

PARKING DEMAND AND SUPPLY ANALYSIS OF DIFFERENT THREE WHEELER VEHICLES IN KHULNA

Sunzid Hassan*¹ and Mohaimin Azmain²

¹ Department of Urban & Regional Planning, Khulna University of Engineering & Technology (KUET), Khulna- 9203, Bangladesh, e-mail: sunzidhassan@gmail.com

² Department of Urban & Regional Planning, Khulna University of Engineering & Technology (KUET), Khulna- 9203, Bangladesh, e-mail: mohaiminazmain@yahoo.com

ABSTRACT

This paper tries to assess the demand and supply situation of parking facilities of three wheeler vehicles in Fulbari gate and Daulatpur and propose recommendations to mitigate this deficiency of parking facility. Three wheeler vehicles are getting popular all over country. Vehicles like Easy bike, Atul/Mahindra, Scooter are main mode of public transportation in Khulna (Lubna & Aman, 2015). They carry passenger and move in Khulna-Jessor Highway. There are a number of stopping point but no planned parking facility for these vehicles. As a result, they park over main road and create serious traffic congestion. According to BRTA and RHD, lack of parking facilities and management are the primary causes of road accidents, traffic collisions, traffic jam and other problems. And this scenario is common all over our country and in South-Asian countries. However, lack of parking facility has received little attention, and proper steps have not been taken to provide parking facility. To solve parking facility problem, determination of Demand and Supply of parking facility is vitally important. To determine parking demand and supply scenario of Khulna, study is conducted in Fulbari gate and Daulatpur (two busiest three wheeler stop). Supply study is done by physical survey. Demand study is done by physical and questionnaire survey. Parking accumulation curve, parking volume was determined from the survey data. From supply and demand gap, the current facility need was identified. Proper facility was planned and illustrated keeping in mind of the available space, flow of vehicle and parking policies.

Keywords: Parking Demand, Parking Supply, Three wheeler vehicle, Traffic congestion, Parking Accumulation

1. INTRODUCTION

Khulna is one of the major cities in Bangladesh. However, the amount of private cars and public transportation is low here. Three wheeler vehicles are the main mode for transportation for small to medium distance travel. Their travel cost relatively low, and these vehicles require little initial investment. As a result, three wheeler vehicles are increasing all over country. According to BRTA, there are about 5636 total vehicles licensed in 2015, while the number was 3958 and 4919 in the consecutive years of 2013 and 2014. (Field Survey, 2015) Among these vehicles 200 are Atul, 500 are Mahindra, 143 are Scooters and approximately 10,000 are license less Easy bike. In 2011, Easy bikes were declared as illegal mode of transport under "Traffic control and Public Vehicles by laws 1973" Despite the ban, Easy bike and other three wheelers are still widely used in different areas of Bangladesh. The stand for these vehicles are usually not planned, and lacks proper space. These vehicles stop, parks and takes passenger on street. Large number of standing vehicles blocks most of the area of busy road. This creates serious traffic congestion problem nearby the stopping points of three wheeler vehicles. This problem is common in Bangladesh and in other South-Asian countries. However, a proper planning and management step has not been taken considering these vehicles. To mitigate this problem, proper parking facility should be provided for these vehicles. Parking supply and demand study is essential to plan parking facility.

In Khulna, there are several stopping points of three wheeler vehicles including Fultala, Fulbari gate, Daulatpur, Khalispur, Boyra, Dakbangla etc. There is a three wheeler vehicle Union and stand. None of these are planned, or authorized. Vehicles move, stand, take passenger on Khulna-Jessore Highway. As a result, vehicle movement is hampering in these sites. This paper tries to determine proper parking facility for these vehicles. To conduct demand and supply study, Daulatpur and Fulbari gate is selected as study area. Daulatpur area is one of the most prominent locations in Khulna, as the place is both educationally and economically vibrant. Fulbarigate area is busy as being near to Khulna University of Engineering & Technology. The three wheeler vehicles are of three main categories: Easy bikes, Scooters and Atul/Mahindra.

The objective of this paper is to analyze the demand and supply situation for different three wheeler vehicles in our study area. To develop systematic on-street parking facilities and regulations where needed. To develop existing three vehicles, stand, and on-street parking facility.

The main approach of parking study is divided into two categories, supply study and demand study. This was done by physical survey. Demand study included recording the parking, departures and arrivals of vehicles in a place with time. Questionnaire survey was conducted on different vehicles, passengers, transportation authority, drivers' union etc. From the help of maps, physical survey the supply inventory was done for the two area of interest. Then demand was figured out by physical and questionnaire survey. From the analysis of data, recommendations were proposed to mitigate the existing problems.

2. METHODOLOGY

2.1 Policies

There are a number of policies related with parking facility design by Transport authority. Some of these policies are matches our condition. They're briefly discussed below.

2.1.1 Roads and Intersections

Parking on the primary roads and intersections has to be discouraged. For waiting and stopping, the places have to be designated and marked. Parking has to be allowed on the on the connector and local roads but safety has to be ensured by the management. Intersection clearway must be defined and vehicles must be restrained from parking and stopping in the clearway (Rahman, 2013).

2.1.2 Shopping Centre and Street

The grocery and wholesale markets usually attract two types of vehicles (HGV) and smaller vans. Their basic concern was to load and unloading goods. On street facility should be provided and provisions have to be taken to minimize the haphazard traffic flow. Most of the shopping centers do not provide parking facility. Proper and adequate parking facility must be provided in the new shopping centers. Safe and convenient dropping bays help to reduce the traffic congestion (Rahman, 2013).

2.1.3 Educational Institutions

Collection and drop-off process can be done within the school premises to reduce the unnecessary parking in front of the schools. Schools and colleges should not be located on the primary roads. High schools and colleges those having comparatively large area should have their own off-street parking facility. Provision of safe bicycling parking facility will encourage students to use bicycle (Rahman, 2013).

2.1.4 Residential Neighbourhood

Heavy vehicles should not be allowed to park or stop in front of the residential neighbourhood. Private vehicles should be allowed to park but other small public transport should be allowed only to stop and wait at the designated places (Rahman, 2013).

2.1.5 Parking Study

Parking study includes demand and supply study. Parking demand refers to the amount of parking that is estimated to be used at a particular time, place and price (Singh & Singh, 1991). In case, we are determining necessary parking space required by three wheeler vehicles in the stopping points in any particular time. Parking supply is the amount of bays available for parking in a particular time in a place. It also includes the available space for parking. In Fulbari gate and Daulatpur, there are no planned parking bays available. However, there are unused space that can be used for parking.

The demand study was done by physical and questionnaire survey. In both sites, the license number of Atul/Mahindra, Easy bike and Scooter were collected separately in different times of day and night. The data was then inputted in Microsoft Excel, and repetitions in license number were found. From the data, vehicles arrived, departure and parked were determine. Parking Accumulation, Parking Volume and Parking Load was determined from the data.

2.1.6 Parking Accumulation

It is the total number of vehicles parked in an area at a specific moment. Normally it is expressed by accumulation curve. Accumulation curve is obtained by plotting the number of bays occupied with respect to time (KVK & VT).

2.1.7 Parking Volume

It is the number of vehicles parking in a particular area over a given period of time. This does not account for repetition of vehicles (KVK & VT).

2.1.8 Parking Load

The area under the parking accumulation curve during a specific period. It is expressed as vehicle hours. It can also be obtained by multiplying the number of vehicles parked at each time interval and the time interval (KVK & VT).

2.1.9 Average Parking Duration

The length of time spent in a parking space.

$$\text{Parking Duration} = \text{Parking Load} \div \text{Parking Volume} \quad (\text{KVK \& VT})$$

2.2 Questionnaire survey

Information was taken from different stakeholders related with three wheeler vehicle including drivers, passengers, union members, and transport authorities.

From these analysis, highest possible accumulation of different three wheeler vehicles on both side of road in Fulbari gate and Daulatpur was determined. Parking facility was designed for these number of vehicles.

3. DATA INTERPRETATION

The parking supply and demand for both sides of two study area is analysed based on the parking characteristics of Atul/Mahindra, Scooter and Easy bike.

3.1 Fulbari gate

3.1.1 Supply Scenario

There is no designated on-street or off-street parking provision for the three wheeler vehicles. However, there is a bus bay situated in front of the Fulbari gate bus station. The three wheelers park and load/unload passenger on road.

3.1.1.1 Space inventory

Vehicles are parked on-street on Khulna-Jessore Highway. About 91 square meter space is used in the east side of the road. There is some extra space beside the road, but the space is not suitable for parking vehicle. This place is situated at the opposite of the intersection of KUET road and highway. While in west side, about 196 square meter space is used for parking. The parking is done mainly in front of Fulbari gate bus stop. There is a bus bay here, but busses don't use this facility. Vehicles park both on the bay and on street. Vehicles also stop near KUET road here. On-street parking is not allowed directly on highway, and thus there are no on-street parking lots here. Off-street parking facility or parking lot for three wheeler vehicles is also absent.

3.1.2 Demand Scenario

To reflect the demand scenario of Fulbari gate, parking volume, parking accumulation and vehicle hour occupation is discussed below.

3.1.2.1 Parking volume

Total parking volume over a period of 7 readings is 313 three wheelers vehicle. But the total amount of vehicle passed in the area in study hour is even more. As the time spent for a vehicle is less than 15 minutes, many vehicles had passed the stop without being accounted.

Table 1: Vehicle Accumulation table of Fulbari gate

Fulbari gate	Atul at east side	Atul at west side	Scoter at east side	Scoter at west side	Easy bike at east side	Easy bike at west side	Sum
11:00 AM	14	6	4	1	2	4	31
11:30 AM	6	10	7	0	4	3	30
12:00 PM	8	8	7	1	2	7	33
7:45 PM	12	10	3	0	2	4	31
8:00 PM	14	5	3	2	2	4	30
8:15 PM	18	7	2	1	2	5	35
8:30 PM	7	10	3	1	0	3	24
Total	11	8	4	1	2	4	31

3.1.2.2 Parking accumulation

From Table 1, we can see that the number of Atul/Mahindra tops in east side of road around 8.15 PM with average accumulation of 11 vehicles (figure 1). In the west side of road, the number is maximum at 10 in different times of the day including 11.30 AM, 7.45 PM and 8.30 PM with average accumulation of 8 vehicles (Figure 2).

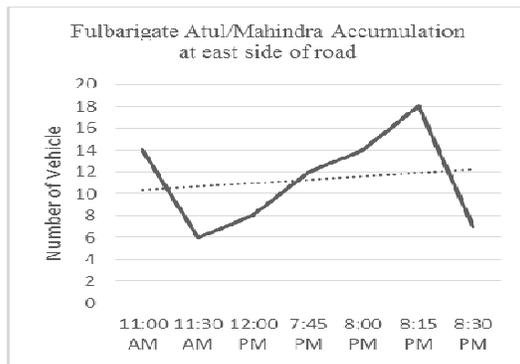


Figure 1: Atul/Mahindra Accumulation at East side of Road.

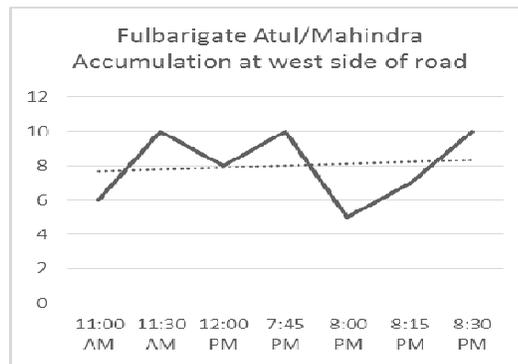


Figure 2: Atul/Mahindra Accumulation at West side of Road.

For scooter, accumulation is highest 7 vehicles during noon at 11.30 AM to 12 PM with average accumulation of 4 vehicles (Figure 3). In the west side of the road, Scooter accumulation is relatively less with average accumulation of 1. The highest accumulation was 2 vehicles at 8 PM (Figure 4).

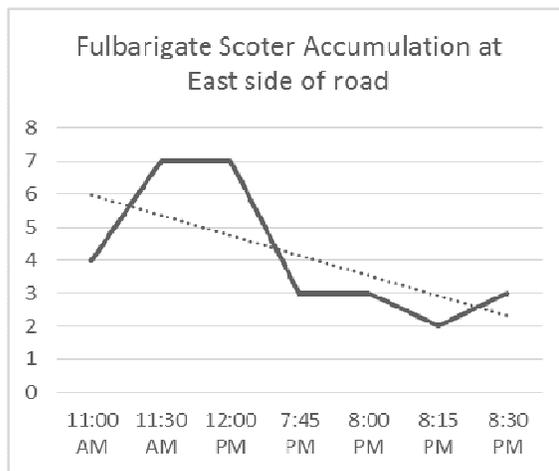


Figure 3: Scooter Accumulation at East side of Road.

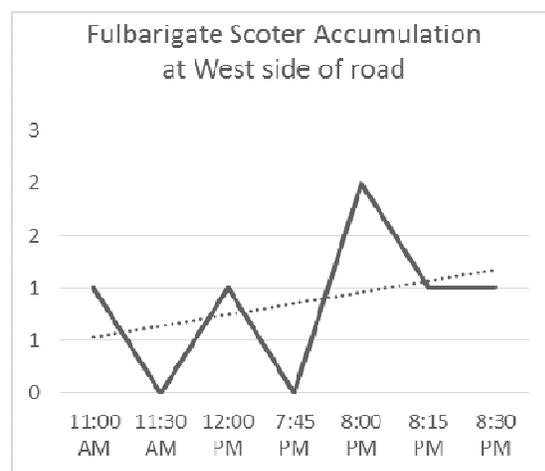


Figure 4: Scooter Accumulation at West side of Road.

Accumulations of Easy bikes are also low in the east side of road with average of 2 vehicles. The top accumulation of 4 vehicle occurred during 11.30 AM (Figure 5). In the west side of road, Easy bike accumulation was higher with average 4 vehicles. The top accumulation of 7 vehicle occurred during 12 PM (Figure 6).

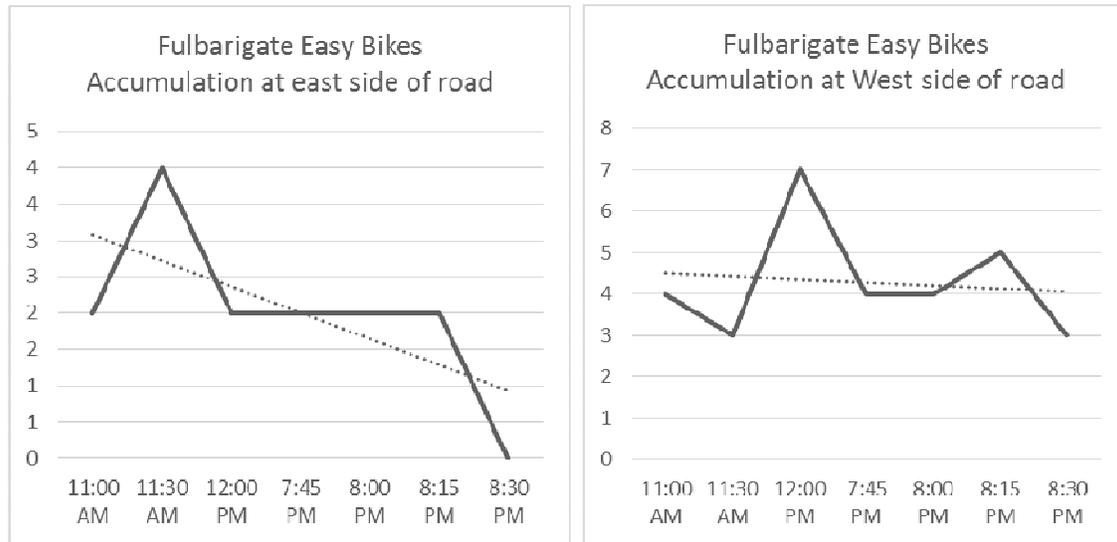


Figure 5: Easy bike Accumulation at East side of Road. Figure 6: Easy bike Accumulation at West side of Road.

From the above data, we can say the maximum number of vehicle in the east side of road is 29. It includes highest 18 Atul/Mahindra’s, 7 scooters and 4 Easy bikes. In the west side of the road, this number is 19. It includes highest 10 Atul/Mahindra’s, 2 scooters and 7 Easy bikes. Both the number can increase in by 2020. So the design demand is for west side of road, and for east side of road.

The growth rate of vehicle in Khulna is about 1.71%. So in coming 5 years, this number can raise up to 32 in east side and 21 in west side.

3.1.2.2 Vehicle-Hour occupation

Average vehicle hour occupation according to physical survey is

Table 2: Vehicle Hour Occupation in the West side of road in Fulbari gate.

Number of times seen	Average duration (Hour)	Atul/Mahindra	Scooter	Easy bike	Total vehicle Parked	Percentage	Vehicle-Hours of Occupation	Percentage
1	0.25	55	6	30	91	98.91	22.75	97.84
2	0.5		1		1	1.08	0.5	2.15
3	0.75				0	0	0	0
						100	23.25	100

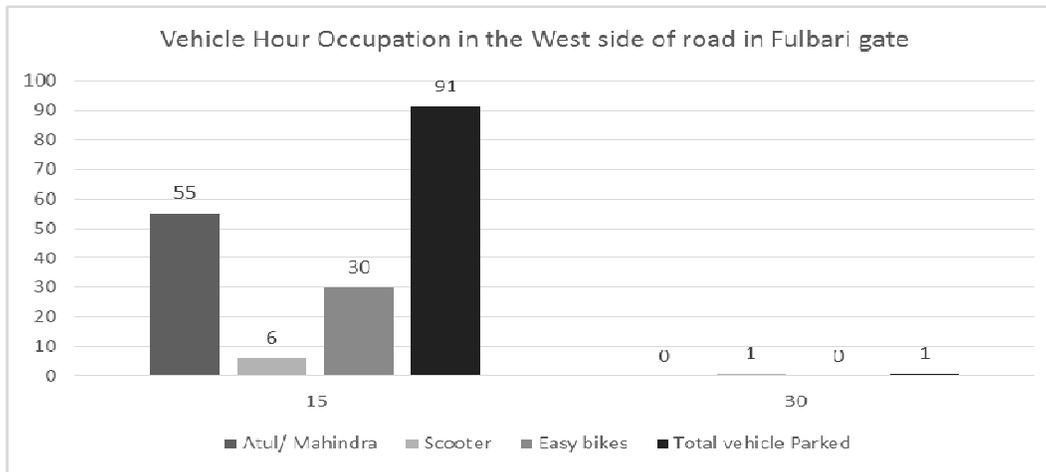


Figure 7: Vehicle Hour Occupation in the west side of road in Fulbari gate.

In West side of road, 97.84% vehicle left parking place in less than 15 minutes. Just 2.15% vehicles parked for more than 15 minutes.

Table 3: Vehicle Hour Occupation in the East side of road in Fulbari gate.

Number of times seen	Average duration (Hour)	Atul/ Mahindra	Scooter	Easy bike	Total vehicle Parked	Percentage	Vehicle-Hours of Occupation	Percentage
1	0.25	76	25	14	115	94.26	28.75	89.15
2	0.5	3	4		7	5.73	3.5	10.85
3	0.75				0	0	0	0
					122	100	32.25	100

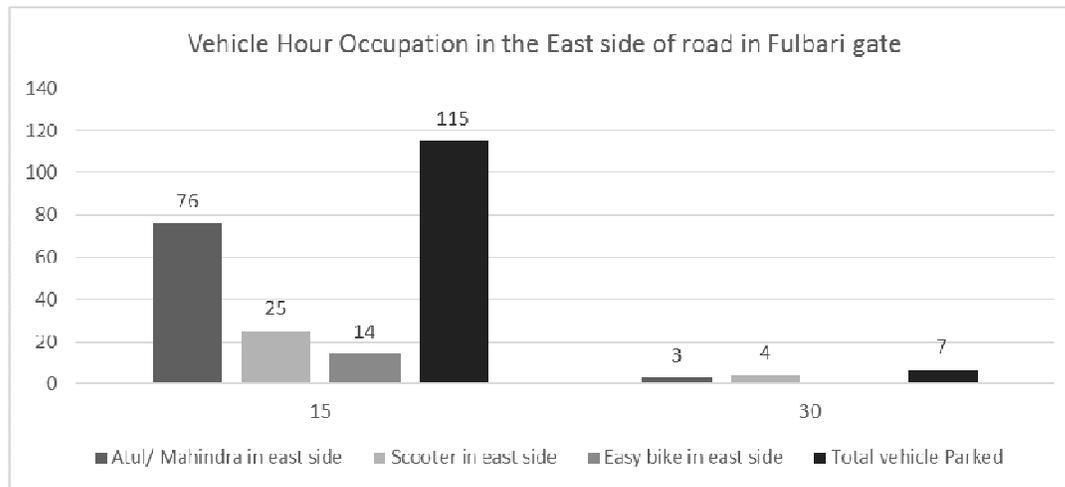


Figure 8: Vehicle Hour Occupation in the East side of road in Fulbari gate.

89.15% vehicle leaves parking place in less than 15 minutes. 10.85% vehicle parks for more than 15 minutes. The three wheeler vehicles usually don't stay in a particular place for a long time. The average parked time according to the physical survey is less than 15 minutes. To have more specific time duration, help of questionnaire survey was taken.

3.2 Daulatpur

3.2.1 Supply Scenario

There is no designated on-street or off-street parking provision for the three wheeler vehicles in Daulatpur too. There is a three wheeler station situated in opposite of the Akankha tower. But the space allocated for the vehicles is very low compared to the need. There is no space allocated is the west side of the road. In both sides, vehicles park and load/unload passenger on road.

3.2.1.2 Space Inventory

Vehicles are parked in a very congested and scattered way on-street on Khulna-Jessore Highway. At the east, there are some extra space in front of Three Wheeler Samity which is not organized and vehicle load and unload passengers as their wish without following any parking instruction. The area at the east where three Wheelers Park is about 251.99 square meters. At the opposite (west) section on the road there is no specific boundary located for parking although they cover maximum portion which is about 116.47 square meters. Though on street parking is not directly prohibited these motorized three wheelers make their own wish to park vehicles to load and unload passengers.

3.2.2 Demand Scenario

To illustrate the demand scenario of Daulatpur, Parking volume, parking accumulation and vehicle hour occupation is discussed below.

3.2.2.1 Parking volume

Total parking volume over a period of 7 readings in 1.30 hour is 313 three wheelers. That means total almost 313 individual vehicles has been experienced during the survey period. So, per hourly average volume of vehicular parking are 178.86; which means on an average in every hour 178.86 new vehicles come into the intersection (both sides) at Daulatpur.

3.2.2.2 Parking accumulation

Table 4: Parking Accumulation in Daulatpur Area.

Daulatpur	Atul at east side	Atul at west side	Scoter at east side	Scoter at west side	Easy bike at east side	Easy bike at west side
12:30 PM	12	12	8	2	5	4
1:00 PM	10	16	12	3	23	5
6:30 PM	6	13	4	0	6	6
6:45 PM	8	11	4	4	3	6
7:00 PM	11	16	3	0	4	3
7:15 PM	13	17	3	1	3	5
7:30 PM	12	21	7	4	4	3
Average Accumulation	10	15	6	2	7	5
Total Parked Vehicle	72	106	41	14	48	32

From Table 4, we can see that the number of Atul/Mahindra tops in east side of road around 7.15 PM with average accumulation of 10 vehicle. In the west side of road, the number is maximum at 21 in different times of the day having an average of 15.

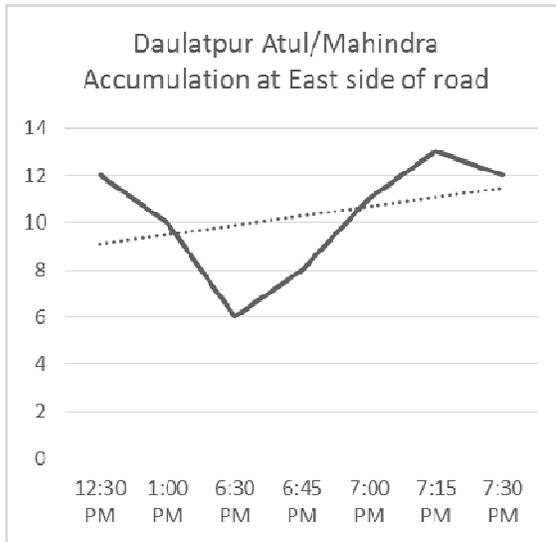


Figure 9: Atul/Mahindra Accumulation at East side of road.

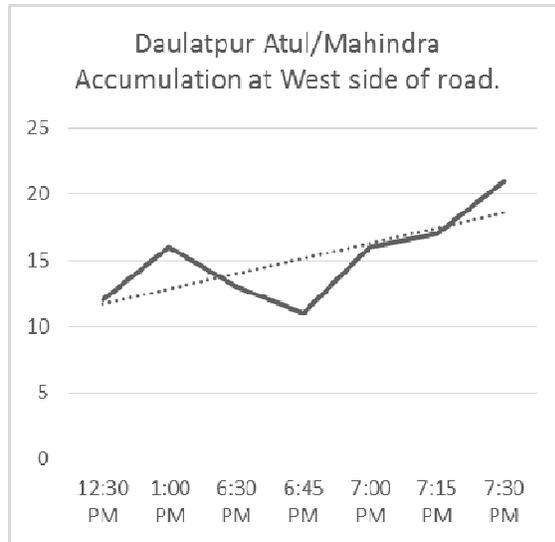


Figure 10: Atul/Mahindra Accumulation at West side of road.

For scooter, accumulation is highest 12 vehicles during noon at 1.00 PM to 7:30 PM with average accumulation of 6 vehicle. In the west side of the road, Scooter accumulation is relatively less with average accumulation of 2. The highest accumulation was 4 vehicles at both 6:45 PM and 7:30 PM.

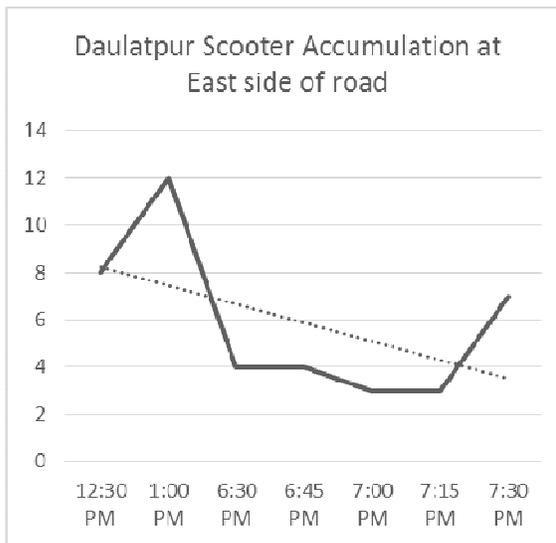


Figure 11: Scooter Accumulation at East side of road.

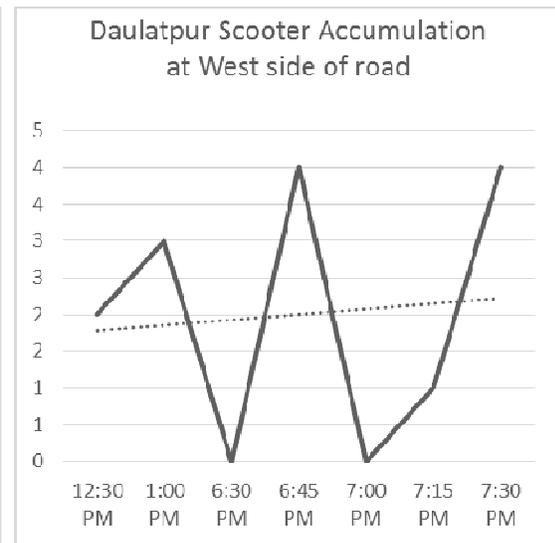


Figure 12: Scooter Accumulation at West side of road

Accumulations of Easy bikes are in the east side of road with average of 7 vehicles. The top accumulation of 23 vehicle occurred during 1.00 PM. In the west side of road, Easy bike was comparatively less with average 5 vehicles. The top accumulation of 6 vehicles occurred during both 6:30 PM and 6:45 PM.

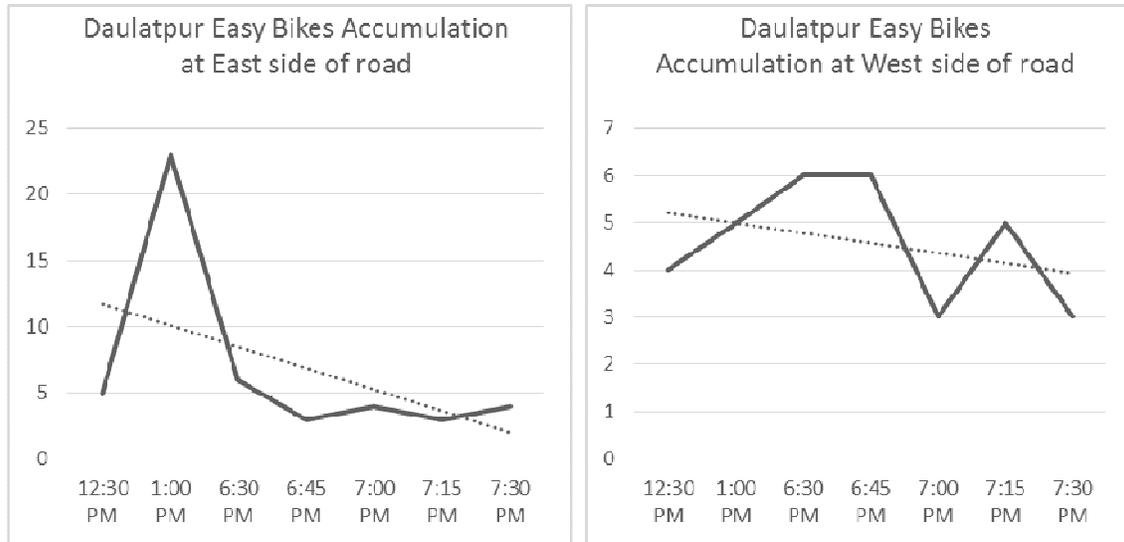


Figure 13: Easy Bikes Accumulation at East side of road. Figure 14: Easy Bikes Accumulation at West side of road.

From the above data, we can say the maximum number of vehicle in the east side of road is 48. It includes highest 13 Atul/Mahindra’s, 12 scooters and 23 Easy bikes. In the west side of the road, this number is 31. It includes highest 21 Atul/Mahindra’s, 4 scooters and 6 Easy bikes. Both the number can increase in by 2020. So the design demand is comparatively higher for west side of road than that for east side of road.

3.2.2.3 Vehicle-Hour occupation

Average vehicle hour occupation according to physical survey is

Table 5: Vehicle Hour Occupation in the West side of road in Fulbari gate.

Number of times seen	Average duration (Hour)	Atul/Mahindra	Scooter	Easy bike	Total vehicle Parked	Percentage	Vehicle-Hours of Occupation	Percentage
1	0.25	102	14	32	148	97.36	37	94.87
2	0.5	4	0	0	4	2.67	2	5.13
					152	100	39	100

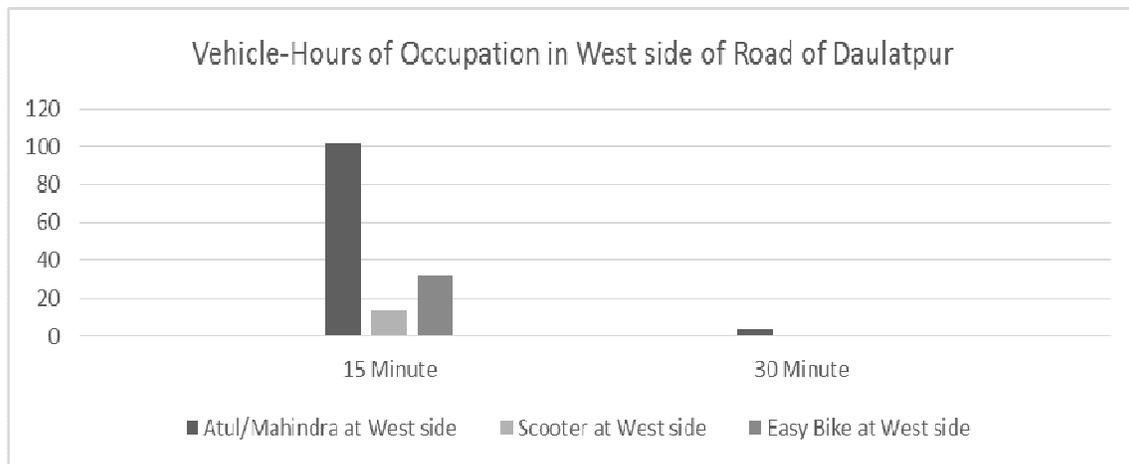


Figure 13: Vehicle-Hours of Occupation in West side of Road of Daulatpur.

In West side of road, 97.84% vehicle left parking place in less than 15 minutes. Just 2.15% vehicles parked for more than 15 minutes.

Table 6: Vehicle Hour Occupation in the East side of road in Fulbari gate.

Number of times seen	Average duration (Hour)	Atul/Mahindra	Scooter	Easy bike	Total vehicle Parked	Percentage	Vehicle-Hours of Occupation	Percentage
1	0.25	68	39	48	155	96.28	38.75	91.71
2	0.5	2	2	0	4	2.48	2	4.73
3	.75	2	0	0	2	1.24	1.5	3.55
					161	100	42.25	100

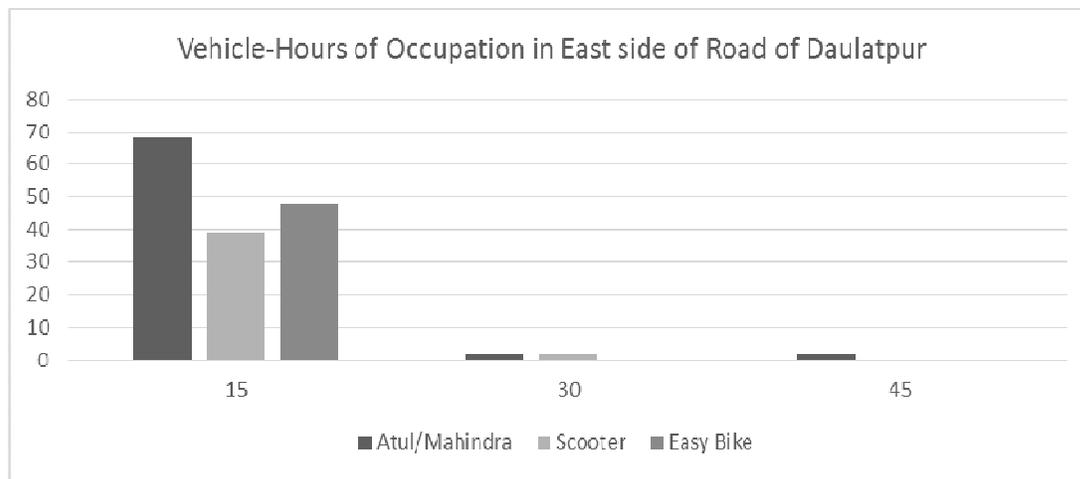


Figure 24: Vehicle-Hours of Occupation in East side of Road of Daulatpur.

Most of the three wheeler vehicle doesn't stay in one place for long time. The average minutes a vehicle stays are less than 15 minutes. Just few vehicles stay in a place longer than 15 minutes. In Daulatpur 94.87% left parking place in less than 15 minutes in west side of road. For east side of road, it's 91.71%.

Multiple common questions were asked to the three wheeler drivers, passengers, and toll collector from the union. Also, some valuable questions were asked to the inspector of the BRTA and Executive Officer of RHD about what their concerns about those unplanned parked areas are and how the situation can be handled in a planned way. They described the existing problems and delivered a short speech about the possible solution according to their perspective.

4. RECOMMENDATIONS AND CONCLUSION

4.1 Lot Design

Among three kinds of three wheelers, ATUL has got the maximum width 1.305 meter and length 2.720 meter. While designing parking lots this size has taken as a standard and each lot dimension (width: 2.205 m and length: 3.62 m) is shaped in a way having the shortest distance both horizontally and vertically about 0.9 meter. Each parking lot will cover about 7.98 square meters.

4.1.1 Daulatpur

There is a bus stand remain unused since long time ago. To minimize the existing haphazard situation at the west side, 18 vehicles can be accommodated at the same time. The bus stand covers about 477.43 square meters. The whole parking lots will cover about 286.57 square meters and the remaining area will serve as a bus stand. The drivers will get the flexibility of loading and unloading passengers according to the demand and time. For this, in front of each row there are 23.93 square meter rectangular area available to cross or overtake the parked vehicles to get direct access to the main road. In case if there is more than least amount of three wheelers then the unmarked lots can provide the facility to park. Each rectangular shaped unmarked space can also accommodate three vehicles at a time. There will be some rules and regulations that should be maintained strictly by the drivers for proper management in case of time elapsing at the parking lot putting engine off etc. At the east side the space in front of Three Wheeler Union where the vehicles are now parking are not much spacious. As the numbers of vehicles are increasing, the future demand will raise for parking. The space can be managed and controlled if the drivers follow the rules and instructions placing their vehicles at safe distance. Another fact, it is seen while surveying some of the vehicles are put aside of the road putting engine off that also create congestion for other vehicles to provide on street parking facility.

4.1.2 Fulbari gate

The research says that there should be parking facility for 31 vehicles in the east side of the road, and parking facility for 21 vehicle in the west side of the road. Fulbari gate intersection in a busy area. There is a bus bay near the intersection. Bussess usually don't use the bus bay. They load/unload passenger on the road. As there is as need of parking facility for three wheeler which always disturbing the main flow of vehicle, the bus bay can provide parking facility for both for buses and three wheelers.

5. CONCLUSION

Parking demand management has a great influence to make transportation system safe and less time consuming. To provide on street parking facilities and spaces in both working and free hours according to the demand is a tough job. Various strategies and policies such as - restriction, fixation of time duration, pricing etc. have already been established to minimize the problems all over the world. As the numbers of vehicles are increasing at a huge rate, it is in need to manage the parked vehicles effectively at peak hours with limited spaces. Effective and suitable strategies can ensure proper parking management with the emerging changing situation which will lead us to achieve long term solution.

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