EVALUATION OF BUSES AND CARS AS TRANSPORTATION MODE TO WORKPLACE

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ABSTRACT

This paper tries to evaluate environmental, economic and space analysis of bus and car as the main two modes of transportation to workplace. Dhaka is facing many transport problems due to unplanned urbanization. The amount of private car has resulted in greater traffic volume than supply of transport facility. Transportation to workplace is a biggest contributor to traffic volume. As a result, traffic jam occurs during workdays. Motijheel is a main work area of Dhaka and has branch of every banks of Bangladesh. The private banks rely on car while public banks use both cars and bus for transporting employees. A better transport system can reduce transport related problems of Dhaka. To plan a better transport system, it is necessary to learn the transport usage pattern of different institution. This paper conducted study on two public and five private banks in Motijheel. Data was collected by doing discussion and conducting survey in the banks. The data included number of employees, transport modes used, transport cost etc. It evaluated the transport usage pattern of those institutions. It evaluated the environmental impact by calculating noise pollution, air pollution of two type of vehicles. It also evaluated the initial investment and cost of cars and buses. Analysis showed that cars causes more pollution, takes more initial and operating cost and takes more space in road than bus. But cars offer better comfort for executing level employees, and offer better mobility.

Keywords: *Workplace transportation, Bus/ Car as mode of transport, environment pollution, transport cost and space, transport facility of banks.*

1. INTRODUCTION

Over the past years, transportation problem in Dhaka City is increasing at an alarming rate. Problems like traffic jam, pollution is causing damage to environment, and cost to its citizens. Dependency on private car is one of the major reasons behind transport related problems in Dhaka city. The volume of private cars is already passed the capacity of roads. A main contributor to this traffic volume is the traffic to and from workplace. That's why in workdays, traffic jam problem gets more severe. Transport problems of Dhaka can be reduced significantly if traffic system and transportation mode to workplace is controlled. To regulate and plan proper transport system for workplace, it's necessary to know the number of worker in an area, their transport usage pattern. If the transport usage pattern, need of users, the value added by different transport mode, their impact on environment and roads can be determined, their significance to the overall workplace system, it'll be possible to plan better transport system.

The study area of this research is Motijheel. It is the commercial hub of Dhaka city. Many financial and other institutes have their branches in this area. Large amount of people comes in this area for work, and later leaves. Large number and different types of transport modes carries these workers. This traffic volume creates severe traffic jam in Motijheel area. This problem occurs during starting and ending hour of offices. Problems like unplanned parking, private car dependency worsens the overall situation. Among the commercial institutes of Motijheel, banks take a remarkable place as almost all the banks of Bangladesh (total 66 banks including public and private) have at least one branch in Motijheel. So the transport system of these banks play a vital role in the traffic congestion of this area. Thus banks were targeted to conduct survey and have an idea about the mode of transportation used by their employees.

In many cases, these institutions provide transport facilities to worker and executives. There are no proper guidelines for the institutions to plan their transport mode. Usually, public banks provide both buses and cars to workers. But private banks depend solely on car. A portion of workers use public bus service, but they stop using them when they're financially capable. Workers also use other transport modes like motorbike, bicycles, Legunas, but their use is limited. As there are two main modes of transport provided by the banks, evaluation of

this two modes can help to have a clear idea and to make a decision about which mode is more convenient. Measuring the impacts of these modes will help to plan better transport system that'll fulfil the users demand, causes less damage to environment, and helps mitigate traffic congestion problem.

Seven banks were chosen randomly for collecting data by surveying. Among them two are public (Agrani Bank, Sonali Bank) and five are private (United Commercial Bank Limited (UCBL), Hong Kong and Shanghai Banking Corporation (HSBC), Shahjalal Islami Bank, South Bangla Agricultural and Commerce Bank (SBAC), Dutch Bangla Bank Limited (DBBL).

The objective of this paper is to provide a clear picture of the evaluation of buses and cars as mode of transportation. From survey it has been found that public banks provide bus along with cars for executive level employees so that other employees can move easily. But there is no bus service for private banks. Bus can be a solution to mitigate traffic congestion problem, but busses comes with many limitations. So analysis of both private car and public bus is done to recommend an efficient transport system which balances benefits of different modes. There are also other factors that contributes to the transport problems. The factors include traffic movement direction, lack of parking management, inefficient use of road space. This study focuses on the evaluation of two main transport mode. The impact of those two modes are analysed and recommendations have been provided to plan a better transport system. This paper will further help to take decision for newly developed bank's transportation mode.

2. METHODOLOGY

To understand the nature of transportation people, use to travel to and from workplace, discussion was done with different bank authorities. There are mainly government and private banks and other financial institutions in Motijheel and Dilkusha commercial area. The pattern of transport mode of government and private banks are different. Questionnaire survey and discussion was done with both public and private banks to understand how their workers and executives comes and leaves workplace, and how the transport mode used by them contributes to total traffic volume. Evaluation was done to figure out the efficiency of cars and buses. This evaluation includes cost assessment where the initial and maintenance cost is shown for cars and buses, a space assessment that gives an idea about space consumption by buses and cars, an environmental assessment where impact on air and noise by buses and cars are shown.

2.1 Environmental impact

The issue of transportation and the environment is paradoxical in nature since transportation conveys substantial socioeconomic benefits, but at the same time transportation harms environment. From one side, transportation activities support increasing mobility demands for passengers and freight, while on the other, transport activities are associated with growing levels of environmental externality. This has reached a point where transportation is a dominant source of emission of most pollutants and their multiple impacts on environment. These impacts fall within three categories:

2.1.1 Direct impacts.

The immediate consequence of transport activities on the environment where the cause and effect relationship is generally clear and well understood.

2.1.2 Indirect impacts.

The secondary (or tertiary) effects of transport activities on environmental systems. They are often of higher consequence than direct impacts, but the involved relationships are often misunderstood and difficult to establish.

2.1.3 Cumulative impacts.

The additive, multiplicative or synergetic consequences of transport activities. They take into account of the varied effects of direct and indirect impacts on an ecosystem, which are often unpredicted. Transportation activities support increasing mobility demands for passengers and freight, notably in urban areas. But transport activities have resulted in growing levels of motorization and congestion. As a result, the transportation sector is becoming increasingly linked to environmental problems. The most important impacts of transport on the environment relate to air quality, noise, water quality, soil quality (Rodrigue, 2013).

2.2 Air pollution

2.2.1 Cars

Unleaded gasoline has 8.91 kg and diesel has 10.15 kg of CO_2 per gallon (Independent Statistics & Analysis, 2011). CO_2 emissions originating from ethanol are disregarded by international agreements however so gasoline containing 10% ethanol would only be considered to produce 8.02 kg of CO_2 per gallon (Independent Statistics & Analysis, 2015). The average fuel economy for cars sold in the US 2005 was about 25.2 MPG giving around 0.35 kg of CO_2 per mile (U.S. DEPARTMENT OF TRANSPORTATION , 2014). The Department of Transportation's MOBILE 6.2 model, used by regional governments to model air quality, uses a fleet average (all cars, old and new) of 20.3 mpg giving around 0.44 kg of CO_2 per mile.

2.2.2 Buses

On average, inner city commuting buses emit 0.3 kg of CO_2 per passenger mile (0.18 kg/km per passenger), and long distance (>20 mi, >32 km) bus trips emit 0.08 kg of CO_2 per passenger mile (0.05 kg/km per passenger) (World Resource Institute). Road and transportation conditions vary, so some carbon calculations add 10% to the total distance of the trip to account for potential traffic jams, detours, and pit-stops that may arise (Carbonfund, n.d.).

2.3 Noise pollution

Noise represents the general effect of irregular and chaotic sounds. It is traumatizing for the hearing organ and that may affect the quality of life by its unpleasant and disturbing character. Long term exposure to noise levels above 75dB seriously hampers hearing and affects human physical and psychological wellbeing. Transport noise emanating from the movement of transport vehicles and the operations of ports, airports and rail yards affects human health, through an increase in the risk of cardiovascular diseases. Increasing noise levels have a negative impact on the urban environment reflected in falling land values and loss of productive land uses.
The following chart gives the values on the decibel scale associated with various types of vehicles; the measurements were made with the vehicles travelling in urban conditions between 45 and 60 km/h.

Table 1: Noise created by different transportation mode.

Type of Vehicle	Noise in decibels
Gasoline passenger car	62-67
Electric trolley bus	60-70
LRT car	72-75
Medium-sized truck	73-78
Urban diesel bus	80-85
Heavy Truck	80-85

(Adapted from: Transport Action, Transport Canada 2000, October 2001; additional data from BC Transit, 1999 and Calgary Transit)

2.4 Cost analysis:

This study evaluated initial investment and monthly operating cost of bus and car. For calculation, we've assumed one passenger for a car. We've selected the price of car as 19,00,000 BDT. All currency is calculated in BDT and included price reflects the market price during mid-2015 in Bangladesh.

2.5 Space analysis:

Space analysis is done by assuming that all cars take *1695*4565 sq. mm* space in road, and all buses take *3550*11930 sq. mm* space in road.

3. DATA ANALYSIS

Public banks provide transportation facilities for all of their employees where private banks provide it only for their executive level of employees. Public banks provide car from the AGM (Assistant General Manager) to the upper level of employees. For other level of employees, they provide bus services in different routes. But there is no such kind of facilities in private banks.

3.1 Air pollution is evaluated for the survey data below

3.1.1 For private banks

Table 2: Air pollution by cars of private banks

Name of the bank	No. of employees	No. of Car Passenger	Amount of CO_2 emission (kg/mile)	Pollution per employee (total emission/total no. of employee)
Shahjalal Islami Bank	56	7	3.08	0.055
Dutch Bangla Bank Limited	84	11	4.84	0.06
United Commercial Bank Limited	103	7	3.08	0.03
Hong Kong Shanghai Banking Corporation	9	0	0	0
South Bangla Agriculture and Commerce Bank	27	12	5.28	0.196

For each bank, pollution per car passenger is 0.44 kg.

3.1.2 For public banks

Table 3: Air pollution by cars of public banks

Name of the bank	No. of Cars	Amount of CO_2 emission by car (kg/mile)
Agrani bank	41	18.04
Sonali Bank	14	6.16

Table 4: Air pollution by bus of public banks

Name of the bank	No. of buses	No of bus passenger	Amount of CO_2 emission by buses (kg/mile)	Total emission
Agrani bank	27	1534	324	342.04
Sonali Bank	35	1976	420	426.16

For each car passenger, pollution is 0.44 while for each bus passenger, pollution is only 0.21. So, bus creates almost half per passenger air pollution in comparison with cars. A bus produces more CO_2 than a car but as one car usually take one person to workplace where a bus carries almost 50 persons, per person CO_2 emission for buses becomes less.

3.2 Noise pollution is evaluated for the survey data below.

3.2.1 For private bank

Table 5: Noise pollution by cars of private banks

Name of the bank	No. of employees	No. of Cars	Noise in decibel	Pollution per car passenger	Per person noise pollution
Shahjalal Islami Bank	56	7	451.5	64.5	8.06
Dutch Bangla Bank Limited	84	11	709.5	64.5	8.45
United Commercial Bank Limited	103	7	451.5	64.5	4.38
Hong Kong Shanghai Banking Corporation	9	0	0	0	0
South Bangla Agriculture and Commerce Bank	27	12	774	64.5	28.67

For each car passenger, noise pollution is 64.5 decibel.

3.2.2 For public banks

Table 6: Noise pollution by cars of public banks

Name of the bank	No. of Cars	Noise in decibel (for cars)	Per person noise pollution
Agrani bank	41	2644.5	64.5
Sonali Bank	14	903	64.5

Table 7: Noise pollution by buses of public banks

Name of the bank	No. of buses	No of bus passenger	Noise in decibel (for cars)	Per person noise pollution
Agrani bank	27	1534	2227.5	1.4
Sonali Bank	35	1976	2887.5	1.46

Per passenger noise pollution for cars is 46 times more than buses.

3.3 Cost analysis

Cost of one Toyota Allion car = around 19 lakh BDT
Initial cost of bank for X cars = (1900000*X) BDT
= 1900000X Million BDT
For car maintenance public banks employees receive money:
For AGM= 40000 BDT
For DGM= 43000 BDT
For GM= 45000 BDT
The average of this data is
(40000+43000+45000)/3 or
42667 BDT
If there is X number of AGM & upper level of employees, then the average monthly cost for the maintenance of the cars is
= 42667X
The rent of the buses which is hired by the public banks
80 seat double taker= 90000 BDT
50 seat single taker= 50000 BDT
So by multiplying this with the number of buses we will find total cost of hiring these buses
Cost of one Toyota AC minibus = around 66 lakh BDT
Initial cost of bank for X buses = (X* 6600000) BDT = 6600000X Million BDT
(Source: Survey, 2015)

3.3.1 Cost analysis of cars of private banks:

Table 8: Cost analysis of card of private banks

Name of the banks	Number of employees	Number of cars	Total cost of buying cars	Monthly cost of maintenance
Shahjalal Islami Bank	56	7	1 crores 33 lakhs	298669 taka in BDT
Dutch Bangla Bank Limited	84	11	2 crores 9 lakhs	469337 taka in BDT
United Commercial Bank Limited	103	7	1 crores 33 lakhs	298669 taka in BDT
South Bangla Agriculture and Commerce Bank	27	12	2 crores 28 lakhs	512004 taka in BDT
Hong Kong Shanghai Banking Corporation	9	0	0	0

3.3.2 Cost analysis of the cars of public banks

Table 9: Cost analysis of cars of public banks.

Name of the banks	Number of cars	Total cost of buying cars	Monthly cost of maintenance (BDT)	Cost per car passenger (BDT)
Agrani Bank (Head office)	41	7 crores & 79 lakhs	1749347 taka in BDT	42,667
Sonali Bank (Head office)	50	9 crores & 50 lakhs	2133350 taka in BDT	42,667

3.3.3 Cost analysis of buses of public banks

Table 10: Cost analysis of buses of public banks.

Name of the banks	Number of double decker Bus	Number of single decker bus	Total bus Passenger	Total monthly rent	Monthly cost per passenger (BDT)
Agrani Bank	5	22	1534	10,30,000	671.44
Sonali Bank	6	29	1976	10,10,000	511.13

Cost for per person is 33.54 BDT for bus, while is amount ranges from 20,000 to 50,000BDT for car. Monthly cost for cars is 1 crore 23 lakhs per bank in average. Monthly rent for buses is 10 lakhs 20 thousand in average for each bank. Monthly cost for cars is almost 12 times than the monthly cost for buses. In addition, cars require a large amount of initial cost. So, buses are proved to be cost effective.

3.4 Space analysis:

*Total space consumed by a private car (for example Toyota Allion) = 1695*4565 sq. mm*
*Total space consumed by X cars that are used by the employees X*1695*4565 sq. mm*
= 7.74X sq. m
*Total space consumed by 1 BRTC bus = 3550*11930 sq. mm*
*Total space consumed by X buses= X*3550*11930 sq. mm*
= 42.4X sq. m

3.4.1 Space analysis of cars of private bank

Table 11: Space analysis of cars of private banks

Name of the banks	Number of cars	Total space	Space taken in road per car user (sq. m)
Shahjalal Islami Bank	7	54.18 sq. m	7.74
Dutch Bangla Bank Limited	11	85.14 sq. m	7.74
United commercial Bank Limited	7	54.18 sq. m	7.74
South Bangla Agriculture and Commerce Bank	12	92.88 sq. m	7.74
Hong Kong Shanghai Banking Corporation	0	0	0

3.4.2 Space analysis of buses of public bank

Table 12: Space analysis of buses in public bank

Name of the bank	Number of double taker buses	Total bus Passenger	Total space	Space per person (sq. m)	Number of single decker bus	Total Passenger	Total space	Space per person (sq. m)	Average space taken by bus (sq. m)
Agrani Bank	5	390	212 sq. m	0.54	22	1144	381.6 sq. m	0.33	0.435
Sonali Bank	6	468	254.4 sq. m	0.54	29	1508	501.98	0.33	0.435

A bus occupies 3 times more space than a car but a bus carries more passenger than a car. Per person space occupancy for a car is 55 times more than a double decker bus and 23 times more than a single decker bus. Using a bus instead of a car can reduce traffic pressure on roads.

3.5 Percentage of users using different mode of transportation:

3.5.1 Percentage of usage of different transportation mode in private banks

Table 13: Percentage of usage of different transport mode in private banks

Name of the banks	Percentage of car user	Percentage user not having any transportation facility
Shahjalal Islami Bank	12.5%	87.5%
Dutch Bangla Bank Limited	13.1%	86.9%
United Commercial Bank Limited	6.8%	93.2%
South Bangla Agriculture and Commerce Bank	44.44%	55.6%
Hong Kong Shanghai Banking Corporation	0%	100%

The data suggests that, cars cause much more pollution, take more space in road and takes more expense. Bus causes significantly less pollution, take less space, and takes less space. But cars provide greater comfort for executive level employees. Cars also provide greater flexibility in mobility for workers. Buses have problems like time schedule, distance from worker residence. Often bus drivers and helpers conduct corruptions that increases the cost for operating bus for the institutions.

4. FINDINGS

Table 14: Comparison of bus and car from CO_2 emission, noise pollution, cost and space taken.

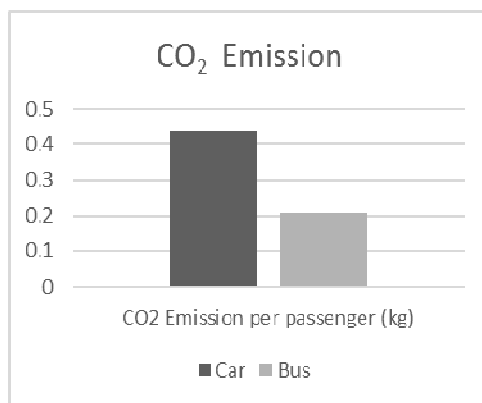| Name of the bank	CO_2 Emission per passenger (kg)	Noise Pollution per passenger (dB)	Monthly Maintenance Cost per Passenger (BDT)	Space Taken per Passenger (sq. m)
Car	0.44	64.5	42,700	7.74
Bus	0.21	1.4	590	0.435

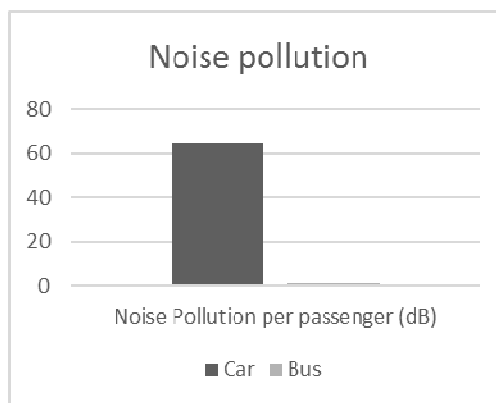Figure 1: CO_2 emission comparison of bus and car.   Figure 2: Noise pollution comparison of bus and car.
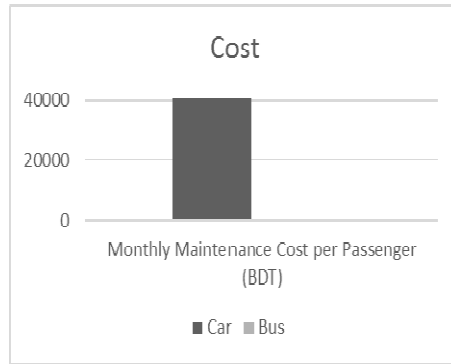
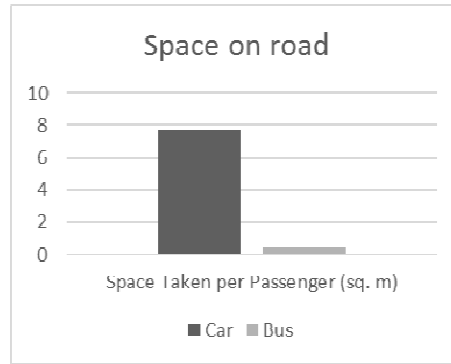Figure 3: Cost comparison of bus and car.   Figure 2: Space comparison of bus and car.

The table shows that cars emits about 2 times CO_2 than buses, causes 46 times more noise pollution, takes 72 times more maintenance cost per person and 17.8 times more space in road.

5. LIMITATIONS AND CONCLUSIONS

The number of banks selected for this study is relatively low compared to all the banks in our study area. The price and space assumed for calculation doesn't reflect the real scenario in all case. Maintenance cost is subject to change with time. There are many other factors like passenger satisfaction, time efficiency that adds to transport mode choice decision. Those values are not acknowledged in this study.

Bus causes less pollution, take less space in road, takes less investment and operating expense than car. But the level of comfort is less in bus. If the level of comfort can be enhanced in bus service, a number of car users might be converted into bus user. Thus pollution, traffic jam and many other problems might be mitigated in Dhaka. In order to get more accurate picture of the transportation scenario, it necessary to conduct study on more financial institutions.

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