Journal of Bangladesh Institute of Planners ISSN 2075-9363
Vol. 6, December 2013, pp. 161-172, © Bangladesh Institute of Planners

Parking Demand and Supply Analysis of Major Shopping Centers in Dhaka – A Case Study of New Market Shopping Center along Mirpur Road

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Abstract

In Dhaka, a rapidly urbanizing mega city, different private car friendly policies and infrastructure development encourage more people to own and use private. This large number of cars require huge parking space. On-street car parking is now creating severe transportation problems in major roads of Dhaka city, like Mirpur road, which is lined with numerous office and commercial spaces and shopping centers. This paper aims to explicate the parking scenario of the major shopping centers of Dhaka through analyzing the parking and demand supply of New Market, which is a very popular shopping center of this city. The study tried to explore the possibilities of moderating the present parking problems of this market, for which a site-specific study was conducted rather than a city-or nation-wide determination of parking characteristics. Required data has been collected from two parking surveys – parking space inventory and parking usage survey by patrol, conducted on two separate working days each covering five hour periods. The study found that the average duration of parking in New Market area is around 45 minutes and a considerable portion of cars occupy the parking area up to 3 to 5 hours which lessens parking turnover. Through analyzing the parking demand and supply of a prominent shopping center of Dhaka city, this study invokes parking characteristics which is a common feature observed in other shopping centers or even in other land uses. Therefore, the findings can be used to provide targeted solutions by addressing specific problems in the parking tendencies.

Introduction

Dhaka is a densely populated city which hosts a population of 14 million, making it the 19th largest city of the world (WorldAtlas, 2013). It is the capital and busiest city of Bangladesh which is the main center of education, administration, trade, commerce, etc. These land uses are attracting traffic from all corners of the country. The present conditions of parking have worsened because the numbers of private car have increased and more and more people have opted to travel

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by private car. According to the Bangladesh Road Transport Authority (BRTA), the number of registered cars in Dhaka up to May 2013 was 185,619 (BRTA, 2013). These cars had been used only for private purpose and constituted almost 25% of all motorized vehicles registered within Dhaka city. Among all other vehicles, private cars create nuisance in various aspects. It has been found that for 95% of their time on road, cars remain stationary – which means that most of the time they are parked which consumes large amount of road space (Bari & Efroymson, 2006). Moreover, as off-street parking is not adequately developed for all land uses in Dhaka, these cars frequently use roadside spaces for parking in free or insignificant amount of charges. Mahmood et al. (2009) asserted that for a city with 80,000 people per square kilometer, the problem of parking is becoming very much severe which the planners failed to realize. In Dhaka city, specially large shopping centers attract huge amount of traffic. Inadequate parking provisions in these shopping centers contribute to the problems in traffic movement (Quazi, 2003). There are around 3,000 roadside shopping centers in Dhaka, and most of them do not have adequate provisions for parking (Rahman M. S., 2010). Mirpur road, being one of the major arterial roads, consists of numerous shopping centers along its route and there has been an increase in the parking of cars on roadside (Bari & Efroymson, 2006). Before any measures for the betterment of the conditions of parking can be formulated, it is required to obtain information concerning the capacity and usage of existing parking facilities (Kadiyali, 2007; UIdaho, 2013).

Unfortunately, there is little research on parking condition of Dhaka city. This context provides the motivations for this study: its objective is to analyze present parking demand and supply situation of different shopping centers along Mirpur road to formulate some initiatives for the improvements of present parking situation.

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 with the notion of movement whereas parking involves the condition when the vehicles are stationary. It is becoming a crucial issue in managing the transportation system since it affects the overall accessibility of a city (Litman, 2012). Providing suitable parking spaces has become a challenge for the transport planners in the scenario of ever increasing private car ownership. In order to identify the situation or measure the betterment of conditions, the availability of parking space, extent of its uses and determination of parking demand is very essential. Also it is required to estimate the parking fares and duration of parking. Depending on the land use characteristics the demand of parking varies, which is influencing the supply parameters.

This becomes more critical in a degenerated transportation management scenario like that prevailing in Dhaka city where most people prefers to use cars in the busy commercial centers. A study conducted by Rahman K. N. (2007) revealed that 60% of the vehicles parked in Motijheel, the busiest commercial area of the city, are private cars. Thus the viability of these commercial areas depends on the availability of convenient parking facilities adjacent to or easily accessible to desired destinations, especially off-street parking facilities. As pointed out by Mahmud et at. (2012), the problem is worsened by the absence of any effective parking policy for Dhaka where illegal on-street parking is a common scenario in every busy street. This constricts the available carriageway for traffic, thus posing as one of the major contributor to traffic jam. Studies show that the vehicles cruising for on-street parking create 8-74% of the traffic congestion (Shoup, 2007). He also found that under pricing of on-street parking is the main cause behind increased tendency to cruise rather than parking on a vacant off-street parking. To ameliorate the parking problems of Dhaka city, Mahmood et al. (2009) suggested identifying available parking spaces and introducing metered parking or monthly-parking permits to control parking tendency.

Frequently and most importantly the question lies in determining the indispensable demand that has to be accommodated. The Institute of Transportation Engineers (ITE) in its period report developed a guideline specifying the number of parking bays required for 1,000 square feet of each category of land use. For shopping centers, ITE recommended 5.05 parking bays for 1,000 square feet area of this land use (ITE, 2010). This area includes shops and also restaurant spaces because of its significant influence on parking demand (ITE, 2013). ITE has developed this standard in a context where a large number of trips are made by cars and where alternative transport options are minimal (Shoup, 1999). The study conducted for preparing Strategic Transport Plan for Dhaka shows that only 7.6% of the people use cars for making internal trips (GoB, DTCA, 2005). Hence, it is inappropriate to apply this standard to provide the minimum number of parking bays in Dhaka city where most of the people use other modes.

Study Area Profile

Among the numerous shopping centers along Mirpur road, New Market is the oldest and busiest one. It is one of the 150 markets of Dhaka City Corporation (DSCC, 2012). After its opening in the year 1954 on 35 acres of land, it served the inhabitants of Dhaka city which is now serving people outside of Dhaka as well (Media Bangladesh, 2012). People of different income groups visit this market everyday as it caters their diverse requirements. A total of 468 shops, occupying a total floor area of 560,683 square feet, host a range of items from books, stationeries, jewellery to groceries and fast foods. A mosque is located at the center inside the triangular area (Figure 1). The central triangular market area and the eastern and western edges are one storied, while the northern edge is extended up to three storeys. This open air shopping complex attracts a huge amount of traffic, a major portion of which are cars that are parked on-street when the market is open for six days in a week. Moreover, the designated space for on-street parking proved to be inapt as the surrounding road is overburdened with parked cars which create traffic congestion. All these conditions made this shopping center ideal for selecting it as the study area to depict the parking demand and supply scenario of the commercial land uses in general for Dhaka city.

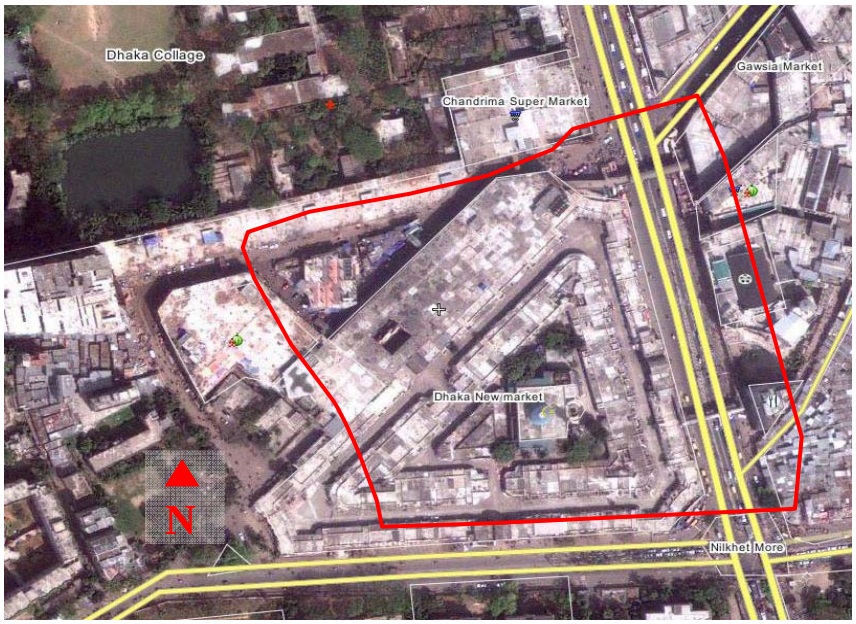

Figure 1: New Market and its Adjacent Areas; Source: Wikimapia.org, 2011

Methodology and Data

In order to collect data on existing parking facilities, one is confronted with the problem of the scale of survey. MAPC (2010) documented that parking surveys falls into one of the two categories, i.e., area parking survey and site-specific parking survey. The first category considers all available parking spaces of an area, thus it opens the possibility of shared parking among different land uses. It also provides information about the compatibility of parking supply and demand considering local zoning requirements. The latter category of parking survey, as the name implies, is conducted for a small area or a land use to determine the localized parking supply and demand. This data provides more realistic parking characteristics of a locale as the traditionally developed national level parking ratios runs the risk of providing unused extra spaces and thus resulting in monetary wastage.

Since one study area has been selected for this study, data has been collected through site-specific surveys. The existing parking demand and supply conditions of New Market have been explicated through seven measures of parking – parking accumulation, parking volume, parking load, parking turnover, average parking duration, parking spill-over and probability of rejection. These seven parking measures have been evaluated by using the data gathered by conducting two parking surveys – parking space inventory and parking usage survey by patrol.

The surveys had been conducted on two separate working days. In the first day, parking inventory survey had been carried out to collect data on the amount, type and location of space actually or potentially available for parking in an area. Parking usage survey by patrol had been conducted on the following day which included counting parked vehicles at 30 minutes intervals through a period of five hours, covering both the morning and evening peak periods. Pilot survey showed that the influx of customers were high during 11:00 to 12:30 and 15:00 to 18:30. This excludes the period in the early morning when the market is yet to open and the lunch period in the afternoon.

New Market has been served by on-street parking space at four locations adjacent to the market. Surveys only included these locations as there are no off-street parking provisions.

Existing Parking Demand and Supply Conditions

Parking Inventory of New Market

The four designated parking spaces of New Market have contained both marked and unmarked parking provisions with an hourly charge of BDT 10, which is collected by a supervisor. There has been no signage related to parking or markings denoting parking restrictions. The arrangement of the parking space around New Market is portrayed in Figure 2.

Parking Space 1

Parking Space 1 has been divided into two sections around Gate 1 (Figure 2). At the right side of Gate 1, marked parking bays have been provided with a capacity of 20 cars at a time. This parking lot has marking for 60^{o} parking but this marking have not been followed by the parked vehicles as observed during the survey. To use the minimum kerb length, cars have been parked perpendicularly. Space on the left side of Gate 1 have also been used for parking purpose but have been unmarked unlike the other one. This is why both perpendicular and parallel parking have been evident with a maximum capacity of 29 cars if parked perpendicularly. A total of 421 feet of kerb length of 17 feet of the carriageway width have been used for parking. Both of these spaces have some indentation of the kerb to allow for some parking space to reduce impact on road traffic.

Parking Space 2

Another designated parking space has been provided opposite to the New Market Gate 1 (Figure 2). Although the markings denoted parallel parking, all cars have been parked perpendicularly using 400 feet of the kerb length and 8.5 feet of the carriageway width. It consisted of 20 parking bays according to the markings.

Parking Space 3

Total kerb length (630 feet) of the road along the New Super Market has been used for parking which is unmarked (Figure 2). Mainly the customers of Katcha Bazaar (kitchen market) and the freights use this parking space. Although a longer kerb length along the New Super Market has been available here for parking, the road has not been wide enough to support on-street perpendicular parking. So, a mixture of perpendicular and parallel parking has been observed during the survey period, which has created an unsystematic and jeopardized picture. A maximum of 31 cars can be parked using 8.5 feet of the carriageway width if parallel alignment to the kerb is maintained.

Parking Space 4

Beside New Market Gate 2, a marked parking space has been observed along the Mirpur road covering 248 feet of the kerb length. The markings directed for perpendicular parking have been barely visible. Indentation of kerb has also been found to accommodate 15.6 feet of the car length. Often, at least an extra row of cars have been parked in parallel in front of the designated perpendicular parked space (Figure 2). Considering the allowed parking arrangement, a total of 20 cars can be parked at a time in this space.

Parking Usage Characteristics of New Market

Data from the parking usage survey have provided useful information about the parking tendency of the car users which resulted in the existing parking problems.

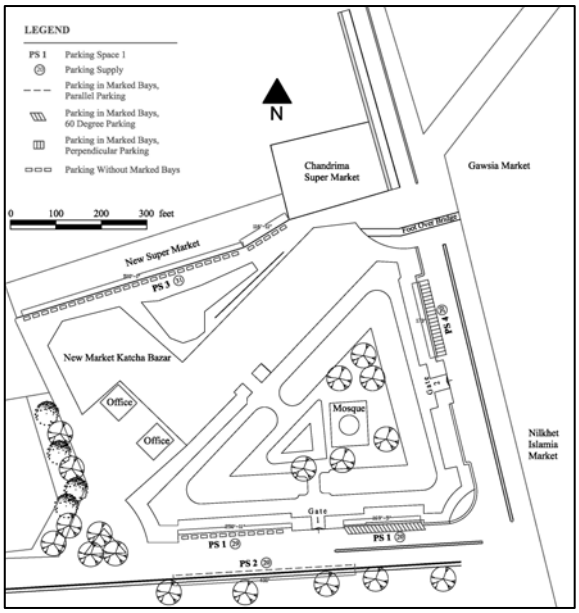

Figure 2: Locations of Existing Parking Provisions around New Market; Source: Field Survey, 2011

Parking Space 1

The overall volume on both sides has been 290.9 vehicles per 5 hours. The number of vehicles parked at a given instant of time is shown in the Figure 3. From the figure, it is found that parking load throughout the day has not been the same, not even close to the average accumulation also. Highest parking load has been found from 11:30 to 12.30 and minimum from 15:00 to 15:30 and calculated total parking load is 257.5 veh-hr. Some motorcycles and bicycles have also been parked in this space along with private cars.

The rate of usage of the available parking space in front of the Gate 1 has been 3.87 vehicles per bay within 5 hour. So the efficiency of this parking lot has been 69%, whereas average length of time spent in each space by each vehicle is 53.1 minutes.

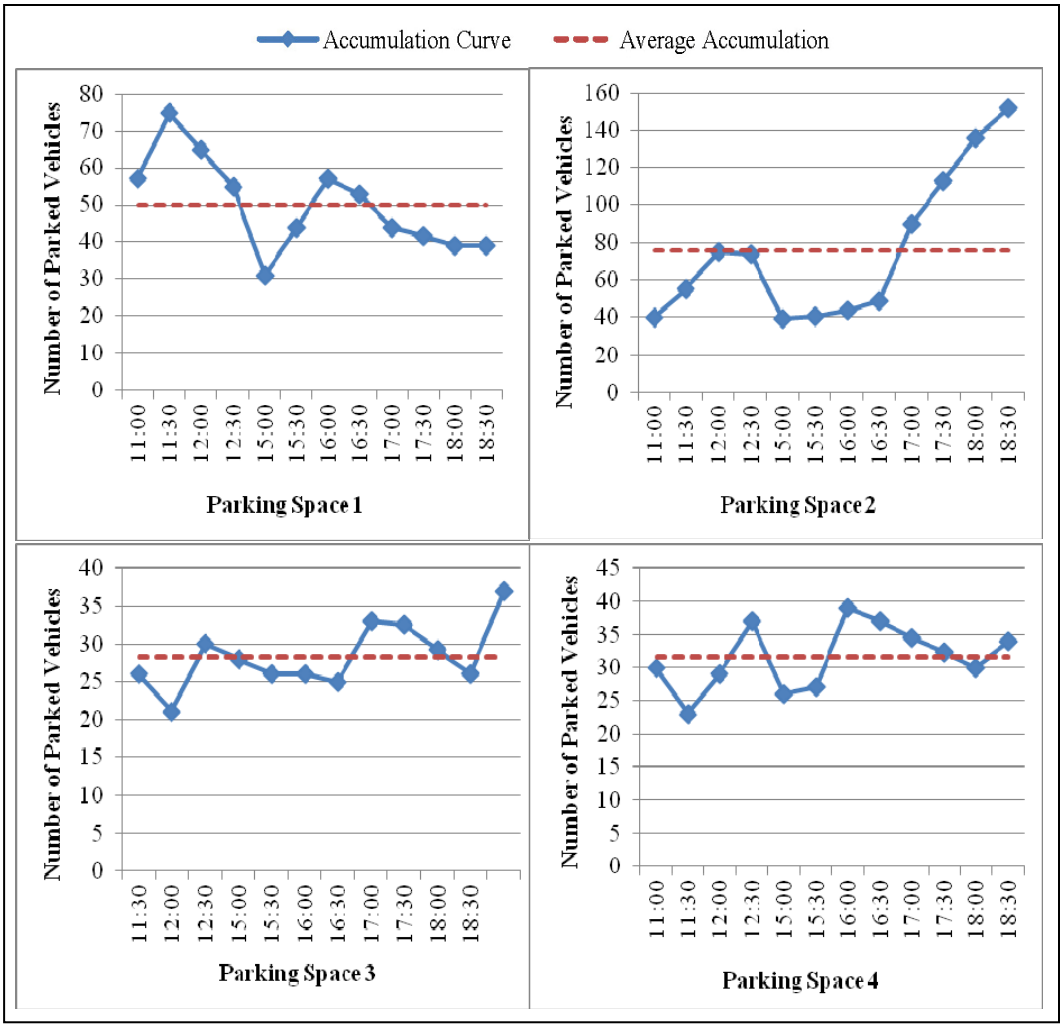

Figure 3: Parking Accumulation Curves Showing the Number of Parked Cars at Different Times of the Day; Source: Field Survey, 2011

Parking Space 2

The parking accumulation curve for the Parking Space 2 shows that the parking accumulation has been high in the evening, because of the addition of one row of parallel parking along with the regular one row of perpendicular parking (Figure 3). The total parking load has been 355.7 veh-hr. Despite the capacity of only 20 vehicles, more than 150 cars have been kept using the extended kerb length. This has resulted in the low efficiency level of this lot which is about 47%. Total parking volume in this parking lot has been 407 vehicles per 5 hours. Average length of time spent in each space by a single vehicle has been 52.4 minute and the rate of usage of one parking space has been 2.7 vehicles in a 5 hours period.

Parking Space 3

As loading and unloading of goods has been frequent throughout the day, a small change has been observed in the number of parked vehicles over the five hour period (Figure 3). In other words, there has been a little deviation from the mean number of parked vehicles.

Most often, the entry and exit of parked vehicles have halted the moving traffic and has resulted in a long queue of stagnant vehicles. Regarding these conditions, the parking volume and load has been low compared to the other parking spaces of New Market, which only reached 186.7 vehicles per 5 hours and 138.5 veh-hr, respectively. As the major portion of the parked vehicles constituted freight vehicles, the average parking duration has not been very long. It has been about 44.5 minutes. The efficiency of this parking lot has been 71% and the rate of using each parking space has been 4.8 veh/bay/5 hr.

Parking Space 4

Number of vehicles parked fluctuated mildly throughout the day (Figure 3). Parking volume has been 296 vehicles per 5 hours and parking load has been 155.8 veh-hr. As a result, the average parking duration attained by vehicles has been 31.6 minutes which causes a large turnover of 7.4 vehicles per bay in a period of 5 hours with a notably high efficiency of about 78%.

Findings from the Present Parking Usage Characteristics

Considering all the four parking spaces, the volume of parked cars has been 236 vehicles per hour. It has been observed that there is a large gap between the supply and demand for parking for New Market. Parking demand has been high from 12:00 to 12:30 and after 17:00. The maximum parking demand has been found to be 306 bays where the total maximum supply has been only 120 bays. Therefore, the maximum parking demand for New Market has exceeded 2.5 times the supply with a spill-over of 155%. Number of parked cars has exceeded the supply all through the peak activity period of the marked. The average spill-over over 5 hours in a day has been 55% considering that all the available parking bays have been occupied in all the four parking spaces. All this reveals that most of the cars attracted by this land use occupy road space. The spill-overs can be attributed to some extent to the low parking turnover and high average parking duration.

Due to low parking charge and weak enforcement of parking regulations, most of the cars have been parked for longer periods. Only BDT 10 has been charged for parking a car for unlimited time period. Because of this, cars from other land uses infiltrate this parking facility, the passengers of which have no business in this shopping center. This scenario has been portrayed in the turnover of about 4.7 vehicles per bay per 5 hours for New Market. This means that less than five cars have been using a parking space in a period of 5 hours, which has been extremely limiting the efficient use of this space. Although the average duration of parking remained satisfactory, around 4% of the cars have been parked for a duration of over 2 hours, which is a very long to be acceptable for such a demanding generator of traffic.

As all parking has been made on-street, the traffic flow has been hampered considerably. In addition, spill-over effect occurring throughout the day has acquired extra space from the available carriageway. This has resulted in two or sometimes three rows of car parking, especially on the road around of New Market Gate 1 (Parking Space 1) and along the Mirpur Road (Parking Space 4).

Parking of cars requires space to maneuver during embarking and disembarking a bay. This large demand of on-street parking space reduces the traffic flow significantly and leads to congestion. The problem has been observed in the case of New Market especially at peak hours since it provided only on-street parking facility. Following sections discuses about the impact of each parking space that shares the carriageway.

Impact of Parking around Gate 1 (Parking Space 1 and 2)

Of the 90 feet total carriageway width of the road connecting Azimpur to Mirpur Road, 40 feet has been occupied by perpendicular on-street parking on both sides. The change in capacity due to parking has been 4,666 PCUs/hour. As no volume data is available, the volume/capacity ratios cannot be compared for this change. The highest average parking duration (52.7 minutes) and lowest average turnover (3.3 vehicles/bay/hour) have been found in this parking area. In peak hours, about 1,500 feet of the kerb length on both sides has been occupied by parking, magnifying the impact on the traffic flow.

Impact of Parking at the Northern Side (Parking Space 3)

Cars were parked here along a kerb length of about 626 feet. The road has been used by rickshaws and vans, the movement of which has been hampered in peak hours due to parking. As the road width is only 36 feet, with the parked cars occupying 8.5 feet (parked parallel) to 18.5 feet (parked perpendicularly), car maneuvering has blocked almost the remaining width of the road and contributed to frequent congestions along this road length.

Impact of Parking between Gate 4 and Gate 2 (Parking Space 4)

The total designated carriageway width for the northbound traffic of Mirpur road is 54.4 feet. Usually cars have been parked in two extra rows over the designated one row of parking (one perpendicular and two parallel), which require a total road width of 37 feet. As the sidewalk has indented inwards to provide 15.6 feet of parking space, the effective carriageway width becomes 21.4 feet. Road width used by normal traffic flow has thus been reduced to a mere 33 feet, which is very low for a busy arterial road like this.

Table 1: Impact of On-Street Parking on Volume-Capacity Ratio

Effective Carriageway Width (feet)	Capacity (PCUs/hr)	Service Volume (PCUs/hr)	v/c Ratio
33 (with parking)	3850	1595	0.41
54.4 (without parking)	6346	1595	0.25

Source: Field Survey, 2011

Assuming 12 feet per lane and a capacity of 1400 PCUs/hr for each lane (DITS, 1994), there has been a significant change in volume-capacity ratio (about 64%) from the condition without any presence of on-street parking (Table 1). Hence, a considerable impact of on-street parking on the traffic flow is evident.

Impact of Parking and Traffic Load

Impact of parking increases when parking spaces are full at maximum load, during which drivers move around, searching for vacant places to park (Black, 1981). These movements hamper the flow of traffic, particularly when parking is made on-street. Hence, a useful relationship can be established between the probability of being rejected from parking with the impact on traffic flow of the road in case of on-street parking. It is important to note that the probability of rejection increases with the traffic load and decreases with the increase in number of parking spaces. Following are the formulae provided by Black (1981) and UIdaho (2013) to calculate the probability of rejection.

$$A = QT_d$$

where,
A = traffic load;
Q = number of vehicles arriving per unit time (parking volume);
T_d = average parking duration.

$$P_r = \frac{A^M/M}{1+A+\frac{A^2}{2!}+\cdots+A^M/M!}$$

P_r = probability of rejection
M = number of parking bays

Table 2 shows the values used in the calculation to estimate the probability of rejection of a vehicle coming to park in the parking spaces of New Market.

Table 2: Calculating Probability of Rejection

Land Use	Volume, Q (veh/hr)	Average Duration T_d (hr)	Traffic Load, A (veh)	Supplied Parking Bays	Probability of Rejection, P_r
New Market	236.04	0.76	179.39	120	0.55

Source: Field Survey, 2011

Probability of rejection for New Market parking area is 0.55. This means that there is a chance of rejection of 55 out of 100 cars coming to park in any of the parking bays at the four locations. These cars cruise on the roads surrounding New Market per hour to look for vacant on-street parking spaces and have a high possibility of interfering with the normal traffic flow, ensuing in frequent traffic congestion on these roads, which is also found by Shoup (2007) in a study which was conducted for determining the time taken to find a kerb parking space in Los Angeles.

Policy Implications and Conclusion

If the average spill-over found from the survey is taken into consideration, 66 more parking bays need to be added, elevating the total supply to 186. Since this increase in supply would not alone relieve the parking pressure, it should be supplemented by optimum parking pricing policy. The parking facilities provided for New Market are on-street which occupies the limited road space designated for movement of traffic. Therefore, on-street parking cannot be a reasonable solution to the parking problem and should be discouraged accordingly. A demand based parking management should be pursued which is advocated by parking policies for Dhaka Metropolitan Development Plan Area (DMDPA). Based on the findings of the study, following policy

recommendations are deemed to be helpful for the study area in recovering from the prevailing adverse parking conditions:

a) All existing on-street parking should be limited or prohibited altogether as it greatly restricts the practical road capacity. Also, rows of vehicles in front of an establishment are nuisance to the passerby and also vitiate the appeal of the shops to potential customers.

b) There should be a provision of increasing the parking charge in peak hours. This would definitely affect the parking duration of each car. For instance, if the parking duration of those cars which are parked more than two hours can be limited to 2 hours, another 46 cars can be accommodated by using the same space. The amount to be charged for using a parking bay for an hour should be decided based on a comprehensive study considering time and duration of parking.

c) A shared parking can be developed to ease the parking demand of commercial and other establishments. Since Mirpur road serves a wide range of adjacent land uses, they have different peak and off-peak hours of activity and thus can share a parking facility. Therefore, shared parking ensures that the existing spaces are used more efficiently and helps to improve urban design (US EPA, 2006; Banerjee and Associates, 2003). For instance, on Tuesdays, when the markets are closed along Mirpur road, parking from other uses can be allowed on charge to generate revenue. It is found that by adopting a shared parking strategy, a mixed use development in Arlington, county of Virginia, USA reduced parking requirement by 25% (US EPA, 2006).

d) To stop the tendency of haphazard parking, all designated parking areas should be marked showing the desired parking alignment and anyone failing to comply with it should be fined with an extra charge.

e) More than 80% of the space of the sidewalks surrounding New Market is occupied by street vendors, making it unattractive to be used by pedestrians. If this space can be freed and linked efficiently to the sidewalks of the connecting streets, then people would be more encouraged to walk to the market rather than using cars. In addition, facilities for bicycle riders can be introduced to make the environment more secure and pleasant. US EPA (2006) discussed several design considerations to ensure access for the pedestrians and cyclists, so people would be less inclined to travel by cars. Moreover, proper integration of public transportation with the major shopping centers and residential areas of Dhaka can reduce car usage to a large extent. All these would in effect reduce car usage to visit New Market, thereby minimizing the parking demand.

f) An amount from the revenue generated by parking charges should be allocated for the maintenance and repair work of the parking spaces.

One crucial issue revealed in this study is that the parking demand have increased at an alarming rate and it becomes difficult to fulfill the existing parking demands of large commercial complexes like New Market with its existing parking facility. Although the average duration of parking in New Market area is 45 minutes, a considerable portion of cars stay as long as 3 to 5 hours which lessens the parking turnover Therefore, it is sensible not to provide parking spaces without any regulation or control and it should be discouraged rather than providing attractive facilities to park more.

In another aspect, the market needs these customers to survive and their interest should also have to be emphasized. So, a complete ban on car parking is not feasible, instead a standard facility

should be developed which will provide a minimum provision of parking without sacrificing the normal traffic flow and the convenience of pedestrians. In this way it will satisfy the demands on both ends. As observed from the study, most of the car parkers are idling on the parking space because of low parking charges and lack of parking controls. Thus, much of the existing problems can be resolved with policy changes which should be targeted to make the existing parking lots more functioning.

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