TRAFFIC STUDIES AND VISSIM ANALYSIS
SAMBRIAL-KHARIAN MOTORWAY

A CASE STUDY

UNDERGRADUATE FINAL YEAR PROJECT

Project submitted in partial fulfillment of the requirements for the degree of

BE Civil Engineering

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MILITARY COLLEGE OF ENGINEERING

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This is to certify that the

BE Civil Engineering Project entitled

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has been accepted towards the partial fulfilment of the requirements for

BE Civil Engineering Degree.

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Dr. Inam

Syndicate Advisor

Dedication

Special dedication to

Our loving parents,

Our supervisor,

Our Instructors,

Our well wishers,

And all those, who helped us reach this mark.

For all support, encouragement and believe in us. Thank you so very much.

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Abstract

NHA intends to extend Lahore Sialkot motorway from its end point at Sambrial towards Kharian (Phase-1) and onward towards Rawalpindi/Islamabad (Phase-2). The total length of the project being conceived between Sambrial to Kharian (Phase-1) is 68 km, including link highway at Kharian connecting to national highway N-5. The proposed alignment of Sambrial Kharian motorway traverses across major populated areas in district Gujrat. The traffic study carried out contains traffic counts, which were carried out for 24 hours consecutively for three (03) days. Total 17 (seventeen) traffic count locations were selected after field visits. Traffic volumes were collected from these locations which connect major regions/population centers along the proposed alignment of motorway. Historical growth trends were reviewed to determine Population growth, growth in GDP, growth of registered vehicles in Pakistan, growth of registered vehicles in Punjab, growth in fuel consumption etc. Origin destination (OD) survey was carried out at selected locations to assess travel patterns between transportation analysis zones (TAZs). Data was analyzed through specialized travel demand modeling software i.e. PTV VISSIM . Maximum-car technique and average-car technique was adopted for travel time survey. Data obtained from travel time survey was used in calibration of VISSIM for analysis. Links along with interchanges were drawn and traffic volume was coded in modelling software. Choice of route was evaluated Origin-Destination Survey using the TAZ's. Vissim analysis was performed to predict the Level of Service throughout the design period. Remedial measures were suggested where the LOS fell below the acceptable range.

CHAPTER 1

INTRODUCTION

1.1 Project Background

NHA intends to extend the Lahore Sialkot motorway corridor from its end point at Sambrial towards Kharian and onwards toward Rawalpindi/Islamabad with possible connection with the new Islamabad International Airport at Thalian interchange on the Islamabad Lahore motorway M-2. Presently the facility is being conceived as a 4-lane extendable to 6-lane motorway. This corridor will serve the greater parts of the population centers located along National Highway N-5 and will also serve northern Punjab along the eastern borders. The development of this high-speed corridor is a phased program where it is intended that Sambrial to Kharian should be taken as second phase and its onward extension from Kharian to Rawalpindi in the third phase, the first phase being Lahore to Sialkot Motorway. The starting point of proposed project is Sambrial city (end point of LSM), situated on the upper bank of Chenab canal and will terminate near Kharian connecting N-5 via high speed fenced link highway. The total Length of the project is 68km including the link highway at Kharian. **Figure 1.1** shows the proposed alignment of Sambrial Kharian motorway traversing along major populated areas in district Gujrat i.e. Jalalpur Jattan, Peru shah, Daulat Nagar, Gulyana and terminates near Kotli Bajar where it will be connected via link highway to N-5 with provision of interchange. The proposed profile of Sambrial Kharian motorway is given below:

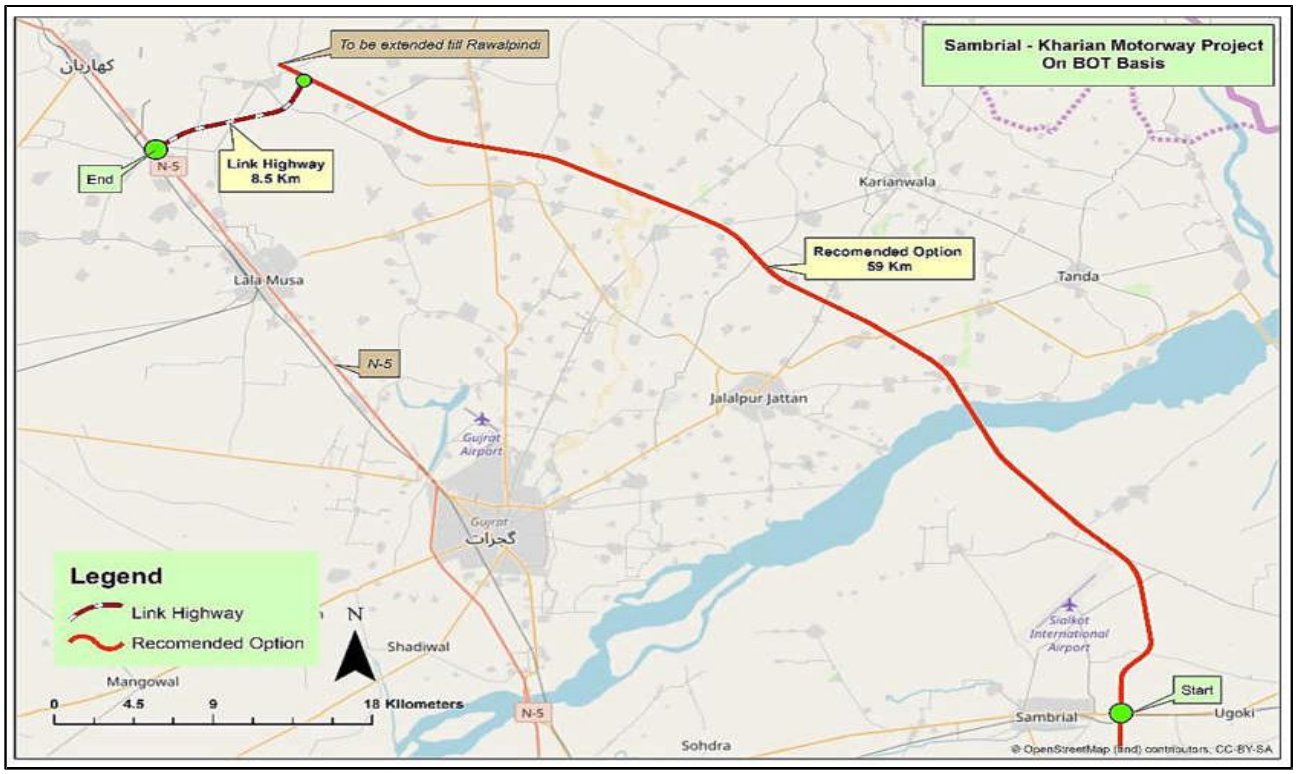


Figure 1.1: Proposed Sambrial Kharian motorway

1.2 Simulation

Simulation modeling provides better solutions by giving clear insights into complex systems. Computer simulation is used when conducting experiments on a real system is impossible or impractical. Simulation can be done at corridor level to analyze delay time, tool revenue, queue length and congestion. Traffic Simulation is used for studying models which are difficult to solve through analytical or numerical technique, for experimental studies, for studying detailed relations and can easily produce future scenario visually in high quality result. Traffic simulation is the mathematical modeling of transportation systems (e.g., freeway junctions, roundabouts, Links and connectors, signal control etc.) through the application of computer software to better help plan, design and operate transportation system. Software used for simulation of Sambrial Kharian Motorway is VISSIM.

VISSIM is microscopic multi-modal traffic flow simulation software. Microscopic simulation considers each individual entity thus considering all factors of an entity, like efficiently analyzing traffic flow through intersection. Micro simulation is often used to evaluate the proposed interventions prior to their construction in reality, its multi-modality allowed it to simulate more than one type of traffic like cars, trucks cycles etc.

Traffic data for the simulation was provided in the study report. Traffic volume of 2021, 2031 and 2041 was given as input and the desired results were obtained, evaluated and analyzed to check the serviceability of the proposed motorway throughout the design period.

1.3 Aims & Objectives

At the completion of the project, following objectives are desired to be achieved

1) Understand different methods through which data is collected for analysis and to learn about the procedure of converting that data into useful input for analysis.
2) Attain Requisite amount of proficiency over the Vissim by learning about the calibration procedures of the software and attaining the desired results by putting in different parameters such as traffic count, link length, simulation period etc.
3) Determine the different parameters such as Queue length, Delay time, Vehicle Delay and LOS by putting in the traffic volume calculated from Traffic Count Locations.
4) Analyze the results obtained for different parameters and conclude whether the proposed road would be sufficient to take the expected traffic during the design period.
5) In case the Level of Service comes in the unacceptable range, to come up with the recommendations to bring the Level of service within the desired range.

1.4 Problem Statement

Road network construction is very time consuming and costly task, so before undertaking the construction of a freeway or motorway, it is necessary to check it for its adequacy and whether it will accommodate the anticipated traffic or not. Since the motorway is yet to be built, so in the absence of any real time data, the only option is to simulate the data and analyze it using some well established measure of effectiveness. In view of above, there is a need to carryout detailed analysis beforehand to save cost and time which will be wasted in undertaking remedial measures once the project has been completed.

Vissim can help us in the analysis of the proposed road network. There are different outputs that can be recorded, and future scenarios can be predicted using this software based on the results of simulation. Level Of Service (LOS) criteria is going to be used as a measure of effectiveness to assess the traffic at the interchanges throughout the design period. LOS will provide sound base for the analysis and remedial measures will be recommended based on the simulation results to counter the drop in LOS.

1.5 Scope of the Study

The project will be covering a variety of the aspects including the understanding of study report as well as the use of the VISSIM software. The scope of the project with respect to these aspects is given below:

1) Study and analysis of traffic report for traffic calculation and Separation Traffic

Study report estimates the traffic on the Sambrial Kharian Motorway for the year 2021 but in order to determine the traffic growth during the design life of the project, Geometric growth Method will be used. For separation of traffic at the interchanges, results from O-D survey will be inducted into the study.

2) Understanding VISSIM, its features and tools

Simulation allows evaluating the future scenario prior to construction for the projects that are time consuming; VISSIM is used for simulation purpose. All the features and characteristics of the VISSIM software will be learnt and practice to attain full command over the VISSIM, minimizing the chances of error.

3) Determining serviceability from Level of service

After running simulation, results will be generated leading to the level of service indicating the serviceability. LOS ranges from A (best) to F (worst). Remedial measures will also be suggested in case of any inadequacy.

Chapter 2

Literature Review

Literature review consists of two different parts:

1) Literature review of study report
2) Literature review of VISSIM

2.1 Literature review of study report

2.1.1 Traffic data collection

To evaluate traffic volume, on-site classified traffic counts data is necessary for which several methods are available. Two (02) of the widely used methods are described below:

2.1.1.1 Manual Counting Method

In this method, vehicles are counted manually using tally sheets. Manual counting method can further be divided into two categories:

2.1.1.1.1 Direct Count Method

In direct count method vehicles are counted at site using tally sheets manually. Using this method vehicles classification and traffic turning counts can also be obtained. Usually 2(two) to 3(three) surveyors are required to carry out this type of traffic count in a single working shift. Accuracy may get effected on high speed traffic volume roads.

2.1.1.1.2 Indirect Count Method

In this method traffic data is collected and saved in digital form using a high resolution video recording cameras. Cameras are installed at a suitable place to cover significant road lengths. This is beneficial since video can be captured for a longer duration without interruption and can be used later in the office for translation into classified counts

2.1.1.2 Automated Count Method

This method is employed in cases where manual count method is not feasible. Various instruments are available for automatic count, each with merits and demerits. Some of the widely used instruments are pneumatic tubes, inductive loops, weigh-in-motion sensor, micro-millimeter wave Radar detectors and video cameras. Given that hi-tech equipment is available in the market, it may be noted all such gadgets are sensitive to axle configurations. This element is important since in most of the developing countries like Pakistan, axle configurations are mostly tailored locally to carry over loads. This puts the accuracy of these equipments in question and needs to be verified with the video recording. In such cases, traffic count becomes a lengthy process.

Figure 2.1 Video Recording Unit

Figure 2.2 Pneumatic Tube

2.1.2 Data Collections and Schedule

Study area was defined based on influential areas of purposed Sambrial Kharian Motorway. Total 17 locations were identified on the roads within study areas. The counts were conducted for 3 days for both directions at 17 locations. **Figure 2.3** shows the traffic count locations on map and **Table 2.1** shows details of traffic count locations. The results of these counts are shown below.

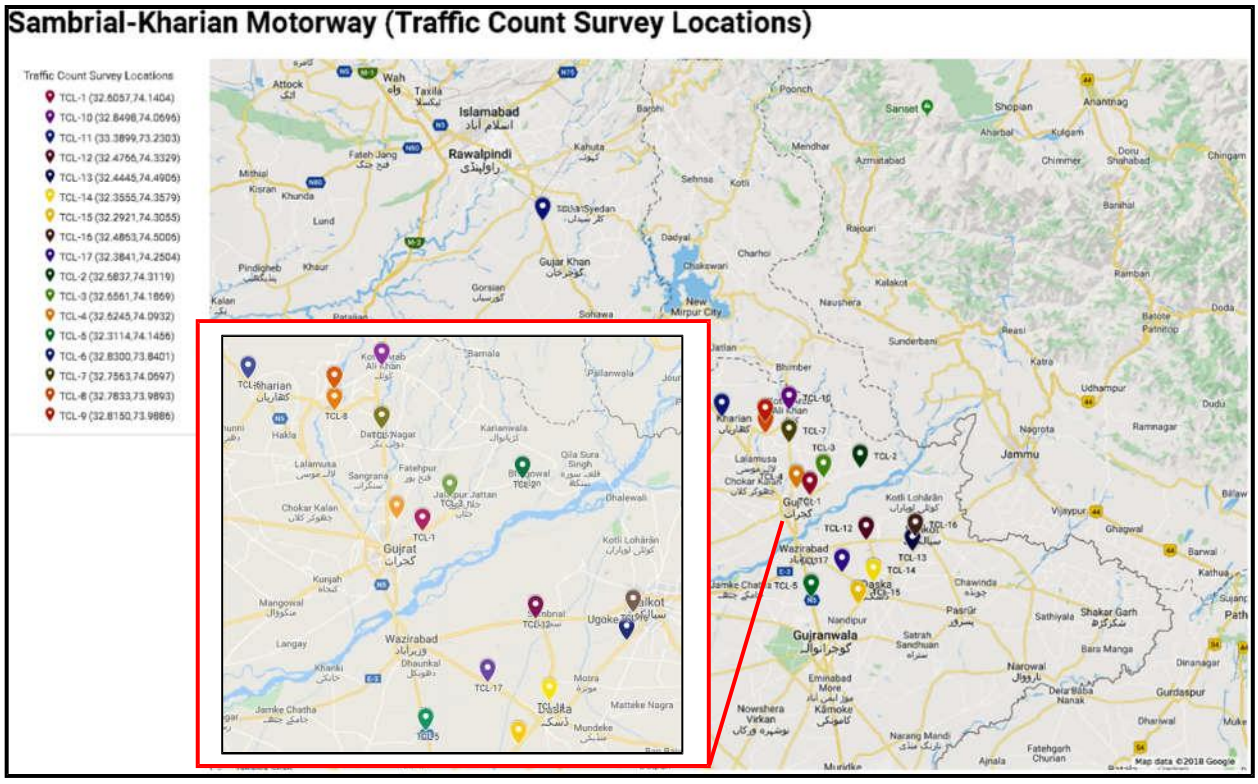


Figure 2.3: Traffic Count Locations

Table 2.1 : List of Traffic Locations

Traffic Count	Location	Google Coordinates	Traffic Movement	
			From	To
TCL-1	Sook Kalan	32.6040, 74.1420	Gujrat	Jalal Pur Jattan
TCL-2	Alam Garh	32.6837, 74.3119	Jalal Pur Jattan	Tanda
TCL-3	Khokha Stop	32.6837, 74.3119	Jalal Pur Jattan	Daulat Nagar
TCL-4	Lorai	32.6245, 74.0932	Gujrat	Fatehpur
TCL-5	Ghakkar Mandi	32.3114, 74.1456	Gujranwala	Wazirabad
TCL-6	Kharian	32.8300, 73.8401	Gujrat	Jhelum
TCL-7	Saida	32.7563, 74.0697	Daulat Nagar	Kotla Arab Ali Khan
TCL-8	Bhaddar	32.7833, 73.9893	Daulat Nagar	Gulyana
TCL-9	Kotli Bajar	32.8150, 73.9886	Kotla Arab Ali	Gulyana
TCL-10	Kotla Arab Ali Khan	32.8498, 74.0696	Bhimber	Daulat Nagar
TCL-11	Mandra	33.3877, 73.2253	Gujar Khan	Rawalpindi
TCL-12	Sambrial	32.4766, 74.3329	Sambrial	Wazirabad
TCL-13	Daska Road	32.4445, 74.4906	Sialkot	Daska
TCL-14	Sambrial Road	32.3555, 74.3579	Daska	Sambrial
TCL-15	Gujranwala Road	32.2921, 74.3055	Daska	Gujranwala
TCL-16	Ugoke Road	32.4863, 74.5006	Sialkot	Sambrial
TCL-17	Daska-Wazirabad	32.3841, 74.2504	Daska	Wazirabad

2.1.3 Vehicle Classification

Following vehicles classes as given in **Table 2.2** below were considered for traffic count surveys:

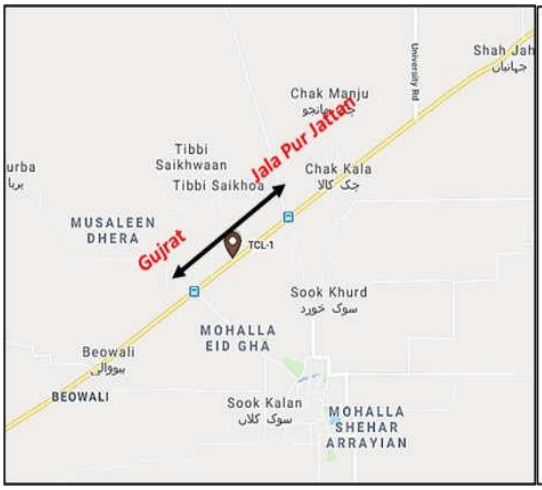
Table 2.2 : Vehicle Classification

Sr. #	Vehicle Class	Category
1	Cars, Jeeps, 4x4, Pickups	Private Vehicle
2	Hiaces, Mini buses	Public Transport Vehicle
3	Large Buses	Public Transport Vehicle
4	2 Axle Rigid Truck	Freight Vehicle
5	3 Axle Rigid and Articulated Truck	Freight Vehicle
6	4 Axle Articulated Truck	Freight Vehicle
7	5 Axle Articulated Trucks	Freight Vehicle
8	>5 or 6 Axle Articulated Trucks	Freight Vehicle

2.1.4 Traffic Study Results

Traffic Count Location 1 (Gujrat with Jalalpur Jattan)

- Traffic count location 1 is situated on a road connecting Gujrat with Jalalpur Jattan near Sook kalan.
- Average of three (03) days equal to 6806 number of vehicles have been considered as an average daily traffic (ADT) for analysis purpose in a specialized traffic modeling software.
- Traffic at count station TCL-1 comprises of 84% of cars, 11% of public transport vehicles and 5% of freight vehicles



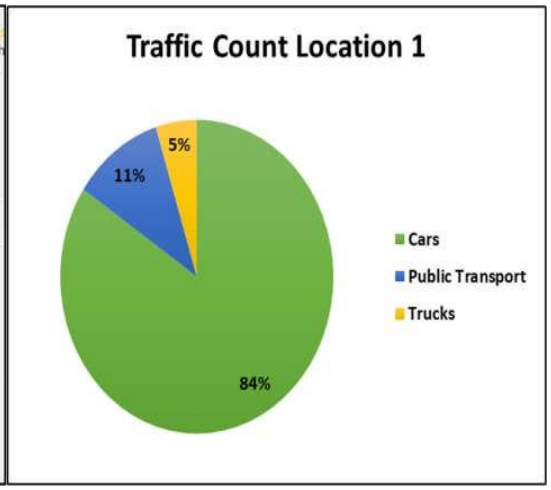
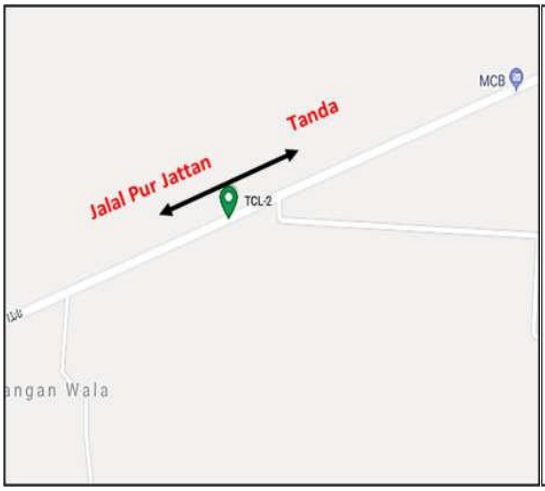


Figure 2.4: Location of TCL-1

Figure 2.5: Proportion of Traffic (TCL-1)

Traffic Count Location 2 (Tanda road)

- Traffic count location 2 is situated on Tanda road (near T-junction of Kasoki road and Tanda road) connecting Jalalpur Jattan with Tanda.
- Maximum of 2288 vehicles were recorded.
- Average of three days equal to 2119 (ADT) has been considered for analysis in the traffic modeling software.
- Traffic at TCL-2 comprises of 78% of cars, 14% of public transport vehicles and 8% of freight vehicles.



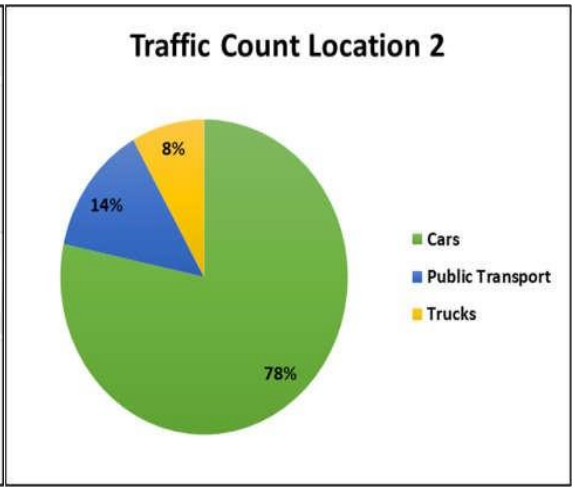


Figure 2.6: Location of TCL-2

Figure 2.7: Proportion of Traffic (TCL-2)

Traffic Count Location 3 (Kharian-Jalalpur Jattan)

- Traffic count location 3 is situated on a Kharian-Jalalpur Jattan road (near Khokha stop) connecting Daulat Nagar with Jalalpur Jattan.
- Maximum 2257 vehicles were recorded.
- Average of three days equal to 1999 (ADT) has been considered for analysis and data usage in modeling software.
- Traffic at TCL-3 comprises of 76% of cars, 15% of public transport vehicles and 9% of freight vehicles.

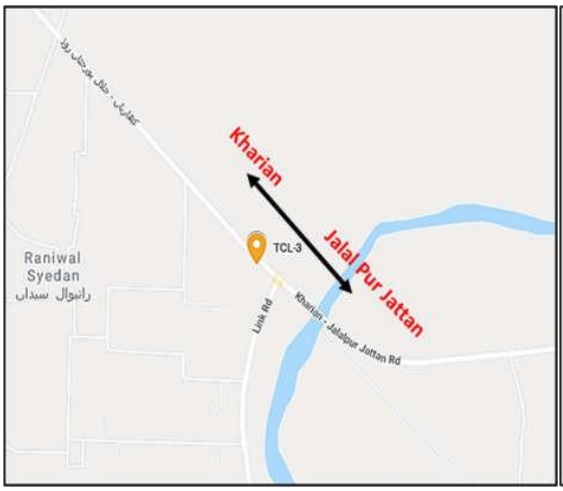


Figure 2.8: Location of TCL-3

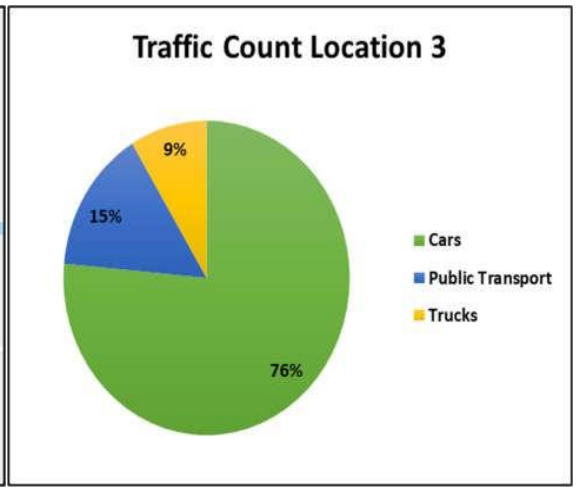
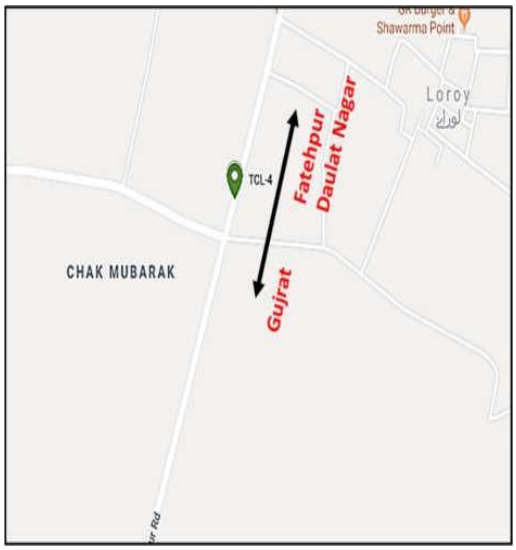


Figure 2.9: Proportion of Traffic (TCL-3

Traffic Count Location 4 (Gujrat-Fatehpur)

- Traffic count location 4 is situated on a Gujrat-Fatehpur road (near Lorai) connecting Gujrat and Fatehpur.
- Maximum 2165 vehicles were recorded.
- Average of three days equal to 2024 (ADT) has been considered for analysis and data usage in modeling software.
- Traffic at TCL-4 comprises of 88% of cars, 8% of public transport vehicles and just 4% of freight vehicles



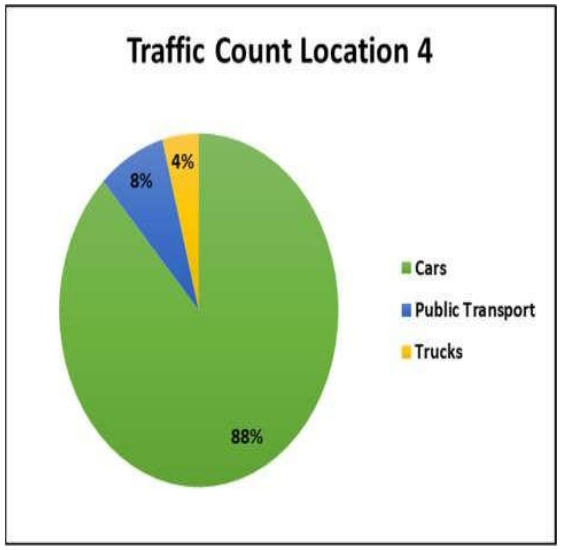


Figure 2.10: Location of TCL-4

Figure 2.11: Proportion of Traffic (TCL-4)

Traffic Count Location 5 (Ghakkar Mandi)

- Traffic count location 5 is situated on a GT road N-5 near Ghakkar Mandi in order to record the traffic volume between Wazirabad and Gujranwala.
- Maximum of 65554 vehicles were recorded at TCL-5 with 59% of cars, 24% of public transport vehicles and 17% of freight vehicles.

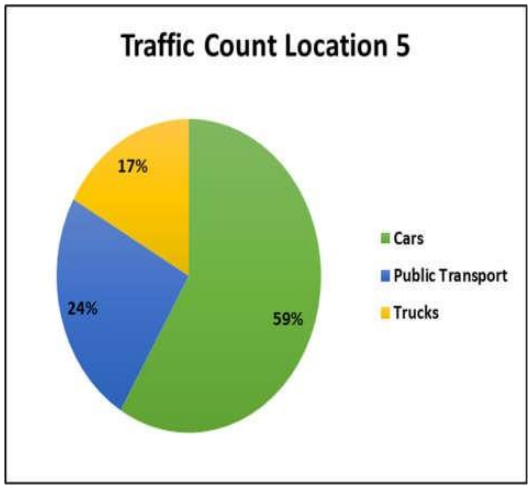


Figure 2.12: Location of TCL-5

Figure 2.13: Proportion of Traffic (TCL-5)

Traffic Count Location 6 (GT road N-5 near Kharian)

- Traffic count location 6 is situated on a GT road N-5 near Kharian in order to record the traffic volume between Gujrat and Jhelum.
- Maximum of 66160 vehicles were recorded at TCL-6 where traffic comprises 52% of cars, 29% of public transport vehicles and 19% of freight vehicles.

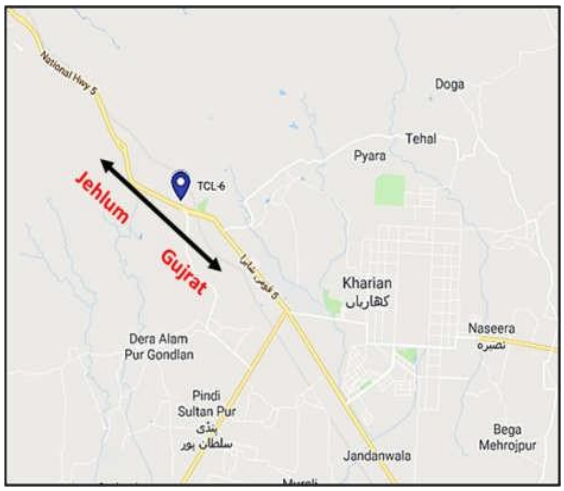


Figure 2.14: Location of TCL-6

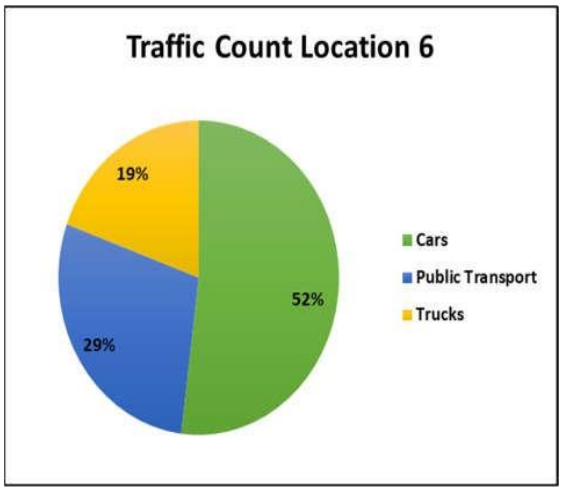


Figure 2.15: Proportion of Traffic (TCL-6)

Traffic Count Location 7 (Bhimber road)

- Traffic count location 7 is situated on Bhimber road (near Saida) connecting Daulat Nagar and Kotla Arab Ali Khan. Maximum of 2105 vehicles were recorded.
- Average of three days equal to 1706 (ADT) has been considered for analysis and data usage in modeling software.
- Traffic at TCL-7 comprises 68% of cars, 25% of public transport vehicles and just 7% of freight vehicles.

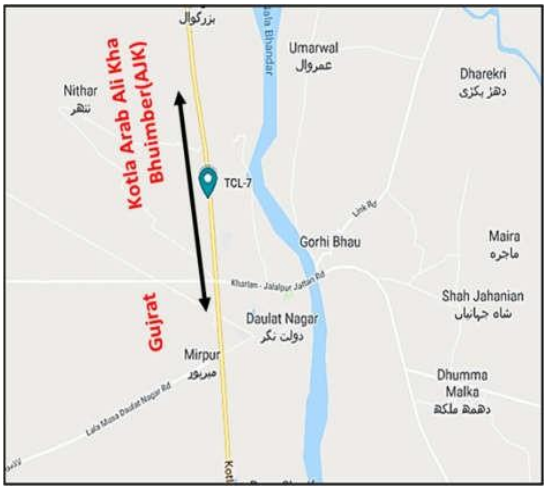


Figure 2.16: Location of TCL-7

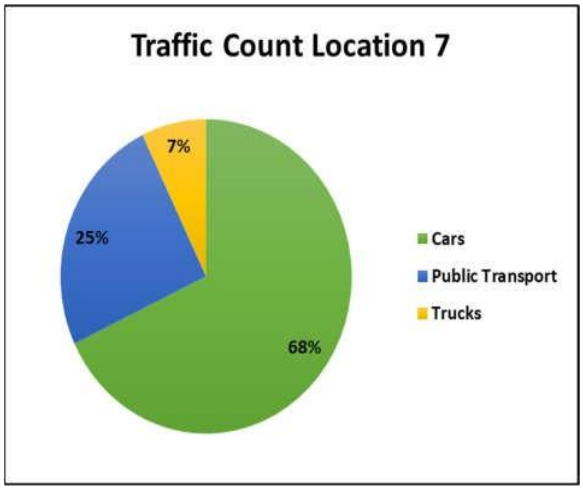


Figure 2.17: Proportion of Traffic (TCL-7)

Traffic Count Location 8 (Kharian-Jalalpur Jattan)

- Traffic count location 8 is situated on Kharian-Jalalpur Jattan road (near Bhaddar) connecting Bhimber to Kharian, Gujrat to Kharian via Daulat Nagar and Jalalpur Jattan to Kharian.
- Maximum of 2580 vehicles were recorded.
- Average of three days equal to 2413 (ADT) has been considered for analysis and data usage in modeling software. Traffic at TCL-8 comprises 80% of cars, 14% of public transport vehicles and just 6% of freight vehicles.

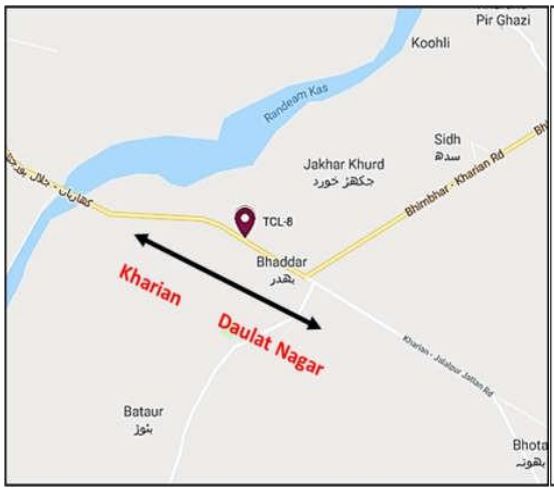


Figure 2.18: Location of TCL-8

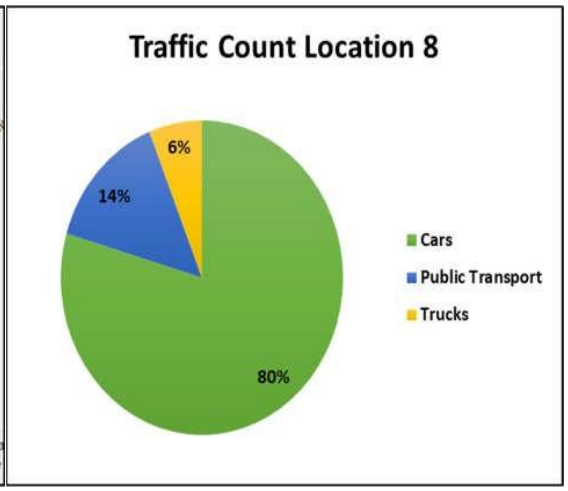


Figure 2.19: Proportion of Traffic (TCL-8)

Traffic Count Location 9 (Gulyana-Kotla Arab Ali Khan)

- Traffic count location 9 is situated on Gulyana-Kotla Arab Ali Khan road (near Kotli Bajar) connecting Kharian and Kotla Arab Ali Khan. The traffic count contains volume of traffic moving between Kharian and Bhimber
- Maximum of 2209 vehicles were observed.
- Average of three days equal to 2023 (ADT) has been considered for analysis and data usage in modeling software. Traffic at TCL-9 comprises 80% of cars, 9% of public transport vehicles and just 11% of freight vehicles.

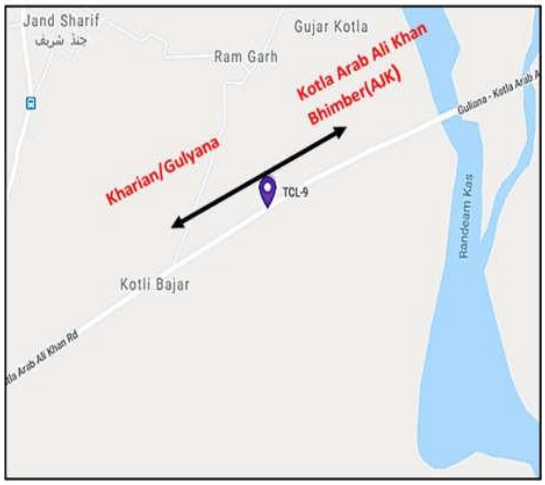


Figure 2.20: Location of TCL-9

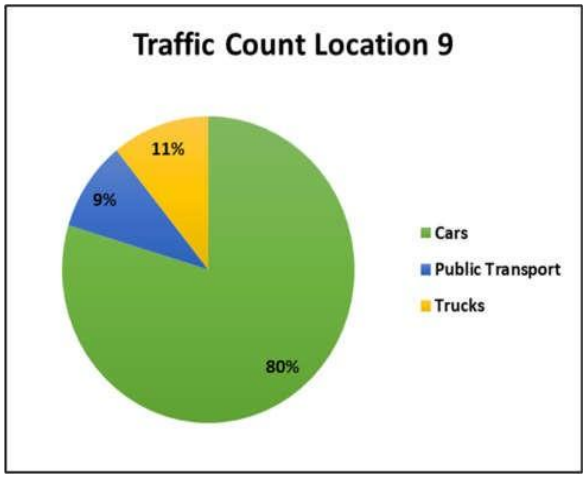


Figure 2.21: Proportion of Traffic (TCL-9)

Traffic Count Location 10 (Kotla Arab Ali Khan)

- Traffic count location 10 is situated on Kotla Arab Ali Khan road (near intersection of Kotla road with Gulyana-Kotla road). The traffic count contains volume of traffic commuting between Bhimber, Kharian and Daulat Nagar.
- Maximum of 4577 vehicles were recorded.
- Average of three days equal to 4290 (ADT) has been considered for analysis and data usage in modeling software. Traffic at TCL-10 comprises 80% of cars, 16% of public transport vehicles and just 4% of freight vehicles.

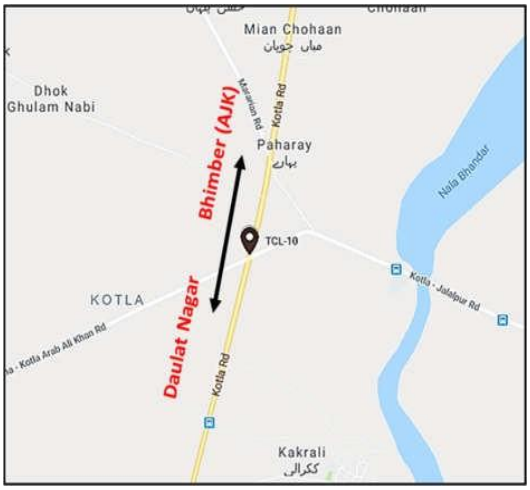


Figure 2.22: Location of TCL-10

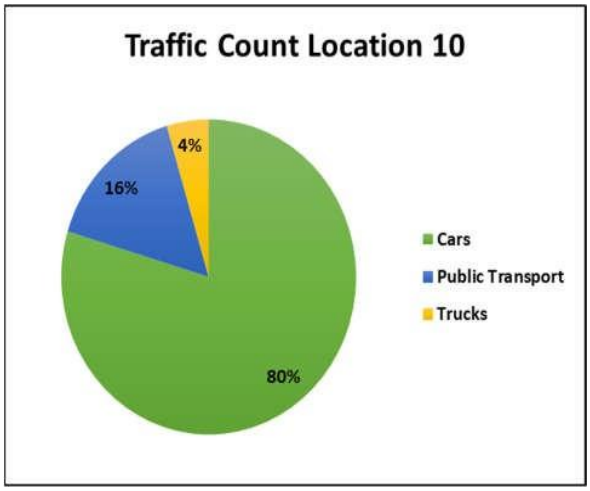


Figure 2.23: Proportion of Traffic (TCL-10)

Traffic Count Location 11 (Mandra Toll plaza)

- Traffic count location 11 is situated on a GT road N-5 at Mandra Toll plaza in order to record the traffic volume commuting between Gujar Khan and Rawalpindi.
- Maximum 33380 vehicles were observed at TCL-11 where traffic comprises 43% of cars, 30% of public transport vehicles and 27% of freight vehicles

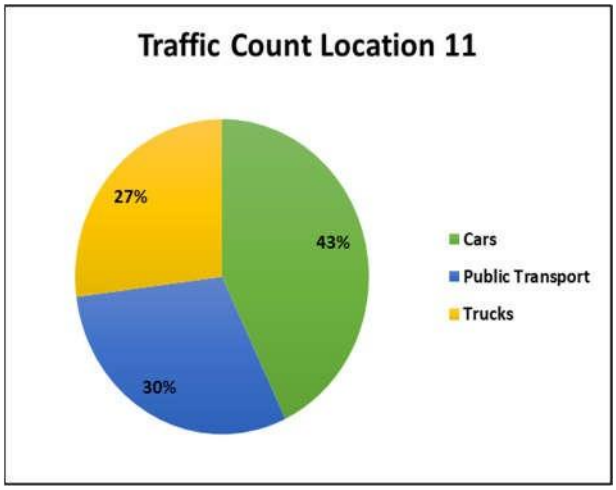


Figure 2.24: Location of TCL-11

Figure 2.25: Proportion of Traffic (TCL-11)

Traffic Count Location 12 (Sialkot-Wazirabad)

- Traffic count location 12 is situated on Sialkot-Wazirabad road where traffic volume commuting between Sambrial and Wazirabad was recorded.
- Maximum of 9549 vehicles were recorded at TCL-12 which comprises 71% of cars, 16% of public transport vehicles and 13% of freight vehicles

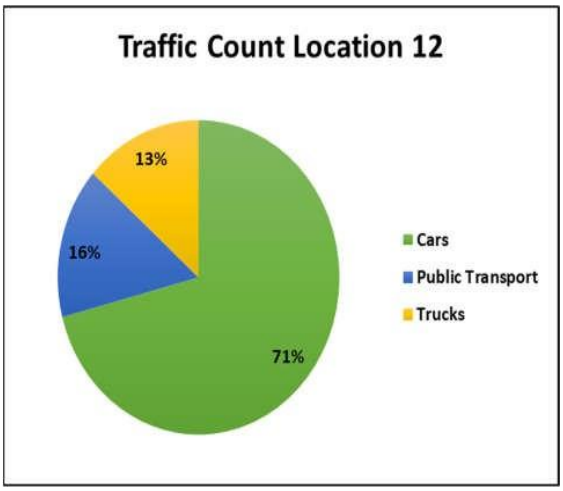


Figure 2.26: Location of TCL-12

Figure 2.27: Proportion of Traffic (TCL-12)

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Traffic Count Location 13 (Sialkot-Daska)

- Traffic count location 13 is situated on Sialkot-Daska road where traffic volume commuting between Sialkot and Daska was recorded.
- Maximum of 17119 vehicles were recorded at TCL-13 which comprise 66% of cars, 22% of public transport vehicles and 12% of freight vehicles.

Figure 2.28: Location of TCL-13

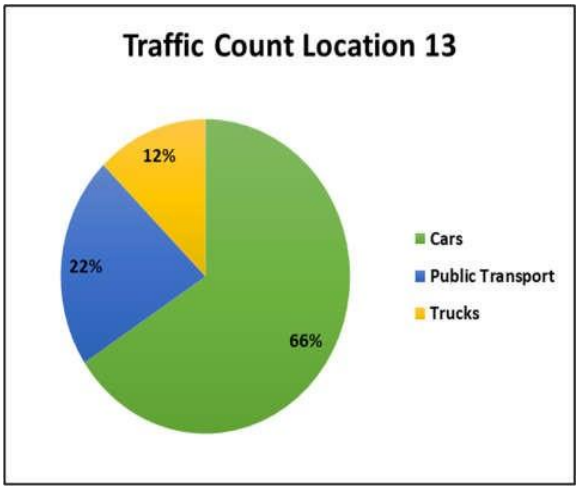
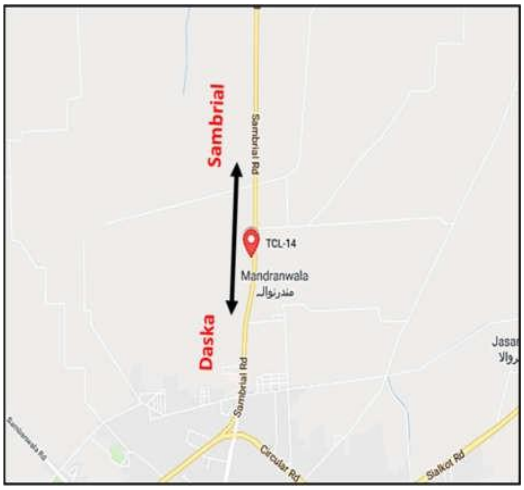


Figure 2.29: Proportion of Traffic (TCL-13)

Traffic Count Location 14 (Sambrial-Daska)

- Traffic count location 14 is situated on Sambrial-Daska road (near Mandran wala) where traffic volume commuting between Sambrial and Daska was recorded.
- Maximum of 4348 vehicles were observed at TCL-14 where traffic comprises 70% of cars, 15% of public transport vehicles and 15% of freight vehicles.



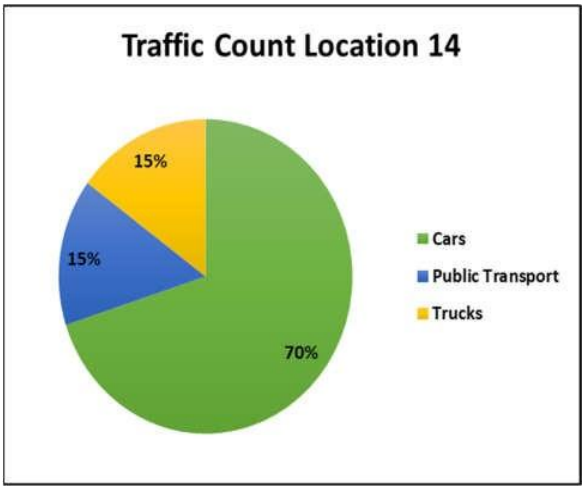
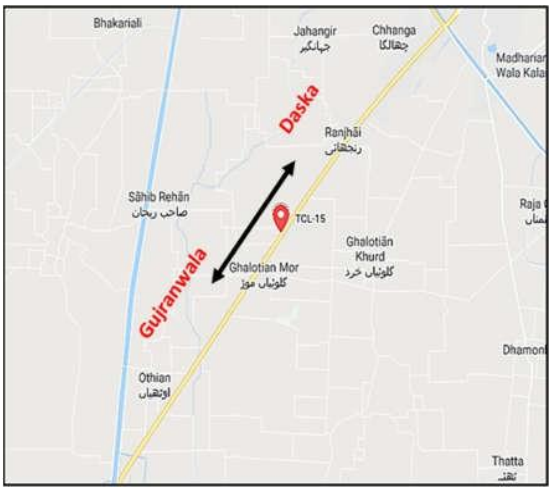


Figure 2.30: Location of TCL-14

Figure 2.31: Proportion of Traffic (TCL-14)

Traffic Count Location 15 (Gujranwala-Daska)

- Traffic count location 15 is situated on Gujranwala-Daska road where traffic volume commuting between Gujranwala and Daska was recorded.
- Maximum of 15412 vehicles were recorded at TCL-15 where traffic comprises 84% of cars, 11% of public transport vehicles and 5% of freight vehicles.



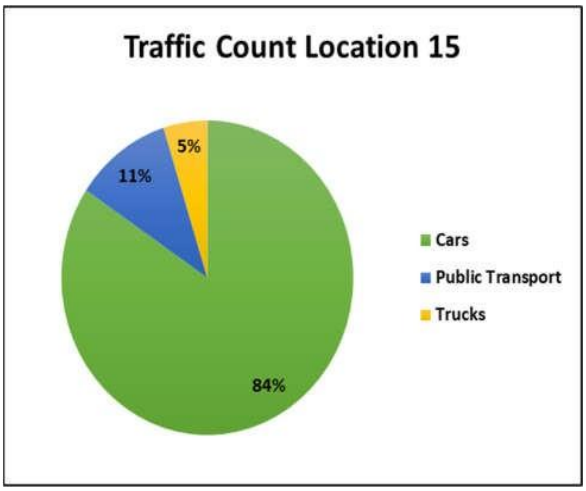


Figure 2.32: Location of TCL-15

Figure 2.33: Proportion of Traffic (TCL-15)

Traffic Count Location 16 (Ugoki)

- Traffic count location 16 is situated on Ugoki road where traffic volume commuting between Sambrial and Sialkot was recorded.
- Maximum of 11643 vehicles were observed at TCL-16 where traffic comprises 68% of cars, 21% of public transport vehicles and 11% of freight vehicles.

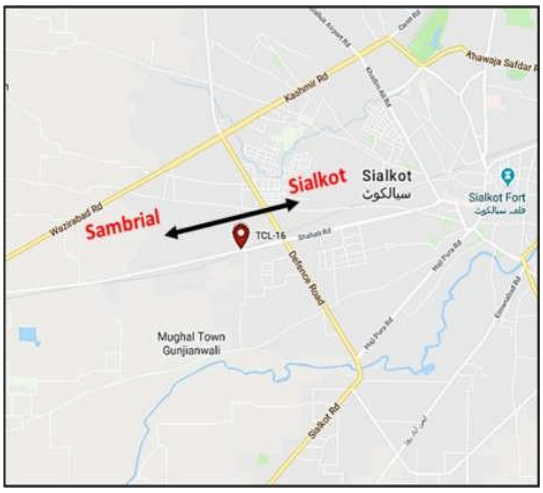


Figure 2.34: Location of TCL-16

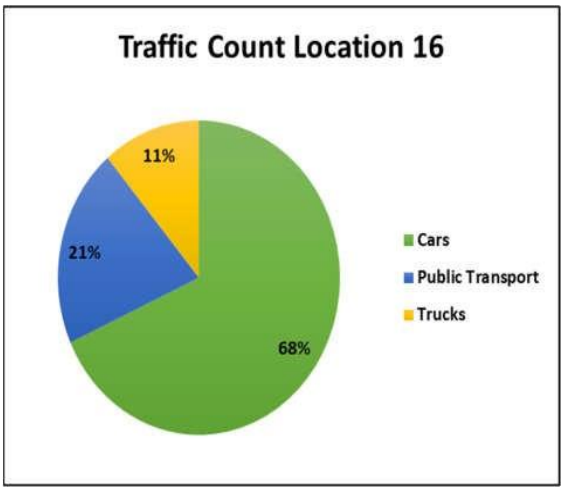


Figure 2.35: Proportion of Traffic (TCL-16)

Traffic Count Location 17 (Wazirabad-Daska)

- Traffic count location 17 is situated on Wazirabad-Daska road in order to record the traffic volume commuting between Daska and Wazirabad.
- Maximum of 2808 vehicles were recorded at TCL-17 where traffic comprises 57% of cars, 18% of public transport vehicles and 25% of freight vehicles.

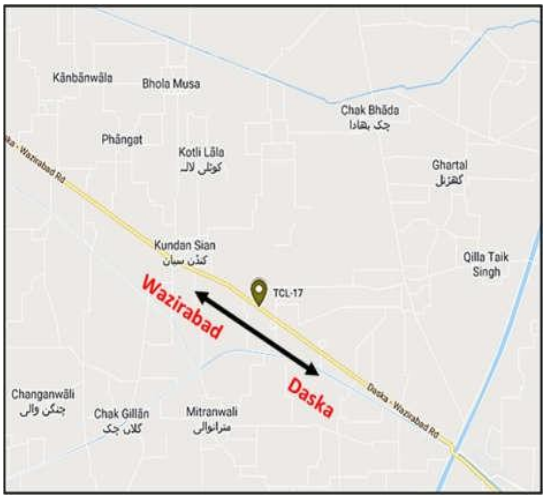


Figure 2.36: Location of TCL-17

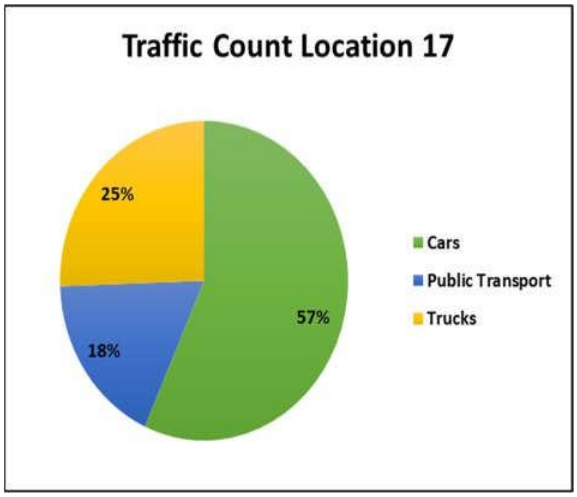


Figure 2.37: Proportion of Traffic (TCL-17)

2.1.5 Average Daily Traffic

Average daily traffic is the 24 hour average volume over a certain location for a time period less than a year. Highest ADT was observed on GT road N-5 near Ghakkar Mandi (TCL 5).

2.1.6 Determination of Growth Rate Factors

To estimate future forecast of travel demand data, traffic growth rate is to be obtained for each class of vehicle considered in the network and facility. Historical growth trends have been reviewed for following indicators to determine growth rates for this study:

- Population growth rates
- Growth in GDP and Growth in industrial and agriculture sector
- Growth of registered vehicles in Pakistan
- Growth of registered vehicles in Punjab

2.1.6.1 Population Growth Rates

Population is taken as primary feature that can directly influence the traffic growth rate. Land use pattern changes with increase in population of region and hence travel demand increases. In Year 2010 Pakistan's estimated population was 173.57 million and country became a 6th most populated country in the world with 57% increase in 19 years. Population data of Pakistan has been reviewed and outcomes revealed that the population growth trend is 1.93% per annum. Recent census conducted in 2017 reveals the population figure of 207.77 million with Punjab being the most populated province among others, sharing 35.4% of the total population and the total urban population is sharing 36.4% of the total population.

2.1.6.2 Growth in GDP & Growth in Industrial and Agriculture Sector

Growth in GDP generally reflects in the growth of passenger and freight traffic. In last 5 decade overall GDP of Pakistan has increased with average growth rate of 5.1% and since 2000 it is increasing with average growth rate of 4.48% per annum. This growth trend of economic value fits well with the growth rate of vehicles in Pakistan.

2.1.6.3 Growth of registered Vehicles in Pakistan

- The average rate of growth of cars for the last five years is 6.3%
- The rate of growth of buses is 3%
- The rate of growth of trucks is 3.4%

2.1.6.4 Growth of registered Vehicles in Punjab

- The rate of growth of cars for last five years in Punjab is 8.5%
- The rate for buses is 5.5%
- The rate of growth of trucks is 10.5%
- This rate is higher than the overall rate of growth in Pakistan

2.1.7 Origin-Destination (OD) Survey

Origin Destination (O-D) survey is considered as most important characteristic to understand the transportation needs of an area and region generating and attracting traffic. This determines the travel demands in terms of trips between various zones, region or cities included in the study area. Travel demand is evaluated in terms of trips which are defined as one-way movement with start (i.e. Origin) to end (i.e. destination). OD surveys are useful in assisting long-range traffic planning, especially for development of new road links. The purpose of OD survey is to assess the travel pattern between transportation analysis zones (TAZs). Therefore, prior to perform survey the study area needs to be divided into zones (TAZs) and series of question should be asked from the travelers of different classes of vehicles i.e. cars, jeeps, buses, trucks etc. An origin-destination survey is also used to determine travel patterns of traffic in transportation network during a typical day. The same data can then be used in specialized travel modeling software i.e. PTV VISSIM for analysis.

2.1.8 Survey Questionnaire

The basic purpose of survey is to have an idea/estimate of the traffic volume for the traffic count.

i. O-D Info

ii. Trip Purpose

iii. Trip Frequency

iv. Willingness to pay toll for new Sambrial-Kharian Motorway

2.1.8.1O-D Info

The destinations and origins of all the vehicles were asked in order to determine the need of the route to minimize the travel time.

2.1.8.2 Trip Purpose

I. Home based trip (traveling towards or coming from home)
II. Work based trip (travelling towards work place)
III. Educational (travelling towards educational institute i.e. school, college, university etc.)
IV. Others (includes: Shopping, recreational etc.)

2.1.8.3 Trip Frequency

I. Daily
II. Once a Week
III. Two or Three Times a week
IV. Others (Once in a month/Rarely)

It was observed that most of the trips in the study area were making daily trips ranging from 33% to 79%.

2.1.9 Willingness to Pay Toll

During the O-D Survey, drivers were asked about the willingness to pay Toll at proposed Sambrial-Kharian Motorway. About 89% users agreed to pay the Toll.

2.1.10 Travel Time Study

Travel time studies are performed between the key trip generation and attraction zones. This study is under taken to utilize the travel time data and speed data in order to analyze the link's Level of Service (LOS) and operational performance. Other major utilization of travel time studies are:

- To identify problem locations on facilities by virtue of high travel times and/or delay;
- To measure arterial level of service, based on average travel speeds and travel times;
- To provide travel-time data for economic evaluation of transportation improvements;

- To develop time, contour maps and other depictions of traffic congestion in an area or region'

Following techniques are generally used to assess travel time:

- **Floating-car technique**. In this technique, the test-car driver is asked to pass as many vehicles as pass the test car. In this way, the vehicle's relative position in the traffic stream remains unchanged, and the test car approximates the behavior of an average vehicle in the traffic stream.
- **Maximum-car technique.** In this procedure, the driver is asked to drive as fast as is safely practical in the traffic stream without ever exceeding the design speed of the facility.
- **Average-car technique.** The driver is instructed to drive at the approximate average speed of the traffic stream.

2.1.11 Travel Demand Modelling

Travel demand modeling is a forecasting tool and procedure to assess travel demand and supply. Since many decades three step modeling is the most popular procedure used by transportation practitioners. Three step modeling includes trip generation, trip distribution, and trip assignment. These are briefly defined below:

2.1.11.1 Trip Generation

Trip generation involves estimating the number of trips that will be produced from or attracted to the proposed development. These estimates are based upon the measures of urban activity present in a particular traffic analysis zones (TAZs).

2.1.11.2 Trip Distribution

Trip distribution is a procedure used to estimate the number of trips generated from each zone going to each of the other zones in the study area that is divided into zones (TAZs). The procedure uses the productions and attractions estimated in the trip generation phase. For Sambrial Kharian motorway trip generation and trip assignment has been completed based on the final matrices obtained from origin destination (OD) survey.

2.1.11.3 Traffic Assignment

Traffic assignment involves assigning the distributed trips to specific paths in the road network. Assignment should be made after taking into account logical routing, available roadway capacities and projected and perceived minimum travel times. Multiple paths should be assigned between origins and destination rather than assigning all of the traffic to the route with the shortest travel time.

2.2 Literature Review of VISSIM

PTV VISSIM is a comprehensive and state of the art travel demand software that allows the transportation planners to analyze and plan transportation systems. Vehicles, public transport, cycles, pedestrians and rickshaws can be simulated by using VISSIM. VISSIM software calculates different parameters by using the data i.e., vehicle delays, queue lengths and level of service. These parameters are used to analyze traffic stream conditions at any intersection. Microscopic simulation reflects each discrete entity, consequently allowing for all factors of an object, like efficiently evaluating traffic flow through intersection.

A literature review has been performed to study the efforts involved in research regarding the calibration and validation of the highway, freeways, models, roundabouts, intersections or interchange with PTV VISSIM. The evaluation is by means of PTV GROUP VISSIM software package, distributed into the general categories of micro simulation modeling and multi-modality. Study of both categories was carried out in order to determine the area of research which has further room for exploration, for both the simulation of interchange traffic and for specific VISSIM specifications.

2.2.1 Calibration and Validation of Traffic Simulation

The process of calibration comprises of three stages which are as follows:

1. Speed based calibration
2. Volume based calibration
3. Objective based calibration

VISSIM can run any type of traffic simulation models. It provides precise outcomes for which we have to make modifications in volume of traffic, route decision, speed estimation, and reduce speed areas for calibration of traffic simulation models. Also, it can serve as a general guideline for building a model, planning traffic simulation project, model calibration validation, and analysis of node results.

The following steps are included:

1. Determination of traffic
2. Data collection
3. Making links and connectors
4. Route decision
5. Delay of vehicle at Toll plaza
6. Run preliminary simulations
7. Results at Node about LOS and delay

The research criteria mainly covers the delay at toll plazas and intersections simulation.

2.2.2 Level of Service

Level of service (LOS) is a qualitative measure which relates the quality of traffic service by transportation planners on transportation devices, or infrastructure. It characterizes the road service for how much it is capable of taking traffic. It elaborates the quality of traffic based on performance measures like density, acceleration, speed etc. LOS is classified as A, B, C, D, E, and F. We have an advantage in VISSIM that it tells the LOS itself at the node, which can be made manually and at the point where analysis is required. LOS up till LOS-C is acceptable, below which the road service include traffic congestion becomes unacceptable.

Table 2.3 : LEVEL OF SERVICE

Time Delay (Seconds)	LOS
< 10	A
10– 20	B
20-35	C
35- 55	D
55- 80	E
>80	F

Table 2.4: LOS A

a. Level of service 'A':

LOS'A' represents traffic operating at free flow speeds.

Flow	Free flow conditions
Freedom to maneuver	Extremely high
Traffic interruption	Negligible
Level of comfort	Excellent
Driver's convenience	Excellent

Table 2.5: LOS B

b. Level of service 'B':

Flow	Near to free flow conditions
Freedom to maneuver	Slight decline than LOS 'A'
Traffic interruption	Slightly noticeable
Level of comfort	High
Driver's convenience	Good

Table 2.6: LOS C

c. Level of service 'C':

Flow	At or near free flow conditions
Freedom to maneuver	Noticeably restricted
Traffic interruption	Significant queue formation due to incident
Level of comfort	Significant decline
Driver's convenience	Significant decline

Table 2.7: LOS D

d. Level of service 'D':

Flow	Slight decline in speed with increase in flow
Freedom to maneuver	More restricted
Traffic interruption	Lengthy queues due to incident
Level of comfort	Reduced as compared to LOS 'C'
Driver's convenience	Reduced as compared to LOS 'C'

Table 2.8: LOS E

e. Level of service 'E':

Flow	Considerable decline with increase in flow
Freedom to maneuver	Extremely limited
Traffic interruption	Even minor disruptions causes delay
Level of comfort	Considerable discomfort
Driver's convenience	Poor

Table 2.9: LOS F

f. Level of service 'F':

Flow	Breakdown in vehicular flow
Freedom to maneuver	Extremely restricted
Traffic interruption	Very high
Level of comfort	Extremely low
Driver's convenience	Very poor

2.2.3 Estimating Delay

Delay is the time that is wasted by the passenger in vehicle due to queue. Delay includes queue time, and the time included in clearance of vehicle. Factors that affect delay are capacity and volume of vehicle in lane group, green time cycle length. Delays may affect LOS.

2.2.4 Queuing

Vehicle queuing is a study of traffic behavior and a significant measure of effectiveness, which should be calculated while analyzing the signalized intersection usually where the demand exceeds available capacity. Vehicle queuing also tells about the capacity of lanes, wait time, and queue. When there is a lot of traffic and if signalized and green time is less than role of traffic engineer comes to solve problems while optimizing the operation of the existing traffic system. The process starts with considering the problems which obstructs the traffic flow along the traffic facility; it is necessary to increase the effectiveness of the traffic control factors so as to minimize the traffic congestion. Therefore, traffic efficiency and performance are the key factors which should be increased while improving the different traffic elements.

2.2.5 Conflict Areas

Those areas where two or more lanes join, meet or cross each other without any traffic signal are conflict areas. VISSIM software can give the priority to the traffic according to the preference specified by the user.

2.2.6 Gap Acceptance

This theory is used in intersection which is not signalized basing on the concept that driver will use a gap of particular size and he is expected to behave in the same manner at all scenarios. Gap acceptance is the least conceivable gap required to cease lane changing in a safe manner.

2.2.7 Traffic Congestion

Traffic congestion also known as traffic jam is a major concern of metropolitan areas, as it results in slower speeds, longer trip times and increased vehicular queuing. Various steps are undertaken to reduce the traffic congestion. The first step in this whole process is the identification of the congestion and its various features to identify correct direction for the selection of suitable and requisite measures. Congestion not only retards the movement of people, it also adversely effects the traffic circulation on various intersections.

Traffic congestion wastes time, elevates stress levels of the people as well as increasing the cost of travelling of the society, along with the increase in pollution. Numerous causes which generate congestion include:

- Number of vehicles exceeding the design capacity
- Blockade on the roadway
- Increase in vehicle ownership causing limited use of mass transit system

Chapter 3

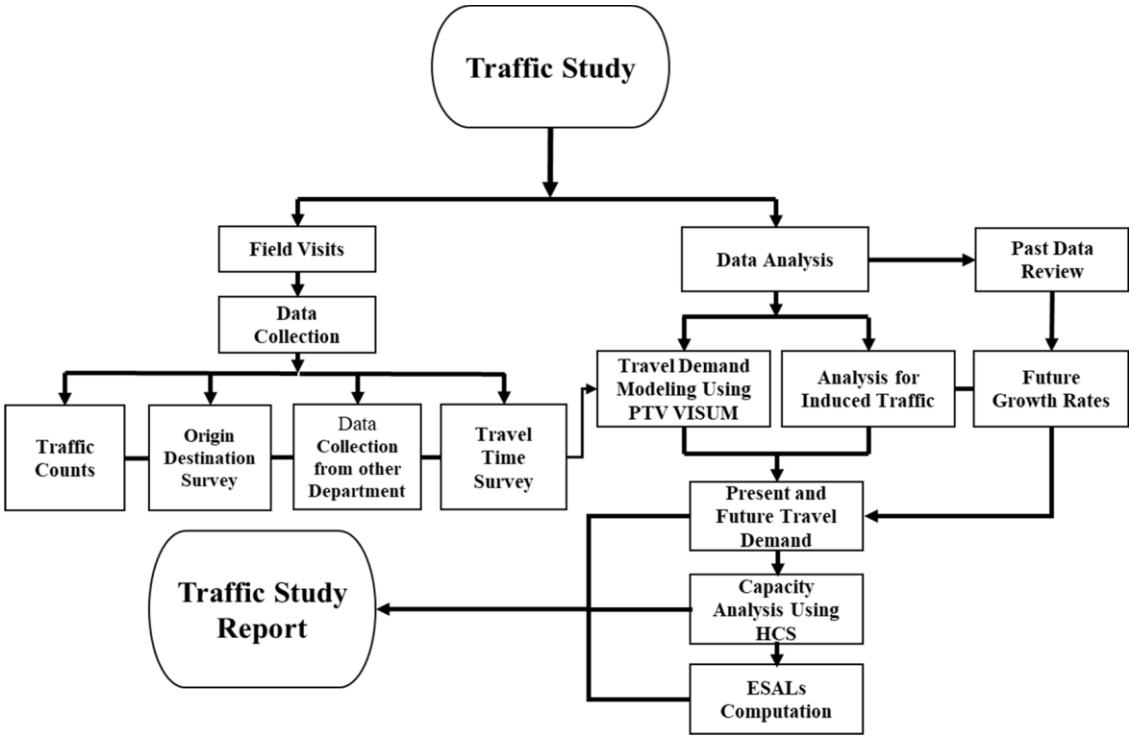
METHODOLOGY

3.1 Introduction

In this part of study, it will be explained what procedure was adopted for research work in order to achieve desired objectives. The research was based on real time traffic data and its analysis was done by using PTV VISSIM version 9. Sambrial-Kharian Motorway have 4 interchanges, all 4 are simulated using VISSIM. The traffic study was carried out in following steps:

- Drawing of freeway, its links and connectors
- Defining Routes and Relative flow
- Traffic input
- Defining composition of vehicles
- Defining reduced speed and conflict areas
- Assigning desired speed to vehicles at each node
- Simulation of Toll Plaza
- Simulating Real Time traffic
- Extracting Final Results

The traffic study described in this report has been carried out using procedure presented in the work flow chart given in **Figure** below



3.2 Data Collection

The data was collected by the consultant firm PAVERON. Method adopted for data collection was indirect manual traffic count in which HD night vision cameras were installed at suitable locations and altitude, and later on the traffic was counted in office on tally sheets to ensure maximum accuracy of classified vehicles data. Time period for data collection was of 24 hours and the cycle was repeated for consecutive 3 days.

Total of 17 locations were selected for traffic count out of which 11 collected fresh traffic data, and for remaining 6 locations traffic data was obtained from Lahore-Sialkot motorway traffic studies which was carried out in recent past.

Vehicle routes were defined after collecting information from the drivers during Origin-Destination (OD) survey. The OD survey was carried out on all 17 TCLs.

3.3 Origin Destination (O-D) Survey

Origin-Destination (OD) survey was the pivotal part of study as it determined the travel need of area. The survey gave the travelling pattern of various type of vehicles in the area.. This led to assessment of travel pattern between transportation analysis zones (TAZs). All 14 ODPs with their actual locations are listed as follows:

Table 3.1: Origin Destination (O-D) Survey

Origin-Destination Survey Point	Location	Google Coordinates
ODP-1	Sook Kalan	32.6040, 74.1420
ODP-2	Alam Garh	32.6837, 74.3119
ODP-3	Khoka Stop	32.6837, 74.3119
ODP-4	Lorai	32.6245, 74.0932
ODP-5	Jehlum Toll Plaza	32.9061, 73.7308
ODP-6	Kharian	32.8300, 73.8401
ODP-7	Saida	32.7563, 74.0697
ODP-8	Bhaddar	32.7833, 73.9893
ODP-9	Kotli Bajar	32.8150, 73.9886
ODP-10	Kotla Arbab Ali Khan	32.8498, 74.0696
ODP-11	Lala Musa	32.6992, 73.9561
ODP-12	Chenab Toll Plaza	32.4910, 74.0896
ODP-13	Gujrat Bus stand	32.5640, 74.0780
ODP-14	Mandra Toll Plaza	32.3114, 74.1456

3.4 Traffic Data for Each Interchange

Traffic count along with vehicles composition for all the interchanges was counted on hourly basis. Each interchange had certain TCLs feeding traffic to and from the interchange. The vehicle count was done by OD matrix survey and vehicles having destinations which were likely to be facilitated by Sambrial-Kharian motorway were counted and used for this simulation. The data collected was for year 2021 and the analysis was done on 10 years basis. Data was extrapolated for 2031 and 2041 by the help of selected growth factor.

3.4.1 Sambrial Interchange: (RD 0+00 – 26+900)

TCLs feeding traffic for this interchange were TCL-14,15,16 and 17. Tabulated data is as follows:

Table 3.2: Traffic Composition Sambrial Interchange

TRAFFIC COMPOSITION			
TCL	**Car**	**Public Transport**	**Freight vehicle**
14	70%	15%	15%
15	84%	11%	5%
16	68%	21%	11%
17	57%	18%	25%
Average	**70%**	**16%**	**14%**

Table 3.3: Vehicle Count Sambrial Interchange

VEHICLE COUNT		
Type	**North Bound**	**South Bound**
In	462	233
Out	121	417
Continued	174	179

3.4.2 Jalal Pur Jattan Interchange: (RD 26+900 – 49+300)

Traffic contribution for this interchange is counted from TCL-1,2 and 3. Tabulated data is as follows:

Table 3.4: Traffic Composition Jalal Pur Jattan Interchange

TRAFFIC COMPOSITION			
TCL	**Car**	**Public Transport**	**Freight vehicle**
1	84%	11%	5%
2	78%	14%	8%
3	76%	15%	9%
Average	**79%**	**13%**	**7%**

Table 3.5: Vehicle Count Jalal Pur Jattan Interchange

VEHICLE COUNT		
Type	**North Bound**	**South Bound**
In	577	30
Out	294	561
Continued	957	596

3.4.3 Dolat-Nagar Interchange: (RD 49+300 – 60+924)

Traffic contribution for this interchange is counted from TCL-3, 4, 7, 8, and 10. Tabulated data is as follows:

Table 3.6: Traffic Composition Dolat-Nagar Interchange

TRAFFIC COMPOSITION			
TCL	**Car**	**Public Transport**	**Freight vehicle**
3	76%	15%	9%
4	59%	24%	17%
7	68%	25%	7%
8	80%	14%	6%
10	80%	16%	4%
Average	**73%**	**19%**	**9%**

Table 3.7: Vehicle Count Dolat-Nagar Interchange

VEHICLE COUNT		
Type	**North Bound**	**South Bound**
In	78	75
Out	78	168
Continued	919	1127

3.4.4 Gulyana Interchange: (RD 0+000 – 9+021)

Traffic contribution for this interchange is counted from TCL-7, 8, and 9. Tabulated data is as follows:

Table 3.8: Traffic Composition Gulyana Interchange

TRAFFIC COMPOSITION			
TCL	**Car**	**Public Transport**	**Freight vehicle**
7	68%	25%	7%
8	80%	14%	6%
9	80%	9%	11%
Average	**76%**	**16%**	**8%**

VEHICLE COUNT		
Type	**North Bound**	**South Bound**
In	1220	-
Out	-	919

3.5 Vehicle Composition

Vehicle composition is volume of vehicles in percentage for each category of vehicle. The data was divided into 3 categories of vehicles for VISSIM which are cars, buses and heavy traffic. Overall average vehicle composition for complete simulation was calculated from tally sheets and same was used for data input in VISSIM, which is as follows:

Table 3.9: Vehicle Composition

VEHICLE TYPE	PERCENTAGE
CAR	80 %
Bus	14 %

HGV	6 %

3.6 Determination of Growth Rate Factor

The study of previous traffic reports and the general literature cited with regard to the population, vehicle registration, fuel consumption and other indicators of the GDP growth was to build-up a rationale for adoption of realistic growth rates for future traffic. The analysis was done in depth to come up with growth rate for year 2031 and 2041 which is as tabulated.

Table 3.10: GROWTH RATE

GROWTH RATE	
YEAR	**PERCENTAGE**
2031	40%
2041	35%

3.7 Toll Plaza

One of the shortcomings of the Vissim software is that it is not having an inbuilt option of making toll plazas, so in order to simulate that effect, an indirect mean had to be adopted through induction of stop signs and signal head at the places of proposed toll plazas. The average delay given at each toll plaza was 10 seconds.

3.8 VISSIM Screenshots for Traffic Analysis

3.8.1 Defining road

Select Links from left top > Ctrl+ Right Click > Move curser to desired Direction and length > Release Ctrl and Right click > (Link Window appears) Set No of lanes, Lane Width and name the link.

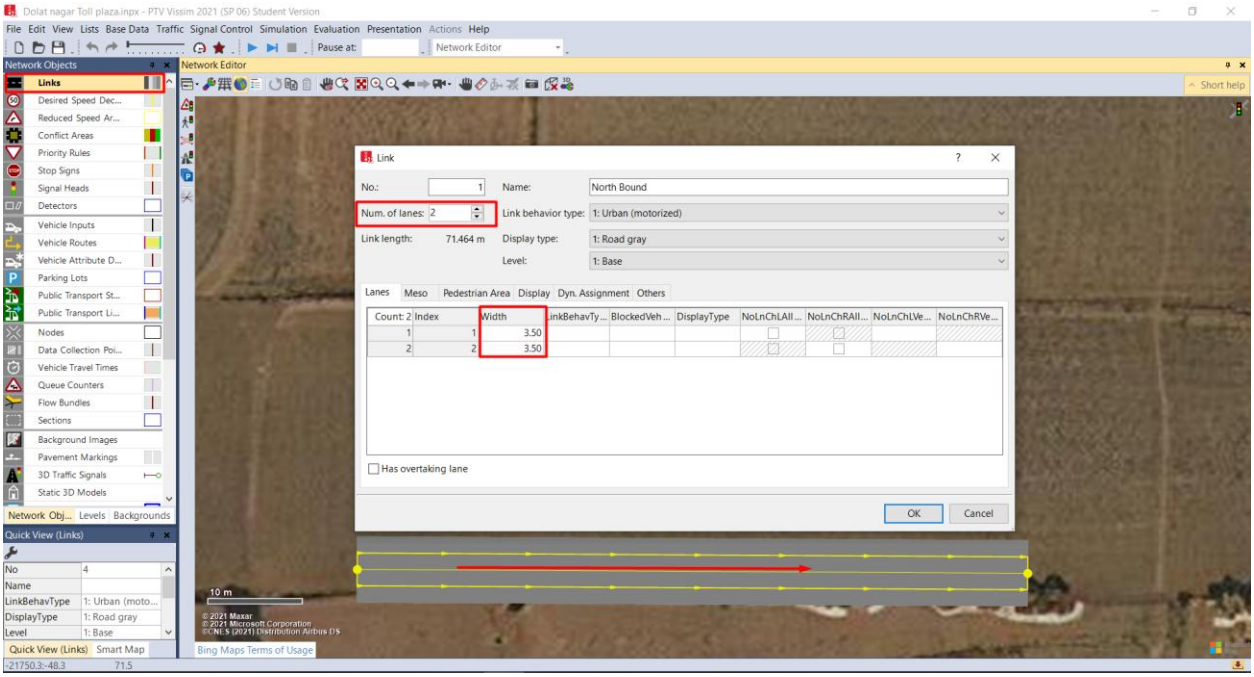


Figure 3.1: Defining road

3.8.2 Reduced Speed Areas

Select reduced speed area from selection window > Ctrl + Right Click and drag to define area > Release Ctrl and right click > (Reduce speed area window appears) Add and Set vehicle speed for each vehicle type.

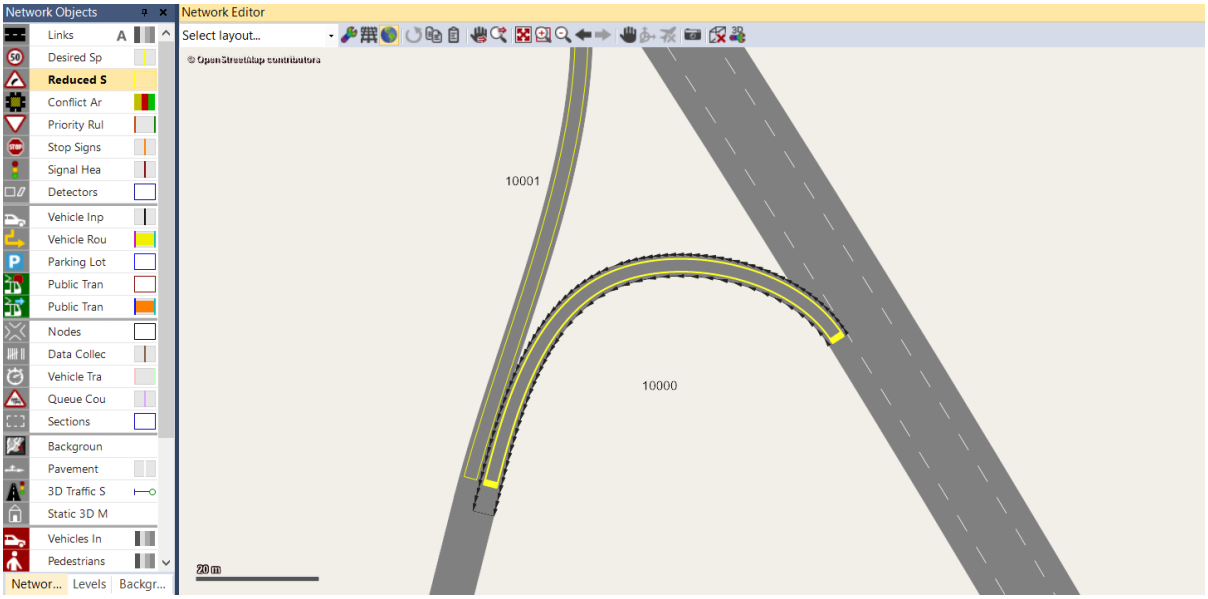


Figure 3.2: Reduced Speed Areas

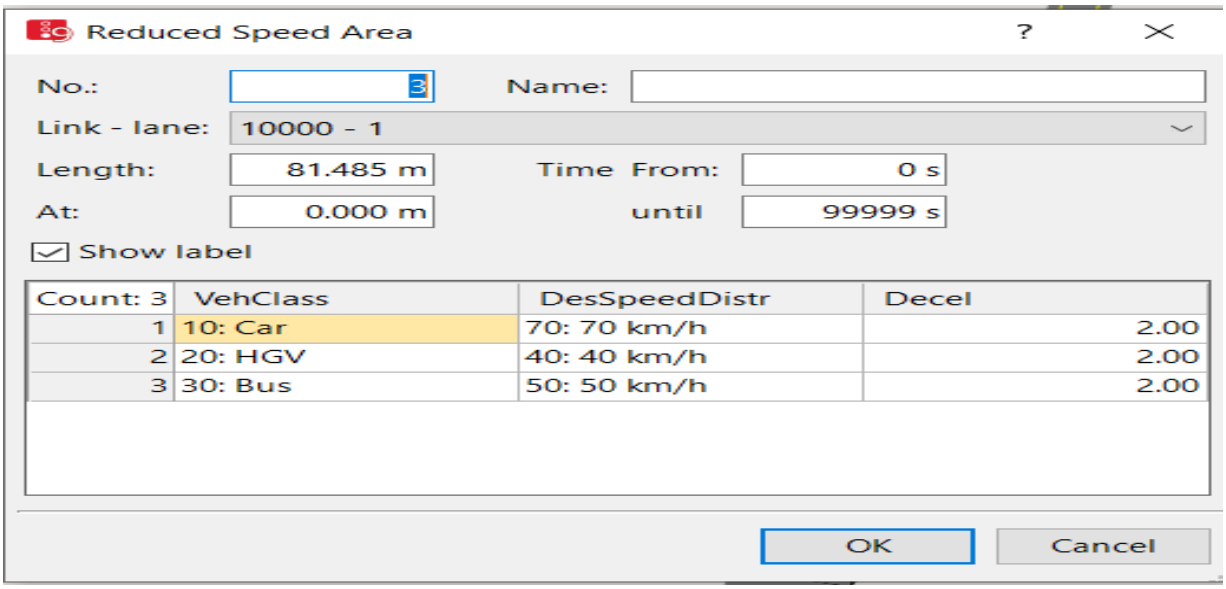


Figure 3.3: Reduced Speed Areas

3.8.3 Conflict Areas

Select Conflict areas from selection window > All conflict areas will be highlighted > Right click on desired side and set status accordingly.

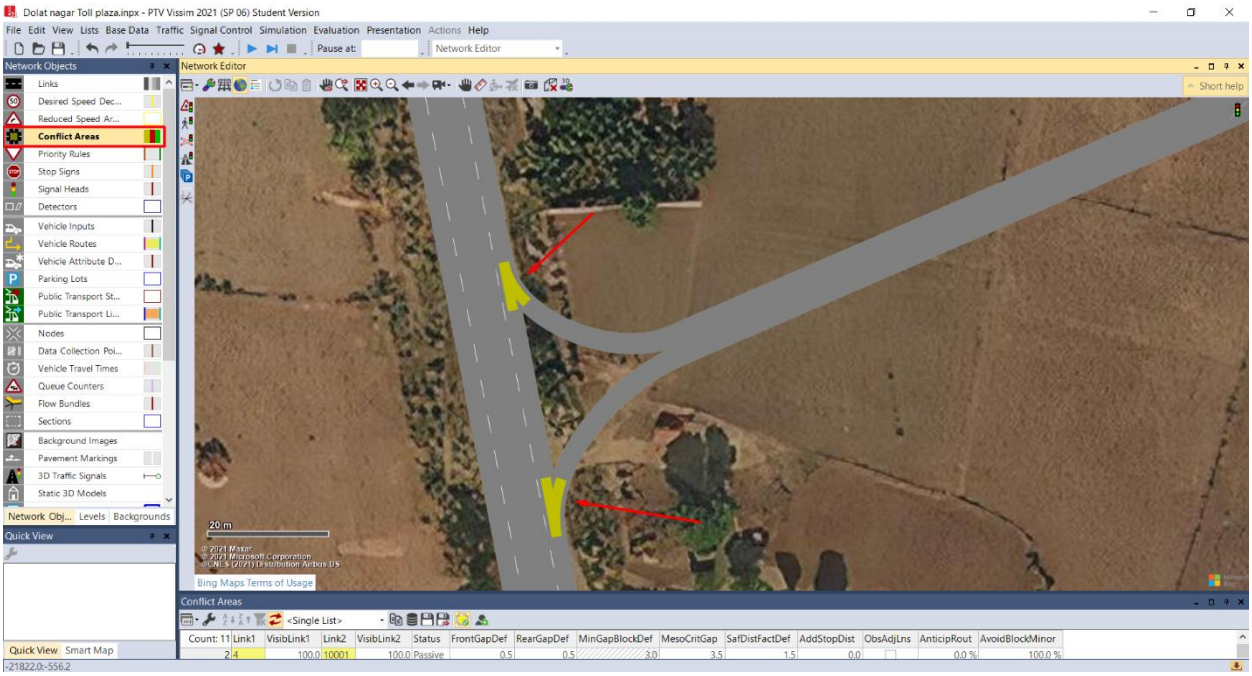


Figure 3.4: Conflict Areas

3.8.4 Vehicle Composition

Select Traffic tab from tool bar > Select Vehicle composition > Parameters window will appear in the bottom > Add vehicle type > Set desired speed and relative flow.

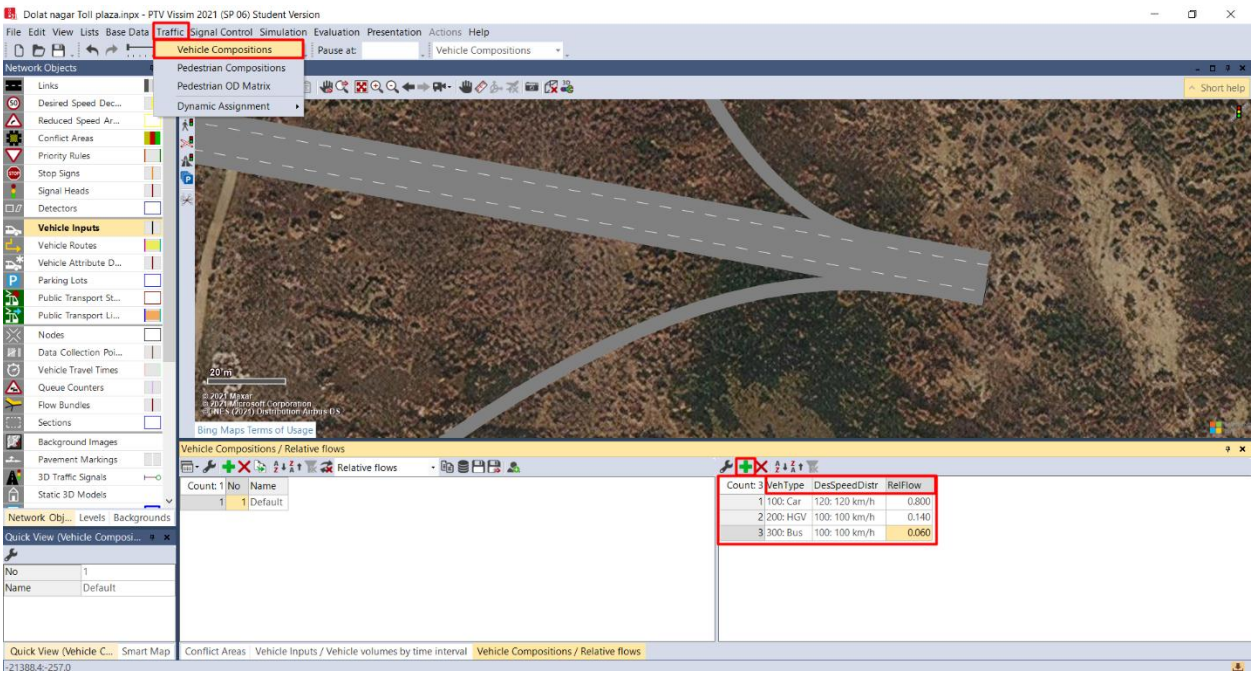


Figure 3.5: Vehicle Composition

3.8.5 Vehicle Input

Select Vehicle Input from Selection window > Ctrl + Right Click on desired direction > Black line would appear at origin of selected direction > Input parameters window will appear in the bottom > Define Volume and Traffic composition.

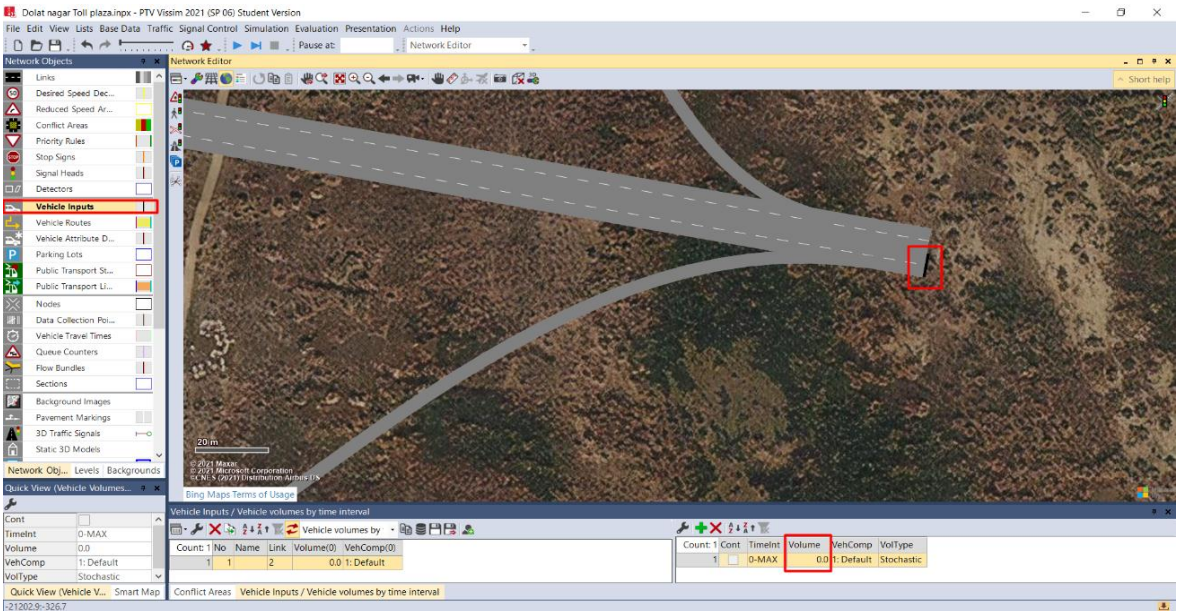


Figure 3.6: Vehicle Input

3.8.6 Defining Vehicle Routes

Select Vehicle Routes from selection window > Navigate to required route junctions > Press Ctrl + Right click > Drag the curser to 1st route > Press right Click (Route 1 is defined) > Drag the mouse curser to 2nd route > Press right Click (2nd route is defined) > Repeat the process for desired No of routes > Press Escape to terminate the route edit > Define Relative flow of traffic from bottom window.

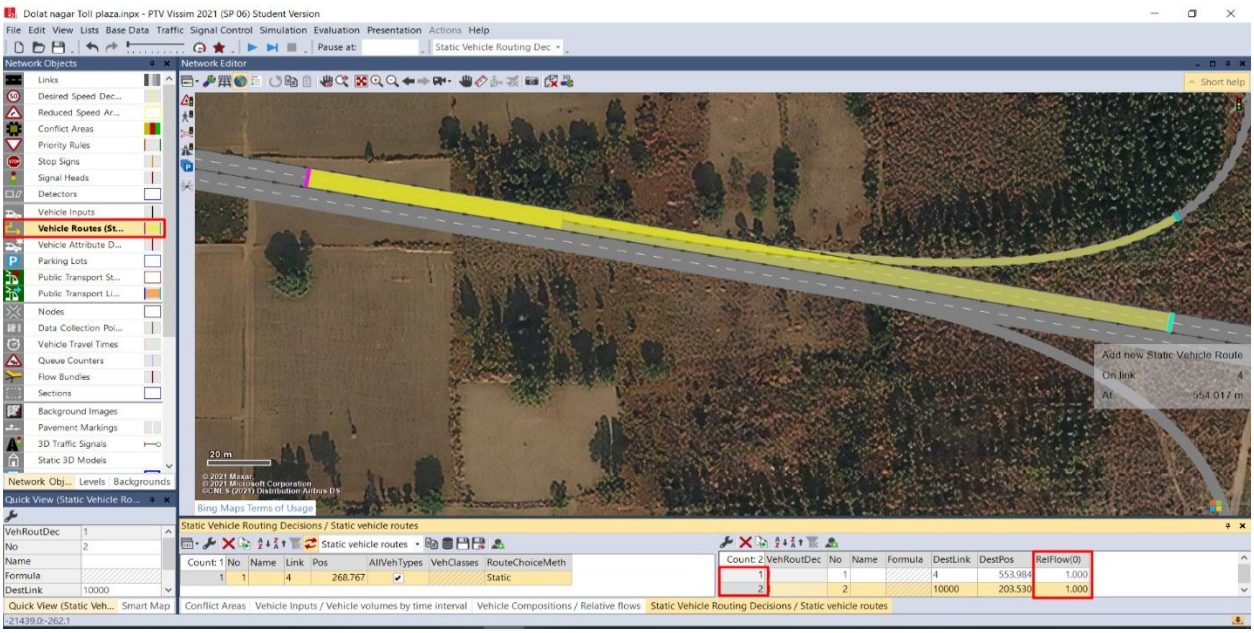


Figure 3.7: Defining Vehicle Routes

3.8.7 Adding Signal Group

Select signal control from tool bar > select signal controllers > Add new signal controller from bottom window (Signal controller window appears) > Select Edit Signal Controller (New Window appears for fixed time) > Add new signal controller from + Button > Select newly added signal controller > Edit signal controller > Select Red – Green signal head > Define duration for stop and move > Select Signal Pro > Add new > Define cycle period > Set red and green duration by dragging the color.

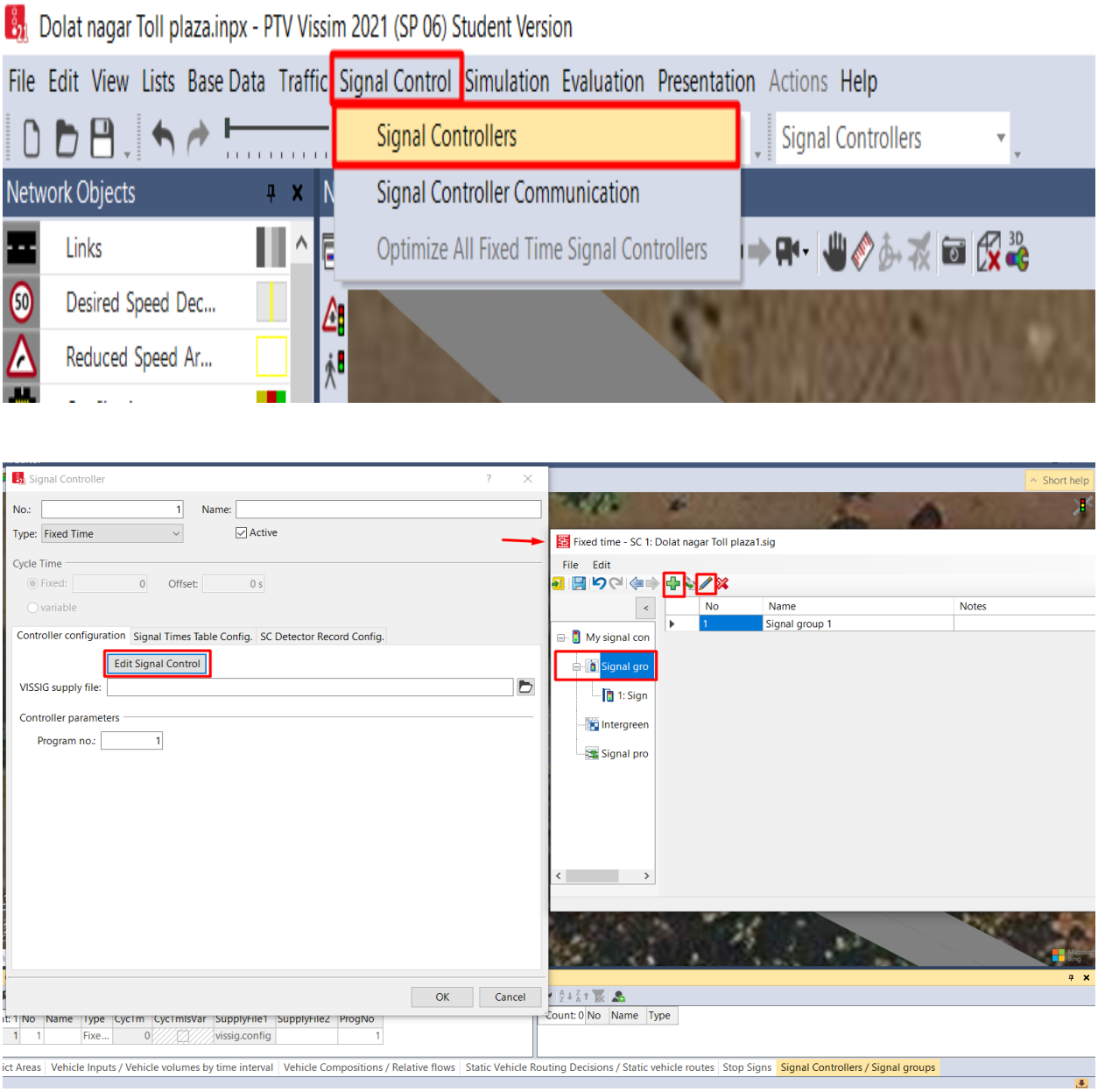


Figure 3.8: Adding Signal Group

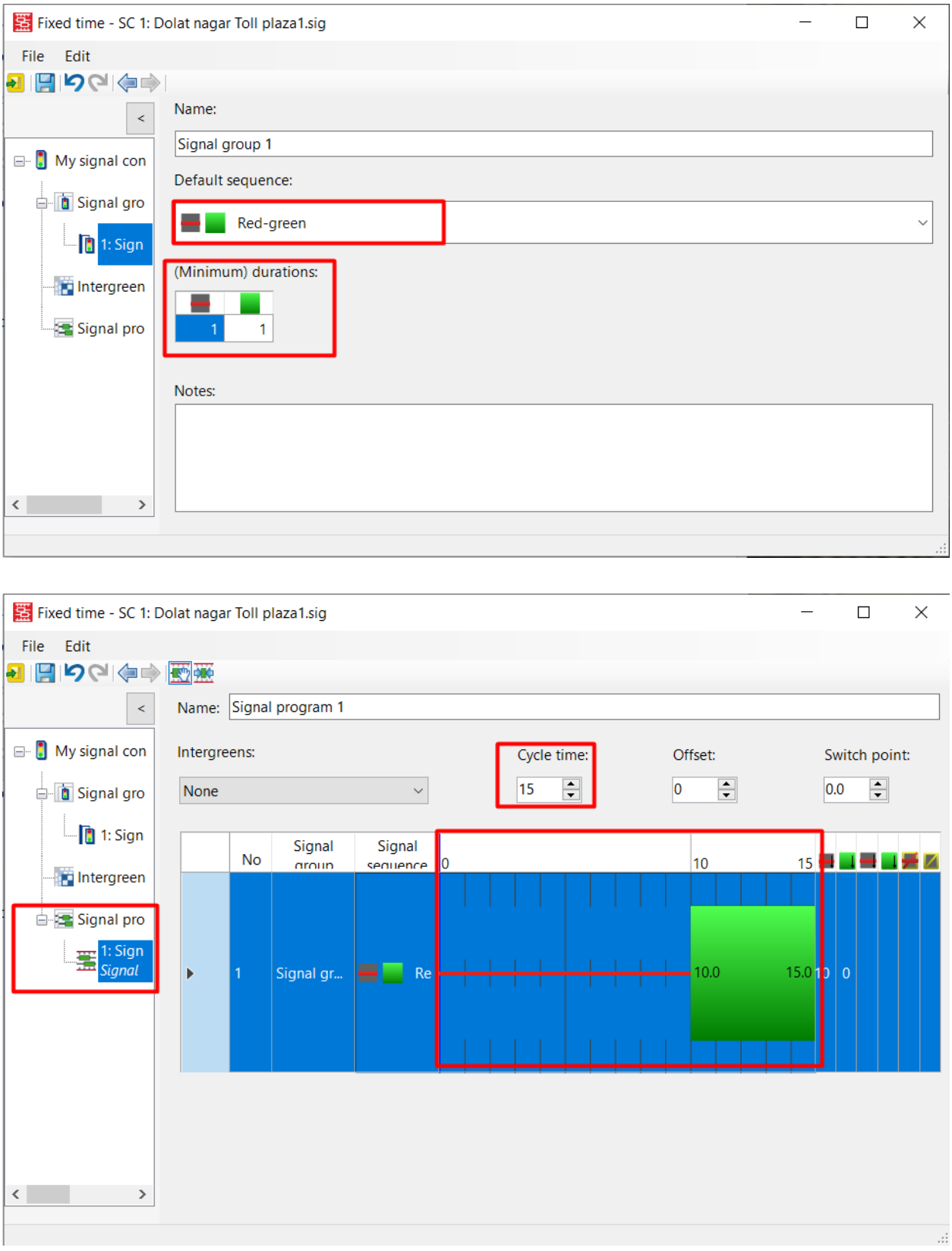


Figure 3.9: Adding Signal Group

3.8.8 Adding Stop Sign

Select Stop Signs from selection window > Click at desired Point where vehicle is needed to stop > Assign signal group from bottom window.

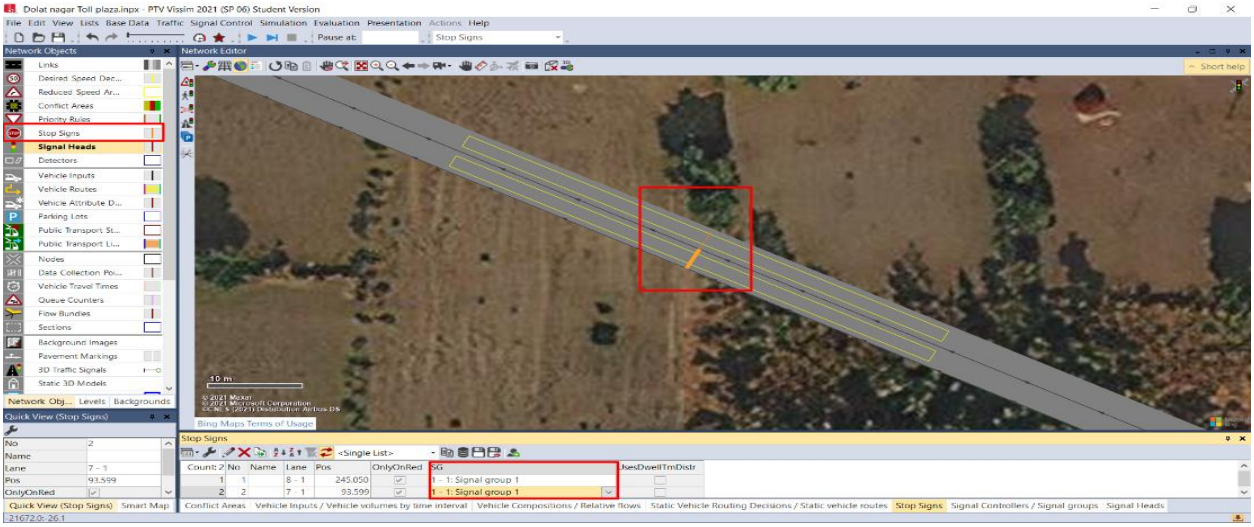


Figure 3.10: Adding Stop Sign

3.8.9 Establishing Toll Plaza

Step 1: Define reduced speed areas

Step 2: Add stop Signs

Step 3: Add Signal Controller (input desired delay time)

Step 4: Add signal Head

Figure 3.11: Establishing Toll Plaza

3.8.10 Establishing Node (For Results Collection)

Select Node from Selection window > Ctrl + Right Click on 4 boundary points (Enclosed area is Node)

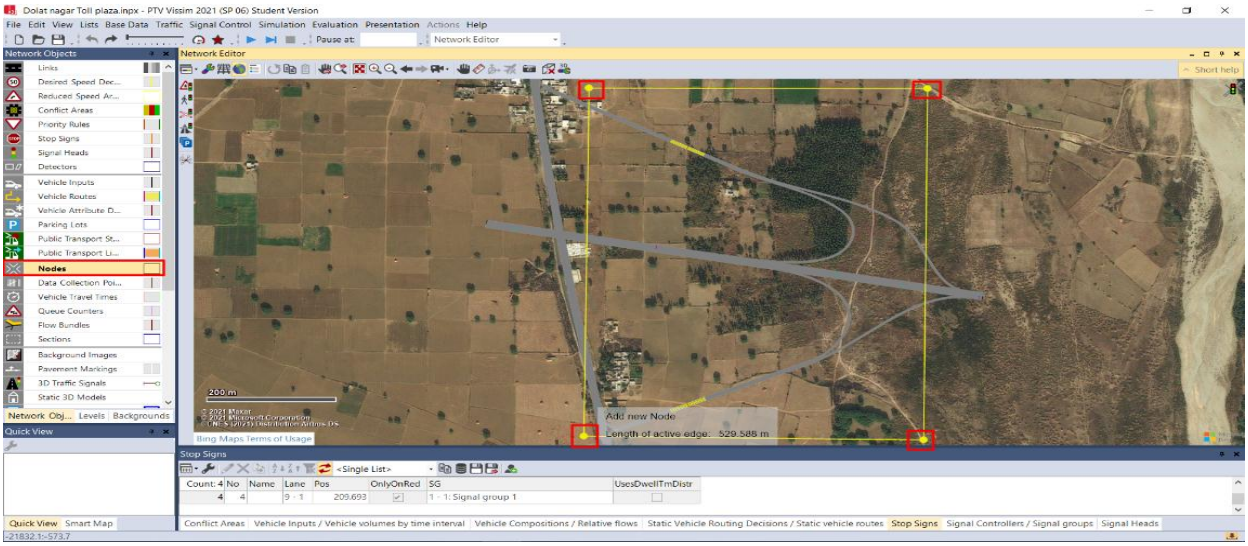


Figure 3.12: Establishing Node: (For Results Collection)

3.8.11 Collection of Results

After defining Node > Play the simulation by selecting simulation continuous button from tool bar > Node results window will appear in the bottom > Wait until the simulation run for desired time > Note down the Node results from bottom window.

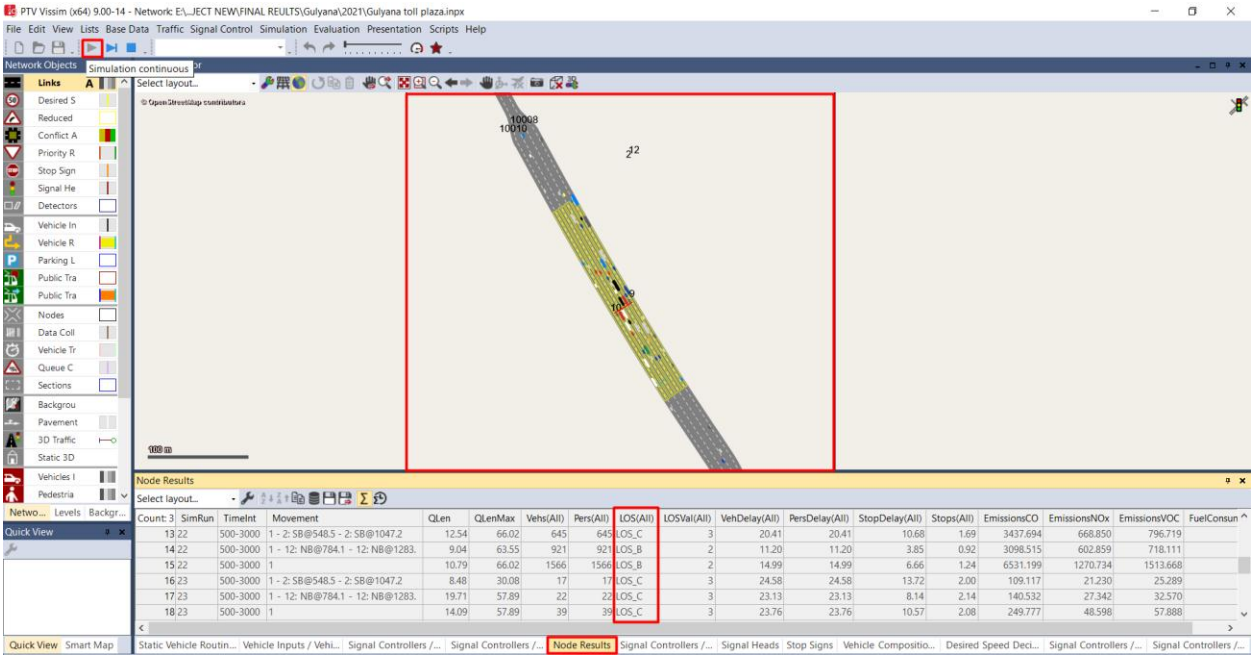


Figure 3.13: Collection of Results

Chapter 4

RESULTS

Vissim software has been used to collect the Results after putting in the traffic count for each interchange. Each interchange has been analyzed for different traffic counts at intervals of 10 years each. Results have been calculated for Year 2021, 2031, and 2041. Analysis of these 3 different sets of results can tell us about the drop in LOS during the design period of the Motorway. Following Parameters have been analyzed in the Vissim and data regarding them has been recorded.

1. **TIMEINT:** It is the time interval in terms of simulation seconds in which the input data was analyzed and our result was obtained.
2. **LOS (ALL)**: It is the value of LOS obtained at the node after Node analysis.
3. **LOSVAL (ALL):** It is the LOS value in the numerical form.
4. **QLEN**: It is the Length of queue at the specified node in terms of meters.
5. **QLEN (MAX)**: It is the max queue length recorded at the specified node during the simulation period.
6. **VEHS (ALL)** : Total number of vehicles passing through the node during the simulation period.
7. **VEHDELAY (ALL)** Vehicle delay caused at the node in terms of seconds during the simulation period.

4.1 Sambrial Interchange

Table 4.1: Results of Sambrial Interchange

YEAR	TIMEINT	QLEN	QLENMAX	VEHS (ALL)	LOS (ALL)	LOSVAL (ALL)	VEHDELAY (ALL)
2021	500-3000	9.6	24.8	512	LOS_C	3	26.3
2031	500-3000	24.3	47.7	640	LOS_E	5	56.1
2041	500-3000	76.9	139.2	789	LOS_F	6	117

- Level of Service dropped drastically from C to F during the design period.
- Queue Length increased from 9.6 m in 2021 to 76.9 m in 2041.
- Vehicle delay time increased from 26,3 seconds to 117 seconds in year 2041.
- Maximum Queue Length observed was of 139 m.
- Graphical comparison of results is as following:

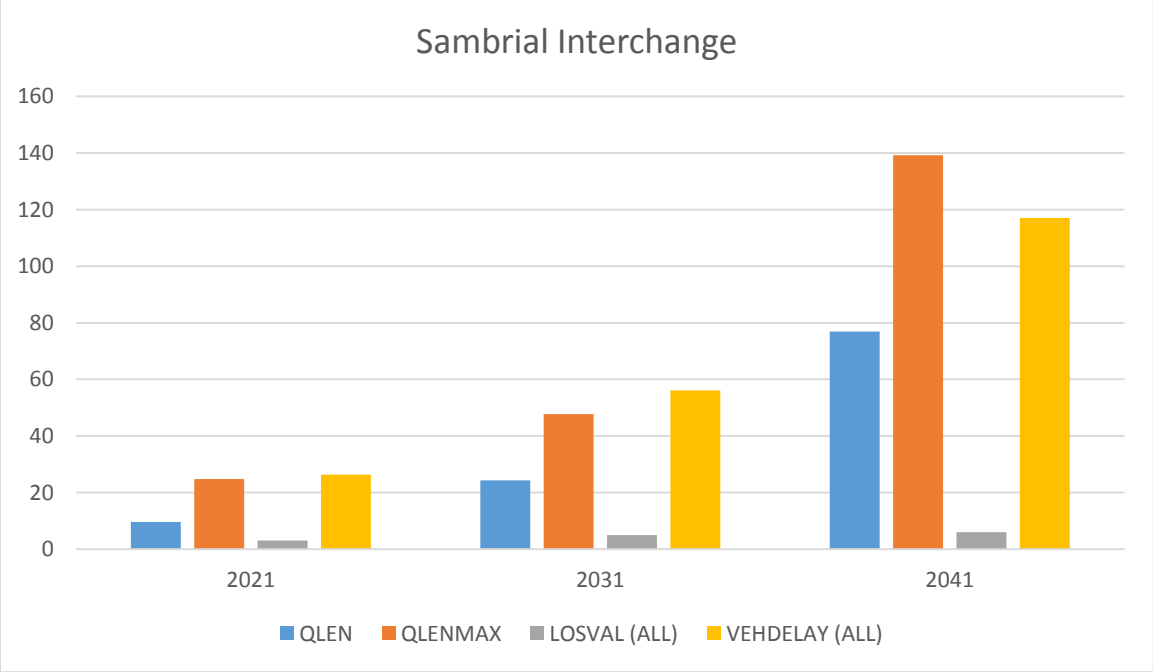


Figure 4.1: Result of Sambrial Interchange

4.2 JALALPUR JATTAN

Table 4.2: Results of JALALPUR JATTAN

YEAR	TIMEINT	QLEN	QLENMAX	VEHS (ALL)	LOS (ALL)	LOSVAL (ALL)	VEHDELAY (ALL)
2021	500-3000	12.9	55.6	358	LOS_B	2	10.9
2031	500-3000	14.1	82.4	491	LOS_C	3	20.6
2041	500-3000	28.3	88.2	514	LOS_C	3	22.1

- Level of Service dropped from B to C during the design period.
- Queue Length increased from 12.9 m in 2021 to 14.03 m in 2041.
- Vehicle delay time increased from 10.7 seconds to 20.15 seconds in year 2041.
- Maximum Queue Length observed was of 88.2 m.
- Graphical comparison of results is as following:

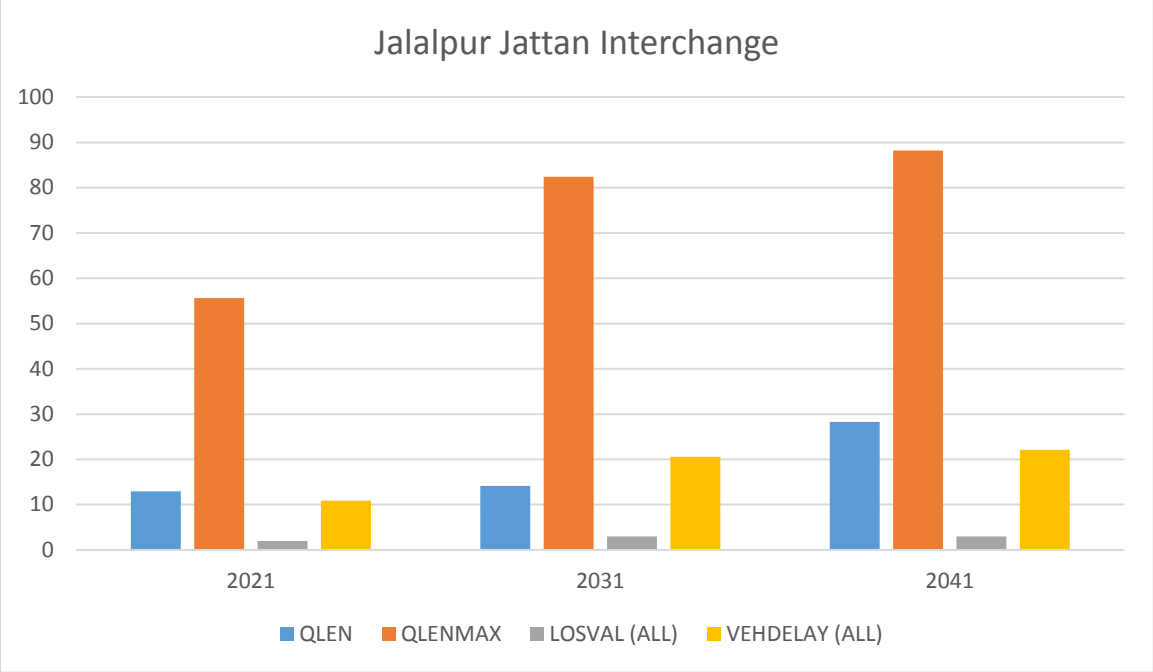


Figure 4. 2 Result of Jalalpur Jattan

4.3 DAULAT NAGAR

Table 4.3: Results of Daulat Nagar

YEAR	TIMEINT	QLEN	QLENMAX	VEHS (ALL)	LOS (ALL)	LOSVAL (ALL)	VEHDELAY (ALL)
2021	500-3000	1.9	32.5	45	LOS_B	2	16.1
2031	500-3000	5.1	47.1	77	LOS_B	2	14.2
2041	500-3000	9.3	68.7	110	LOS_C	3	21.9

- Level of Service dropped from B to C during the design period.
- Queue Length increased from 1.9 m in 2021 to 9.3 m in 2041.
- Vehicle delay time increased from 16.1 seconds to 21.9 seconds in year 2041.
- Maximum Queue Length observed was of 68.7 m.
- Graphical comparison of results is as following:

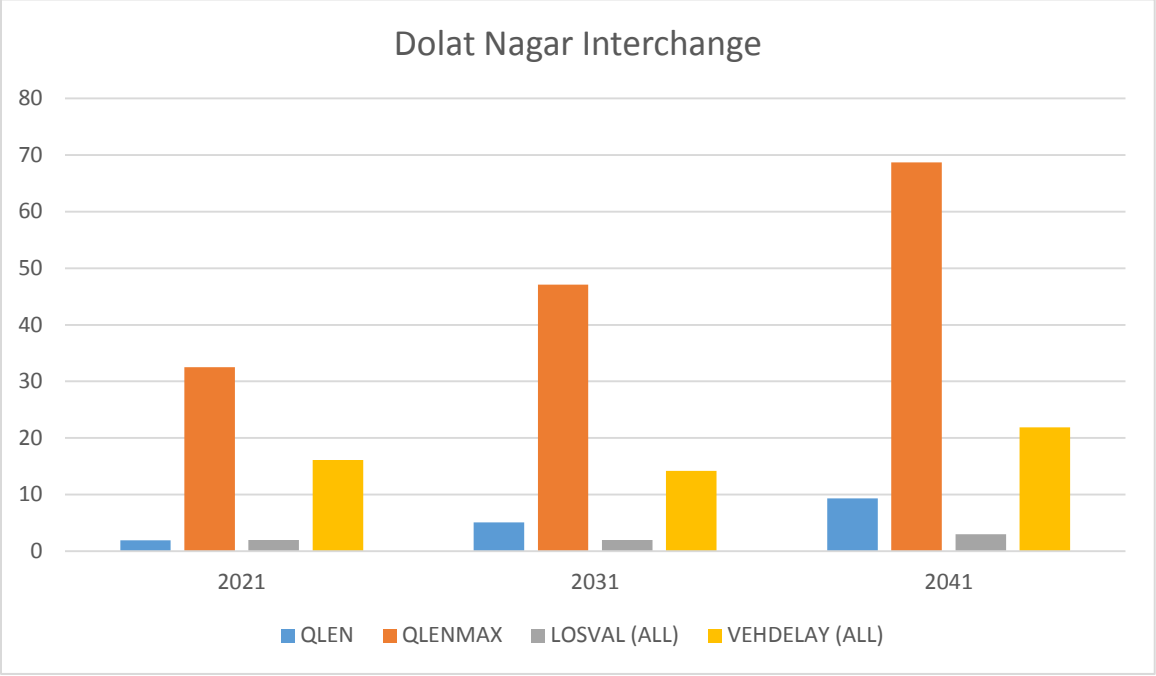


Figure 4. 3 Result of Dolat Nagar

4.4 GULYANA

Table 4.4: Results of GULYANA

YEAR	TIMEINT	QLEN	QLENMAX	VEHS (ALL)	LOS (ALL)	LOSVAL (ALL)	VEHDELAY (ALL)
2021	500-3000	12.5	66	645	LOS_C	3	20.4
2031	500-3000	63.6	230.3	938	LOS_E	5	64.5
2041	500-3000	230.9	512.3	813	LOS_F	6	185.1

The results showed that

- Level of Service dropped from C to F during the design period.
- Queue Length increased from 12.5 vehicles in 2021 to 290.9 vehicles in 2041.
- Vehicle delay time increased from 20.4 seconds to 185.1seconds in year 2041.
- Maximum Queue Length observed was of 512.3 vehicles.
- Graphical comparison of results is as following:

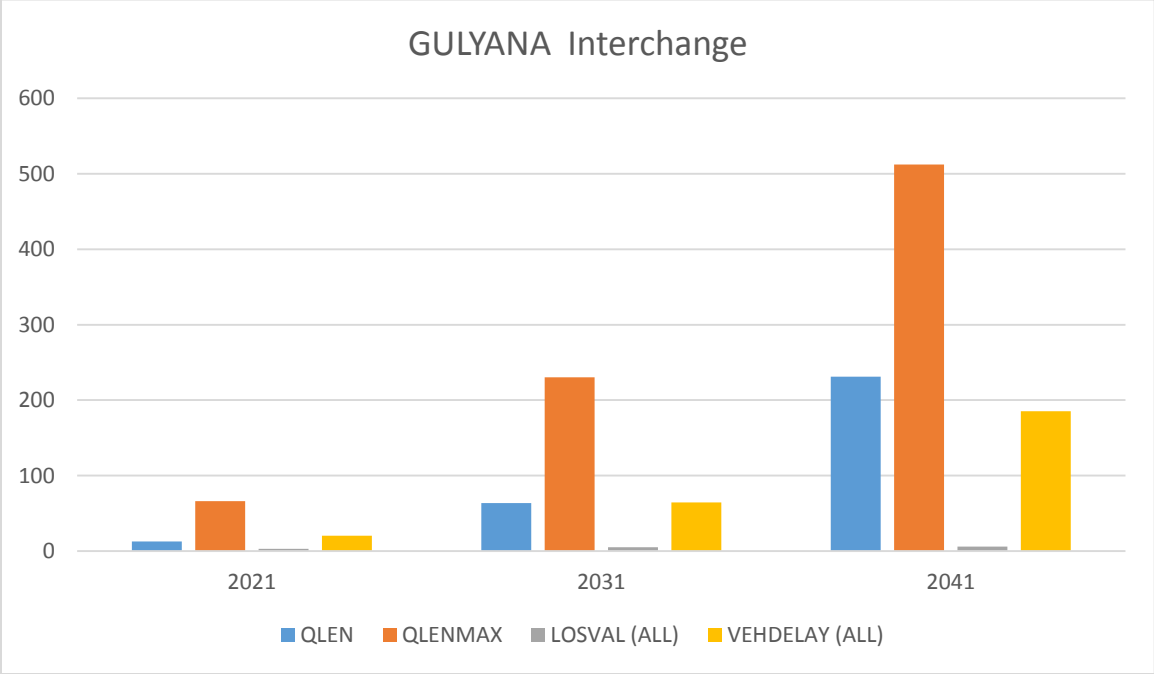


Figure 4. 4 GULYANA

CHAPTER 5
ANALYSIS

The complete process of acquiring the results of Vissim simulation has been undertaken with the aim of analyzing the interchanges for their design period and to ascertain whether they have the capacity to accommodate the required traffic over the period of its design life. The results obtained will be analyzed over here and remedial measures will be suggested in case there is a drop of Level of service down to the undesired level.

5.1 Analysis of Results

A pattern needs to be identified using the correct analysis of different parameters which would help us in determining the correct remedial measures. The individual analysis of the interchanges on Sambrial-Kharian motorway is as following:

5.1.1 Sambrial Interchange

Findings for this interchange are as:

- LOS has dropped from LOC C to LOC F which will directly contribute towards reduction of the efficiency of motorway travel and cause increase in the travel time.
- There is a drastic increase in the Vehicle Delay during the design period which has contributed directly towards the drop in Level of Service.
- A maximum Queue length of 139.2 m has been observed which will cause congestion on the interchanges and ultimately lead to delay in travel time of the users of motorway.

5.1.2 Jalalpur Jattan Interchange

Analysis of this interchange is as following:

- There is very slight change in the level of service during the entire period of the design life and overall it remains within the acceptable range.

- Vehicle delay has also increased slightly in the 20 years of analysis which has a direct bearing on the LOS so LOS has not been effected much. The increase in vehicle delay is quite acceptable.

5.1.3 Daulat Nagar Interchange

- There is again very little change in the LOS of the interchange as it remains within the acceptable range throughout the design period..
- A maximum vehicle delay of 21.9 second is observed at the end of design period which is also quite acceptable as it will not have a major effect on the Level of service of the interchanges.
- Queue length at the end of design period is 9.3m which is small and cannot have any appreciable effect on the LOS and will not cause congestion at the interchanges.

5.1.4 Gulyana Interchange

- The worst Level of service has been observed at this interchange with LOS dropping to LOS E in 2031 and LOS F in 2041 both of which are unacceptable.
- The drop was expected at this interchange since it serves as the starting point for the Kharian-Lahore section and end point for the Lahore-Kharian section and ultimately it will observe the maximum traffic count.
- Queue Length has also increased drastically during the design period which has contributed directed towards the drop in LOS. This queue length will also contribute towards congestion of the traffic and ultimately cause a delay in travel time for the motorway users.

Chapter 6

CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

The analysis undertaken above shows that the interchanges which are present in between Gulyana and Sambrial are showing an acceptable level of service throughout the design period. This is a positive sign since there will be no need for any kind of interventions on these interchanges throughout the design period.

However, Gulyana and Sambrial interchanges of the Sambrial-Kharian motorway are showing drastic decrease in the Level of Service during the entire duration of its design period. Their Level of Service drops to LOS E during the first decade of the design period and ultimately drops to LOS F during the last decade of the design period. There is a need for remedial interventions in order to ensure that an acceptable level of service is obtained during the entire period.

Timely implementations of the below mentioned remedial interventions will not only lead to the improvement in Level of Service but will also contribute towards mitigation of congestion problems, keeping in view the growth rate of the the vehicles in Pakistan, which will ultimately have a direct bearing on the Level of Service provided by the motorway.

6.2 Recommendations for 2021

The lowest Level of Service observed amongst all the interchanges in the year 2021 was LOS_C which is within the acceptable range, The delay imposed is also acceptable keeping in view the delay caused at the toll plazas. No intervention is required during the year 2021 at any of the interchanges.

6.3 Recommendations for 2031

The level of service for Dolat Nagar and Jalalpur Jattan remained within the acceptable range. However, The LOS has dropped to LOS E at both Gulyana and Sambrial Interchange. This LOS

is unacceptable and will ultimately lead to congestion at the intersection and increase in delays experienced by the users of motorway.

Following interventions are recommended for both the interchanges,

6.2.1 Extra Toll Booth

- Since maximum delay is being observed at the toll plazas so an increase in toll plaza will directly lead to improvement in the LOS.

6.3 Recommendations for 2041

Year 2041 has observed the worst Level of Service at Sambrial and Gulyana interchanges. The Level of Service has hit the worst value that can be achieved i.e. LOS_F. In order to ensure smooth functioning of the motorway, a major intervention is required at these two interchanges.

As for Jalalpur Jattan and Dolat Nagar, no intervention is required since the LOS remains within the acceptable range.

Following recommendations are proposed for Sambrial and Gulyana interchange.

6.3.1 Extra Toll Booths

Provision of extra toll plazas will directly lead to improvement in LOS since the maximum queue is observed at the toll plazas and increase in there number will lead to speedy operations and less vehicle queues.

6.3.2 Provision of E-Tag lanes

Provision of Fast lanes known as E-lanes will also lead to improvement in the LOS since the vehs will not stop at the toll plazas which will ultimately lead to less queue length and improvement in LOS. This method will not only be less costly but will also improve functioning of toll plazas.

6.3.3 Extra Lane at the Ramps

Traffic at ramps also leads to reduction in the LOS. So in order to counter it, extra lanes can also be provided at the ramps which will lead to speedy arrival of vehicles at the toll plazas.

Closing Remarks

The analysis of the motorway and the linked interchanges provides us with the time to plan for the problems that might be encountered in the future. Any measure that can contribute towards mitigation of the problems encountered should be implemented well in time so that the issues do not accumulate over the design period which will ultimately lead to lesser reaction time and over accumulation. The recommendations given above serve as only the guideline and the method adopted should be based on resources and preference of the implementing authority.

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