

A Study on Travel Time Characteristics of Bus System in Dhaka: Analyzing Drivers' Intentional Waiting Time for Passenger Collection

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With the growing population of the megacity, Dhaka is facing severe deficiency in transportation sector. For its cheap fare, the main mode of transport for the poor is bus. Also it is the only option available as public transport. But the level of service of bus is not satisfactory. In addition to the insufficient public transportation system, Dhaka also lacks in infrastructure. On top of that car ownership is increasing pretty rapidly piling up the traffic congestion. These sum up to a longer travel time; a significant portion of which is spent halting either for congestion or for collecting passengers. This study focuses on the stopping time and the moving time of a bus trip. The discrepancy between demand and supply of public transport is quite severe in Dhaka. During the peak period, buses get full and over-crowded at earlier stoppages as the demand is higher than supply. In such cases, drivers skip the later bus stops where people need to wait longer for bus. But the scene is completely reversed at off-peak period when demand is less than supply. In such periods, drivers tend to wait longer at the earlier bus stops in the hope of collecting sufficient passengers. This study tries to understand and verify the situation. It also looks into user perception on the quality of bus service in Dhaka.

Key Words : *Public Transport, Travel time, Intentional waiting time, Satisfaction, Dhaka*

1. INTRODUCTION

Dhaka, the capital of Bangladesh is ranked top as built-up urban areas by urban population density with a density of 44,100 per sq. km. (Demographia 2016). Being a third world developing country it lacks sufficient infrastructure to serve the transportation need of such huge population. In order to ensure a sustainable transportation system, the role of public transport

cannot be overlooked as it can ensure higher passenger-km with relatively cheaper price by proper planning and management. Regrettably, road based transportation system of Dhaka only provides low quality bus service as public transport and till date no other mass transit like BRT or metro is available in Dhaka. In spite of that 44% of all household trips is made by bus (STP 2005).

As only 5% of the buses are government owned, the dominating private sector acts like a syndicate

providing monopolistic service (Rahman, 2011). The bus services in Dhaka is considered unsatisfactory due to lack of proper planning, management and maintenance, (Olsson and Thynell 2004). Most of the users are captive user and highly dissatisfied with the service, especially with longer travel time as bus is found to be stopped for a significant time either intentionally for passenger collection or for congestion. This encourages user to shift to other modes like private car, motorbike or taxi whenever affordable.

Studies related to bus in Dhaka city mainly concerns with intersection delay at signal. Whereas, this study takes into account the intentional delay at bus stop along with the intersection delay.

This paper provides the background and motivation of the study at the beginning followed by methodology and data collection. Showing the ongoing analysis the paper concludes with the expected result.

2. BACKGROUND AND MOTIVATION

To ensure sustainable movement, a city must have sufficient infrastructures and transportation facilities. Nevertheless Dhaka Metropolitan City, in spite of being the most densely populated megacity with annual population growth of about 8%, has only 9% of total space occupied by roads and streets and only 6% for pavement area (RMMS, 2004). Moreover, being the capital of a developing country, large number of Dhaka residents are poor (The World Bank). As a

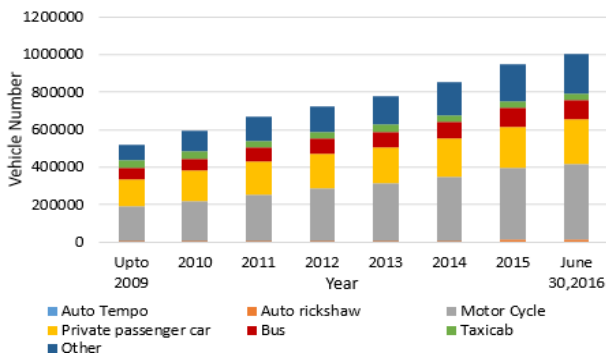


Fig.1 Motorized vehicle growth of Dhaka (Source: BRTA)



Fig. 2 Peak hour congestion (left) and off-peak hour passenger collection (right)

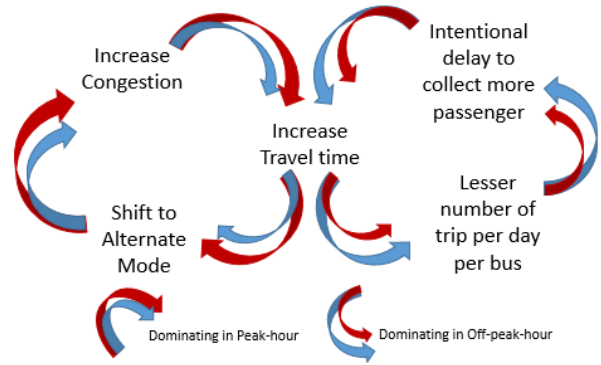


Fig.3 Assumed travel time cycle

result 84% of households do not have any sort of transport vehicles and depend on public transport. (STP 2005).

Bus, having the cheapest transport cost per km, comprises only a small proportion of vehicle numbers (11½%) but carry about 77% of people (STP 2005). In spite of high demand, the monopolistic private sector is not increasing the investment to expand bus fleet in Dhaka for the probability of unprofitable business (Hoque et al., 2004). Fig. 1 shows the trend in motorization in Dhaka. Also, the quality of transport is fairly poor and not appreciated by the travelers (DSM Consultants, 2000). 22% of users reported to travel over 2 times of the travel distance while using public transport instead of a car. In other words high travel time have a highly negative impact.

While travelling the waiting time can broadly be classified into two category; one is the time in congestion or signal queue and the other is the time spent intentionally at bus stop to collect more passenger even after regular boarding/alighting is over. Which portion of the waiting time dominates might depend on the location of bus stop, time of the day and passenger on board.

At peak period congestion dominates while at off-peak period the intentional waiting time may lead to a higher overall travel time (Fig.2). This study focuses on these two different types of waiting time with the hypothesis that they contribute to longer travel time (Fig. 3). For example, driver’s intentionally waiting at the bus stop increase travel time, especially at off-peak period which in turn results in fewer trips per day per bus. So drivers tend to compensate the loss by waiting for extra passengers which again increase the travel time. Again at peak period congestion might be the dominating element for waiting time. The aim is to find some solutions to reduce the travel time by minimizing waiting time preferably intentional waiting time.

3. OVERVIEW OF DHAKA CITY

The World Bank report stated “Dhaka is a city stretched to its limit.” As showed in Fig. 4, the city center is located at South end and the city continued to grow to the North.

In Dhaka city, there are 149 bus routes (JICA Report- Phase II, 2011). Then again most of them are expanded eccentrically in the north-south direction (Mahmud et al., 2008). Moreover, among the buses running along the route almost 95% are privately owned. Although ownership of the remaining 5% is to the government organization named Bangladesh Road Transport Corporation (BRTC), their operation is sub-contracted out to the private sectors.

For study purpose, one route of 13.4 km (Route no: 19/E), shown in Fig. 4, connecting the Northern residential zone with the CBD and educational hub at South is selected. Selection was done after a thorough review of OD maps and desire maps of DHUTS. In this paper the North to South bound trips are referred as (R-1) while South to North bound trips are referred as (R-2).

4. RESEARCH METHODS AND DATA COLLECTION

Comprehensive field survey of bus user and non-user was carried out for investigating the perspective of people in general. Also, interviews were conducted with the bus drivers and the bus company of selected route to understand the driver behavior and

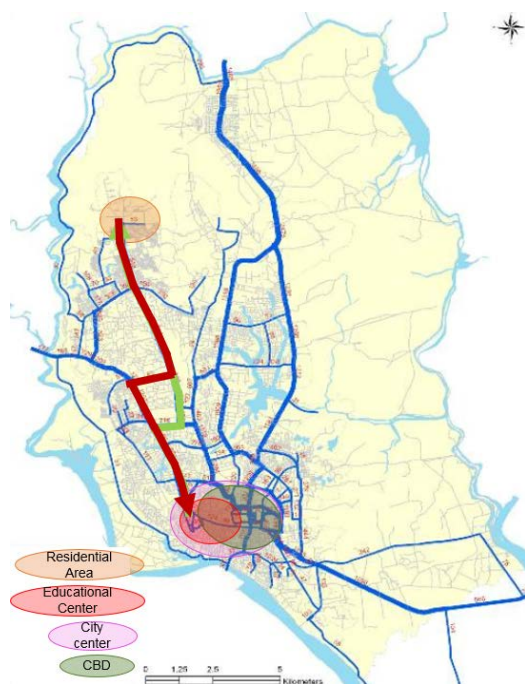


Fig.4 Dhaka Bus Route Network (Source: DTCB 2009)

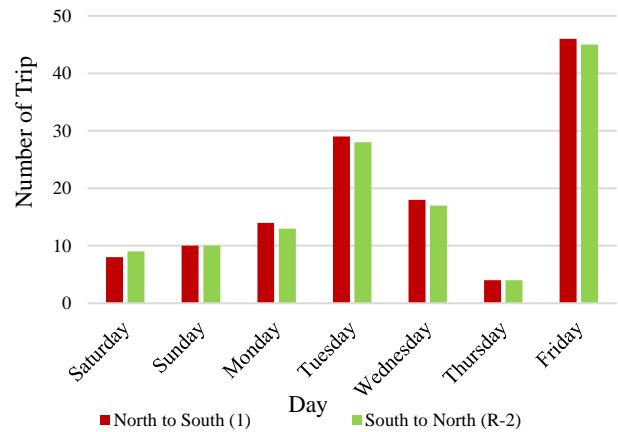


Fig.5 Number of GPS data collected.

management policy. Bus users of the selected route were sampled randomly as respondents in March 2016. They were asked personally by the surveyors while riding the bus. The questionnaire items were composed of four basic components: (i) general information such as gender, age, occupation, income, vehicle ownership, trip purpose and frequency, (ii) detailed information on the travel preference and satisfaction with bus service relating to the factors like travel time, waiting time, cost, reliability, comfort, safety and availability of bus and availability of seat in the bus, (iii) the third part of the questionnaire inquired about user and driver behaviors such as unauthorized boarding and alighting from the bus, the tendency of the drivers to stop at unauthorized locations and view on the waiting time and (iv) stated preference scenarios like willingness to pay in hypothetical scenarios and behavior in such scenarios. The prime purpose was to identify whether the user were satisfied with travel time. A poor satisfaction level justifies further research on improvement of travel time.

Once the user verifies the initial assumption of poor travel time of bus, travel time data along the route was collected using GPS for both peak period, off-peak period and weekdays and weekends (Fig.5) to carry out further analysis. This GPS data was processed to calculate distance, moving time, congestion time and intentionally waiting time both at authorized bus stops and intermediate unauthorized locations. To support the data, video clips of random trips were recorded from inside of the bus.

5. DATA ANALYSIS

After sorting, the questionnaire data were analyzed by percentage. As shown in Table 1, the majority of respondents (n=70) are male (67%). Furthermore,

Table 1 General Characteristics of Respondents.

Characteristics	Statistics
Gender	Male (67%) , Female (33%)
Age	18-30 years (73%), 31-50 years (24%), >50 years (3%)
Occupation	Student (47%), Service (37%), Business (4%), Housewife (10%), Other (2%)
Income (BDT*/month) (*1 BDT = 1.32 JPY)	< 15,000 BDT/month (58%), 15,000-50,000 BDT/month (40%), >50,000 BDT/month (2%)
Vehicle ownership	None (90%), Car (2%), Motorcycle (4%), Bicycle (4%)
Trip purpose	Education (48%), Work (30%), Business (6%), Shopping (6%), Recreational (4%), Other (6%)
Trip frequency	Everyday (78%), Once a week (4%), Once a month (3%), Occasionally (15%)

educational purpose by students.

For the purpose of analysis, the raw data of GPS were transferred in a common .cvg file by developing a program using programming software, PERL. After that further scrutiny was made.

In order to determine the distance between GPS points Haversine formula (1) was adopted.

$$d = 2R \arcsin \sqrt{\sin^2 \left(\frac{Lat_2 - Lat_1}{2} \right) + \cos Lat_1 \cos Lat_2 \sin^2 \left(\frac{Lon_2 - Lon_1}{2} \right)} \quad (1)$$

For simplification purpose, vehicle is considered to be stopped when the instantaneous speed is less than 5 km per hour. Intentional waiting include waiting time for regular passenger boarding and alighting along with extra time waiting to collect more passenger at or apart from designated bus stops. While congestion include waiting time at signalized intersection as well as traffic congestion along the route.

To look into deeper image, the entire route was divided into 13 segments based on 3 characteristics like i) presence of bus stop, ii) presence of both bus stop and signal and iii) absence of bus stop and signal (Fig.6).

6. RESULTS

The results of this study are presented under two sub-headings: user perception and travel time.

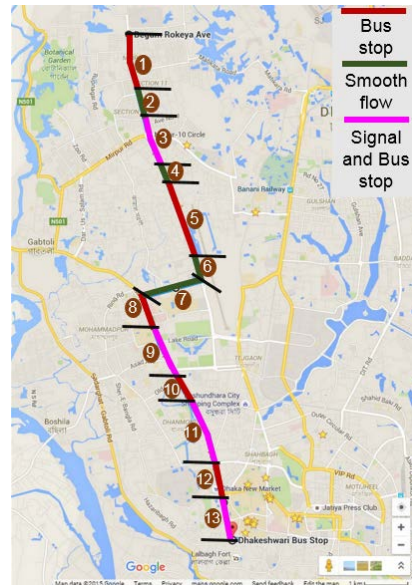


Fig.6 Segmentation of North to South route (R-1)

(1) User Perception

This section discusses the result of the questionnaire survey and points out the user rating on the key characteristics of the bus service (Fig.7). People seems to be satisfied with the cost and availability of bus. And comfort are point of main concern as more than 70% people reported to be dissatisfied with them.

The perception on present service quality is plotted in Fig.8. More than 80% of the users reported of boarding and alighting the bus at unapproved/unauthorized bus stops. Bus is reported to skip bus stops

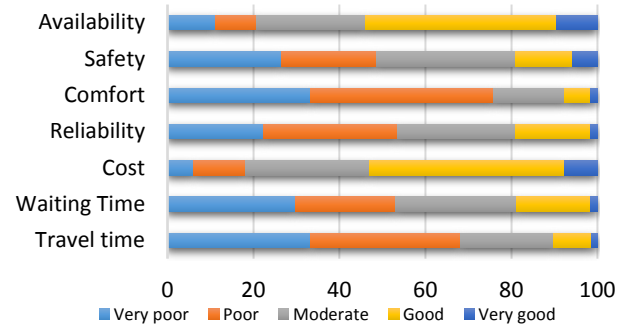


Fig.7 Respondents' rating on key characteristic

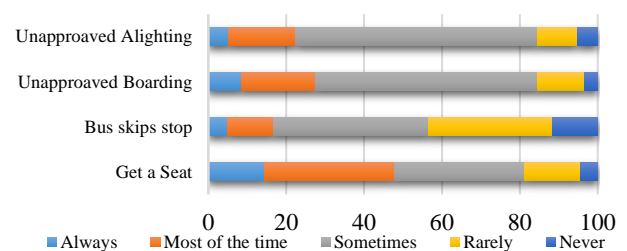


Fig.8 Respondents' perception on bus service

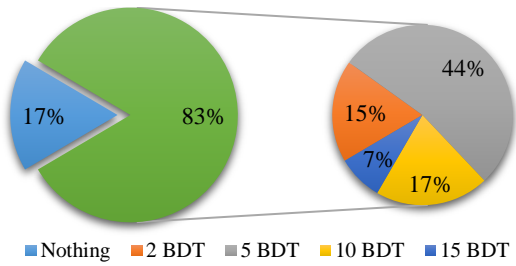


Fig.9 Willingness to pay (WTP)

more than 50% of the time. Only people boarding from earlier stops tend to get a seat whereas 20% of total respondents most of the time fail to do so, even though the service was originally intended to carry no standee.

When asked about the willingness to pay (WTP) under circumstances like buses follow certain frequency or schedule, 83% of them agreed to pay for better service. That gives the motivation to study this field. Although the amount of WTP varies to a great extent from the existing fare of 25 BDT (Fig.9).

(2) Travel time and waiting time

The travel time along with waiting time is analyzed separately for the entire trip and each segment.

a) Entire trip

In Weekdays, for trips toward CBD in R-1, it requires less time between 2 p.m. and 4p.m. (Fig.10). During that time the Stopping time is significantly low. Then again, trips generated for R-2 gets the peak between 11 a.m. to 2 p.m. (Fig.11). Also overall travel time in this direction is relatively low.

Weekend trip pattern is little different than that of weekdays. Unlike weekdays, no significant peak is observed at 8 a.m. towards the CBD; rather the peak is shifted at around 12 p.m. (Fig.12). Also travel time reduces as a result of low stopping time. R-2 trip from CBD reaches the peak at around 6 p.m. when people are returning to their residences (Fig.13).

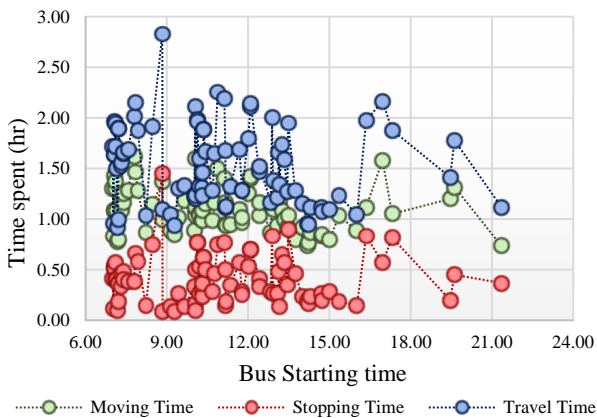


Fig.10 Entire trip from North to South (R-1) in Weekdays

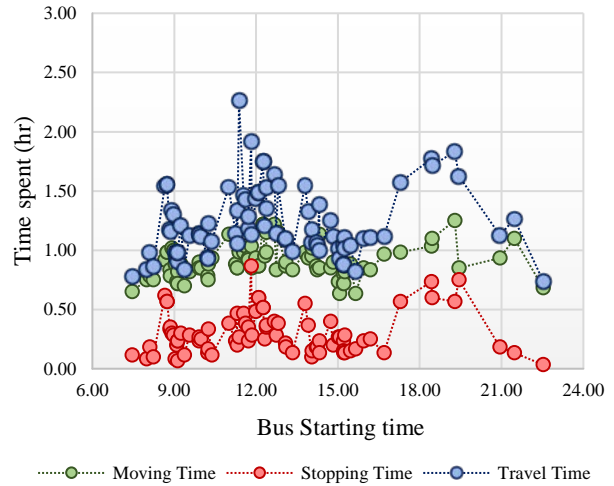


Fig.11 Entire trip from South to North (R-2) in Weekdays

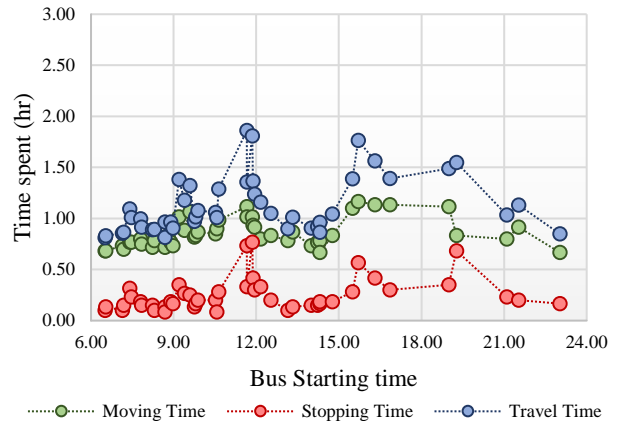


Fig.12 Entire trip from North to South(R-1) in Weekends

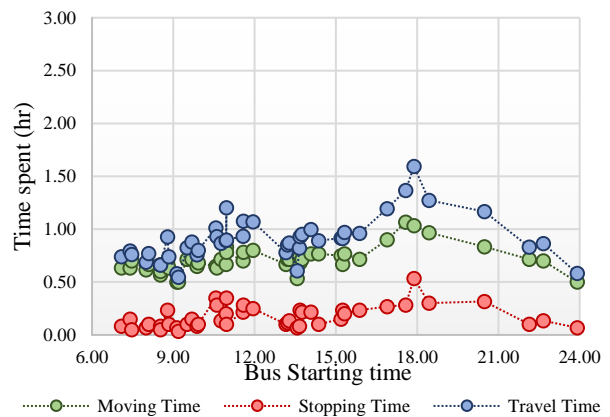


Fig.13 Entire trip from South to North (R-2) in Weekends

b) Segmental detail of R-1

Looking into the South bound trip components, it is clear that intentional waiting time governs till first 5 km; whereas congestion dominates the travel time from 9 km in weekdays (Fig.14). Similar pattern can

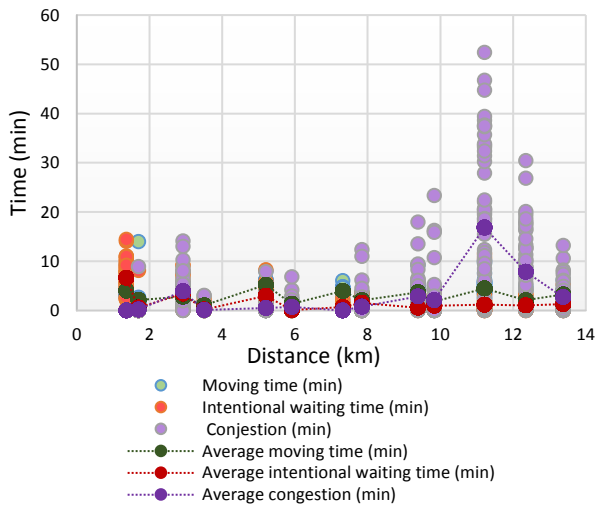


Fig.14 Segmental analysis: North to South (R-1) in Weekdays

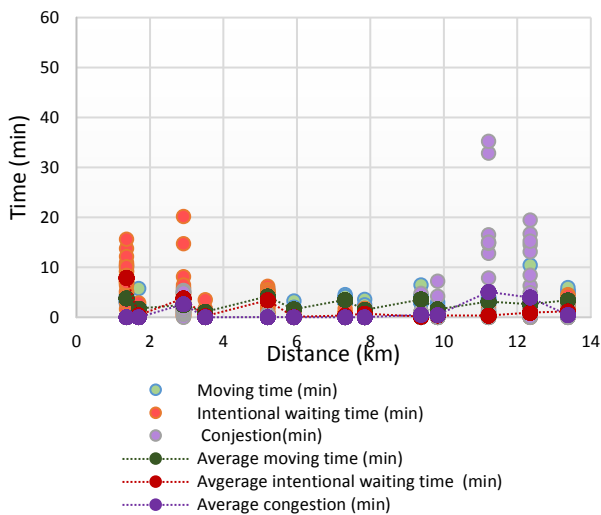


Fig.15 Segmental analysis: North to South (R-1) in Weekends

be observed in weekends (Fig.15) also. At the earlier bus stops the drivers waits for a longer time to collect sufficient passengers.

A detail study on understanding the trend as well as analysis for the other direction is ongoing.

7. CONCLUSIONS

Based on the travel time survey, travel time fluctuates significantly within the same day as well as between weekdays and weekends. It may exceed twice the free flow time in peak hour. Also for the waiting time, intentional waiting time governs the first half of the trip whereas congestion dominates the second half.

This results a great dissatisfaction among the users

toward bus travel. As most of them are captive user, they continue to use bus for its cheap travel cost and availability. It can be assumed that the might shift to other alternative if affordable unless the present condition is not improved. That being said, it is clear that improvement of the service quality, especially the travel time, should be given high priority.

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