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Parking Volume Analysis of Selected Locations; a Study on Khulna City

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ABSTRACT

With the rise in urbanization and automobile demand, research on parking volume has gained much greater significance. It is a typical occurrence in the Khulna metropolitan region for many motorized and non-motorized vehicles to be parked on the streets and junctions of the chosen areas, which causes severe traffic congestion. In order to lessen the negative effects of insufferable congestion, it is crucial to examine the impact of that uncontrolled parking on highways. To determine parking volume and determine whether the parking patterns at the chosen places are unique or similar, a reconnaissance assessment of eight strategically significant areas in Khulna City was conducted. A maximum of 375, 79, and 38 number of two-wheelers, three-wheelers, and four-wheelers were found parked at Khulna Shopping Complex, New Market, and also New Market Zone, respectively, for a specific period of time. The related maximum Passenger Car Unit (PCU) values of Khulna Shopping Complex and New Market are 224.5 and 348.5, respectively, indicating that New Market is the busiest parking area of all the selected locations. Among the selected eight locations, Khulna New Market and KCC Building hold the highest and lowest PCU values of 348.5 and 20, respectively. The local government was discovered to be in charge of parking management, and some areas charge significant fees for a set length of time. One sample t-test performed by SPSS V25 indicates that parking facilities and parking patterns in the eight chosen locations differ from each other.

Keywords: Parking Volume Study, Capacity of Roads, Congestion, PCU, Khulna City

1. INTRODUCTION

Khulna is the third-largest city in Bangladesh after Dhaka and Chittagong [1]. It is the ministerial zone of Khulna District and Khulna Division. In the 2011 census, the city had a population of 663,342 [2] . The Khulna metropolitan area had an estimated population of 1.022 million in 2014 [3]. Khulna stands on the bank of the Rupsha and Bhairab Rivers. Khulna, being the center of the Bangladeshi industry, hosts many national companies. Khulna acts as a gateway to the nearby

seaport of Mongla (the second-largest seaport in the country) and is one of two principal naval command centers hosting the Bangladesh Navy. The navy base, Bangladesh Naval Ship (BNS) Titumir, is in the city. The N7 highway connects Khulna with the rest of Bangladesh, and the Khulna City Bypass is a major road. The R760 connects Satkhira and western Khulna Districts. There are several nationwide bus services available in Khulna (mostly privately owned), and the Bangladesh Road Transport Corporation (BRTC) operates an inter-district bus service from the city. Sonadanga Bus Terminal is Khulna's main bus terminal. Rickshaws are the most popular means of public transport in Khulna for short trips, and auto-rickshaws are also common. Nagar Paribahan buses have frequent service between Rupsha and Phultala, with stops throughout Khulna. Motorcycles are popular among the middle class, and wealthier people prefer a private car. Parking is an issue of significance both at the local and strategic levels [4]. It is advisable to thoroughly research parking behavior and features before establishing a definite parking regulation. The editorials or special articles published in the national weekly newspapers and journals in recent years have reflected the growing concern about the need for more parking facilities [5-9]. According to certain seminars' recommendations [10-19]; and Dhaka Metropolitan Police note from 1986, the scenario further lacks parking facilities. A city ought to have adequate parking spots to offer its citizens and visitors a place where they can park their cars, as parking spaces are crucial to cities. Therefore, for a good transportation system, parking spots must be properly designed. It will be chaotic for everyone if there is a lack of parking and facilities and because of this, it is crucial to analyze the availability of parking in a city before creating a parking space. Even while sufficient parking for cars is a requirement for good urban planning, trade, and commerce cannot thrive without it. However, the most ignored issue in the context of overall urban transportation management in Khulna City is the availability of space for parking automobiles. The study's primary objectives are to determine the volume, diversity, and density of vehicles at specific locations in Khulna City as well as whether or not these areas' parking patterns are similar or dissimilar from one another.

2. METHODOLOGY

2.1. SELECTION OF STRATEGIC LOCATIONS

Khulna is Bangladesh's third-largest city, in the southwestern part of the country, on the Rupsha and Bhairab Rivers, it covers an area of 59.57 sq km [13]. The district covers 4,394.46 sq km. Study areas were selected after conducting a reconnaissance survey based on the amount and type of traffic, parking characteristics along with management of parking. The selected locations for this research are some busy commercial, hospital, and trading zones named New Market, Bangladesh Bank, City Inn. Hotel, Jalil Tower, Khulna City Corporation (KCC) Building, Khulna Development Authority (KDA) Building, Khulna City Medical College Hospital (KCMCH), and Khulna Shopping Complex.

2.2. DATA COLLECTION AND ANALYTICAL APPROACH

This exploratory research is split into different parts. The research started by conducting a reconnaissance survey in all of the parking lots of the selected locations in order to find out the existing availability of parking facilities. To do this accurately, the study section of each area was divided into suitable numbers of different sites. Then each of the different sites was surveyed by an observer. The number of vehicles that entered and exited the parking lot was counted for a particular time interval. In this study case, the total duration of the study is 6 hours for each of the locations. This duration is subdivided into 12-time slots having a beat duration of 30 minutes. At the start of each time slot, each individual observer recorded the number of vehicles parked in that particular site of road assigned to them. The same procedure was repeated 12 times for each time slot. In this study case, from 9:00 AM to 12:00 PM in the morning hour and from 5:00 PM to 8:00 PM in the evening hour. The number of vehicles was categorized into 3 different groups i.e. Four-Wheeler, Three-Wheeler & Two-Wheeler. In terms of this study case, these working procedures have been conducted for eight (8) days for the eight (8) different

selected locations. The related PCU of the parked vehicles was calculated using Table 1 which shows the PCU value for different types of vehicles in Bangladesh.

Table 1. PCU for Different Types of Vehicles in Bangladesh

Vehicle Categories	PCU
Passenger Car	1.00
Light Goods Vehicles	1.00
Truck	3.00
Bus	3.00
Auto Rickshaw / Motor Cycle	0.75
Rickshaw / Van	2.00
Bicycle	0.50

(Source: [20])

For this research, t-test analysis has been applied using SPSS V25. The t-test estimates the true difference between two group means using the ratio of the difference in group means over the pooled standard error of both groups. Equations (1) and (2) show the formula for t value and df value. A t-test was conducted to find out whether the parking pattern, facility, and characteristics are different from each other or not.

$$t = \frac{a_1 - a_2}{\sqrt{{S_1}^2 - {S_2}^2}} \quad (1)$$

$$df = \frac{({S_1}^2 - {S_2}^2)^2}{\frac{{S_1}^4}{n_1 - 1} + \frac{{S_2}^4}{n_2 - 1}} \quad (2)$$

Where, “t” indicates the t-value, while “a” denotes the parameters, parameters included mean and intercept, “s” indicates a standard error, “d” denotes the value of the degree of freedom, and “n” indicates the number of samples. A confidence interval indicates the probability that a parameter will fall between a pair of values around the mean. Confidence intervals measure the degree of uncertainty or certainty in a sampling method. They are most often constructed using confidence levels of 95% or 99%.

3. RESULTS AND DISCUSSIONS

3.1. VOLUME OF VEHICLES WITH PCU IN THE SELECTED LOCATIONS

Eight strategically important locations were selected on the basis of volume and density of parking. Table 2 below shows the parking characteristics with PCU of the New Market area of Khulna.

Table 2. Parking Characteristics with PCU in New Market Area

Time	Volume of Vehicles Parked			PCU
	Two-Wheeler	Three-Wheeler	Four-Wheeler	
9:00 AM -9:30 AM	9	7	1	21.5
9:30 AM -10:00 AM	33	17	6	68.5
10:00 AM -10:30 AM	79	41	12	157.5
10:30 AM -11:00 AM	114	55	19	224
11:00 AM -11:30 AM	119	46	21	214.5
11:30 AM -12:00 AM	124	61	27	265
5:00 PM -5:30 PM	104	39	14	172
5:30 PM -6:00 PM	109	48	17	201.5
6:00 PM -6:30 PM	129	60	23	253.5
6:30 PM -7:00 PM	141	67	29	291.5
7:00 PM -7:30 PM	158	75	35	334
7:30 PM -8:00 PM	153	79	38	348.5

Table 2 illustrates the parking characteristics of the New Market area Khulna. Being a busy commercial zone this place accepts a huge amount of parking vehicles of different types all through the day. Motorcycles and cars are the main two types of vehicles that are parked in 3 to 4 places in New Market. The highest volume of two-wheelers, three-wheelers, and four-wheelers were 158, 79, and 38, respectively. The lowest average PCU at the location is 21.5, which is recorded from 9:00 AM to 9:30 AM and the highest average PCU at the location is 348.5 which was recorded from 7:30 PM to 8:00 PM. Being a very busy trading and marketplace, this area's parking system is variant in nature. There are mainly 3 spaces (In front of Baitun Nur Jame Masjid, Gate 2, and Gate 3) of parking where people have to pay fees to park their vehicles. As a huge number of vehicles come in and out every single hour, the related PCU value is much higher than the other sample locations taken into consideration for this study.

Table 3 below portrays the parking characteristics of the Bangladesh Bank building, a branch of the central bank of Bangladesh. A huge amount & various types of vehicles are parked every day in this area. Private cars, motorcycles, and bicycles are the major vehicles that are being parked in this area.

Table 3. Parking Characteristics with PCU in Bangladesh Bank Area

Time	Volume of Vehicles Parked			PCU
	Two-Wheeler	Three-Wheeler	Four-Wheeler	
9:00 AM -9:30 AM	32	4	5	39
9:30 AM -10:00 AM	53	2	8	54.5
10:00 AM -10:30 AM	61	1	14	74.5
10:30 AM -11:00 AM	64	3	14	80
11:00 AM -11:30 AM	57	3	19	91.5
11:30 AM -12:00 AM	60	2	18	88
5:00 PM -5:30 PM	45	5	15	77.5
5:30 PM -6:00 PM	33	4	13	63.5
6:00 PM -6:30 PM	24	1	8	38
6:30 PM -7:00 PM	17	2	7	33.5
7:00 PM -7:30 PM	14	0	7	28
7:30 PM -8:00 PM	12	2	5	25

The highest volume of two-wheelers, three-wheelers, and four-wheelers were 64, 5, and 19, respectively. The above table implies that the lowest average PCU at the location is 25, which is recorded from 7:30 PM to 8:00 PM and the highest average PCU at the location is 91.5, which is recorded from 11:00 AM to 11:30 AM. The most dominant vehicle in this area is motorcycle and government-owned cars. Being a commercially important zone, it has a separate parking space controlled by the authority, and parking is without fees.

Table 4 delineates the parking characteristics of City Inn Hotel Ltd., which is the most modern facilitated international standard hotel and holds a prime location and booming area in Khulna city the southern part of Bangladesh. This upmarket hotel comprises two recognized parking areas; one outside the main opening and the other in the basement. Parking is charge-free here and security for vehicles parked here is much better than the other sample locations. The table below indicates that the dominant vehicles in this zone are two-wheelers and four-wheelers. Being an important meeting and recreation place, many national and international programs are arranged here.

Table 4. Parking Characteristics with PCU in Hotel City Inn. Area

Time	Volume of Vehicles Parked			PCU
	Two-Wheeler	Three-Wheeler	Four-Wheeler	
9:00 AM -9:30 AM	12	2	6	28
9:30 AM -10:00 AM	14	3	6	31
10:00 AM -10:30 AM	11	1	7	28.5
10:30 AM -11:00 AM	15	5	9	44.5
11:00 AM -11:30 AM	10	3	9	38
11:30 AM -12:00 AM	12	2	12	46
5:00 PM -5:30 PM	15	7	14	63.5
5:30 PM -6:00 PM	17	5	11	51.5
6:00 PM -6:30 PM	22	5	12	57
6:30 PM -7:00 PM	24	8	13	67
7:00 PM -7:30 PM	20	6	15	67
7:30 PM -8:00 PM	27	4	11	54.5

The Maximum volume of two-wheelers, three-wheelers, and four-wheelers is 27, 8, and 15 respectively. The above table implies that the lowest average PCU at the location is 28, which is recorded from 9:00 AM to 9:30 AM and the highest average PCU at the location is 67, which is recorded from 6:30 PM to 7:30 PM. On any occasion, the volume of parked vehicles is much higher than this and so is the PCU. Table 5 demonstrates the parking characteristics of Jalil Tower also known as Jalil Market. It is one of the leading markets of Khulna City Which comprising of one recognized parking area. Motorcycles and bicycles are the two types of vehicles that are parked inside. This place is mainly known as the market for computer accessories. Parking here requires fees of Tk 10. A much larger volume of motorcycles are parked here and sometimes the authority has to return the vehicles for lack of space for parking.

Table 5. Parking Characteristics with PCU in Jalil Tower Market Area

Time	Volume of Vehicles Parked			PCU
	Two-Wheeler	Three-Wheeler	Four-Wheeler	
9:00 AM -9:30 AM	67	9	1	54.5
9:30 AM -10:00 AM	89	15	3	83.5
10:00 AM -10:30 AM	104	20	4	104
10:30 AM -11:00 AM	119	18	2	101.5
11:00 AM -11:30 AM	127	17	2	103.5
11:30 AM -12:00 AM	129	12	3	97.5
5:00 PM -5:30 PM	140	22	4	126
5:30 PM -6:00 PM	146	25	4	135
6:00 PM -6:30 PM	151	16	2	113.5
6:30 PM -7:00 PM	147	19	1	114.5
7:00 PM -7:30 PM	131	14	2	99.5
7:30 PM -8:00 PM	110	13	2	87

Table 5 delineates that the maximum volume of two-wheelers, three-wheelers, and four-wheelers are 151, 25, and 4 respectively. The lowest average PCU at this location was 54.5, which is recorded from 9:00 AM to 9:30 AM and the highest average PCU at the location was 135, which is recorded from 5:30 PM to 6:00 PM. So, it is evident that this parking space remains busier than any other location in Khulna city.

Table 6 illustrates the parking characteristics of the Khulna City Corporation (KCC) Building. It is one of the major divisional city corporations of Bangladesh. Motorcycles, bicycles and cars are the main types of vehicles that are parked here. Being a busy place people of different professions visit here for various reasons.

Table 6. Parking Characteristics with PCU in Khulna City Corporation Area

Time	Volume of Vehicles Parked			PCU
	Two-Wheeler	Three-Wheeler	Four-Wheeler	
9:00 AM -9:30 AM	95	2	4	63.5
9:30 AM -10:00 AM	102	3	6	75
10:00 AM -10:30 AM	127	6	10	105.5
10:30 AM -11:00 AM	138	2	13	112
11:00 AM -11:30 AM	124	4	15	115
11:30 AM -12:00 AM	142	3	19	134
5:00 PM -5:30 PM	97	2	11	85.5
5:30 PM -6:00 PM	88	2	10	78
6:00 PM -6:30 PM	63	1	7	54.5
6:30 PM -7:00 PM	29	3	5	35.5
7:00 PM -7:30 PM	17	0	4	20.5
7:30 PM -8:00 PM	12	1	4	20

The above table implies that the lowest average PCU at the location is 20, which is recorded from 7:30 PM to 8:00 PM and the highest average PCU at the location is 134, which is recorded from 11:30 AM to 12:00 PM. The maximum volume of two-wheelers, three-wheelers, and four-wheelers are 142, 6, and 19 respectively.

Table 7 demonstrates the parking characteristics of the Khulna Development Authority (KDA) Building. It is a governing body in Khulna City. Motorcycles and cars are the main two types of vehicles that are parked inside.

Table 7. Parking Characteristics with PCU in Khulna Development Authority Building Area

Time	Volume of Vehicles Parked			PCU
	Two-Wheeler	Three-Wheeler	Four-Wheeler	
9:00 AM -9:30 AM	18	3	8	39
9:30 AM -10:00 AM	31	5	11	58.5
10:00 AM -10:30 AM	36	4	12	62
10:30 AM -11:00 AM	43	3	12	63.5
11:00 AM -11:30 AM	46	2	14	69
11:30 AM -12:00 AM	51	1	12	63.5
5:00 PM -5:30 PM	37	5	11	61.5
5:30 PM -6:00 PM	30	2	9	46
6:00 PM -6:30 PM	24	3	10	48
6:30 PM -7:00 PM	17	4	9	43.5
7:00 PM -7:30 PM	14	2	8	35
7:30 PM -8:00 PM	9	1	8	30.5

The highest volume of two-wheelers, three-wheelers, and four-wheelers are 51, 5, and 14 respectively. The above table implies that the lowest average PCU at the location is 30.5, which is recorded from 7:30 PM to 8:00 PM and the highest average PCU at the location is 69, which is recorded from 11:00 AM to 11:30 AM. Table 8 depicts the parking characteristics of Khulna City Medical College Hospital (KCMCH). It is one of the best private medical college hospitals in Khulna City. Motorcycles, bicycles, rickshaws, autos, cars, and especially ambulances are parked here. This place has recently become one of the busiest places in the Khulna city area. It has a parking space that charges free and a specified basement for parking. But most of the motorcycles and auto-rickshaws are parked just outside the hospital creating congestion.

Table 8. Parking Characteristics with PCU in Khulna City Medical College Hospital Area

Time	Volume of Vehicles Parked			PCU
	Two-Wheeler	Three-Wheeler	Four-Wheeler	
9:00 AM -9:30 AM	83	7	8	79.5
9:30 AM -10:00 AM	90	5	10	85
10:00 AM -10:30 AM	102	4	7	80
10:30 AM -11:00 AM	113	5	12	102.5
11:00 AM -11:30 AM	128	7	15	123
11:30 AM -12:00 AM	121	6	13	111.5
5:00 PM -5:30 PM	165	4	14	132.5
5:30 PM -6:00 PM	144	6	15	129
6:00 PM -6:30 PM	132	8	18	136
6:30 PM -7:00 PM	147	10	21	156.5
7:00 PM -7:30 PM	154	6	18	143
7:30 PM -8:00 PM	151	5	16	133.5

The maximum volume of two-wheelers, three-wheelers, and four-wheelers is 165, 10, and 21 respectively. The above table implies that the lowest average PCU at the location is 79.5, which is recorded from 9:00 AM to 9:30 AM and the highest average PCU at the location is 156.5, which is recorded from 6:30 PM to 7:00 PM. Table 9 shows the parking characteristics of the Khulna Shopping Complex. It is the only central AC and escalator-based shopping complex in Khulna City. Lots of motorcycles and bicycles are parked inside the parking lot. This place has the largest underground parking in Khulna City.

Table 9. Parking Characteristics with PCU in Khulna Shopping Complex Area

Time	Volume of Vehicles Parked			PCU
	Two-Wheeler	Three-Wheeler	Four-Wheeler	
9:00 AM -9:30 AM	79	8	0	55.5
9:30 AM -10:00 AM	101	11	2	78.5
10:00 AM -10:30 AM	172	16	2	124
10:30 AM -11:00 AM	205	12	1	129.5
11:00 AM -11:30 AM	251	12	0	149.5
11:30 AM -12:00 AM	287	10	3	172.5
5:00 PM -5:30 PM	334	15	2	203
5:30 PM -6:00 PM	369	9	2	208.5
6:00 PM -6:30 PM	375	17	1	224.5
6:30 PM -7:00 PM	361	14	1	211.5
7:00 PM -7:30 PM	368	10	2	210
7:30 PM -8:00 PM	352	11	1	201

The highest volume of two-wheelers, three-wheelers, and four-wheelers are 375, 17, and 3 respectively. The above table implies that the lowest average PCU at the location is 55.5, which is recorded from 9:00 AM to 9:30 AM and the highest average PCU at the location is 224.5, which is recorded from 6:00 PM to 6:30 PM.

3.2. CHARACTERITICS OF PARKING PATTERN IN SELECTED LOCATION

Figure 1 shows the PCU values of parked vehicles in different time slots for eight strategic locations in Khulna City. Here NM, BB, CIH, JT, KCCB, KDAB, KCMCH, and KSC indicate New Market, Bangladesh Bank, City Inn Hotel, Jalil Tower, Khulna City Corporation Building, Khulna Development Authority Building, Khulna City Medical College Hospital, and Khulna Shopping Complex respectively. PCU variation occurred due to change in the volume of parked vehicles and it is quite evident in the last six time slots. the New Market area is seen as the busiest parking zone among the selected locations of Khulna City followed by the Khulna Shopping Complex.

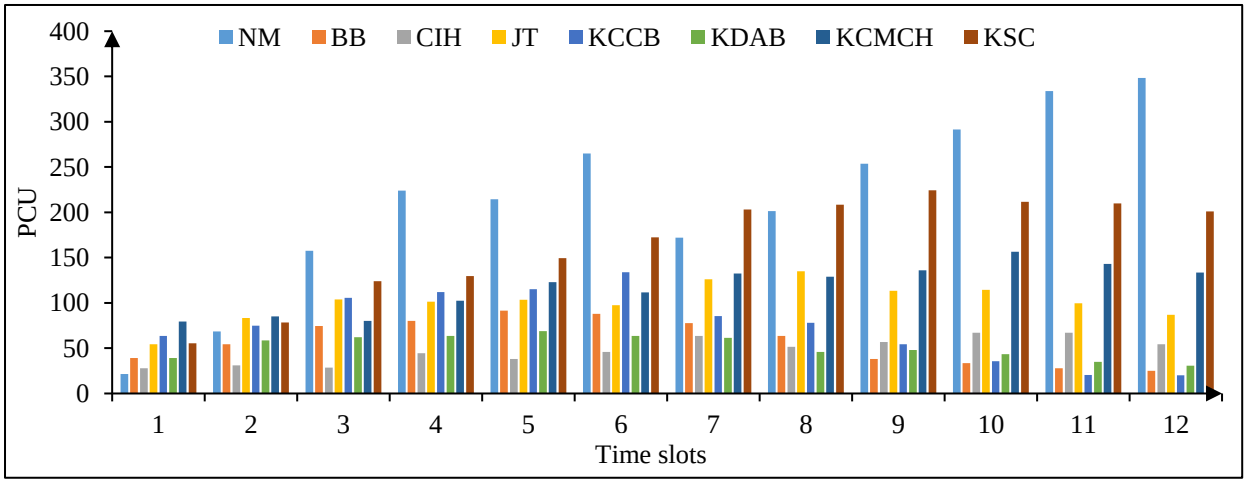

Figure 1. PCU comparison of selected strategic locations of Khulna city

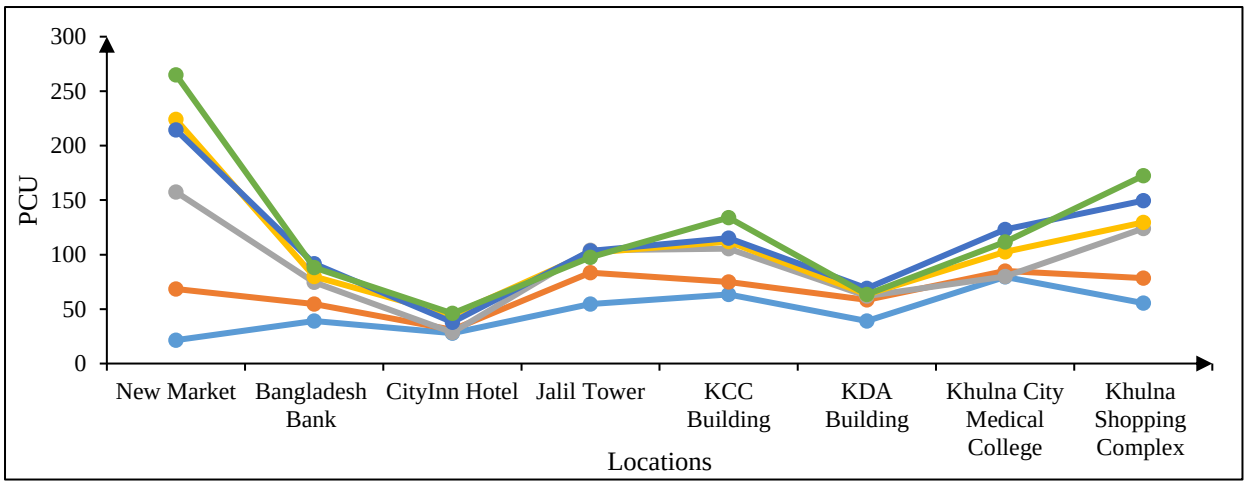

Figure 2. PCU of parked vehicles from morning to noon (9 AM to 12 PM)

Figure 2 shows the variation of the parked vehicle's PCU value from 9 AM to 12 PM. Both the highest and lowest PCU of 265 and 21.5 have been recorded for New Market. According to Figure 2, New Market, KCC building, and Khulna Shopping Complex are the busiest places during the specific time period.

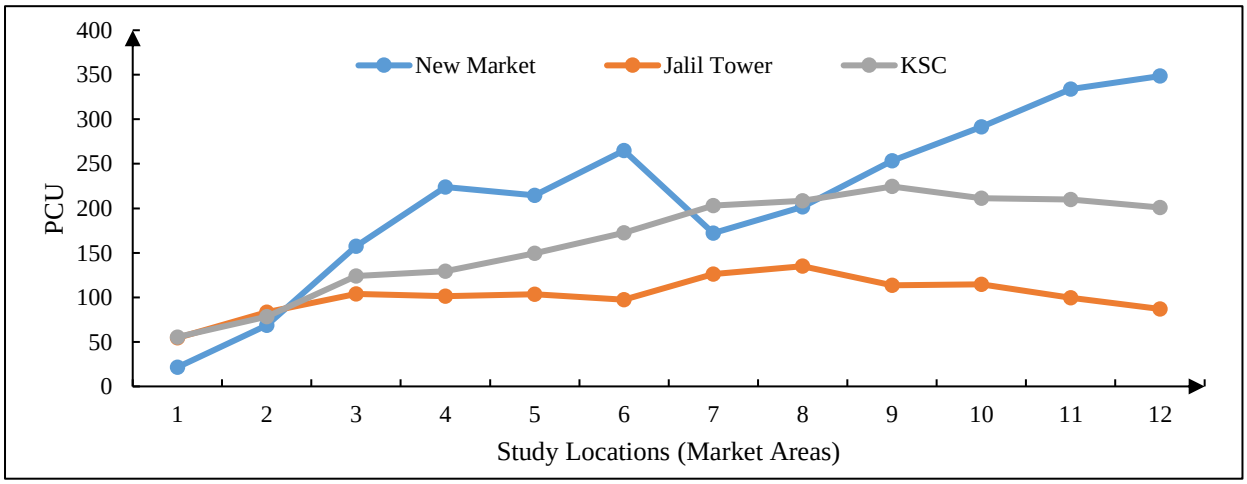

Figure 3. PCU of parked vehicles from afternoon to night (from 5 PM to 8 PM)

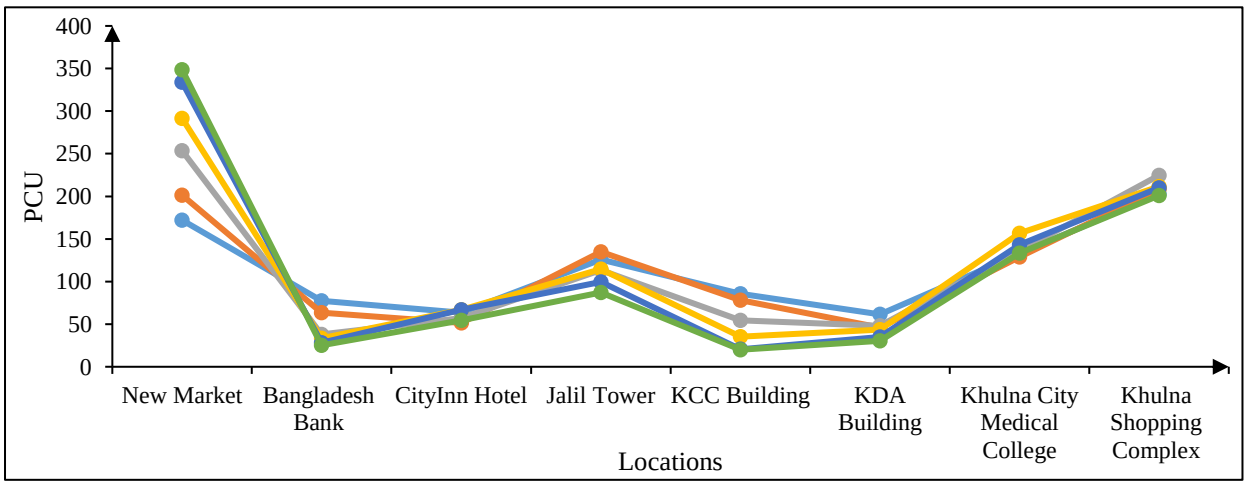

Figure 4. PCU of parked vehicles in study areas (Market place)

Figure 3 shows the variation of parked vehicles' PCU values from 5 PM to 8 PM. The highest and lowest PCU of 348.5 and 20 have been recorded for New Market and KCC building, resepctively. According to Figure 3, New Market, Khulna Shopping Complex, Khulna City Medical College Hospital, and Jalil Tower are the busiest places during the specific time period.

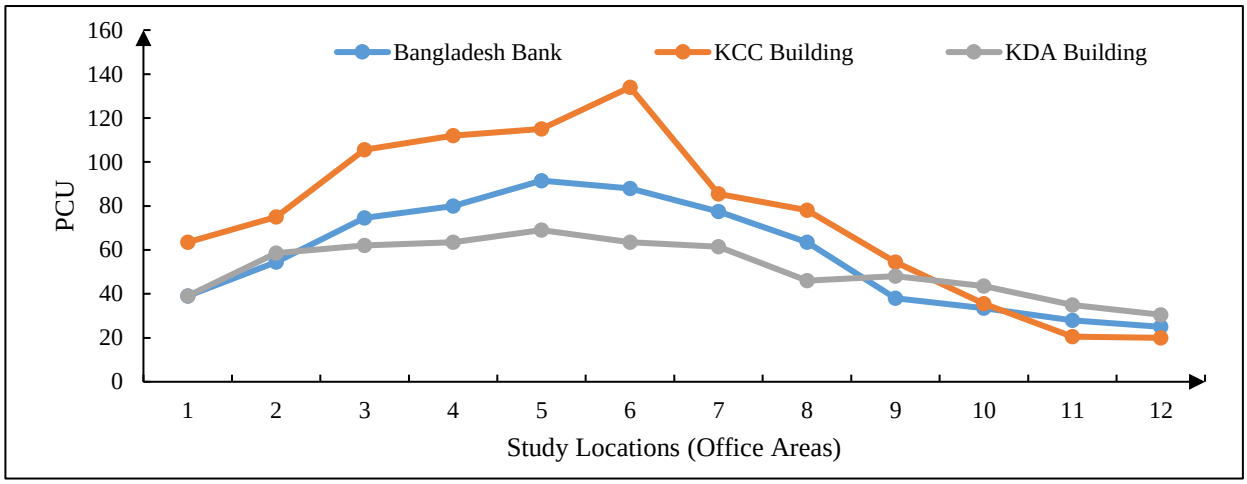

Figure 5. PCU of parked vehicles in study areas (Office Places)

Figure 4 and Figure 5 show the PCU values of parked vehicles in study areas. It has been evident that the PCU values in market areas are much higher than that in hospital areas. In this, more than 50% of the vehicles are parked illegally in market areas which is one of the main reasons for the reduction of the capacity of roads. A group of people take lease of the parking places from the market authority for a specific period of time and they maintain the parking in their own way. On the other hand, in-office places parking has been seen as more disciplined than that of marketplaces.

Inter-Item Correlation Matrix can be examined using inter-item correlation. It assesses whether specific questions on a test or questionnaire yield reliable, appropriate results; many items intended to gauge the same broad concept or idea are examined to see if they yield answers that are comparable [14]. Table 10 shows the intercorrelation of PCU values of parked vehicles in study areas. Here NM, BB, CIH, JT, KCC, KDA, KCMCH, and KSC indicate New Market, Bangladesh Bank, City in Hotel, Jalil Tower, Khulna City Corporation, Khulna Development Authority, Khulna City Medical College Hospital, and Khulna Shopping Complex respectively.

Table 10. Inter-Item Correlation Matrix

	NM	BB	CIH	JT	KCC	KDA	KCMCH	KSC
NM	1.000							
BB	-.249	1.000						
CIH	.752	-.378	1.000					
JT	.395	.283	.575	1.000				
KCC	-.362	.959	-.531	.111	1.000			
KDA	-.314	.929	-.398	.245	.907	1.000		
KCMCH	.805	-.342	.935	.592	-.504	-.369	1.000	
KSC	.821	-.215	.891	.742	-.361	-.276	.913	1.000

The One-Sample t-test examines whether the mean of a population is statistically different from a known or hypothesized value. The One-Sample t-test is a parametric test. This test is also known as, Single Sample t-test (t-test analysis, Investopedia).

Table 11. One-Sample t-test based on PCU of locations

Locations	t Value	Critical t Value	df	Sig. (2-tailed)	95% Confidence Interval of the Difference	
					Lower	Upper
New Market	7.502	4.437	11	.000	150.2	275
Bangladesh Bank	8.198		11	.000	42.2	73.2
City Inn Hotel	11.551		11	.000	38.8	57.1
Jalil Tower	16.844		11	.000	88.3	114.9
KCC Building	6.890		11	.000	50.9	98.8
KDA Building	13.879		11	.000	43.4	59.8
Khulna City Medical College Hospital	15.797		11	.000	101.2	134
Khulna Shopping Complex	10.063		11	.000	128.1	199.8

Confidence Interval of the difference has been selected to 95% for this research. From Table 11, it can be seen that the t-critical value is 4.437 where the t-stat value ranges from 6.890 to 16.844. So, the highest t-stat value is 16.844, for Jalil Tower Market and the lowest t-stat value is 6.890, for Khulna City Corporation Building. The t-stat value has to be greater than the t-critical value which is 4.437 for the parking patterns to be different. As the analyzed t-stat values for the selected eight locations are greater than the t-critical value 4.437, the parking pattern for the selected eight locations is different from each other. None of the parking patterns for the eight locations are similar to each other.

4. CONCLUSIONS

The volume of Two-wheelers, Three-wheelers, and Four-wheelers varied based on the intensity of traffic and the importance of the locations. The maximum numbers of 375, 79, and 38 two-wheelers, three-wheelers, and four-wheelers were found parked at Khulna Shopping Complex, New Market, and New Market Zone, respectively, for a specific period of time. The related maximum Passenger Car Unit (PCU) values of Khulna Shopping Complex and New Market are 224.5 and 348.5, respectively, indicating that New Market is the busiest parking area of all the selected locations. Among the selected locations, Khulna New Market and KCC Building hold the highest and lowest PCU values of 348.5 and 20, respectively. Parking management was found to be controlled by the local authority, and a considerable amount of fees are required in some locations for a specific period of time. The t-test showed that the patterns of parking are very different from each other on the basis of parking management. Mass awareness should be developed about effective parking management so that traffic facilities may be enhanced to achieve a hassle-free transportation system.

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CONFLICT OF INTEREST

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5. REFERENCES

[1] Largest Cities in Bangladesh. Geonames. February 2019.(Online). [View at Publisher].

[2] Population & Housing Census, Bangladesh Bureau of Statistics. p. 44. Archived from the original, 2011. [View at Publisher].

[3] Bocquier P. World Urbanization Prospects: an alternative to the UN model of projection compatible with the mobility transition theory. Demographic Research. 2005 Jan 1;12:197-236. [View at Google Scholar]; [View at Publisher].

[4] Hossain MS, Chowdhury SR, Navera UK, Hossain MA, Imam B, Sharifuzzaman SM. Opportunities and strategies for ocean and river resources management. Dhaka: Background paper for preparation of the 7th Five Year Plan. Planning Commission, Ministry of Planning, Bangladesh. 2014 Dec. [View at Google Scholar]; [View at Publisher].

[5] Hossain, Z., "Rajdhanir Sarak Babyastha: Janbahan Samashya - o - Somadhan", Robbar, Dhaka, Eid Issue, May 22. (1988).

[6] Chowdhury AA, Arefeen S. Software risk management: importance and practices. IJCIT, ISSN. 2011 Jul:2078-5828. [View at Google Scholar]; [View at Publisher].

[7] Mahmood, S. “Rajdhanir Traffic Babyastha – Shesh Parba”, Sangbad, August 30, (1989).

[8] Comert G, Khan Z, Rahman M, Chowdhury M. Grey models for short-term queue length predictions for adaptive traffic signal control. Expert Systems with Applications. 2021 Dec 15;185:115618. [View at Google Scholar]; [View at Publisher].

[9] The Bangladesh Observer , "Parking Space", Editorial report, The Bangladesh Observer, Dhaka, March 24. (1990). [View at Google Scholar]; [View at Publisher].

[10] Ahmed, S. Noor-Ud-Deen and Hoque, A.M., "Transportation and Traffic in Dhaka – Review of the Past, Present, and Future.” Paper presented to the Seminar on Dhaka 2000, held at Institution of Engineers, Dhaka, Bangladesh, June 2 and 3. (1988).

[11] Ahsan, H.M., and Hoque, M.M., (1989), “Mass Transit in Metropolitan Dhaka – Some Issues.” Paper presented to the 33rd Annual Convention of the IEB, held at Dhaka, March 1989.

[12] Wahab, M.A., “Paper on Prevention of Accident on Municipal Network of Communication.” Paper presented to the Seminar on Prevention of Accident, held at Dhaka, organized jointly by Ministry of Home and World Health Organization, (1989), February 11-17. [View at Publisher].

[13] Bhuiyan SH. Modernizing Bangladesh public administration through e-governance: Benefits and challenges. Government Information Quarterly. 2011 Jan 1;28(1):54-65. [View at Google Scholar]; [View at Publisher].

[14] Stephanie Glen. "Average Inter-Item Correlation: Definition, Example" From Statistics HowTo.com: Elementary Statistics for the rest of us!, (2011). [View at Publisher].

[15] Hossain MS, Moudud Ahmad M, Islam M, Asadujjaman M. Traffic scheduling simulation: the case of Dhaka City. J. Mod. Sci. Technol. 2017 Sep;5(1). [View at Google Scholar]; [View at Publisher].

[16] Qin H, Xu N, Zhang Y, Pang Q, Lu Z. Research on Parking Recommendation Methods Considering Travelers’ Decision Behaviors and Psychological Characteristics. Sustainability. 2023 Apr 18;15(8):6808. [View at Google Scholar]; [View at Publisher].

[17] Young W, Thompson RG, Taylor MA. A review of urban car parking models. Transport reviews. 1991 Jan 1;11(1):63-84. [View at Google Scholar]; [View at Publisher].

[18] Chowdhury MM. Traffic congestion and mismanagement in dhaka city. Planned Decentralization: Aspired Development, World Town Planning Day. 2013. [View at Google Scholar]; [View at Publisher].

[19] Hoque MM, Nasrin S, Sultana S. Operational hazards of bus transportation in Dhaka metro city. InProceedings of the International Conference on Recent Innovation in Civil Engineering for Sustainable Development (IICSD-2015), DUET, Gazipur 2015.

[20] Moc J, Carr DA. Understanding distributed systems via execution trace data. InProceedings 9th International Workshop on Program Comprehension. IWPC 2001 2001 May 12 (pp. 60-67). IEEE. [View at Google Scholar]; [View at Publisher].