TRAFFIC PATTERN MODELING USING CLUSTERING ALGORITHM

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DHAKA, BANGLADESH
FEBRUARY 2023

APPROVAL

This Project/internship titled **"Traffic Pattern Modeling Using Clustering Algorithm"**, submitted by Maruf Hassan Khan, ID No:183-15-2269 and Afiatul Babul Mim, Student ID:182-15-2207 to the Department of Computer Science and Engineering, Daffodil International University has been accepted as satisfactory for the partial fulfillment of the requirements for the degree of B.Sc. in Computer Science and Engineering and approved as to its style and contents. The presentation has been held on 06.02.23

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ACKNOWLEDGEMENT

First we express our heartiest thanks and gratefulness to almighty God for His divine blessing makes us possible to complete the final year project/internship successfully.

We really grateful and wish our profound our indebtedness to **Aliza Ahmed Khan**, Department of CSE Daffodil International University, Dhaka. Deep Knowledge & keen interest of our supervisor in the field of "*Machine learning"* to carry out this project. His endless patience, scholarly guidance ,continual encouragement , constant and energetic supervision, constructive criticism , valuable advice ,reading many inferior draft and correcting them at all stage have made it possible to complete this project.

We would like to express our heartiest gratitude to Aliza Ahmed Khan, Mohammad Jahangir Alam and Head**,** Department of CSE, for his kind help to finish our project and also to other faculty member and the staff of CSE department of Daffodil International University.

We would like to thank our entire course mate in Daffodil International University, who took part in this discuss while completing the course work.

Finally, we must acknowledge with due respect the constant support and patients of our parents.

ABSTRACT

Traffic congestion is one of the most alarming problems of Dhaka, the capital of Bangladesh. In order to control traffic intensity of this densely populated city we need to find traffic pattern and the factors that influence traffic congestion. In this paper, we have analyzed traffic intensity pattern for different cases with respect to time. For macroscopic modeling, we have used 13 DPZ zones of Dhaka proposed by RAJUK and have analyzed traffic pattern for each zone. For finding similarities among zones, clustering method has been used using the land use information of each zone. For finding the factors that influence traffic congestion we have used regression analysis considering both land use pattern and social infrastructures of zones. Bus routes and road intersections have been also analyzed for finding the reasons behind traffic congestion. Thus the whole analysis will help to take proper steps in urbanization planning in order to minimize traffic congestion of this beautiful Dhaka city.

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CHAPTER 1

INTRODUCTION

1.1 Motivation

Dhaka, the capital of Bangladesh and one of the most densely populated cities in the world. About 17 million people live in the greater Dhaka in an area of 1528 square kilometers with more than 45,000 people per square kilometer in the main area [1]. Only 8% of Dhaka's total land areas are being used as road networks in Dhaka where smooth traffic system demands 25% of the city's surface area [2]. According to BRTA, number of registered motor vehicles in Dhaka are 10,59,403 and there are 27,537 registered buses and 10,214 registered mini buses in Dhaka city by 2016 [3] which are not sufficient for public transportation. People waste lots of time in traffic jam and it hampers directly on the economic growth of total nation. People spend on an average 2.35 hours in traffic activities daily of which

1.30 hours are eaten up due to traffic congestion. So people are losing about 55% of their traffic time in Dhaka and per day amount of loss is taka 260.54 million [4]. Another problem of Dhaka is its unplanned land use structure. The legitimate au- thority to prepare the land use plan is Rajdhani Unnayan Kartipakkha (RAJUK) and they suggest efficient land use of Dhaka. But some problems such as political influences, inappropriate monitoring systems, corruptions etc are altering the land use plan. Land use changes also hamper the regular traffic flow and create traffic congestion. In order to control current situations, we need to analyze the traffic intensity pattern of Dhaka to take the proper steps to maintain it. We also need to investigate the factors that increase traffic intensity. For better modeling of the situation we need to analyze the properties of different zones using land use pattern.

1.1.1 Current Initiatives for Controlling Traffic Congestion

The government is always trying to control traffic congestion and have taken some initiatives also. For traffic signaling, the government is planning to introduce remote controlled traffic signal system in Dhaka city instead of following traffic policeman's hand language. The World Bank has funded 70 traffic signals at major intersections of the city in 2005 at a cost Taka 130 million [5]. There are at least 17 big and 14 small digital display boards across the city displaying traffic rules and speed limits [5].

Dhaka Mass Transit Company LTD (DMTC) is the authority for implementation of the Dhaka Mass Rapid Transit Project. It is currently handling the implemen- tation unit of the Dhaka Metro Rail projects which is 2,20,000 million (2.5 billion) US Dollar project is aimed at an improved, faster, comfortable and time-bound public transportation service [6]. There are mainly three metro rail projects in Dhaka. Those are :

- MRT-1: It will connect Dhaka Airport to Kamalapur, which will later be extended from the Airport to Gazipur and Kamalapur to Keraniganjs Jhilmil residential area. The construction of MRT-1 will be completed at 2025 and will carry 13,65,800 passengers daily [7]. • MRT-5: The proposed MRT line 5 will start from Bhulta on Dhaka- Sylhet highway and stretch to Hatirjheel link road via Bhatara, Natun Bazar, Madani Road, Kamal Ataturk Avenue, Mirpur 10, Gabtoli bus terminal, Mirpur Road, Dhanmondi and Basundhara City.The length is 35 kilome- ters. It will carry 14,78,600 passengers daily at 2035 [8].

- MRT-6: MRT Line-6 will run from Uttara to Motijheel serving 16 sta- tions along the way. The project is jointly financed by the Government of Bangladesh and Japan International Cooperation Agency (JICA). The commercial operation of the full system is expected by the end of 2020 [9]. Figure1.1shows the route map of MRT-6.

RAJUK has also undertaken some steps for reducing traffic jam [10]. Some major projects are:

- Extension of Madani Avenue to the Balu River(Proposed Eastern embank- ment).
- Widening of link Road from Indira Road to Phanthapath.
- Link Road from near Sonargaon Hotel to Mohakhali Rail Crossing (along the railway Track Behind Prime-ministers offices).
- Link Road from Malibagh to Janapath.
- Extension of Link Road from Notre Dame College to Janapath.
- Construction of Road from Kadamtali to Monikdee.
- Constriction of Road from Bashabo Jame Mosque to Trimohonee to Shekher Bridge via Nandipara.
- Construction of different internal Roads at DND Area.

In order to minimize the traffic intensity, Bangladesh Bridge Authority has in- tended to deliver a project for the construction of approximately 23 km of Elevated Expressway in the northern part of Dhaka City on a Public Private Partnership (PPP) basis [11]. Flyovers

are also build for faster transportation. Some already completed and ready flyovers are Mohakhali Flyover(1.12 Kilometers), Khilgaon Flyover (1.90 Kilometers), Bijoy ShoroniTejgaon Link Road, Kuril Flyover (3.19 Kilometers), Mayor Hanif flyover (11.8 Kilometers), Mirpur-Airport Road flyover with an overpass (4.1 Kilometers), Moghbazar-Malibagh [12].

Japan International Cooperation Agency (JICA) conducted the preparatory sur- vey on Dhaka city for urban transport network development Bangladesh from 2009 to 2010 [13]. It was a field surveys and has given an overview of the future plan- ning on transport network of Dhaka. We have covered the analysis of DHUTS with more details in 2.2.

Bangladesh government is trying to cope with the acute traffic jam of Dhaka city. But the real scenario of traffic intensity is needed to be focused. Only field surveys are not enough for development. For controlling traffic intensity, the properties and pattern of traffic congestion should be considered. The factors that influence the traffic intensity should be found out also which are the area we have explored and have written in this paper.

1.2 Research Objective

In order to find out the reasons behind traffic congestion we need to analyze the factors influencing traffic intensity. Recent studies of traffic do not much focus about it and home based surveys cannot give us the answer. For this reasons we have focused on finding traffic pattern using the traffic data set we have.

We have tried to find the traffic pattern in macroscopic form. For that we can see the overall traffic intensity conditions of a large area which may help us to take the administrative level decisions more easily for controlling traffic congestion. We have divided Dhaka city into zone zones using the land use pattern information published by RAJUK and have separated the road segments among different zones of Dhaka city.

Overall Dhaka city’s traffic conditions have been shown that gives us the traffic intensity pattern of our study area. We have also compared the traffic pattern in weekdays and weekends. Rickshaw free roads have also considered for further

1.3 Challenges

Finding traffic pattern from raw data is not easy task. Form data set, we have gained the information of time stamp when the record of traffic intensity was generated and latitude, longitude coordinates information of road segments.
The data definitions are described in more details in chapter 3. We have to overcome some challenges in order to find the factors influences traffic intensity and for better modeling of traffic pattern. The challenges we have faced are given below:

First, removal outlier from the raw data set and prepares data set for analysis.

Second, finding road intersections from the data we have as only latitude and longitude information of road segments was given.

Third, plotting the zones of Dhaka city for better visualization from a government report where only the corresponding DCC wards information are given for each zone.

Fourth, finding road segments of all the zones and analyze traffic intensity pattern for each zone.

Fifth, selecting the factors that may influences traffic congestion.
Some factors (land use pattern, social infrastructures, road intersections, bus routes etc.) are analyzed in order to find the reasons behind traffic congestion. We have also analyzed the traffic pattern for each zone and found the similarity between the zones and their traffic intensity pattern for further development of the transportation and urban planning.

1.4 Overview of the Analysis

We want to find the traffic patterns in order to display the traffic condition of the Dhaka and compare them for some cases. For that reason, we have divided the city into different zones in order to find the relationships between traffic density and land use of Dhaka. To develop such system, we divide our tasks into five, those are mentioned in below:

1. First task is to analyze the data and outlier removal.
2. Second Task is to analyze the traffic intensity pattern for different cases.
3. Third is to divide the Dhaka city into some zones.
4. The fourth task is to find the traffic pattern of different zones and compare them.

5. The final task is to find the reasons behind traffic congestion with the data we have.

1.5 Literature Review

We have to study previous works on related topics in order to understand the challenges and the properties for dividing Dhaka into zones and modeling traffic pattern. Thatunderstand also helps us to find the difficulties of our work thus we can find our way to build such modeling scheme. There are three topics we need to cover in order to understandthe full works. Those are:

- Traffic Modeling and Analysis.
- Dhaka Urban Transport Network Development Study.
- Determining Zones of a City.

1.6 Traffic Modeling and Analysis

We need to understand how urban traffic network models have been built. As we have divided Dhaka into different zones in order to find the land use and traffic pattern, we need to consider how the macroscopic traffic modeling is designed and different features of it. Dagenzo and Geroliminis have proposed an observa- tion based models. They have tried to model a system that is repeatedly modified based on observation. They described macroscopic relations between traffic vari- ables for a single link and also presented MFD for large road network. Watling[15] evaluate the various models with regard to their suitability and compared various traffic models like TRAFFICQ which has been designed forstudying a detailed section of road network, DYNEMO which is a mixed microscopic and macroscopic model. Tsubota, Bhaskar and Chung developed MFD for Brisbane, Australia. They divided the Brisbane into four regional barriers. They have presented graphs consisting information of area average flow and area average traffic density. Li, Han, Lee, Gonzalez have implemented an algorithm named FlowScan. It is a density based algorithm and find the hot routes in road net- works. A hot route is just a general traffic flow pattern in road network. They have clustered road segments based on traffic density instead of clustering the moving object. DHUTS have published the latest work on traffic survey and analysis. They conducted HIS (Household Interview Survey) and collect the data of travel

behavior patterns throughout the DMA (Dhaka Metropolitan Area). They have set a priority level on transportation mode in their observations and public modes (i.e: trains, buses) have the higher priority than private mode (i.e: private car, motorbike). They have also provided the modal choice with respect to different income level. They have also provided the resident movement across the DMA, DCC and RAJUK area. They have found the Trip Production Rate which is con- sidered as trips/day. A trip may be linked or unlinked. The linked trip means an entire trip of a person to terminate a single purpose. The unlinked trip is a part of linked trip segregated by transport mode. Draft Dhaka Structure Plan (2016-2035) [20] published by RAJUK has given overview of daily passenger movement in Dhaka. It has some models for controlling traffic congestion and also provided the information of modal share.

CHAPTER 2

BACKGROUND

2.1 Dhaka Urban Transport Network Development Study

The JICA Study Team and Dhaka Transportation Coordination Board under the Ministry of Communications of Bangladesh have been working together for for- mulating the basic concept of urban development for Dhaka Metropolitan Area (DMA) in 2025 as well as formulating the projects for the JICA assistance pro- gram. A report has published entitled Preparatory Survey Report on Dhaka Urban Transport Network Development Study (DHUTS) in Bangladesh . They have not only focused on urban transport but also in economic conditions of Bangladesh. They have divided the study area in six zones.

Figure2.1shows the study area and six zones of that area.

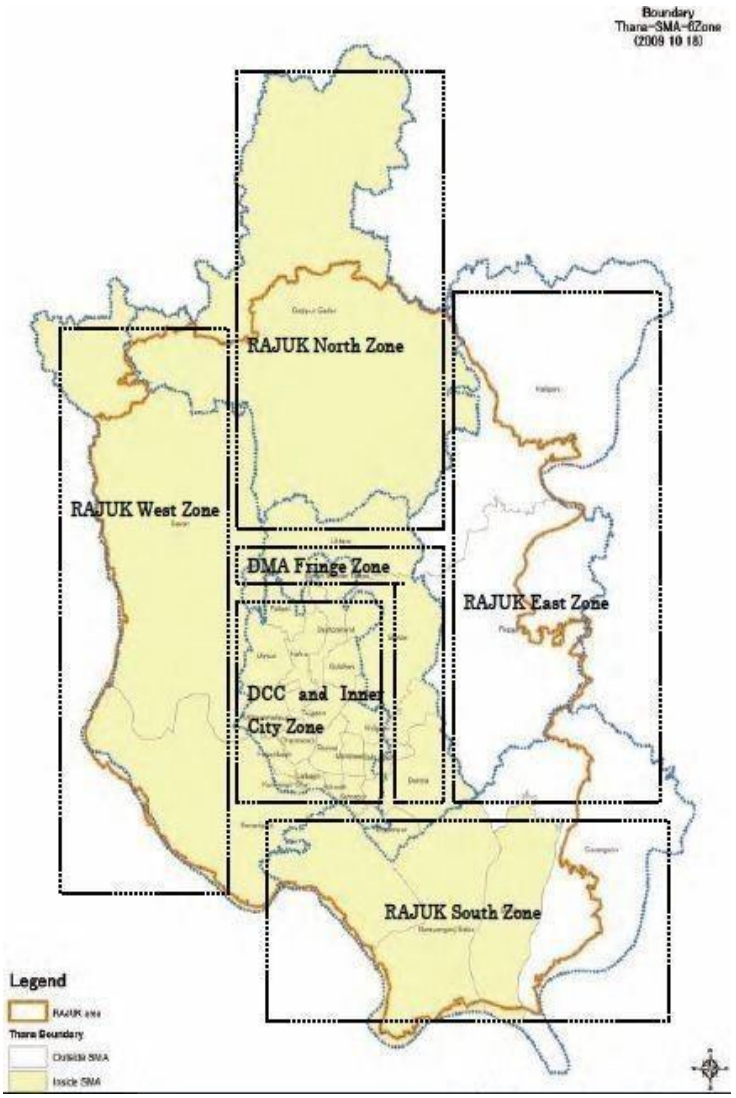

FIGURE 2.1: Six zones in DHUTStustduydy (Dhaka Metropolitan Area). (Source: JICA Team)

DHUTS conducted Household Interview (obtaining trip characteristics of residents in the study area), Cordon Line (obtaining current traffic volume entering and exit from/to DMA) and Screen Line Survey (To obtain current traffic volume within DMA).

From household survey, DHUTS found residents movement in the study area. From that survey the trips that peoples makes daily also found. Total 20.8 million trips are made by the residents in the study area per day. The study alsodivided people in three categories named group 1 (monthly household income with more than BDT 50,000), group 2 (monthly household income between BDT 20,000 and BDT 49,999) and group 3 (monthly household income with less than BDT 19,999). Figure2.2shows the trips made by each group. From that we have found the pattern of movement of different levels of people.

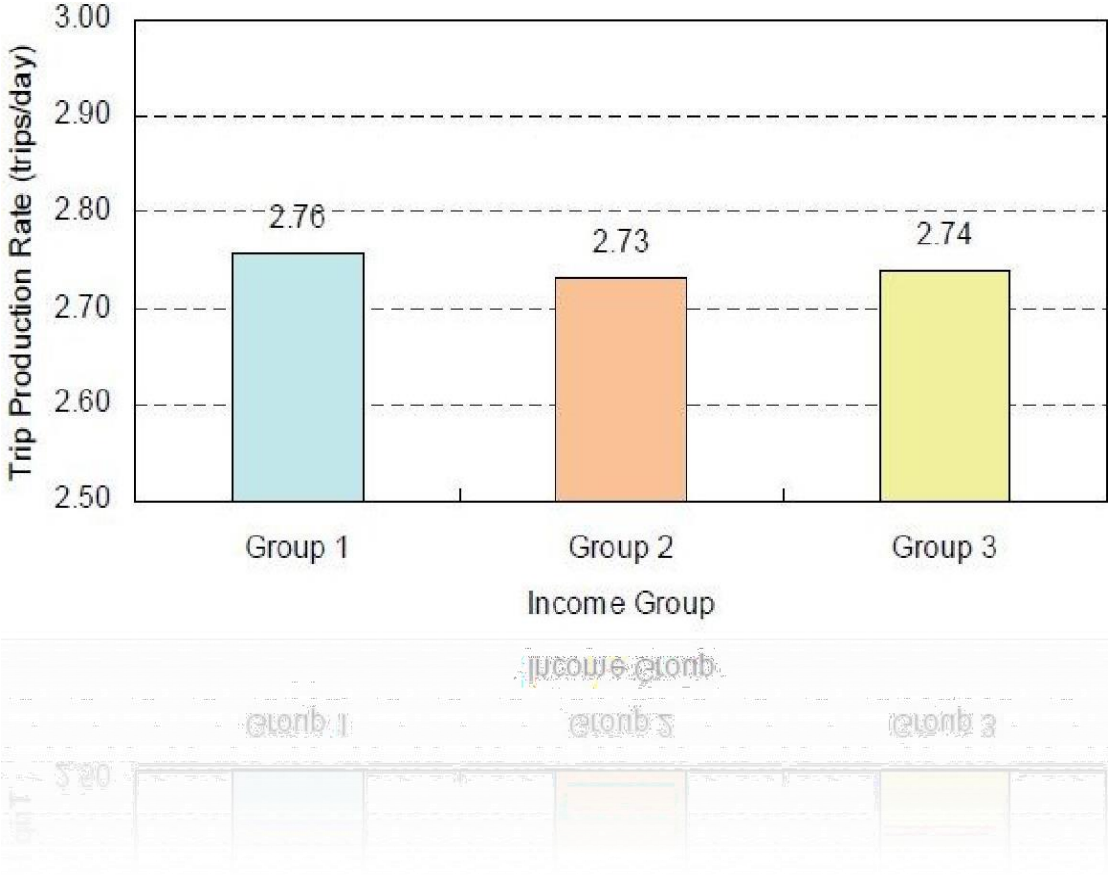

Figure 2.2: Average trips per day forgroup 1 (monthly household income with more than BDT 50,000), group 2 (monthly household income between BDT 20,000 and BDT 49,999) and group 3 (monthly household income with less than BDT 19,999). (Source: JICA Study Team)

The study also investigated the traffic pattern and bus speed for morning peak or office hour and afternoon off-peak hour for different routes. Form that, wecan find out the routes which are more congested considering the bus speed. Figure 2.3shows the average bus speed information for different routes.

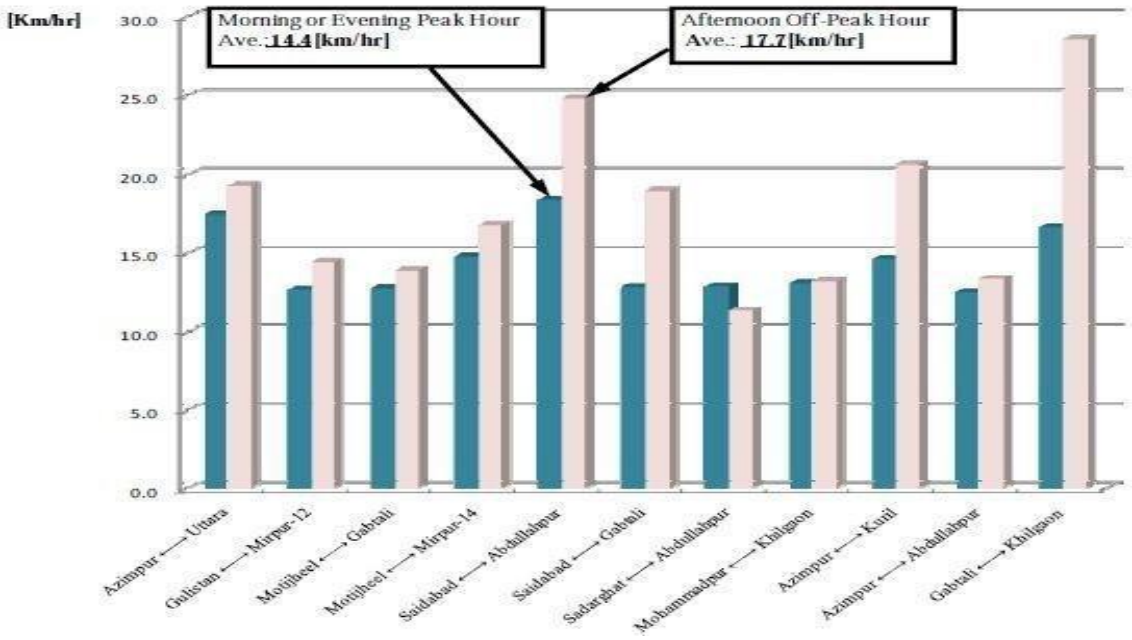

FIGURE 2.3: Average bus speed for peak time (morning or evening) and off peak time (afternoon) for different bus routes. (Source: JICA Study Team

The land use patterns of study area are also described in the study for future development of urbanization. The future plans of DHUTS study are shown in figure2.4.

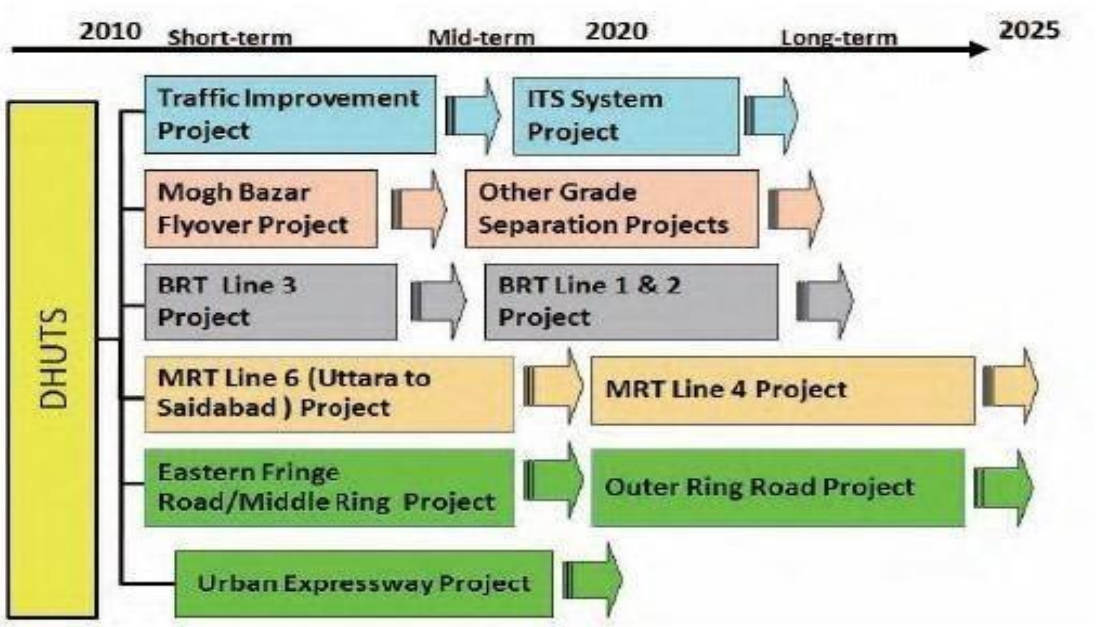

FIGURE 2.4: PROJECTS THAT HAD BEEN TAKEN BY GOVERNMENT

The study helps us to understand the current condition of traffic systems. But the problem is, most of the analysis was completed manually means household surveys or counting vehicles by people. So, in order to fix the real problem we need an automated system which gives us the accurate data for analyzing. We have tried to figure out a model in order to find out the traffic pattern from GPS data rather than manual survey. This can help us visualizing the traffic conditions in macroscopic form.

2.2 City Zoning for Urban Development

Paul Waddell [21] has described a model call UrbanSim for modeling urban development considering land use, transportation and environmental planning. He de- fined some operational urban model with respect to characteristic of land use.Guiliano, Genevieve [22] have given an overview the relationships between transportation and land use. It examines the impact of land use on the transportation. They have given a brief description of factors to considering when examining land use pattern and the impacts of it on transportation investments.Ashraf M. Dewan Yasushi Yamaguchi [23] have illustrated the land use change in DMA using topographic maps and multi temporal remotely sensed data from 1960 to 2005. The analysis has showed the change of agricultural zones of Dhaka city and how the urban land area has increased in 45 years. The final report [24] , the fifth of the series of the reports submitted under the DAP (Detailed Area Plan) which covered 108.97 sq.km and examined by Group C presented a full report planning Dhaka. The entire area was divided into 13 planning zones. Each zone was defined as DPZ (Detailed Planning Zone). The area was divided considering population density, homogeneity of the land use and existing situation. In Plan Dhaka (2016-2035)

[20] published by RAJUK has divided the DMR (Dhaka Metropolitan Region) into six zones and planned further development according to this zones. The zones are Dhaka central region, eastern region, northern region, south-western region, south- ern region andwestern region. DHUTS [13] has prepared existing land use map of 2009 and also dividedsix geographical zones for further development and gave an overview of traffic conditionsof their experimental area.

CHAPTER 3

DATA COLLECTION AND PREPROCESSING

3.1 Data Description

For analyzing traffic intensity pattern, we have collected traffic data. The data has been provided from a private company named GoBd which is currently working on Dhaka's traffic pattern analysis and suggest routes. They have used some pro- prietary algorithms and used the GPS traces for calculating the traffic intensity. The data we have has the information from 1st September, 2015 to 15th Septem- ber, 2015. A single road is divided into multiple road segments and we have total 11,769 road segments traffic data. The size of our data is 714 Megabytes. There are 16,23,280 records in whole data. Each record contains the following information:

1. TimeStamp: Time stamp when the record was created [DataType: Date- Time].
2. OsmName: Human readable name for the road segment (e.g. Dhaka-Sylhet Highway) [DataType: String]
3. Intensity:The intensity of traffic jam on the road segment within 0.0 1.0 range [DataType: Float].
4. Path: Starting and ending geographic coordinates of the road segment [DataType: Lat/ Long range].
5. DistanceKM: The length of the road segment in Kilometers [DataType: Float].
6. RoadSpeedKMH: Expected speed speed of the road segment in Kilometers per Hour [DataType: Integer].

We have plotted the road segments in our study area. For this we have first gen- erated the KML files using the road segments latitude and longitude coordinates. For this we have used Google maps. We have generated a csv file containing all the lattitude, longitude information of road segments from our data set. Then we convert it to kml file using earthpoint1 which is a tool for Google earth. We have drawn the polygon which indicates us the study area (Dhaka) in Google map and then also convert it kml file from map options. Then we load both of our kml file in QGIS as vector layar and export them as shape file. So that we can generate the geographical information from our map. The road segments (red

colored line) information we have and Dhaka's area map (sky-blue colored area)which is our study area.

3.2 Selecting Threshold for Finding Strong Data

We have set a threshold for analyzing the data we have. Here, the threshold means the minimum number of data for a road segment for a specific time from 1st September, 2019 to 15th September, 2019. For better analysis, we have divided the 24 hours of a day into 48 segments each having 30 minutes staring from 00:00:00 (Hour:Minute:Second). So the first segment contains the information of 00:00:00 to 00:30:00 and the next is 00:30:00 to 00:01:00 and so on. We have calculated the number of records for all road segments. We have the time-stamp information of all records. If a road segment has less than 5 records in 30 minutes or in a time segment from 1st September, 2019 to 15th September, 2019 of records list then we have removed them from the data set. So, if any road segment contains less than five records for 00:00:00 to 00:30:00 time duration we do not take those records for further processing and remove them from the original data set. After cleaning the data, we have 8,966 road segments data 3.3 Outlier Detection and Removal

For detecting outlier we have used the 2-standard deviation of the arithmetic mean formula. We first partition an entire day in 48 segments (30 minutes each) then calculating arithmetic mean and standard deviation for each time segments from the data we have for every road.

ArithmeticMean(μ) = NNxii = 1… .....(3.1)

StandardDeviation(σ) =1

Σi=1 (xi − x¯)^2… .....(3.2)

Using equation3.1and3.2we have detected the outlier using 2-standard deviation of mean.

Omin = μ − 2 ∗ σ.....(3.3)

Omin = μ + 2 ∗ σ.....(3.4)

If we consider an traffic intensity record as X. Then using equation3.3and3.4We can determine outliers and clean them from the original data set. Fig3.2shows the road segments after detecting threshold and removing outlier.

We have taken only those records into consideration if, Omin ≤ X ≤ Omax.

3.3 Zoning of Dhaka City

RAJUK have published a report [24] containing structure planning of Dhaka.The main theme of structure plan and the urban area plan is to help in providing more detailed planning proposals for specific sub areas of Dhaka. Those area identified sub areas as DPZ, which contains detail land use proposals including infrastruc- tures. We use that land use information for further traffic pattern modeling and analysis the modeling macroscopically. We have also analyzed the infrastructures using the report [24] for each DPZ zones also in order to find the reasons behind traffic congestion. RAJUK also published the information about wards of DCC for each zone. They have divided the wards among different zones according to land use and homogeneity of the wards.

Table3.1shows the information about all the zones and corresponding DCC wards.

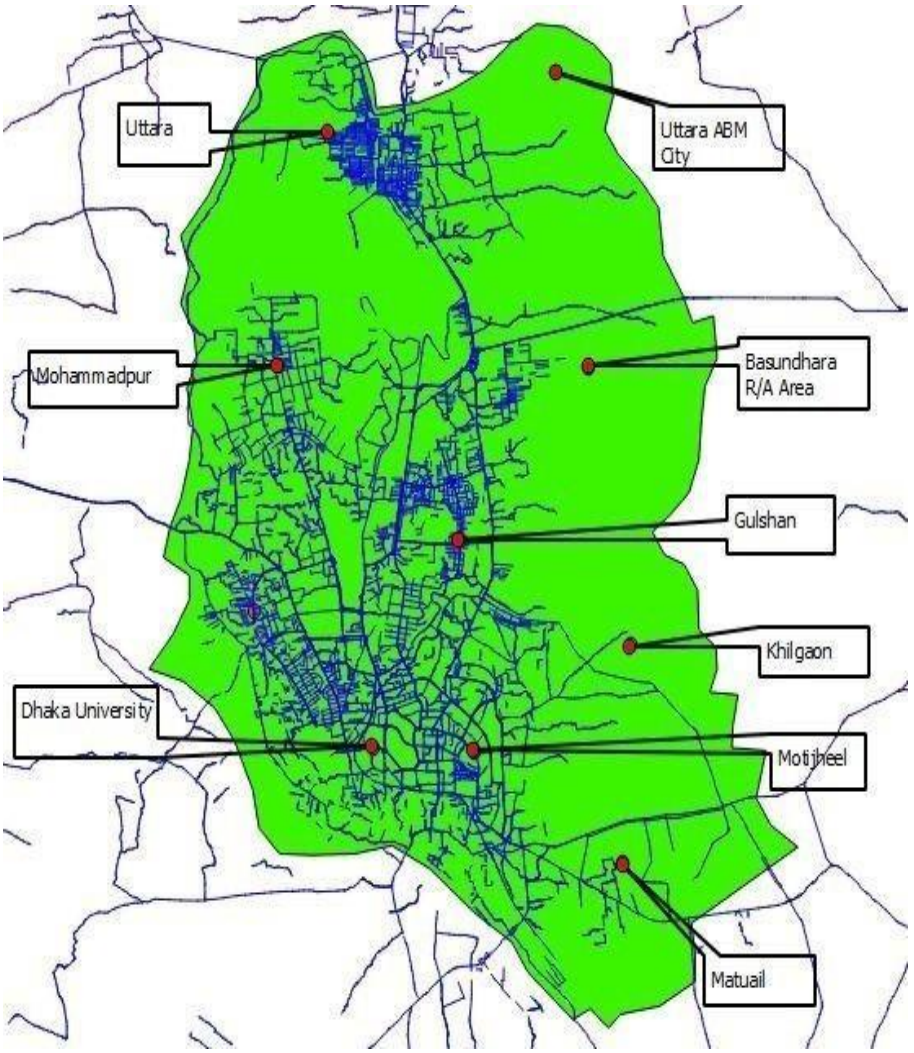

Figure 3.1: Studied area with road segments and map of Dhaka City

Table 3.1: Divided zones of Dhaka City

Zones	DCC Wards
DZP-1	59,60,61,62,63,64,65,66,67,68,69,70,71,72,73
DZP-2	74,75,76,77,78,79,80,81,82,83,90
DZP-3	56,57
DZP-4	32,33,36,53,54
DZP-5	22,23,24,25,27,28,29,30,31,34,35,55,84,85,86,87,88,89
DZP-6	37
DZP-7	38,39,40,49,50,51
DZP-8	47,48,52,58
DZP-9	42,43,44,45,46
DZP-10	9,10,11,12,13,14,16,41
DZP-11	19,20
DZP-12	2,3,4,5,15
DZP-13	6,7,8

We also have the land use pattern information for each DPZ zones. Table3.2and table3.4show the land use pattern for each zones. For dividing the zones, we have drawn the polygons onto Google Maps and export it in shape file using QGIS using the same process described in 3.1. Thus we have found the coordinates (Latitude, Longitude) for all zones using the wards distribution information we have. Fig3.3shows the zones we have plotted using the wards information of DCC.

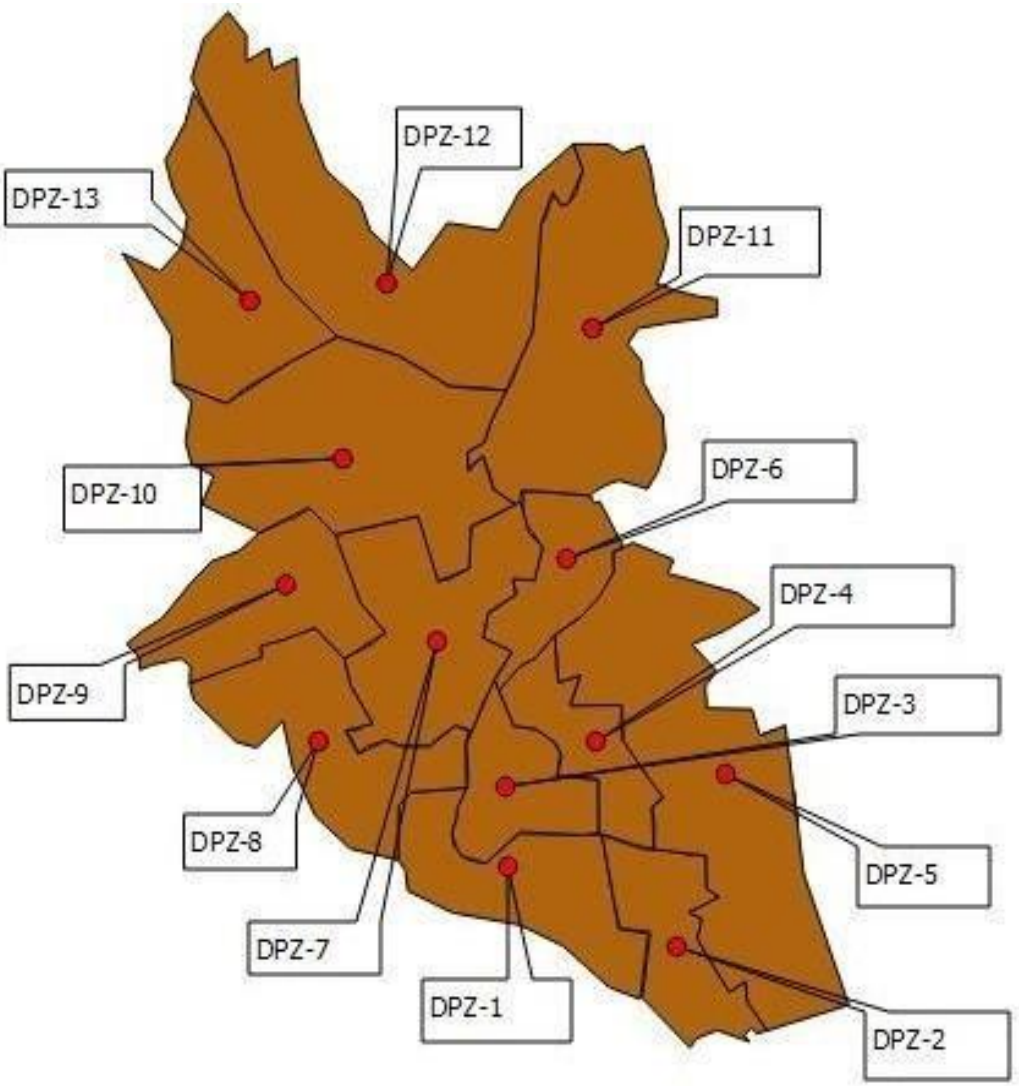

Figure 3.2: Zoning of Dhaka City

We have divided the social infrastructures of each DPZ zone into three categories. Those are:

1. **Educational**: Primary School, High School, College, University, Madrasha are kept under this categories. Table3.4shows the information for each zones.
2. **Commercial**: Community Center, Market, Bazaar, Bank Branch are kept under this categories. Table3.5shows the information for each zones.
3. **Public Utility**: Hospital, Park, Mosque, Graveyard, Temple/Church are kept under this categories. Table3.6shows the information for each zones.

3.4 Public Utility

Table 3.2: Number of public infrastructure

Zones	Primary School	High School	College	University	Madrasha
DPZ-1	81	12	31	1	41
DPZ-2	86	21	9	1	30
DPZ-3	11	5	6	2	2
DPZ-4	11	5	6	2	2
DPZ-5	79	25	27	1	23
DPZ-6	15	6	6	0	0
DPZ-7	40	38	8	8	21
DPZ-8	42	10	8	1	11
DPZ-9	47	17	18	2	31
DPZ-10	86	34	13	1	33
DPZ-11	3	4	4	3	11
DPZ-12	45	28	11	1	35
DPZ-13	53	21	12	1	45

Table 3.3: Percentage of infrastructure

Zones	Institutional	Recreational	Restricted	Special	Water body	Retention Pond
DPZ-1	5.57	0.44	3.88	2.85	0	10.96
DPZ-2	0	0.94	0.32	0	8.92	0
DPZ-3	0	18.66	1.98	0	1.96	0
DPZ-4	0	2.98	15.49	0	3.56	0
DPZ-5	0	0.25	0.83	0	8.4	0
DPZ-6	0	0	4.11	0	9.96	0
DPZ-7	3.94	1.5	17.79	0	0	2.03
DPZ-8	6	0.17	13.3	0	6.99	0
DPZ-9	2.14	0.01	0	0	2.84	0
DPZ-10	4.35	0.29	13.6	2.57	4.96	0
DPZ-11	0	0.45	44.66	0	4.85	0
DPZ-12	2.38	0.06	0.07	0.16	13.35	0
DPZ-13	0.76	5.89	5.92	0	4.96	0

3.5 Educational

Table 3.4: Number of Educational infrastructures

Zones	Community Center	Bazaar	Market	Bank Branch
DPZ-1	15	33	245	44
DPZ-2	5	72	337	10
DPZ-3	7	3	122	40
DPZ-4	1	3	122	7
DPZ-5	11	38	84	29
DPZ-6	0	1	5	3
DPZ-7	17	94	191	27
DPZ-8	0	1	12	6
DPZ-9	8	6	48	10
DPZ-1 0	2	38	39	4
DPZ-1 1	2	1	12	4
DPZ-1 2	2	24	166	1
DPZ-1 3	11	49	128	17

3.6 Commercial

Table 3.5: Number of commercial infrastructure

Zones	Hospital	Park	Mosque	Graveyard	Temple/Church
DPZ-1	52	2	185	2	22
DPZ-2	32	0	144	10	74
DPZ-3	43	0	63	0	2
DPZ-4	48	1	51	0	2
DPZ-5	98	4	100	0	5
DPZ-6	0	0	35	0	1
DPZ-7	56	0	207	0	9
DPZ-8	0	0	27	0	3
DPZ-9	39	0	59	1	0
DPZ-10	25	0	87	0	0
DPZ-11	25	4	27	0	0
DPZ-12	34	1	204	0	0
DPZ-13	55	2	134	1	11

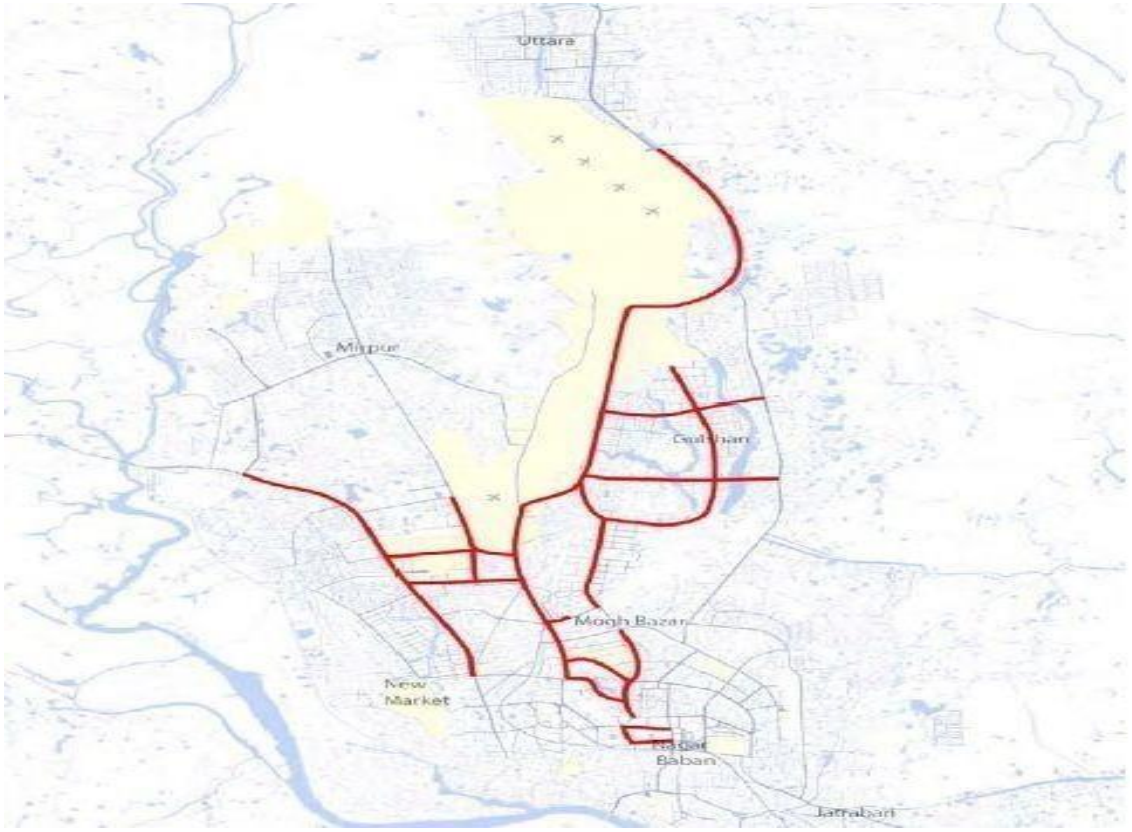

Figure 3.3: Rickshaw free road of Dhaka City

3.7 Rickshaw Free Roads of Dhaka City

Rickshaw is a three wheeled pedicab. It is one of the most popular modes of transportation in Bangladesh. It is mostly operated in residential area. According to JICA report [13], approved bus fare is in the range of BDT 1.00 to 1.20 per Kilometer, fare of cycle-rickshaws is around BDT 10.00 per Kilometer. The average trip length is around 3 Km. According to Kalabamu [27] In 1981 there were 26,925 registered rickshaws in the city. The number is increasing. The government introduced a ban on rickshaws not to operate on major trunk roads since 2004. Fig fig:rickshaw shows the rickshaw free roads of Dhaka (red line). We need to analyze how rickshaws are making congestion in roads. So, we have also separated the rickshaw free road segments from our data for analyzing effect of rickshaws on traffic congestion.

CHAPTER 4

METHODOLOY

4.1 Distributing Road Segments among Zones

From the raw data we have collected for traffic pattern modeling, we have the coordinates (Latitude, Longitude) information of road segments. We have used that information for dividing the road segments among zones. For that, if all the coordinates of a particular road segment is fallen under a zone's area then we have considered that particular road segment as a property of that zone. If the coordinates of a road segment fall under more than one zones then we have considered that road segment as a connection path between those zones. We have plotted each and every coordinates of a road segment to understand if that road is a property of a particular zone or a connecting path between zones. Fig4.1shows the corresponding road segments of all the zones.

4.2 Selecting Market Places Area

We have analyzed the market effect on traffic congestion.For that, we have selected an area where many markets and shopping complex situated.

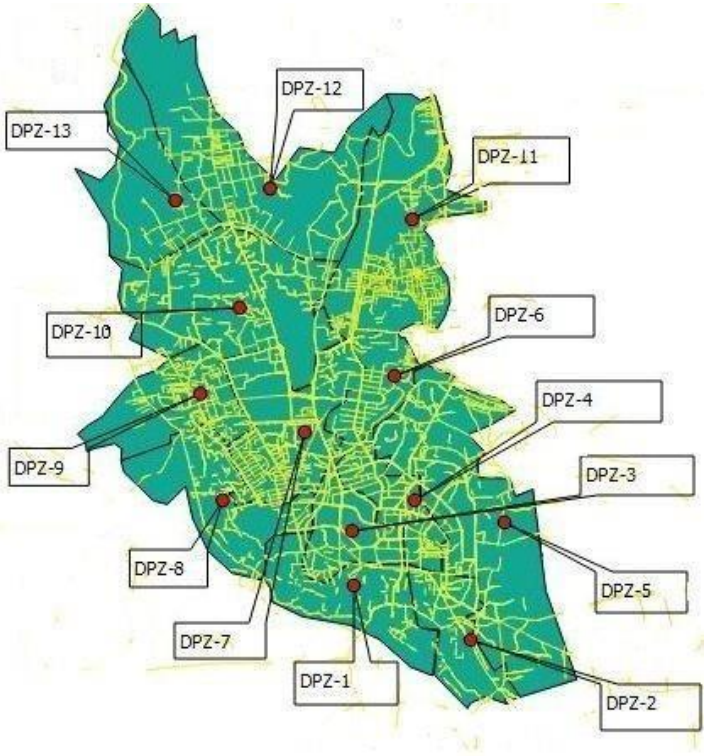

Figure 4.1: DPZ Zones and Corresponding Road Segments.

shows our study area for analyzing market effect on traffic intensity. The area size is 4.02 km^2 and we have also showed some popular markets and shopping complex in that area. We have considered convex polygon as our study area and the points are the markets we have shows in fig4.2. We have also considered some extra land as the roads beside markets may suffer from traffic congestion.

There are 362 road segments situated in our study area for analyzing market effect on traffic intensity. We have found it by taking the road segments those are situated in the polygon. For that, we need to check each latitude, longitude coordinates of the road segments. Fig4.3 shows the road segments we have in our study area of market effect.

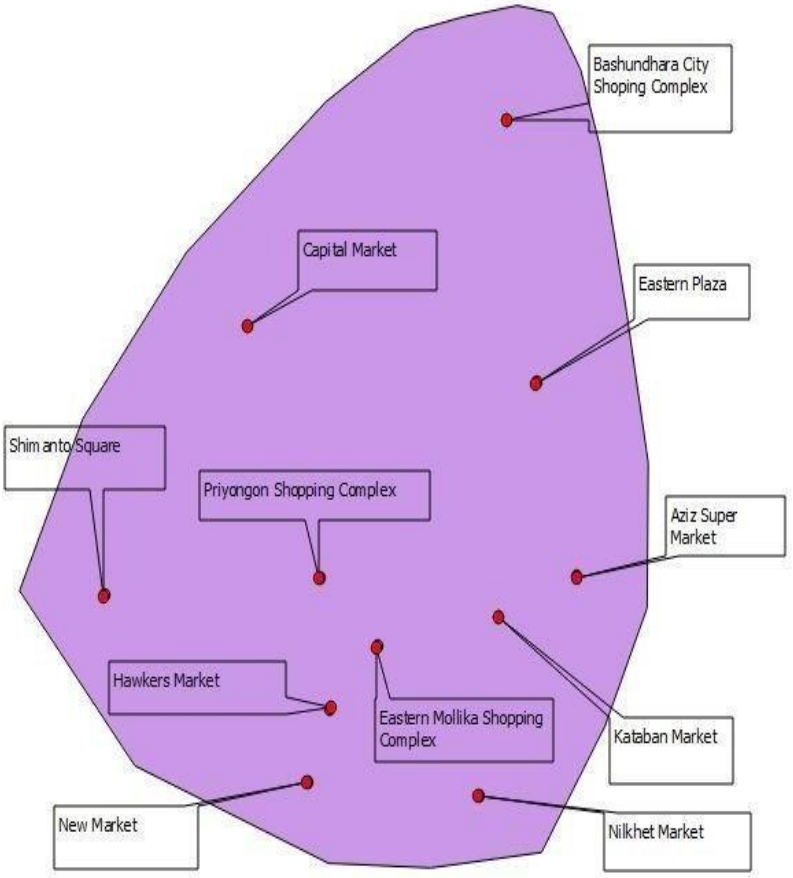

Figure 4.2: Study area and markets for analyzing markets effect on traffic co

4.3 Analyzing Traffic Intensity Factors

Regression analysis estimates relationships between independent (predictor)vari- ables and a dependent (response or outcome) variable. It is a way of relating variables to each other. What we want to find is an equation that best fits the data that we have in regression analysis. Regression

analysis helps one understand how the typical value of the dependent variable changes when any one of the inde- pendent variables is changes, while the other independent variables are held fixed. Many techniques for carrying out regression analysis have been developed. For finding the factors related with the traffic pattern we use linear regression.

A very simple regression analysis model that we have used for our findings is called the linear model, which uses a simple linear equation to fit the data. It is used when we want to predict the value of a variable based on the value of another variable. For finding the best land use factors, we have used simple linear regression analysis. The goal is to find the equation of the straight line shown in 4.1.

$$y = b + m * x \quad \text{..... (4.1)}$$

In equation4.1 y is referred as dependent variable,b is intercept value, m is referred as slope and x is the dependent variable.

We have used the multiple regression analysis in order to finds the factors behinds traffic intensity. A linear regression model that contains more than one predictor variable is called a multiple linear regression model. Multiple linear regression attempts to model the relationship between two or independent variables and a dependent variable by fitting a linear equation to observed data. We have used OLS method for estimating the unknown parameters. The goal of this model is to closely fit a linear function with the data. The idea is to minimize the sum of squared errors from the data. Equation4.2shows the equation for multiple linear regression analysis.

$$y = \beta_0 + \beta_1 * x_1 + \beta_2 * x_2 + \beta_3 * x_3 + \text{.....} + \beta_n * x_n + s \quad \text{..... (4.2)}$$

equation 4.2, y is referred as dependent variable, parameter β_1, β_2, β_3, β_n are referred as partial regression coefficients. x_1, x_2, x_3, x_n are referred as the indepen- dent variables. β_0 is the intercept of the plane. s is the error.

We have analyzed data using coefficient values of independent variables (Which signifies how the change effect on dependent variable), R-squared value which is also known as coefficient of determination (measure of how close the data are to the fitted regression line), p value (determines the significance of the result) and standard error of our model.

In order to find the factors that may influence traffic congestion. We have analyzed the land use pattern information. We have selected residential, commercial, road network,

mixed, industrial information from table3.2and used simple linear regression with each of them and found the effect of them on traffic congestion. We have used average intensity value of all the DPZ zones from table4.5.

After finding which variables we should take for further analysis, we have also analyzed the multicollinearity between those variables from land use pattern in- formation. From thiswe have known that if there is any correlation between those variables. We have then use multiple linear regression analysis and have found if our model predicts better than before by considering R square and p value.

For finding the effect of social infrastructures, we have use multiple linear re- gression using the information from table4.4. We have taken the average traffic intensity of each zone as dependent variable shown in table4.5.

For linear regression analysis, we want to predict the traffic intensity for different cases. We take the dependent variable as the traffic intensity. We have partitioned a day into 8 and 4 segments having three and six hours each. We have calculated the traffic intensity for that each particular time segment by taking the average intensity of each DPZ zones from 1st September, 2019 to 15th September, 2019 within that time segment. Table4.1and4.2show the information of traffic intensity for three hours segments (total 8). Table4.3shows the information of traffic intensity for six hours segments (total 4).

TABLE 4.1: Average traffic intensity information (six hours segment) for 13 DPZ Zones.

Zones	00.00 - 03.00	03.00 - 06.00	06.00 - 09.00	09.00 - 12.00
DPZ-1	0.678406726	0.723587418	0.760378654	0.783975485
DPZ-2	0.64731141	0.718088718	0.698992872	0.719641809
DPZ-3	0.556964365	0.708588012	0.715658598	0.725337881
DPZ-4	0.618108265	0.724107119	0.738715154	0.733847346
DPZ-5	0.704637603	0.706385683	0.691222381	0.692381684
DPZ-6	0.513748879	0.683004412	0.632206005	0.62042807
DPZ-7	0.598869104	0.713611627	0.722485071	0.699802861
DPZ-8	0.568311778	0.713383653	0.727756931	0.726475414
DPZ-9	0.628857343	0.654805942	0.656702702	0.635865507
DPZ-1 0	0.514390747	0.565997384	0.555859155	0.557298792
DPZ-1 1	0.433606288	0.528132374	0.538762197	0.53691151
DPZ-1 2	0.480898678	0.513549869	0.503269305	0.51772062
DPZ-1 3	0.282025073	0.417630861	0.449005903	0.424650924

We have taken different factors as independent variable for regression analysis. We have taken both land use information of DPZ zones and also take the infor- mation of educational institutions, hospitals, markets and bazaars. We normalize the number of these attribute between 0 and 100 considering the highest num- ber of that attribute. Table3.2and4.4show these attributes we have taken as independent variables in our multiple linear regression analysis.

We have analyzed regression analysis on traffic intensity using bus routes and roadsegments intersections information. For this we have taken the average intensity for each zone for 1st September, 2015 to 15th September, 2019 as our dependent variable. We havecalculated the intersection density for each zone using the equation4.3.

$$\text{Density} = \text{Total-Intersections} \quad \ldots\ldots (4.3)$$

Here is the regression analysis of the of our study and method.

CHAPTER 5

RESULTS

5.1 Overview of Dhaka's Traffic Intensity Pattern

We have analyzed the traffic intensity pattern of Dhaka city over the time from September 1st, 2015 to September 15th, 2015. We have found that the traffic pattern differs with respect to time in a day. For this, we have segmented twenty four hours in 48 segments each having 30 minutes duration. We have taken the average of traffic intensity for all time slots for that experimental 15 days. Then we have plotted the graph which represents the traffic intensity pattern of whole Dhaka city in different period of time. Fig5.1shows the graph we have generated. There the X axis represents the time slots (hour) and Y axis represents the corre- sponding traffic intensity in that time slot. The intensity is measured in range 0 to 1. Higher the value of intensity means more traffic congestion.

From fig5.1, we have found that Dhaka suffers with heavy traffic intensity in most of the time in a day. At night from 11.00 pm to 03.00 am is a big period of time when traffic intensity

is relatively low. As it covers all the road segments of data we have collected. It means both narrow lanes and highway roads are included 37

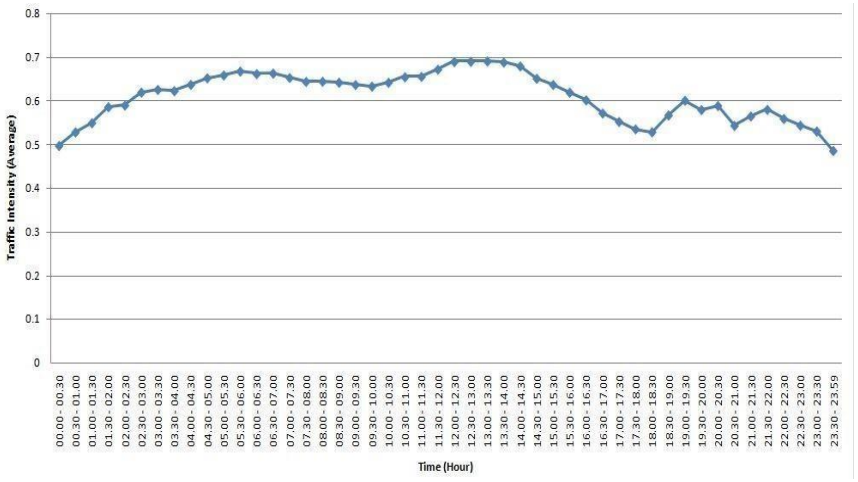

Figure 5.1: Traffic Intensity Pattern Of Dhaka.

for calculating average. For that reason, some information from the graph may questionable from different perspectives like, people those live in residential zone may question that why the traffic intensity is so high at 3.30 am! But, if we consider the

highways of Dhaka, at 3.30 am there are lots of trucks in the roads and increase the traffic intensity. So there are lots of attribute like road length, land use etc should be considered for answering all the questions are raised from the graph. We try to discover the effect of some attributes or factors involving traffic intensity pattern in later section of our analysis.

5.2 Comparison between Government Holidays and Other Weekdays Traffic Condition

We have also analyzed the traffic intensity pattern for Government Holidays and Other Weekdays. We have taken Friday and Saturday as weekends. The holi- days are 4th, 5th, 11th and 12th September from 1st September, 2015 to 15th September, 2015. We have calculated the average intensity over time for compar- ison. From that analysis, we have found that the traffic intensity is relatively low in weekends comparing other weekdays. Traffic intensity form 08.00 pm to 10.30 pm is high in weekends as many people participate many programs or enjoy the weekends outside of their home in that time period. Fig5.2shows the comparison between holidays and other weekdays. The X axis represents the time slots (hour) and Y axis represents the corresponding traffic intensity in that time slot.

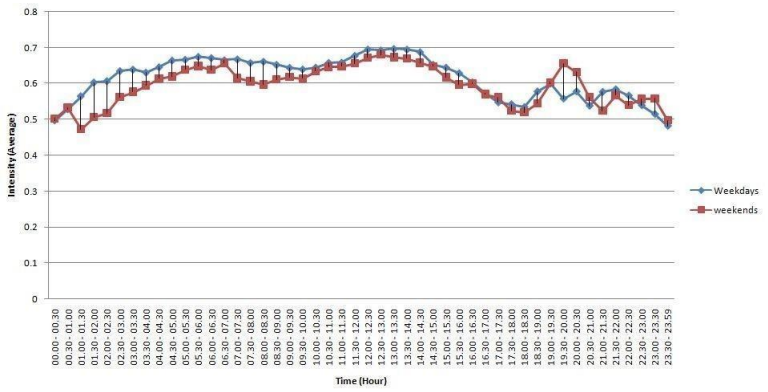

Figure 5.2: Comparison between Government Holidays and Other Weekdays Traffic

5.3 Influences of Market Places on Traffic Intensity

We have compared the traffic intensity pattern for the area shown in fig4.2as the traffic intensity pattern for closed and opened day of market. The markets of mentioned are kept closed in Tuesday. So from 1st September, 2015 to 15th September,2015 the 1st, 8th and 15th September are the days when the market was closed. We compare them with other

days in mentioned 15 days period. Fig 5.3shows the comparison of traffic intensity pattern for market closed and those days when the market was opened.

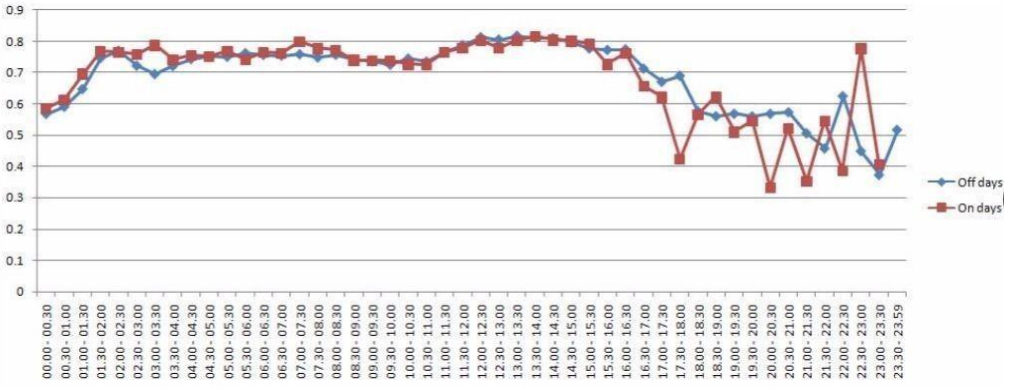

Figure 5.3: Effect of markets on traffic intensity.

5.4 Traffic Intensity Pattern for Rickshaw Free Roads

We have described about rickshaw free roads of Dhaka at 4.4. we have find the traffic pattern for those roads also. We take the average intensity of 15 days in order to find the traffic pattern. Fig5.4shows the traffic intensity pattern of rickshaw free roads.

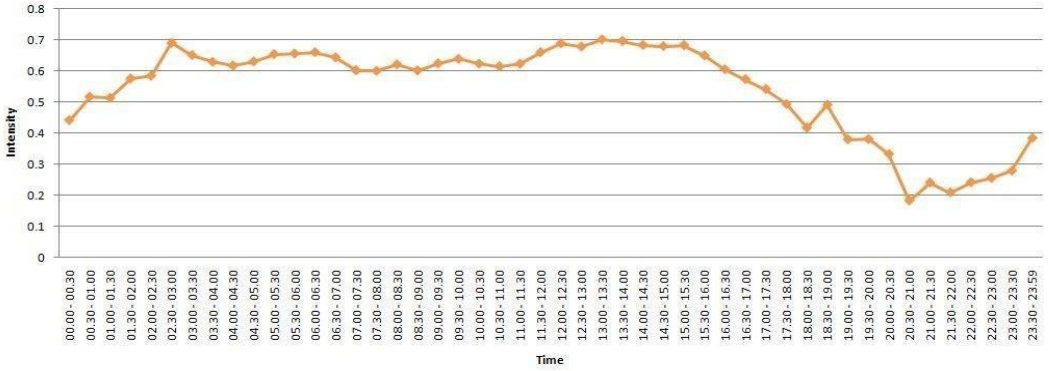

Figure 5.4: Traffic intensity pattern for rickshaw free roads.

From fig5.4we have found that the roads are congested most of the time. So, if rickshaws were not banned from those roads then the congestion would not be controlled for those roads. We need to find out more roads which are congested due to rickshaws.

5.5 Analyzing Factors of Social Infrastructures that Influence Traffic Congestion

For finding the effect of social infrastructures, we have use multiple linear re- gression using the information from table4.4. We have taken the average traffic intensity of each zone as dependent variable shown in table4.5. Table5.4shows the result of our analysis.

TABLE 5.1: Result of multiple linear regression on social infrastructures.

	R Square	0.4238817	
Education	0.0006128 35	0.50463 56	0.0008773 01
Market		0.10726	
	0.0017647 34	77	0.0009729 57
Facilitie	Coefficient	p values	Standards rd error
Bazar			
	-0.0011704 72	0.30655 39	0.0010717 02

5.6 Analyzing Traffic Factors for Different Time Segments

We have used the linear regression for different time periods of day for finding the factors behind traffic intensity. We have divided 24 hours into multiple sections as to find which factors are responsible in certain time. We have done it by dividing the 24 hours in 3 hours and 6 hours segments. Here we have used the information of road network and mixed land use as our independent variable. Average traffic intensity has been taken as our dependent variable.

5.6.1 Analyzing traffic factors for Three Hours Segments

For 3 hours segmentation we have divided 24 hours into 8 segments. The seg- ments are 00:00:00 (HH:MM:SS) to 03:00:00, 03:00:00 to 06:00:00, 06:00:00 to 09:00:00, 09:00:00 to 12:00:00, 12:00:00 to 15:00:00, 15:00:00 to 18:00:00, 18:00:00 to 21:00:00, 21:00:00 to 24:00:00. So each segment has three hours time slot. Ta- ble4.1and table4.2show the average traffic intensity information for 3 hours segments we have calculated. Table5.5shows the value of R square and standard error of our regression analysis. Table5.6shows the coefficient values we have found. Table5.7shows the Standard error for each variable. Table5.8shows p value.

TABLE 5.2: R square and standard error of multiple regression analysis.(3 hours segment)

Time	R Square	Standard error
00–03	0.279446	0.105943 42
03–06	0.409301	0.086056 4 26
06–09	0.470973	0.080673 8 72
09–12	0.516958	0.081029 8 98
12–15	0.538647	0.069019 7 83
15–18	0.649102	0.072052 9 51
18–21	0.26334	0.140288 2 36
21–24		0.16299505

5.6.2 Analyzing traffic factors for Six Hours Segments

We have also analyzed the regression model for 6 hours time slot. The time seg- ments are 00:00:00 to 06:00:00, 06:00:00 to 12:00:00, 12:00:00 to 18:00:00, 18:00:00 to 24:00:00. Table4.3show the average traffic intensity information we have cal- culated for 6 hours segments.Table5.9shows the value of Rsquare, standard error of our regression analysis.

Table5.10shows the coefficient values we have found. Table5.11shows the Standard error for each variable. Table5.12shows p value

TABLE 5.3: R square, standard error result from regression analysis (6 hours)

Time	R Square	Standard error
00-06	0.4356	0.0889224
06–12	0.4986	0.0806982

CHAPTER 6

CONCLUSION

AND FUTURE

SCOPE

6.1 Brief Description of Our Work

Accurate traffic intensity pattern is useful in order to find the reasons behind traffic congestion. In our research, we have analyzed the traffic intensity pattern macroscopically. We have also considered the urban planning schemes for finding how traffic intensity varies with land use pattern. Social infrastructures are used to find the factors that influence the traffic congestion. Investigation of market places area and the traffic intensity pattern have showed us that markets should not be built beside the roads that are frequently used. Thus our work will help to make planning of efficient urban development considering better transportation system.

6.2 Limitations

We have tried our best to analyze the traffic intensity pattern for different cases and find the factors that influence traffic intensity with the data we have. We have faced some limitations in our work. Those are mentioned below.

1. We have analyzed traffic pattern macroscopically. Macroscopic Fundamental Diagram is one of the popular modeling for finding pattern for a large area. But this modeling needs the speed of vehicles and the counter that counts how many vehicles pass a certain point. But we don't have such data to model the fundamental diagram.

2. If we have the raw GPS data of the vehicle then we can view the current condition of the roads of any point. So, we can make dynamic decisions to minimize the traffic congestions. But instead of vehicles GPS information we have the latitude, longitude information of the road segments.

3. Traffic sensors can give us the real time overview of the traffic intensity. If we have that information we can compare our analysis in real time.

4. We have the traffic data for only 15 days (1st September, 2019 to 15th September, 2019). We need more data for analyzing the actual information.

5. There are many illegal constructions that were not included in urban development planning. So, the results of social infrastructures that cause traffic congestion may not reflect the actual conditions for each zone. So, we need the actual land use pattern and social infrastructures number for better decision making.

6.3 Future Work

We have analyzed traffic pattern with respect to time, land use pattern and other factors that influence traffic intensity. Further research should be done for better traffic modeling in order to see the traffic pattern. We have pointed out some of them here.

- Installing traffic sensors in the road intersections can give us the real time view of traffic condition. It also helps us to generate vehicle numbers for modeling macroscopic fundamental diagram.
- For detecting traffic congestion accurately we need to install GPS devices in vehicles which can help us to generate traffic pattern. It also gives us a way to measure traffic congestion accurately by analyzing the timestamps, speed and distance which we can generate using GPS device.
- Roads information such as length, width and number of intersections should be found out in order to analyze traffic pattern both microscopically and macroscopically. As all roads are not equally important from all points of view, we need road information for modeling better traffic pattern.
- Land use is an important issue for urbanization. We need to plan intelli- gently for better transportation system. For that, we need the actual social infrastructures and land use pattern and find the factors which may increase traffic congestion.

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