TRAFFIC ANALYSIS AND CONGESTION MITIGATION OF DEFENCE ROUNDABOUT, RAWALPINDI

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This is to certify that the

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TRAFFIC ANALYSIS AND CONGESTION MITIGATION OF DEFENCE ROUNDABOUT

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"In the name of Almighty Allah, the Most Beneficent, the Most Merciful"

First and foremost, all thanks and praises to ALLAH Almighty for the strength, patience, knowledge and His blessings to complete this project. We are obliged to our respected supervisor, Assistant Professor Saqib Mehmood, who gave us his precious time and shared his life-long hard-earned knowledge and experience.

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Abstract

Aging transportation infrastructure of Rawalpindi is unable to meet the enhanced traffic demand due to increased motorization. A well-planned, efficient and sensible transportation system is necessary to ensure better traffic movement. This project analyzes the Current Traffic Condition of Defence Roundabout, Rawalpindi by performing microscopic multi-modal traffic flow simulation, and offers Congestion Mitigation Measures, including infrastructure development.

Chapter 1

Introduction

For any modern society, a well-established Transportation system is crucial for its growth and development. The formation of urban societies is largely influenced by the type of the transportation system available. Every day, a massive number of people commute from one place to another to perform their day to day tasks such as going to school, work, shopping, and recreational purposes etc. Among all forms of transportation, road transportation holds the greatest importance in terms of its usage and impact. People in both the developed as well as developing countries travel daily for work, education, recreation, shopping and other amenities using road transportation means. A lot of resources, including fuel and time, are consumed during transportation operations and any hindrance to these operations imparts a lot of strain on these resources. This renders it vital that the traffic runs smoothly without any interruptions and delays.

Traffic has increased in recent years in twin cities due to increased commercial and development activities. Defense roundabout located on the junction of Defense Avenue and G.T road has been affected due this traffic increase. Traffic volumes are more than the capacity of roundabout. In our project, we have analyzed different options for congestion mitigation of the roundabout. We have analyzed the roundabout for projected volumes after ten years for proposed solution and noted LOS in Vissim software. We suggested some temporary and permanent solutions for the problem. We have also made models for the solutions considered and the solution provided.

Roundabout

A roundabout, also called a traffic circle, road circle, rotary, rotunda or island, is a type of circular intersection or junction in which road traffic flows almost continuously in one direction around a central island.

So-called "modern" roundabouts require entering traffic to give way to traffic already in the circle and optimally observe various design rules to increase safety. Compared to stop signs, traffic signals, and earlier forms of roundabouts, modern roundabouts reduce the likelihood and severity of collisions by reducing traffic speeds and minimizing T-bone and head-on collisions. Variations on the basic concept include integration with tram and/or train lines, two-way flow, higher speeds and many others.

Traffic exiting the roundabout comes from one direction, rather than three, simplifying the pedestrian's visual environment. Traffic moves slowly enough to allow visual engagement with pedestrians, encouraging deference towards them. Other benefits include reduced driver confusion associated with perpendicular junctions and reduced queuing associated with traffic lights. They allow U-turns within the normal flow of traffic, which often are not possible at other forms of junction. Moreover, since vehicles on average spend less time idling at roundabouts than at signaled intersections, using a roundabout potentially leads to less pollution.

Site Description

The Defense Roundabout, located near Ayyub Park Rawalpindi has been a part of the new development and expansion within the city limits of Rawalpindi. With more attractions, shopping centers, and commercial development, there has been an increase of traffic to the area. The roundabout serves as an intersection between the Grand Trunk Road and the Defense Avenue. However, the project has failed to meet the current traffic demands of the area. The area has been subjected to frequent traffic congestions especially during the peak hours. The problem is only expected to worsen with the growing development in the twin cities.

This round about carry traffic from

- DHA Phase I Rawalpindi/ Islamabad.
- DHA Phase IV Rawalpindi/ Islamabad.
- From Rawat towards Saddar.
- From Al Shifa Hospital and Ayub Park towards Saddar.
- Traffic of Fauji Foundation Hospital.

Purpose of the Project

With the growing economy, there has been a surge of people from all over the country to find employment opportunities in the twin cities, Rawalpindi and Islamabad. Both the cities are rapidly becoming a destination for firms and companies to relocate their offices and personnel. In order to provide space to accommodate this growth, there is a need to provide the most efficient transportation solution for the cities. With the current rate of influx toward the twin cities, the situation of traffic is going to worsen in the anticipated future. Already, Islamabad and Rawalpindi have been occasionally witnessing huge traffic jams.

Current Design

The current design for the proposed roundabout is a non-traditional roundabout. As already discussed, the project has failed to meet the current traffic demands of the area. The area has been subjected to frequent traffic congestions especially during the peak hours. The problem is only expected to worsen with the growing development in the twin cities.

We are planning to design the roundabout to achieve the following objectives:

- Offering less collision points;
- Minimize the weaving;
- Encouraging fewer cars to enter the roundabout, making the roundabout more efficient.

Chapter 2

Literature Review

Engineering terms definition:

Traffic Engineering

Traffic engineering is of one of civil engineering's branch that deals with the roads and streets design and construction and uses engineering practices to assure the safe and efficient movement of people and goods on roadways.

Traffic Congestion

Traffic congestion is a situation on transport networks that occurs as its usage increases, and is characterized by slower speeds, longer trip times, and increased vehicular queuing. The most common example is the physical use of roads by vehicles. When traffic demand approaches the capacity of a road or of intersection then due to the interaction between vehicles, speed of moving vehicles slow down and congestion sets in. When the speed of vehicles is almost zero, a situation referred to as "traffic jam" occurs.

Average Daily Traffic

Average daily traffic or ADT, and sometimes also known as mean daily traffic, is the total volume of vehicles during a given time period (in whole days), more than one day and less than one year, divided by the number of days in that time period.

Annual Average Daily Traffic (AADT)

Annual Average Daily Traffic (AADT) is the total volume of vehicles (EPCUs) of a highway for one complete year divided by 365 days (number of days in the year). It gives us some idea about the demand of the particular road.

Traffic Count

A traffic count is counting of vehicles along a particular road, it can either done electronically (JAMAR counter etc.) or manually using Traffic Count Sheets.

Passenger Car Unit (PCU)

Passenger Car Unit (PCU) is a metric used in Transportation Engineering, used for expressing highway capacity. A Passenger Car Equivalent is basically the impact that a mode of transport has on traffic variables (such as headway, speed, density) compared to a single car. For example, typical values of PCU (or PCE) are:

Table: Equivalent Passenger Car Units for each class as defined by AASHTO, Green Book.

VEHICLES	**PCU/PCE**
Car (including taxis, jeeps, land Cruisers, Hiace, Wagons, Minibus, Mazda)	1.0
Motorcycles, Rickshaw, Qingqi, Bicycle	0.5
Large Bus (>3o seats)	3.0
All Trucks including construction vehicles	4.0
Tractors with or without trolley	5.0

Peak Hour Factor

One hour period is the accepted unit of time for expressing flow rate. The total hourly volume that can be served without exceeding a specified degree of congestion is equal to or less than four times the maximum 15- minutes count. The factor used to convert the rate of flow during the highest 15-minute period to the total hourly volume is the peak hour factor (PHF).

Capacity Modeling

Major research on roundabout capacity has been carried out in multiple countries. Software can help calculate capacity, delay and queues. Packages include ARCADY, Rodel, Highway Capacity Software and Sidra Intersection, PTV Vissim. PTV-VISSIM is a powerful analysis tool being used widely in transportation planning. It was developed by PTV Planning transport Varchar A.G, A German based company. It is used to evaluate the effectiveness of various proposed alternatives. VISSIM uses micro-simulation techniques for simulating the entities of real world in simulation. The salient feature of the software is its multi-modality, which means more than one kind of traffic can be simulated

Objective

To redesign defence roundabout to eliminate traffic congestion and delays

- Acquire/ estimate present and future capacity of our concerned area.
- Conduct traffic count and other surveys with a view to assess existing traffic on the section.
- Assess future traffic based upon pace of construction and vehicle growth rate

- Analyze present and increased capacity demand of the section in future using HCM and computer software, VISSIM and HCS.
- Conclusion and recommendations for congestion mitigation, including traffic management measures and infrastructure development, if necessitated.

JUSTIFICATION FOR SELECTION OF TOPIC

Inadequate Capacity

Inadequate Capacity due to high traffic volumes intercepting the roundabout from Rawat to Saddar with the merging traffic at a high weaving. Moreover, lane capacity varies widely due adjoining lanes, lane width, number of heavy vehicles, and inadequate lane formation during congestion. The practical capacity falls extensively below the ideal capacity and the Level of Service (LOS) drops below the minimum recommended by HCM.

Noise Pollution

In rapid developing built – up cities, traffic noise has become a severe problem nowadays because of inefficient town and urban planning. The problem has been compounded by rise in traffic volumes more than the expectations. Traffic congestion leads to an increase in the background Noise of an area beyond the recommended levels.

Air Pollution

Growing traffic and industrial activities lead to air pollution by emitting gases which contains arsenic, cadmium, nickel and other hydrocarbons. Air pollution is bad for health and for the environment. The most problematic pollutants today are fine particles, nitrogen dioxide and ground level ozone emitted by motor vehicles.

Time Delays

The foremost thing that comes in mind when considering congestion is the delay. Delay is directly related to the stress caused to the drivers. Morning traffic congestion leads to arriving late at work place and evening rush adds to frustration of drivers because they want to reach home and relax. This frustration can also lead to road accidents.

Fuel Consumption

The consumption of fuel is more as stopping and starting in traffic jams consumes the fuel at a faster rate as compared to uninterrupted traffic flow conditions. Higher the rate of fuel, higher will be the cost and it will be very uneconomical and it also adds to the total of emissions released by the vehicles which in return results in more pollution. It has adverse impacts on environment too.

Chapter 3

Methodology

This section will cover up the methodology which we had carried out for completion of this study. The step carried out in executing this project would be mentioned.

The following methodology is carried out:

- Literature review
- Field surveys
- Data Collection
- Capacity Modeling and Analysis
- Problems Identification
- Evaluating possible solutions
- Compilation of Results

Surveys

Survey is a very crucial for carrying out any type of analysis. Therefore, following survey was carried out for the study:

- Volume/Traffic count survey

Capacity Analysis

The procedure adapted for capacity analysis included the collection of traffic counts for the turning movements and through movements at the Roundabout. The traffic counts enabled us to get the peak hour volume of the traffic which in turn is used to find the peak hour factors. This peak hour volume and peak hour factor is further used to determine the existing overall delay, capacity of roundabout, whether is suffice or not with the help of simulation on VISSIM.

Traffic Count Survey

The Defense Roundabout is a busy intersection. It comprises of three legs. Traffic counts for turning moment and through movement have been done. These traffic counts are required for further analysis process. Volume count is carried out to find the peak hour volume and peak hour factor. Counting is carried out using manual method. The survey has been conducted for following timings:

- 8 am to 10 am
- 1 pm to 3 pm
- 4 pm to 7 pm

These timings have been selected after observance of traffic flow. 8 am to 10 am is selected because during this duration people travel for reaching to their work places, offices, colleges, schools etc. 4 pm to 7 pm time for evening count is selected because during this span of time people travel back towards their homes and large amount of traffic transverse through the roundabout. Whereas, the afternoon period (1 pm to 3 pm) was included

because very high amount of congestion was observed during this time period. Traffic counts were done for:

- Traffic coming from Rawat and going towards Saddar, DHA, and Fauji Foundation hospital.
- Traffic entering roundabout from Fauji Foundation hospital and DHA.
- Traffic coming from Saddar and going towards Fauji Foundation hospital and DHA.

Methods for traffic count

Two methods are accessible for conducting traffic volume counts namely Manual counts and Jamar Counter. We used the manual method for conducting the traffic volume counts.

Manual Count

Tally sheets are used for the traffic count manually. Tally marks are the basic units of unary numeral system used for counting purpose. They are grouped in five so that calculation may become easier and legible.

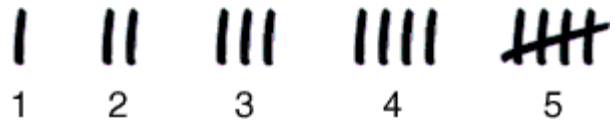


Figure 4.2: Manual Count (Tally Bar)

Manual Count Method

First of all traffic was segregated into following classes.

- **Bikes**

    - Bicycles
    - Motor Bikes
- **Rickshaws/ Qingqi**
- **Cars**
    - Passenger Cars
    - Hiace
    - Land Cruisers
    - Suzuki
    - Coasters (less than 16 seats)
- **Buses**
    - Coasters (up to 24 seats)
    - Public Transport Buses
- **Trucks**
    - Construction Vehicles
    - 2-Axle Trucks
    - 3-Axle or above
    - Tractors (with or without trolley)

Selection of representative day: Traffic counts conducted during Monday morning and Friday evening rush/peak hour may show exceptional behavior of high traffic volumes and are not generally used in analysis therefore, counts are usually taken on Tuesday, Wednesday, or Thursday.

Selected time slot: Initial visits to the location were made to select timings for survey to determine peak hour. Timings selected were

Table 4.2: Time Slots

• Morning	• 8:00 - 10:00 AM
• Afternoon	• 1:00 - 3:00 PM
• Evening	• 4:00 - 7:00 PM

Manual Count, Recording Method and Timings.

Noting down data onto manual tally sheet is the most simple and easy method of taking counts. A stop watch is needed to note the desired count interval. The complete details of the traffic counts are provided in the end (Appendix-A).

Refer to Annex A for manual traffic count sheet and working of peak hour volumes by converting each class to its EPCU using Excel Sheets.

Personnel Involved in a Manual Count Study:

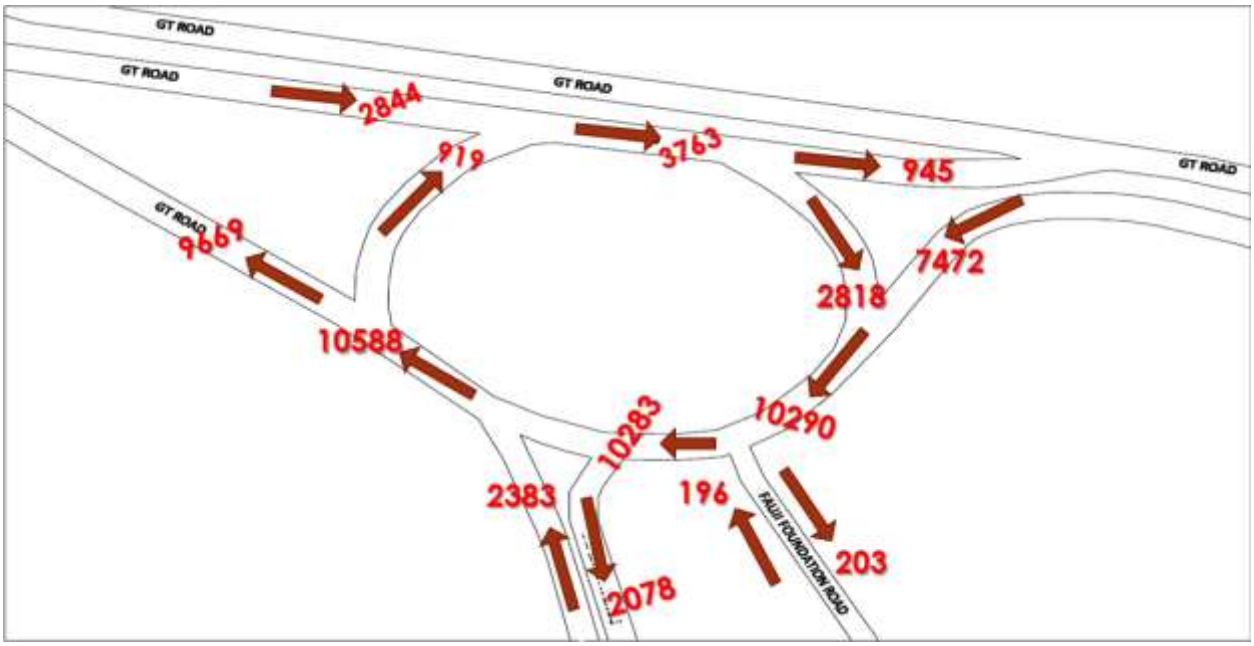
The data collection team size depends on the counting period span, the type of count being executed and the volume level of traffic. The number of personnel desirable also depends

on the study data needed. For example, two observer can record certain types of vehicles in one direction while rest can count in other direction.

Determining Peak Hour Volume:

Peak hour volume is the traffic volume that occurs during the peak/ rush hour. It is expressed in EPCUs per hour and it represents the highest traffic volume. For calculating peak hour first of all different types of vehicles were converted into EPCU (Equivalent Passenger Car Units).

Traffic counts for each 10 minutes time period were converted to EPCU of different vehicles, added and total EPCU was determined. Peak hour volume was taken which yielded the max EPCUs for 60 consecutive minutes. EPCUs for the peak hour are shown in the diagram below:



Chapter 4

Results and Discussion

Data Simulation - PTV VISSIM

PTV-VISSIM is a powerful analysis tool being used widely in transportation planning. It was developed by PTV Planning transport Varchar A.G, A German based company. It is used to evaluate the effectiveness of various proposed alternatives. VISSIM uses micro-simulation techniques for simulating the entities of real world in simulation. The salient feature of the software is its multi-modality, which means more than one kind of traffic can be simulated. These entities include:

- Vehicles (Cars, Buses, Trucks, Oil Tankers)
- Public Transports (Trams, Buses)
- Cycles (Bicycles, Motorcycles)
- Pedestrians
- Rickshaws

It shows each identity at microscopic level thus giving the exact picture of a real-world scenario. It can analyze the various public and private transport operations under different restraints including

- lane configurations
- different compositions of vehicle mix
- stops signs

- traffic signals
- barriers

Thus effectiveness of various alternatives can be analyzed under different conditions of estimated and projected volumes. VISSIM also models the operations of pedestrians either individually or combined with the traffic operations.

Benefits of VISSIM

Other than multi modeling, there are some other features that make this software more effective.

Scenario Management:

Different scenario results can be matches conveniently, giving the user a clear idea of which scenario is the best. Using this information an effective solution to traffic congestion or low LOS can be proposed.

Maximum Accuracy:

With the help of this software maximum accuracy can be achieved. User can map network and any desired geometry can be achieved, i.e. from a standard node to a complex intersection. Realistic behavior of all road users within the existing and planned infrastructure is possible in this software.

Ease of Use and Productivity:

It is very user friendly software allowing us to build our own interfaces (Driver Model, Driver Simulator etc.). The interfaces with dock able windows allows for efficiently creating and editing network objects.

Flexibility and Integration Capacity:

The Generic COM interface allows interacting with external applications. It enables you to have manual settings for drivers and vehicle properties at different levels. For current studies it helps you to test the environment. Besides this, you can connect your work to any other PTV software.

Visualization in 2D and 3D:

Switch perspective helps you to display your analysis results in both 2D and 3D. This assists in public decision-making processes with the help of detailed reports. This salient feature makes the traffic simulations more appealing and understandable to all.

Simulation of present scenario

Roundabout was analyzed in present conditions without any change for noting queue lengths and delays which were then used to determine LOS. Different priority rules were also tried at each node. The priorities were so adjusted to give the minimum delays.

PTV VISSIM generated model of Defence Roundabout

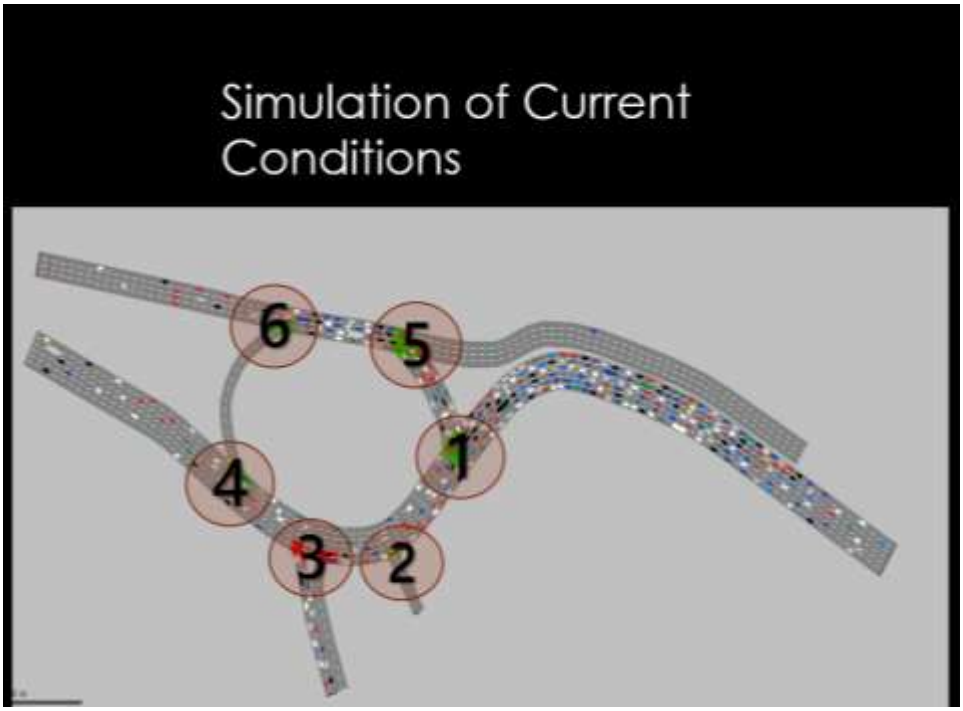


Figure 1: VIssim Model of the current Roundabout Design

Simulation of Present Scenario- RESULTS Weekday Afternoon (1:30 pm to 2:30 pm)

The table below shows the results of the simulation at present conditions and current volumes. The node numbering is in the order of the numbering shown in Figure 1.

At Current Volume		
Node	QLEN (Meters)	VEHDELAY(ALL) (Seconds)
1	245.36	55.26
2	88.97	12.76
3	72.13	23.51
4	66.62	3.48
5	28.97	6.01
6	18.09	5.93

This table below shows the queue length and vehicle delays for the traffic volumes after 10 years projected at 3 percent annual vehicle growth rate as given by Pakistan Bureau of Statistics

At Projected Volume after 10 years		
Node	QLEN (Meters)	VEHDELAY(ALL) (Seconds)
1	249.57	91.25
2	90.86	15.64
3	75.65	24.46
4	66.59	3.81
5	79.77	16.38
6	166.57	64.14

Chapter 5

Evaluation of Possible Solutions

After analyzing different options, different solutions were considered including provision of slip lanes, signalization of Roundabout at critical nodes or Grade Separation.

Provision of Slip Lanes:

A slip lane is a road traffic lane provided at an intersection to allow vehicles to turn at the intersection without actually entering it and interfering with through traffic.

Slip lane can offer a low cost solution to resolve the congestion problem at the Defence Roundabout. However, space restrictions and other geometrical considerations does not allow the provision of slip lanes. Furthermore, the provision of a slip lane still doesn't completely put an end to all the conflicting movements at the roundabout.

Signalization

The second solution that was evaluated to mitigate the congestion was to signalize the roundabout at critical nodes. This solution is the most economical as compared to the other considerations and is easy to provide. An analysis of the roundabout was done by signalizing the critical Node (Node 1) and the conditions were simulated during the peak hour. The simulation yielded the following results:

At Current Volume		
Node	**QLEN (Meters)**	**VEHDELAY(ALL) (Seconds)**
1	**249.24**	**51.06**
2	**87.38**	**19.7**
3	**75.25**	**27.71**
4	**72.07**	**5.57**
5	**91.68**	**33.66**
6	**167.47**	**62.27**

At Projected Volume for 10 years		
Node	**QLEN (Meters)**	**VEHDELAY(ALL) (Seconds)**
1	**249.13**	**82.02**
2	**87.69**	**19.1**
3	**73.69**	**33.1**
4	**66.46**	**5.99**
5	**92.22**	**32.9**
6	**167.86**	**63.47**

The results from signalization shows that signalization of the Roundabout at Node 1 improves the LOS from F to D. However, Signalization too fails with Traffic growth projected after 10 years.

Grade Separation

Grade separation is the name given to a method of aligning a junction of two or more surface transport axes at different heights (grades) so that they will not disrupt the traffic flow on other transit routes when they cross each other.

For the current roundabout, a fly over was considered for the through traffic from Rawat towards Saddar as the third solution and this solution was analyzed and simulated at current volumes as well as volumes after five and ten years. As already said, a three percent increase in traffic per year for future analysis was used.

Results (After Grade Separation)

For current volumes after Grade separation, we have LOS A for the roundabout as shown by the simulation results tabulated below. The node numberings in the tables are in accordance with the nodes shown in Figure 2.

Figure 2 Nodes Analyzed After Grade Separation

At Current Volume		
Node	QLEN (Meters)	VEHDELAY(ALL) (Seconds)
1	0.1	2.09
2	0.32	1.37
3	6.12	2.38
4	0	0.19
5	0	0.63
6	0	0.22
7	0	0.12
8	0	0.3

For traffic volumes after ten years the queue length and vehicle delays were increased a bit but we still have an LOS A after ten years if traffic is increased at a rate of 3% per year.

At Projected Volume after 10 years		
Node	QLEN (Meters)	VEHDELAY(ALL) (Seconds)
1	43.33	4.74
2	76.52	2.09
3	51.25	3.08
4	0	0.34
5	25.18	2.54
6	14.2	1.8
7	17.05	0.26
8	0	0.48

Chapter 6

CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

Although signalization of the critical Node can improve the level of service from F to D during the peak hours, but with the projected increase in traffic volumes in the next 5 to 10 years, signalization is also bound to fail. Therefore, a permanent solution to cater this issue would be to go for grade separation. It has been proven from the results that grade separation is a long term solution and gives best results after five years.

RECOMMENDATIONS

For this project, the quantitative effects of Public transport occupancy were not taken into account. However, the Public Transport occupancy in front of Fauji Foundation Hospital also contributes to the traffic congestion. Therefore, provision of a separate parking space for local transport along with signalization of the critical node can somewhat improve the current situation

Works Cited

- Rao, A. M., & Rao, K. R. (2012). Measuring urban traffic congestion-a review. *International Journal for Traffic and Transport Engineering*, *2*(4), 286-305.
- Goodwin, P. (2004). The economic costs of road traffic congestion.
- Davis, L. C. (2012). Mitigation of congestion at a traffic bottleneck with diversion and lane restrictions. *Physica A: Statistical Mechanics and its Applications*, *391*(4), 1679-1691.
- Arnott, R., & Small, K. (1994). The economics of traffic congestion. *American scientist*, 446-455.
- Lahore Urban Transport Master plan Study conducted by Transport Department of Government of Punjab.
    - Vehicle Classification for Traffic Count Survey (Page 47 Table A.4.1)
    - Manual Classified Counts (MCC) (Page 87 Table B.3)
- Transportation Engineering Basics (Second Edition) By A.S. Narasimha Murthy & Henry R. Mohle.
- Highway Capacity Manual, 4th Edition, Transportation Research Board, Washington, D.C. 2000.
- American Association of State Highway and Transportation Officials ASHTO Green Book.
- Travel Time Data Collection Handbook.
- Parajapat, V.N., and Gundaliya, P.J. (2010), “Simulation of heterogeneous traffic intersection using VISSIM.”

The diagram below shows the traffic moments tabulated in Appendix A:

Appendix A

Traffic Counts Data

Week 1 Weekday

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
8:00-8:15	251	135	386	137	249	1720	1969	57	42	1954	271	637	2320	2185
8:15-8:30	241	112	353	114	239	1760	1999	34	36	2001	271	642	2372	2260
8:30-8:45	286	146	432	148	284	1772	2056	29	52	2079	252	576	2403	2257
8:45-9:0	310	142	452	145	307	1753	2060	35	48	2073	223	590	2440	2298
9:00-9:15	289	121	410	123	287	1755	2042	52	40	2030	289	628	2369	2248
9:15-9:30	260	135	395	137	258	1732	1990	38	44	1996	249	652	2399	2264
9:30-9:45	242	132	374	134	240	1769	2009	30	35	2014	264	623	2373	2241
9:45-10:00	262	123	385	125	260	1735	1995	30	37	2002	276	644	2370	2247

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
5:00-5:15	621	231	852	237	615	1741	2356	28	43	2371	595	527	2303	2072
5:15-5:30	593	157	750	162	588	1682	2270	15	51	2306	509	521	2318	2161
5:30-5:45	645	221	866	227	639	1842	2481	46	51	2486	559	564	2491	2270
5:45-6:00	743	207	950	214	736	1869	2605	45	50	2610	527	626	2709	2502
6:00-6:15	692	197	889	203	686	1863	2549	37	41	2553	533	522	2542	2345
6:15-6:30	606	216	822	222	600	1793	2393	41	43	2395	528	576	2443	2227

6:30-6:45	595	214	809	219	590	1644	2234	68	52	2218	467	523	2274	2060
6:45-7:00	595	203	798	208	590	1732	2322	50	30	2302	549	528	2281	2078

Week 1 Weekend

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
8:00-8:15	191	103	294	104	190	1290	1480	44	36	1472	215	516	1773	1670
8:15-8:30	205	96	301	98	203	1391	1594	29	28	1593	217	482	1858	1762
8:30-8:45	218	114	332	116	216	1383	1599	24	40	1615	212	490	1893	1779
8:45-9:0	248	111	359	113	246	1438	1684	28	40	1696	190	472	1978	1867
9:00-9:15	240	94	334	96	238	1492	1730	39	30	1721	235	515	2001	1907
9:15-9:30	198	111	309	112	197	1386	1583	29	35	1589	202	489	1876	1765
9:30-9:45	182	102	284	103	181	1398	1579	23	27	1583	214	530	1899	1797
9:45-10:00	221	104	325	106	219	1336	1555	23	30	1562	221	509	1850	1746

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
5:00-5:15	603	213	816	219	597	1689	2286	43	68	2311	560	553	2304	2091
5:15-5:30	570	148	718	153	565	1615	2180	23	78	2235	494	541	2282	2134
5:30-5:45	620	210	830	216	614	1750	2364	71	80	2373	515	575	2433	2223
5:45-6:00	706	195	901	202	699	1795	2494	67	79	2506	491	651	2666	2471
6:00-6:15	658	178	836	184	652	1789	2441	59	61	2443	502	537	2478	2300
6:15-6:30	582	206	788	211	577	1722	2299	63	65	2301	486	604	2419	2213
6:30-6:45	578	197	775	202	573	1595	2168	102	79	2145	435	533	2243	2046
6:45-7:00	566	189	755	194	561	1663	2224	75	45	2194	511	538	2221	2032

Week 2 Weekday

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
8:00-8:15	251	135	386	137	249	1706	1955	53	50	1952	290	631	2293	2158
8:15-8:30	240	121	361	123	238	1765	2003	43	55	2015	269	643	2389	2268
8:30-8:45	272	129	401	131	270	1783	2053	47	48	2054	261	594	2387	2258
8:45-9:0	314	136	450	139	311	1754	2065	35	46	2076	241	579	2414	2278
9:00-9:15	295	118	413	120	293	1749	2042	41	40	2041	279	627	2389	2271
9:15-9:30	255	128	383	130	253	1738	1991	49	33	1975	247	646	2374	2246
9:30-9:45	242	134	376	136	240	1758	1998	33	37	2002	261	627	2368	2234
9:45-10:00	254	121	375	123	252	1730	1982	36	40	1986	276	643	2353	2232

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
01:00-01:15	629	243	872	249	623	1718	2341	50	53	2344	554	526	2316	2073
01:15-01:30	600	219	819	225	594	1706	2300	46	41	2295	505	554	2344	2125
01:30-01:45	682	249	931	255	676	1893	2569	56	49	2562	547	576	2591	2342
01:45-02:00	786	245	1031	252	779	1896	2675	49	53	2679	514	650	2815	2570
02:00-02:15	738	213	951	220	731	1862	2593	52	49	2590	532	546	2604	2391
02:15-02:30	638	212	850	218	632	1821	2453	46	45	2452	485	611	2578	2366
02:30-02:45	605	242	847	248	599	1639	2238	44	41	2235	488	513	2260	2018
02:45-03:00	635	218	853	224	629	1748	2377	50	43	2370	554	541	2357	2139

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
5:00-5:15	612	232	844	238	606	1738	2344	22	47	2369	602	525	2292	2060
5:15-5:30	580	175	755	180	575	1699	2274	27	52	2299	516	538	2321	2146
5:30-5:45	643	235	878	241	637	1895	2532	47	43	2528	566	559	2521	2286

5:45-6:00	750	210	960	217	743	1872	2615	44	51	2622	524	620	2718	2508
6:00-6:15	705	180	885	187	698	1869	2567	42	49	2574	520	510	2564	2384
6:15-6:30	606	206	812	212	600	1807	2407	29	50	2428	523	580	2485	2279
6:30-6:45	586	211	797	216	581	1644	2225	75	32	2182	476	519	2225	2014
6:45-7:00	600	187	787	193	594	1740	2334	49	27	2312	541	524	2295	2108

Week 2 Weekend

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
8:00-8:15	201	110	311	112	199	1382	1581	42	39	1578	244	480	1814	1704
8:15-8:30	197	92	289	93	196	1465	1661	34	46	1673	229	502	1946	1854
8:30-8:45	229	100	329	102	227	1498	1725	40	39	1724	215	476	1985	1885
8:45-9:0	249	104	353	106	247	1369	1616	29	37	1624	181	487	1930	1826
9:00-9:15	231	91	322	93	229	1400	1629	35	34	1628	221	515	1922	1831
9:15-9:30	197	107	304	108	196	1426	1622	41	26	1607	210	511	1908	1801
9:30-9:45	199	101	300	102	198	1407	1605	26	30	1609	222	477	1864	1763
9:45-10:00	194	95	289	96	193	1384	1577	28	31	1580	227	496	1849	1754

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
8:00-8:15	365	144	509	147	362	997	1359	50	53	1362	316	300	1346	1202
8:15-8:30	342	119	461	122	339	939	1278	45	44	1277	273	327	1331	1212
8:30-8:45	348	127	475	130	345	1004	1349	59	50	1340	279	340	1401	1274
8:45-9:0	464	143	607	147	460	1100	1560	54	55	1561	278	390	1673	1530
9:00-9:15	392	122	514	125	389	1043	1432	55	52	1429	304	295	1420	1298

9:15-9:30	364	109	473	112	361	929	1290	44	46	1292	253	306	1345	1236
9:30-9:45	351	138	489	141	348	886	1234	42	45	1237	279	262	1220	1082
9:45-10:00	356	120	476	123	353	874	1227	53	41	1215	327	298	1186	1066

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
5:00-5:15	602	214	816	220	596	1686	2282	47	63	2298	561	552	2289	2075
5:15-5:30	567	149	716	154	562	1619	2181	19	74	2236	499	546	2283	2134
5:30-5:45	621	210	831	216	615	1747	2362	74	82	2370	515	573	2428	2218
5:45-6:00	710	195	905	202	703	1793	2496	70	74	2500	489	647	2658	2463
6:00-6:15	658	173	831	179	652	1793	2445	54	65	2456	499	540	2497	2324
6:15-6:30	581	201	782	206	576	1725	2301	61	62	2302	487	604	2419	2218
6:30-6:45	582	199	781	204	577	1594	2171	100	80	2151	431	531	2251	2052
6:45-7:00	567	188	755	193	562	1665	2227	73	40	2194	508	542	2228	2040

Peak Hour Volumes and Projected Peak Hour Volumes

Rate of growth (%)	=	3

For Year 0	
1	2844
2	919
3	3763
4	945
5	2818
6	7472
7	10290
8	203
9	196
10	10283
11	2078
12	2383
13	10588
14	9669

For Year 5	
1	3296
2	1065
3	4362
4	1095
5	3266
6	8662
7	11928
8	235
9	227
10	11920
11	2408
12	2762
13	12274
14	11209

For Year 10	
	3822
	1235
	5057
	1270
	3787
	10041
	13828
	272
	263
	13819
	2792
	3202
	14229
	12994