	38.30%
CNG	6.60%
Walk	19.80%
Railway	0%

Source: JICA Report- Phase I, 2009

The public transport systems (buses, rickshaws, and taxis) are operated by both the government and the private sectors. Public sector involvement through the Bangladesh Road Transport Corporation (BRTC) is quite limited while private sector operators are fragmented and numerous. Bangladesh Road Transport Authority (BRTA) issues licenses for bus routes and operation to operators except Bangladesh Road Transport Corporation (BRTC), which has the right to operate buses at its own discretion. Bus fares are fixed and regulated by BRTA. Bangladesh Road Transport Corporation (BRTC) was established as a government corporate transport body with a view to provide modern mass communication service to esteemed passengers throughout the country. At the early stages BRTC was organized and operated by its own staff. All the staff like bus driver, fare collector, conductor were BRTC bus staff. Single decker and double decker buses both were operated by the same staffing system. Now only single decker buses operated from Kamalapur bus depot are run by its own staff. For a long time the traditional staffing system predominated in BRTC bus service. However this staffing system did not prove to be quite effective.

To overcome the existing problems of transportation of Dhaka, an efficient transport system needs to be developed. It is therefore, emphasized that the selected urban transport system must provide at least a minimum level of mobility, safety and accessibility to all urban residents with minimum cost.

Conceptual Framework and Research Design

Conceptual Framework

In order to extend the service of the articulated bus service in Dhaka, it is important to assess the performance level of this service. Along with environmental goal achievement,

cities with increasing economic growth intend to plan for rapid transit to make it congestion-free, faster and reliable for the movement of people. Golias (2002) argued that any new public transport system should be based on the perceived impacts, such as increased market share for public transportation, reduced automobile dependence, positive effects on environment and urban development. Among them, most important and common issue is to reduce car use and increase the use of public transport. According to Karlaftis and Tsamboulas (2012), the term (economic) efficiency refers to the comparison between the real or observed values of output(s) and input(s) with the optimal values of input(s) and output(s) used in a production process. Economic efficiency requires that producers of a good or of a service make the best use of the resources available to them; when, for example, a bus repair facility employees five mechanics when four could have done the same job in the same amount of time, then this is classified as inefficient use of resources. In essence, when an economy is inefficiently organized, goods and services that could have been produced are sacrificed had labor or capital been used differently; in economic terms, efficient use of resources equates to economic welfare maximization (or maximizing average standard of living).

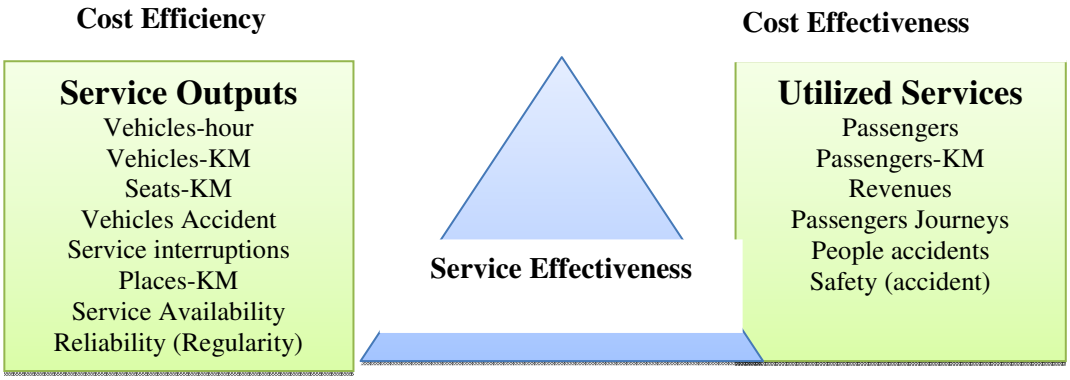
Articulated (including bi-articulated) single deck buses, carrying up to 270 passengers and sometimes even more, are efficient movers of large numbers of passengers. They are more maneuverable than rigid buses of the same length. They can be much longer than rigid buses up to 25 meters is possible, although the normal maximum length is approximately 18 to 20 meters. This type of bus is also known as accordion bus, harmonica bus, jointed bus, or bendy bus, all because of the shape of the bellow and the fact that the design of the turntable joint allows for sharp turns (Used-buses, 2015).

In 1946, a 60-foot articulated over-the-road coach was constructed as a speculation and operated between Los Angeles and San Francisco. The body was constructed of a magnesium-aluminum alloy. It operated in regular service until 1951 (Curbside, 2012). It is argued that articulated buses can be very effective where passenger volumes are high, roads are relatively wide and straight, and space is not severely restricted, labor is scarce or expensive. With well-designed bus stop facilities and appropriate fare collection systems, they can load and unload very quickly despite their size. However, they require greater skill to drive, particularly when reversing. The number of routes that they may be used is often also limited. Specially designed depot facilities may also be required. Where congestion is severe and roads are narrow they may be impractical. However, their more complex construction makes them more expensive to purchase and maintain than rigid single-deckers or double-deckers (typically, 25% or 30% more than a double-decker), and reliability may be a problem where road conditions are poor. Therefore, articulated buses must have good access to bus stops, with all doors accessible from the curb without obstruction from parked cars or street furniture. It is particularly important to ensure that passenger shelters and safety barriers are positioned so that they do not obstruct any of the doors of buses using the stop.

Fielding and Anderson (1982) conducted a concept of transit performance. This transit performance concept has three triangles, where efficiency and effectiveness are measured. Efficiency is concerned with how well the available labor and capital resources are utilized, effectiveness is concerned with how well the produced services are consumed. Figure 2 presents the service performance concept.

- Resource efficiency (measuring service output against resource input)
- Resource effectiveness (measuring service consumed against resource input)
- Service effectiveness (measuring service consumed against resource output)

Each of these three broad dimensions can further be subdivided to reflect different aspects of bus operations. For an example, resource efficiency may be subdivided into labor, vehicle, fuel and maintenance efficiencies. These sub classifications help consideration of desired evaluation aspects in a more systematic way. These are also helpful in formulating the actual indicators of those variables which best represent the subdivided categories of the performance concept.



Source: Fielding, 1985; MacDorman, 1988; Deloucas, 2002

Figure 2: Transit performance concept

The five important parameters of judging the performance of public transportation are:

- Reliability in service
- Travel time
- Comfort
- Cost/Fare
- Maintenance/Repair cost

Studies Related to Service Performances Evaluation Technique

Self-reporting is the most widely used approach to scaling responses in survey research. When responding to service attribute of the questionnaire, respondents specify their level of satisfaction or dissatisfaction on a symmetric agree-disagree scale for a series of statements. Thus, the range captures the intensity of their feelings for a given service.

Likert's Scale Technique

Most frequently used summated scale in the study of social attitudes follows the pattern devised by Likert. For this reason, they are often referred to as Likert-type scale. In a Likert scale, the respondent is asked to respond to each of the statements in terms of several degrees, usually five degrees (but at times 3 or 7 may also be used) of agreement or disagreement. Likert scales are developed by utilizing the item analysis approach wherein a particular item is evaluated on the basis of how well it discriminates between

those people whose total score is high and those whose score is low. Those items or statements that best meet this sort of discrimination test are included in the final instrument (Kothari, 2014).

Determination of Service Acceptability by Indexing

The composite index approach is a simple and straightforward format that is widely used in planning and evaluation studies such as the human-development index and the rating index (Sullivan, 2002; Sullivan et al. 2003). An indexing methodology was employed to determine the acceptability of the service attributes to the passengers, which is presented in the next section.

Research Design

Individual opinion survey was undertaken through a structured questionnaire. A 37 km long Gazipur to Gabtoli route of articulated bus service was selected for the research (BRTC, 2014). A questionnaire focusing on service quality and passenger's attitude was developed in simplified form for better understanding by the respondents. A total of 125 samples were considered for the study, 85 respondents were the users of articulated buses and the rest 40 respondents were the users of single decker buses. Most of the operational data needed for this study were collected from BRTC sources (from the Gazipur bus depots and the head office) and other secondary sources. All data pertaining to the analysis of this study were based on the 2015 records. Secondary data have been collected from secondary data sources (Article, BRTA, City Corporation, Report, Newspaper etc.).

Microsoft Excel is employed for data analyses. The technique of indexing was applied to evaluate the acceptability of service attributes of the articulated bus and single decker bus modes of Gazipur to Gabtoli route of Dhaka city. The satisfaction level of the respondents with eight service attributes related to service performance were measured using Likert scale. The measured service attributes are the following:

- Fare of the buses
- Travel time
- Waiting time for bus services
- Crowding
- Riding comfort
- Cleanliness
- Safety
- Crew behavior

From these data, the average acceptability ratings, both for articulated bus and single decker bus have been calculated by using the formula (Bhandary, 2007):

Average Acceptability index, $\mathbf{A_i} = \sum_{i=0}^{n} \frac{wifi}{N}$

$\mathbf{A_i}$ = Index of acceptability (For a service attribute)

$\mathbf{F_i}$ = Frequency of respondents giving the rating from lowest to highest

$\mathbf{W_i}$ = Weight of the rating

N = Total number of respondents.

The average acceptability index represents the perception of the passengers/users about service performance of the articulated bus as well as single decker bus.

Selection of Performance Indicator

Transit performance can be evaluated by selected quantitative indicators. The performance concept embraces mainly the following three groups of measures, namely efficiency, effectiveness and social impact. Because of non-availability and difficulty in obtaining the required information, in this study performance evaluation was carried out considering efficiency and effectiveness measures of BRTC services.

Performance of the Articulated Bus Service in Dhaka

The operational performance of the articulated bus service has been assessed in terms of resource efficiency, resource effectiveness and service effectiveness.

Resource Efficiency

As presented in Table 4, the survey findings revealed that each bus employed 2.8 drivers, 0.25 cleaners and 1.8 technicians for its operation. Further, each vehicle is capable of making two round trips each day travelling 148 km in total containing 6 km of dead mileage. Accordingly, each bus travels 2.12 km by per liter of fuel. Further, operating expenses per bus per km is calculated as Taka 6.75.

Table 4: Measuring resource efficiency

Factor	Indicator	Efficiency measure
Labor Efficiency	Employee per bus	Driver-2.8
		Cleaner-0.25
		Technician-1.8
Vehicle utilization efficiency	Vehicle km per bus per day	• 2 Round Trips per day (37× 4) = 148 km) • Dead milase-6 km
Fuel Efficiency	Vehicle km per liter (KpL)[1]	• 2.12
Operating and maintenance Efficiency	Operating expenses per bus per km (Tire and other equipments)	• Taka 6.75

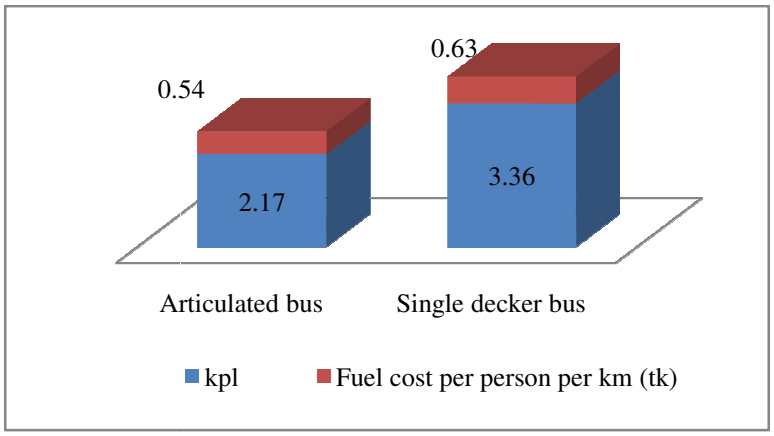
Source: Gazipur BRTC Bus Depot, 2015

Resource Effectiveness

Resource effectiveness depends on service consumption and total expenses for a trip. For a round trip from Gazipur to Gabtoli bus stoppage, it runs 74 km. From Gazipur bus depot, the starting bus stoppage Gazipur chaurasta is 3 km far and therefore, everyday 6 km is counted as dead mileage. Articulated bus consumed 45442 Liter of diesel to run

[1] Kilometer per liter (KpL) is a measurement unit of fuel consumption or fuel economy. The unit measures how much distance in kilometers a vehicle can travel on one liter of fuel.

96793 km in November, 2015. The distance between the study routes (Gazipur to Gabtoli) is 37 km. where each articulated bus needed on an average 17 Liter of diesel to make a trip. After discussion with the drivers and crew it was found that with 58 comfortable seats, an articulated bus often carried average 100 passengers per trip. On the contrary, the single decker bus named Boshumoti needed average 11 Liter of diesel to make a trip in the same area. With 32 seating arrangement, this bus often carried average 50 passengers per trip. After calculating the fuel cost per passenger per km of single decker bus and articulated bus, as presented in Figure 3, it is found that articulated bus is more cost effective (0.54 tk.) than the single decker bus (0.63 tk).



[1 Liter Diesel = 68 TK, Bangladesh Petroleum Corporation, 2015]

Source: Field survey, 2015

Figure 3: Comparative fuel effectiveness of an articulated bus with single decker bus

Above figure shows that single decker bus consumes less fuel to run more distance. But the overall fuel cost per person per kilometer is less for the high capacity articulated bus.

Service Effectiveness

Passenger's attitude survey was carried out to evaluate the service performance of bus services. The section below presents the findings about eight service attributes, such as fare of the bus, travel time, waiting time, crowding, riding comfort, cleanliness, safety and crew behavior, which were considered to examine their acceptability to the passengers. Table 5 presents the average acceptability index of single decker and articulated bus services based on the findings of the respondents.

Opinion on Fare, Travel Time and Waiting Time of Buses

Travel cost is very important factor for choosing the bus service. If the fare is offered at reasonable rate for travelling on long distance, passengers would like to ride on those buses. Articulate buses have great benefit for travelling long distance with relatively low fare. About 75 percent of the total respondents are satisfied about the fare. The higher value (3.42) of the average acceptability index of the articulated bus service than the single decker bus (2.875) as presented in Table 5 represents that in terms of fare of the bus, the articulated bus service was more accepted.

Travel time is usually considered as the specified period of time spent in traveling through the vehicle. Due to the presence of 36 stoppages from Gazipur to Gabtoli, maximum passengers were dissatisfied about the travel time for long distance travelling through the articulated buses. The long distance passengers preferred single decker buses to reach their destination to save their travel time. Waiting time for buses is a very important subject for choosing a bus service. Since almost 80 single decker buses are operated in the study route, a passenger could get into any of the single decker buses within five to ten minutes of waiting time. However, the waiting time for articulated bus was so high that sometimes it might took more than one hour to get into a bus. The very low number of articulated buses operating in this route made the frequency of the bus low leading to long waiting time.

Opinion on Crowding and Riding Comfort of Buses

Crowding on buses depends on the number of passengers and the available space for the passengers inside the seats. In terms of internal environment and crowding of the bus, more than half of the passengers were satisfied about the articulated buses. Therefore, the crowding environment of articulated bus is more acceptable than single decker bus.

Due to having much space and comfortable seating arrangement, well ventilation, sufficient knee/leg room and easy access through doors most of the passengers of articulated bus were satisfied. From the survey, it was found that the acceptability index of articulated bus in terms of riding comfort was much higher (4.02) than that of the single decker bus (2.63). The front-to front distance between two seats for articulated bus was 34 inch which is much lower for the counterpart, for example only 22 inch for a single decker bus (Boshumoti) serving in the same route. Besides, the width of door for articulated bus was 34 inch where it was 24 inch for single decker bus. The side-to-side distance between two seats was only 14 inch for single decker bus which made the passengers to feel cramped in rush hour. However, for articulated bus, two passengers could stand along comfortably. Sufficient number of safe fans and four manually operated roof hatches were found in the articulated bus which facilitated ventilation.

Opinion on Cleanliness, Safety and Crew Behavior

More than 75 percent of the total passengers were satisfied about the cleanliness of the articulated bus services. Further, due to having interior space, maximum people felt comparatively safer in this bus than the single decker bus. The articulated bus services are operated by the skilled and well trained drivers, which enhanced the safety feelings. The bus was also furnished with firefighting instruments in driver area and passenger area with one emergency window in right hand tractor part and one manual door at right hand side in trailer part.

In Bangladesh, it is assumed that the behavior of any bus crew is the worst. But most of the respondents agreed about the better behavior of the crew of the articulated buses.

Acceptability Index of Articulated and Single Decker Bus Service

Based on the opinion of the respondents about eight service attributes, an acceptability index of articulated bus and single decker bus is measured and presented in Table 5. From the table, it is observed that the articulated bus service has higher acceptability index of 3.199 indicating higher acceptance by the respondents than the single decker bus service having an acceptability index of 2.81.

Table 5: Measuring Acceptability Index of articulated and single decker bus service

No.	Indicator	Types of Mode		Very dissatisfied (1)	Dissatisfied (2)	Moderately Satisfied (3)	Satisfied (4)	Very Satisfied (5)	Average Acceptability index, **A** $\sum_{i=0}^{n} \frac{wifi}{N}$
1	Fare of buses	Articulated Bus	in No.	0	6	43	31	5	3.42
			in %	0%	7%	51%	36%	6%	
		Single decker bus	in No.	0	9	27	4	0	2.875
			in %	0%	22.5%	67.5%	10%	0%	
2	Travel time by buses	Articulated Bus	in No.	26	26	19	12	02	2.27
			in %	31%	31%	22%	14%	2%	
		Single Decker	in No.	4	9	21	6	0	2.725
			in %	10%	22.5%	52.5%	15%	0%	
3	Waiting time for buses	Articulated Bus	in No.	32	31	17	5	0	1.94
			in %	38	36	20	6	0	
		Single Decker	in No.	4	7	16	9	4	3.0
			in %	10%	17.5%	40%	22.5%	10%	
4	Crowding of buses	Articulated Bus	in No.	05	13	41	23	05	3.07
			in %	6%	15%	48%	27%	6%	
		Single Decker	in No.	09	16	08	07	0	2.325
			in %	22.5%	40%	20%	17.5%	0%	
5	Riding comfort of buses	Articulated Bus	in No.	0	4	15	41	25	4.02
			in %	0%	5%	18%	48%	29%	
		Single Decker	in No.	03	19	09	08	01	2.625
			in %	7.5%	47.5%	22.5%	20%	2.5%	
6	cleanliness of buses	Articulated Bus	in No.	0	4	29	43	9	3.61
			in %	0%	5%	34%	50%	11%	
		Single Decker	in No.	2	4	22	12	0	3.1
			in %	5%	10%	55%	30%	0%	
7	Safety of buses	Articulated Bus	in No.	0	7	24	37	17	3.75
			in %	0%	7%	29%	44%	20%	
		Single Decker	in No.	0	13	22	5	0	2.8
			in %	0%	32.5%	55%	12.5%	0%	
8	Crew behavior of buses	Articulated Bus	in No.	0	2	34	46	3	3.59
			in %	0%	2%	40%	54%	4%	
		Single Decker	in No.	2	7	18	11	2	3.1
			in %	5%	17.5	45%	27.5	5%	

Source: Authors, 2015

Total Acceptability index

Total Acceptability index for articulated bus $= A_1 + A_2 + A_3 + A_4 + A_5 + A_6 + A_7 + A_8$

$= 3.42 + 2.24 + 3.07 + 4.02 + 3.59 + 3.61 + 3.729 + 1.91$

$= 25.589$

Average Acceptability index for articulated bus $= \frac{25.589}{8} = 3.199$

Total Acceptability index for single decker bus $= S_1 + S_2 + S_3 + S_4 + S_5 + S_6 + S_7 + S_8$

$= 2.875 + 2.5 + 2.325 + 2.73 + 3.1 + 3.1 + 2.8 + 3.04$

$= 22.47$

Average Acceptability index for single decker bus $= \frac{22.47}{8} = 2.81$

Problems of the Articulated Bus Service

Although the articulated bus service shows higher acceptability index implying more acceptance by the respondents and has its advantage over all other transport modes of Dhaka, plethora of problems is identified which hinder the efficient operation of this bus service.

Problems Related to Infrastructure

Insufficient Numbers of Articulated Buses: Only 25 articulated buses are operating in Gazipur to Gabtoli route. So the frequencies of these buses are very low. It is a quite common scene that there is not found these buses after waiting more than one hour.

Insufficient Road Width and Turning Difficulties of the Buses: As proposed in STP, 2004 the space requirement for implementation of BRT is presented as minimum road width is required for BRT (articulated bus) station with overtaking road is 37 meter, followed by BRT station without overtaking road is 28 meter and BRT runway 1 lane per direction is 25 meter. But, space along the entire route is not sufficient and it is highly difficult to expand or acquire land for the expansion of the road space in the proposed road segment. With containing large capacity of passengers, articulated bus is 16 m (52.6 ft), while regular buses are 11 to 14 m (35-45 ft). To make them speedy enough to safely navigate streets at their increased length, they are fitted with an extra axle (set of wheels) and a joint usually located slightly behind the midpoint of the bus, behind the second axle. It hampered on the rubber bellows on joint point. Rubber bellows is so expensive (about 36 lakhs in Taka) to repair it.

Mixed Modes on the Roads and Illegal Encroachment of the Roads: Gazipur to Gabtoli route network is characterized by mix traffic system. All types of vehicles, both motorized and non-motorized vehicles are in operation on each and every road, except NMT restricted airport road. From this chaotic situation, it is highly difficult to separate lane for articulate bus only. Most of the roads are not fully used by traffic. Presence of dustbin, on-street parking, hawkers and retail traders on roads as well as construction materials for building are placed on roads reduce road spaces and hinder smooth flow of traffic.

Problems Related to Management

***Lack of Route Information and Ticketing System*:** Passenger information, in terms of route maps, schedules, or service time coverage, is virtually non-existent. Furthermore, most buses are not identified by route number. There is no ticketing system and it is a common scene of bargaining with a hot temperament for a fare between passengers and crew. Besides, sometimes the crews cannot manage to bill the fare efficiently which lead to loss of actual revenue.

Lack of Specific Bus Stoppage: Though there are 38 bus stoppages but they are not in fixed point lacking passenger shed. For this reason, women, old age people and physically challenged passengers are affected most during riding and landing.

Lack of Staff: There are insufficient numbers of drivers, crews, cleaners and technical persons working for the effective operation of the bus service. Besides, most of the crews are appointed on temporary basis.

Lack of Passengers' Cooperation: Passengers and crews both are not willing to follow the instruction of the buses. In peak hour when the bus is full of passengers, they stand on the middle point avoiding the instruction. It effects on rubber bellows in turning moment.

Recommendations to Improve Articulated Bus Service

To cope with the existing demand and to get relief from the deficiencies as mentioned above, integrated and holistic measures should be taken encompassing different sectors related to Dhaka transport system.

Recommendations for Infrastructural Improvement

Redesigning and Reconstruction of Intersection: In order to facilitate smooth turning, the existing intersections should be redesigned and reconstructed to support the operation of buses. As rapid transit transportation system, articulated bus should be given priorities at intersections.

Reclaiming Road Space and Widening of Road: Proper and satisfactory use of the road spaces should be ensured by reclaiming road space which are currently encroached by uses other than traffic. Widening of road is essential especially at some segments of road and bus stoppage locations.

Increasing Passengers' Sheds: Modern bus stops should be designed with pre-board ticketing and comfortable waiting facilities. Passengers' shed should be built with seating arrangements and display boards showing the information about bus routes, fare and service hours.

Recommendations for Enhancing Service and Operational Performance

Making Suitable for Women, Children and Physically Challenged Person: Only 9 seats from 58 are reserved for women, children and physically challenged passengers. As this bus services offer more spacious, comfortable and safe arrangements, the reserved seats for women and physically challenged persons should be increased. Besides, to facilitate the comfortable riding for physically challenged persons, ramp should be provided.

Increasing the Number of Buses to Reduce Waiting Time: The number of articulated bus should be increased as it has great advantage over all other transport modes in respect of using the limited urban road space. It has a great potential to resolve the urban traffic problems.

Conducting Regular Supervision of Buses: Regular fitness and maintenance checking should be ensured by the efficient staff to offer improved services. BRTC should initiate performance evaluation process for providing better service to the passengers and for solving the transport problems of Dhaka.

Concluding Remarks

Inadequate road infrastructure, lack of traffic policy and management practices, absence of a dependable public transport system along with somewhat uncontrolled manner of land use development have resulted a chaotic traffic situation in Dhaka. The existing bus system could not solve the transport problems of Dhaka city because now a day's bus itself creates jam in different routes. Indeed, augmentation of improved and modern mass transit system, like articulated bus is an urgent requirement to ensure mobility, which is safe and efficient. Comfortable movement is a necessity to enhance livable urban environment for Dhaka city in future. Articulated bus has great potentials to solve the existing problems of Dhaka, but it cannot be directly implemented in Dhaka. The widening of road, improvement of intersections, road side hazard management, provision of more buses for all groups of people and enough passenger sheds are essential to improve the transport condition of Dhaka. Land-use reforms should be encouraged by placing higher densities close to the articulated bus stations. The use of GPS or other locator technologies with a central control area should be introduced to manage bus location for its journey time and facilitate rapid reaction to problems.

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