Capacity Analysis of Toll Plaza at Golra morr and Possible Solutions to congestions

By

Muhammad Affan Munir

Bilal Arshad

Taimur Karim

Shakaib Arsalan

Syed Muhammad Imran Ali

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Certified that the contents and form of thesis entitled “Capacity Analysis of Toll Plaza at Golra Morr” submitted by this group have been found satisfactory for the requirement of the degree.

Supervisor: _____

Lecturer (Malik Saqib)

DEDICATED

TO

OUR FAMILY

OUR FACULTY

OUR SUPERVISOR

AND COLLEAGUES

ACKNOWLEDGEMENTS

We are thankful to All Mighty Allah, who gave us strength and patience to complete our research. We would like to pay debt of gratitude to Malik Saqib, being advisor for this study, whose countless inspiration and guidance made it possible to complete my research work and gave us guidance and feedback throughout the thesis process.

We would like to pay gratitude to the academic members of the NUST Institute of Civil Engineering who provided a lot of knowledge during academic in the under-graduate program. In the end, we pay our earnest gratitude with a sincere sense of respect to our parents for their encouragement, sincere prayers and best wishes for successful completion of our project work.

GROUP MEMBERS

Muhammad Affan Munir	BE-CE-2009-65
Bilal Arshad	BE-CE-2009-23
Shakaib Arsalan	BE-CE-2009-121
Taimur Karim	BE-CE-2009-134
Syed Muhammad Imran Ali	BE-CE-2008-141

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Executive Summary

The rapid growth in the population coupled with urbanization in search of better livelihood has aggravated the transportation problems in cities of Pakistan. Islamabad is no exception but here situation has further worsened because of its location being next to very populated city of Rawalpindi and being capital of Pakistan as every Govt. department lies here.

Islamabad has experienced a phenomenal increase in traffic congestion, mismanagement in past few decades. Poor economic growth has hindered the government from tackling this growing problem despite continued efforts that have proved futile. The congestion is more and more intolerable during the peak hours. Authorities are feeling an uphill task to manage ill-discipline, impatient and non-responsive drivers with meager traffic controls and nominal funding.

This project is being undertaken to study the problems of traffic congestion at toll plaza at Islamabad entrance, access the gravity in real terms and suggest remedial measures to manage traffic.

Chapter 1

1.1 INTRODUCTION

In the development and economic growth of a country highways and freeways are indispensable. They have a direct impact on the economy and urbanization of the area. The more sophisticated the highway and freeway system, the more helpful it is for a country and its development.

Islamabad – the capital of Pakistan – is known for its well-designed and properly managed transit system but even then there are areas where there is room for improvement. Kashmir Highway – the most important highway of the capital – connects the city to the frequently used and newly built Motorway and adjoining areas. It also connects many areas of the capital to the Grand Trunk road; the significance of which cannot be ignored when it comes to highways. Since there is a great influx of traffic from the Motorway and Grand Trunk road that continues to increase on a daily basis, the Kashmir Highway is undergoing a scheme of expansion to cater to the increasing incoming traffic.

An important aspect of a transportation network is the Toll Plazas. They require special analysis and consideration to understand how they operate and the interaction of traffic on these points with other roadway components. On one hand, these facilities are one of the most effective means of collecting Toll Tax for roadways, bridges and tunnels and on the other, they adversely affect the throughput and capacity they serve. This is particularly evident during rush hours when each vehicle must stop in order to be processed. The throughput per lane drops from freeway rates of 2000 vph to Toll Plaza rates in the range of 350 to 500 vehicles per hour.

Based on these numbers, it is not surprising that highway toll plazas when exceed processing capacity experience lengthy vehicular queues and long delays. Efficient sizing of toll plazas become critical in minimizing space requirements and capital expense of collecting user fees.

The Golra-Morr Toll Plaza currently serves as the entrance to Islamabad. The traffic on this important toll plaza is increasing daily and vehicles experience great delays. People have to wait in long queues. The current toll plaza cannot accommodate the amount of traffic effectively. The condition of the toll plaza is not up-to-the-standard as well.

With the development of adjoining sectors of Islamabad G-13, 14 and 15 as well as the increasing population of the country and more travelling; this intersection is expected to witness even more traffic.

The aim of this project is to find out the current vehicular capacity of Golra Morr toll plaza, find out the possible problems causing delays resulting in large queues as well as suggestion of a possible solution and design which is compatible with Islamabad as well developmentally sound, sophisticated and scenically appropriate

1.2 REASONS FOR THE SELECTION OF THIS PARTICULAR PROJECT

Golra-Morr toll plaza is an important intersection that connects the twin cities to M2 and GT road.The toll plaza is situated on one of the most important highways of the Capital i-e Kashmir highway.High amounts of delay and large queues are experienced by the vehicles in peak hours.The traffic at the interchange is expected to rise in the coming years and level of service is expected to decrease.The current condition of the toll plaza is not up to the mark and standards of the Islamabad.

The construction of the new Islamabad airport will increase the traffic on this particular interchange and toll plaza.With the development of the adjoining sectors G-13, G-14 the traffic on the toll plaza will increase causing more congestion and delays.The delays and large queues at the toll plaza do not make a good impression on the people visiting the Capital.

The delays and congestion suggest that the current design of the toll plaza is not good enough for handling of large of traffic that is supposed to increase in the upcoming years.The field work and the surveys conducted will help the group members in attaining a considerable amount of field experience.

1.3 OBJECTIVES

Main objective is to find the extent of congestion at toll plaza at Islamabad entrance and do the capacity analysis based upon volume analysis and queuing theory and find the delays the people are experiencing and to suggest possible solutions. The solutions are expected to encompass:

- Find the level of service of the current toll plaza by conducting surveys.
- Finding of the congestion and delays using systematic approach and conducting different surveys.
- Draw a model of the current situation on software (Synchro).
- Test the model on the expected increase in traffic for the upcoming ten years.
- Plans for smooth traffic flow with minimum delays.
- Suggesting possible economic solutions to congestion.
- Suggesting low cost management techniques.

1.4 AN OVERVIEW OF THE GOLRA-MORR ROUNDABOUT

Golra-Morr about is an important four legged intersection. It is situated on the Kashmir Highway and connects the twin cities via Golra Road. Also connects the developing

area of G-13/1 to the Kashmir Highway. Following Figure 1 is an image showing the Golra-Morr roundabout and adjoining areas. The Capital Development Authority toll plaza has four processing lanes. There is also a security check post just before the toll plaza. The newly constructed Golra road has 4 lanes and the Kashmir highway has 6 lanes.

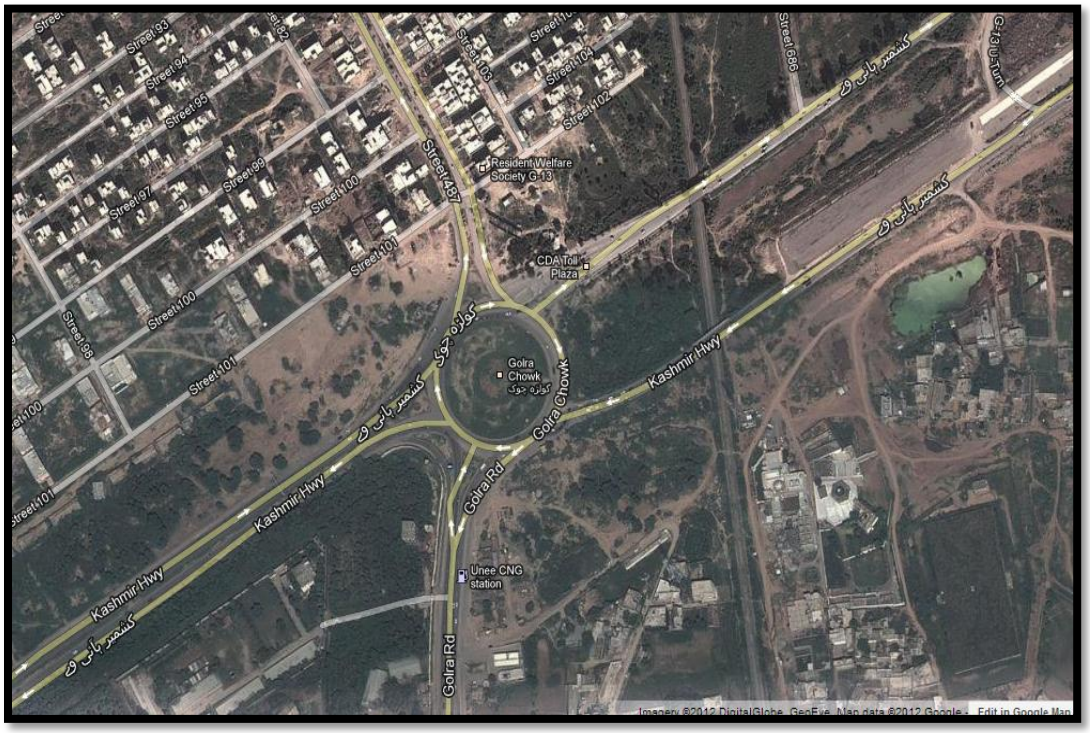


Figure1: Overview of project site

Chapter 2

LITERATURE REVIEW

2.1 INTRODUCTION

The rapid growth in the population coupled with urbanization in search of better livelihood has aggravated the transportation problems in cities of Pakistan. Islamabad is no exception but here situation has further worsened because of its location being next to very populated city of Rawalpindi and being capital of Pakistan as every Govt. department lies here.

Islamabad has experienced a phenomenal increase in traffic congestion, mismanagement and unwanted encroachments in past few decades. Poor economic growth has hindered the government from tackling this growing problem despite continued efforts that have proved futile. The congestion is more and more intolerable during the peak hours. Authorities are feeling an uphill task to manage ill-discipline, impatient and non-responsive drivers with meager traffic controls and nominal funding.

This project is being undertaken to study the problems of traffic congestion at toll plaza at Islamabad entrance, access the gravity in real terms and suggest remedial measures to manage traffic

2.1.1 Toll Plaza

Toll Plazas are built to pay toll. They cause delays in traffic but they are necessary for purpose. So finding toll plaza capacity is very important so that it may not cause congestions and provide smooth flow with minimum delays.

2.1.1.1 Toll plaza capacity

Toll plaza capacity can be found with a proper methodology. Different surveys and analyses carried

These analyses involve some of the following:

- Volume Count surveying and Analysis
- Queuing Survey and Analysis
- Processing time Survey and Analysis
- Capacity Analysis

2.1.2 Surveying

To carry out analysis of any type, surveying is the basic thing to do. Different surveys are being carried out. They can be done manually or with the help of machines. We have to be precise in estimating traffic because surveying affect the analysis a lot.

2.2 CAPACITY ANALYSIS

Capacity analysis tells us about if our toll plaza is sufficient to accommodate our traffic or not. Because if toll plaza capacity is not enough to support out traffic, it will cause congestions in traffic which will cause troubles and delays.

2.2.1Processing Rates Determination

The analysis uses vehicle processing rates to determine lane capacities. The processing rate for a vehicle through the toll plaza is defined as the time it takes a vehicle to enter the plaza, collect a ticket or pay the toll, and exits the toll plaza lane. The processing rate is used to determine vehicle through-put at the various toll plaza lanes and is also used in the queuing operations analysis.

In order to proceed with analysis of toll barrier capacity, the average ticket dispensing/toll collection processing rate of various vehicle classifications is required. This processing rate information is used to determine the future operating conditions.

2.2.2 Lane capacity

Lane capacity is the maximum lane throughput and is measured in the number of vehicles that can pass through a toll lane in a given period of time. This lane capacity is measured by finding the number of lanes at toll plaza and their maximum rate to accommodate maximum vehicles at certain time. After measuring lane capacity, it is compared with the traffic volumes and find out the number of lanes required to process the vehicle based on lane capacity. These lanes are the minimum lanes required at the toll plaza.

2.2.3 Average Delays

Delay time is the total time that a particular vehicle wastes at toll plaza while paying the toll and leaving the toll plaza. It gives us the idea about the congestion that to how much extent the congestion type is. If the delay time for each vehicle exceeds the time assigned during constructing the toll plaza, congestion of traffic appears. So, to find congestion we will find out the average delay time for different type of vehicles (Buses, cars, wagons etc.). Delays are measured by counting the time of every vehicle at toll plaza and then finding out the average delay time for each type of vehicle.

2.2.4 Queue analysis

A queue analysis is required to determine the relative efficiency in which a proposed toll plaza will process vehicles. The efficiency is based on a number of factors including vehicle arrival factors and plaza geometry. After the lane capacity analysis is calculated for the plaza, a queue analysis is required to model the anticipated queues at the plaza for design traffic volumes. Although a plaza has the capacity to process the required number of vehicles projected during the peak hour, the associated traffic and plaza characteristics may create unacceptable queues. To calculate the size of the plaza necessary to maintain acceptable queues at the plaza, the analysis is completed for varying numbers of lanes. We will find out the lengths of the queues formed due to congestion with the help of delay times for each type of vehicle.

2.2.5 Traffic volume analysis

Volume analysis is basically measuring the total volume of traffic at toll plaza. This analysis is divided into two categories and those are following

1. Peak hours volume analysis
2. Regular hours volume analysis

Chapter 3

METHODOLOGY

3.1SURVEYS

To determine the capacity and to identify the problems causing congestion we carried several surveys during the course of our study. With the consent of our supervisor we carried out the following four surveys.

- Volume count (count the traffic during the peak hours of weekdays and at weekends).
- Turning moment count survey.
- Queue length survey
- Processing time survey.

3.1.1 Volume Count

To find out the Peak hour and Average daily traffic that passes through the toll plaza the group carried out a volume count survey. The survey was conducted on three locations simultaneously four hours with the time interval of 15 minutes.

The survey was conducted during the peak hours of the following days.

- Monday: 6am to 10am, 4 pm to 8pm.
- Sunday: 4pm to 8pm

These timings were selected after observing the traffic patterns prior to the survey. Traffic count is done for a week day and on Sunday. The time 6am-10am was selected because people want to reach their work places, offices, schools, colleges etc. The time 4pm-8pm was selected because people are heading back home and the people using M1, M2 are reaching the Federal area. The time 4pm-8pm was selected because there is a massive amount of traffic coming from the Motorway for those people who coming back to Islamabad at the end of the weekend. The traffic during the morning hours on Sunday is negligible so the count was not conducted.

To carry out the survey we had to options either to use the Jamal counter or use manual method of counting cars. The manual method was used in conducting these counts. We classified the vehicles in the following categories.

1. Motor-cycle
2. Cars
3. Jeep/pick-up
4. Vans
5. Mini-bus
6. Bus
7. Truck
8. Trailer/multi-axle

3.1.2 Survey Count Locations

Following are the locations at which the survey was conducted.

1. Location 1: Approximately 500 meters from the toll plaza, count of the vehicles exiting the toll plaza.
2. Location 2: Approximately 1000 meters before the toll plaza, count of the vehicles entering the toll plaza vicinity.
3. Location 3: Count of the vehicles leaving Islamabad.

Survey locations have also been shown in figure 2.

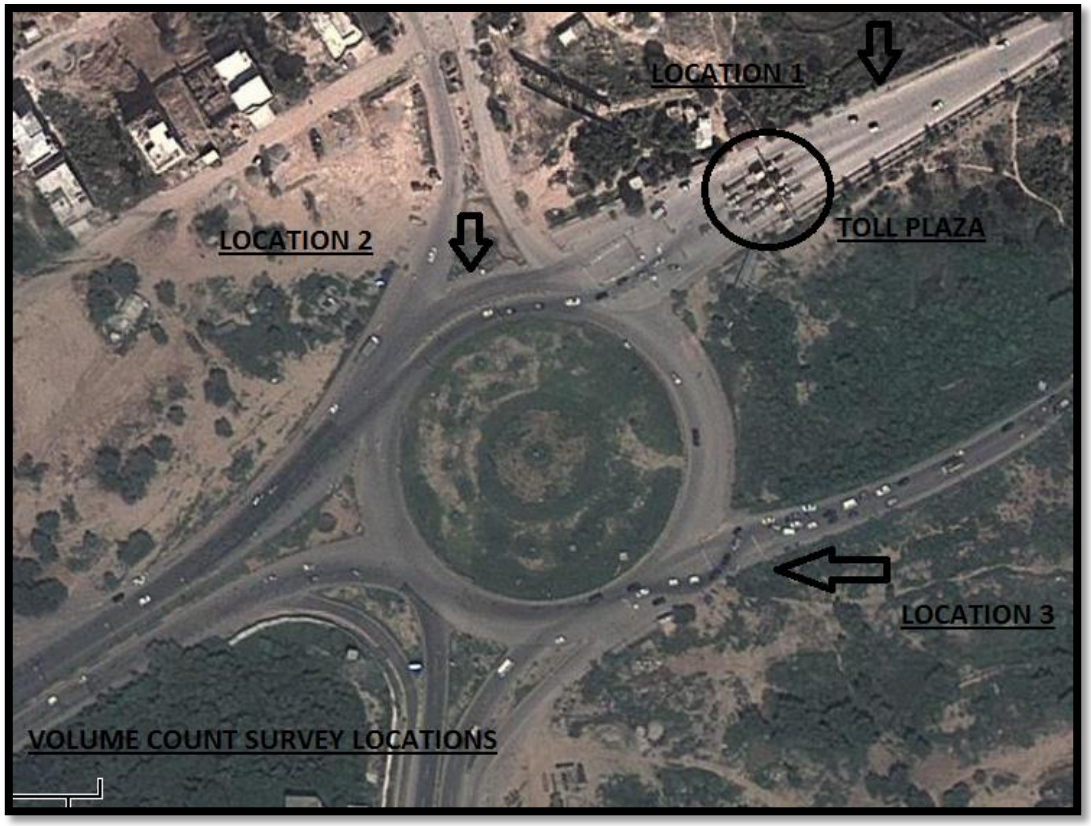


Figure 2: A Google Map image showing the locations

3.1.3 Survey Counts and Peak Hour Volumes

3.1.3.1 Location 1: count of vehicles exiting the toll plaza

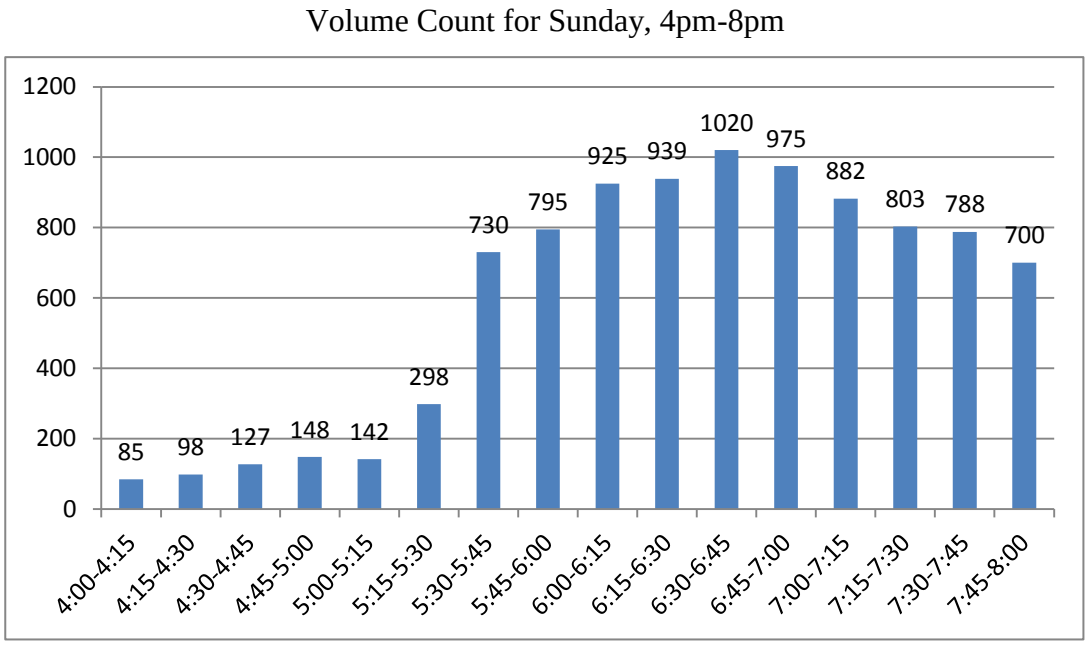


Chart 1: showing volume count with fifteen minutes interval.

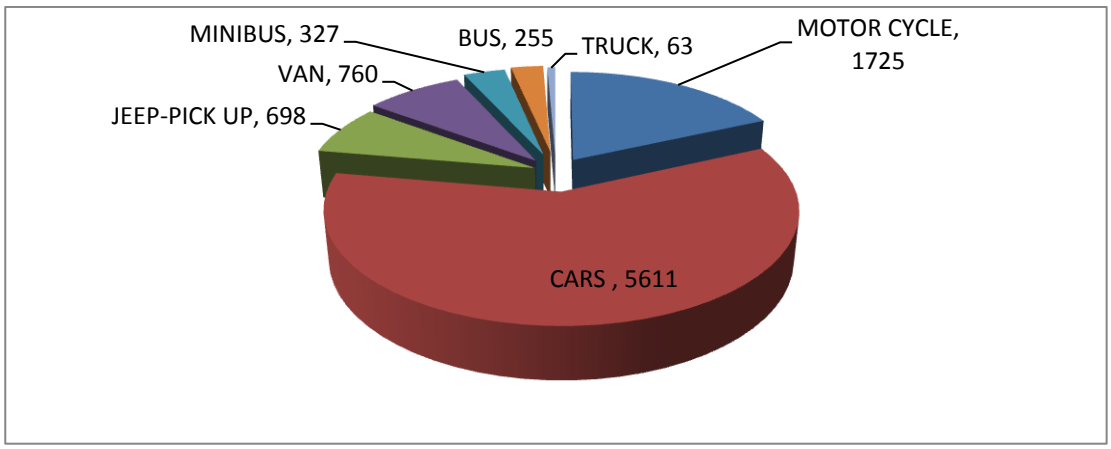


Figure 3: Pie chart showing modal distribution of vehicles during the volume count from 4pm-8pm

Vehicle Count for Monday (16/12/2012) From 6am-10am:

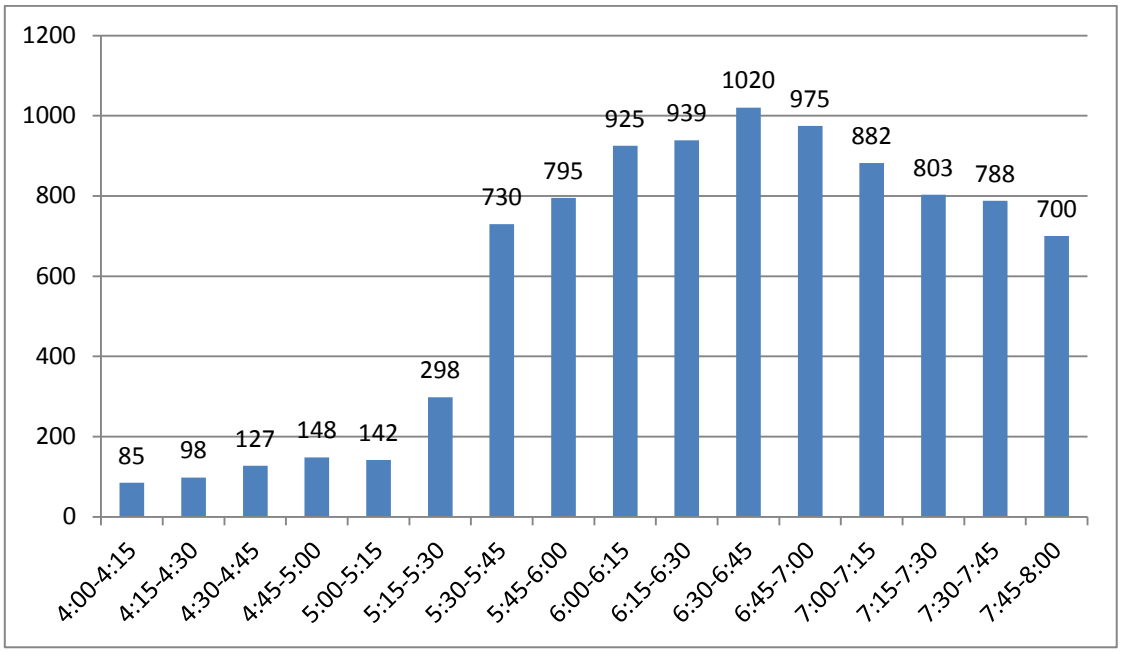


Chart 2: showing volume count with fifteen minutes interval.

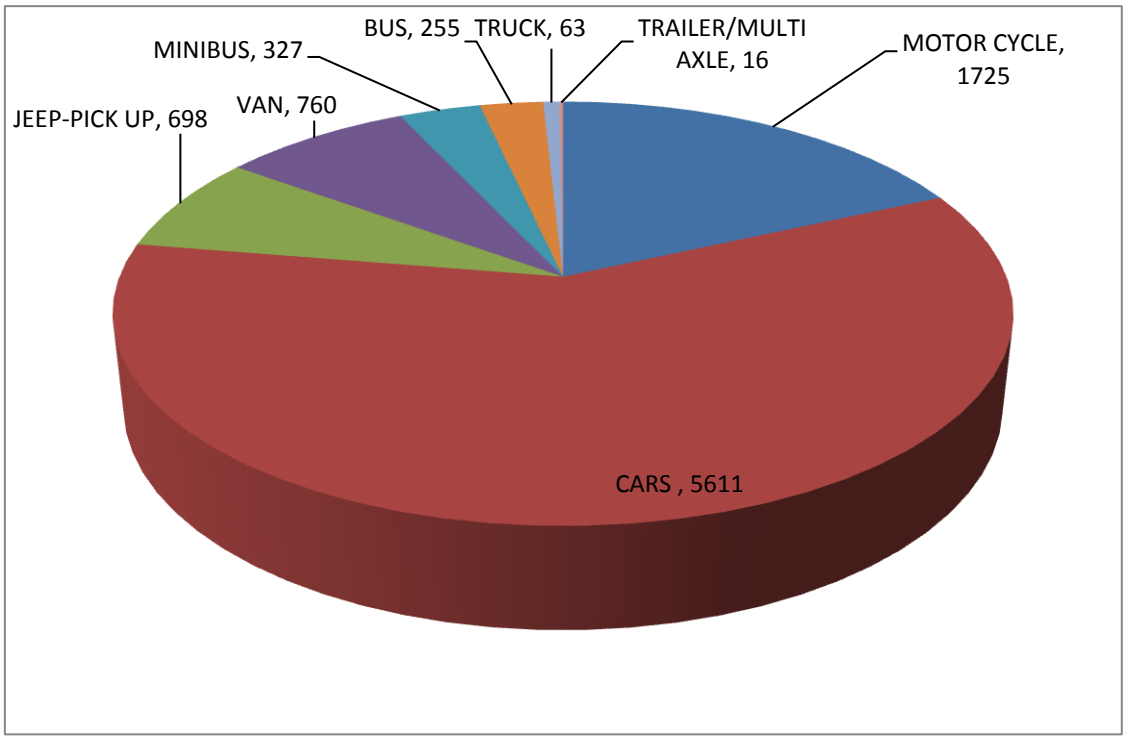


Figure 4: Pie chart showing modal distribution of vehicles during the volume count from 6am-10am.

Vehicle Count for Monday (17/12/2012) From 4pm-8pm:

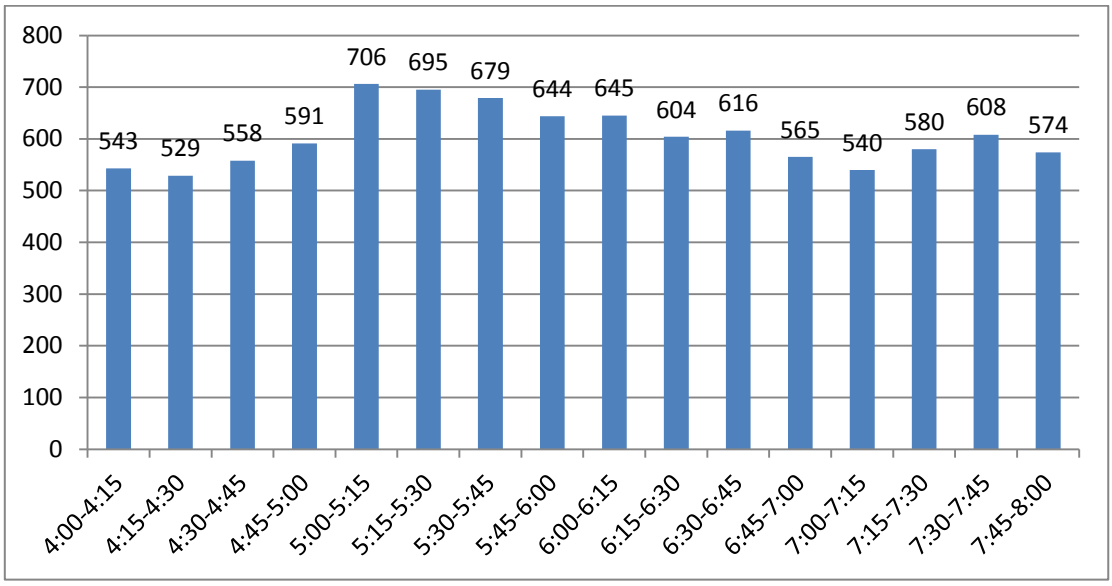


Chart 3: showing volume count with 15 minutes interval.

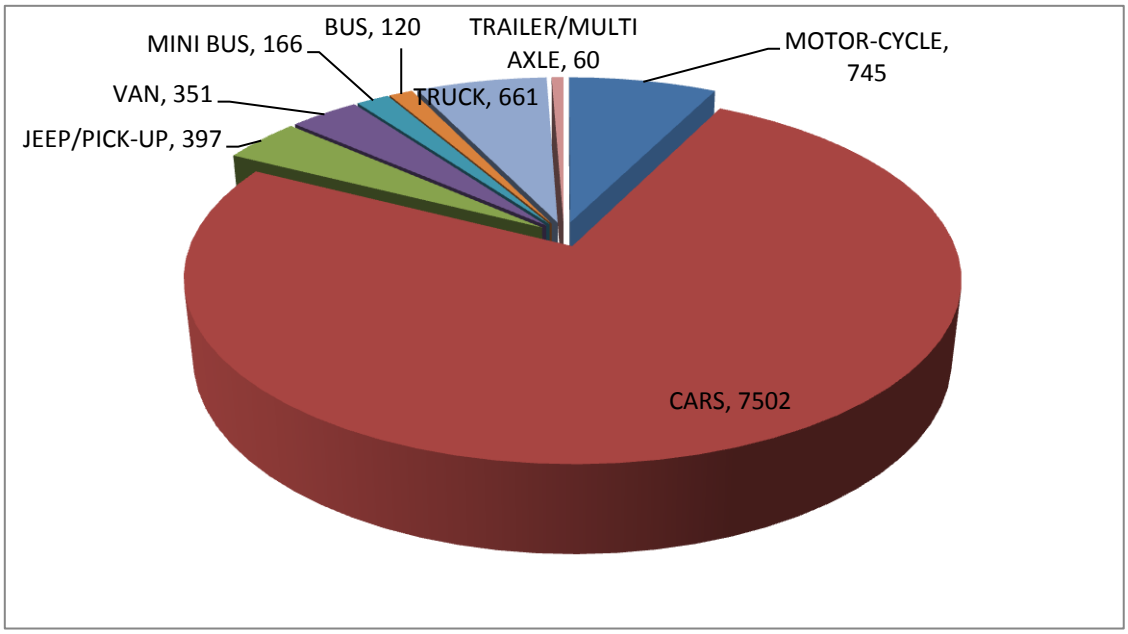


Figure 5: Pie chart showing modal distribution of vehicles during the volume count from4pm-8pm.

3.1.3.2 Location 2: Count of Vehicles Entering the Toll Plaza:

Volume count for vehicles on Sunday 4pm-8pm:

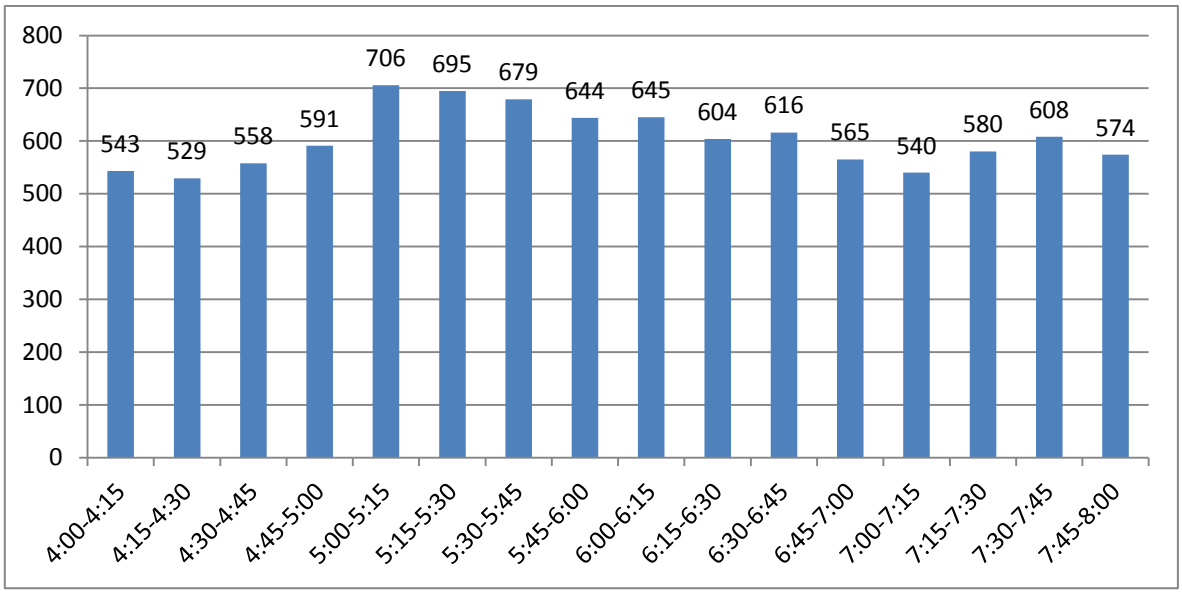


Chart 4: showing volume count with 15 minutes interval.

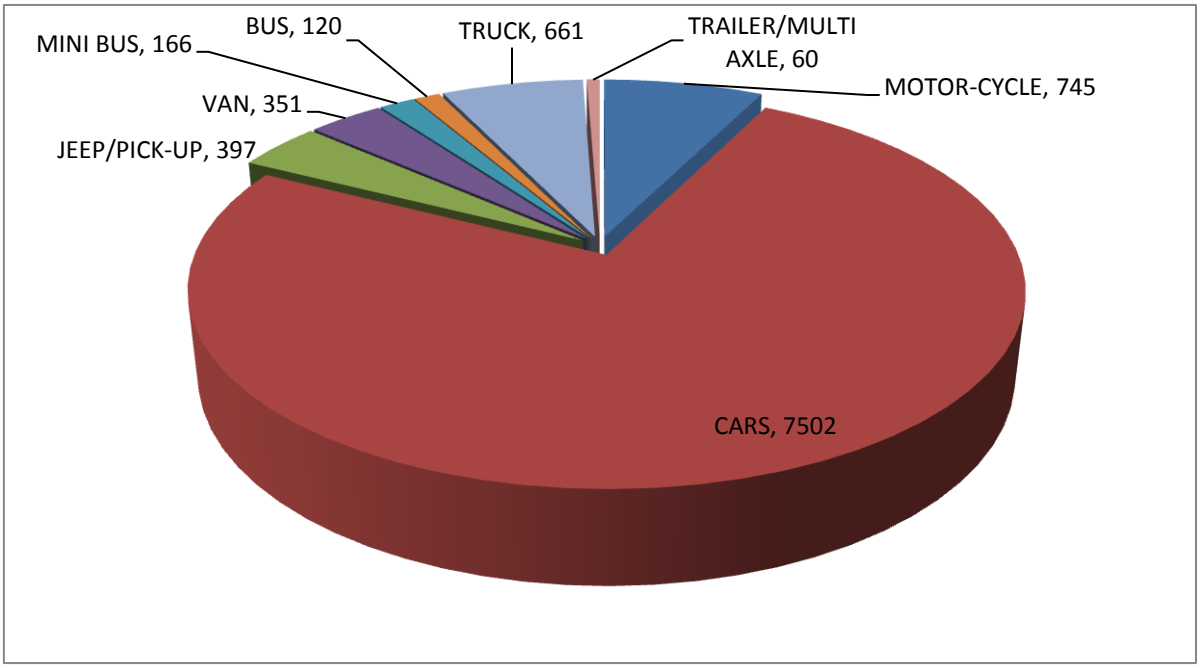


Figure 6: Pie chart showing modal distribution of vehicles during the volume count from 4pm-8pm.

Volume count for Monday (17/12/2012) 6am-10am.

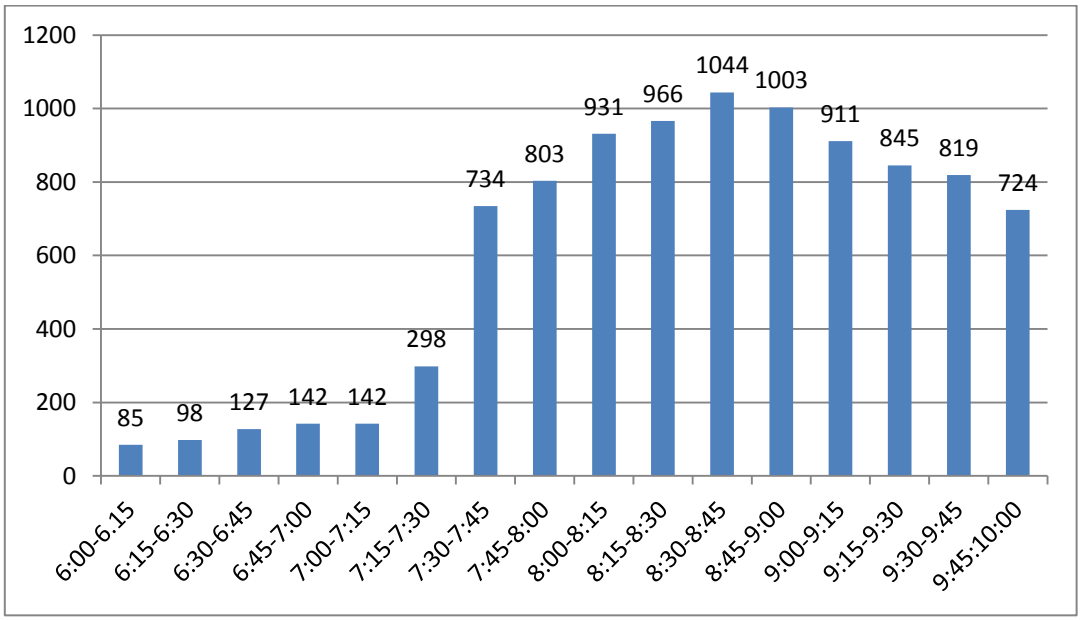


Chart 5: showing volume count with 15 minutes interval.

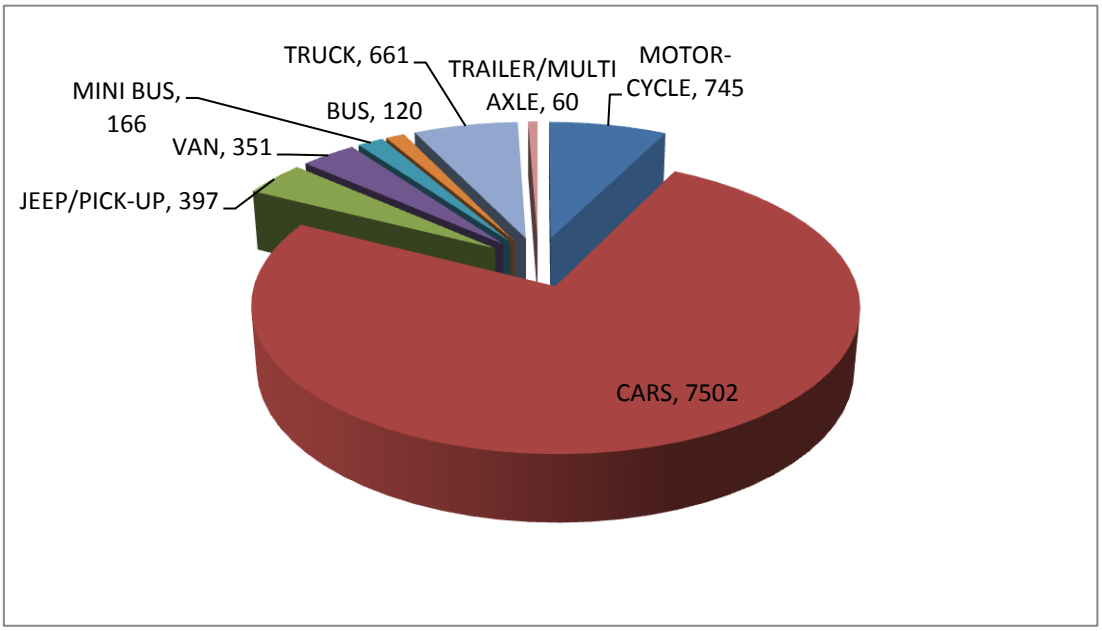


Figure 7: Pie chart showing modal distribution of vehicles during the volume count from 6-10AM

Volume count for Monday (17/12/2012) 4pm-8pm:

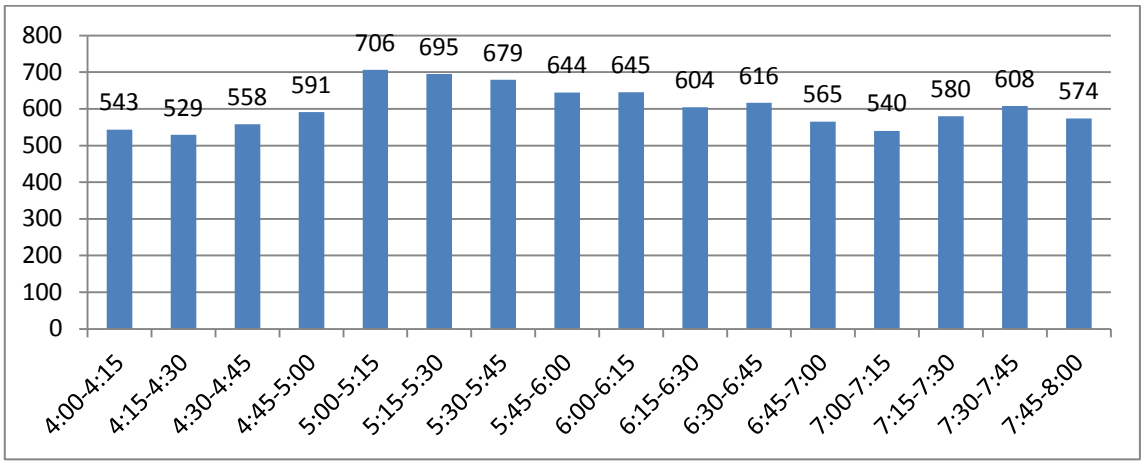


Chart 6: showing volume count with 15 minutes interval.

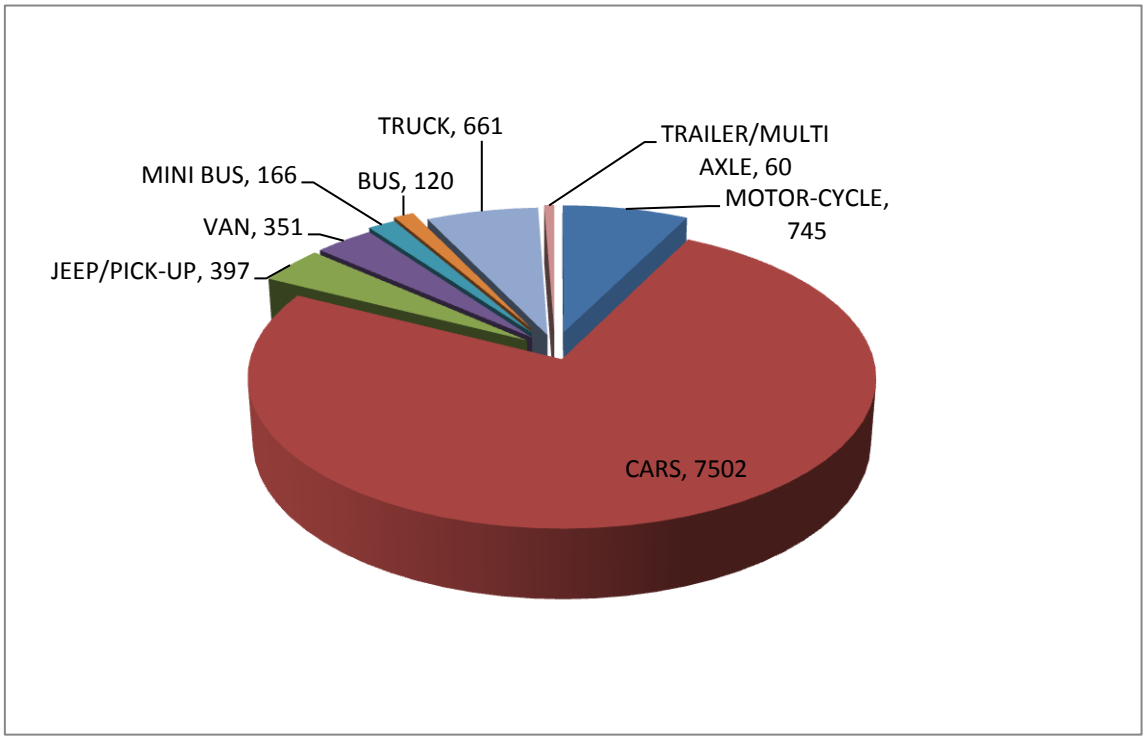


Figure8: Pie chart showing modal distribution of vehicles during the volume count from4pm-8pm.

3.1.3.3 Location 3: Count of Vehicles Exiting Islamabad:

Volume count for vehicles on Sunday 4pm-8pm:

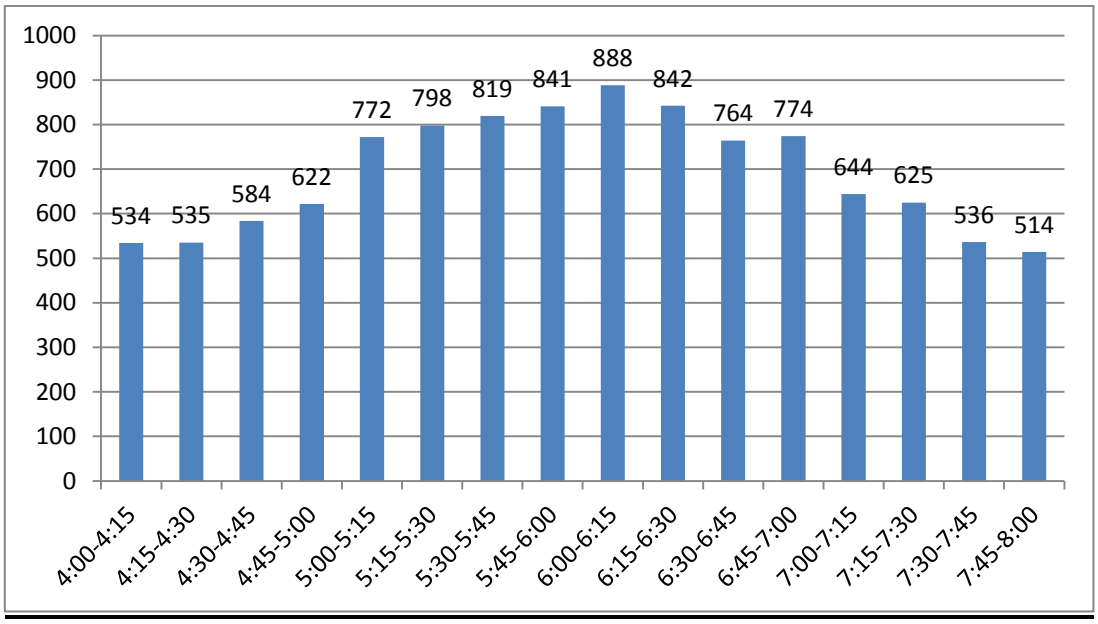


Chart 7: showing volume count with 15 minutes interval.

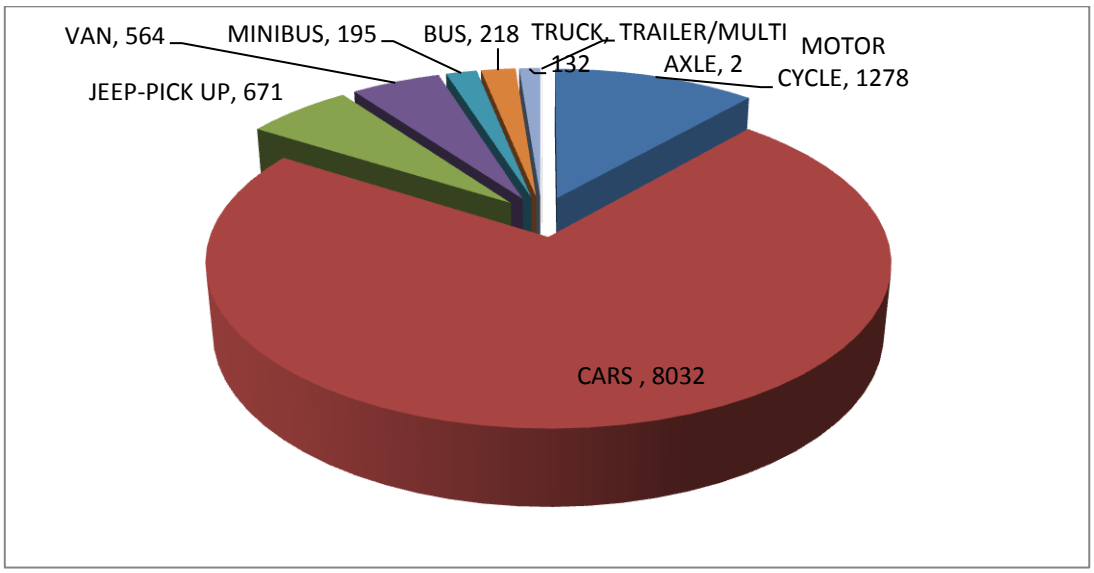


Figure 9: Pie chart showing modal distribution of vehicles during the volume count from4pm-8pm.

Volume count for Monday (17/12/2012) 6am-10am.

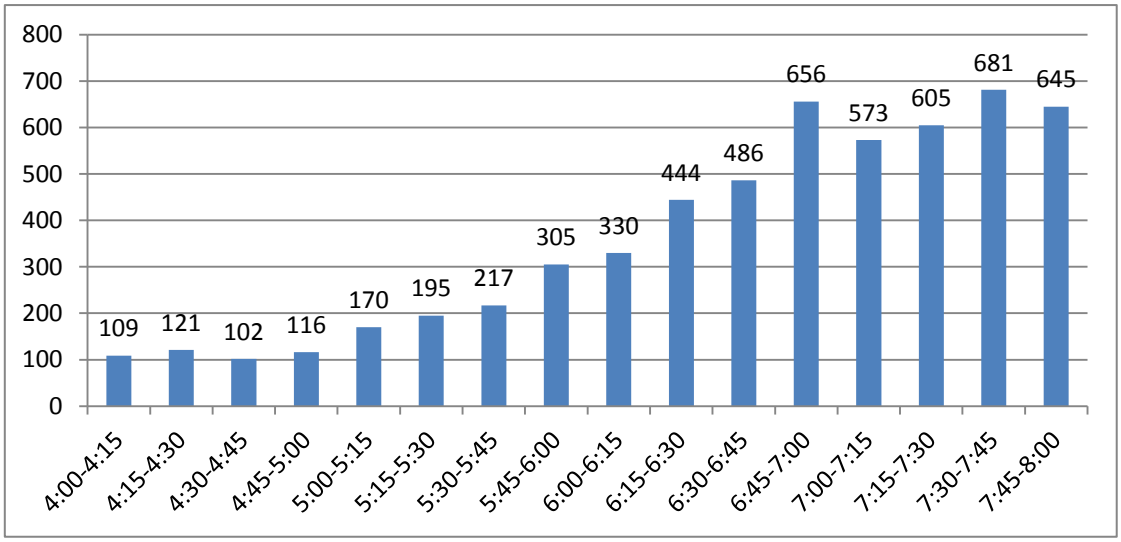


Chart 8: showing volume count with 15 minutes interval.

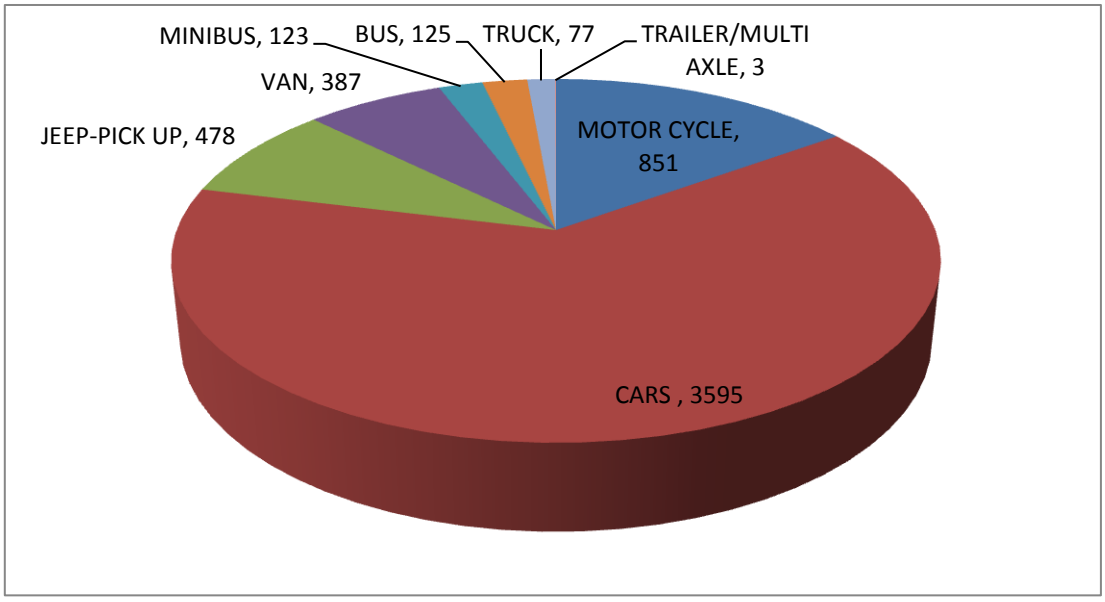


Figure 10: Pie chart showing modal distribution of vehicles during the volume count from 6am-10am.

Volume count for Monday (17/12/2012) 4pm-8pm:

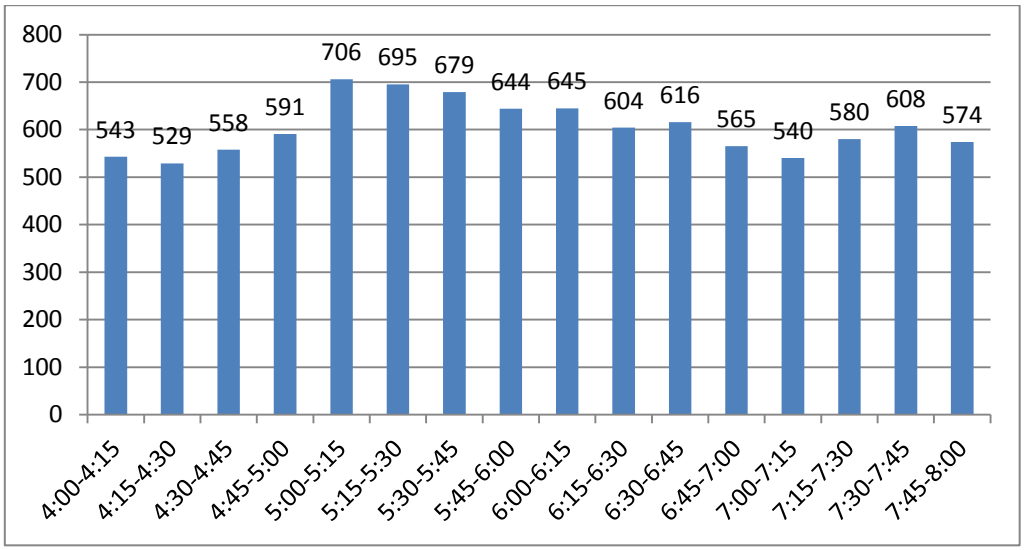


Chart 9: showing volume count with 15 minutes interval.

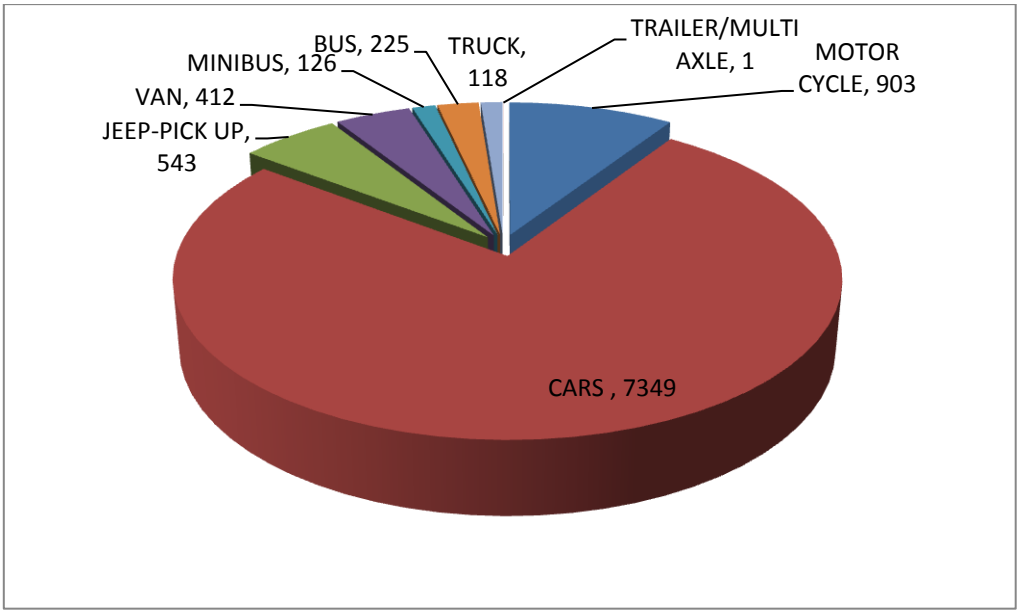


Figure11: Pie chart showing modal distribution of vehicles during the volume count from4pm-8pm.

3.2. AVERAGE DAILY TRAFFIC

3.2.1 ADT Calculations

Average daily traffic, abbreviated ADT, is a measure used primarily in transportation planning and transportation engineering. It is the total volume of vehicle traffic of a highway or road for a total of 24 hours. ADT is a useful and simple measurement of how busy the road is. Average daily traffic is also used to find out the peak hours and plot a graph between the traffic and time. Thus it is showing the total amount of traffic on a specific for 24 hours.

The group calculated average daily traffic for Monday 17/12/2012. The calculation were carried out on excel sheet which are shown on the next page. The peak hours calculated is as follows

- Peak hour during morning hours= 0915-1015
- Peak hour during evening hours= 1745-1845

The average daily traffic was calculated as:

- Peak hours traffic count
- Take average traffic hour of peak hours and assume it a peak hour
- Take 60% traffic of assumed peak hour for 10AM-4PM
- Again take average hour of calculated traffic
- Take 30% traffic of above calculated hour for 8PM-10PM
- Repeat the process and take 15% traffic of new peak hour for remaining day

ADT calculated is:

- For location 1 i-e vehicles entering Islamabad= 30,771 vehicles
- For location 2 i-e vehicles exiting Islamabad= 37,114 vehicles
- Total = 67,885 vehicles

3.2.2Average Daily Traffic Calculation

Table 3.1: showing ADT calculations

Location	Kashmir Highway							
Time	Dir. 1	Dir. 2	Sum	Hourly Vol.	PH Starts	Max Val. (15 min.)	PHV	PHF
600	50	50	100	0	0	0	0	0.00
615	109	85	194	0	0	0	0	0.00
630	121	98	219	312	0	0	0	0.00
645	102	127	229	805	0	0	0	0.00
700	116	148	264	1752	0	0	0	0.00
715	170	142	312	2852	0	0	0	0.00
730	195	298	493	3795	0	0	0	0.00
745	217	730	947	4685	0	0	0	0.00
800	305	795	1100	5244	0	0	0	0.00
815	330	925	1255	5353	0	0	0	0.00
830	444	939	1383	5553	0	0	0	0.00
845	486	1020	1506	5578	0	0	0	0.00
900	234	975	1209	5541	0	0	0	0.00
915	573	882	1455	5677	915	1469	5876	0.97
930	605	803	1408	5243	0	0	0	0.00
945	681	788	1469	4856	0	0	0	0.00
1000	645	700	1345	4408	0	0	0	0.00
1015	409	612	1021	4084	0	0	0	0.00
1030	409	612	1021	4084	0	0	0	0.00
1045	409	612	1021	4084	0	0	0	0.00
1100	409	612	1021	4084	0	0	0	0.00
1115	409	612	1021	4084	0	0	0	0.00
1130	409	612	1021	4084	0	0	0	0.00
1145	409	612	1021	4084	0	0	0	0.00
1200	409	612	1021	4084	0	0	0	0.00
1215	409	612	1021	4084	0	0	0	0.00
1230	409	612	1021	4084	0	0	0	0.00
1245	409	612	1021	4084	0	0	0	0.00
1300	409	612	1021	4084	0	0	0	0.00
1315	409	612	1021	4084	0	0	0	0.00
1330	409	612	1021	4084	0	0	0	0.00
1345	409	612	1021	4084	0	0	0	0.00
1400	409	612	1021	4084	0	0	0	0.00
1415	409	612	1021	4084	0	0	0	0.00
1430	409	612	1021	4084	0	0	0	0.00
1445	409	612	1021	4084	0	0	0	0.00
1500	409	612	1021	4084	0	0	0	0.00
1515	409	612	1021	4084	0	0	0	0.00
1530	409	612	1021	4009	0	0	0	0.00
1545	409	612	1021	4024	0	0	0	0.00
1600	409	612	1021	4174	0	0	0	0.00
1615	534	412	946	4391	0	0	0	0.00
1630	535	501	1036	4796	0	0	0	0.00
1645	584	587	1171	5204	0	0	0	0.00
1700	622	616	1238	5534	0	0	0	0.00
1715	772	579	1351	5805	0	0	0	0.00
1730	798	646	1444	6009	0	0	0	0.00
1745	819	682	1501	6079	1745	1555	6220	0.98
1800	841	668	1509	5937	0	0	0	0.00
1815	888	667	1555	5819	0	0	0	0.00
1830	842	672	1514	4264	0	0	0	0.00
1845	764	595	1359	2750	0	0	0	0.00
1900	774	617	1391	1391	0	0	0	0.00

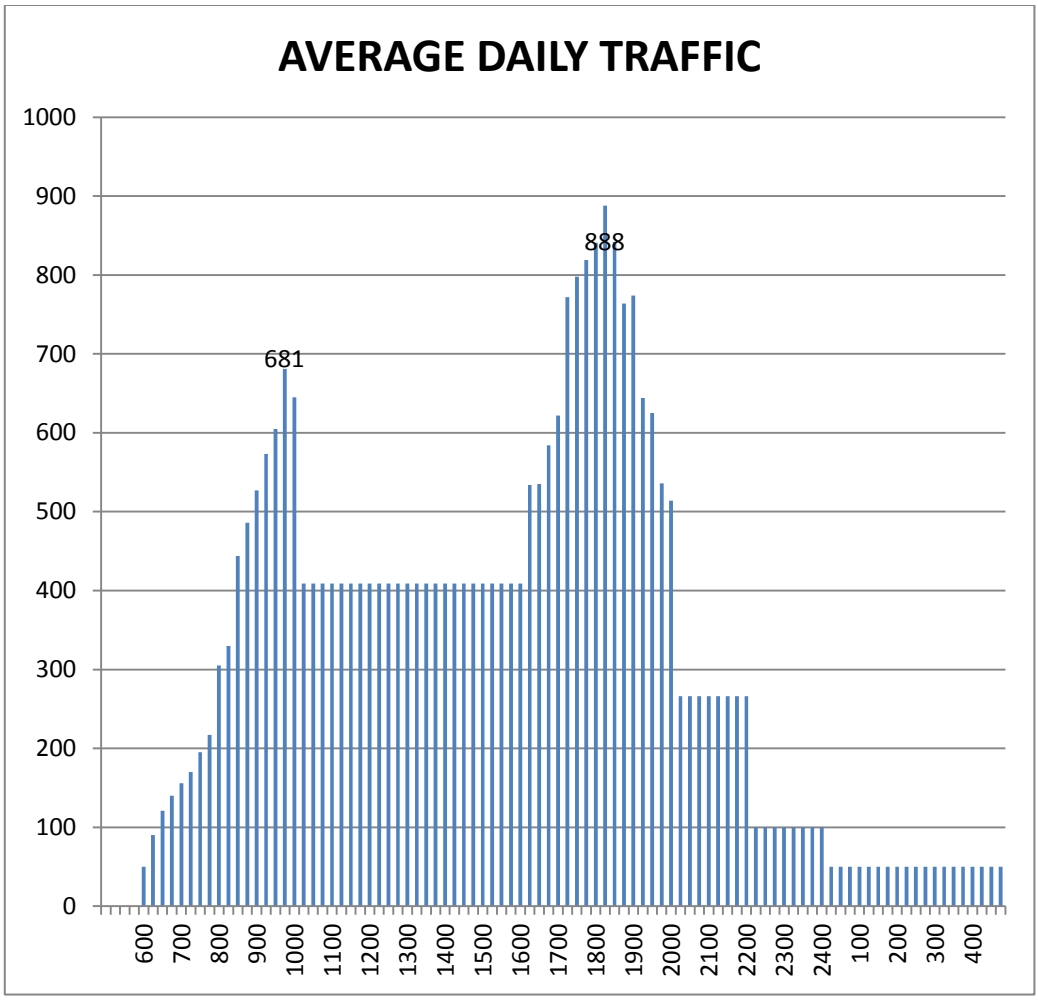


Figure 12: Showing ADT with Peak Values

3.3 QUEUING SURVEY

3.3.1 Surveying and Measurements

The total time taken by a vehicle to enter a queue process through the toll plaza and attain the free flow speed was noted using stop watches. A sample of 500 vehicles was taken and average time spent in a queue was calculated which is given in Table 3.2.

- Average time spent in queue : 6 mins
- Maximum time spent by a vehicle in a queue: 10 mins

These surveys were conducted in the following hours:

- 4pm-8pm Sunday (16/12/2012) = 200 vehicles.
- 6am-10am Monday (17/12/2012) = 100 vehicles.
- *4pm-8pm Monday (17/12/2012) = 200 vehicles*

Table 3.2: Delay Time Survey for 25 vehicles (Sample)

CAR.NO	REGISTRATION NUMBER.	ENTRANCE IN THE QUEUE Hr :min	LEFT THE TOLL PLAZA Hr :min	TIME TAKEN IN QUEUE (MINS)	COMMENTS
1	LRJ5558	8:25	8:28	3	
2	UZ596	8:27	8:29	2	
3	QA607	8:35	8:37	2	
4	LOW32	8:45	8:48	4	Due to people coming to their working places on Monday morning
5	C4744	8:46	8:49	4	
6	KK824	8:48	8:51	3	
7	LEC3201	9:20	9:22	2	
8	LED5744	9:30	9:32	2	
9	LHB1771	17:00	17:09	9	
10	JZ318	17:02	17:11	9	
11	V1166	17:12	17:21	9	
12	MA087	17:13	17:22	9	
13	PIP3428	17:30	17:40	10	Due to People coming to Islamabad from different

					cities on Sunday
14	LES2792	17:34	17:44	10	
15	DEA9900	17:35	17:45	10	
16	RH819	17:40	17:50	10	
17	PA400	17:52	18:00	8	
18	LZ9177	17:59	18:06	7	
19	RIY9393	18:03	18:10	7	
20	LDA382	18:07	18:13	6	
21	LY619	18:11	18:17	6	
22	LA643	18:26	18:31	5	
23	MW168	19:09	19:14	5	
24	RZA497	19:20	19:24	4	
25	PE024	19:25	19:30	5	

3.4 PROCESSING TIME ANALYSIS

3.4.1 Surveying and Measurements

To find out the efficiency and the current situation of the toll plaza the group conducted toll collection processing time analysis. Processing time is defined as:

"The time spent by a vehicle to stop at a toll plaza make payment, take the receipt and attain the free flow speed is known as processing time."

For this purpose a total sample of 500 vehicles was taken using stop watches and average time taken and the maximum processing time was calculated.

- Average time taken for processing: *7.8 seconds*
- Maximum time taken during processing: 23 seconds

The survey was conducted on the followings days and timings.

- 4pm-6pm Tuesday (18/12/2012) = 200 vehicles.
- 7am-9am Wednesday (19/12/2012) = 100 vehicles.
- 4pm-6pm Sunday (22/12/2012) = 200 vehicles.

Table3.3: showing processing time of 25 vehicles

CAR.NO	REGISTRATION NUMBER.	ENTRANCE IN THE QUEUE Hr :min	LEFT THE TOLL PLAZA Hr :min	TIME TAKEN IN THE QUEUE Minutes	COMMENTS
1	LRJ5558	8:25	8:28	3	
2	UZ596	8:27	8:29	2	
3	QA607	8:35	8:37	2	
4	LOW32	8:45	8:48	4	Due to people coming to their working places on Monday morning
5	C4744	8:46	8:49	4	
6	KK824	8:48	8:51	3	
7	LEC3201	9:20	9:22	2	
8	LED5744	9:30	9:32	2	
9	LHB1771	17:00	17:09	9	
10	JZ318	17:02	17:11	9	
11	V1166	17:12	17:21	9	
12	MA087	17:13	17:22	9	
13	PIP3428	17:30	17:40	10	Due to People coming to Islamabad from different cities on Sunday
14	LES2792	17:34	17:44	10	
15	DEA9900	17:35	17:45	10	
16	RH819	17:40	17:50	10	
17	PA400	17:52	18:00	8	
18	LZ9177	17:59	18:06	7	
19	RIY9393	18:03	18:10	7	
20	LDA382	18:07	18:13	6	
21	LY619	18:11	18:17	6	
22	LA643	18:26	18:31	5	
23	MW168	19:09	19:14	5	
24	RZA497	19:20	19:24	4	
25	PE024	19:25	19:30	5	

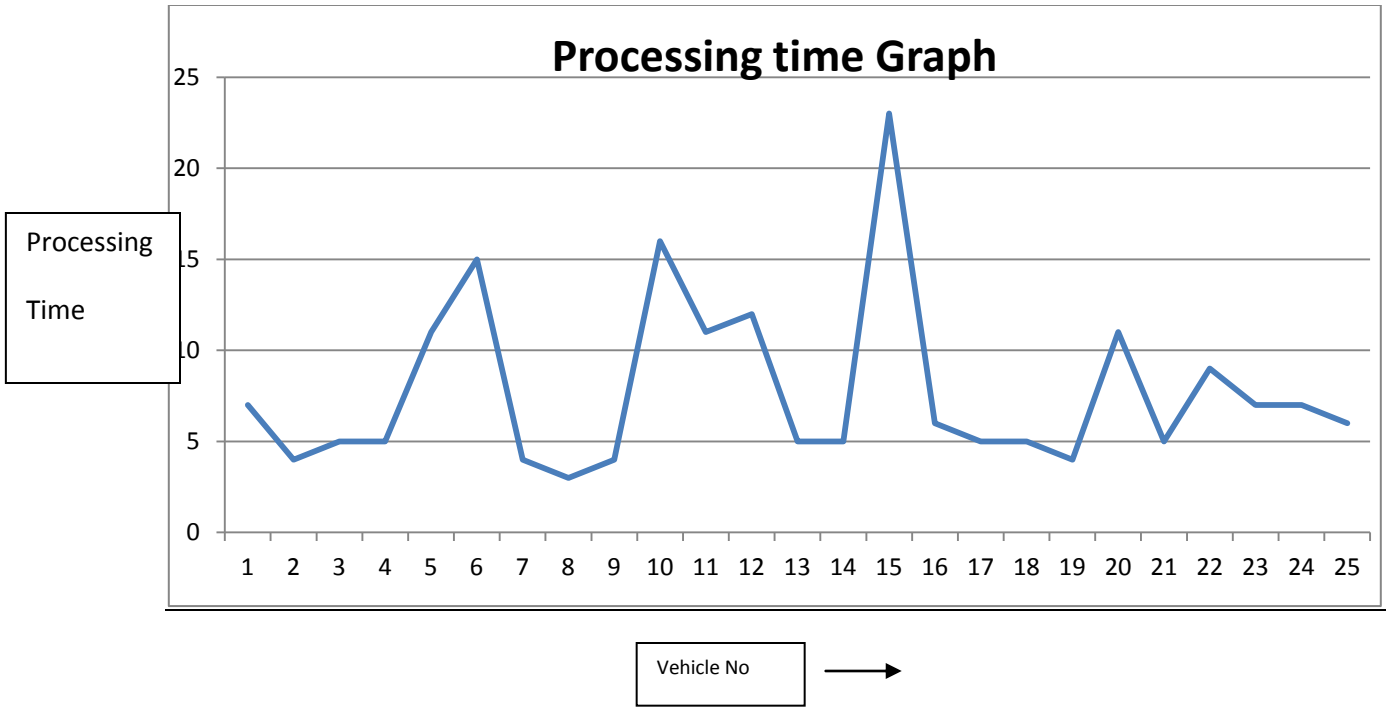


Figure 13: Showing processing time

3.5TURNING MOMENTS

3.5.1 Survey

The roundabout at Golra morr is quite a busy intersection. It has four legs and every leg has three turning moments. To find out the turning moment values turning moment survey was conducted for each leg of the intersection and data accumulated. The survey was conducted on Monday 17/12/2012, form 6am-10am and 4pm-8pm. Counting was done using manual method.

Following are the moments for which the count was done also shown in figure 14.

1. North bound left = Count of vehicles coming from Pindi heading towards M2
2. North bound right= Count of vehicles coming from Pindi entering Islamabad
3. North bound through= Count of vehicles coming from Pindi entering G-13 sector
4. East bound left= Count of vehicles coming from M2/GT Road entering G-13 sector
5. East bound right= Count of vehicles coming from M2/GT Road heading to Pindi

6. East bound through= Count of vehicles coming from M2/GT Road entering Islamabad.
7. South bound left= Count of vehicles coming from G-13 entering Islamabad
8. South bound right= Count of vehicles coming from G-13 heading to M2/GT Road
9. South bound through= Count of vehicles coming from G-13 heading to Pindi
10. West bound left= Count of vehicles exiting Islamabad and heading to Pindi
11. West bound right= Count of vehicles exiting Islamabad and entering G-13
12. West bound through= Count of vehicles exiting Islamabad and heading to M2/GT Road.

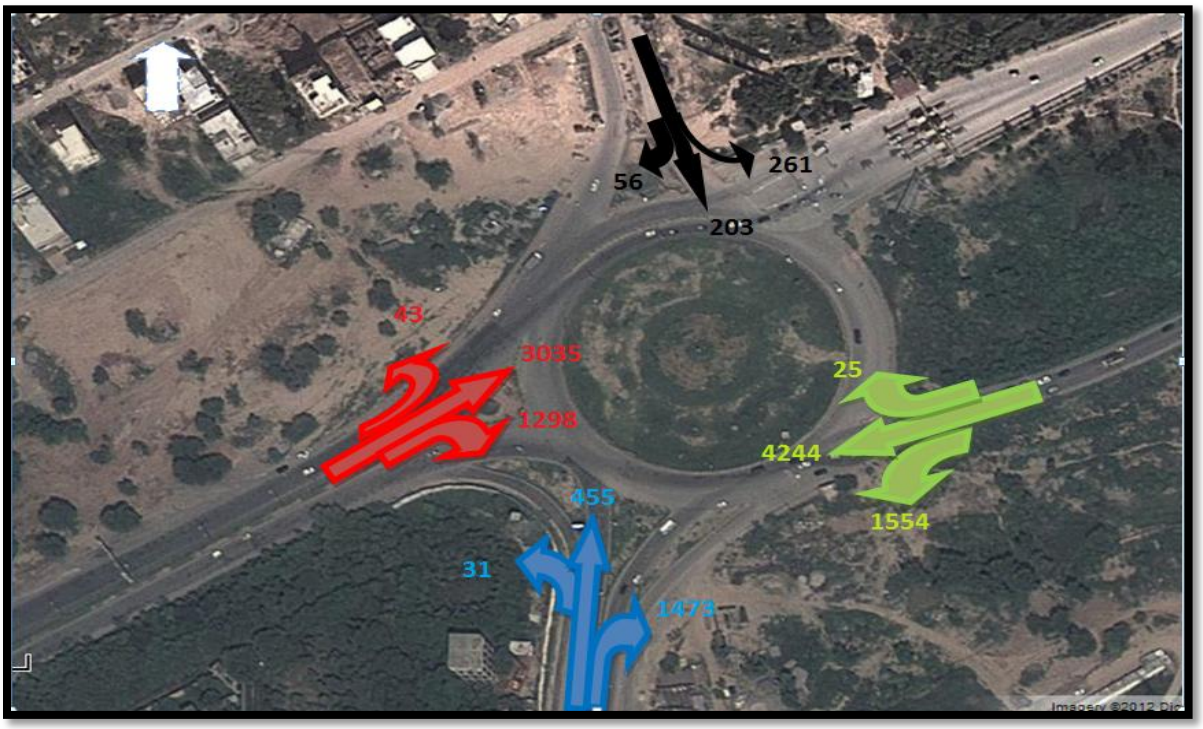


Figure 14: showing turning movements via different color arrows

3.5 Turning moments and PHF.

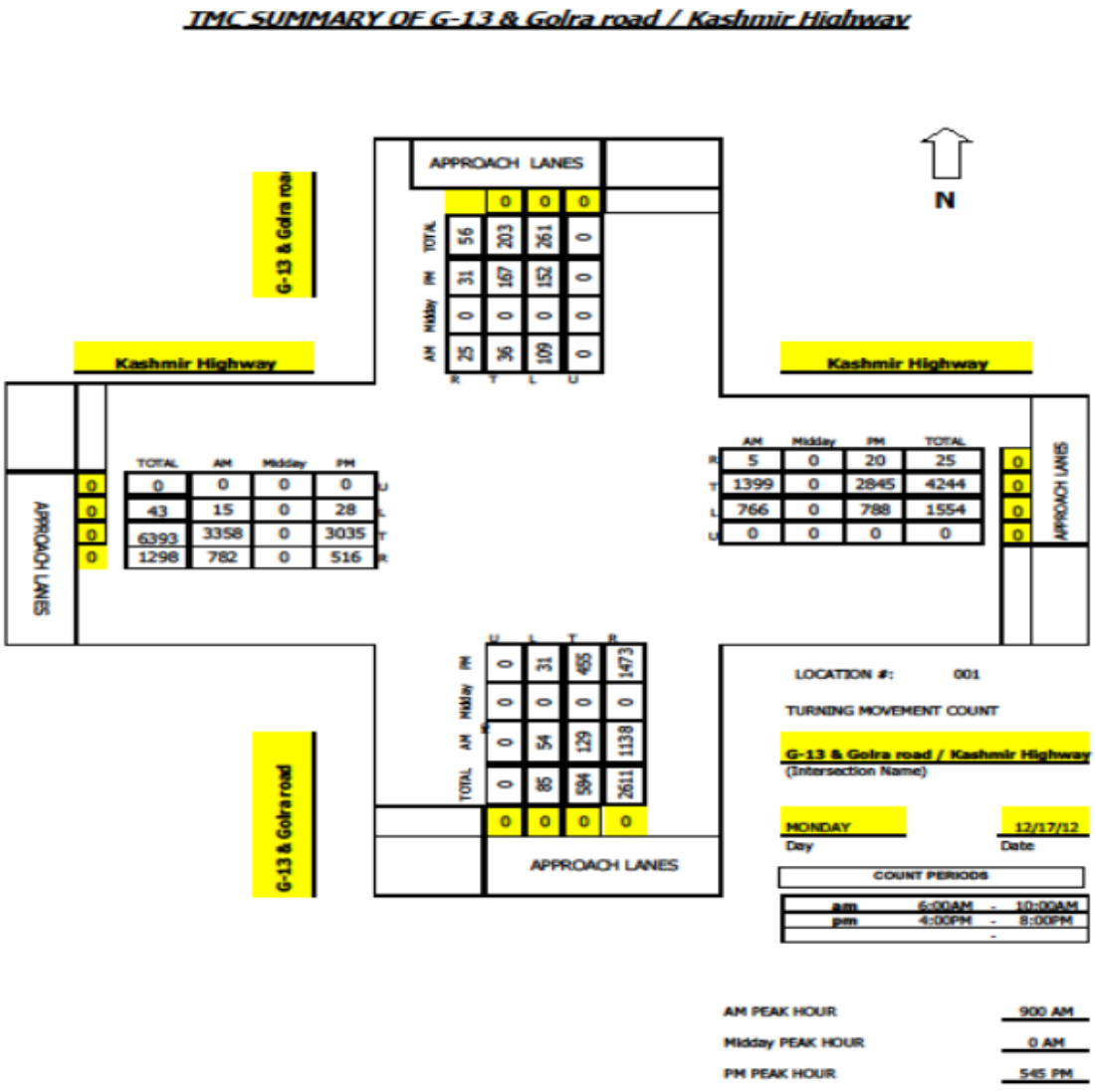


Figure 15: Software Chart showing turning movements and PHF

3.6 QUEUING ANALYSIS (D/D/N)

3.6.1 Introduction

Queuing Theory is a theory that models the process when customers line up to wait for service. Basic Queuing theory states:

- Customers requiring service are generated over time by an input source
- These customers enter the queuing system and join a queue
- At certain times, a member of the queue is selected for service by some rule known as the queue discipline.
- The required service is then performed for the customer by the service mechanism, after which the customer leaves the queuing system.
- A queuing system has the following basic characteristics:
- Arrival pattern of customers
- Service pattern of servers
- Number of servers
- System capacity
- Queue discipline

The standard notation for describing the configuration of a queuing process is A/B/X where A and B shows the types of departure and X is no of departure channels. Basically, traffic delay in a toll plaza is caused by

- Toll collection
- Car stream merging

Therefore, we break the problem into two parts: delay in tollbooths and at merging points. In a tollbooth, drivers wait for the service of toll collection, while at a merging point, drivers may stop to wait for a chance to get onto the merged lane.

3.6.2 Queue Disciplines:

Refers to the order in which members of the queue are selected for service

– FIFO – first-in first-out

- First customer to arrive is first to depart

– LIFO – last-in first-out

- Last customer into queue is first to leave

– SIRO – service in random order

– Priority

- Customers get served in order of priority (highest to lowest)

3.6.3 D/D/N Queuing

• Deterministic Approach

• Deterministic departures

• N departure channels

3.6.3.1 Assumptions:

Few assumptions are made to carry out this analysis.

- The traffic flow is constant in a short period.
- The time between two cars entering the toll plaza is of exponential distribution.
- The traffic streams enter into tollbooths smoothly and evenly. We have assumed the entrance into the toll booth does not contribute to delay in a mannerwhich is dependent on the parameters under consideration.
- The drivers are delayed by waiting in lines for toll collection. If there is a line at the chosen tollbooth when the driver arrives, the driver will have to wait untilother cars have left to enter the booth.
- The drivers are delayed by toll collection, and the delay is distributed exponentially.
- Departure rate is uniform

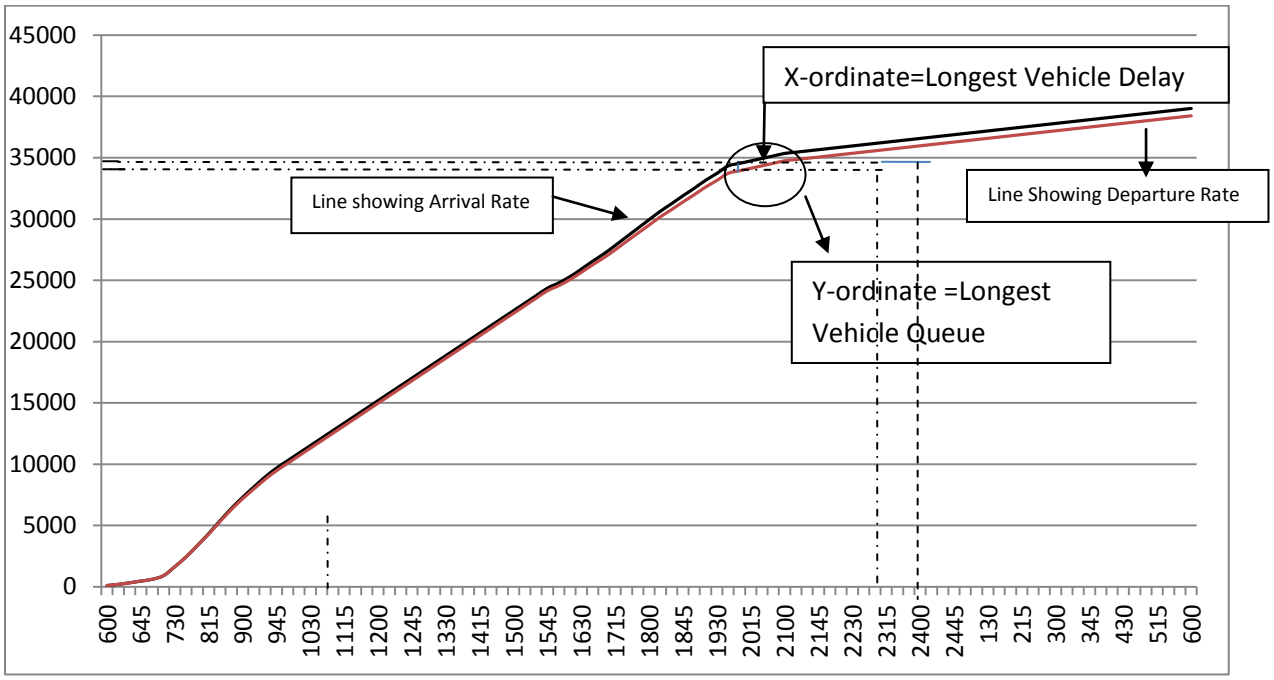


Figure 16: Graph showing Queue Analysis

3.6.4 Findings from Graph (D/D/N)

- When the arrival curve is above the departure curve, a queue will exist.
- The point at which the arrival curve meets the departure curve is the moment when the queue dissipates (no more queue exists).
- The point of queue dissipation can be determined from graph.
- Thus the queue that began to form at 8:45 A.M. will continue to grow.
- Under FIFO queuing discipline, the delay of an individual vehicle is given by the horizontal distance between arrival and departure curves.
- So, by inspection of graph, the vehicle to have the longest delay is of 16 minutes (the longest horizontal distance between arrival and departure curves).

- The total length of the queue is given by the vertical distance between arrival and departure curves at that time.
- Maximum length of queue is at 8:15 pm where length of queue grows to approximately 200 vehicles Total vehicle delay, defined as the summation of the delays of each individual vehicle, is given by the total area between arrival and departure curves i.e Average delay time is about 6 minutes per vehicle.

Chapter 4

DATA COLLECTION AND ANALYSIS

4.1 Traffic Modeling using Synchro:

A capacity analysis is performed as part of a traffic impact study. The operational characteristics of an intersection are calculated using Synchro and HCS 2000 traffic software. HCS utilizes the methodology established within the Highway Capacity Manual (HCM) 2000. Synchro utilizes the HCM and also the Intersection Capacity Utilization (ICU) 2003 method. The measure of highway capacity is typically presented by addressing the intersection Level of Service.

The HCM method determines Level of Service by calculating the delay time experienced by vehicles approaching the intersection. HCM Level of Service is rated on a scale of A to F, Level of Service a being a condition of very low delay and Level of Service F being a condition of long delays. The ICU method gives insight into how an intersection is functioning and how much extra capacity is available to handle traffic fluctuations. ICU Level of Service is rated on scale of A to H, Level of Service a being a condition of no congestion with a large reserve capacity and Level of Service H being over capacity with long periods of congestion.

The two methods are closely interrelated and Synchro provides both the HCM and ICU Levels of Service. Synchro also allows data from multiple intersections to be input together as one network in order to determine the effects the traffic from each intersection will have on the adjacent nearby intersections in a neighborhood or along an entire traffic corridor.

Synchro is software used for optimizing traffic signal timing and evaluating capacity analyses. The software uses splits, offsets, and cycle lengths for individual intersections, an arterial, or a complete network. Synchro evaluates capacity analyses

using both the Intersection Capacity Utilization (ICU) and HCM methods. Synchro provides detailed time space diagrams that can show vehicle paths. Synchro can be used for creating data files for Simulated Traffic. Sim Traffic models signalized and un-signalized intersections and freeway sections with cars, trucks, pedestrians, and buses.

We designed three models using this software

- **Model based on existing Conditions**
- **Model Based on Improved Geometry**
- **Model Based on Future Conditions with improved geometry**

4.2Existing geometry:

Our project site is basically a combination of a roundabout and intersection. Each east and west bound traffic has two lanes as well as north bound traffic. Apart from that south bound traffic has one lane which is coming from G-13.Our toll plaza is actually situated on service road. Following figure supports this claim.

East bound Traffic = Two lanes

West bound Traffic = Two lanes

North bound Traffic = Two lanes

South bound Traffic = One lane

Figure 17: Existing Geometry

4.3 Model Based on Existing Geometry:

Synchro doesn't perform roundabout analysis as we have multi lanes in our roundabout at site. Synchro only supports one lane roundabout. Although our existing level of service is F so we don't need to perform roundabout analysis though. So assuming it a single lane roundabout our Synchro model looks like:

4.4 Model Based on Improved Geometry:

We provided a signalized intersection by removing the roundabout. We provided all measures of our own desires to improve the geometry and traffic flow to its maximum extent. Then we performed analysis through Synchro which gave us the following

results:

Figure 19: Showing Improved Geometry

4.5 Model based on future conditions with improved geometry:

As far we know with increase in population, our traffic grows too. That is why there are being made some alterations in our project site. Kashmir highway is being extended and toll plaza is being shifted in certain years. New improved geometry contains five lanes in Kashmir highways each for incoming and outgoing. So we did perform a capacity analysis on future conditions using Synchro. Toll plaza is being shifted on Kashmir highway after some time. It will be provided after **150 meters** of the interchange.The model gave us the following results:

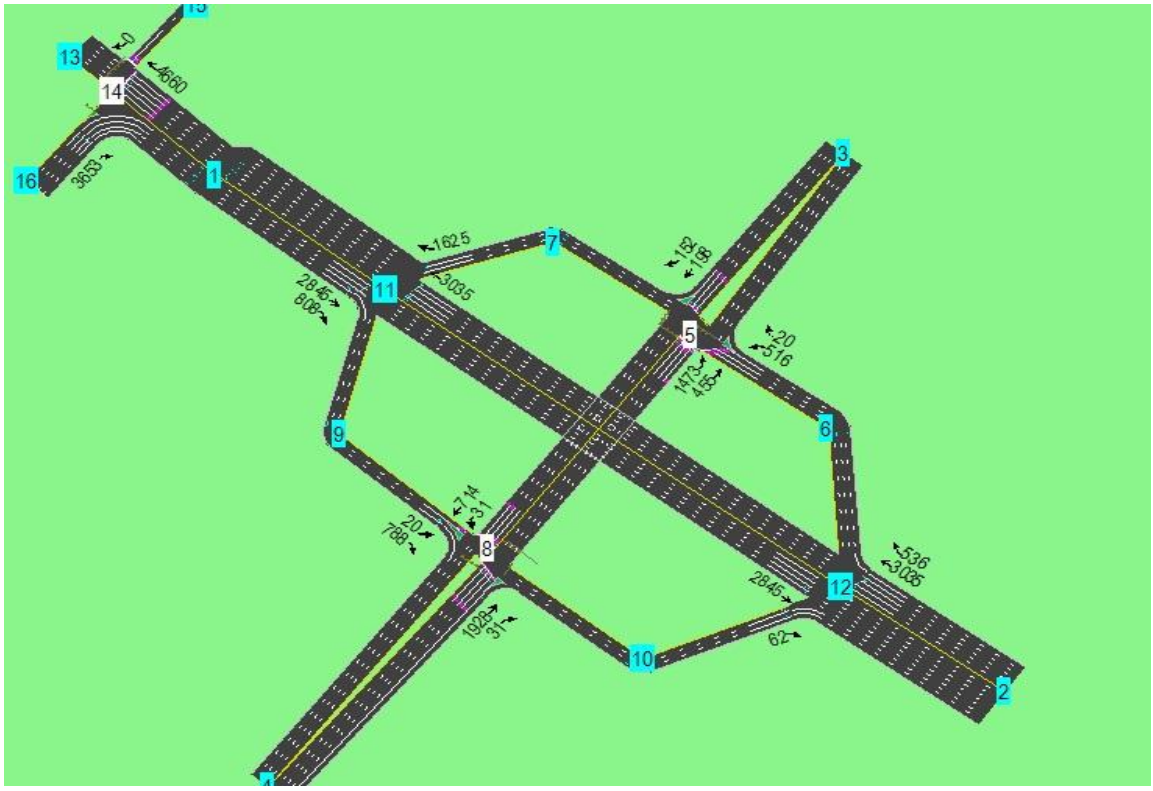


Figure 20: Showing Improved Geometry with Grade Separation

Chapter 5

RESULTS AND DISCUSSIONS

5.1 Proposed Solution:

As we have designed three models on improved geometry. The only possible solution to this congestion is grade separation. We will have to build an interchange. We have designed a diamond interchange which is best suitable and economical for our project site. The results came after the analyses of diamond interchange are good and congestion solving.

5.2 Results:

Model based on improved geometry with a diamond interchange shows the following results:

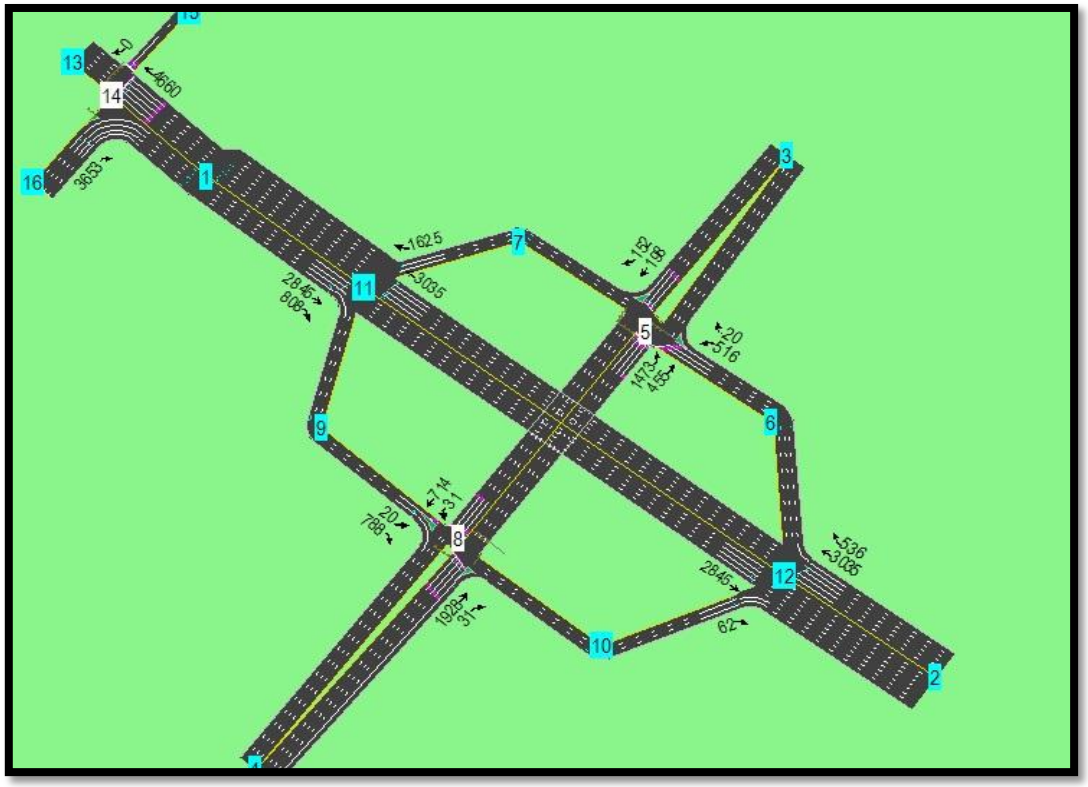
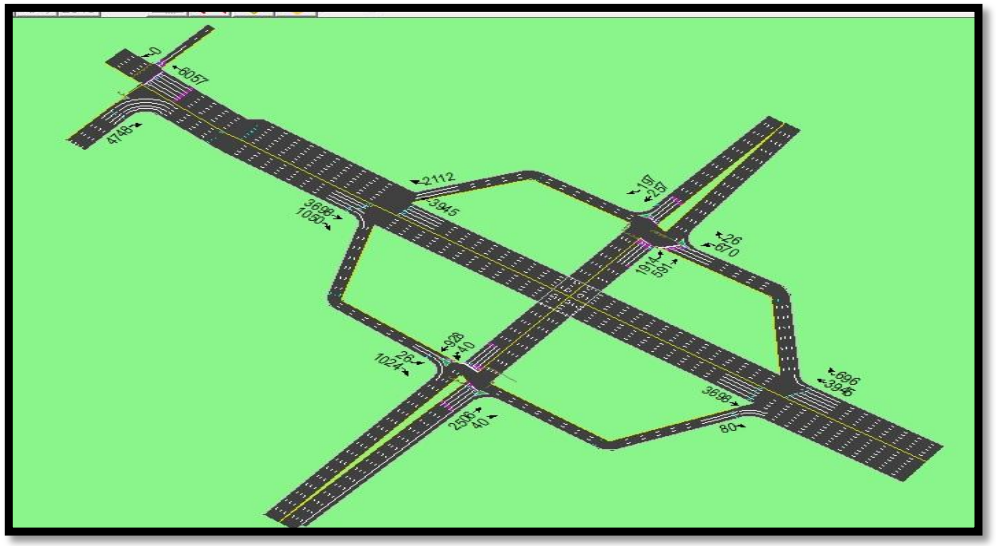


Figure 21: Showing Impro ved Geometry with Diamond Interchange

5.3 Future Research Proposal:

Our model's results shows that it was still satisfactory for 10 more years. The growth rate for traffic volumes is about 3% as directed by Capital Development Authority (CDA). So we did analysis on future volumes too and the results were still satisfactory. So the only way to remove congestions and traffic delays is grade separation and our proved suggestion is a **DIAMOND INTERCHANGE.**



Chapter 6

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