

## **ON-STREET PARKING EFFECTS ON ROADWAY CAPACITY AND PARKING FACILITY BASED ON DEMAND AND SUPPLY**

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### **ABSTRACT**

Most of the cities in Bangladesh are facing the imbalance of demand and supply of parking space. Deficiency of adequate parking space in unplanned infrastructure caused on-street parking which is a common phenomenon in the rapidly growing Faridpur city, having a tremendous impact on roadway capacity. 80% of infrastructure does not have a parking facility according to Bangladesh National Building Code-1993 specification. Due to lack of proper management, operation, and maintenance the existing parking facilities have been affected which decreasing roadway capacity and creating severe problems like congestion, delay, accident probability, and some other relevant problems. Uncontrolled Auto-Bikes are occupied most of the roads and load unload the passengers over a short distance and park along the roadside, reducing roadway capacity also. 44% reduction in roadway capacity due to on-street parking is found on the road of Mujib Sarak, Janatar More. The percentage of reduction is 45% in the case of Thana Road in front of the New-market. 27% reduction in roadway capacity is found due to on-street parking on Goalchamat Road, Raffles-Inn More. This study also shows the impacts of on-street parking on effective carriageway width, V/C ratio and level of service. It is necessary to ensure proper parking facility and prohibit on-street parking totally if possible; if not possible, proper parking operation management policy should be obtained for having a smooth flow of traffic. Before that unplanned land use and automobile usage should be controlled to reduce congestion and other traffic problem.

**Keywords:** *Parking demand and supply; BNBC; Traffic Congestion; Degree of Saturation (DOS); Level of Service (LOS).*

## 1. INTRODUCTION

The population growth in metropolitan cities of any country has resulted in an increase in travel demand. In the 21st century, due to the increase in population, income and improved quality of life, the propensity to own private vehicles is increased. Thus, travelers particularly in metropolitan cities preferred the private car as their favourite mode of transportation, which generated huge parking demand. Almost all Metropolitan cities are experiencing parking problems. The parking problem reduces the flow speed and creates congestion on the street, particularly in the CBD. The problem is more serious in the case of on-street parking (Debasish, 2016).

Parking is an essential component of the transportation system. The growing population of Bangladesh has created many problems, one of the challenging ones being car parking of the commercial areas which we confront almost every day. Parking is one of the major problems that is created by increasing road track and other vehicles. The availability of less space in urban areas has increased the demand for parking space especially in areas like the Central business district. The parking index of the building is an important basis for the construction of the city's parking facilities (Sudipta, 2014).

It is a basic type of requirement for any type of development. The areas with the 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 facilities, unauthorized on-street parking is practiced which affects the roadway capacity greatly and creates some relevant problems (Suthanaya, 2017).

### 1.1 Objective:

The objectives of the present study are the followings:

- To gather information about the parking capacity of selected shopping centers and hospitals to compare with the requirements as per BNBC.
- To gather geometric data to compare 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.

### 1.2 Scope and Limitation

The scope of this study was limited to some selected hospitals, shopping centers, and roads and others were not included in this study. Furthermore, the analysis was a segmented study rather than an area-wide or regional study. Hence, it focused mainly on the on-street parking of those places and roadway capacity and the relative effect on operating speed was not discussed as it needs a wider and comprehensive exploration.

## 2. LITERATURE REVIEW

Parking denotes the basic requirement in a transportation system. But more often its impact on the efficiency of traffic movement evades our contemplation. This is because our perception of transportation is limited to the notion of movement whereas parking involves the condition when the vehicles are stationary. It has become a crucial issue in managing the transportation system since it affects the overall accessibility of a city (Litman, 2012).

### 2.1 Types of Parking

Parking facilities can be classified into 2 categories:

1. On-street parking
2. Off-street parking

**On-street parking:** This is also known by name curb parking. In this system, vehicles are parked along the curb, designed for this purpose. Since car parking may lead to traffic congestion and may also be the possible cause of several accidents they should be designed for adequate capacity while planning is being done for new townships.

Parking may be done parallel to the curb or at an angle with the curb named as parallel parking and angle parking. Angle parking is done at 30°, 45°, 60° and 90° with the curb.

**Off-street parking:** When parking places are provided away from the road curb, it is known as off-street parking. This system of parking is most desirable as it does not harm the capacity of the road (Gurcharan, 2004).

## 2.2 Parking Demand

The parking demand may be evaluated by different methods.

- a. By counting the number of vehicles parked in the area under study during different periods of the day. By noting the registration number of each parked vehicle at 30 minute or one-hour interval, it is possible to estimate the duration of parking of each vehicle at the parking area. This method is useful when the parking demand is less than the area available.
- b. Another method is to interview the drivers of the parked vehicles and other vehicle owners of the area. This method is useful when the demand is higher than the available area in the study locality.
- c. By doing the cordon counts of the selected area and the recording accumulation of vehicles during peak hours by subtracting the outgoing vehicles from the incoming vehicles (B. L Gupta, 2003).

## 2.3 Level of Service by V/C ratio

Passenger Car Equivalent (PCE) or Passenger Car Unit (PCU) is a method of expressing various types of vehicles having different characteristics in a common equivalent unit which takes into account the spatial differences between vehicles (Kadiyali, 2006).

In recent years, the level of service is become more familiar to represent the speed characteristics of the highway. Level of service (LOS) is a quality measure describing operational conditions within a traffic stream, generally in terms of such service measures as speed and travel time, freedom to maneuver, traffic interruptions, and comfort and convenience (Transportation Research Board, 2016). Six LOS (A–F) are defined according to the volume and speed of vehicles-

Table 1: Level of service

Volume to Capacity Ratio	Level of Service
≤0.6	A
≤0.7	B
≤0.8	C
≤0.9	D
≤1	E
> 1	F

Source: (Kadiyali, 2006)

## 3. METHODOLOGY

To fulfill the objectives the study is conducted in different steps. First of all, data on parking supply facility and parked vehicles were collected from selected shopping centers and hospitals of Faridpur city. They are Newmarket, Diabetic Association Hospital, Lab Aid Hospital PVT. Ltd., Arogya Sodon

Hospital, Shamorita Hospital. Hourly parking demand data was collected from the field survey at Lab Aid Hospital PVT. Ltd., Arogya Sodon Hospital and Shamorita Hospital on Mujib Sarak. The geometric survey was conducted on Mujib Sarak in front of Arogya Sodon Hospital, in front of Newmarket Thana road and Masjid Bari Sarak in front of Diabetic Hospital. Geometric data was collected using measuring tape from selected roads. Traffic volume was collected manually from those roads. The parking space facility survey data was collected by negotiating with selected building authorities and parking demand was calculated manually.

### 3.1 Description of study location

Our study was conducted in several selected places. For comparing with the BNBC requirement of parking facility we have selected three different hospitals in Faridpur city and Newmarket placed at the center of Faridpur. The hospitals are Diabetic Association Hospital, Lab Aid Hospital PVT. Ltd., Arogya Sodon Hospital, Shamorita Hospital. And the selected roads for analyzing roadway capacity are Mujib Sarak, Thana Road and Goalchamat Road.

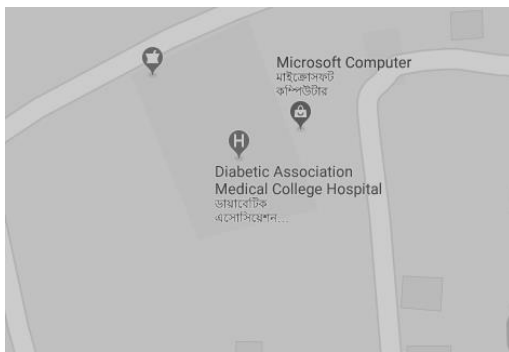


Figure 1: Diabetic Association Medical College Hospital (Google, 2019)

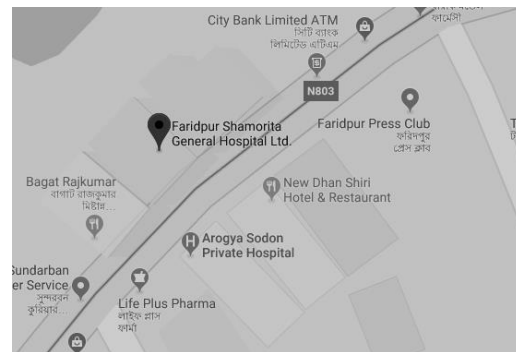


Figure 2: Shamorita General Hospital and Arogya Sodon Private Hospital (Google, 2019)

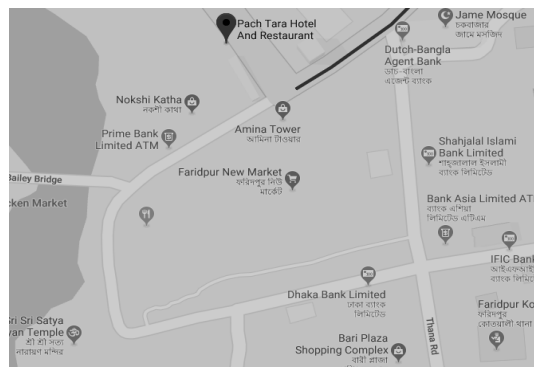


Figure 3: Faridpur Newmarket (Google, 2019)

### 3.2 Data Collection

To accomplish the objectives of this research several types of quantitative data such as traffic flow or volume data, vehicle occupancy data, travel time data, on-street parking data, road users' congestion perception data, causes of traffic congestion and parking demand and supply data were required. But for this research, only traffic volume data, geometric data, parking demand, and supply data at selected places and on-street parking data were collected.

#### 3.2.1 Traffic volume data

Traffic volume is very important to determine and understand the flow pattern in the facility, to determine the peak flow rates and peak periods, to assess the relationship between traffic volume and congestion. Furthermore, it is extremely required to analyze the level of service.

The traffic volume count was collected for a period of 8 hours (9:00 am 5:00 pm) on the study day.

Heavy Vehicles: Bus, Trucks

Light Vehicles: Cars, Pickup, Mahindra, Easy Bike, Rickshaw, Bi-cycle, Van, etc.

The traffic volume in the passenger car unit and the movement of traffic on each road are also essential for the analysis. The passenger car equivalent factors are used to convert the number of vehicles in the passenger car unit. The PCU values given in the geometric design of Highways (MoC, 2010) are given in Table 2.

Table 2: PCU of Different Types of Vehicles in Bangladesh.” (MoC, 2010)

Categories	PCU
Passenger Car	1.00
Light Good Vehicle	1.00
Bus	3.00
Truck	3.00
Auto Rickshaw/ Motorcycle	0.75
Rickshaw/ Van	2.00
Bycycle	0.50

### 3.2.2 Service Volume

Design service volume is defined as the maximum hourly volume at which vehicles can reasonably be expected to traverse a point or uniform section of a lane or roadway during a given time period under the prevailing roadway, traffic and control conditions while maintaining a designated level of service.

Design service volumes for different categories of urban roads corresponding to above-referred conditions are given in Table 3.

Table 3: Recommended design service volumes (PCU per Hour).

S.No	Type of carriageway	Total design service volume for different categories of urban roads		
		Arterial	Sub-arterial	Collector
1	2-Lane (One way)	2400	1900	1400
2	2-Lane (Two way)	1500	1200	900
3	3-lane (One way)	3600	2900	2200
4	4-Lane Undivided (Two-way)	3000	2400	1800
5	4-Lane Divided (Two way)	3600	2900	----
6	6-Lane Undivided (Two-way)	4800	3800	----
7	6-Lane divided (Two way)	5400	4300	----
8	8-Lane divided (Two way)	7200	----	----

Source: IRC 1990

### 3.2.3 Geometric data

The width of the roads for capacity reduction calculation was collected by tape measurement. The parking space of selected hospitals and shopping malls is collected by negotiating with the building authority from an architectural plan and on field observation.

### 3.2.4 Parking data

The parking supply survey was conducted by counting the allotted parking space for the vehicles in the selected shopping mall and hospitals. And parking demand was measured by doing the cordon counts of the selected area and according to the accumulation of vehicles during the parked hours by subtracting the outgoing vehicles from the incoming vehicles

## 4. RESULT AND ILLUSTRATIONS

Due to the lack of adequate parking space, scattered on-street parking occurred, reducing the roadway capacity. This is a common scenario in Faridpur city and it is increasing day by day.

### 4.1 Comparison of parking supply and demand

According to BNBC-1993, space should be allotted for 1 car for every 200 m<sup>2</sup> for business purposes and 1 car for every 300 m<sup>2</sup> for health care purposes. A 23 m<sup>2</sup> parking space is required for 1 car. But 80% of the selected organization has not followed this standard.

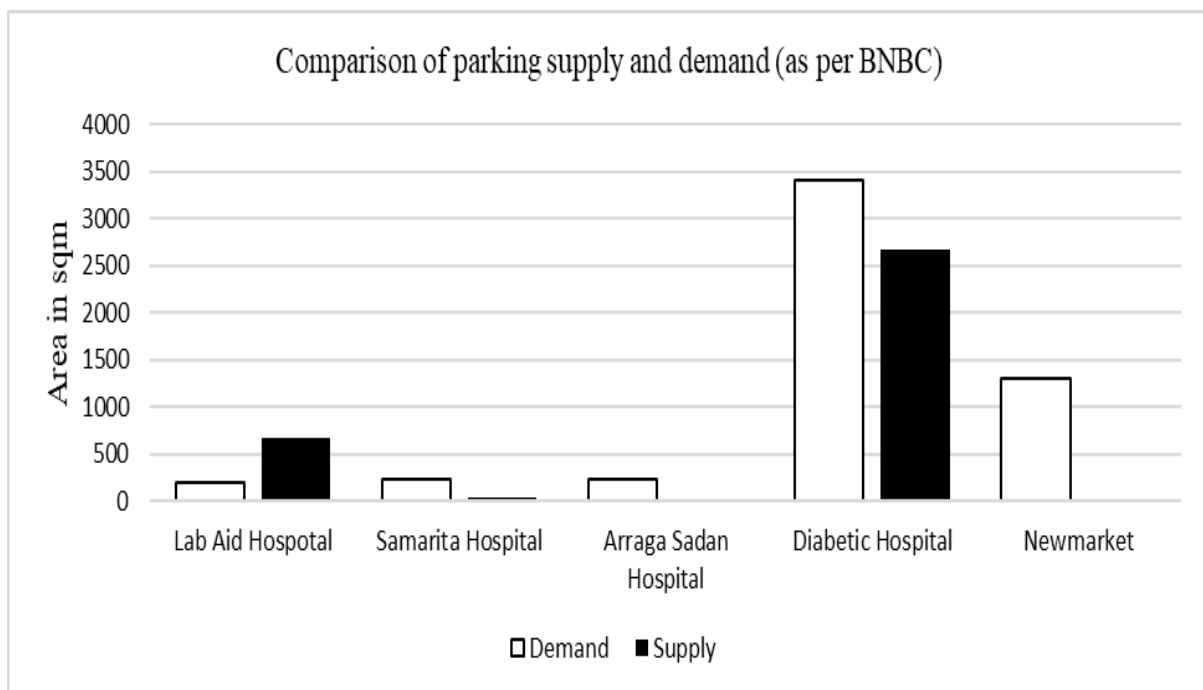


Figure 4: Comparison of parking supply and demand (as per BNBC)

Figure 4 shows the deficiencies of the parking supply of the selected shopping center and hospitals in Faridpur city. Even some organizations do not have a parking supply facility which is a common phenomenon in Faridpur. Besides this, space for loading-unloading purposes is not provided by the organizations except Diabetic Association Medical College Hospital. And most of the organizations are located onshore of busy roads. 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 movements of pedestrians and traffic.

#### 4.1.1 Hourly parking Demand

Figure 5, 6 and 7 represents the hourly parking demand and Supply of Newmarket, Mujib Sarak and Goalchamat Roads balance respectively. There is no parking supply facility among those selected roads. At Newmarket road, it is shown that the maximum number of the vehicle was parked at 11 pm to 12 pm. In Mujib Sarak maximum parked vehicle was found at 10 am and at Goalchamat Road it was found 12 pm.

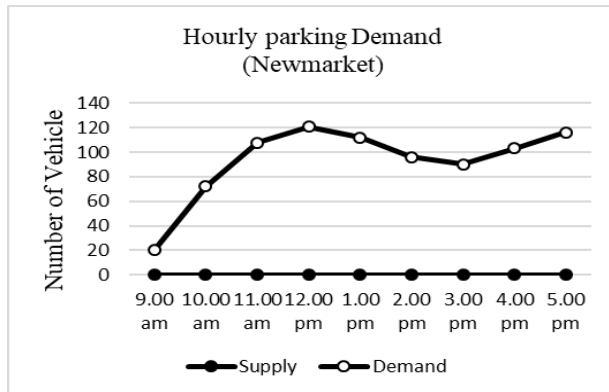


Figure 5: Hourly parking demand (Newmarket)

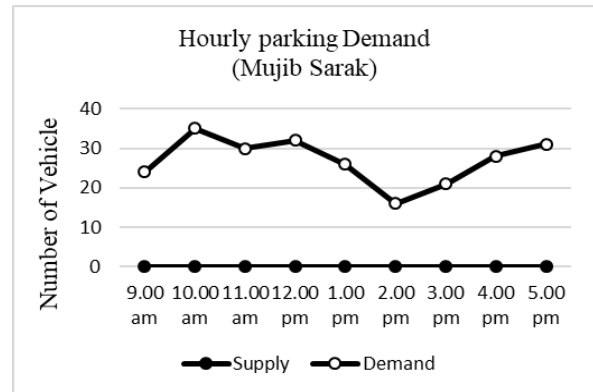


Figure 6: Hourly parking demand (Mujib Sarak)

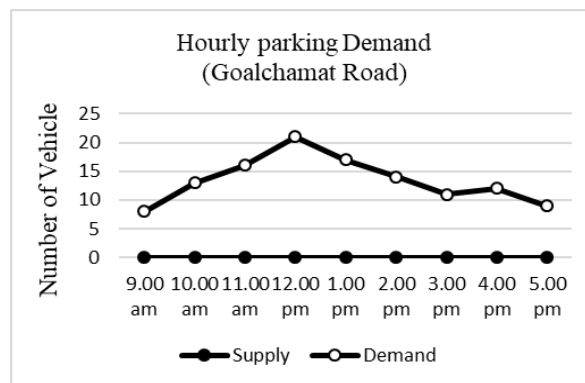


Figure 7: Hourly parking demand (Goalchamat Road, Raffles-Inn More )

#### 4.2 Calculation of capacity reduction

Due to the on-street parking in one row and sometimes more than one row on the roads of Mujib Sarak and Thana Road, the effective carriageway width is reduced greatly. Almost 45% of carriageway occupied by parking. On the other hand, in Goalchamat Road, the rate of roadway capacity reduction is low. This reduced roadway width is one of the major reasons of capacity loss and result congestion.

Table 4: Effects of On-Street Parking on Capacity

Road	Effective carriageway width (ft)	Capacity (PCU/hr)	Capacity reduction (%)
Mujib Sarak	27(without parking)	2529	44
	15(with parking)	1405	
Thana road	40(without parking)	1117	45
	22(with parking)	614	
Goalchamot road	30(without parking)	1796	27
	22(with parking)	1317	

### 4.3 Level of Service

Level of Services is affected by capacity reduction where on-street parking reduces the effective roadway width, having a great impact on the capacity that we found in Mujib Sarak. The effect of unauthorized on-street parking on Level of Service is shown in table 5 below.

Table 5: Effects of on-street parking Level of Service

Road	Effective carriageway width (ft)	Capacity (PCU/hr)	Service volume (PCU/hr)	Degree of saturation (Volume/Capacity)	Level of Service
Mujib Sarak	27(without parking)	2529	1500	0.6	A
	15(with parking)	1405	1500	1.01	F
Thana road	40(without parking)	1117	1200	1.1	F
	22(with parking)	614	1200	1.95	F
Goalchamot road	30(without parking)	1796	1500	0.84	D
	22(with parking)	1317	1500	1.14	F

The Level of Service of all roads was found F with on-street parking which is the indication of congestion.

### 5. CONCLUSIONS

Due to the lack of adequate parking facility, parking regulatory system and parking charges unauthorized on-street parking is practiced which affects the roadway capacity greatly and creates some relevant problems.

- Most of the organization didn't follow the BNBC code, as a result, scattered on-street parking developed noticeably.
- Though there were no on-street parking facilities on selected places, the on-street parking occurred which reduce roadway width, as a result, the roadway capacity reduced in almost half.
- All roads are facing long-standing traffic congestion which is the worst condition according to Level of Service.

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### REFERENCES

- B. L. Gupta, A. G. (2003). *Roads, Railways, Bridges, Tunnels and Harbour-Dock Engineering* (5th ed.). Dehli, India: STANDARD PUBLISHERS DISTRIBUTORS.  
BNBC-1993 (Bangladesh National Building Code)



- Gurcharan Singh, J. S. (2004). *Highway Engineering* (Fifth Edition ed.). Delhi, India: Standard Publishers Distributors.
- Google Maps. (2019). <http://www.maps.google.com>
- IRC (The Indian Roads Congress 1990), GUIDELINES FOR CAPACITY OF URBAN ROADS IN PLAN AREAS,
- Kadiyali, L. (2006). *Traffic Engineering & Transport Planning*. Delhi: Khanna Publication.
- Litman, T. A. (2012). *Parking Management - Strategies, Evaluation and Planning*. Retrieved from [http://www.vtpi.org/park\\_man.pdf](http://www.vtpi.org/park_man.pdf)
- Ministry of Transport & Communication (MoC) ,(2010). Project Profile on the Establishment of Traffic Operation Center (TOC) for the City of Addis Ababa.
- Mr. Debasish Das, P. M. (n.d.).(2016). Controlling on-street parking demand using sensitivity analysis: A case study at Kolkata. *Journal of Transportation Systems, Volume 1*( Issue 3).
- Sudipta Chowdhury, K. U. (2014, July). Demand & Supply of Parking System Analysis at Chittagong Commercial Area in Bangladesh. *International Journal of Scientific & Engineering Research, Volume 5*(Issue 7).
- Suthanaya, P. A. (2017). Development of Parking Demand Model for Private Hospital in Developing Country (Case Study of Denpasar City, Indonesia). *Journal of Sustainable Development, Vol. 10*. DOI:10.5539/jsd.v10n5p52
- Transportation Research Board. (2016). *Highway Capacity Manual*. United States: Transportation Research Board.