Current Vehicle Parking Situation in Khulna City Corporation

N. G. Das, S. A. Ali , M. A. Rahman, Q. S. Hossain , M. I. Nazir

Abstract— **The impact of increasing economic activities left most Asian cities confronted with various parking problems such as insufficiency of parking spaces, illegal parking, ineffective parking ordinances, etc. The parking characteristics provide a clear understanding of the parking system which is essential in any planning and implementation of car parking within a city. This study explores the parking characteristics in the Central Area of Khulna Metropolitan City, Bangladesh, specifically on the adapted parking ordinances, the current parking supply, the degree and efficiency of parking space utilization. An inventory on the parking supply revealed that most of the available parking spaces are sufficient against current demand. Parking charges are not allocated for both off-street and on-street parking. The off-street parking spaces are available around the New Market and its parking capacity is more than that of on-street parking capacity on Dakbanglo Mor. the degree of utilization of off-street and on-street parking facilities are analyzed and compared with each other. It has been revealed from the study that the current supply of parking space is enough to meet the current parking demand.**

Index Terms*— *Parking, on-street, off-street, parking turnover, parking demand and supply

I. INTRODUCTION

Metropolitan centers in Bangladesh are increasing both in number and population. The economic activities like trade, commerce and administration are increasing rapidly. The improvement in the economic status of the people coupled with availability of personal modes of transport has contributed to the growth in vehicular traffic at this activity centers. The economic activities in the form of wholesale trade, commerce, house hold industries, administration and tourist spots generates heavy traffic to and from these areas [1] The typical feature of these areas is that the carriageways and footpaths, meant respectively for vehicular and pedestrian traffic, are occupied by hawkers and vendors reducing the capacity of carriageways, adding to the problems of crawling traffic and choked roads. As of today the commercial areas in every city are faced problem of parking congestion, accidents and environment pollution. Previous studies have shown that the capacity of the road network can be reduced considerably if parking facilities and locations are not selected and controlled properly [2,3]. The parking characteristics of an area provide a clear understanding of the parking system which is essential in any planning and implementation of car parking within a city. Hopefully, the results of this study would pave the way for better understanding about the current parking situation in Khulna City Corporation.

Khulna is the 3rd largest city in Bangladesh. It is located on the banks of the river Rupsha and Bhairab & at the Southwest of the country. Khulna City Corporation is the third largest metropolitan city in terms of land area, covering 45.65 square Kilometres in Bangladesh. The city centre consists of 17.84 square kilometres where the central business district is located.

The primary purpose of the study is to investigate the current car parking situation and develop effective measure that help to understand the current parking situation in Khulna Metropolitan City, Bangladesh. Specifically it is aimed at achieving the following objectives:

- To study the existing parking condition in Khulna metropolitan city.
- To give strategic suggestions with respect to the existing parking system.

The historical development of traffic system indicated that parking was initially provided on the roadway, which contained space capacity [4]. It has been noted that this type of parking comprises roughly 60 to 90% of the parking requirements in small town and around 30% in urban areas [5]. Urbanization and traffic growth have made road networks congested and demand more parking spaces, prompting traffic authorities to prohibit on-street parking. Once parking is taken from the street, and a parking area is used for storing vehicle, this is referred to as off-street parking [4].

Parking demand in Khulna City Corporation is met mainly by roadside parking i.e., on-street parking along the major road and the only off-Street parking facility which is provided at the New Market area. This study covered limited but strategic areas of Khulna metropolitan city. The areas are New Market and Dakbanglo Mor. Figure 1 and Figure 2 show the parking facilities provided at New Market and Dakbanglo Mor respectively.

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Figure 1 Off-street parking at New Market

Figure 2 On-street parking at Dakbanglo Mor

I. METHODOLOGY

The data has been collected by using two features namely Inventory of parking facilities and On-street License plate survey technique. A short description about these two features is given below.

A. Inventory of parking facilities

Inventories of both on-street and off-street parking facilities were carried out to determine the availability of parking spaces in the Central Business Area (Dakbanglo Mor & New Market). On-street parking inventories were carried for marked spaces. Marked curb spaces were manually counted by a group of surveyors. The number of spaces was tabulated according to site. Curb parking inventory includes the location of spaces, parking orientation and the characteristics of the adjacent streets.

A separate inventory of off-street parking facilities in the study site (New Market) was conducted manually to determine the availability of parking spaces in the study site.

B. License Number Plate Survey

The main purpose of this survey is to gather information on the degree of utilization of parking facilities and demand of parking in the study sites. On-street parking survey was carried out on Wednesday, from 8:00 A.M. until 7:00 P.M. Since, the availability of Wednesday to monitor the whole site in one setting was possible, the survey was conducted in two consecutive Wednesday, one day for each site. Two surveyors were assigned to monitor at Dakbanglo Mor. The license number plates of parked vehicles, their location, time arrival, and time departure were checked and recorded by the surveyors assigned to monitor the vehicles in their respective assignment, revisiting each space within their scope at every 30 minutes interval. Three digits of the plate numbers were recorded.

Other surveyors were assigned to monitor the vehicle parked in off-street facilities. It was conducted simultaneously with the on-street parking survey. License number plates of parked vehicles were checked and recorded and time of arrival or departure was recorded at the instant of observation.

The survey in New Market was conducted from 8:00 A.M. until 7:00 P.M. on Thursday. Surveyors were positioned at the entrance and exit points to record the time-in and time-out of each vehicle corresponding with their respective number plates. Separate observational surveys were conducted on the facilities to gather information on the travel time, and parking time within the system.

Data gathered from the survey were analyzed using conventional statistical approach and specialized computer software. The degree of parking utilization and description of parking characteristics in the study sites are the core of this study. Analyses were carried out in zone by zone basis. Parking supply and demand for each site were analyzed by comparing the parking capacity and observed vehicles.

II. RESULT & DISCUSION- PARKING CHARACTERISTICS

To provide an overview, present parking practices and the parking ordinances imposed by local authorities are presented. Parking inventory for both on-street and off-street parking facilities are covered as well. Furthermore, a site by site analysis on the utilization of parking facilities is also presented to elaborate the present parking demand. The following deliberations discuss the results obtained in Khulna Metropolitan city.

A. Parking Ordinances and Provisions

A separate inventory of off-street parking facilities in the study site (New Market) was conducted manually to determine the availability of parking spaces in the study site

i. On-Street Parking Ordinance- On-street parking is commonly noticed in the central business area of Khulna Metropolitan City. Actually, there is no specific on-street parking ordinance enacted by the city government. The parking demand does not reach at a problematic level so city government does not make on- street parking ordinance.

ii. Off-Street Parking Ordinance- There is no specific off-street parking ordinance enacted by the city government. However, the off-street parking site is around the new

market, here parking demand is also within tolerable limit but there is not proper management i.e. haphazard parking, conflict, collision etc. are noticed in the site.

Table 1 Summary of parking space inventory

Site	Off street (space)	On street (space)	Overall (space)
New Market	34	0	34
	100%	0%	100%
Dakbanglo Mor	0	14	14
	0%	100%	100%
Total	34	14	48
	70.83%	29.17%	100%

A. Parking Inventory

A complete parking space inventory was conducted, which include the location, capacity, and type of facility of both on-street and off-street facilities in the two selected study sites of Khulna metropolitan city. The summary of parking spaces available in the study site is presented in table 1. Of the total supply 48 spaces, Only 14 curb parking spaces are available here. Though the facility seems to be limited but with respect to on-street demand it is sufficient. The parking stall pattern is angular or inclined with respect to the traffic flow. The length of marked on-street parking stalls were less than 6.0 meters long. The observed stalls are equal in length and are located along the busiest street such as Dakbanglo Mor. A total 34 off-street parking spaces were recorded in the study site (New Market). No such parking facilities have been established by the city government yet. This emphasizes the need for continued development off-street parking facilities.

Table 2 Parking accumulation pattern in the study area

Study Area	Type of facility	A.M.								P.M.			
		8.00	8.30	9.00	9.30	10.00	10.30	11.00	11.30	12.00	12.30	1.00	1.30
New Market	vehicle	0	0	0	2	1	5	10	20	22	25	13	15
	Available space	34	34	34	34	34	34	34	34	34	34	34	34
	V/C ratio	0.00	0.00	0.00	0.06	0.03	0.15	0.29	0.59	0.65	0.74	0.38	0.44
Dakbanglo Mor	vehicle	0	0	3	2	2	2	4	4	6	4	5	4
	Available space	14	14	14	14	14	14	14	14	14	14	14	14
	V/C ratio	0.00	0.00	0.21	0.14	0.14	0.14	0.29	0.29	0.43	0.29	0.36	0.29
Overall Accum-u lation	vehicle	0	0	3	4	3	7	14	24	28	29	18	19
	Available space	48	48	48	48	48	48	48	48	48	48	48	48
	V/C ratio	0.00	0.00	0.06	0.08	0.06	0.15	0.29	0.50	0.58	0.60	0.38	0.40

Study Area	Type of facility	P.M.										
		2.00	2.30	3.00	3.30	4.00	4.30	5.00	5.30	6.00	6.30	7.00
New Market	vehicle	18	8	5	5	5	8	8	16	26	28	34
	Available space	34	34	34	34	34	34	34	34	34	34	34
	V/C ratio	0.53	0.24	0.15	0.15	0.15	0.24	0.24	0.47	0.76	0.82	1.00
Dakbanglo Mor	vehicle	5	6	3	1	3	2	5	8	6	6	7
	Available space	14	14	14	14	14	14	14	14	14	14	14
	V/C ratio	0.36	0.43	0.21	0.07	0.21	0.14	0.36	0.57	0.43	0.43	0.50
Overall	vehicle	23	14	8	6	8	10	13	24	32	34	41

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Accumulation	Available space	48	48	48	48	48	48	48	48	48	48	48
	V/C ratio	0.48	0.29	0.17	0.13	0.17	0.21	0.27	0.50	0.67	0.71	0.85

A. Parking Utilization

The general utilization indices are: accumulation of vehicle, occupancy ratio, turnover rate, and duration. These are discussed in the succeeding sections.

i. *Parking Accumulation*- This index shows the pattern and timing of vehicle on how they utilized the space. Accumulations are specified according to time and type of facilities. The pattern of accumulations is summarized in table 2. The on-street morning peak occurs from 11:30 a.m. to 12:00 p.m. while the afternoon peak is 5:30 p.m. to 7:00 p.m. as shown in table 2. The maximum overall utilization occurred at 5:30 p.m. when 8 vehicles were observed randomly utilizing 14 available spaces in the study site.

The off-street morning peak occurs from 11:30 a.m. to 12:30 p.m., while the afternoon peak is 6:00 p.m. to 7:00 p.m. as shown in Table 2. The maximum overall utilization occurred at 7:00 p.m. when 34 vehicles were observed utilizing 34 available spaces in the study site. More vehicles utilized the off-street facilities than the curb spaces throughout the day. This is an indicator that off-street parking is widely practiced than on-street parking. Every day many people come to new market for shopping purpose. Moreover, there is many fast food stall which is another cause of peoples coming. On the other hand, at Dakbanglo Mar, car owners come most of the time for official purpose.

ii. Occupancy Ratio- Occupancy ratio or vehicle-capacity ratio is another measure of parking utilization. A ratio of greater than one implies demand exceeds the available space supplied. It determines the degree of utilization and indicates the existing illegal parking.

Table 2 shows the occupancy ratios with respect to time of observation. It is highest from 5:30 p.m. to 7:00 p.m. for on-street parking and from 6:30 p.m. to 7:00 p.m. for off-street parking. Since occupancy ratio is a function of the vehicles observed in the area so it follows the same pattern as that parking accumulation. Table 3 shows the summary of average occupancy rate in the study area. The average overall occupancy rate of on-street facilities is 0.35 while 0.29 for off-street parking. Some even registered a minimum of zero occupancy ratios, an indication that no vehicles were recorded during one cycle time of observation. This indicated that utilization of space is not well distributed. It also reflected the nature of drivers who prefer to park their vehicles nearest to their destination.

iii. Parking Turnover- Another measurement of parking facilities utilization is the parking turnover rate. This measurement reveals the number of vehicles utilizing the same stall over a given time period. Papacostas and prevedours (1993) mentioned that a turnover rate of 4.00 or more during an 8-hour period is considered high [6]. Since the study conducted the observation in 11-hours period, proportionally, a turnover rate of 7.54 veh./stall/day is also high.

Parking turnover rate has been examined separately for on-street parking and off-street parking facilities. As presented in Table 3. On-street parking at Dakbanglo Mor shows an average turnover rate of 19.57 veh./stall/day and off-street parking at New Market show an average turnover rate of 2.59 veh./stall/day. Dakbanglo Mor falls under high turnover rate category. Mostly the on-street parking facilities are used primarily by all-day parkers, thus high turnover rate is obtained.

IV. Parking Duration- Parking duration is the time spent in the parking space. It presents various results depending on the trip purpose and type of facilities. The on-street parking has an average duration of 0.13 hours per vehicle. The average duration of stay in every off-street parking facility is 0.04 hours per vehicle. Duration of stay for every vehicle according to their arrival time were observed and summarized in table 4. The pattern shows that those vehicles arriving at 8:00 a.m. have to stay at least 12.67 minutes. Also, arrivals at 10:00 a.m. to 11:00 a.m. would stay for 69.27 minutes on the average. Vehicle arriving before 1:00 p.m. stayed shorter because of noon break. The duration of stay arriving at 6:00 p.m. is about one and half hour but this result is unreliable since the survey stopped at 7:00 p.m. It cannot be verified whether these vehicles stayed beyond 7:00p.m.

Table 5 shows the volume of parkers with respect to time spent in the parking space. Vehicles have to stay on the parking spaces depending on the purpose of trip. The result showed that 161(48%) vehicles would stay for 30 minutes. This signifies a large number of users are short term parkers and it constituted a large portion of the demand. It is also observed that the percentage of long term parking vehicle is considerably low at the both sites.

B. Parking Demand and Supply

Parking demand refers to the number of vehicles whose driver desired to park at specific location of the study area. It is usually expressed in the number of vehicles. There are two types of parking demands; the latent demand, and revealed demand. Due to limited capabilities to gather data, this study presents only the revealed demand. Revealed demand refers to the actual observation of vehicles in the parking facilities during the study period. While latent demand considers even those vehicles intending to park but due to limited spaces have to be turned away.

Table 3 Parking Utilization Indices Summary

Study Area	Available space	Observed vehicle	Hour used	Average duration (Hr/ Veh)	Rate of turnover (Veh/Stall/day)	V/C ratio		
						Avg.	Min.	Max.
New Market	34	88	11	0.13	2.59	0.35	0.0	1
Dakbanglo	14	274	11	0.04	19.57	0.29	0.14	0.5

Mor								
Total	48	362	22	0.06	7.54	0.32	0.07	0.75

Table 4 Parking duration (minute) according to the time of arrival

Zone	Type of facility	Time of arrival										
		8.00-9.00	9.00-10.00	10.00-11.00	11.00-12.00	12.00-1.00	1.00-2.00	2.00-3.00	3.00-4.00	4.00-5.00	5.00-6.00	6.00-7.00
New Market	On street	0	0	0	0	0	0	0	0	0	0	0
	Off street	0	48	24	33.48	26.88	32.48	18.5	66.5	31.36	42.54	60.71
Sub total		0	48	24	33.48	26.88	32.48	18.5	66.5	31.36	42.54	60.71
Dak banglo Mor	On street	12.67	69	45.27	33.53	32.3	39.31	44	55	34.4	40.21	29.1
	Off street	0	0	0	0	0	0	0	0	0	0	0
Sub total		12.67	69	45.27	33.53	32.3	39.31	44	55	34.4	40.21	29.1
overall	On street	12.67	69	45.27	33.53	32.3	39.31	44	55	34.4	40.21	29.1
	Off street	0	48	24	33.48	26.88	32.48	18.5	66.5	31.36	42.54	60.71
Total		12.67	117	69.27	67.01	59.18	71.79	62.5	121.5	65.76	82.75	89.81

Table 5 Parking demand according to the duration of parking

Sudy Area	**Parking Duration**						
	0- 0.5 hrs	0.5- 1 hr	1- 2 hrs	2- 3 hrs	3- 6 hrs	> 6 hrs	total
New Market	89	58	46	0	0	0	193
	46%	30%	24%	0%	0%	0%	
Dakbanglo Mor	72	38	25	2	2	1	140
	51%	27%	18%	1%	1%	1%	
Total	161	96	71	2	2	1	333
	48%	29%	21%	1%	1%	0%	

One of the important factors that influence the parking demand is the drivers' destination. Parking generators are assumed to be nearest or within convenient walking distance from the parking space utilized. The summaries of parking demands are presented in Table 6. Out of the total 48 spaces available, 362 vehicles were observed utilizing the spaces. Curb space utilization draws the highest demand at 274 vehicles for the 11 hours study period. The demand on curb may even be higher as there are still vehicles parking beyond this 11 hours observation period. This high demand is due to high turnover rate and shorter duration of parking on curb. Off-street parking facilities have not been fully utilized. About 88 vehicles or roughly 24.3% of the total demands were observed utilizing this type of parking facility.

Parking supply depends on the available spaces and degree of utilization. Since parking demand is expressed in terms of total observed vehicles in the site, it is proper to determine the number of vehicles that can be accommodated on the available space. Parking duration and turnover dictated the number of vehicles that can park in a space. Parking supply can be expressed in terms of dynamic capacity of the parking space.

A total of 362 cars can be accommodated in 48 available spaces in the study site. This does not mean that these vehicles would park at the same time, rather, in over 11 hours all these vehicles could park. On-street parking can accommodate a total of 14 vehicles on the 14 available curb spaces. On the other hand, off-street facilities can accommodate a total of 34 vehicles on the 34 available parking spaces. A comparison of the parking demand and supply revealed the deficiencies and surpluses of parking spaces in the study site. Surplus and deficiency in space would not occur because the supply does not exceed the existing need to park.

Table 6 Summary of parking Demand and supply

Type of facility	**Available spaces**	**Avrage duration (Hr/Veh)**	**Parking Demand (Veh)**	**Parking supply (Veh)**	**Surplus (Veh)**	**Deficiency (Veh)**
Off street						
New Market	34	0.13	88	34	0	-
Dak Banglo Mor	0	0	0	0	0	-
Sub total	34	0.13	88	34	0	-

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On street						
New Market	0	0	0	0	0	-
Dak Banglo Mor	14	0.04	274	14	0	-
Sub total	14	0.04	274	14	0	-
Total	48	0.17	362	48	0	-

I. CONCLUSIONS AND RECOMMENDATION

The inventory of the existing car parking has revealed that 29.17% of the parking spaces are on-street and 70.83% of the available spaces are used for off-street parking. The on-street parking at Dakbanglo Mor falls under high turnover rate category because a large number of day parkers are using this facility. The maximum occupancy ratio was found at New Market off-street car parking. The occupancy ratio was 1.0 whereas the on-street facility had shown a maximum of 0.5.But parking demand do not exceed the supply in Khulna metropolitan city. Although the parking facility at Dakbanglo Mor is angular and parallel, but the parking stall is not provided at new market. Due to the lack of proper management, illegal parking has been found. The City Corporation should consider their parking fee policy in order to reduce the illegal parking. Present parking system is able to meet the demand. A financial analysis may be done to evaluate future parking demand. Non- motorized vehicle may be included in the future study.

REFERENCES

[1] Reddy, T.S. and Jalihal, S.A, "Parking Management Strategy for the Walled city of Jaipur". *Journal of Indian Institution of Engineers (lEI*), India, PP. 64-70, 2003.

[2] Kimber, R.M., "The Effects of Wheel Clamping in Central London", *Transport and Road Research Laboratory, TRRL Laboratory Report 1136*, Crowthorne,1984.

[3] Hobbs, F.D., "Traffic Planning & Engineering", Pergamon Press, London, 1979.

[4] Ogden, K.W. and Bennett, D.W., "Traffic Engineering Practice (4th edition), *Monash University*, 479 p. Melbourne,1989.

[5] Afroze, N., "A Study of Parking Characteristics in Bangkok", *AIT-Thesis* GT- 92-37 c.2, Bangkok, 1991

[6] C.S. Papacosta and P.D. Prevedours., "Transportation Engineering and Planning. New York: Prentice-Hall Internasional Edition, 1993.