Traffic Signal Design and LOS Determination in a T-Intersection: An Empirical Example at Science Lab Intersection, Dhaka, Bangladesh

A Project and Thesis submitted in partial fulfillment of the requirements
for the Award of Degree of

Bachelor of Science in Civil Engineering

Submitted By

Md.Tarikul Islam

(ID: 191-47-909)

Shamim miah

(ID:191-47-877)

Md.Momenul Islam Shams

(ID:191-47-881)

Supervised By

Dr. Mohammad Hannan Mahmud Khan

Associate Professor & Head

Department of Civil Engineering

DEPARTMENT OF CIVIL ENGINEERING

FACULTY OF ENGINEERING

DAFFODIL INTERNATIONAL UNIVERSITY

September 2022

APPROVAL

This is to certify that this project and thesis entitled **"Traffic Signal Design And LOS Determination in A T-Intersection: An Empirical Example at Science Lab Intersection, Dhaka, Bangladesh"** is done by the following students under my direct supervision and this work has been carried out by them in the Department of Civil Engineering under the Faculty of Engineering of Daffodil International University in partial fulfillment of the requirements for the degree of Bachelor of Science in Civil Engineering. The presentation of the work was held on 17th September 2022.

____

Dr. Mohammad Hannan Mahmud Khan
Associate Professor & Head
Department of Civil Engineering
Daffodil International University.

DECLARATION

This is to certify that this project and thesis entitled **"Traffic Signal Design And LOS Determination in A T-Intersection: An Empirical Example at Science Lab Intersection, Dhaka, Bangladesh"** is done by the following students under my direct supervision and this work has been carried out by them in the Department of Civil Engineering under the Faculty of Engineering of Daffodil International University in partial fulfillment of the requirements for the degree of Bachelor of Science in Civil Engineering. The presentation of the work was held on 17th September 2022

Md.Tarikul Islam
ID: 191-47-909

Shamim miah
ID:191-47-877

Md.Momenul Islam Shams
ID:191-47-881

ACKNOWLEDGMENT

At first, we want to thank almighty God. All praise goes to Almighty God who gives hardworking capability and patience, which guided us to success, which make us possible to complete this thesis successfully. We worked for this thesis under the supervision of our respected teacher **Dr. Mohammad Hannan Mahmud Khan**, Associate Professor and Head, Department of Civil Engineering, Daffodil International University. For his wonderful consistent guidance, constructive criticism and invaluable assistance and suggestions, inspiration, encouragement we have been able to finish our thesis successfully. Many people helped us in various ways. We are also thanking them from our heart.

Finally, we would like to thank our parents who given us tremendous inspiration and supports. Without their financial and mental supports, we would not be able to complete our study.

DEDICATION

Dedicated To Our Family Members

ABSTRACT

Traffic congestion is regarded to be the most unpleasant problem for urban inhabitants in Bangladesh due to the prevalence of non-lane based heterogeneous vehicle composition. Especially in the downtown area, the problem has been made worse by the overabundance of unnecessary traffic intersections. City planners and designers must consider signal planning, design, analysis, control, and administration crucial to the effective management of city traffic. The study's overarching goal is to enhance traffic signal design in general, but more specifically, to find a workable solution for the economically significant "Science lab" junction. Webster's approach was used to create the signal after collecting data from a variety of vehicles, and the volume capacity ratio (v/c) was used to establish the service level (LOS). The lowest and maximum green timings for the road condition are given, with the least being 26 seconds and the highest being 69 seconds. In addition, the v/c ratio shows that the LOS is in bad shape, with the vast majority of vehicles going under the speed limit, requiring the driver to pay much more attention to the road. Finally, the study presents some relevant suggestions to lessen delays and guarantee a more continuous flow across the junction under consideration.

CONTENTS

List Of Tables

LIST OF FIGURES

CHAPTER 1
INTRODUCTION

1.1. Background of the Study:

Dhaka is the main political and economic center of Bangladesh. In 2020, Dhaka will have a higher population than all but seven other cities on Earth. (Review of the World's Population in 2020). Hundreds of Bangladeshi and foreign businesses, as well as the thriving counterculture, have contributed to the country's expansion and increase in population. Still, like in many other global cities, the rising population has led to worsening conditions such as pollution, traffic, and poverty [1].Congestion, pollution, and injuries to tourists are only some of the problems caused by the constantly growing number of vehicles on the road. Avenue crossings have become a serious issue for municipal planners and engineers because of how frequently these sorts of incidents have occurred there. The Bangladesh Road Transport Authority reports that between 2011 to 2019, the number of registered automobiles in the Dhaka metropolitan area increased by 85%. (BRTA). A community's social, economic, recreational, and other activities all rely on a nice highway system, the maintenance needs of which have a major influence on urban wellbeing. As the city's street system's operational quality declines due to a rise in visitor number and a greater degree of service is required, a well-planned and efficient accelerated strategy is required to guarantee that outstanding street transportation conditions are maintained permanently [3]. Consequently, taking into consideration these significant crossings would be more effective in terms of reducing the amount of traffic congestion. The intersection of Science Laboratory and Elephant road is considered to be one of the most significant intersections in the city of Dhaka. This intersection is being served by traffic originating from the Dhanmondi Residential neighborhood, New Market, Shahbagh, and Farmgate. Therefore, it is absolutely necessary to find a solution to the traffic problem at this crossroads in order to reduce the amount of congestion on Elephant road and New Market overall. One of the crucial tasks in the management and improvement of urban visitors systems is the evaluation of the current status quo reputation and overall performance of road intersections. Analysis findings allow transportation authorities to identify the methods and strategies that improve the efficiency of both appeal measures and scarce financial resources. [4] Surprisingly, though, most of Bangladesh's major thoroughfares lack an automated traffic signal, which means that vehicles sit at intersections for longer than necessary, resulting in significant social and economic costs. Traffic congestion in Dhaka costs the city's economy an estimated TK370 billion every year, as reported by the Accident Research Institute (ARI) of the Bangladesh University of Engineering and Technology (BUET). At present, there are six primary phases of the signal design process. Phase design, calculating amber and clearing times, establishing a cycle length, dividing up green time, addressing pedestrian crossing needs, and assessing the design's performance are all part of the process. [4]

However, with enough planning, the existing difficulty may be decreased. As a result, the authors decided to look into the correlation between the functioning circumstances of a signalized junction and its safety record.

1.2. Objectives:

Following are some of the goals of this research:

- To analyze the LOS and link it to the safety problem at this crossroads.
- Through the use of a three-phase signal design, competing motions at a junction may be separated into their own phases, where they should no longer interfere with one another.

1.4. Scope:

The goal of this study is to examine congestion patterns over time by simulating traffic conditions using collected data. In addition, the level of service (LOS) is a qualitative measure of the efficiency of traffic services. Performance indicators like as speed, density, and other characteristics are used in LOS to classify traffic flow and give traffic quality levels. National governments have used several criteria for defining LOS. [5]

1.5 Organization of the Thesis:

- The research work presented in this thesis paper is arranged into five chapters. Chapter 1 covers the background, objectives, and rationale of the study.
- Chapter 2 covers a literature review.
- Chapter 3 includes Data Collection & Methodology
- Chapter 4 covers Analysis & Result .
- Chapter 5 includes the conclusion.

CHAPTER 2
LITERATURE REVIEW

2.1 Introduction:

Every single day, traffic congestion negatively impacts the lives of over a billion people. People are regularly delayed in traffic for a number of minutes that are inadequate, causing them to waste both time and money. This is particularly the case in the urban areas of today. As a consequence of traffic intervals, the health of drivers may be negatively impacted, and the risk of being involved in a car accident increases. Vehicles also have an effect on the environment because of the massive quantities of dangerous carbon radiation that they leak into the atmosphere. This radiation contributes to the alarming rate of global warming.

2.2. Literature Review:

At street level, a location is referred to be an intersection when two or more roads or streets meet or cross each other. As a consequence of the high volume of traffic, it is a breeding ground for altercations, which in turn causes traffic congestion and accidents. The capacity of junctions, which is defined by the traffic control system utilized at the intersection, is a major factor in determining the capacity of the urban road network [6]. The vast majority of key intersections will have some kind of traffic management, which may or may not include signalization [7]. There is a third kind of connection that maintains a manageable level of traffic even during peak hours and does not impose any restrictions on the volume of that traffic. There is no possible way to overestimate the significance of traffic lights. [8] At intersections, traffic control systems often include traffic lights as an essential component. The design of a traffic signal, on the other hand, is what determines how effective the signal will be [9].

Fixed time controllers, vehicle actuated controllers, and computer-based area coordinated controllers are the most typical signal controllers studied in the literature. Green periods and cycle times are predefined and have a definite duration in fixed time controllers. This style of a traffic light may work well in areas where the flow of traffic on multiple approach roads is not significantly varied. Although controllers are simple and inexpensive, they are rigid and require careful setup. It can function as a stand-alone control system or as part of a larger control system. The most significant disadvantage is that signal timings are set regardless of real-time vehicle flows or wait for lengths, which may be unreasonable [10]. Vehicle-actuated controls modify the phase and cycle timings in response to traffic demand. This is made feasible by placing detectors in every traffic lane [11]. ATSC stands for "computer-based area coordinated signal," which refers to the practice of continually adjusting the timing of a traffic signal depending on changing vehicle arrival patterns at an intersection. A traffic light gives each intersection approach green time depending on projected arrivals at surrounding intersections during the procedure. The duration of green time allotted to each approach fluctuates as arrival patterns alter from cycle to cycle [12].

Ideas for early signal design approaches were offered by Webster, Cobbe, Miller, Stephanopoulos, and Michalopoulos, in addition to Newell [13]. When compared to the techniques used by Webster and Cobbe (1958), Miller (1963), and Newell (1989) to explain delay at stationary traffic signals, Webster's hypothesis was found to be more technically sound than the other ideas [14]. Following exhaustive analyses of cycle duration and delay in relation to incoming traffic volumes, Webster's minimum delay method was shown to provide the optimal signal cycle, which corresponds to the smallest overall delay to traffic at the signalized junction. Because it is founded on mathematics, this approach is deemed to be a valid methodology, and it serves as the cornerstone for the research being done on traffic signals today [15]. As a direct consequence of this, a number of research have been conducted to examine the Webster model. On the basis of the Webster method, Benekohal and El-Zohairy constructed and validated a uniform delay model for coordinated signalized junctions [16]. Oskarbski et al. made use of the VISSIM program in order to provide suggestions for enhancing traffic conditions and pedestrian safety at signalized crossings in Poland [17]. They found a number of factors that led to accidents in the area under investigation, such as a lengthy wait for the green signal for autos, a short green time for pedestrians, and pedestrian traffic that collided with turning movements. In the end, the results of their investigations produced no conclusions. In addition, Surisetty and Sekhar built a traffic signaling system at a T-intersection in India using a variant of the Webster Method called the Indian Road Congress method [18].Mindur analyzed Webster's delay formula modification using the M + / G + / 1 queuing model (Mindur and Sierpiski, 2017), where he suggested a delay model based on the Webster approach that used a variation of service time as one of the traffic flow at the signalized junction. Sierpinski and Woch suggested a time delay model based on the Webster principle that uses average waiting time in queues for queue systems M + / G + / 1 with compressed queue operations reservation system [2].

Ceylan and Bell solved the problem of optimizing the time of a single traffic light by using a Genetic Algorithm, which led to a 34% improvement in comparison to the mutually consistent solution [21]. A signal optimization model has been designed specifically for asymmetric two-leg continuous flow intersections. The proposed solution eliminates the potential for queue overflow into left turn bays and enables the progression of through traffic as well as heavy turning traffic at the same time [22]. In addition to enhancing the functionality of traffic lights at a junction, this research used

Level of Service analysis to investigate the existing operating circumstances during peak hours. According to the HCM from 2010, "A qualitative metric defining operational conditions within a traffic stream and their perception by motorists and/or passengers" (HCM). As a consequence of this, LOS is a method that may be used to ascertain, from the point of view of a passenger, how efficiently a certain transportation facility is operating. LOS has been investigated at a wide variety of traffic infrastructure, including junctions and highways; however, the focus of this investigation is only on LOS at signalized intersections. The HCM determines line of sight as a function of the average vehicle control delay at signalized and un signalized intersections respectively. LOS can be calculated for each movement or approach for every junction layout, although LOS for the intersection as a whole is only specified for signalized and all-way stop configurations [23]. LOS can be estimated for any junction layout. Oh and Ritchie (2002) provided an alternate measure of effectiveness or evaluation approach for LOS, which is a significant idea for determining how well transportation systems are operating as a whole. In their argument against HCM's use of delay as the major criteria for defining line-of-sight at signalized intersections, Pécheux and Pietrucha cited 14 other characteristics that were obtained from driver focus groups. According to the findings of the study, it was suggested that more research be conducted on the impact of vehicle location at crossings, in addition to turning movement and phasing scheme [24]. Oh and Ritchie created real-time LOS criterion by making use of a metric called Re-identification Delay. This metric was generated via an examination of vehicle inductive signatures and the re-identification of cars that were moving through a large signalized junction in Irvine, California..

Using a cumulative logit regression model at mid-blocks and intersections, Jensen computed pedestrian and bicycle LOS on highway segments in Denmark [25].Wang et al. [26] investigated the connection between line of sight and safety in the context of signalized intersections. When they used Generalized Estimation Equations with a negative binomial link function, they found that the six-level LOS indicator performed better than the average delay in accident frequency models. This was the discovery that they made. They made the discovery that the LOS indicator is an essential component in predicting the occurrence of collisions at crossings; nonetheless, they found that it is insufficient. The Highway Capacity Manual (HCM) Model for Evaluation of Capacity and LOS at Signalized Intersections cannot be applied to India's diversified traffic flow on its own, as stated by Tiwari et al. [27]. [27] It is proposed that the model be modified with certain measures, and factors are constructed based on the required modifications, in order to make it more appropriate for the conditions that exist in India. An analysis was performed on both the lane width adjustment factor and the passenger car equivalency factors.[28] .

Prevedouros and Chang conducted research to determine the effect that wet weather has on the level of service (LOS) at signalized junctions in the United States.They discovered that inclement weather affects three components of signalized intersection operations: saturation headway (thus saturation flow and capacity), lost times (thus effective green and capacity), and progression, all of which affect average control delays and the corresponding LOS, using readily available rainfall accumulation data from the National Oceanic and Atmospheric Administration. Using the same criteria as the HCM, Saito and Fan constructed a multilayer artificial neural network (ANN)–based LOS assessment model [29]. The method was an extension of the HCM model that combined delay and safety in order to generate the delay and safety index, which is a new comprehensive LOS indicator. At signalized crossings, the model represented the trade-off between safety and efficiency, taking into account both vehicle-to-vehicle and vehicle-to-pedestrian conflicts. This was done by taking into account both vehicle-to-vehicle and vehicle-to-pedestrian conflicts. Pan et al. are the ones who first proposed the idea of safety LOS (SLOS).

The authors build a SLOS model for signalized intersections that takes into account vehicle conflicts, intersection geometry, signal phasing, pavement markings, signs, pavement quality, and ambient lighting. The SLOS model is affected by things that affect both the safety of an intersection and how well it works [31]. Petritsch and his colleagues made a LOS model that shows how pedestrians see crossings at signalized intersections. This model includes perceived safety and comfort, which are measured by perceived exposure and conflicts, as well as operations, which are measured by delay and signalization. The result is a model that shows how well an intersection works from the point of view of a pedestrian. From a pedestrian's point of view, the resultant model shows how well an intersection's physical and operational features meet pedestrian needs [32].

According to the aforementioned literature, a great deal of effort has been put into developing design standards and theoretically investigating junction management via visitors warnings to examine the efficacy of sign systems. Even yet, one of the primary concerns of traffic engineers is still the best way to manage junctions when traffic signals are in place. Intersection congestion and safety threats are particularly severe in Bangladesh's major cities due to the high volume of non-motorized and paratransit vehicles that contribute to the non-lane based, non-automobile based traffic flow [20]. This has made the installation of site visitors alerts a priority for improving traffic mobility at these intersections. Unfortunately, few studies have addressed the critical need for effective visitor notifications in Bangladesh.

Image processing is being used in Dhaka's smart traffic management system to make estimates of traffic density in different areas in real time. The study develops a method for controlling traffic congestion by identifying traffic density based on the area of automobile edges using an algorithm, morphology, and camera images. In spite of this, no studies have been undertaken using the suggested method [35]. At a busy crossroads in Dhaka, Bangladesh, controlled by static time traffic lights, this three-pronged strategy generates excellent variable signal timing profiles. Video footage of the intersection under study was examined using a computer vision technique to obtain traffic statistics. Microscopically, two-hybrid situations were constructed and simulated using the data and input from experts. A significant reduction in traffic congestion was achieved with the implementation of personalized, variable traffic signal timing profiles, which cut wait times for vehicles by 40% while increasing average travel speeds by 20%. [36]. Dhaka is the only location in Bangladesh where any research on signal optimization has been conducted. Due to the lack of access to contemporary technology for the installation of ITS in a developing country like Bangladesh, we used the Webster technique to optimize fixed signals in this study, despite the availability of many innovative ways. The standards for traffic lights are not agreed upon by everyone. Congestion, pedestrian safety, disputes between vehicles, economic advantages, and so on are only a few of the many elements that play a role [37].

The study indicates that automated signals will ultimately replace police personnel, despite the fact that police officers now use manual vehicle actuation, which is preferred to fixed traffic signals. As the ratio of police officers to citizens in Bangladesh is under 1:300, removing them from their current duties at traffic lights would free them up to do other, more important duties, such as patrolling and investigating crimes, that need human contact. It's important to remember that police officers are also human, thus even if they work shifts, they can't be available 24/7 [38]. A survey of the region revealed that traffic officers are only available between the hours of 8 a.m. and 10 p.m. Large numbers of big trucks transporting goods from businesses all through the night need traffic control far after police officers' shifts finish. Therefore, independent signals are required in the field of study. Therefore, a proposal is being made that will temporarily address traffic issues without the need for traffic police while a more permanent solution is sought. In addition, LOS was calculated at the signalized junction to evaluate the state of things.

2.4. Study Area:

Dhaka south city corporation (DSCC) is part of Our Capital City. Our study area name is ‘Technical More’ is located in Mirpur, map of 23°44'7"North 90°23'1.3" East, which is Nearby Dhaka New Market& Dhaka City Collage, As a major crossroads in the midst of Dhaka, the Science Laboratory Lab is a landmark in the area. This crossing is a crossroads for vehicular traffic from the Dhanmondi Residential Area, New Market, Shahbagh, and Farmgate. Major Garment industries, schools, and universities in Dhaka city make it geographically important. Hence, this study is carried out to find a solution to this problem. At virtually all traffic crossroads, the Dhaka Metropolitan Police (DMP) still uses hand signals. DMP and transportation authorities are required to learn to recognize and complete the deployment of a basic traffic light system for major junctions across the city in order to decrease pollution and manage high traffic [36]. Members of the DMP and other agencies in charge of Dhaka's urban transportation sector studied different generations of traffic signal systems and how to manage them via efficient inter-agency coordination through study visits to major cities in India and China that have learned to handle traffic signal systems. The exchange promoted awareness of the need of having an urban traffic light system while also learning the skills and consensus required to implement key authorities in Dhaka together to execute it.. [36]

CHAPTER 3

METHODOLOGY

3.1. Data Collecting Methods:

During the period that we are collecting data, we do a 15-minute long count of cars, buses, pickup vans, CNG vehicles, motorcycles, and non-motorized vehicles. The flowchart for determining the number of vehicles passing through technical intersections on three roads, namely New market Road, Elephant Road, and Mirpur Road When analyzing traffic data, we count intersections.

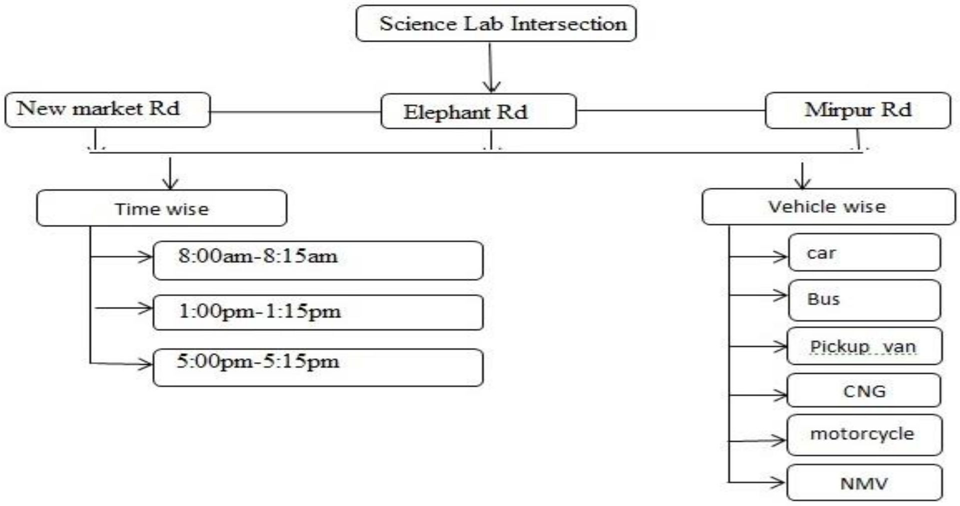

Fig 3.1: Flowchart for Science Lab intersections.

3.2. Primary Data Collection Method:

The gathering of primary data might be carried out utilizing a wide number of distinct approaches. In spite of this, the research methods that are used the most commonly are interviews, field observations, self-administered questionnaires, and experiments. The gathering of primary data requires a greater investment of time and money in contrast to the acquisition of secondary data.

The majority of the data that we used to construct this thesis came from surveys that we conducted and administered ourselves, as well as from field observations that we took. In order to collect the data pertaining to the intake of New market Road, the intake and movement of Mirpur Road, and the intake and movement of Elephant Road, we needed to visit to the thesis region. Additionally, when we were gathering our data, we videotaped the majority of the thesis area using many cameras. In order for us to collect data in a manner that was both efficient and accurate, the main issue of our thesis was subdivided into three distinct subtopics. These three different roads are,

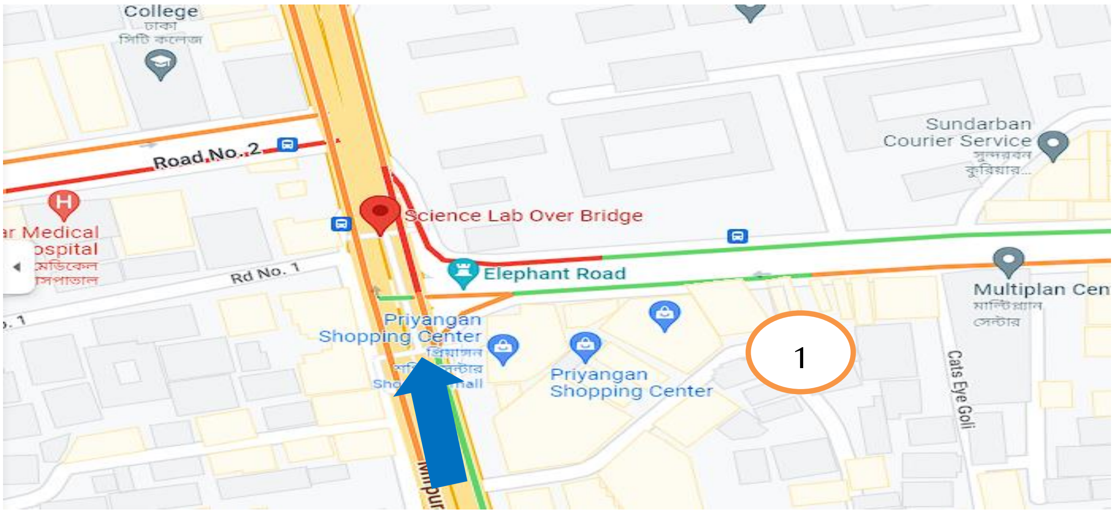

Fig 3.2 : Intake of New market Road

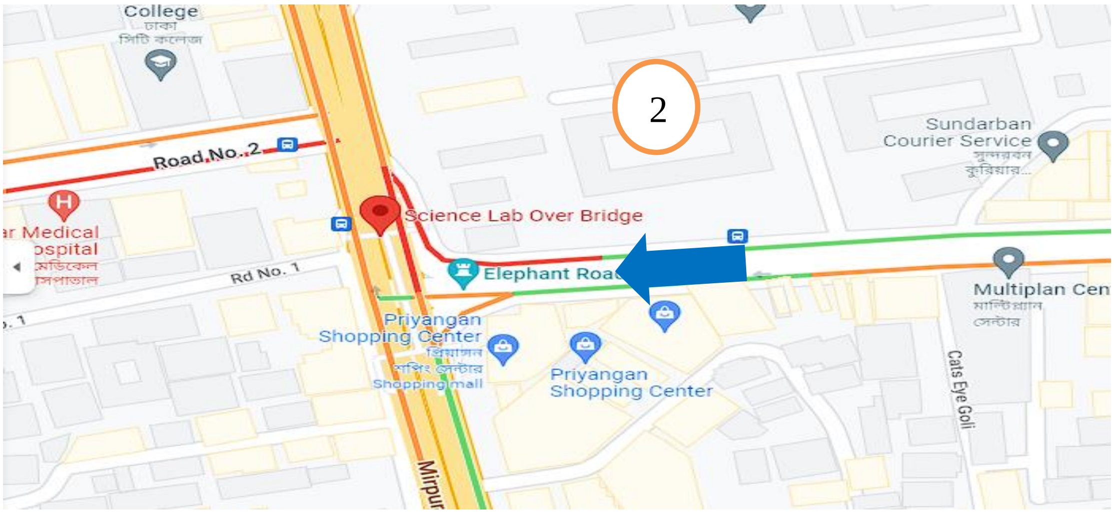

Fig 3.3: Intake of Elephant Road

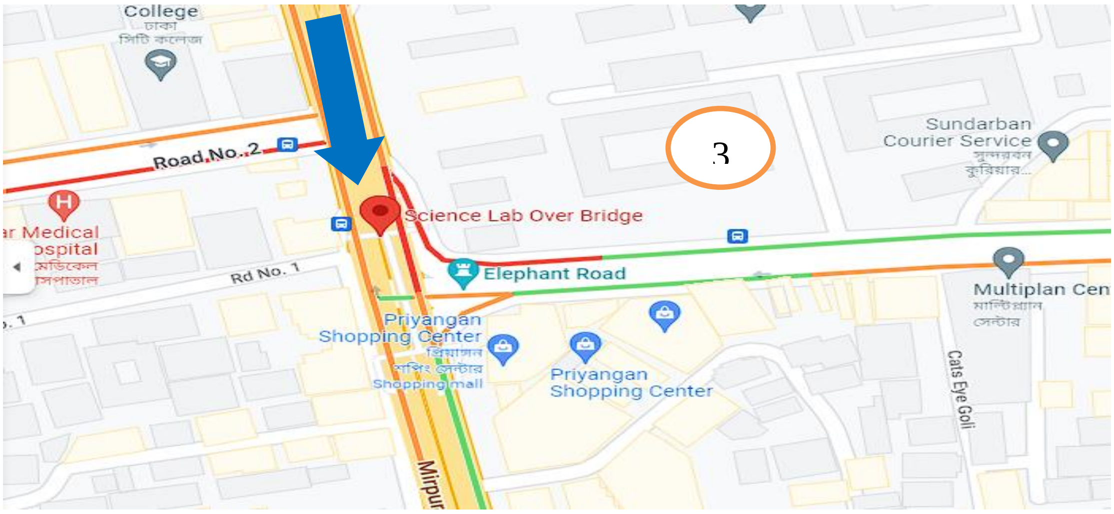

Fig 3.4: Intake of Mirpur Road

3.3. Data Collection:

For the analysis, various crossings in Dhaka city were chosen. The intersection was chosen from a list of technical intersections. New market Road, Mirpur Road, and Gabtoli Road are all technical crossroads. We took traffic 15minites counts for all streams for three days, from June 25 to JUNE 30, 2022. The information is gathered and then entered into Microsoft Excel. At the crossroads, there are six different traffic flows. Morning peak hour (8 a.m.–10 a.m.), afternoon peak hour (12 p.m.–2 p.m.), and evening peak hour (8 p.m.–10 p.m.) data were gathered (4 pm-6 pm).

A 24-hour traffic volume count taken from video of the crossing revealed peak hours. A 15-minute categorized traffic count was conducted at the following periods to determine the relative degree of usage of road space: 8:00-8:15 a.m. (morning peak), 1:00-1:15 p.m. (afternoon peak), and 5:00-5:15 p.m. (evening peak). Because vehicles of diverse sizes and weights pass through the research region, a common measurement unit was required to quantify their impact.

3.3.1Traffic count Daily New market Rd in:

3.1: Traffic count Daily New market Rd in

Date : 25-06-22								
Time	Car	Bus	Truck	Pickup van	CNG	Motorcycle	NMV	Total
8.00-8.15	183	49	5	32	43	47	81	440
1.00-1.15	155	32	1	15	60	98	135	496
5.00-5.15	143	33	3	11	50	95	142	477
Date: 26-06-22								
Time	Car	Bus	Truck	Pickup van	CNG	Motorcycle	NMV	Total
8.00-8.15	162	38	2	10	44	105	77	438
1.00-1.15	143	31	2	21	51	88	119	455
5.00-5.15	114	36	3	12	46	120	129	460
Date: 29-06-22								
Time	Car	Bus	Truck	Pickup van	CNG	Motorcycle	NMV	Total
8.00-8.15	177	38	3	13	43	93	79	446
1.00-1.15	156	45	3	17	40	97	123	481
5.00-5.15	121	37	4	11	36	100	125	434
Date: 30-06-22								
Time	Car	Bus	Truck	Pickup van	CNG	Motorcycle	NMV	Total
8.00-8.15	155	43	2	16	38	65	71	390
1.00-1.15	141	23	5	15	37	115	120	456
5.00-5.15	139	24	2	13	27	63	101	369

3.3.2Traffic count Daily New market Rd Out:

3.2 Table: Traffic count Daily New market Rd Out

Date: 25-06-22								
Time	Car	Bus	Truck	Pickup van	CNG	Motorcycle	NMV	Total
8.00-8.15	315	96	8	55	110	135	110	829
1.00-1.15	246	101	11	49	141	152	223	923
5.00-5.15	239	112	7	56	169	181	294	1058
Date: 26-06-22								
Time	Car	Bus	Truck	Pickup van	CNG	Motorcycle	NMV	Total
8.00-8.15	386	100	5	56	103	125	105	880
1.00-1.15	239	102	10	46	122	165	175	859
5.00-5.15	228	104	12	50	167	190	283	1034
Date: 29-06-22								
Time	Car	Bus	Truck	Pickup van	CNG	Motorcycle	NMV	Total
8.00-8.15	310	112	10	37	116	98	120	802
1.00-1.15	279	109	7	51	155	161	218	981
5.00-5.15	222	105	5	50	165	206	246	999
Date: 30-06-22								
Time	Car	Bus	Truck	Pickup van	CNG	Motorcycle	NMV	Total
8.00-8.15	290	108	8	39	121	117	119	802
1.00-1.15	265	104	4	44	136	181	257	991
5.00-5.15	235	109	8	49	180	196	281	1058

3.3.3Traffic count daily Elephant RD In:

3.3Table: Traffic count daily Elephant RD in

Date: 25-06-22								
Time	Car	Bus	Truck	Pickup van	CNG	Motorcycle	NMV	Total
8.00-8.15	231	41	6	33	31	76	116	534
1.00-1.15	250	39	4	19	32	95	190	629
5.00-5.15	249	46	8	35	45	164	175	722
Date: 26-06-22								
Time	Car	Bus	Truck	Pickup van	CNG	Motorcycle	NMV	Total
8.00-8.15	225	35	6	45	23	39	105	478
1.00-1.15	234	32	4	23	36	62	165	556
5.00-5.15	269	42	5	48	54	92	150	660
Date: 29-06-22								
Time	Car	Bus	Truck	Pickup van	CNG	Motorcycle	NMV	Total
8.00-8.15	199	32	5	30	20	43	96	425
1.00-1.15	219	33	3	47	41	74	157	574
5.00-5.15	270	48	6	39	42	110	168	683
Date: 30-06-22								
Time	Car	Bus	Truck	Pickup van	CNG	Motorcycle	NMV	Total
8.00-8.15	250	36	8	36	33	64	99	526
1.00-1.15	266	34	3	46	31	54	163	597
5.00-5.15	214	49	6	30	57	116	140	612

3.3.3Traffic count daily Elephant RD out:

3.3Table: Traffic count daily Elephant RD out

Date: 25-06-22								
Time	Car	Bus	Truck	Pickup van	CNG	Motorcycle	NMV	Total
8.00-8.15	347	105	6	56	107	160	139	920
1.00-1.15	380	111	8	37	169	214	230	1149
5.00-5.15	359	116	5	21	175	260	276	1212
Date: 26-06-22								
Time	Car	Bus	Truck	Pickup van	CNG	Motorcycle	NMV	Total
8.00-8.15	370	106	5	21	105	154	153	914
1.00-1.15	372	105	6	39	160	213	212	1107
5.00-5.15	370	89	11	31	159	254	250	1164
Date: 29-06-22								
Time	Car	Bus	Truck	Pickup van	CNG	Motorcycle	NMV	Total
8.00-8.15	354	118	9	23	129	167	187	987
1.00-1.15	382	156	8	43	155	216	284	1244
5.00-5.15	380	116	7	22	144	240	232	1141
Date; 30-06-22								
Time	Car	Bus	Truck	Pickup van	CNG	Motorcycle	NMV	Total
8.00-8.15	393	116	6	21	145	137	145	963
1.00-1.15	396	95	8	36	144	241	232	1152
5.00-5.15	373	107	6	31	179	236	278	1210

3.3.5 Traffic count daily Mirpur RD In:

3.5Table: Traffic count daily Mirpur RD In

Date: 25-06-22								
Time	Car	Bus	Truck	Pickup van	CNG	Motorcycle	NMV	Total
8.00-8.15	370	66	5	22	65	113	73	714
1.00-1.15	304	76	7	22	108	115	180	812
5.00-5.15	258	82	4	10	125	169	215	863
Date: 26-06-22								
Time	Car	Bus	Truck	Pickup van	CNG	Motorcycle	NMV	Total
8.00-8.15	236	67	3	11	61	49	76	503
1.00-1.15	338	75	5	17	110	125	134	804
5.00-5.15	257	62	7	19	113	135	192	785
Date: 29-06-22								
Time	Car	Bus	Truck	Pickup van	CNG	Motorcycle	NMV	Total
8.00-8.15	277	79	6	10	86	75	113	646
1.00-1.15	252	85	5	26	116	120	161	765
5.00-5.15	258	77	3	11	109	141	167	766
Date: 30-06-22								
Time	Car	Bus	Truck	Pickup van	CNG	Motorcycle	NMV	Total
8.00-8.15	238	72	4	42	108	112	83	659
1.00-1.15	255	71	3	20	107	127	189	772
5.00-5.15	235	83	5	17	152	174	190	856

3.3.6Traffic count daily Mirpur Rd Out:

3.6 Table: Traffic count daily Mirpur Rd Out

Date: 25-06-22								
Time	Car	Bus	Truck	Pickup van	CNG	Motorcycle	NMV	Total
8.00-8.15	243	68	5	66	75	156	115	728
1.00-1.15	271	58	4	57	92	137	201	820
5.00-5.15	292	61	8	45	95	153	200	854
Date: 26-06-22								
Time	Car	Bus	Truck	Pickup van	CNG	Motorcycle	NMV	Total
8.00-8.15	313	69	3	55	65	126	107	738
1.00-1.15	246	57	6	45	87	128	130	699
4.55-5:20	261	77	7	65	99	166	183	858
Date: 29-06-22								
Time	Car	Bus	Truck	Pickup van	CNG	Motorcycle	NMV	Total
8.00-8.15	309	70	6	39	84	137	130	775
1.00-1.15	231	75	6	45	79	106	184	726
5.00-5.15	285	65	8	51	78	164	221	872
Date: 30-06-22								
Time	Car	Bus	Truck	Pickup van	CNG	Motorcycle	NMV	Total
7.55-8:20	315	80	6	50	72	121	102	746
1.00-1.15	293	57	7	53	61	170	211	852
5.00-5.15	275	51	5	30	76	123	176	736

3.4. Methodology:

The basic objective of the three-phase design is to compartmentalize the conflicting emotions that occur at a junction into a number of distinct stages so that they do not interfere with one another. There must be a significant number of phases completed in order to successfully segregate all of the motions and avoid any conflicts. On the other hand, in order to avoid any confusion, a pertinent notation has been included below. The following is a list of terminology that was utilized over the course of this research. [2]

Three-phase signal: When there are three roads coming together at an intersection, a signal with three phases is used. At crossroads with two competing right-turn lanes, a three-phase signal design is the most effective solution.

Cycle time: The amount of time required to complete one full length of iteration, also known as one complete rotation of all signal indications, is referred to as the cycle time. It is represented by the letter C. In this investigation, the optimum cycle time was determined by applying Webster's approach, which corresponded to the least amount of overall delay..

Green time: g is the symbol that represents this particular movement or combination of movements, and it is represented by the color green. This is the real amount of time that a traffic signal's green light is illuminated for before it turns off again.

Red time: It is the red indication for a particular movement or set of movements and is denoted by R.

Amber time: Clearance amber is the name given to the transition interval that occurs between the illumination of a red signal and the termination of a related green signal. This helps the traffic at the intersection to clear out before the green signal is illuminated for traffic coming from the perpendicular or any other oncoming directions..

Red amber: The time period for which when red and amber lights are shown simultaneously, usually when the red indication is about to end. This is intended to give indication to drivers to start their engines. In our study, red amber is assumed to be zero.

All-red time: The time span throughout which all approaches display a red indication for the same amount of time. It gives vehicles that entered the intersection soon before the commencement of the red light the opportunity to avoid a collision with the opposing traffic flow before the light becomes red. In addition, this duration can make it possible for pedestrians to cross safely from any direction, including diagonally, so long as they follow the rules.

The signal has been designed following these steps:

- Three Phase design
- Determining of amber time and clearance time
- Determined optimum cycle length
- Apportioning of green time
- The presentation estimates of the above design.
- Determining the level of service

Webster's Method

It is an essential method for obtaining the optimal signal cycle time Co that corresponds to the least amount of delay for all of the cars approaching the intersection from the approach roads [2].

$$C_o = \frac{1.5L+5}{1-Y} \qquad (1)$$

Where,

L= Total lost time per cycle sec = 3n+R

n = is the number of phases

R=all-red time;

$Y=y_1 + y_2 + y_3$ (2)

$y1 = q1/S_1$, $y2 = q2/S_2$ and $y3 = q3/S_3$ (3)

$$g1 = \frac{y1}{Y}(C0 - L), g2 = \frac{y2}{Y}(C0 - L), g3 = \frac{y3}{Y}(C0 - L) \qquad (4)$$

The fieldwork consists of determining the following set of values on each approach road near the intersection:

1. The normal flow "q" on each approach during the design hour.
2. The saturation flow, S, in PCU per unit time

The normal flow values q1, q2 and q3 on road 1, 2 and 3 are determined from field studies conducted during the design hours of the traffic during peak 15-minute period. Careful field studies are used to calculate the saturation flow of vehicles. This is done by accurately noting the number of vehicles present in the compact flow stream during the green periods of the study and the intervals that correspond to those phases.

On approach roads 1, 2, and 3, respectively, the ratios y1 = q1/S1, y2 = q2/S2, and y3 = q3/S3 are determined by using the values that were selected for normal flow. It is important to convert the various vehicle classes in terms of relevant PCU values at the signalized intersection in the event that there is mixed traffic; in the event that these are not accessible for this purpose, it may be determined separately. Conducting field studies during off-peak hours to design different sets of signal timings during other periods of the day, as required, in order to obtain different signal settings can also be another way to determine the normal flow of traffic on the approach roads. This will allow for different signal settings to be obtained. The signal time is designed as per Roads and Highways Department of Bangladesh.

To evaluate traffic condition in cities, volume-capacity Ratio (v/c) is one of the most used measure of effectiveness for determining LOS, in which v is the total number of vehicles passing a point in one hour and c is the maximum number of vehicles that can pass a certain point at the reasonable traffic condition. Volume-capacity Ratio (v/c) is a measure that reflects the mobility and quality of travel of a facility or a section of a facility. It compares roadway demand (vehicle volumes) with roadway supply (carrying capacity). The v/c method is associated with LOS and determining how well a roadway is performing. This measure can alert transportation providers to areas where traffic mitigation measures should be considered.

v/c ratio was calculated by the following formula:

Volume-capacity ratio = Total hourly PCU /Capacity

The Capacity was calculated using

$$C = \frac{N*S*g}{co} \qquad (5)$$

where,

c=capacity (pcu/hr)

N = number of lanes (ln)

S = saturation flow rate

g =effective green time (s)

C_o = cycle time. (s)

Table 3.7 Traffic performance measurement by v/c ratio (HCM, 2010)

LOS	v/c Ratio	Detailed Description
A	0.00-0.35	Represents the best-operating conditions and is considered free flow. Individual users are virtually unaffected by the presence of others in the traffic stream
B	0.35-0.58	Represents reasonably free-flowing conditions but with some influence by others. Represents a constrained constant flow below speed limits, with additional attention
C	0.58-0.75	Represents a constrained constant flow below speed limits, with additional attention required by the drivers to maintain safe operations. The comfort and convenience levels of the driver decline noticeably
D	0.75-0.9	Represents traffic operations approaching unstable flow with high passing demand and passing capacity near zero, characterized by drivers being severely restricted in maneuverability
E	0.9-1.00	Represents unstable flow near capacity. LOS E often changes to LOS F very quickly because of disturbances (road conditions, accidents, etc.) in traffic flow.
F	>1.00	Represents the worst conditions with the heavily congested flow and traffic demand exceeding capacity, characterized by stop-and-go waves, poor travel time, low comfort and convenience, and increased accident exposure

CHAPTER 4

Analysis & Result

4.1. General:

As a result, a thesis statement for a research paper address a HOW determining issue.

4.2. Analysis Basis:

Variation in the current data.

4.3. Analysis Procedure:

According to the Geometric Design Standards for Roads and Highways Department, Bangladesh (Roads and Highways Department, 2001), the following Passenger Car Equivalent (PCE) factors were utilized in order to convert the vehicle counts to passenger car units: 0.30 for a motorbike, 1.00 for a rickshaw, 0.30 for a bicycle; 2.5 for a bus; 2.5 for a truck; 1.25 for a mini-truck; 1.00 for a car or microbus; 1.00 for compressed natural gas; 0.30 for a bicycle, 1.00 for a rickshaw, and 0.30 for a motorcycle As a consequence of this, traffic flow was measured in terms of PCUs by multiplying the data on the number of vehicles by the PCE factors.

4.4. Variation in the current data:

In this part, we show the variation at Science lab intersections in Dhaka. In 25-06-2022, 26-06-22, and 30-06-2022 variation in data analysis. Several intersections are selected in Dhaka city for the analysis. The intersection is selected Mirpur road, those intersections are new market road and Elephant road. Those are intersections:

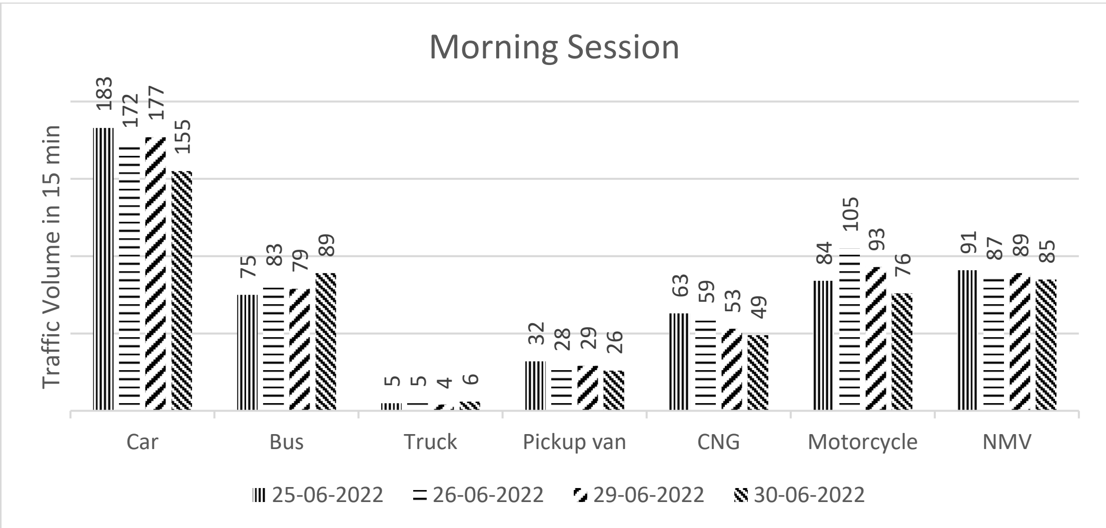

Fig 4.1: Intake of New market Road in

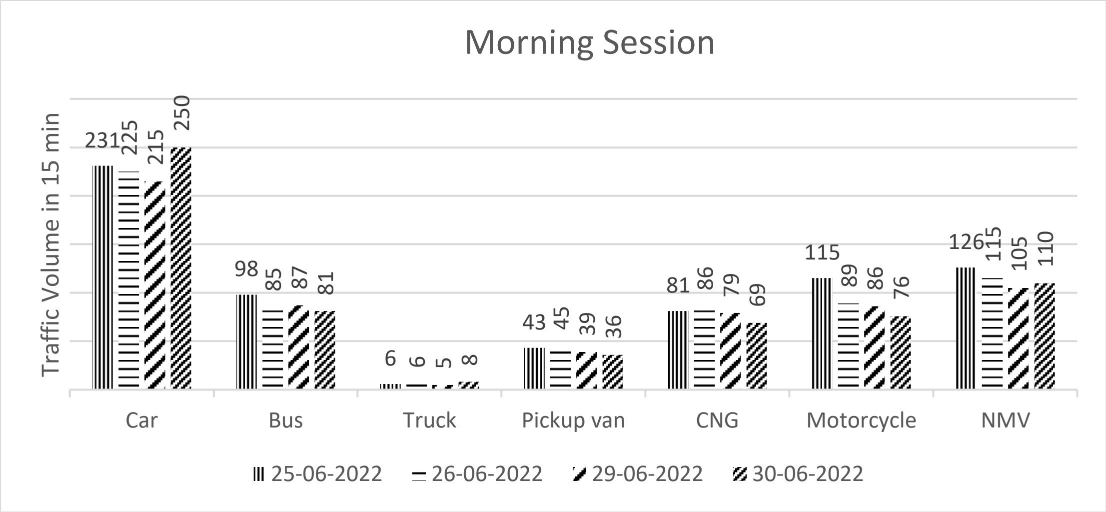

Fig 4.2: Intake of Elephant Road in

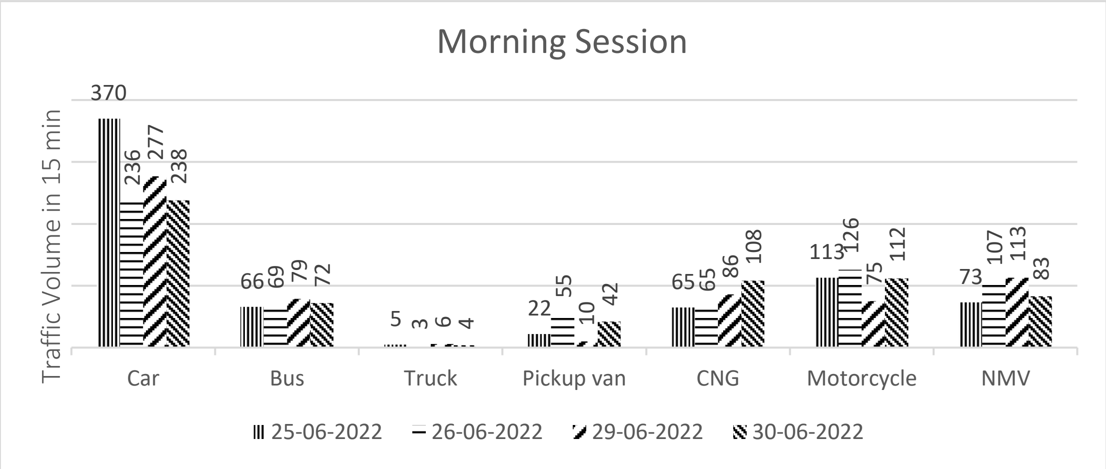

Fig 4.3: Intake of Mirpur Road in

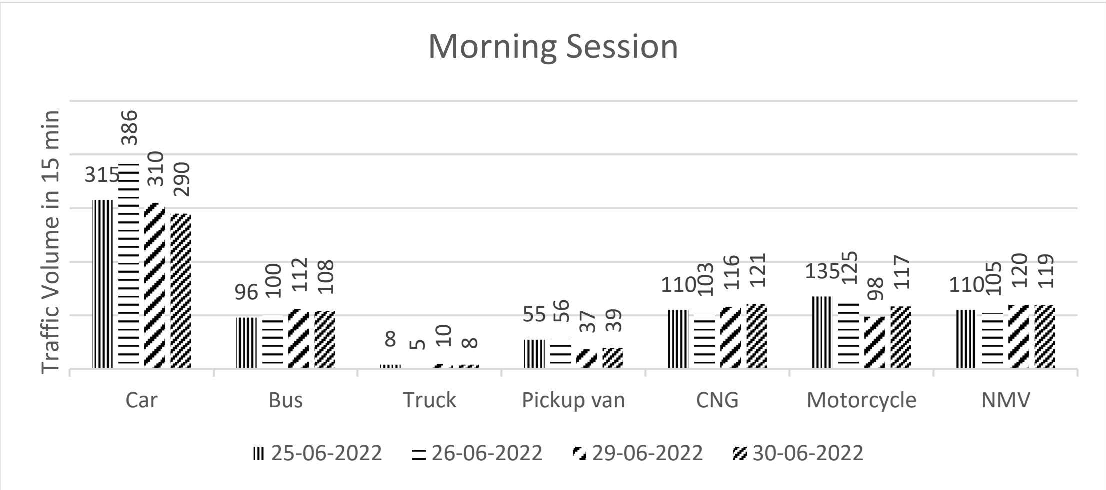

Fig 4.4: Intake of New market Road out

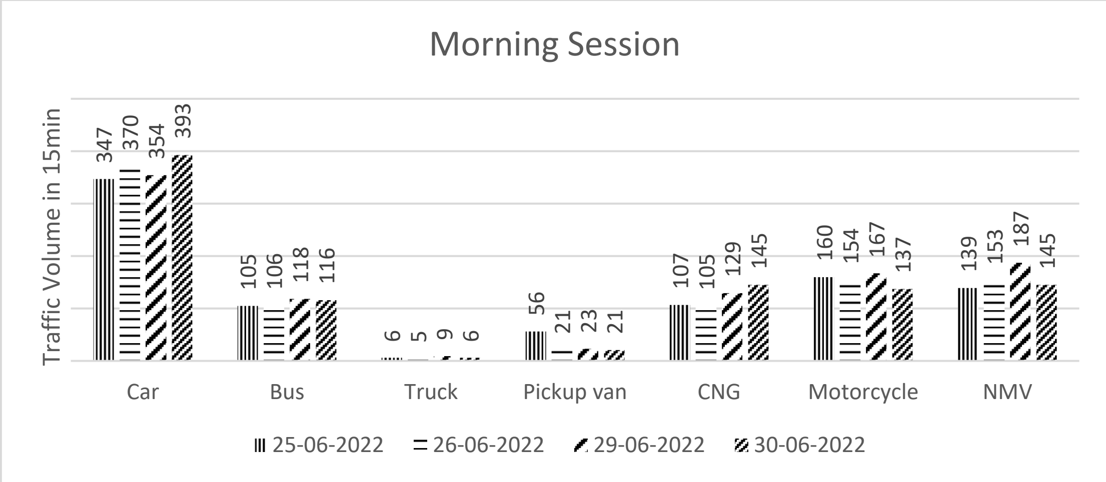

Fig 4.5: Intake of Elephant Road out

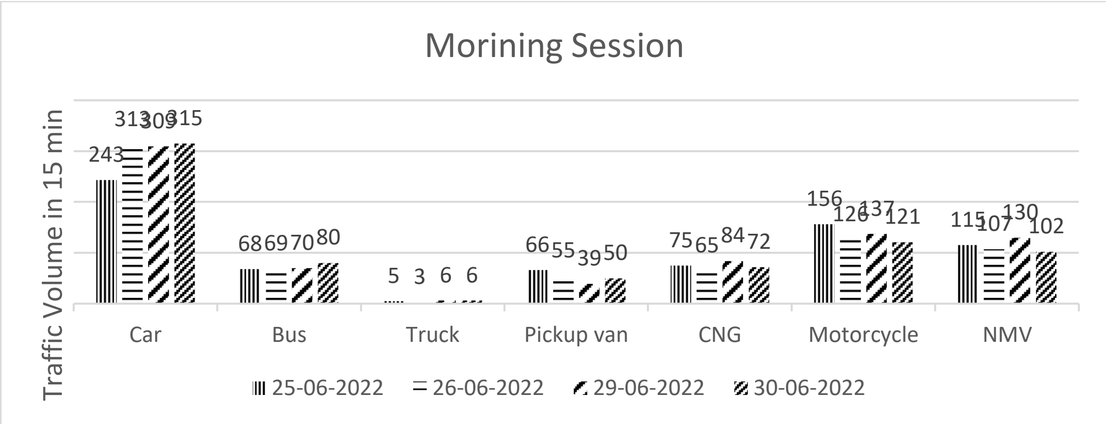

Fig 4.6: Intake of Mirpur Road out

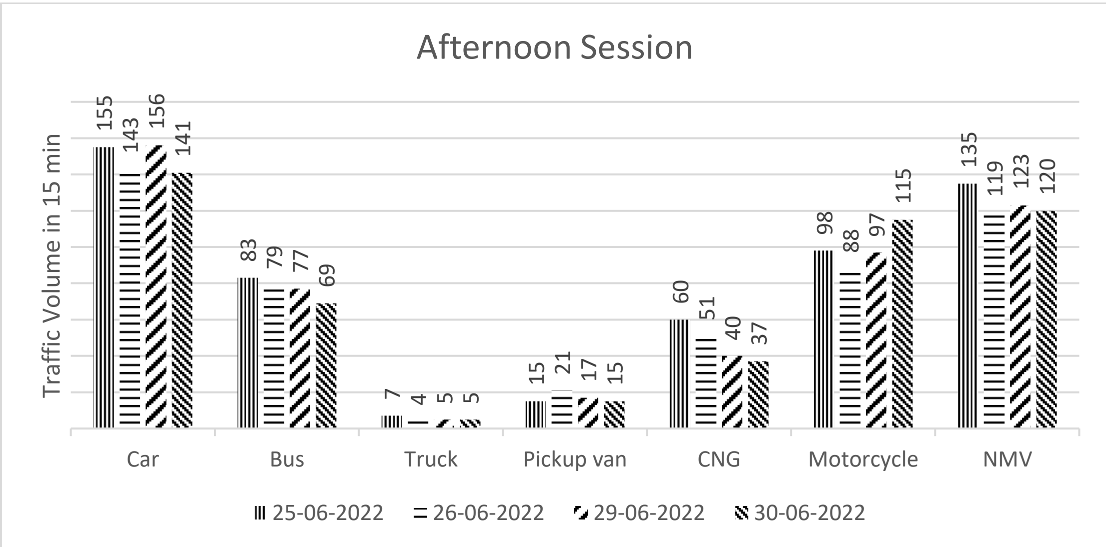

Fig 4.7: Intake of New Market Road in

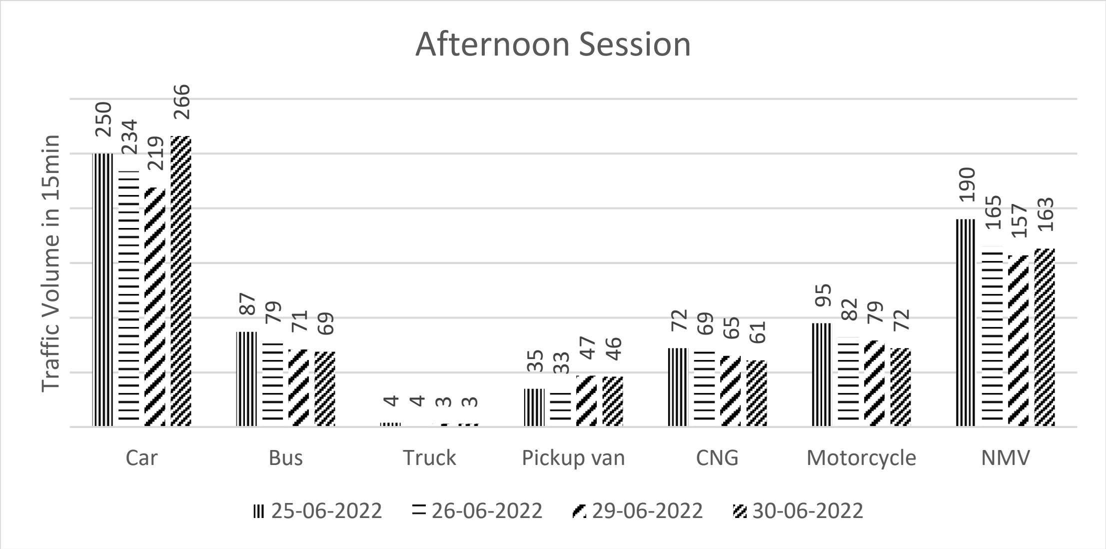

Fig 4.8: Intake of Elephant Road in

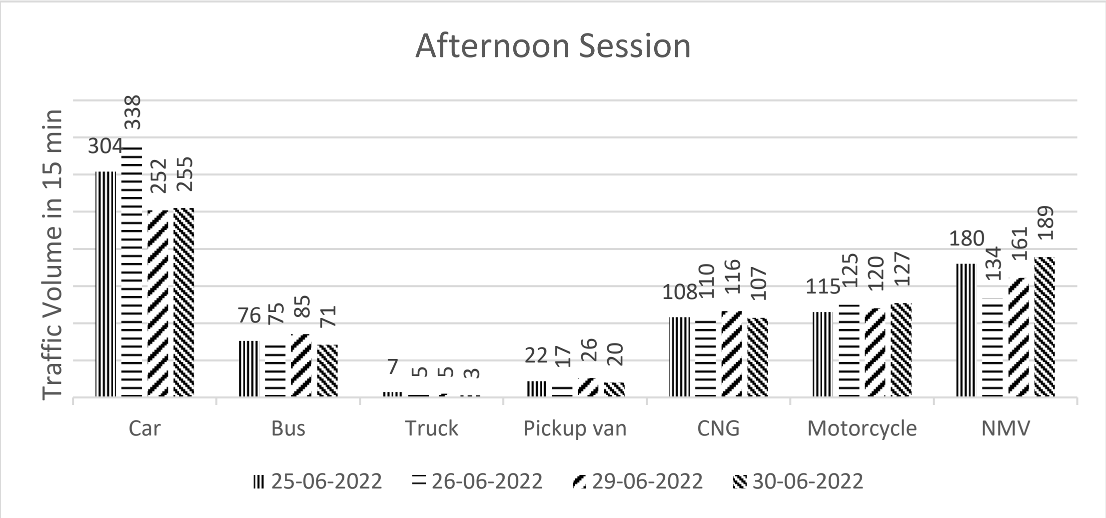

Fig 4.9: Intake of Mirpur Road in

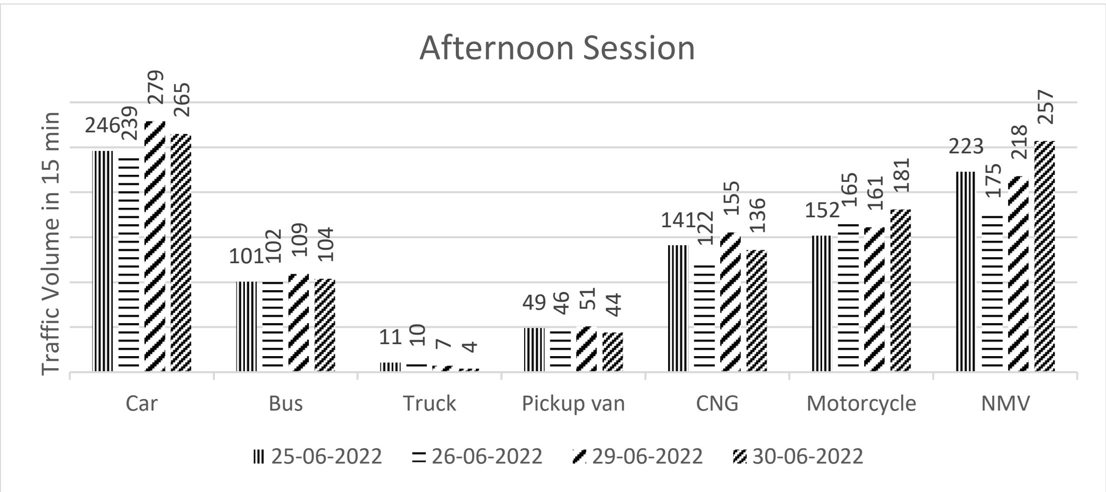

Fig 4.10: Intake of New market Road out

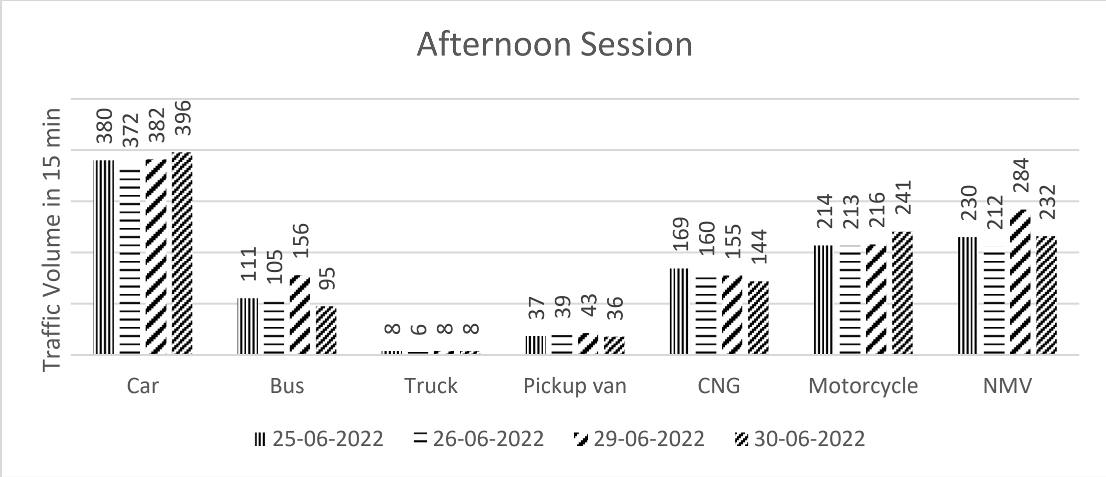

Fig 4.11: Intake of Elephant Road out

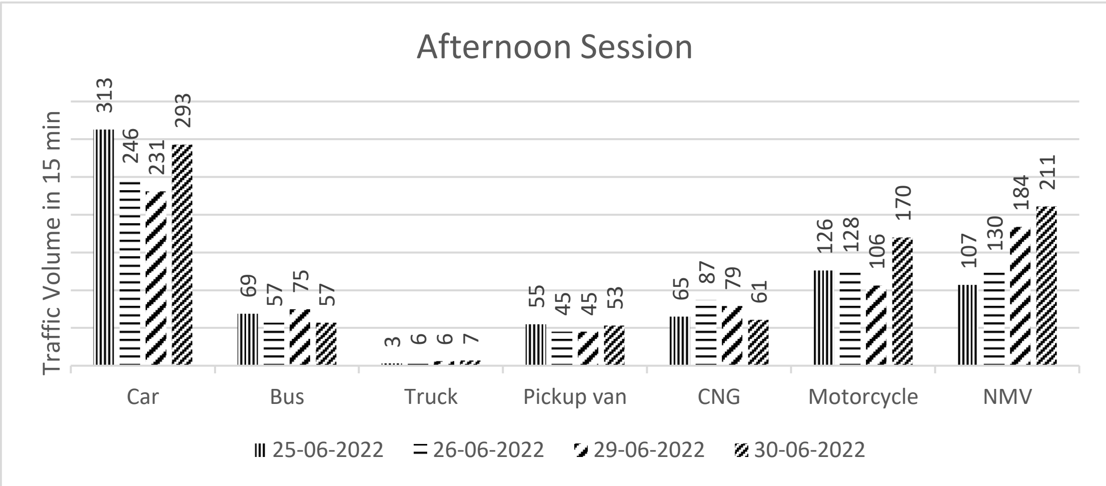

Fig 4.12: Intake of Mirpur Road out

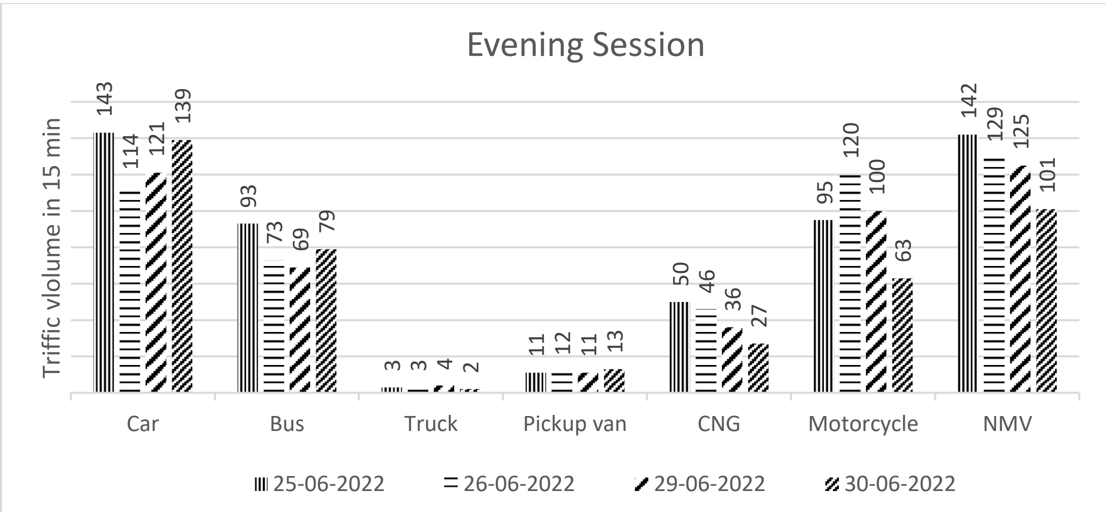

Fig 4.13: Intake of New market Road in

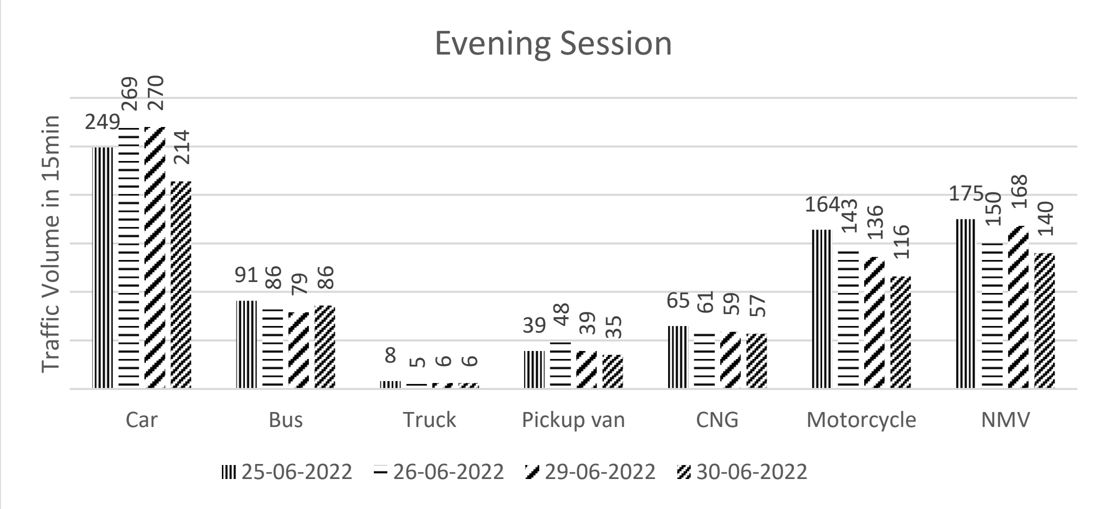

Fig 4.14: Intake of Elephant Road in

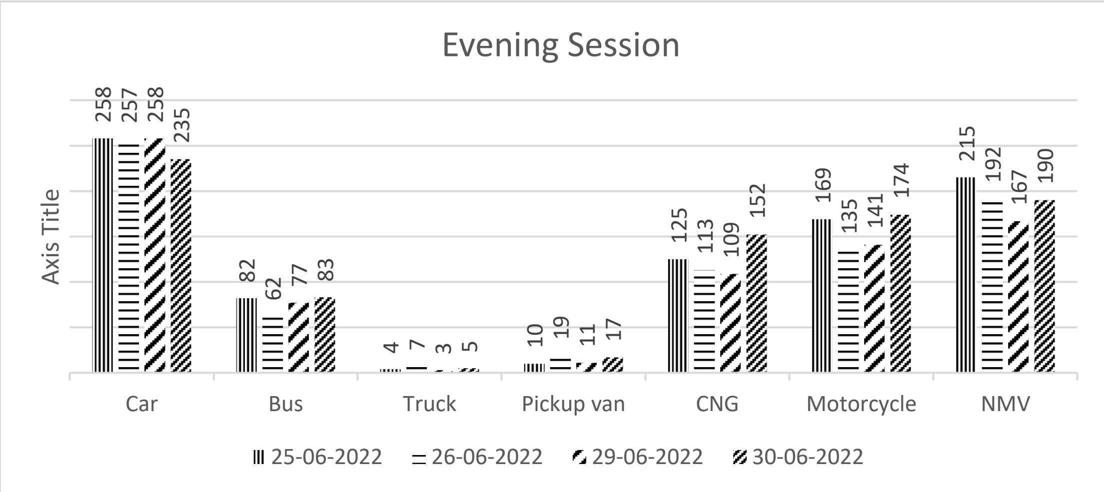

Fig 4.15: Intake of Mirpur Road in

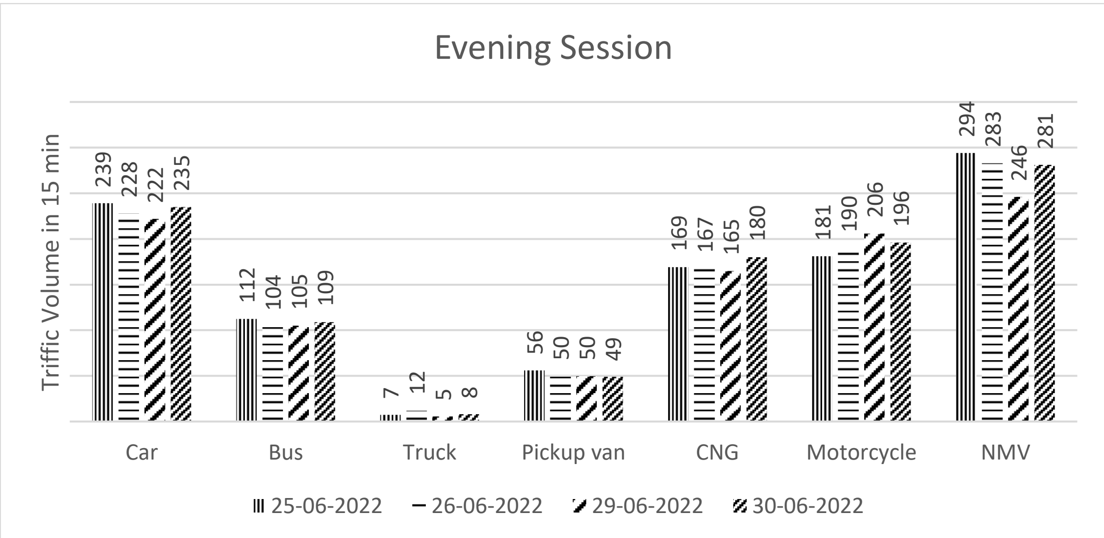

Fig 4.16: Intake of New Market Road out

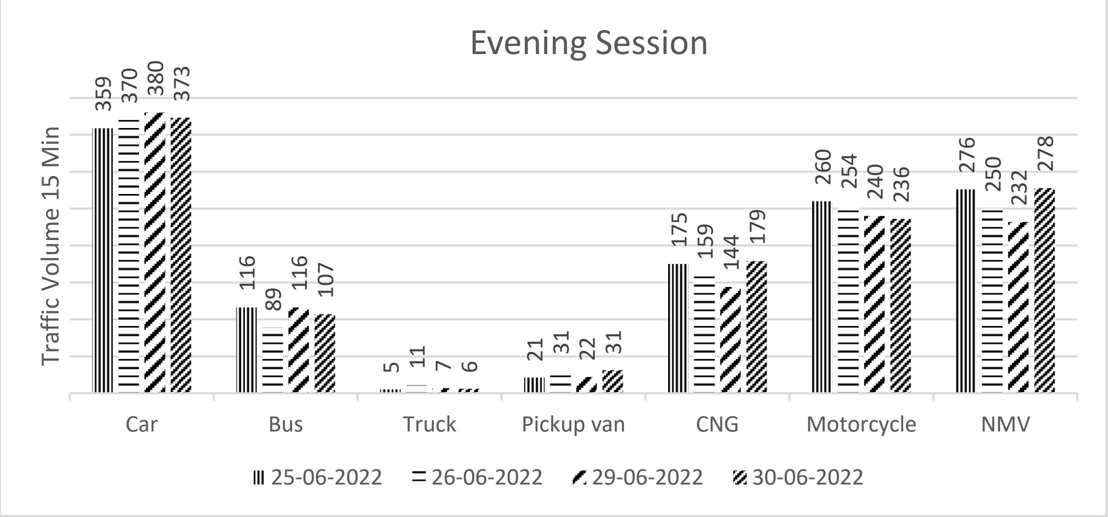

Fig 4.17: Intake of Elephant Road out

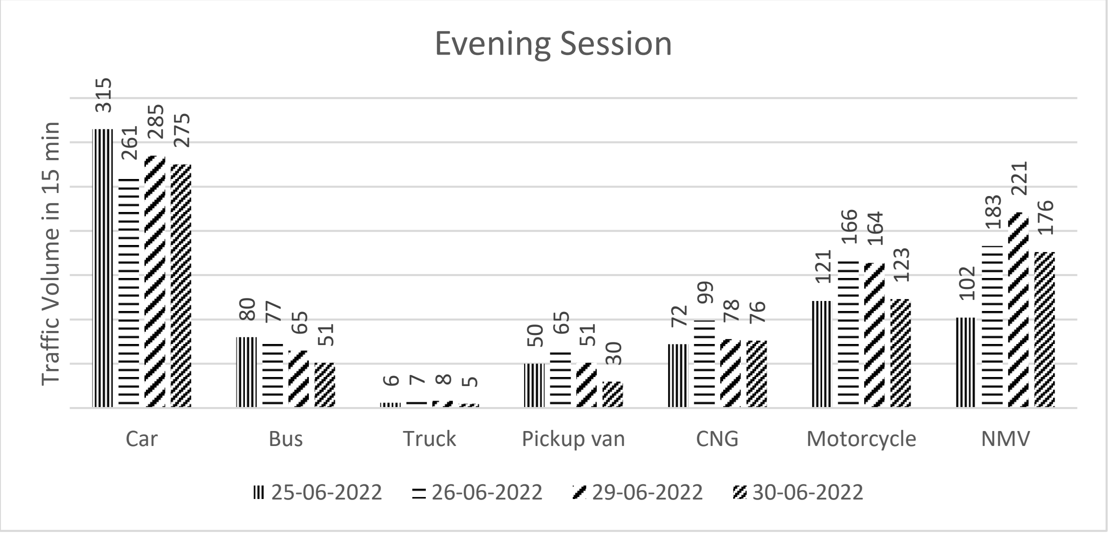

Fig 4.18: Intake of Mirpur Road out

4.5. Results and Discussion:

Using the data that were obtained, we were able to calculate the time of each cycle for the morning, afternoon, and evening sessions. In addition, the LOS was calculated for each of 6 different orientations at the investigated junction during the entirety of the research. The results of the study are summarized here for your convenience.

Calculation of Cycle length:

Morning Session:

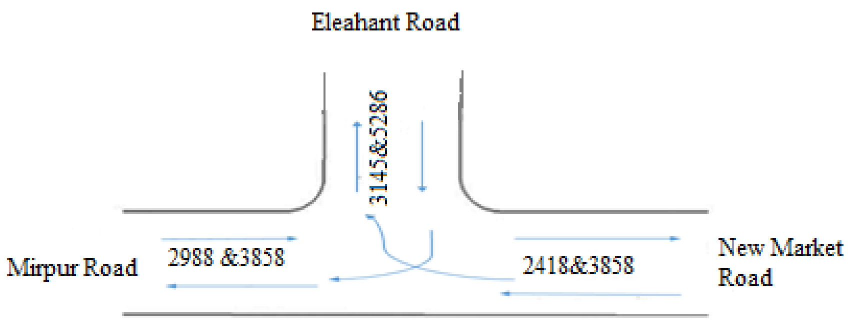

Fig 4.19: PCU Values for the Morning session from different streams

From the above PCU values, the maximum PCU value from each phase is taken for the Calculation of cycle length. And for the calculation of cycle length for phase 1, phase 2 and Phase 3 the value is taken 49.8%, 54.6%, and 35.6% respectively of the original value

Phase 1	39.8	%
Phase 2	54.6	%
Phase 3	35.6	%

For the calculation of cycle length, saturation value (S) is required and it is taken As 7350

The width of the approach w=14 Meters

Now

$q_1=$	1536	pcu/hr
$q_2=$	2884	pcu/hr
$q_3=$	1229	pcu/hr

Now ,

$y_1=$ 0.21

$y_2=$ 0.39

$y_3=$ 0.17

$Y= y_1+y_2+y_3 =0.769$ Sec

According to Webster method Cycle length, $C_o=(1.5L+5)/(1-Y)$

Considering amber time 3 sec for each phase and Enter-green time 6 sec for each phase

Enter-green time = amber time + all red time

All red time for each phase = 3

Total all red time for three phase, R =9Sec

Total lost time, L = 3n + R = 18Sec

Therefore, $C_o=$ 138Sec

Calculation of Green Time:

Phase 1:

g1= (y1/Y)*(Co-L) = 33 Sec

Phase 2:

g2= (y2/Y)*(Co-L) = 61 Sec

Phase 3:

g3= (y3/Y)*(Co-L) = 26 Sec

Total Cycle length = 138 Sec

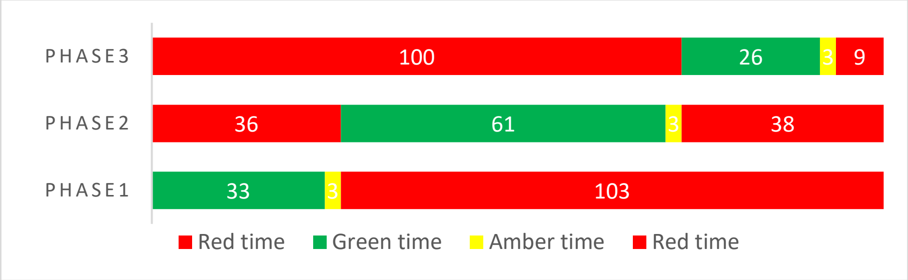

Fig 4.20: Signal Phase Diagram for Morning Session

Afternoon Session:

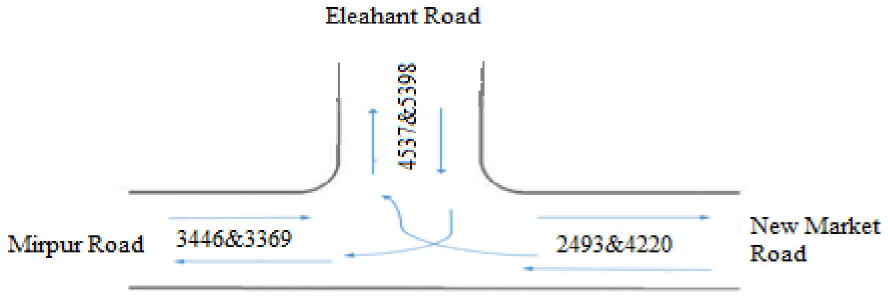

Fig 4.21:PCU Values for the Afternoon session from different streams

From the above PCU values, the maximum PCU value from each phase is taken for the Calculation of cycle length. And for the calculation of cycle length for phase 1, phase 2 and Phase 3 the value is taken 42%, 53.7%, and 34.3% respectively of the original value

Phase 1	42	%
Phase 2	53.7	%
Phase 3	34.3	%

For the calculation of cycle length, saturation value (S) is required and it is taken As 7350

The width of the approach w=14 Meters

Now

q1=	1772	pcu/hr
q2=	2900	pcu/hr
q3=	1182	pcu/hr

Now ,

y1= 0.24

y2= 0.39

y3= 0.16

Y= y1+y2+y3 = 0.796Sec

According to Webster method Cycle length, Co=(1.5L+5)/(1-Y)

Considering amber time 3 sec for each phase and Enter-green time 6 sec for each phase

Enter-green time = amber time + all red time

All red time for each phase = 3

Total all red time for three phase, R =9Sec

Total lost time, L = 3n + R = 18 Sec

Therefore, Co= 157 Sec

Calculation of Green Time:

Phase 1 :

g1=(y1/Y)*(Co-L)= 42 Sec

Phase 2:

g2=(y2/Y)*(Co-L)= 69 Sec

Phase 3 :

g3=(y3/Y)*(Co-L)= 28 Sec

Total Cycle length = 157Sec

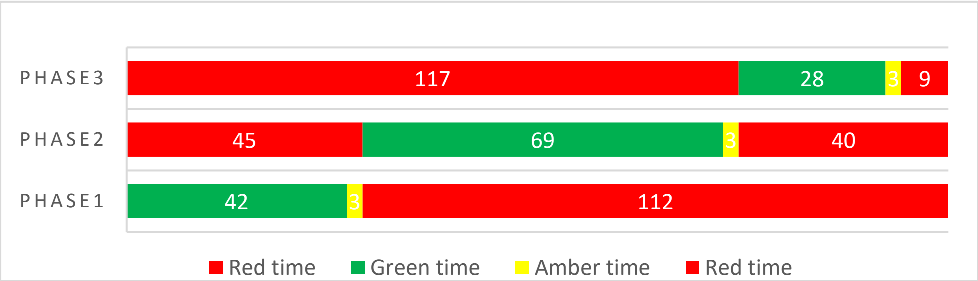

Fig.4.22: Signal Phase Diagram for Afternoon Session

Evening Session:

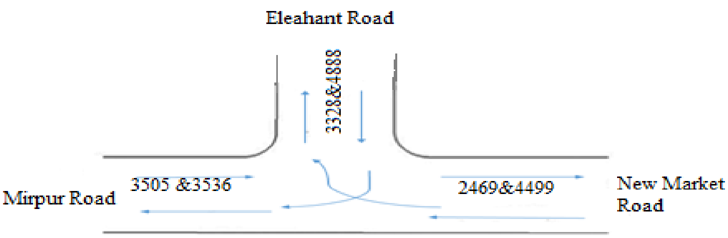

Fig.4.23: PCU Values for the Evening session from different streams

From the above PCU values, the maximum PCU value from each phase is taken for the Calculation of cycle length. And for the calculation of cycle length for phase 1, phase 2 and Phase 3 the value is taken 45%, 49%, and 36% respectively of the original value

Phase 1	45	%
Phase 2	49	%
Phase 3	36	%

For the calculation of cycle length, saturation value (S) is required and it is taken

As=7350

The width of the approach w=14 Meters

Now

q1= 2036 pcu/hr

q2= 2404 pcu/hr

q3= 1258 pcu/hr

Now ,

y1= 0.28

y2= 0.33

y3= 0.17

Y= y1+y2+y3 = 0.775Sec

According to Webster method Cycle length, Co= (1.5L+5)/(1-Y)

Considering amber time 3 sec for each phase and Enter-green time 6 sec for each phase

Enter-green time = amber time + all red time

All red time for each phase = 3

Total all red time for three phase, R =9Sec

Total lost time, L = 3n + R = 18Sec

Therefore, Co= 142 Sec

Calculation of Green Time:

Phase 1 :

g1=(y1/Y)*(Co-L)= 44 Sec

Phase 2:

g2=(y2/Y)*(Co-L)= 52 Sec

Phase 3 :

g3=(y3/Y)*(Co-L)= 27 Sec

Total Cycle length = 142 Sec

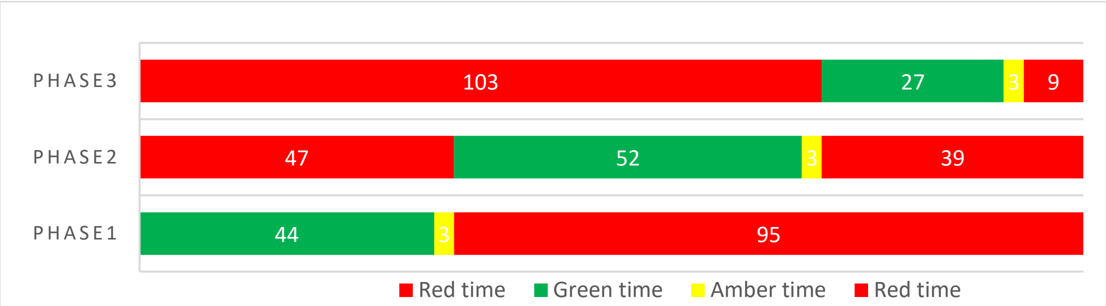

Fig. 4.24: Signal Phase Diagram for Evening Session

4.5.2Calculation of Service (LOS):

Table 4.1Calculation of Service (LOS):

The Capacity was calculated using equation Flow-Capacity ratio were used to identify LOS at different approaches of the studied intersection at different times of the day with the help of Table 1. The results are provided in Tables 2, 3 and 4 for morning, afternoon and evening peak respectively								
Level of services of different lanes of TM intersection by Volume Capacity ratio method at Morning Peak.								
Lane name	S(pcu//hr/In)	Co (sec)	g(sec)	N(In)	c(Pcu/hr)	v(pcu/hr)	v/c	LOS
New market Rd in	7350	138	33	3	5215	2418	0.46	B
New market Rd Out	7350	138	33	3	5215	3858	0.74	C
Elephant Rd In	7350	138	61	3	9793	3145	0.32	A
Elephant Rd Out	7350	138	61	3	9793	5286	0.54	B
Mirpur Rd in	7350	138	26	3	4172	2988	0.72	C
Mirpur Rd Out	7350	138	26	3	4172	3450	0.83	D
Level of services of different lanes of TM intersection by Volume Capacity ratio method at Afternoon Peak.								
Lane name	S(pcu//hr/In)	Co (sec)	g(sec)	N(In)	c(Pcu/hr)	v(pcu/hr)	v/c	LOS
New market Rd in	7350	157	42	3	5910	2493	0.42	B
New market Rd Out	7350	157	42	3	5910	4220	0.71	C
Elephant Rd In	7350	157	69	3	9672	4537	0.47	B
Elephant Rd Out	7350	157	69	3	9672	5398	0.56	B
Mirpur Rd in	7350	157	28	3	3942	3446	0.87	D
Mirpur Rd Out	7350	157	28	3	3942	3369	0.85	D
Level of services of different lanes of TM intersection by Volume Capacity ratio method at Evening Peak.								
Lane name	S(pcu//hr/In)	Co (sec)	g(sec)	N(In)	c(Pcu/hr)	v(pcu/hr)	v/c	LOS
New market Rd in	7350	142	44	3	6884	2469	0.36	B
New market Rd Out	7350	142	44	3	6884	4499	0.65	C
Elephant Rd In	7350	142	52	3	8126	3338	0.41	B
Elephant Rd Out	7350	142	52	3	8126	4888	0.60	C
Mirpur Rd in	7350	142	27	3	4252	3505	0.82	D
Mirpur Rd Out	7350	142	27	3	4252	3536	0.83	D

LOS	v/c Ratio	Detailed Description
A	0.00-0.35	Represents the best-operating conditions and is considered free flow. Individual users are virtually unaffected by the presence of others in the traffic stream
B	0.35-0.58	Represents reasonably free-flowing conditions but with some influence by others. Represents a constrained constant flow below speed limits, with additional attention
C	0.58-0.75	Represents a constrained constant flow below speed limits, with additional attention required by the drivers to maintain safe operations. The comfort and convenience levels of the driver decline noticeably
D	0.75-0.9	Represents traffic operations approaching unstable flow with high passing demand and passing capacity near zero, characterized by drivers being severely restricted in maneuverability
E	0.9-1.00	Represents unstable flow near capacity. LOS E often changes to LOS F very quickly because of disturbances (road conditions, accidents, etc.) in traffic flow.
F	>1.00	Represents the worst conditions with the heavily congested flow and traffic demand exceeding capacity, characterized by stop-and-go waves, poor travel time, low comfort and convenience, and increased accident exposure

CHAPTER 5

CONCLUSION

5.1. Conclusion:

The suggested timings for the signals at the junction streamline practical traffic scenarios while yet allowing for free movement. Settling traffic at this crossroads is aided by the presence of traffic control and operational features. Morning sessions should last 103 seconds, afternoon sessions 117 seconds, and evening sessions 103 seconds. It means that the evening session requires the most time for sending and receiving signals. Possible explanation: many motorcyclists with automated features leave the area after dark.

The LOS on the Mirpur Road out approach was found to be B at all times throughout the examination. This situation is characterized by a constant flow below the speed limit, an unstable flow with a strong demand for passing and a passing capacity close to zero, and a significant lack of maneuverability for drivers. LOS is B during the morning peak, CB during the midday peak, and B during the evening peak on the new market Rd In approach; while, LOS is C during the morning peak, C during the afternoon peak, and C during the evening peak on the new market Rd In Our approach. Stop-and-go waves, inconvenient travel times, a lack of comfort and convenience, and increased accident risk are characteristics of the very congested flow and traffic demand that exceeds capacity, making it difficult for drivers to maintain safe operations. The degree of the driver's comfort and convenience decreases significantly. A and C are the optimal operating parameters and free flow for the Elephant RD In & out technique. Individual users are little impacted by the presence of others in the traffic flow. LOS is C in both directions of this approach at Evening peak in the new market Rd Out direction during the study hours. Consequently, it may be said that the overall condition of the Science Lab junction is inadequate for the free flow of traffic.

Several suggestions may be made based on the study's results to improve the mobility and service quality of interchanges and other roadways under similar situations. Our study's signal timings may be used to regulate traffic flow in the region. It is believed that disagreements might be minimized by giving out the proper signals. In addition, it is anticipated that the scientific Lab's dependence on traffic officers to regulate traffic would be minimized. This method may be used to address more intersections. The authority/future researcher may utilize the LOS data to comprehend the present service condition of roads in the study region, so enabling them to take remedial action. A reconnaissance investigation of the research area indicated that bus ticket counters were positioned near junctions and that local businesses and parked cars occupied the right-of-way at intersections. Counters and parking spaces should be relocated away from junctions, and the right-of-way must be restored at intersections. To discourage jaywalking, appropriate zebra crossings may be installed and enforced.

The limitations of this investigation are significant. It did not specify when the predicted signal timings should be executed. This may be investigated in the future.

5.2. Limitation:

1. **Physical counting:** We have limitation in physical counting because we have less group member. With this group member we cannot count large area so this the limitation of group counting.
2. **Camera position**: There is also limitation in camera position when we count in peep the place the camera position is so blurb that when we count the vehicle there, we fill obstacle and server problem also screen recording problem.
3. **Obstruction due to vehicle height:** When we were counting the Buss or Truck were creating the screen for that we fill trouble to count small vehicle like Car, Mini Buss, Motorcycle, CNG, and NMV.

REFERENCES:

1. Dhaka Population 2021 (Demographics, Maps, Graphs) (worldpopulationreview.com)
2. Mindur, L., Sierpiński,G.: "Webster ' s Delay Formula Revision by M + Δ / G + Δ / 1 Queuing Model Usage," Logist. Transp., vol. 35, no. 3, pp. 5–12 (2017)
3. Li, J., Yue, Z. Q., Wong, S. C.: "Performance Evaluation of Signalized Urban Intersections under Mixed Traffic Conditions by Gray System Theory," J. Transp. Eng., vol. 130, no. 1, pp. 113–121, (2004).
4. Traffic Signal Design and LOS Determination of a T-intersection: An Empirical Example of Shib-Bari-Mor,Gazipur, Bangladesh: Conference Proceedings: 1st International Conference on Transportation Research 2020 (ICTR 2020) 2020 .
5. Prof. Tom V. Mathew Design Principles of Traffic Signal [https://www.civil.iitb.ac.in/tvm/nptel/571_TrSignal/web/web.html
6. Boumediene, A., Brahimi, K., Belguesmia, N., Bouakkaz, K.: "Saturation flow versus green time at two-stage signal controlled intersections," *Transport*, vol. 24, no. 4, pp. 288–295, (2009).
7. Benekohal, R. F., El-Zohairy, Y. M.: "Multi-regime arrival rate uniform delay models for signalized intersections," *Transp. Res. Part A Policy Pract.*, vol. 35, no. 7, pp. 625– 667, Aug. (2001).
8. Baumgaertner, W. E.: "Levels of service - getting ready for the 21st century," *ITE J. (Institute Transp. Eng.*, vol. 66, no. 1, pp. 36–39, (1996).
9. Ceylan, H., Bell, M. G. H.: "Traffic signal timing optimisation based on genetic algorithm approach, including drivers' routing," *Transp. Res. Part B Methodol.*, vol. 38, no. 4, pp. 329–342, (2004).
10. Jj jbj Chang, T.-H., Lin, J.-T.: "Optimal signal timing for an oversaturated intersection,"
    a. Transp. Res. Part B Methodol., vol. 34, no. 6, pp. 471–491, Aug. (2000).
11. Jkjj Cameron, R.: "G3 F7--An expanded LOS gradation system," ITE J., vol. 66, no. 1, pp. 40–41, (1996).
12. Fajardo, D., Au, T.-C., Waller, S. T., Stone, P., Yang, D.: "Automated Intersection
13. Control: Performance of a Future Innovation Versus Current Traffic Signal Control,"Transp. Res. Rec. J. Transp. Res. Board, vol. 2259, no. 1, pp. 223–232, Jan. (2011).

14. HCM, Highway Capacity Manual 2010. Washington DC: Division of Engineering and Industrial Research, National Academy of Sciences-National Research Council, (2010).
15. Fahmy, M. M. M.: "An Adaptive Traffic Signaling For Roundabout With Four Approach Intersections Based On Fuzzy Logic," J. Comput. Inf. Technol., vol. 15, no. 1, pp. 33–45, (2007).
16. Heidemann, D.: "A Queueing Theory Model of Nonstationary Traffic Flow," Transp. Sci., vol. 35, no. 4, pp. 405–412, Nov. (2001).
17. Ha, T. J., Berg, W. D.: "Development of safety-based level-of-service criteria for isolated signalized intersections," Transp. Res. Rec., vol. 30, no. 1, pp. 98–104, (1996).
18. Hutchinson, T. P.: "Delay at a Fixed Time Traffic Signal—II: Numerical Comparisons of some Theoretical Expressions," *Transp. Sci.*, vol. 6, no. 3, pp. 286–305, Aug. (1972).
19. Islam, M. R., Hasan, M. M., Hossain, M. K.: "Factors Attribute to the Railway Services in Bangladesh; A Typical Example of Joydebpur Railway Station," *DUET J.*, vol. 5, no. 1, pp. 101–109, (2019).
20. Islam, M. R.: "Performance Evaluation of Flyovers Constructed over Level Crossings in Dhaka City," Bangladesh University of Engineering and Technology, (2018).
21. Islam, R., Musabbir, S. R., Ahmed, I. U., Hadiuzzaman, M., Hasnat, M., Hossain, S.:"Bus service quality prediction and attribute ranking using probabilistic neural network and adaptive neuro fuzzy inference system," *Can. J. Civ. Eng.*, vol. 43, no. 9, pp. 822– 829, Sep. (2016).
22. Islam, N., Ali, M. A.: "A Study on Service Quality of the Bangladesh Police," *Glob. J. Bus. Excell.*, vol. 1, no. 1, pp. 1–8, (2008).
23. Jensen, S. U.: "Pedestrian and Bicyclist Level of Service on Roadway Segments,"
24. *Transp. Res. Rec. J. Transp. Res. Board*, vol. 2031, no. 1, pp. 43–51, Jan. (2007).
25. Khan, S.I., Huda, N., Zaman, M.R., Nurullah, A.B.M., Rahman, M.Z.: "Traffic Congestion in Dhaka city: Suffering for City Dwellers and Challenges for Sustainable Development," *Eur. J. Soc. Sci.*, vol. 57, no. 1, pp. 116–127, (2018).
26. Kou, W., Chen, X., Yu, L., Gong, H.: "Multiobjective optimization model of intersection signal timing considering emissions based on field data: A case study of Beijing," *J. Air Waste Manag. Assoc.*, vol. 68, no. 8, pp. 836–848, (2018).
27. Kafy, A., Ferdous, L., Poly, S.A., Arafat, M., Monira, S., Rahman, S.: "Estimating Traffic Volume to Identify the Level of Service in Major Intersections of Rajshahi ," *Trends Civ. Eng. its Archit.*, vol. 2, no. 4, pp. 292–309, (2018).

28. Kamarajugadda, A., Park, B. B.: “Stochastic Traffic Signal Timing Optimization,” *Distribution*, no. August, p. 129, (2003).

29. Labib, S. M., Mohiuddin, H., Al Hasib, I. M., Sabuj, S. H., Hira, S.: “Integrating Data Mining and Microsimulation Modelling to Reduce Traffic Congestion: A Case Study of Signalized Intersections in Dhaka, Bangladesh,” *Urban Sci.*, vol. 3, no. 2, p. 41, (2019).

30. Li, J., Yue, Z. Q., Wong, S. C.: “Performance Evaluation of Signalized Urban Intersections under Mixed Traffic Conditions by Gray System Theory,” *J. Transp. Eng.*, vol. 130, no. 1, pp. 113–121, (2004).

31. Mindur, L., Sierpiński,G.: “Webster ’ s Delay Formula Revision by M + Δ / G + Δ / 1 Queuing Model Usage,” *Logist. Transp.*, vol. 35, no. 3, pp. 5–12 (2017).

32. Mannion, P., Duggan, Howley, E.: “An Experimental Review of Reinforcement Learning Algorithms for Adaptive Traffic Signal Control,” in *Autonomic Road Transport Support Systems*, T. McCluskey, A. Kotsialos, J. Müller, F. Klügl, O. Rana, and R. Schumann, Eds. Cham, Switzerland: Birkhäuser Basel, pp. 47–66, (2016).

33. Miller, A. J.: “Settings for Fixed-Cycle Traffic Signals,” *J. Oper. Res. Soc.*, vol. 14, no. 4, pp. 373–386, (1963).

34. Deficiencies of traffic system in Dhaka city

35. https://www.researchgate.net/publication/270890207_DEFICIENCIES_OF_TRAFFIC_SIGNAL_SYSTEM_IN_DHAKA_CITY

36. Deficiency of traffic signal control system in Dhaka city.

37. http://lib.buet.ac.bd:8080/xmlui/handle/123456789/462

38. Bangladesh Perspective: Vehicle Speed Proposition System Using Localized Wireless Identification

39. https://www.researchgate.net/publication/310613367_Bangladesh_Perspective_Vehicle_Speed_Proposition_System_Using_Localized_Wireless_Identification

40. The smartest ways to deal with traffic congestion in Dhaka.

41. TRAFFIC SIGNAL DESIGN AND LOS DETERMINATION OF A T-INTERSECTION AN EMPIRICAL EXAMPLE TECHNICAL MORE, DHAKA, BANGLADESH (researchgate.net)

Appendix

Maximum PCU

Morning Session

8:00-8:15

Lane	PCU in 15Min	PCU in 1 Hr	Total			
New market Rd in	605	2418	3858		Phase-1	40
New market Rd out	964	3858				
Elephant Rd In	786	3145	5286	12594	Phase-2	55
Elephant Rd out	1322	5286				
Mirpur Rd in	747	2988	3450		Phase-3	36
Mirpur Rd out	863	3450				
						130

Afternoon Session

1:00-1:15

Lane	PCU in 15Min	PCU in 1 Hr				
New market Rd in	623	2493	4220		Phase-1	42
New market Rd out	1055	4220				
Elephant Rd In	1134	4537	5398	13064	Phase-2	54
Elephant Rd In	1350	5398				
Mirpur Rd in	862	3446	3446		Phase-3	34
Mirpur Rd out	842	3369				
						130

Evening Session

5:00-5:15

Lane	PCU in 15Min	PCU in 1 Hr				
New market Rd in	617	2469	4499		Phase-1	45
New market Rd out	1125	4499				
Elephant Rd In	834	3338	4888	12924	Phase-2	49
Elephant Rd out	1222	4888				
Mirpur Rd in	876	3505	3536		Phase-3	36
Mirpur Rd out	884	3536				
						130