TRAFFIC OPERATION ANALYSIS OF D.I. KHAN-PESHAWAR MOTORWAY INTERCHANGES THROUGH VISSIM

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TRAFFIC OPERATION ANALYSIS OF D.I. KHAN-PESHAWAR MOTORWAY INTERCHANGES THROUGH VISSIM

A CASE STUDY

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

BE Civil Engineering

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MILITARY COLLEGE OF ENGINEERING

NATIONAL UNIVERSITY OF SCIENCES & TECHNOLOGY

Dedication

Special dedication to

Our beloved parents,

Our respected supervisor,

Our Instructors,

Our friends,

And all those, who helped us achieve this landmark.

For all your support, encouragement, and belief in us.

Thank you so much.

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ABSTRACT

Civil Engineering projects such as motorways are an important part of a county's economic growth and are a sign on progress. They provide the people with comfort and ease of travelling to far off locations. Similarly, the Dera Ismail Khan-Peshawar Motorway will help bolster regional connectivity and connect two distinct portions of the nation through a series of interconnected highways. However, as civil engineers it is important to take into account the physical changes that projects tend to undergo with the passage of time in order to ensure the standard of service and predict any decline in performance and provide remedial measures if the need arises.

To predict those changes VISSIM software was used to simulate various interchanges by providing the traffic data as input for three different years i.e. 2021, 2031 and 2041. Traffic data used for this process was provided by a traffic study report. Traffic for 2021 was provided by the study report while the traffic for 2031 and 2041 was calculated using different growth factors. Various parameters such as LOS, Stop Delay, Queue Length, maximum Queue Length and Vehicles delays were estimated.

These parameters, prioritizing Level Of Service (LOS), were used to understand the performance of interchanges in the future. Any deterioration or decline in efficiency, if observed, was used to suggest remedial measures in order to improve the system and maintain maximum output of facility.

Chapter 1

INTRODUCTION

1.1 BACKGROUND

Pakistani motorways form an integral piece of Pakistan's "National Trade Corridor Project", whose goal is to connect all three of Pakistan's Arabian Sea ports namely Karachi, Bin Qasim and Gwadar Port, to the rest of the nation via its network of national motorways and highways and with Afghanistan, China towards north and Central Asia. This endeavor was planned around 1990. The objective of China Pakistan Economic Corridor (CPEC) is to connect Kashgar (China) and Gwadar Port using the motorways, highways, and expressways of Pakistan**.**

1.2 D.I Khan-Peshawar Motorway

Peshawar, from a strategic point of view is situated within close vicinity to Afghanistan. Khyber Pakhtunkhwa will surely become a center for commerce, trade and economic progress following construction of 365 kilometers long Dera Ismail Khan-Peshawar Motorway and Swat Motorway Project, 81 kilometers in length.

The two mega projects would benefit as trade corridors between Afghanistan and Pakistan, enabling Khyber Pakhtunkhwa to fully benefit from CPEC projects.

The government of KPK under the umbrella of its large communication development initiative has planned to establish state-of-the art PDIKM to enhance regional integration and enhance speed of industrial and economic progress in the lesser developed districts of southern KPK and seven combined tribal districts.

It would be recognized as an international trade corridor (ITC) by giving immediate entry to Afghanistan and Central Asian Republics (CARs) to enhance their trade via seaports of Karachi and Gwadar.

The project was discussed with the joint working group (JWG) of CPEC under the new proposed road project from 10 to 11 October 2019, and it was decided to include it in the CPEC framework. Later, it was also discussed at the Ninth Joint Coordination Committee (JCC) meeting held in Islamabad on 5 November 2019 and it was agreed to review it at the next JWG meeting after the Planning Committee approved PC-I.

The project would be further linked to western part of CPEC for easy access to Karachi and Gwadar ports for the future. The project upon completion would also reduce vehicles' transportation costs.

It would also link Punjab via Darya Khan bridge located in district Bhakkar on Indus River and progress to Sindh through N-55 besides linking through Hakla-Yarik Motorway and DI Khan-Zhob-Quetta Road leading to Gwadar seaport.

The project would connect South and North Waziristan, Kurram and Orakzai tribal districts through links roads, 19 interchanges, would be fenced completely, having length of 365 kilometers, 100 meter right of way, two important tunnels with speed of 120 kms an hour on plains and speed of 60 kms an hour through hilly regions.

Table 1.1 Motorway Interchanges

LIST OF INTERCHANGES	
Sr No.	**Names**
1	Peshawer M1 Interchange
2	Peshawer - Tarnab Interchange
3	Peshawer Ring Road Interchange
4	Mattani - Badaber Interchange
5	Dara Ademkhel Interchange
6	Kohat Interchange
7	Sherkot - Ustarzai Interchange
8	Raisan - Jawraza Interchange
9	Hangu - Thali Interchange
10	Krapa - Lachi - Ahmadi banda - Karbogha Interchange
11	Soor Dagh - Latambar Interchange
12	Bannu-Domail Interchanges
13	Sarai Nuarang - Gandi - Bannu - Miran Shah Interchange
14	Ghazni Khel - Lakki Interchange
15	Pezu - Tank Interchange
16	Yarik - Hakla - Islamabad Interchange
17	DI Khan Interchange
18	Zhob - Quetta Interchange
19	Darya Khan - DI Khan Interchange

While calling it a game changer for southern and western districts of KPK, the official said the motorway would be established with a budget calculated at Rs 276.599 billion rupees along with the additional expenditure of rupees 20 billion for land purchases.

Two tunnels would also be constructed including one near Kohat at Dara Adamkhel having length of 5.6 kilometers and other at Banda Daud Shah in Karak district, 1.6 kilometers long.

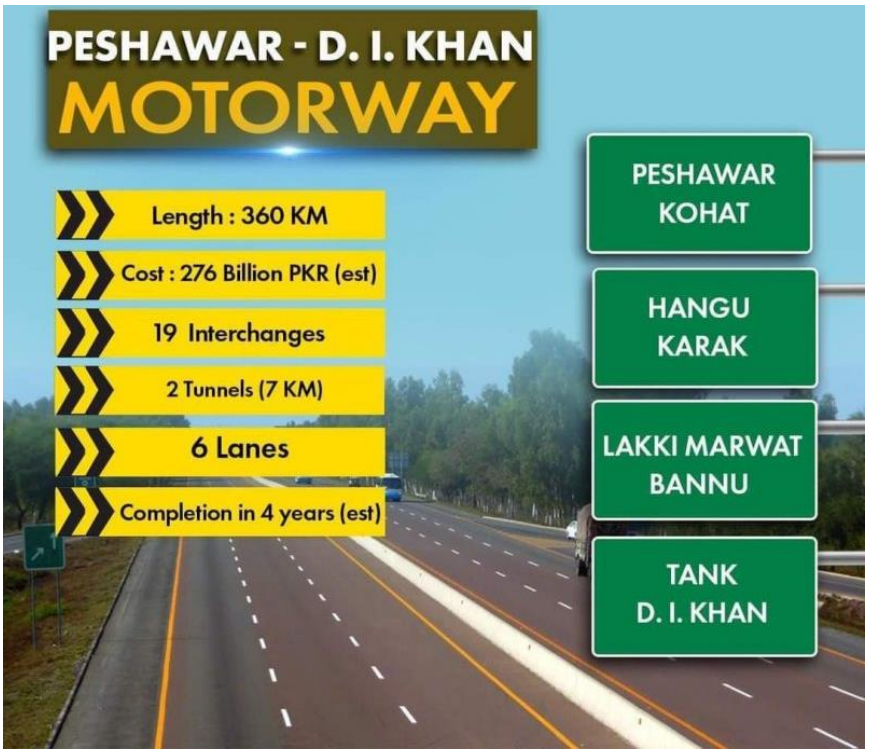

Figure 1.1

1.3 PROBLEM STATEMENT

The 365 kilometers fenced motorway would be further connected to western route of CPEC for comfortable access to Karachi and Gwadar seaports while having relatively shorter distance in comparison to other routes of CPEC apart from minimizing vehicle operating costs.

The six-lane motorway would originate at Chamkani and would travel through Dara Adamkhel, Hangu, Bannu, Kohat, Tank, Lakki Marwat and would conclude at Qureshi Mor in D.I Khan on N-55 on the southern side.

We will be carrying out Traffic Studies and VISSIM Analysis of the under-study highway project. In the absence of any real data on freeway which is yet to be built, the only option left is to simulate the traffic and analyze the traffic operations in the light of some well-established

measure of effectiveness (MOE). Level of Service (LOS) criteria is used to assess the traffic operations through simulations of PTV VISSIM software.

1.4 AIM OF STUDY

The project aimed at achieving the subsequent objectives:

- To be able to understand how to carry out a research on traffic engineering ventures and be able to present a suitable report on the subject.
- To be acquainted with the basic functioning of VISSIM 9 software and be able to generate output based on valid inputs. Plus, to be able to analyze a road section under traffic management criteria like Level of Service (LOS) etc.

1.5 Simulation

Simulation modeling produces better results by providing clear understanding of complex networks. Computer simulation is used when carrying out experimentation on a real system is impractical or impossible. 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, 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, downtown grid systems, signal control etc.) using software to better aid in the planning, design and operation of transportation system. Software used for simulation of D.I Khan-Peshawar Motorway is VISSIM.

VISSIM is a software for microscopic multi-modal simulation of traffic flow. 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 allows it to simulate more than a single type of traffic like cars, trucks cycles etc.

Figure 1.2 PTV VISSIM Logo

1.6 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 future traffic on the D.I Khan-Peshawar Motorway for the year 2021 but design life of project is 30 years so for 2031 and 2041 the traffic is calculated through Geometric growth Method. Also, for the separation of traffic for interchanges various factors and mathematical techniques will be used.

2) Understanding VISSIM, its features and tools

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

3) Determining serviceability from Level of service

After running simulation, results will be generated based on 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

The **objective** of a literature **review** is to help develop a perception of the existing **research** and arguments related to a specific subject or field of **study**, and to provide that information in a written report form. Carrying out a **literature review** helps you build your knowledge in your field.

In relation to our own **study**, the **literature review** can help in the following **four** ways. It can:

- contextualize our findings.
- bring focus and clarity to our **research** problem.
- enhance our **research** methodology.
- widen our knowledge based on our area of research.

Literature review in our final year project 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 Introduction

The six-lane motorway would originate at Chamkani and would travel through Dara Adamkhel, Hangu, Bannu, Kohat, Lakki Marwat, Tank, and would conclude at Qureshi Mor in D I Khan on N-55 from southern side.

The 365 kilometers long fenced motorway would be further connected to western route of CPEC for easy access to Gwadar and Karachi seaports in future having relatively less travelling distance in contrast to other routes of CPEC apart from minimizing operating costs for vehicles.

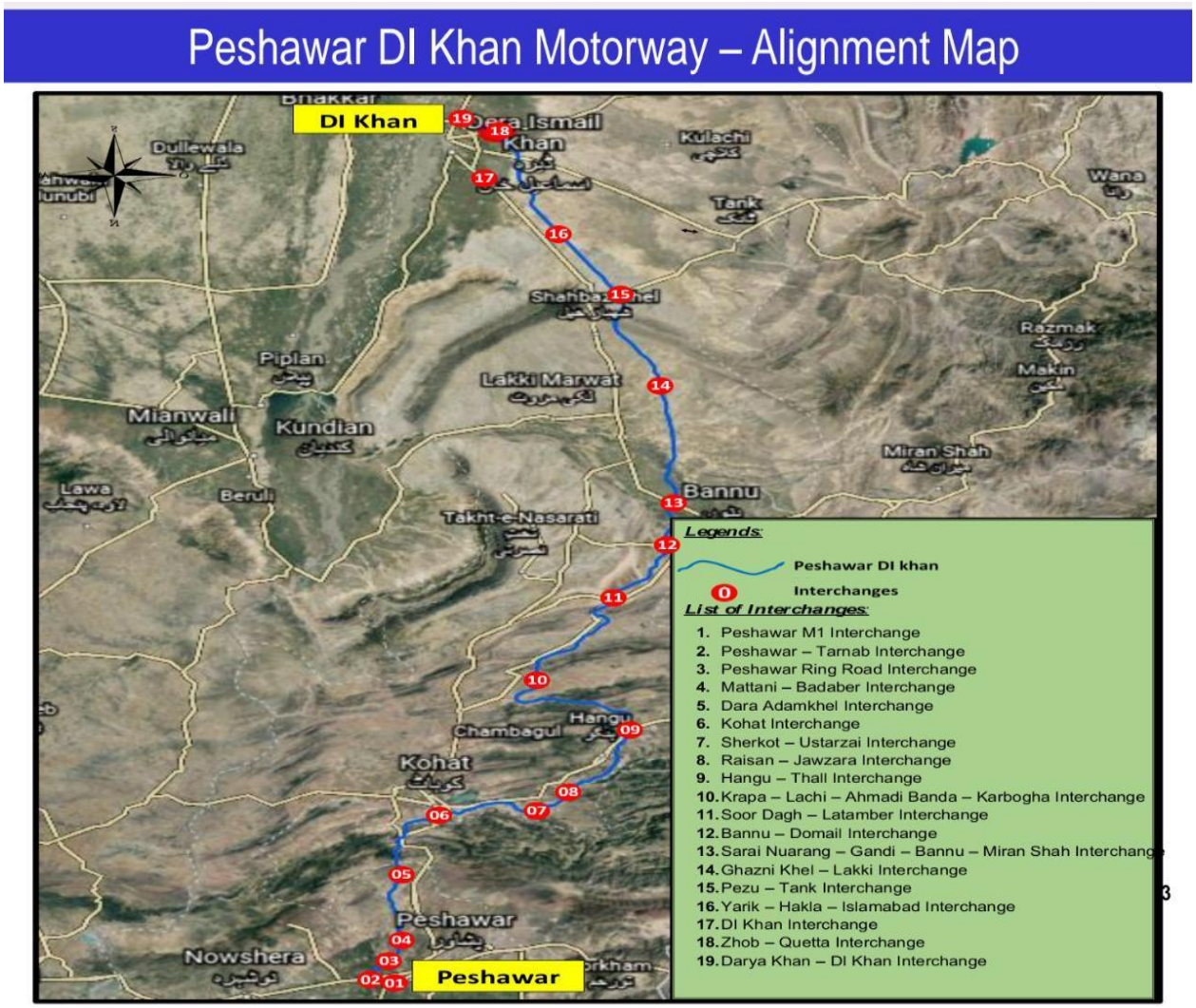

Figure 2.1 D.I Khan-Peshawar Motorway Map

2.1.2 Scope

The traffic study report incorporates traffic data of various locations such Traffic Volume. This data will be used as input for the design traffic of D.I Khan-Peshawar Motorway.

2.1.3 Traffic Data Collection

Traffic data necessary to carry out simulations for this traffic study was provided to us via Private Consultant. The consultant was private company PAVRON International (pvt.) Limited.

Pavron is a Professional Civil Engineering Company registered with the Pakistan Engineering Council. Their experience in the Transportation and Communication sector goes back to the mid 1990's. It was this era when the professionals were engaged in acquiring skills who once would make PAVRON.

No groundwork has been carried out as the project is going through the process of bidding.

Equipment Used:

The equipment used during the collection of data used are:

- Pneumatic tube
- Video Recording Unit

Figure 2.2 Pneumatic Tube

Similarly, video recording unit is also shown here.

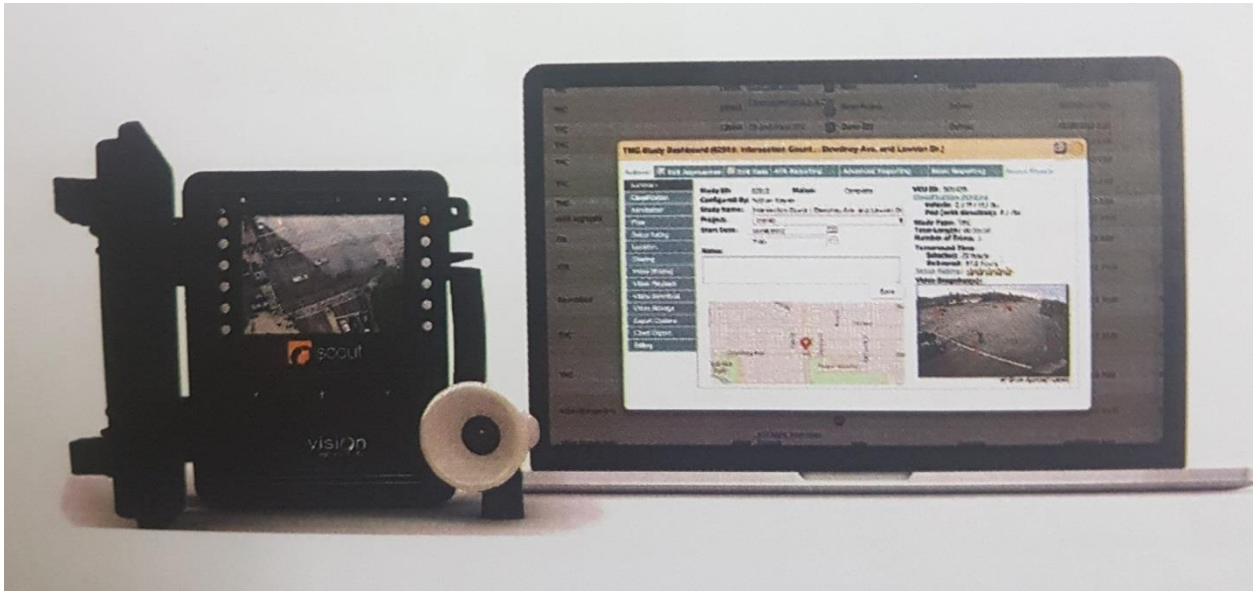

Figure 2.3 Video Recording Unit

2.1.4 Data Collections and Schedule

. A total of 12 locations were defined on the route within study area. The counts were carried out for 2 days for at all 12 locations. The ADT of these counts are listed below.

2.1.5 Traffic Study Results

Location 1 Bannu Link Road:

Table 2.1

Total ADT	Bikes/ Three Wheelers	Cars/ Jeep	Hiace/ Suzuki	Mini-Bus	Large Bus	Trucks/Tractor Trolleys	Total
	1153	1166	681	28	24	436	3488

- Average Daily Traffic was found to be 3488 vehicles per day.
- These counts include 33% bikes, 33.4% cars, 21% public transport and 12.5% trucks.

Location 2 Gaandi-Chowk to Sarai Naurung:

Table 2.2

Total ADT	Bikes/ Three Wheelers	Cars/ Jeep	Hiace/ Suzuki	Mini-Bus	Large Bus	Trucks/Tractor Trolleys	Total
	2762	1642	1184	6	74	846	6514

- Average Daily Traffic was found to be 6514 vehicles per day.
- These counts include 42.4% bikes, 25.2% cars, 19.4% public transport and 13% trucks.

Location 3 N-55 near Mangla Banda:

Table 2.3

Total ADT	Bikes/ Three Wheelers	Cars/ Jeep	Hiace/ Suzuki	Mini-Bus	Large Bus	Trucks/Tractor Trolleys	Total
	1488	1541	1125	28	140	2487	6809

- Average Daily Traffic was calculated as 6,809 vehicles per day.
- These counts include 22% bikes, 23% cars, 19% public transport and 37% trucks.

Location 4 N-55 near Daulat Tajazai:

Table 2.4

Total ADT	Bikes/ Three Wheelers	Cars/ Jeep	Hiace/ Suzuki	Mini-Bus	Large Bus	Trucks/Tractor Trolleys	Total
	2370	1832	1418	52	152	2985	8809

- Average Daily Traffic was calculated to be 8809 vehicles per day.
- These counts include 27% bikes, 21% cars, 18.4% public transport and 33.6% trucks.

Location 5 Essa-Khel Mianwali Road (Lakki Marwat):

Table 2.5

Total ADT	Bikes/ Three Wheelers	Cars/ Jeep	Hiace/ Suzuki	Mini-Bus	Large Bus	Trucks/Tractor Trolleys	Total
	3610	1373	711	0	26	264	5984

- Average Daily Traffic was calculated as 5984 vehicles per day.
- These counts include 60.3% bikes, 23% cars, 12.3% public transport and 4.4% trucks.

Location 6 Shahbaz Khel:

Table 2.6

Total ADT	Bikes/ Three Wheelers	Cars/ Jeep	Hiace/ Suzuki	Mini-Bus	Large Bus	Trucks/Tractor Trolleys	Total
	1725	1280	853	68	136	1877	5939

- Average Daily Traffic was calculated as 5939 vehicles per day.
- These counts include 29% bikes, 22% cars, 18% public transport and 32% trucks.

Location 7 Gul Imam:

Table 2.7

Total ADT	Bikes/ Three Wheelers	Cars/ Jeep	Hiace/ Suzuki	Mini-Bus	Large Bus	Trucks/Tractor Trolleys	Total
	777	804	536	46	73	754	2990

- Average Daily Traffic was calculated as 2990 vehicles per day.
- These counts include 26% bikes, 27% cars, 22% public transport and 25% trucks.

Location 8 D.I Khan Mianwali Road:

Table 2.8

Total ADT	Bikes/ Three Wheelers	Cars/ Jeep	Hiace/ Suzuki	Mini-Bus	Large Bus	Trucks/Tractor Trolleys	Total
	10980	2561	795	16	81	707	15140

- Average Daily Traffic was calculated as 15140 vehicles per day.
- These counts include 72.5% bikes, 17% cars, 5% public transport and 4.5% trucks.

Location 9 N-50 Zhob-D. I Khan Road:

Table 2.9

Total ADT	Bikes/ Three Wheelers	Cars/ Jeep	Hiace/ Suzuki	Mini-Bus	Large Bus	Trucks/Tractor Trolleys	Total
	3359	1080	561	71	282	2195	7548

- Average Daily Traffic was calculated as 7548 vehicles per day.
- These counts include 44.5% bikes, 14.3% cars, 12.1% public transport and 28.6% trucks.

Location 10 N-55 Near Basti Nawab:

Table 2.10

Total ADT	Bikes/ Three Wheelers	Cars/ Jeep	Hiace/ Suzuki	Mini-Bus	Large Bus	Trucks/Tractor Trolleys	Total
	4324	1008	581	14	111	2047	8085

- Average Daily Traffic was calculated as 8085 vehicles per day.
- These counts include 53.5% bikes, 12.5% cars, 9% public transport and 25% trucks.

Location 11 N-55 Chashma Sugar Mills:

Table 2.11

Total ADT	Bikes/ Three Wheelers	Cars/ Jeep	Hiace/ Suzuki	Mini-Bus	Large Bus	Trucks/Tractor Trolleys	Total
	13281	3635	2110	10	157	1624	20817

- Average Daily Traffic was calculated as 20817 vehicles per day.
- These counts include 64% bikes, 17.5% cars, 11% public transport and 7.5% trucks.

Location 12 Bakhar Road:

Table 2.12

Total ADT	Bikes/ Three Wheelers	Cars/ Jeep	Hiace/ Suzuki	Mini-Bus	Large Bus	Trucks/Tractor Trolleys	Total
	4089	784	460	91	87	1480	6991

- Average Daily Traffic was calculated as 6991 vehicles per day.
- These counts include 58.5% bikes, 11% cars, 9% public transport and 20.5% trucks.

2.1.6 Average Daily Traffic

Average daily traffic (ADT) is the average 24-hour traffic volume at a specified location for a period less than a year (6 months or a season, a month or, a week or some days). The highest ADT was observed near N-55 Chashma Sugar Mills (location 11) with an ADT of 20817 vehicles per day.

2.1.7 Estimation OF Traffic Growth

There are several factors on which traffic growth is dependent. Different indicators were reviewed for the estimation of growth factor for the travel demand forecasting which include rate of increase in

- No. of registered vehicles
- No. of vehicles on roads
- Agriculture & Industrial production
- Population
- GDP

2.1.7.1 Population Growth

- The current population of Pakistan in 2021 is 224,198,947, a 1.96% increase from 2020.
- The population in 2020 was 220,891,239, a 2.1% increase from 2019.
- The population in 2019 was 216,565,227, a 2.05% increase from 2018.
- The population in 2018 was 212,227,285, a 2.07% increase from 2017.

2.1.7.2 Growth of registered Vehicles

The vehicles registered within the country improved by 9.5 percent during 2018 since amount of vehicles have risen to 23,588,268 in the preceding year when in comparison to 21,506,641 vehicles in 2017, as per Pakistan Bureau of Statistics (PBS).

The data highlighted that two-wheel registered motor bikes had the highest increase during that period showing a rapid rise in their registration of 11.5 percent. Their number has now soared to 17,465,880 from 15,664,098 in the preceding year.

Similarly, motor cars, jeeps and wagons have grown by 5.3 percent reaching to 3,043,593 from 2,889,500 during the period of one year. However, the growth in the registration of three-wheel motorcycles, trucks, buses, taxis, and other vehicles displayed normal increase.

The number of trucks has surged to 277,416 from 272,934 in one year time period. The number of buses has also risen to 236,461 from 233,884, the data showed.

2.1.7.3 Growth of Vehicles on Roads of Pakistan

- The rate of growth of cars on roads for the last five years is 17.13%
- The rate for the growth of buses is 3.73%
- The rate for the growth of trucks is 4.75%

2.1.7.4 Growth in Agricultural and Industrial Sectors

- Agriculture sector, which forms 19.3% of the GDP, recorded a year-on-year growth of 2.67% in Fiscal Year 2020, lesser than the aim of 3.5%, but better than last year's growth of 0.58%.

- Pakistan's Industrial Production increased 23.33 percent in March of 2021 over the same month in the previous year.

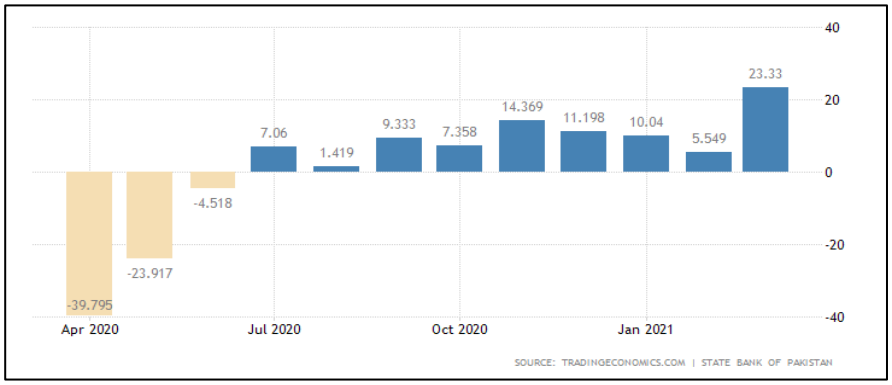

Figure 2.4 Industrial Production of Pakistan

- Annual Growth Rate of GDP in Pakistan decreased to -0.38 percent in 2020 from 1.91 percent in 2019.

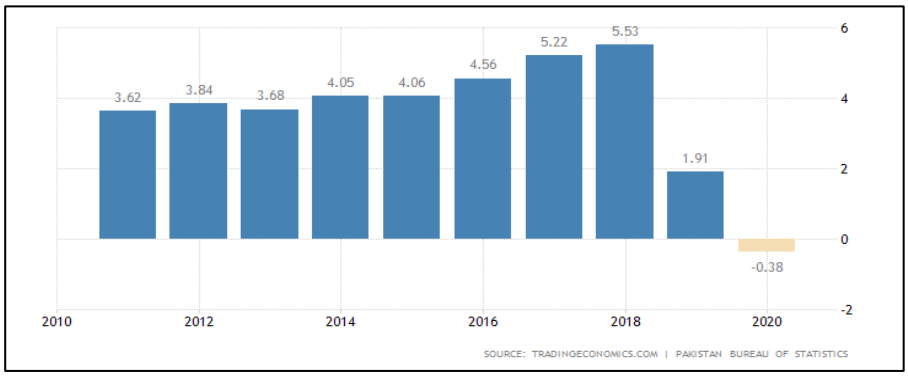

Figure 2.5 GDP Growth of Pakistan

2.1.8 Origin-Destination (OD) Survey

Origin-destination (O-D) surveys impart a thorough understanding of the travel and trip patterns of a region's residents. Such surveys help process important info related to households, individuals, and trips. This data enables shareholders to:

- Comprehend travel characteristics and patterns.
- Measure trends.
- Submit input for development of model for travel demand.
- Predicting, and planning for needs and services of area-wide transportation.
- Progress in implementing transportation policies.

2.1.8.1 Survey Questionnaire

All drivers interviewed were asked the following five questions:

1. Where did your trip begin? (Origin)
2. Where will your trip end? (Destination)
3. What is the purpose behind this trip? (For passenger vehicles only)
4. What are you carrying? (For Goods vehicles only)
5. How often do you tend to travel using this route?

O-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.

Trip Purpose:

- Home (Coming or Going)
- Work
- Education (Coming or Going)

Trip Frequency:

- Daily
- Once per Week
- Two or Three Times per week
- Others (Once in a month/Rarely)

2.2 Literature Review of PTV VISSIM

VISSIM is an acronym of "Verkehr In Stadten – SIMulation". The model was designed at the University of Karlsruhe, Germany during the early 1970s. Commercial distribution of VISSIM began in 1993 by PTV Trans world AG. VISSIM is regarded today as a leader in the arena of micro-simulation software. VISSIM provides a range of urban and highway applications, integrating public and private transportation. Complex traffic conditions are visualized with high degree of detail supported by realistic traffic models. VISSIM is multi-modal microscopic traffic simulation software. **Multi-modal simulation** defines the ability to simulate more than one type of traffic. In VISSIM the following types of traffic can be simulated

- Vehicles (cars and trucks)
- Public transport (trams, buses)
- Cycles (bicycles, motorcycles)
- Pedestrians

VISSIM models the movements of individual vehicles dynamically in the network on a second-by-second basis using car following models. These tools require detailed geometric, control and demand data and a large number of calibrated parameters to accurately model driver behavior in the network. Because of the fine level of detail required in a microscopic model, applications tend towards traffic operations over a relatively small geographical area. VISSIM consists of a GUI (graphical user interface), which enables the user to input traffic data, and signal data to preexisting base maps of road layouts and intersections. This distinct feature of VISSIM not only minimizes the effort needed for data input, but it also enhances the standard of animation of traffic and transit operations (Kaur, 2015).

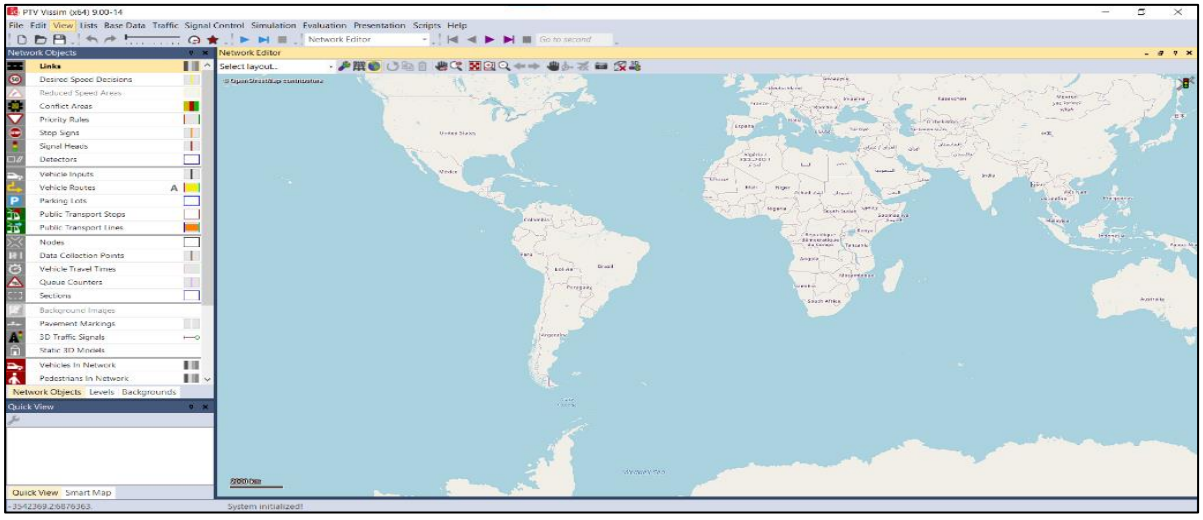

Figure 2.6 VISSIM Interface

2.2.1 General Traffic Simulation and Calibration

These processes present statistical functions for the validation of simulating the models of any place such as roads, highways etc. It consists of three stages; they are as follow:

- Volume based calibration
- Speed based calibration
- Objective based calibration

Any type of traffic simulation models can be run on VISSIM it gives accurate results for that we have to give modifications to Volume of traffic, Route decision, Speed estimation and reduce speed areas for calibration of traffic simulation models. It can be a general guideline for building model also, planning traffic simulation project, model calibration validation, and node analysis of results. It runs through a license and a student version; both have some limits.
The nine steps include:

1) Determination of traffic
2) Data collection
3) Identification of Peak hour
4) Route decision
5) Sign boards
6) Delay of vehicles
7) Determination of parameters
8) Run preliminary simulations
9) Results of Node regarding LOS and delay.

2.2.2 Traffic Study

A traffic study is a meticulous investigation and elaborate analysis of the transportation system of a specified region, which is supported by an extensive gathering of data. Usually, traffic studies are carried out to inspect a persistent transportation problem and provide a solution that will yield less traffic and congestion in that region.

A very large number of people tend to travel from Peshawar and D.I Khan for one reason or the other whether it may be personal or business. Too much time is wasted while travelling via GT road so motorways are being constructed so that at a speed of 120 km/h time can be saved as well as increasing the efficiency of travelling along with the increase in pollution. Numerous causes for which the project is under consideration include:

- Amount of vehicles exceeding the design capacity at GT road.
- Low speed at GT road.
- Frequent Intersections
- Increasing Traffic demand.
- Excessive pedestrian crossing.
- Rise in vehicle ownership causing limited use of public transport.

2.2.3 Intersection Delays

In the traffic system, urbanized road network performs vital role in operations and application in intersections, they are divided into two groups, on grade and without grade and they are basically on different levels of intersection control. It can be signalized; semi controlled or may be completely controlled. These factors affect delay, queue, and LOS.

2.2.4 Capacity

Highway Capacity Manual says at any given time max hourly rate at which vehicles is required to traverse a point in a road. It may be assessed using saturation stream. Capacity may change by changing various roadway conditions like grades change or lane usage allocations, no. of lanes and lanes width.

2.2.5 Estimating Delay at Real-World

Delay is the time that is wasted by the passenger in vehicle due to queue. Delay includes queue time, clearance lost time and start up lost time.

Factors that affect delay are capacity and volume of vehicle in lane group, green time cycle length, delays may affect LOS.

2.2.6 LOS

LOS is abbreviated as Level of Service. It is system used for determining how well a transportation facility is functioning from a traveler's perspective based on performance measure like density, acceleration speed etc.

Typically, six levels of service are defined, and each is assigned a letter designation from A to F, with LOS A representing the best operating conditions, and LOS F the worst. It is categorized as A, B, C, D, E, and F. If the delay is less than 10 seconds then LOS is A and if it is in between 10-20 seconds LOS is B, for 20-35 seconds LOS is C, for 35-55 seconds LOS

is D, 55-80 seconds is LOS E, higher than 80 seconds is LOS F. Hence, we get the LOS from this time. VISSIM benefits us such that it provides the LOS grade itself by creating a node where we want results.

Table 2.13 Level of Service

LOS	Signalized Intersection	Un-signalized Intersection
A	≤10 sec	≤10 sec
B	10–20 sec	10–15 sec
C	20–35 sec	15–25 sec
D	35–55 sec	25–35 sec
E	55–80 sec	35–50 sec
F	>80 sec	>50 sec

2.2.7 Vehicle queuing

It is measure of effectiveness and behavior of traffic that also tells about the capacity of lanes, wait time and about the queue. When there is a lot of traffic and if signalized and green time is less than here the role of traffic engineer comes is to solve problem problems while optimizing the operation of the existing traffic system. The queue length is much more important and similar to that it has a unit of vehicle and characterizes as no. of vehicles its formula: **Queue length = Vehicle per hour x Queue time**

2.2.8 Conflict Areas

When 2 or more lanes merge, diverge or cross each other without any traffic signal it becomes a conflict area. VISSIM can give priority to the traffic depending upon the preference specified by the user.

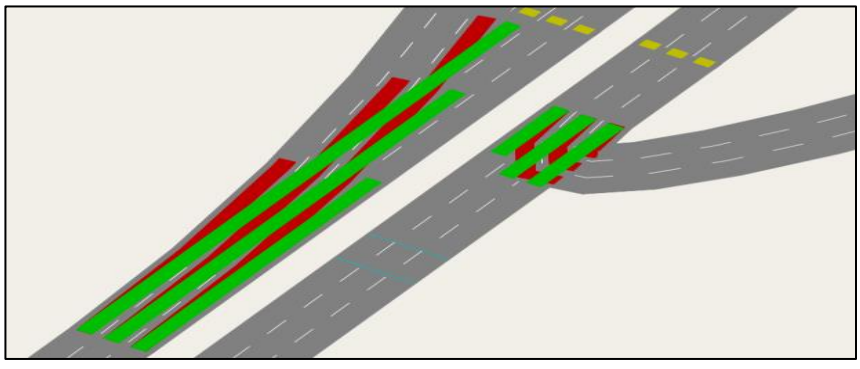

Figure 2.7 Conflict Areas

2.2.9 Gap Acceptance

Gap acceptance is the least possible gap required to cease lane changing in a safe manner. Hence, its model can assist describe how a driver guess that he has to accept or reject. It may also be defined as a minor stream vehicle accepts accessible the available gap to maneuver.

2.2.10 Intersections

It is a point where two or more roads intersect It has many types in our interchange it is simple, the traffic coming from different areas conflict and go towards Toll plaza that creates Grade separated intersections or interchanges that ensure the elimination of crossing conflicts that can occur at intersections with vertical separations in the road.

There are many types of intersection like 3,4,5,6,7-way approach, It can be T junction Y junction or may be signal controlled intersection, in our motorway design the toll plaza plays a role as interchange where the traffic has to move to its destination and it stops for a while hence they changes its routes by intersection.

Basically, the various turning ramps, various patterns of roadways are defined as interchanges. The design of an intersection is made to ensure:

- Economical flow of traffic
- Direction of traffic movement
- Right of way (ROW)
- Type of controls units
- Topography and operation at the crossing facilities which is the most important factor

Chapter 3

Methodology

3.1 Introduction

This part of the research work explains the research methodology adopted during the study to achieve the stated objectives. Research methodology or method to conduct a study is considered as "a strategy, design or process lying behind the choice of and use of particular methods". Its purpose is to explain and justify the use of particular methods (Wellington, 2000).

D.I Khan-Peshawar Motorway contains 19 interchanges out of which 8 were simulated using VISSIM.

Table 3.1 Understudy Interchanges

LIST OF INTERCHANGES	
Sr No.	**Names**
1	Bannu-Domail Interchange
2	Sarai Nuarang - Gandi - Bannu - Miran Shah Interchange
3	Ghazni Khel - Lakki Interchange
4	Pezu - Tank Interchange
5	Yarik - Hakla - Islamabad Interchange
6	DI Khan Interchange
7	Zhob - Quetta Interchange
8	Darya Khan - DI Khan Interchange

Simulation of these interchanges included different steps:

- Drawing of Links and Connectors
- Assigning Traffic Routes
- Adding Traffic
- Adding Traffic Composition
- Running Simulation
- Getting Data Output

3.2 Data Collection

Data was collected using the following parameters.

3.2.1 Traffic Volume Study

We utilized all the data provided in the traffic study report and used that data to give traffic inputs in the different interchanges and the traffic influencing those interchanges.

3.2.2 Geometric Condition

The on-site geometric parameters which should be considered important for the investigation of Motorway Interchanges are:

- Type of Area
- Number of lanes, N
- Average lane width, W (ft)
- Grade, G (%)
- Existence of exclusive LT or RT lanes

3.2.3 Signalization Conditions

In order to induce the effect of Toll Plazas on the interchange ramps we made use of the application of Stop Signs since VISSIM 9 software does not support the placement of Toll Plazas.

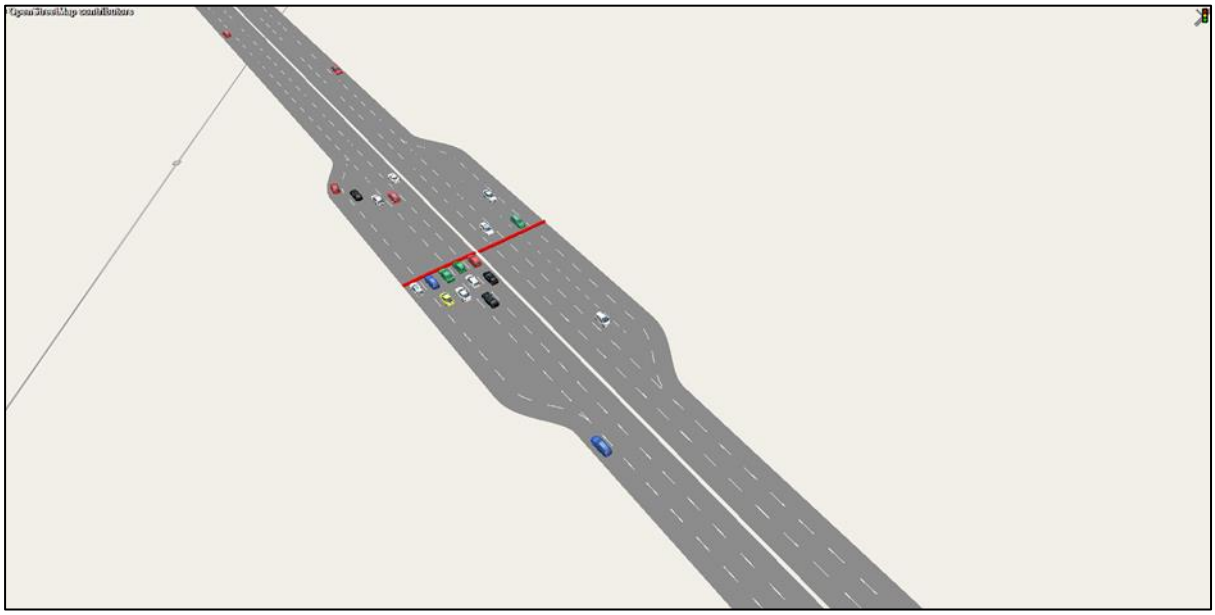

Figure 3.1 Use of Stop Signs as Toll Plazas

The onsite prevailing signalization conditions parameters which should be imperative for the investigation of designated urban signalized intersection would be as under:

- Cycle length, C (s)
- Green time, G (s)
- Yellow-plus-all-red change-and-clearance interval
- Inter-green, Yellow (s)
- Actuated or pre timed operation.

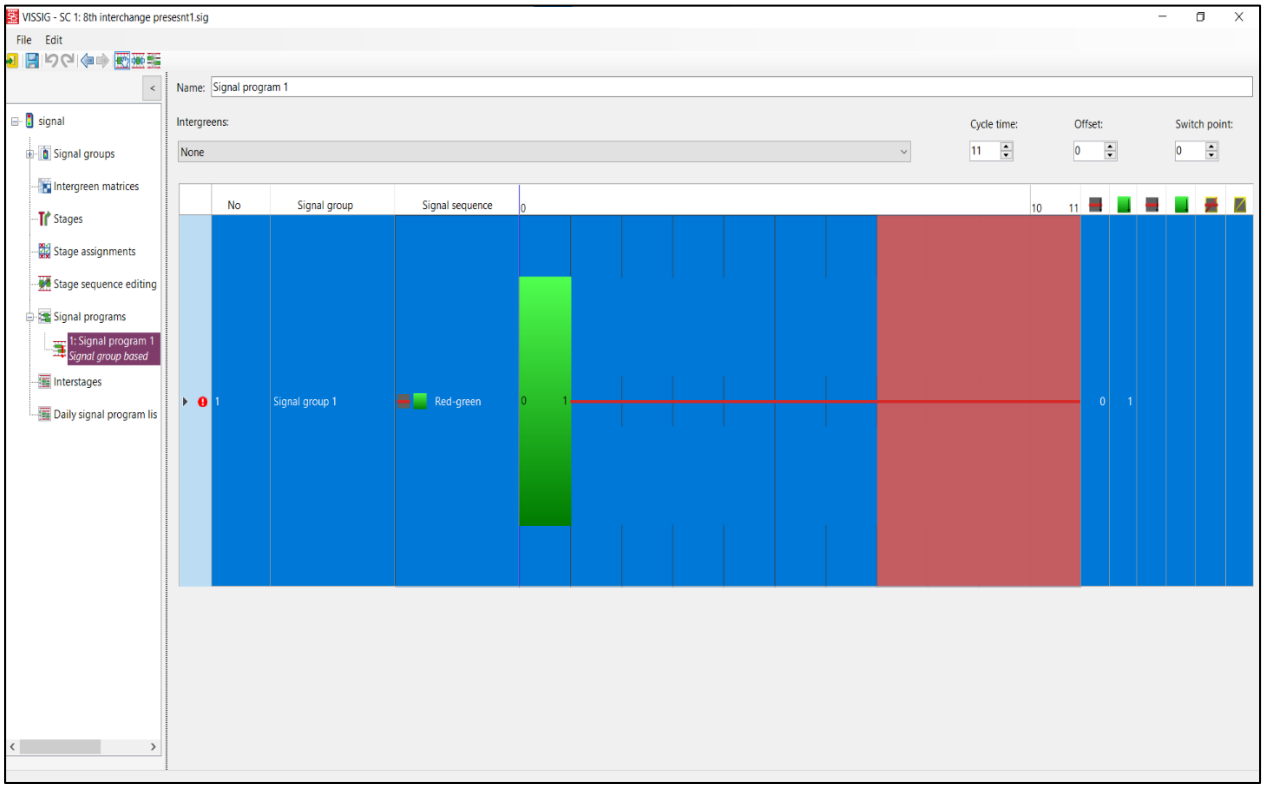

Figure 3.2 Signal Programming

3.3 Determination of LOS

All the above parameters are put in VISSIM 9 software to determine the LOS of the intersections. The intersections are signalized having pre-timed cycle lengths. After putting in the data the results were generated which gave the LOS of existing conditions.

3.4 Proposed Design Alternatives

After the analysis of the LOS, time delay and Queue Length with the help VISSIM 9, it was concluded to suggest various design alternatives to improve the LOS. These alternatives consisted of short term and long-term measures.

3.5 Peak Hour Factor

It is the measure of traffic demand variation within the analysis hour and describes the connection between complete hourly volume and the peak 15-min flow rate within that hour. It is given by dividing the hourly volume by the peak 15-min flow rate within the analysis hour. In calculating value of PHF, a 15-min interval is used because it is considered as the minimum time over which traffic flow is statistically stable. And it can be calculated as

PHF = (average flow rate)/ (4*Peak 15-minute flow rate)

The maximum and minimum values for PHF are 1.00 and 0.25, respectively. A PHF of 1.00 indicates no variation in traffic flow within the analysis hour while a PHF of 0.25 indicates that the entire hourly volume occurred during the peak 15-min interval.

The study report provided the data about the daily traffic, but it didn't provide any data to calculate the Peak Hour Factor for the interchanges. So, in the absence of any data PHF can be taken as 0.94 as specified in Highway Capacity Manual for Freeways. So, the value of PHF has been taken as 0.94 and the traffic for peak hour was calculated. All the interchanges have been simulated for that peak hour traffic.

3.6 Data for individual interchanges

The dimensions of links and connectors, traffic and traffic routes for all the interchanges were different from one another depending upon the design of interchanges. Data about individual interchanges is given below:

Figure 3.3 Alignment of Interchanges on VISSIM

3.6.1 Bannu-Domail Interchange

The current and future traffic input used for this interchange is as follows:

Table 3.2

	Bannu-Domail Interchange		
Year / Direction	2021	2031	2041
N	1186	1470.64	1897.6
S	148	183.52	236.8
E	7	8.68	11.2
W	75	93	120

The model of the interchange prepared on VISSIM is as displayed:

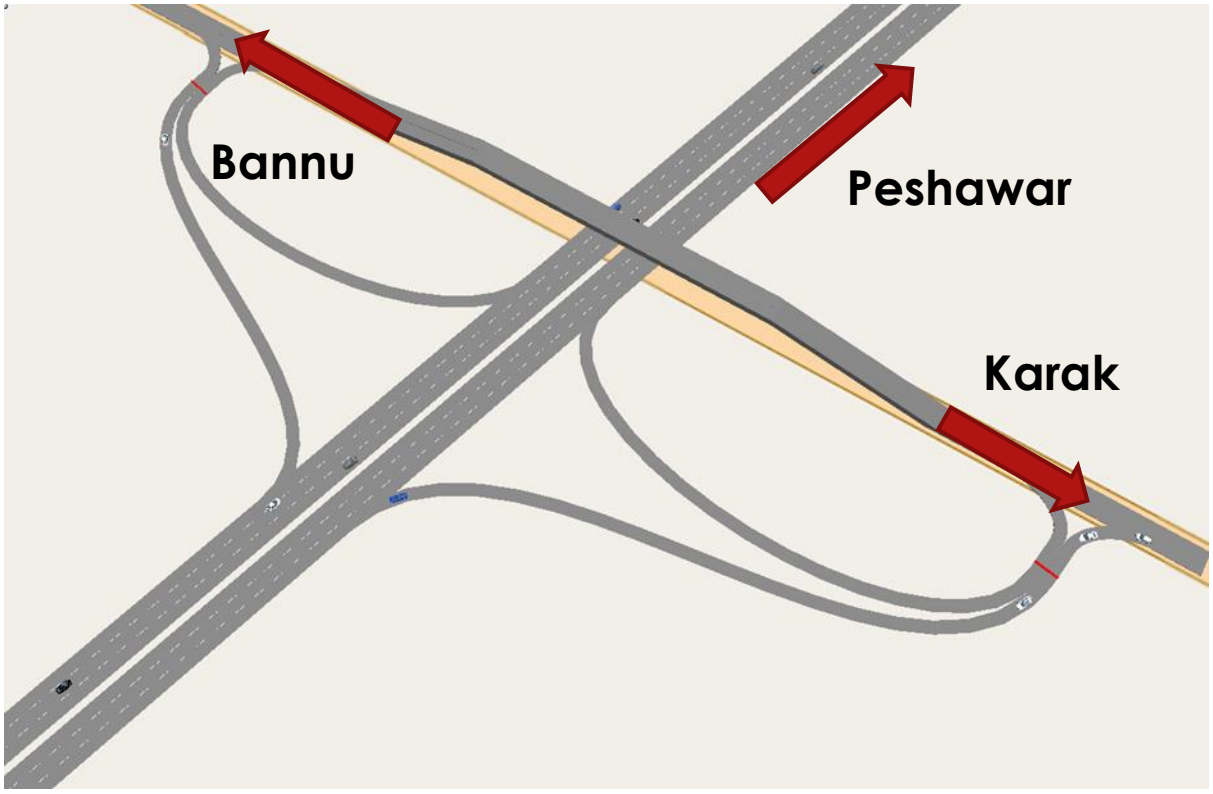

Figure 3.4 Bannu-Domail Interchange

3.6.2 Sarai Nuarang - Gandi - Bannu - Miran Shah Interchange

The current and future traffic input used for this interchange is as follows:

Table 3.3

	Sarai-Nuarung Miran Shah Interchange		
Year / Direction	2021	2031	2041
N	1400	1736	2240
S	210	260.4	336
E	496	615.04	793.6
W	591	732.84	945.6

The model of the interchange prepared on VISSIM is as displayed:

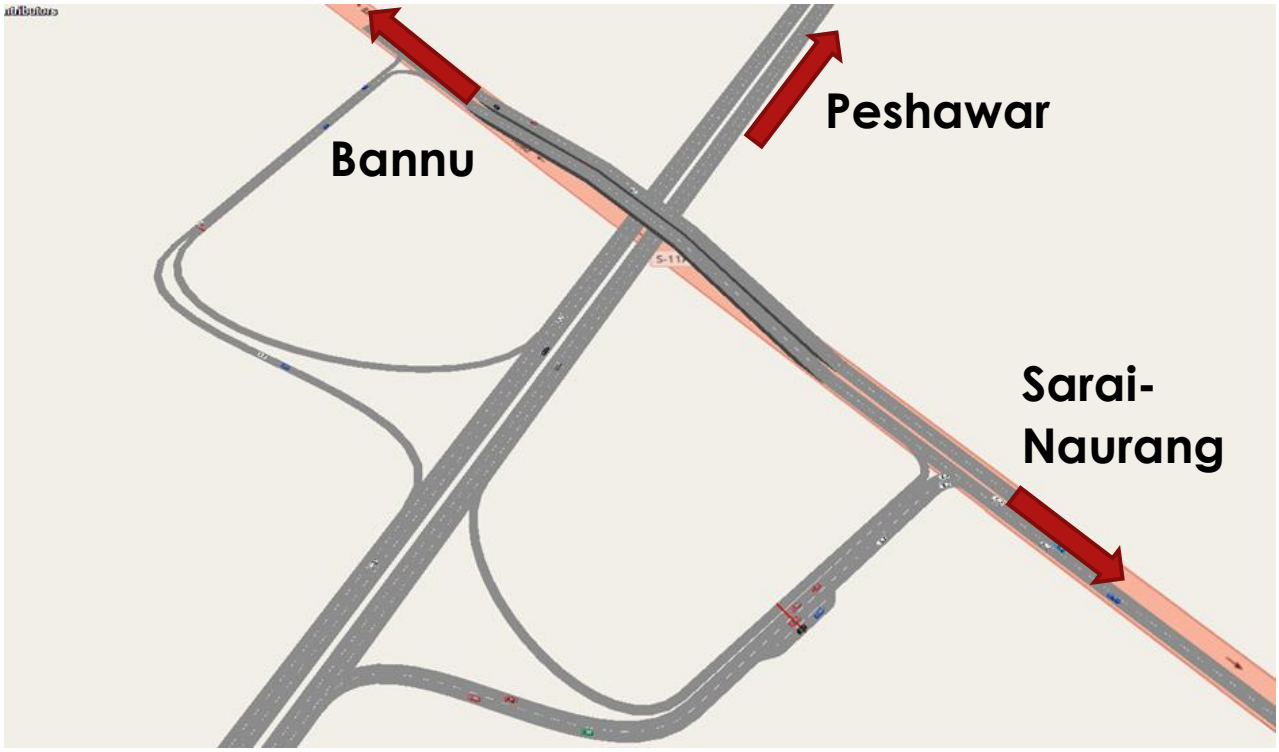

Figure 3.5 Sarai Nuarang - Gandi - Bannu - Miran Shah Interchange

3.6.3 Ghazni Khel-Lakki Interchange

The current and future traffic input used for this interchange is as follows:

Table 3.4

	Ghazni Khel-Lakki Interchange		
Year / **Direction**	**2021**	**2031**	**2041**
N	1440	1785.6	2304
S	764	947.36	1222.4
E	69	85.56	110.4
W	143	177.32	228.8

The model of the interchange prepared on VISSIM is as displayed:

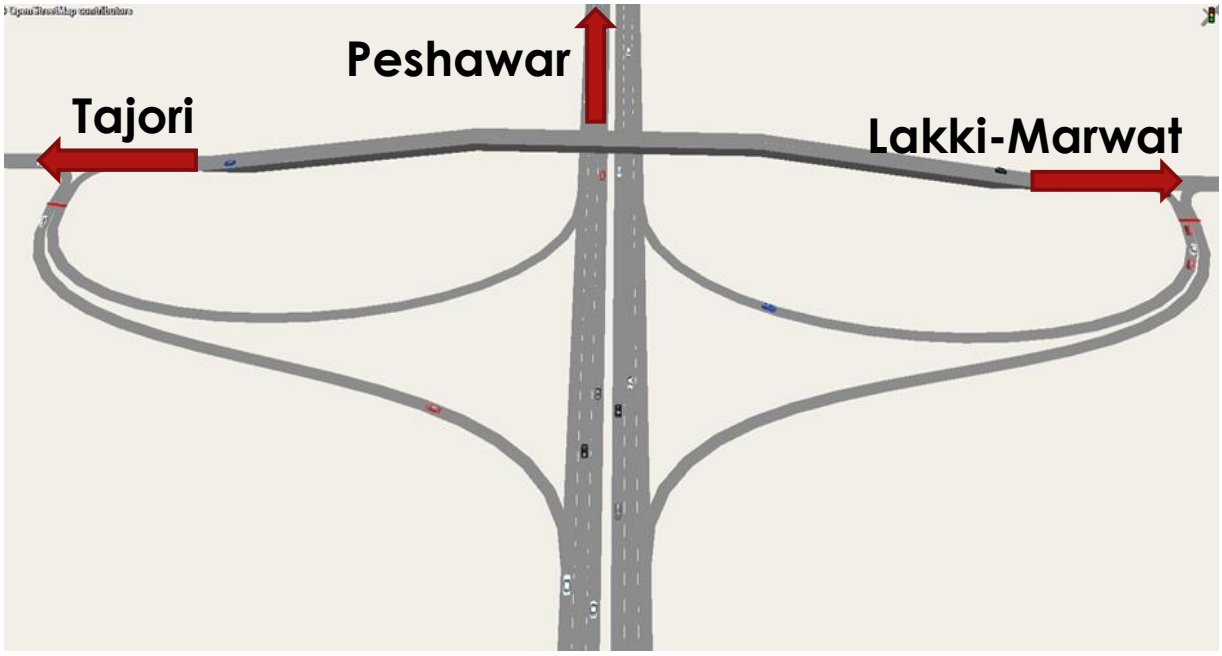

Figure 3.6 Ghazni Khel-Lakki Interchange

3.6.4 Pezu-Tank Interchange

The current and future traffic input used for this interchange is as follows:

Table 3.8

	Pezu-Tank Interchange		
Year / Direction	2021	2031	2041
N	1411	1749.64	2257.6
S	653	809.72	1044.8
E	167	207.08	267.2
W	50	62	80

The model of the interchange prepared on VISSIM is as displayed:

Figure 3.7 Pezu-Tank Interchange

3.6.5 Yarik-Hakla-Islamabad Interchange

The current and future traffic input used for this interchange is as follows:

Table 3.6

	Yarik-Hakla-Islamabad Interchange		
Year / Direction	2021	2031	2041
N	1382	1713.68	2211.2
S	654	810.96	1046.4
E	60	74.4	96
W	152	188.48	243.2

The model of the interchange prepared on VISSIM is as displayed:

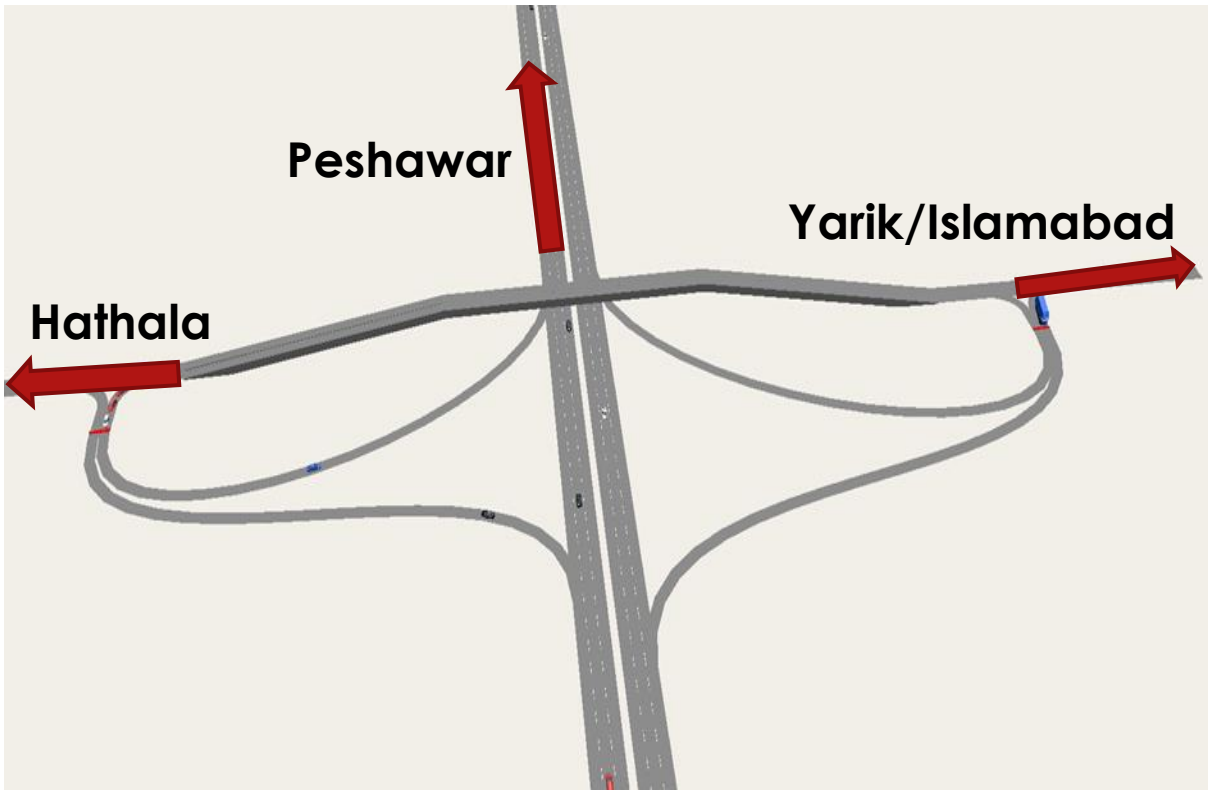

Figure 3.8 Yarik-Hakla-Islamabad Interchange

3.6.6 D.I Khan Interchange

The current and future traffic input used for this interchange is as follows:

Table 3.7

	D.I Khan Interchange		
Year / Direction	2021	2031	2041
N	1360	1686.4	2176
S	703	871.72	1124.8
E	140	173.6	224
W	170	210.8	272

The model of the interchange prepared on VISSIM is as displayed:

Figure 3.9 D.I Khan Interchange

3.6.7 Zhob-Quetta Interchange

The current and future traffic input used for this interchange is as follows:

Table 3.8

	Zhon-Quetta Interchange		
Year / Direction	2021	2031	2041
N	1267	1571.08	2027.2
S	597	740.28	955.2
E	7	8.68	11.2
W	110	136.4	176

The model of the interchange prepared on VISSIM is as displayed:

Figure 3.10 Zhob-Quetta Interchange

3.6.8 Darya Khan-D.I Khan Interchange

The current and future traffic input used for this interchange is as follows:

Table 3.9

	Darya Khan-D.I Khan Interchange		
Year / Direction	2021	2031	2041
N	1267	1571.08	2027.2
S	518	642.32	828.8
E	870	1078.8	1392
W	630	781.2	1008

The model of the interchange prepared on VISSIM is as displayed:

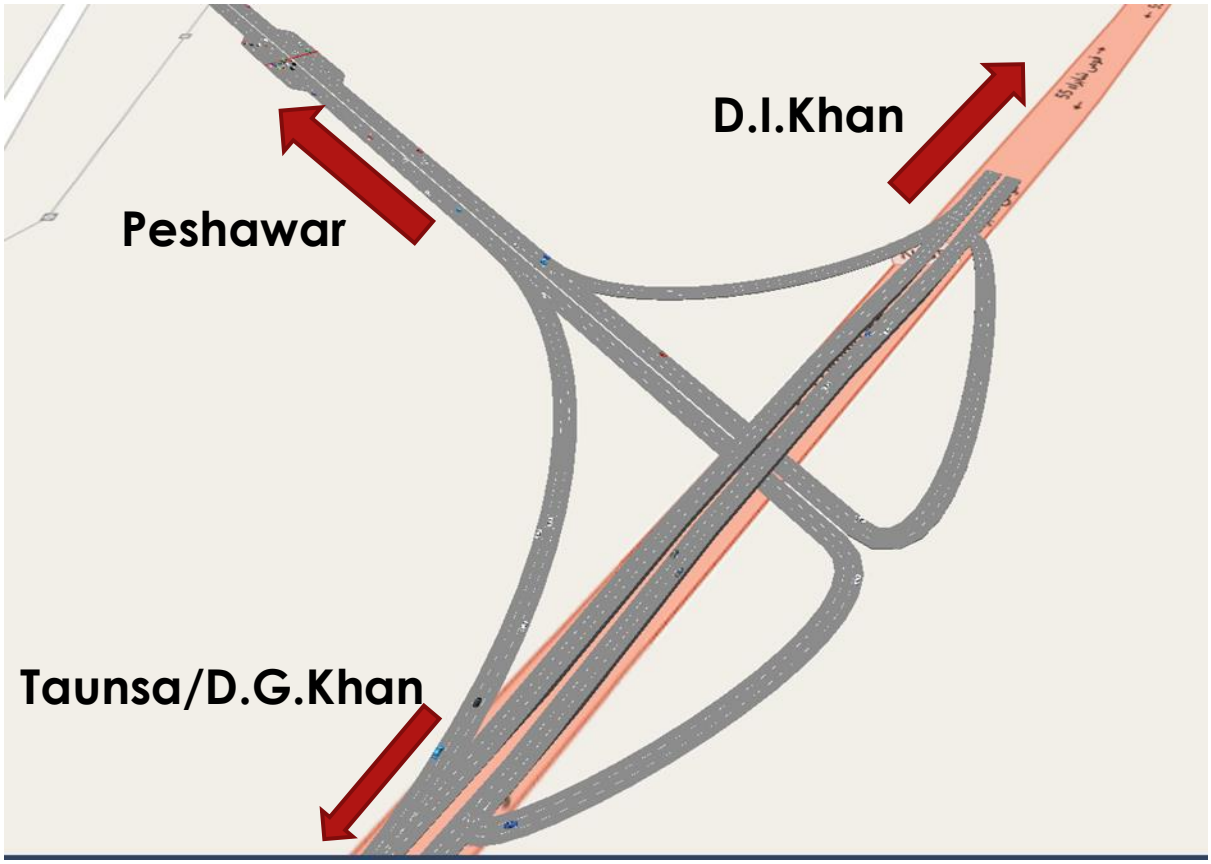

Figure 3.11 Darya Khan-D.I Khan Interchange

3.7 Speed of the Traffic

The simulation of interchanges involves the simulation of three different types of roads.

- Main Motorway
- Interchange/Ramps
- Local Roads

Different speeds are used for the traffic on these different roads. The speed used during the simulation is as follows:

Table 3.10 Speed of Traffic at interchanges

Type of Road	Type of Traffic	Speed(km/hour)
Motorway	LTV	120
	HTV	100
Ramps	LTV	60
	HTV	50
Local Roads	LTV	90
	HTV	80

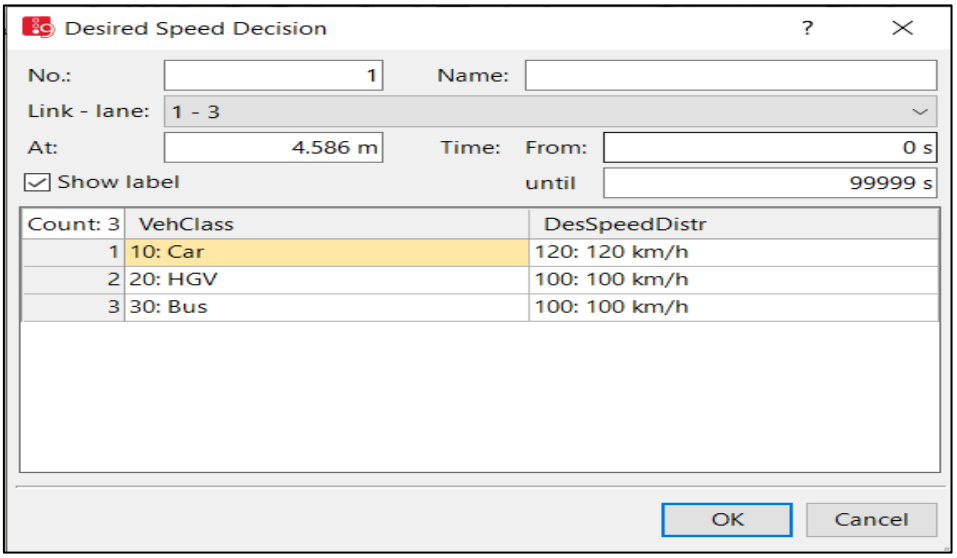

Figure 3.12 Speed Decisions on VISSIM Software

3.8 Traffic Composition

Traffic composition is the percentage of different varieties of vehicles on any road. On any road, mostly cars are in abundance while large buses are least in quantity. VISSIM requires a specific composition of traffic to be inculcated in it which may generate results accordingly.

In VISSIM, three types of vehicles can be considered in traffic composition i.e.

- Cars
- Buses
- Heavy Traffic Vehicles

Cars and Wagons moving on the motorway have been considered in cars category. Large buses were given their percentage in the buses category while all trucks have been considered as Heavy Traffic. The composition according to this distribution is given below:

Table 3.11 Traffic Composition

Section	Cars (%)	Buses (%)	Truck Traffic (%)
Bannu Link Road	49.93576	31.39186	18.67238
Gaandi Chowk to Sarai Naurang	43.76333	33.6887	22.54797
N-55 (Near Mangla Banda)	28.96072	24.29994	46.73933
N-55 (Near Daulat Tajazai)	28.45162	25.19025	46.35813
Essa-Khel-Mianwali Road	57.83488	31.04465	11.12047
Shahbaz Khel	30.37494	25.08306	44.542
Gul Imam	36.33077	29.59783	34.0714
D.I Khan-Mianwali Road	61.5625	21.44231	16.99519
N-50 (Zhob-D.I Khan Road)	25.78181	21.81905	52.39914
N-55 (Near Basti Nawab)	26.80138	18.7716	54.42701
N-55 (Chashma Sugar Mills)	48.23514	30.21497	21.54989
Bakhar Road	27.01585	21.98484	50.99931

3.9 Parameters Set in VISSIM

There are different parameters which are specified before running the simulation. Those parameters are explained here:

3.9.1 Simulation Speed

Simulation speed can be defined as number of real time seconds in one simulation second. It means that in one step of simulation, number of real time seconds passed.

For running the simulation, maximum speed was used which was:

Simulation speed = 10 Real Time Second/ Simulation Second

3.9.2 Time Interval

Time interval can be defined as the number of simulation seconds for which the simulation was run for the purpose of obtaining the results.

During the simulation, the time interval was selected as 500-3000 simulation seconds. Initial 500 simulation seconds were provided for the purpose of initialization of the traffic flow.

By using these parameter i.e. PHF, Traffic speed and Traffic composition all the interchanges were drawn and then analyzed against the standard LOS. The results are shown in the next Chapter.

Chapter 4

Results and Discussion

VISSIM can provide us with a number of different outputs regarding the traffic at any link or connector. These results include:

1) Queue Length
2) Maximum Queue Length
3) Vehicle Delay
4) Delay Time
5) Stop Delay
6) Person Delay
7) Level of Service
8) Fuel Consumption
9) Gases Emission

But since we are only concerned with the traffic operations on the roads, so, we will not consider the fuel consumption and gases emission because these things are more related to the environment. Moreover, the amount of individuals in a single vehicle are not specified, so person delay cannot be exactly determined. As a default value, it is considered that there is a single person in every vehicle, so person delay is same as vehicle delay.

The results are mainly dependent on the traffic counts provided at every interchange. Since, each interchange has been simulated for the three different traffics of 2021, 2031 and 2041, so, each interchange has three different results and LOS corresponding to the year for which it was simulated. A comparison of these three years can provide us with an in-depth view regarding the drop of LOS in these 20 years of design life of the motorway. Traffic for these years has been provided in the previous chapter. The corresponding results for that traffic are given in this chapter. The results are interchange-wise starting from Bannu-Domail to Darya Khan-D.I Khan Interchange.

4.1 Important Terminologies:

Following are the terminologies used in VISSIM in data output.

TIMEINT	It is the simulation in simulation seconds time during which the output data was obtained.
QLEN	The length of vehicle queue in terms of vehicles in the specified node at which data is being obtained.
QLEN (MAX)	The maximum queue length generated at the specified node
VEHS (ALL)	The number of vehicles passing through the node in time interval
LOS (ALL)	Level of Service at the node
LOSVAL (ALL)	Level of Service in digital form
VEHDELAY (ALL)	Delay of the vehicles in seconds caused at the node due to the congestion.
STOPDELAY (ALL)	The time during which a vehicle stopped completely in seconds.

4.2 Bannu-Domail Interchange:

The results obtained are as follows:

Table 4.1

Year	TIMEINT	Qlen	QLen Max	Veh (All)	LOS (All)	LOSVal (All)	VehDelay (All)	PersDelay (All)	StopDelay (All)
2021	500-3000	0.903	18.69227	51	LOS_A	1	0.741253	0.741253	0.244267
2031	500-3000	0.143	18.76842	1208	LOS_B	2	11.13733	11.13733	4.48344
2041	500-3000	0.119	11.40237	10	LOS_B	2	11.78072	11.78072	2.670913

The graph for the above table is also provided:

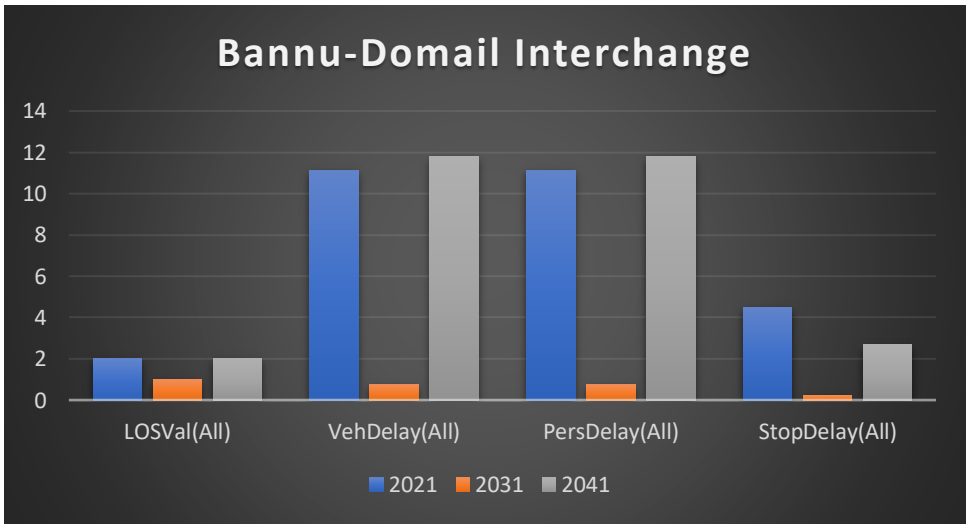

Figure 4.1 Bannu-Domail Interchange Results

The following observations were made:

- In 2021, LOS was graded A and the values for Vehicle Delay, Pers Delay and Stop Delay were negligible.
- In 2031, LOS dropped to B while there was a significant rise in the other three parameters.
- In 2041, LOS remained the same and the same goes for rest parameters.

4.3 Sarai Nuarang - Gandi - Bannu - Miran Shah Interchange:

The obtained results are as follows:

Table 4.2

Year	TIMEINT	Qlen	QLen Max	Veh (All)	LOS (All)	LOSVal (All)	VehDelay (All)	PersDelay (All)	StopDelay (All)
2021	500-3000	18.561	68.898	147	LOS_D	4	41.889	41.889	17.952
2031	500-3000	87.702	188.276	175	LOS_F	6	152.871	152.871	46.292
2041	500-3000	367.697	510.205	178	LOS_F	6	462.560	462.560	136.841

The graph for above table has also been provided:

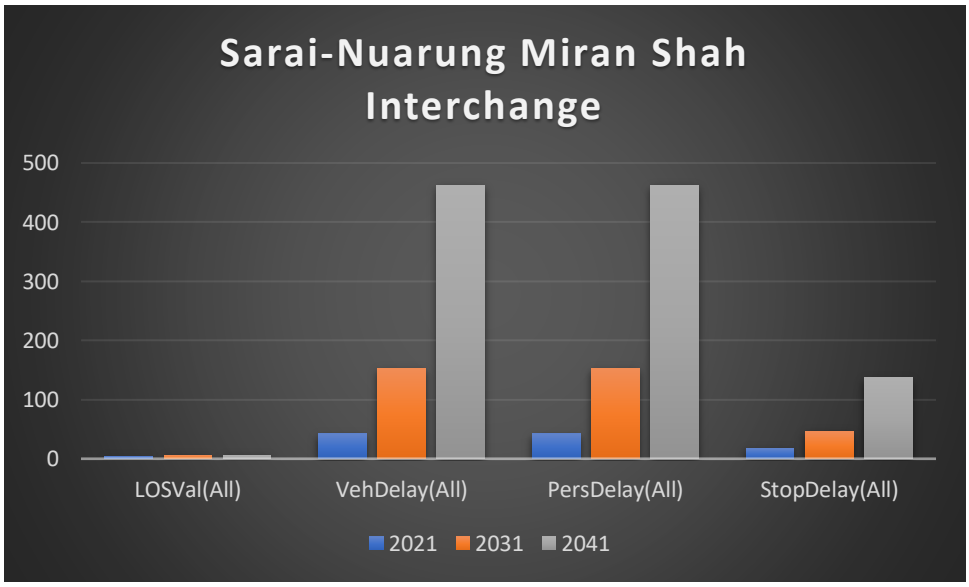

Figure 4.2 Sarai-Nuarang Miran Shah Interchange Results

The following observations were made:

- In 2021, LOS was graded D and the values for Vehicle Delay, Pers Delay and Stop Delay were relatively high providing proof of poor performance.
- In 2031, LOS dropped to F stating failure in performance.
- In 2041, LOS remained at F and continuous rise in Vehicle Delay, Pers Delay and Stop Delay.

4.4 Ghazni Khel-Lakki Interchange:

The results obtained are as follows:

Table 4.3

Year	TIMEINT	Qlen	QLen Max	Veh (All)	LOS (All)	LOSVal (All)	VehDelay (All)	PersDelay (All)	StopDelay (All)
2021	500-3000	5.471	38.671362	100	LOS_C	3	23.460191	23.460191	12.038157
2031	500-3000	8.125	44.737593	121	LOS_C	3	28.9629	28.9629	13.560238
2041	500-3000	30.932	94.962637	154	LOS_E	5	74.166111	74.166111	27.351253

The graph for above table has also been provided:

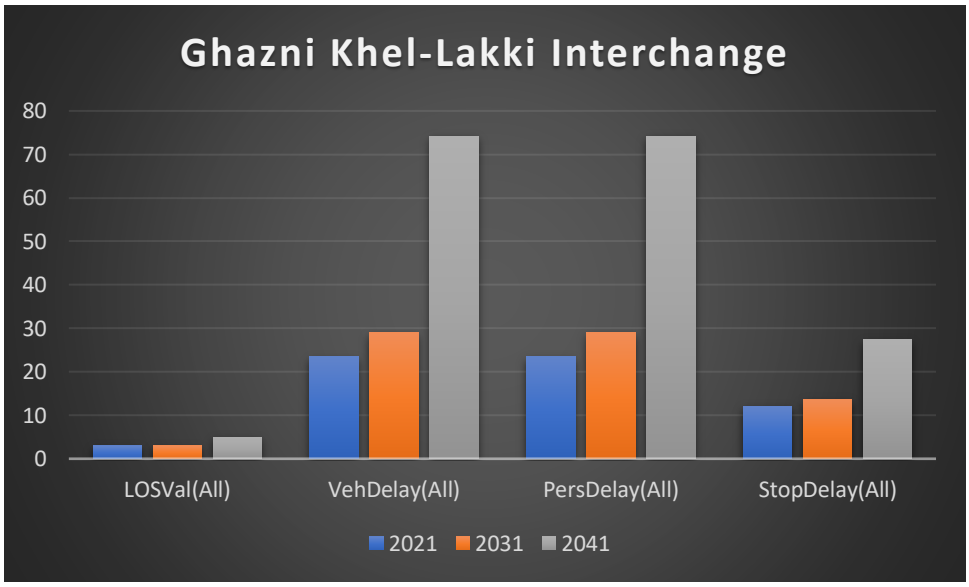

Figure 4.3 Ghazni Khel-Lakki Interchange Results

The following observations were made:

- In 2021, LOS was graded C and the values for Vehicle Delay, Pers Delay and Stop Delay were adequate.
- In 2031, LOS remained at C while a small rise in values of other parameters was detected.
- In 2041, LOS dropped to E and there was a significant rise in Vehicle Delay, Pers Delay and Stop Delay.

4.5 Pezu-Tank Interchange:

The results obtained are as follows:

Table 4.4

Year	TIMEINT	Qlen	QLen Max	Veh (All)	LOS (All)	LOSVal (All)	VehDelay (All)	PersDelay (All)	StopDelay (All)
2021	500-3000	0.014	5.476086	1	LOS_C	3	26.688821	26.688821	14.810251
2031	500-3000	0	0	1	LOS_C	3	24.003637	24.003637	11.333882
2041	500-3000	1.872	19.681186	55	LOS_C	3	19.700377	19.700377	9.705833

The graph for above table has also been provided:

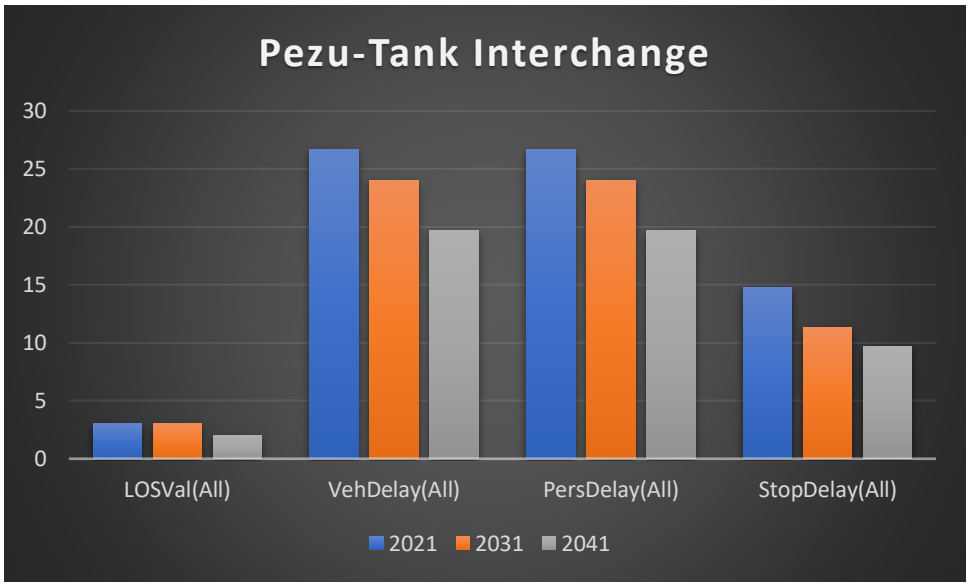

Figure 4.4 Pezu-Tank Interchange Results

The following observations were made:

- In 2021, LOS was graded C and the values for Vehicle Delay, Pers Delay and Stop Delay were adequate.
- In 2031, LOS remained at C while a negligible change in values of other parameters was observed.
- In 2041, LOS remained C and there was a slight drop in Veh Delay, Pers Delay and Stop Delay.

4.6 Yarik-Hakla-Islamabad Interchange:

The results obtained are as follows:

Table 4.5

Year	TIMEINT	Qlen	QLen Max	Veh (All)	LOS (All)	LOSVal (All)	VehDelay (All)	PersDelay (All)	StopDelay (All)
2021	500-3000	2.479	18.729	64	LOS_C	3	26.696622	26.696622	15.152295
2031	500-3000	4.842	37.739	79	LOS_C	3	31.140171	31.140171	17.654013
2041	500-3000	13.878	56.371	106	LOS_E	5	59.41535	59.41535	30.870016

The graph for above has also been provided:

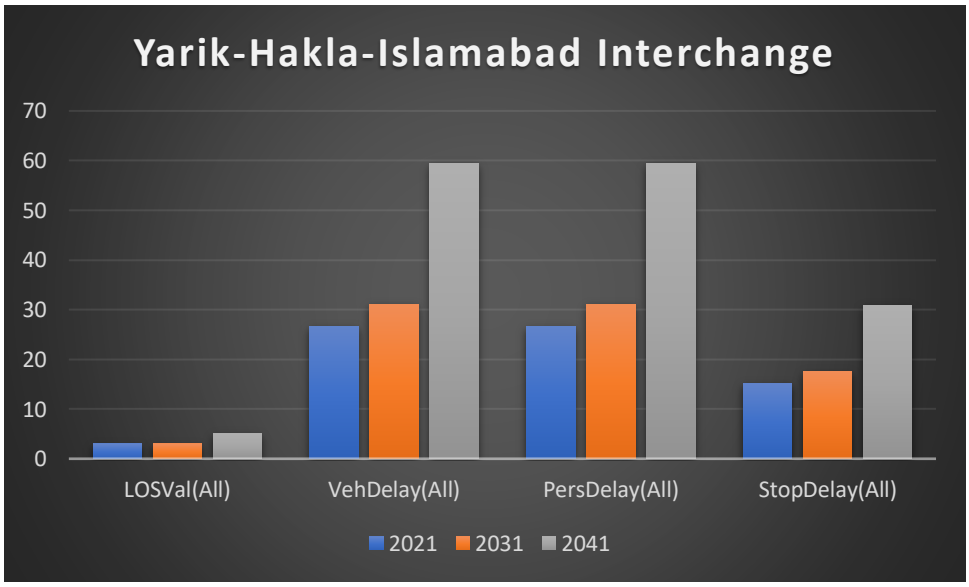

Figure 4.5 Yarik-Hakla-Islamabad Interchange Results

The following observations were made:

- In 2021, LOS was graded C and the values for Vehicle Delay, Pers Delay and Stop Delay were adequate.
- In 2031, LOS remained at C while a negligible change in values of other parameters was observed.
- In 2041, LOS dropped to E and there was a significant rise in Vehicle Delay, Pers Delay and Stop Delay.

4.7 D.I Khan Interchange:

The results obtained are as follows:

Table 4.6

Year	TIMEINT	Qlen	QLen Max	Veh (All)	LOS (All)	LOSVal (All)	VehDelay (All)	PersDelay (All)	StopDelay (All)
2021	500-3000	4.378	39.164256	94	LOS_C	3	20.9122	20.9122	10.655936
2031	500-3000	7.216	39.563584	110	LOS_C	3	29.864338	29.864338	13.814698
2041	500-3000	22.289	81.159148	141	LOS_E	5	63.893808	63.893808	23.832797

The graph for above table has also been provided:

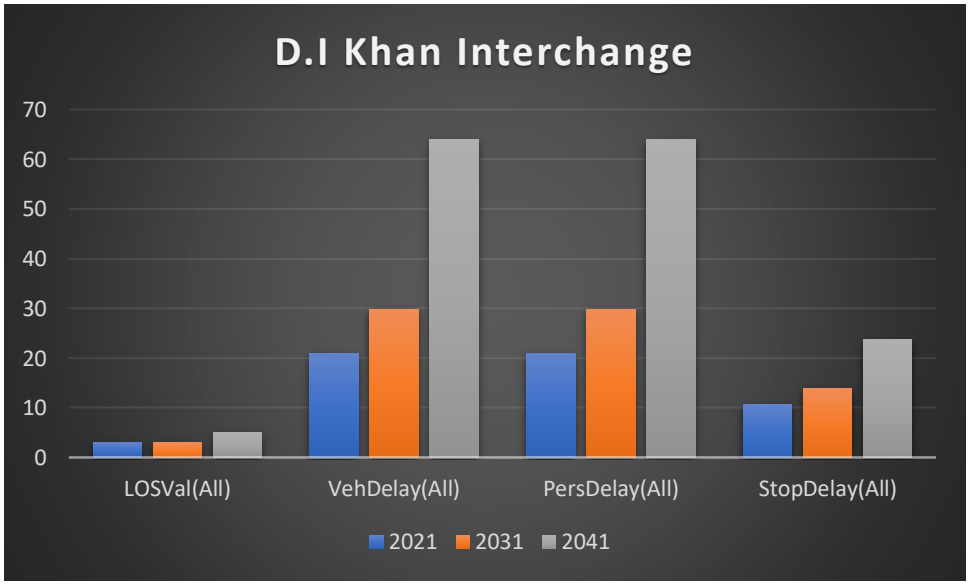

Figure 4.6 D.I Khan Interchange Results

The following observations were made:

- In 2021, LOS was graded C and the values for Vehicle Delay, Pers Delay and Stop Delay were adequate.
- In 2031, LOS remained at C while a slight increase in values of other parameters was observed.
- In 2041, LOS dropped to E and there was a significant rise in Vehicle Delay, Pers Delay and Stop Delay.

4.8 Zhob-Quetta Interchange:

The results obtained are as follows:

Table 4.7

Year	TIMEINT	Qlen	QLen Max	Veh (All)	LOS (All)	LOSVal (All)	VehDelay (All)	PersDelay (All)	StopDelay (All)
2021	500-3000	15.102	68.3463	126	LOS_D	4	45.1124	45.1124	18.4908
2031	500-3000	58.414	130.4275	157	LOS_F	6	128.9889	128.9889	45.456
2041	500-3000	85.509	171.0396	195	LOS_F	6	135.3694	135.3694	34.0226

The graph for above table has also been provided:

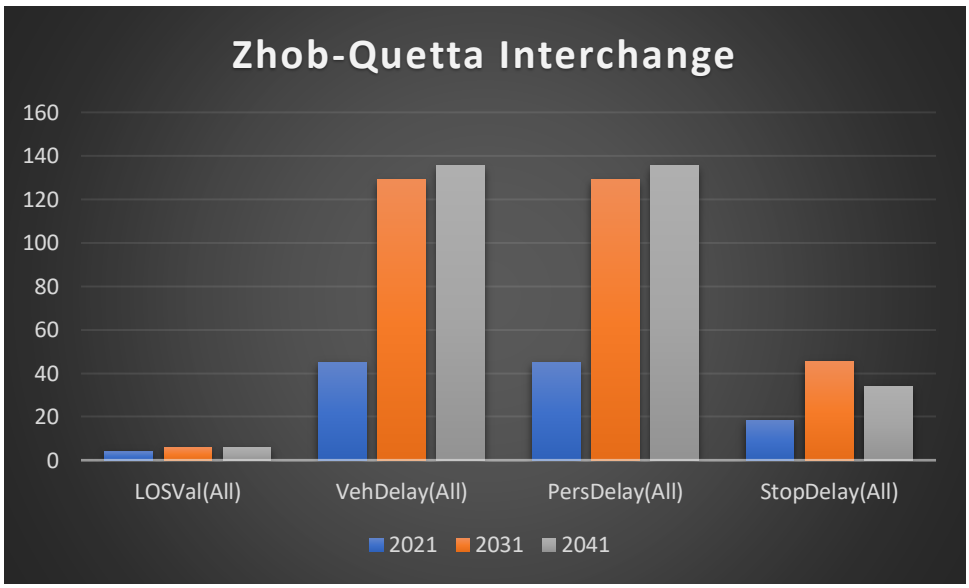

Figure 4.7 Zhob-Quetta Interchange Results

The following observations were made:

- In 2021, LOS was graded D and the values for Vehicle Delay, Pers Delay and Stop Delay were relatively high.
- In 2031, LOS dropped to F while a high increase in values of other parameters was observed.
- In 2041, LOS remained at F and there was a consistency in Vehicle Delay, Pers Delay and Stop Delay.

4.9 Darya Khan-D.I Khan Interchange:

The results obtained are as follows:

Table 4.8

Year	TIMEINT	Qlen	QLen Max	Veh (All)	LOS (All)	LOSVal (All)	VehDelay (All)	PersDelay (All)	StopDelay (All)
2021	500-3000	6.983	32.7895	927	LOS_A	1	9.095885	9.095885	3.170028
2031	500-3000	10.517	42.7664	1114	LOS_B	2	12.150864	12.150864	3.594548
2041	500-3000	215.635	318.221	1347	LOS_F	6	102.118915	102.118915	17.296185

The graph for above table has also been provided:

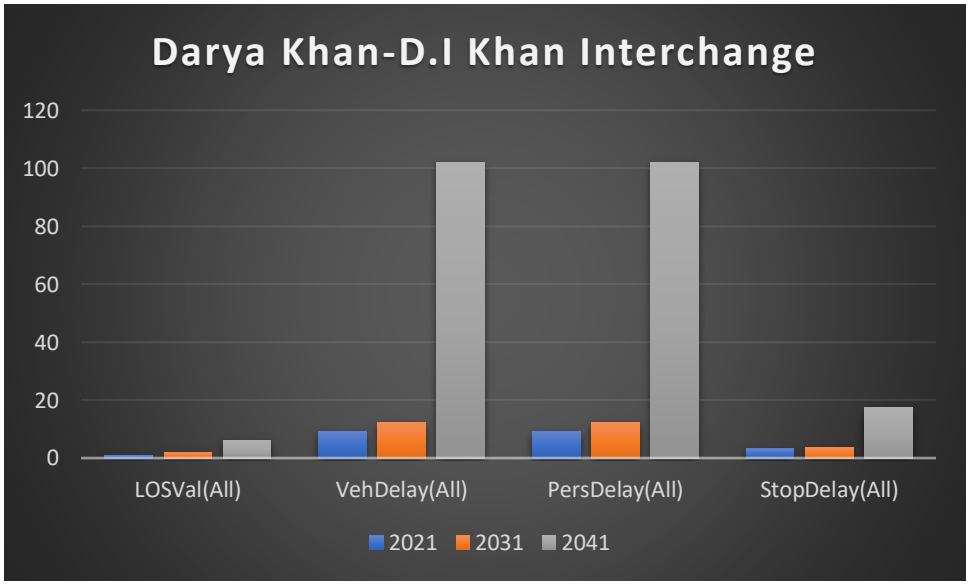

Figure 4.8 Darya Khan-D.I Khan Interchange Results

The following observations were made:

- In 2021, LOS was graded A and the values for Vehicle Delay, Pers Delay and Stop Delay were negligible.
- In 2031, LOS dropped to B while a slight increase in values of other parameters was observed.
- In 2041, LOS dropped to F and there was a vast rise in Vehicle Delay, Pers Delay and Stop Delay.

Chapter 5

Analysis and Conclusion

This chapter of the report will cover the findings of our project work. After the successful running of simulation, Level of Service and all other related factors that can affect the serviceability of the motorway have been determined. Now, these factors can help in analyzing the interchanges and then the suggestion of remedial measures to improve performance where required.

5.1 Comparison of Results

A comparison of the results over a period of time can help in determining the pattern of drop in LOS. Here is a brief comparison of the results of all the interchanges.

5.1.1 Bannu-Domail Interchange:

Findings for this interchange are as

- LOS of this interchange is mostly consistent for it's design life. It drops to a minimum value of B from A and remaining consistent for the years 2031 and 2041.
- Vehicular Delay reaches at the maximum value of approximately 12 seconds at the end of 2031 and remains somewhat same for the next 10 years as well.
- Stop Delay is also quite low. A maximum stop delay of 5 seconds was observed at the end of 2031 is appreciable.

5.1.2 Sarai Nuarang - Gandi - Bannu - Miran Shah Interchange:

The conclusion from the simulation can be summarized as

- LOS rises significantly high to D at the end of 2021 and drops further to F for the next 20 years.
- Queue Length shows a very vast increase throughout the design period.
- Vehicular Delay peaks at 463 seconds for the year 2041 which complements LOS F.

5.1.3 Ghazni Khel-Lakki Interchange:

The results can give the idea that,

- The serviceability of the interchange is consistent at C for 2021 and 2031 but drops to further grade of E for 204.
- Similarly, Stop Delay is constant for first 20 years of design period but is double for the last 10 years.
- Vehicular Delay displays a similar trend as Stop Delay.

5.1.4 Pezu-Tank Interchange:

The results can be compared,

- The interchange shows most constant results out of all the interchanges.
- LOS remains C at all the three stages of simulation.
- Stop Delay and vehicle delay remain the same.

5.1.5 Yarik-Hakla-Islamabad Interchange:

The results are depicting that,

- LOS remains C for the years 2021 and 2031.
- In the year 2041, LOS drops to E.
- Similarly, queue length remains low for the years 2021 and 2031. But for the year 2041, queue length rises to almost 14.
- This shows that the conditions slightly deteriorate during the final ten years of the design life of the interchange.

5.1.6 D.I Khan Interchange:

The conclusion of the simulation is given below,

- Level of Service at this interchange is C for first 20 years of design life.
- LOS further drops to E for the year 2041.
- Queue Length is also a measure of serviceability. The queue length remains low in the years 2021 and 2031 but it shows a significant rise to 22 in 2041.

5.1.7 Zhob-Quetta Interchange:

The results highlight that,

- Level of Service rises to D in 2021 indicating average performance but further degrades to F for final 20 years.
- Vehicle Delay value rises above 120 for the final 20 years.
- Queue Length peaks at approximately 86 at 2041.

5.1.8 Darya Khan-D.I Khan Interchange:

The outcome indicates that,

- LOS is graded at A for 2021 and B for 2031 however drops directly to F for 2041.
- Queue Length maxes out at 216 for 2041 which complements the LOS F for that year.
- Vehicle Delay is below 15 till 2031 but rises above 100 during 2041.

5.2 Conclusion

The above discussion shows that most of the interchanges are displaying quite suitable results. Zhob-Quetta and Sarai-Nuarand Miran Shah are the interchanges showing a LOS F in the years 2031 and 2041 while all other interchanges are showing LOS better than E. It means all the interchanges can easily accommodate the specified traffic without any difficulty. Remedial measures should be taken for the improvement of LOS at the above-mentioned interchanges.

In short, different interchanges are showing different behavior under different conditions. So, remedial measures cannot be same for all the interchanges. Depending upon the need and the traffic conditions at the interchange, different measures should be recommended. These measures have been highlighted in the next chapter.

Chapter 6

Recommendations

With the passage of time, the traffic count will rise significantly due to numerous factors such as increase in population, increasing ownership of vehicles, industrial development and much more. Hence, with time Level of Service will show a gradual drop and efficiency of performance will decrease as well. Therefor after a certain period of time improvements will be required to keep the performance standards at a high. This chapter will discuss those recommendations that can improve LOS after a certain period of time.

6.1 Recommendations for Sarai Nuarang - Gandi - Bannu - Miran Shah Interchange:

At this interchange, it was observed that the Level of Service was graded D for 2021 however it dropped massively to F for 2031and 2041 highlighting the failure of the interchange and the need for improvements before time.

Following improvements can be made:

- To bring LOS up to a satisfactory level at this interchange we should add an extra lane to the interchange ramp in order to accommodate the extensive traffic coming in from the eastern direction.
- There should be addition of an extra toll booth in order to reduce traffic congestion during stop delays and to keep the smooth flow of traffic operational.

6.2 Recommendations for Ghazni-Khel-Lakki Marwat Interchange:

At this interchange the Level of service was observed to be consistent at Grade C for the years 2021 and 2031 which is adequate however the LOS drops to Grade E for the final 10 years of design period up till 2041 showing a decrease in performance standards.

Following improvements can be made:

- There should be addition of an extra toll booth in order to reduce traffic congestion during stop delays and to keep the smooth flow of traffic operational.

6.3 Recommendations for Pezu-Tank Interchange:

At this interchange the Level of service was observed to be consistent at Grade C for the entirety of the design period which is border line average:

Following improvements can be made:

- There should be addition of an extra toll booth in order to reduce traffic congestion during stop delays and to keep the smooth flow of traffic operational.

6.4 Recommendations for Yarik-Hakla-Islambad Interchange:

At this interchange the Level of service was observed to be consistent at Grade C for the years 2021 and 2031 which is adequate however the LOS drops to Grade E for the final 10 years of design period up till 2041 showing a decrease in performance standards.

Following improvements can be made:

- There should be addition of an extra toll booth in order to reduce traffic congestion during stop delays and to keep the smooth flow of traffic operational.

6.5 Recommendations for D.I Khan Interchange:

At this interchange the Level of service was observed to be consistent at Grade C for the years 2021 and 2031 which is adequate however the LOS drops to Grade E for the final 10 years of design period up till 2041 showing a decrease in performance standards.

Following improvements can be made:

- There should be addition of an extra toll booth in order to reduce traffic congestion during stop delays and to keep the smooth flow of traffic operational.

6.6 Recommendations for Zhob-Quetta Interchange:

At this interchange, it was observed that the Level of Service was graded D for 2021 however it dropped massively to F for 2031and 2041 highlighting the failure of the interchange and the need for improvements before time.

Following improvements can be made:

- To bring LOS up to a satisfactory level at this interchange we should add an extra lane to the interchange ramp in order to accommodate the extensive traffic coming in from the eastern direction.

- There should be addition of an extra toll booth in order to reduce traffic congestion during stop delays and to keep the smooth flow of traffic operational.

6.7 Recommendations for Darya Khan-D.I Khan Interchange:

At this interchange, the LOS for the 2021 was graded A and dropped to B for 2031 which indicates a relatively high level of performance for first 10 years of design period however towards the end of this period by 2041 the LOS drops to F.

Following improvements can be made:

As we can see that since the LOS for 2021 and 2031 is acceptable so we need to plan a project for future in which we should add two extra toll plazas in both directions in order to reduce Queue Length, Vehicle Delay and Stop Delay.

Work should also be done on the main highway to improve overall LOS.

6.6 Ending Notes.

In general, all the interchanges are efficiently accommodating the traffic demand with expected drop of LOS with the passage of time except for a few cases. The remedial measures, if taken properly, can help to improve the LOS and can also enable the interchanges to accommodate more traffic in future.

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THROUGH VISSIM

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