Pabna is the most ancient city of Bangladesh having a parking problem in CBD area. This study is mainly focused on the demand and supply of parking system in CBD area. The deficiency of parking supply and illegal occupancy of the traffic lane with parking has become a common practice. Basically, an existing parking accommodation, parking demand, parking turnover, average parking duration, parking types and parking index are analyzed on the base of modified patrol survey. The parking space inventory survey helps to identify the present parking spaces, number of parking bays, vacant land for the multistoried parking facility. Both on-street and off-street parking have surveyed to find out the actual measurement of the demand and supply of parking. It should be mentioned that the feasibility of a multistoried parking facility is also proposed to shift the existing on-street parking of CBD.

Index Terms—CBD; Multi-Storied Parking, Parking Demand; Parking Volume.

I. INTRODUCTION

Pabna Municipality is one of the oldest Municipalities in Bangladesh and it was established in 1876. The area of Pabna Municipality is 15.66 Sq.km. The population density is 8130/sq.km. It was upgraded to ‘A’ Category Municipality. The CBD area of Pabna Municipality covered most of the part of ward no 02 & 03 as administrative and commercial zone and it covered 341.473 acres of land [7]. Both off-street and on-street parking notice available here but off-street parking is used for the only building owner. So, the proportion of the two types of parking facilities is not equal. The off-street parking facilities are limited.

II. LITERATURE REVIEW

L. R. Kadiyali, on his book “Traffic Engineering and Transport Planning” that every car owner would wish to park the car as closely as possible to the destination. This result in great demand for parking space in the CBD and other commercial areas where the activities are gathered [1].

M. Tariq, recommended that an effective design method towards providing adequate parking space is an essential consideration for the construction of shopping centers in Dhaka city [2].

T. V. Mathew, K. K. Rao, focused on their book “Introduction to Transportation engineering.” different types of parking characteristics. The calculation of on-street parking parameters was mentioned in this book with examples [3].

S. Chowdhury, M. Kutub Uddin Chisty, S. Misuk, revealed that the Demand & Supply of Parking System Analysis at Chittagong Commercial Area in greater Chittagong city was undertaken. This study has investigated the evidence about the impact of different types of parking measures and policies on road traffic, congestion and transport safety, car parking, on the level of parking survey of transports through the activity of commercial area in “Agrabad” also analysis demand and supply of parking system [4].

III. MATERIAL AND METHODS

The data was collected primarily through the field survey. It was necessary to visit the study area thoroughly in a systematic way for the data collection. For fulfilling the research work it was necessary to conduct systematic parking study which includes parking demand and regulatory measure that were possible for controlling parking. Following methods are followed:

a) Parking Space Inventory Survey
b) Type Parking Usage Survey by Patrol
c) Physical feature survey
d) Parking demand survey
e) Questionnaire Type Parking Usage Survey

After conducted primary survey total counting parked vehicle convert into PCU for calculating parking, volume, parking accumulation.

Passenger Car Unit (PCU) Calculating vehicles such as rickshaw, motorcycle, CNG, and car are in a single and same unit as a car. For this conversion there are rickshaw=.5, CNG=.5, motorcycle=.25 and the car =1 as a unit for taking actual measurement and the facilities of the calculation [4].

Parking load gives the area under the accumulation curve. The parking load is closely related to the parking accumulation and helps to develop the peak and off-peak parking period of the study area.

Average Duration = \[
\frac{\text{Sum of Accumulation for each Time Interval} \times \text{Time Interval}}{\text{Total Survey Time (in minutes)}}
\]
According to [3], Average duration is the average time for which the parking lot was used by the vehicles. So,

\[
\text{Average Duration} = \frac{\sum (\text{Time Interval} \times \text{Time Interval})}{\text{Total Parking Volume}}
\]

Parking index is also called occupancy or efficiency

\[
\text{Parking Index} = \frac{\text{Parking Load}}{\text{Parking Capacity}} \times 100
\]

Turnover is the ratio of a different number of vehicles parked in duration to the number of parking bays available. This can be expressed as a number of vehicles per bay per time duration.

\[
\text{Average Turn-over} = \frac{\text{Sum of turn-over Vehicles}}{\text{Total no. of bays}}
\]

IV. DATA ANALYSIS AND FINDINGS

After lunch time at 03:00 PM to 04:30 PM is the peak period when a maximum number of the vehicle is accumulated.

![Fig.2. Parking Accumulation curve at Weekday and Weekend](image)

From Fig.2, it is clear that the difference between calculated and expected number of vehicles is higher at weekday. On the other side, the difference between calculated and expected number of vehicles is lower at weekend than a weekday.

![Fig.3. Calculation of expected volume of Parked Vehicles](image)

Fig. 3 shows that demand and supply relationship at different time period. Parking demand curve always remains above Parking supply curve in weekday. Since the parking supply is fixed and there is no way to increase the parking supply, so always some spillover parking is created at this peak time.

![Fig.4. Parking Demand and Supply Relationship at Weekday](image)

Average duration is the average time for which the parking lot was used by the vehicles [3].

\[
\text{Average Duration} = \frac{\text{Sum of the accumulation for each time interval} \times \text{Time interval}}{\text{Total parking volume}}
\]

So, average duration = \(\frac{3745 \times 30}{1418}\) = 79.23 minutes/vehicle or 1.32 hours/vehicle.

Average parking duration indicates that each vehicle parked for 1.32 hour which means the time period using by each vehicle exceeds the moderate level.

A. Demand Calculation

During peak hour, there were about 525 vehicles used CBD areas for parking. The Space requirement for parking as per Building Construction Rules, 1996 in Bangladesh is given below.

**TABLE I: PARKING DEMAND IN THE STUDY AREA ACCORDING TO BUILDING CONSTRUCTION RULES, 1996**

<table>
<thead>
<tr>
<th>Features (Type of Activity)</th>
<th>Number of Major Features</th>
<th>Area Occupied (sq.ft)</th>
<th>Parking Demand (sq.ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hotel</td>
<td>5</td>
<td>16000</td>
<td>1820</td>
</tr>
<tr>
<td>Commercial Site and Market Center</td>
<td>7</td>
<td>85090</td>
<td>8835</td>
</tr>
<tr>
<td>Mixed Use Zone</td>
<td>8</td>
<td>89884</td>
<td>8825</td>
</tr>
<tr>
<td>Shopping Mall</td>
<td>4</td>
<td>32595</td>
<td>7485</td>
</tr>
<tr>
<td>Bank Offices</td>
<td>11</td>
<td>37638</td>
<td>4335</td>
</tr>
<tr>
<td>Others (Commercial, Restaurant)</td>
<td>More than 150</td>
<td>25000</td>
<td>2870</td>
</tr>
<tr>
<td>Total Activity</td>
<td></td>
<td>286207</td>
<td>34170</td>
</tr>
</tbody>
</table>

The table shows that the parking demand, according to Building Construction Rules 1996, is 34170 sq.ft for the CBD area.

B. Number of Vehicles and Their Space Requirement

The number of parked vehicles in the study area during peak period (Weekday) is 525. In weekday Rickshaws occupy 4134 sq.ft, 28 cars occupy 6916 sq.ft.

**TABLE II: PARKING DEMAND IN THE STUDY AREA ACCORDING TO NUMBER OF VEHICLES (PEAK HOUR) [6]**

<table>
<thead>
<tr>
<th>Types of vehicles</th>
<th>Weekday</th>
<th>Weekend</th>
</tr>
</thead>
<tbody>
<tr>
<td>No.of</td>
<td>Required</td>
<td>No.of</td>
</tr>
</tbody>
</table>

DOI: [http://dx.doi.org/10.24018/ejers.2017.2.9.453](http://dx.doi.org/10.24018/ejers.2017.2.9.453)
Table III: Distribution of Number of Vehicles According to Duration and Type of Vehicles

<table>
<thead>
<tr>
<th>Type of vehicles</th>
<th>Average number of vehicles parked</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Weekday 11:30AM-12:30 PM</td>
</tr>
<tr>
<td>Rickshaw</td>
<td>106</td>
</tr>
<tr>
<td>Car</td>
<td>28</td>
</tr>
<tr>
<td>Micro/ Pick up</td>
<td>72</td>
</tr>
<tr>
<td>Bus/ Truck</td>
<td>11</td>
</tr>
<tr>
<td>Auto/ CNG</td>
<td>146</td>
</tr>
<tr>
<td>Van</td>
<td>56</td>
</tr>
<tr>
<td>Motorcycle</td>
<td>106</td>
</tr>
<tr>
<td>Total</td>
<td>525</td>
</tr>
</tbody>
</table>

The demand according to type of Building Construction Act:

- Demand according to type: \( D_A = 34170 \text{ sq.ft} \)
- Demand according to type of number of parked vehicles: \( D_v = 43821 \text{ sq.ft} \)

So the parking demand for CBD area in Pabna Municipality can be estimated as follows-

\[
\frac{\sum D_A + D_v}{3} + \frac{34170 + 43821 + 43821}{3}
\]

\[
= \frac{34604 \text{ sq.ft}}{3} = 11534.67 \text{ sq.ft}
\]

E. Conflict Point in CBD Area

Due to the on-street parking some conflict points are created near the undesignated parking spaces. For improper distribution of parked vehicle at the undesignated spaces some conflict points are found during the survey period.

Fig. 5. Conflict point in CBD area

V. Recommendation

The present study finds that there are no public parking facilities. There are some of the parking lots for some residential building, banks, cinema hall and auditorium but this is used only for their own purposes. There is no parking space for hotel, restaurant, shopping mall, commercial site, small or single shops etc.

A. Adopting Proper Sign, Symbol and Markings

Proper directional parking sign including parking charge, parking type is needed to overcome this situation. This sign should be placed at different places of Abdul Hamid road, Boro Bridge road, Fazlul Haque road, and H.M. Mohsin road thus the Parker can easily understand which place is legal or prohibited parking space.
The feasible option is that the delivery vans should be allowed only at the off peak period of the day in three different slots at 06:00 AM – 09:00 AM, 02:00PM – 03:00PM and 09:00PM – 10:00PM to conduct their activities. This will avoid the on street occupancy at the peak traffic periods. Provisions for Two Wheeler (Bicycle & Motor Bike) Parking Space. The area is the South – West site of Traffic Morr, in front of A.R. Plaza and Khan Bahadur Shopping Mall, beside Muktijoddha Market and Sonali Bank there is space where two wheeler vehicles can be accommodated.

The parker who parked the vehicle at the undesignated space should be under penalty for his illegal activity. The concerned traffic police of Pabna Sadar Thana will impose the penalty according to their law and the leaseholder of the parking space will help him to identify the illegal parking. This coordinating approach should help to reduce the illegal parking activity.

### VI. CONCLUSION

The outcome of study has represented the inadequate space for parking. Lack of maintenance of the present system and lack of implementation of the rules and regulation related to the parking makes the situation worse. Improvement of parking situation is the immediate need by creating parking supply blending with the impose rules and restrictions against illegal parking. By which the traffic jam, accidents can be removed. Proper parking spaces not only help to solve the transportation problems like traffic jam, accidents but also increase the aesthetic beauty of a city. A proposed multistoried parking scheme has been suggested in the recommendation section that due to land scarcity. For the future plan this study will help to provide better ideas about parking problems. A proposed multistoried parking scheme has been suggested in the recommendation section that due to land scarcity. For the future plan this study will help to provide better ideas about parking problems. Besides this solution some other strategies should be introduced to reduce the parking problems like better facilities for short time parkers to reduce the parking demand. It is the task of the urban development authorities to cater to the demand for parking.

### ACKNOWLEDGEMENT

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