DEMAND AND SUPPLY OF PARKING FACILITY AND THE EFFECTS OF ON STREET PARKING ON ROADWAY CAPACITY

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ABSTRACT
Parking demand in Dhaka city is increasing greatly due to the increase in number of vehicles especially passenger cars and the trip attractions to the shopping centers, hospitals and other commercial buildings which are developed in an unplanned way and without following Bangladesh National Building Code (BNBC) properly. It is found from the analysis that 60% of the organizations do not have adequate parking facility as specified in BNBC. Improper management, operation and maintenance are also present even if enough parking supply is provided in some cases. Due to the lack of proper parking facilities and strict regulations, on street parking has become a very common phenomenon in Dhaka city which decreases the roadway capacity and creates severe problems like congestion, delay, accident potentiality and some other relevant problems. 50-65% reduction in roadway capacity due to on street parking is found on the roads of Shapla Square, Motijheel. The percentage of reduction is 52% in case of Mirpur Road in front of New Market. 43% reduction in operating speed is found due to on street parking on Mirpur Road. To get a smooth flow of traffic stream on roads, it is necessary to ensure proper parking facility and prohibit on street parking completely where possible; and where it is not possible, proper parking operation and management policy should be adopted. Before that, unplanned land use should be controlled and restrictions should be imposed on automobile usage to control the demand for parking as well as congestion and other transportation related problems.

Keywords: BNBC; parking demand; operating speed; congestion

INTRODUCTION
Dhaka is the capital as well as the largest and most densely populated city of Bangladesh. Due to the nature of central development in industrial, commercial, educational, health and all other sectors, people from every corner of the country are coming to Dhaka for their livelihood. So the population of Dhaka is increasing largely day by day. This increasing number of population increases the demand for travel as like as other basic needs. To fulfil that need, the number of vehicles is also increasing alarmingly that is shown in Table 1. Besides the population growth, unplanned growth of shopping malls, hospitals and other commercial buildings leads to the problems of congestion and increases the demand for parking spaces. The number of registered private car was 143379 in 2009 whereas after June 2015 it has been increases to 214987 which show almost 70% increase in growth within only five years. The total number of motor vehicles is 903803 (June 2015) among which 24.9% are private cars carrying only 5.1% of total trip (Development of EST in Bangladesh 2010). This increasing number of car needs not only roads to move but also space for parking (A. Ahmed and M.S., 2012). So the provision of parking facilities is very much essential for any type of building. But this is ignored most of the time or provided little importance. Lack of parking provision along with the improper facility location encourages the vehicles to be parked on street. This unauthorized on street parking reduces traffic flow and roadway capacity, increases accident potential and hampers vehicular and pedestrian movements. Hospitals, Shopping malls and commercial buildings are essential part of

daily urban life. To prevent these essential buildings from creating problems due to on street parking, planners and designers are responsible to provide proper off street parking facilities within shortest possible distance from the individual building or within the building. This study is aimed to assess the existing parking conditions for the Shopping Malls and Hospitals in Dhaka City through analysing demand and supply situations directly. Besides, analysis of the ill effects of on street parking on roadway capacity and flow behaviour is also the aim of the study. The objectives of the present study are the followings:

- To obtain information regarding parking capacity of selected Shopping Centers and Hospitals to compare with the requirements as per BNBC.
- To obtain geometric data to compare between the capacity calculated from geometry with and without on street parking.
- To compare the Level of Service (LOS) and operating speed with and without on street parking.

METHODOLOGY

For the fulfillment of the objectives, the study is conducted in several steps. First of all, data on parking supply facility and weekly data of parked vehicle was collected from some selected shopping centers and hospitals of Dhaka city. They are: New Market, Bashundhara City, Concord Arcadia, Metro Shopping Center, Pink City, Plaza A.R, Apollo Hospital, Bangabandhu Sheikh Mujhib Medical University, Central Hospital, Square Hospital and United Hospital. Hourly parking demand data was collected from field survey at New Market and Dainik Bangla to Shapla Square, Motijheel Road. Geometric Survey was conducted on Mirpur Road in front of New Market and the Roads of Shapla Square. Then, volume and speed count survey was conducted on two sections (i.e one at bottle neck created by unauthorized parking and another at full width) on both working day and market off day. Volume and speed count survey was also conducted on the roads of Shapla Square. Roadway capacity from geometric data was calculated by following Highway Capacity Manual (FHWA, USA).

Roadway Capacity = Capacity at ideal condition* Passing Sight Distance Factor* Lane width Factor*Clearance Factor

Fig. 1: Study Area (New Market, Dhaka)

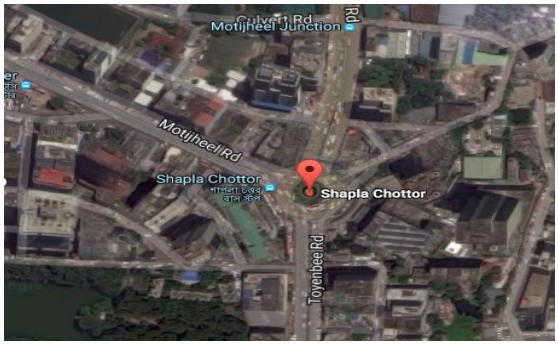

Fig. 1: Study Area (Shapla Square, Dhaka)

RESULTS AND DISCUSSIONS:

Parking supply survey was conducted by counting the allotted parking space for the vehicles in the selected shopping malls and hospitals. According to BNBC, space should be allotted for 1 car for every 200 m^2 for business purposes and 1 car for every 300 m^2 for health care purposes. A 23 m^2 parking space is required for one car. But 60%of the selected organizations have not followed this standard. Figure 3 shows the deficiencies of parking supply of the selected shopping centers and hospitals of Dhaka city. Besides this, space for loading-unloading purposes is not provided by the organizations except Bashundhara City. And most of the organizations are located by the side of busy roads and some of them are at intersections. Due to on-street parking and loading-unloading activities on the busy roads, roadway capacity decreases greatly and creates a lot of congestion, accident potentialities, hindrance to movements of pedestrian and traffic.

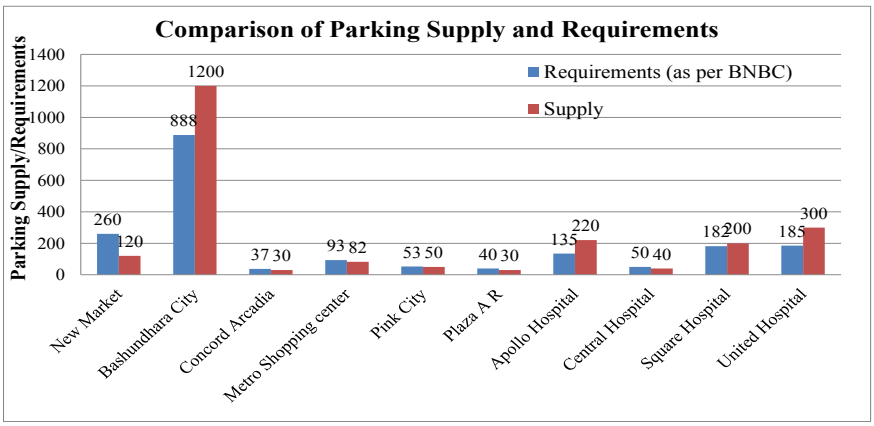

Fig. 3: Comparison of Parking Supply and Requirement as per BNBC

Parking data of a week was collected from the above mentioned shopping centers and hospitals. The parking patterns of all the shopping centers are all most same. The maximum parking was noticed in weekends (i.e Friday and Saturday) and minimum or zero parking was on the off day. On the other hand, the parking pattern of hospitals is almost same for all days of the week. If there is any off day of the hospital, minimum or zero parking was recorded on that day.

Hourly Parking Demand

Among the selected shopping centers and hospitalas, the hourly parking demand data was collected from field survey at New Market. There are four parking spaces available around New Market (i.e in front of Gate 1, Gate 2 and Katcha Bazar) with a total parking capacity of 120 cars at a time. From survey data, it is found that the supply rarely satisfies the parking demand (Figure 4). As a result, parking on active road is practiced greatly.

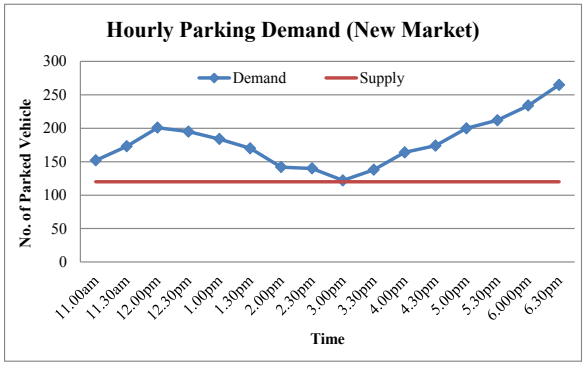

Fig. 4: Hourly Parking Demand in New Market

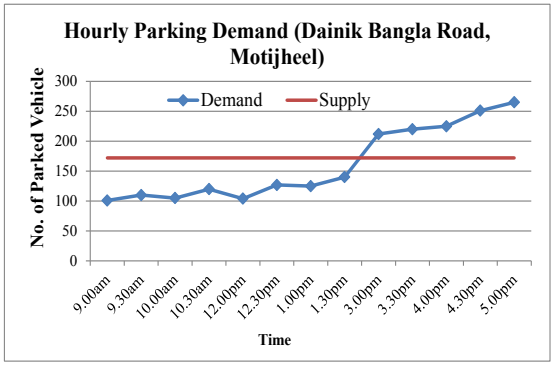

Fig. 5: Hourly Parking Demand in Dainik Bangla Road, Motijheel, Dhaka

Motijheel is the major business and commercial hub of Dhaka city. More offices and business institutions are located there than any other part of the city as well as it is home to the largest number of corporate headquarters in the nation (Jahan and Amin 2011). All these activities generate a large volume of parking demand per day. Buildings of this area do not have enough provisions for parking. On street parking facilities are provided by the city corporation along the road. The parking demand is more than the provided facility (Khatun, Ahmed, Suman, Rafiq, Md., Akhter and Hasan, 2013). Parking Supply and Demand data were collected from a whole day survey to analyze the on street parking condition which is shown in Figure 5.

Due to the lack of proper parking facility, on street parking has become a common phenomena on the roads of dhaka city. Unauthorized on street parking decreases the active roadway width which in result decreases roadway capacity and operating speed. The effects of on street parking on Level of

Service and Operating Speed in Mirpur road (in front of New Market) are shown in Table 1, below.Fig. 6 and Fig. 7.

Table 1: Effects of On Street Parking on Capacity and Operating Speed (at Mirpur Road)

Effective Carriage way Width (feet)	Capa -city (PC U/hr)	Capa c-ity Red uctio n (%)	Servic e Volum e (PCU/ hour)	Volum e/ Capacit y Ratio	Level of Service	Operati ng Speed Miles/h r	Speed Reduc- tion (%)
At different sections on same time							
38 (Full width)	2856	60	1915	0.67	C (Stable)	15.5	43
24(Bottle neck)	1371		1697	1.24	F (Forced)	8.9	
At same section on different time							
38 (Without Parking)	2856	60	1576	0.55	B (Reasona- bly Free)	13.5	34
24 (With Parking)	1371		1697	1.24	F (Forced)	8.9	

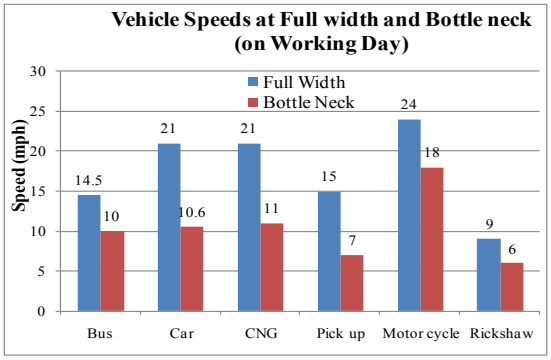

Fig. 6: Speedof vehicles at two sections full width and bottle neck created by on street parking

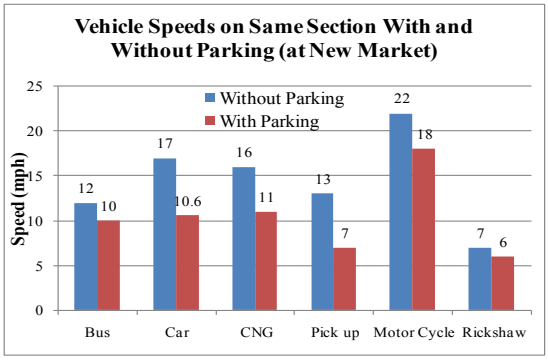

Fig. 7: Speed at same section at full width and bottle neck

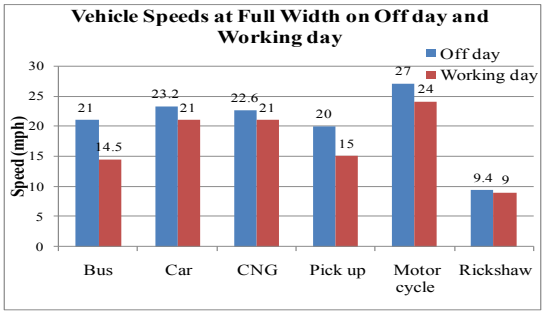

Fig. 8: Speed at same section of full width with and without parking

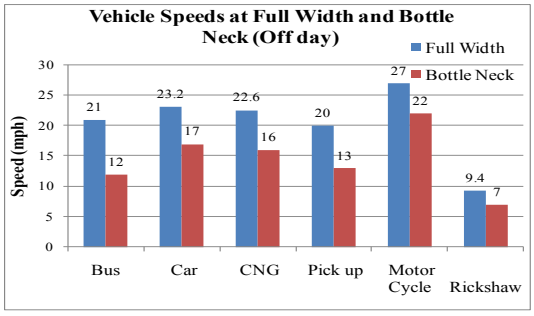

Fig. 9: Speed at two sections without parking

On street parking not only affects the speed and volume capacity ratio along length where there is parking, but also a longer distance from parking space. There is a considerable difference between the speeds (Figure 8) of vehicles on the working day and off day at the section of full width though that section was parking free. That might be happened due to the parking at a distance behind this section.

The operating speed on working day is found to be 9% less than that of an off day. Vehicle speed on both the sections should be same on off day as there remain no parking. But even then, there is almost 23% difference in operating speed (Figure 9). The reasons may be the loading and unloading activity of public vehicles, pedestrian activity and hawkers' activity in front of New Market.
Due to the on street parking in one row and sometimes more than one row on the roads of Shapla Square, Motijheel,Dhaka , the effective carriageway width is reduced greatly. Among four lanes, almost two lanes are occupied by parking. This reduced roadway width is one of the major reasons of capacity loss and results congestion. The effect of unauthorized on street parking on Level of Service is shown in Table 2 below.

Table 2: Effects of on street parking Level of Service (at Shapla Square)

Road	Effective Carriageway Width(ft)	Capacity (PCU/ hour)	Service Volume (PCU/ hour)	Volume/ Capacity Ratio	Level of Service
Shapla Square to Dainik Bangla	46(without parking)	3694	1838	0.5	A (Free)
	22(with parking)	1330	1838	1.38	F (Forced
Shapla Square to Notre Dame College Road	44(without parking)	3694	2095	0.57	B (Reasonably Free)
	30(with parking)	1871	2095	1.12	F (Forced)
Shapla Square to Tikatuli	45(without parking)	3694	1587	0.43	A (Free)
	21(with parking)	1248	1587	1.27	F (Forced)

Though the Level of Service of all the roads is F which is the indication of congestion, vehicles were relatively in better speed on Shapla Square to Notre Dame College road as parking, hawkers' and pedestrian activity is less on that road. So the speeds of vehicles of other two roads are compared with speeds of that road which is shown in Figure 10. Figure 11 shows the comparison between the speed of vehicles in a section with on street parking in one row and two rows.

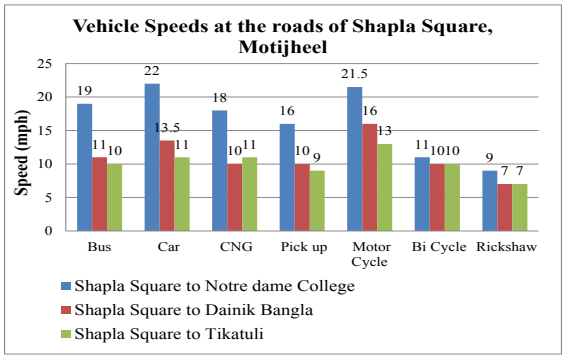

Fig. 10: Vehicle Speed at the roads of Shapla Square

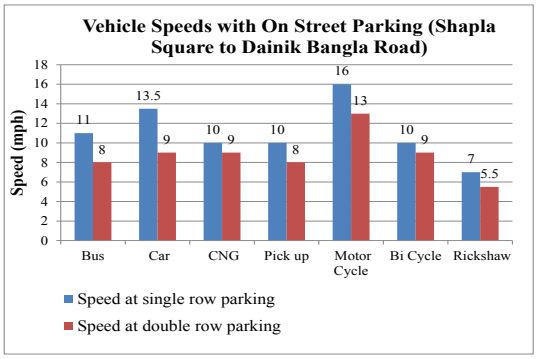

Fig. 11: Comparison of Speed at one row and two row on street parking

As unauthorized on street parking reduces the active roadway width and thus reduces capacity and speed, it is very much necessary to stop this practice for the mobility of the city. Some general recommendations are given below:

- A detailed development plan, framework and policy should be adopted to prevent any unplanned institutional development
- Inspection of the buildings should be made by the authority to check if the building construction guidelines are properly followed or not.
- Development of any commercial building near the intersection or by the side of busy roads should be controlled strictly by the authority (Saifuddin Ahmed, 2013).
- Restrictions must be provided on using private vehicles and the number of vehicles should be minimized by improving public transits. Road pricing and congestion pricing policy should be adopted for private automobiles.
- Proper inspection of roads should be ensured to avoid on street parking. Parking charge should be applied on hourly basis where on street parking can't be prohibited completely.
- Side frictions like hawkers' activity, pedestrian activity, loading-unloading activity of transits etc. should be controlled for better performance of the road.

CONCLUSION

Parking is a basic type of requirement for any type of development. The areas with development of shopping centers, hospitals and other commercial buildings attract a lot of trips as well as increase the demand for parking. Due to the lack of adequate parking facility, unauthorized on-street parking is practiced which affects the roadway capacity greatly and creates some relevant problems. So, it is necessary to adopt policies for the allotment of adequate off-street parking facilities, proper operation, management and maintenance of both on-street and off-street parking facilities for the better performance of the road and a balanced transportation growth.

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