ANALYSIS OF HIGHWAY SAFETY ISSUES ON NATIONAL HIGHWAY N-15 MANSEHRA TO CHILAS (233KM)

SUMAID HASAN
(00000119152)

A thesis submitted in partial fulfillment of

the requirements for the degree of

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Signature: _____

Name of Supervisor: **DR. MUHAMMAD JAWED IQBAL**

Date: _____

Signature **(HOD)**: _____

Date: _____

Signature **(Dean/Principal)**: _____

Date: _____

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DEDICATED

TO

HOLY PROPHET (PBUH)

MINARET OF KNOWLEDGE

AND

MY LOVING PARENTS & INSTITUTE

WHO GAVE ME LOT OF INSPIRATION

COURAGE &

SUPPORTED ME MORALLY &

FINANCIALLY FOR MY STUDIES

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(Engr. Sumaid Hasan)

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LIST OF ABBREVIATIONS

AADT	-	Average Annual Daily Traffic
AASHTO	-	American Association of State Highway and Transportation Officials
AH-7	-	Asian Highway network route 7
ASTM	-	American Standards of Testing Materials
Ch.	-	Chainage
Dwg.	-	Drawing
MUTCD	-	Manual of Uniform Traffic Control Devices
NH&MP	-	National Highway and Motorway Police
ROW	-	Right of way
RSA	-	Road Safety Audit
TEARS	-	Traffic Engineering and Road Safety Consultants
USA	-	United States of America
USAID	-	United States Agency for International

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ABSTRACT

This research will present the results of study of road safety issues in Pakistan specifically in "Hilly Areas", which will be carried out with the intent of developing a better understanding of the road safety profile of the country. The nature of the study will be exploratory. A need for reforms at institutional, physical, institutional and operational levels is suggested and to bring change at social level through transformation of behavior, intensive monitoring of traffic enforcement of law along with conduction of research work related to road safety is needed.

Road Safety in Pakistan is still considered as an unfamiliar concept. At all levels, there is a general state of indifference towards issues related to road safety regardless of this acceptance that every one of us has affected by these issues. We as a nation ready to accept Road Safety as a Public Health Concern and Social Problem and decided to live in a state of denial. It is a fact that, every year, more than 12000 road users are getting killed and more than 55000 are injured severely and become disabled in Pakistan. If the laws are not equitably and efficiently applied the road related institution will fail to bring changes on ground and they must have held responsible for that. To save the precious lives of our road users a comprehensive and well-coordinated approach is needed to address this huge task. To bring discipline in road user towards our road requires all level strong commitment. In this usual scenario, NH&MP plays a significant role to improve the situations on our motorways and highways and their efforts are a ray of hope by enforcing law strictly, fairly but with courtesy. To teach our drivers a better road sense and to bring discipline to our roads, printing a National Road Safety Journal is a revolutionary effort. It is an open secret that for saving lives of road users driver him/herself is the weakest link in this whole effort. In fact, one of biggest killers on our roads is speed and our drivers still don't bother to wear seat belts and have a habit of going beyond the speed limits. Publication of Road Safety Journal is the key way of raising awareness level about among the users regarding such issues. Various issues related to road safety including road user awareness and education ranging from road engineering to implementation has been focused in the current copy of journal of National Road Safety. In the present journal issue, several topics are included which enforces the concerned departments to areas which require immediate attention. We can

save lives of road users in our country by improving the current road safety situation with strong commitment and serious efforts.

Highway Safety is one of the most important aspects of transportation engineering as traffic accidents are unavoidable in human life. Pakistan are faced with new dimension of highway safety challenges after the advent of motorways, safety management of motorways demand more meticulous addressal of safety issues due to involvement of high speed dynamics. This Study presents a method by which the accident-prone locations on roads, commonly termed as accident blackspots, can be identified. The reasons for the accidents can be attributed to the lack of driving skill, lack of education, economic values, lack of signage, geometric design problems and improper design of pedestrian crossing. There are however, other factors, which contribute directly or indirectly to the accidents include road, vehicle, road user and environmental factors.

Chapter 1

INTRODUCTION

Transportation system has become a fundamental part of a society in today's environment of civilization and it is generally thought as means of convenience and luxury in our daily life. Movement is an ultimate requirement because at the same place one cannot relax or shop. In the prosperity of a country transport system plays a vital role. Transportation system mainly reflects the production and development rate. Many rules have been implemented to reduce the traffic crashes effects on the road.

21st century major problem is traffic crashes and accidents. As the gradual increase in number of vehicular traffic on the roads the space available for road is limited in the cities. These accidents cause causalities as well problem for other road users as well. The wastage of time is also an economic loss. This causing a lot of wastage of time that can be usefully spent. Intelligent management of the traffic measures or road safety measures can reduce many accidents because there are human lives at stake. Therefore, the solving of this problem is the most important need.

1.1 PROJECT BACKGROUND

The Mansehra to Chilas National Highway designated as Route N-15 is considered a very important link of Pakistan’s road network, forming part of tourism in northern areas of the country. This route linking the beautiful places of country Naran, Jalkhand and Babusar. It also serves as a transit route for bypassing National Highway N-35 also known as Karakoram Highway which ends at Khujerab Pass China Border. The Mansehra to Chilas highway has been identified as a priority road for improvement as it is a major route for tourism. Consequently, improvements to several sections of the Mansehra to Chilas Highway have either been completed, or on-going with support from the donor community. The 233Km Mansehra to Chilas road/highway was constructed between 1998-2008 with funding from National Highway Authority through Government of Punjab.

The entire route details are.

- Mansehra to Balakot
- Balakot to Kaghan Valley

- Kaghan to Naran
- Naran to Burhwai
- Burhwai to Batakundi
- Batakundi to Jalkhand
- Jalkhand to Gittidas
- Gittidas to Behsal
- Behsal to Babusar
- Babusar to Chilas

1.2 PROBLEM DEFINITION

The Mansehra to Chilas road had been identified from a very accident-prone road from the audit report of road safety with high road traffic crashes rate of registered vehicles from 2012-2017, in which year 2016 with comparatively high casualties. Crashes reported most of the time were on sharp curves and sudden change of grade throughout the route with a considerable proportion involving heavy traffic with passenger cars or wagons. Additionally, it is recorded that more than half of the fatalities were of passenger cars. Speed is reported to be a major problem on the road, and contributes to the poor safety conditions on road. Considering this, stake holders in the road development programme attached importance to the problem of road traffic safety in the development and operation of this highway.

1.3 RESEARCH OBJECTIVE

The objectives of the research were to:

1. To analyze the performance of the installed road safety measures.
2. To assess incident response capacity and performance of relevant agencies in the remote/study area.
3. To suggest suitable measures to address the road safety issues.

1.4 JUSTIFICATION

Justification of research is supported by following:

1. Road traffic safety is a very important concept in the planning, operation, construction and design of infrastructure of road the concept of road traffic safety is very important.
2. To justify the installation of road safety devices or their planned installation on roads, the performance of these devices should be established.
3. There is need to address/discuss the frequent problem associated with the use and provision of road safety devices as they are being installed on roads throughout the country.

1.5 SCOPE OF WORK

The research work covered the following:

1. Literature review.
2. Collection and study of road traffic crash records.
3. Detailed survey and study of the whole route (N-15).
4. Study of as-built drawings.
5. Classified count of traffic volume and measurement of speed.
6. Driver interviews.
7. Field observation of use of installed safety measures.

Every year in Road Accidents more than 1.2 million people lost their lives. In Road Accidents, the loss of GNP (Gross National Product) is about 3% to 4%. In every 3 minutes 1 child lost his life in Road Accidents. Annual death toll of accident which is 12,00,000 is about 5 times more than the death toll of Tsunami of 2004, which was about 2, 30,000.

There are number of factors that are deeply rooted with road accidents including, especially, attitude and behavior of drivers, insufficient traffic and transport regulations enforcement, urban and interurban road networks physical insufficiencies, road safety information and road safety education shortcomings, driver training and testing insufficiencies, inadequate control of vehicles, incident management response, rescue and emergency service weaknesses, monitoring system and evaluation systems underdevelopment, and institutional setup disintegration. To bring a continuous decrease in road traffic accident all these factors need to be addressed in a comprehensive and cohesive way.

In interurban passages and inner-city areas, crash reduction and related injuries and fatalities is the project objective, through the experience expanded in the projects, to permanently improve the institutional capabilities of all the sectors with main responsibility for road safety, including the roads agency, as well as police, health care, and public administration.

To bring all the issues together for developing a suitable outcome, areas of high injury rate causalities rate (black spots) are targeted in this project. With effective programs of safety, the replication of good practice elements is the goal of this project. A model is provided through the targeted areas experience which helps us to implement the same techniques and methodologies throughout the country.

1.6 RELEVANCE TO NATIONAL NEEDS

The MOC (Ministry of Communication) is working on an exclusive plan of road safety to mitigate these issues and decrease the high rate of incident saving precious lives. Due to poor road structure, poor maintenance of vehicles, irresponsible driving and a complete disrespect of road safety in Pakistan, there is a dreadful record of fatal crashes in general. According to the official data release about accident in 2013 approximately 4,600 people have lost their lives in road traffic accidents. Traffic accident deaths reached almost 30,000 (2.7%) of total deaths making Pakistan 67th country for poor road safety in world according to data published by WHO in year 2014.

Awareness in public along with thorough planning and strong implementation is required to reduce the number of road traffic accidents. A coordinated communications network is a dire need along motorways and national highways so that help could immediately and instantly approach to the injured persons in case of an incident and ministry also stressed on this need on highways. A very important factor in case of any accident to the injured persons is efficient incident management response system and trauma response when it comes to saving lives. In detailed road safety, national plan issues such as road safety funding, to provide reliable road safety environment, planning of infrastructure, road safety enhancement at work sites, overloading of long haul vehicles overloading, guaranteeing vehicles insurance, increasing risks awareness, ensuring valid driving license are addressed. To ensure passenger safety, coordination with development authorities, authorities enforcing traffic law, highway authorities is maybe the major factor of such a plan. As no proper system for resting along the corridor so drivers moving

on long distance routes must focus on this plan. Accidents occur every day due to buses overcrowding especially in the northern areas and because the rules are also not strictly enforced therefore, no one takes the road plan seriously and the chaos has been created on the road which is a sorry situation.

1.7 ADVANTAGES

1. Road Safety (RS) pro-actively address safety.
2. RS identify low-cost/high-value improvements.
3. RS provide continuous advancement of safety skills and knowledge.
4. RS contribute feedback on safety issues for future projects.
5. RS support optimized savings of money, time, and – most importantly – lives.
6. RS enhance consistency in how safety is considered and promote a “safety culture.

1.8 AREAS OF APPLICATION

The study area is the northern side of Pakistan i.e. National Highway N-15 (Mansehra to Chilas). The National Highway N-15 is a 233-Km highway in Pakistan starting from Mansehra (Khyber Pakhtunkhwa) and ends at Chilas (Gilgit Baltistan) province. It is often used as a bypass for the N-35 National Highway and due to its attractive beauty, areas and regions it is also very popular among tourists who visit Naran and the surrounding region. The portion is passing through areas i.e. Balakot, Kholian, Paras, Mohandri, Kaghan, and Naran. Location map (Appendix A).

ORGANIZATION OF THE THESIS

This section provides a summary of contents of each chapter included in this report.

Chapter 1: (Introduction): In this chapter, the problem statement of the project is given describing why the analysis of road safety issues of this National Highway need to be conducted and road safety issue should be analyzed and to give suitable solutions to these problems.

Chapter 2: (Literature Review): In this chapter, past research relating to road safety audit conducted in Pakistan or abroad and what were the issues there and what was recommended have been discussed.

Chapter 3: (Methodology): In this chapter, the scope of project along with present traffic congestion and its related issues in Pakistan have been discussed. Then Different congestion solution have been provided to mitigate congestion problem. Firstly, the survey questionnaire data was collected and compiled. Accident data from hospitals was collected and compiled. The whole subject route N-15 Mansehra to Chilas was monitored and surveyed and all the road safety issues and road safety devices and problems were identified and their pictures and videos were made.

Chapter 4: (Data Collection & Compilation and Analysis): Firstly, the data from the sources i.e. Hospitals (Ayub Medical College AMC, King Abdullah Teaching Hospital KATH) is collected and compiled. Secondly the questionnaire survey analysis for the SPSS software have been added. Then the field detailed study, analysis, problem identification through pictures of the subject route has been included to check the road safety issues on the N-15 Highway.

Chapter 5: (Conclusion): In this chapter, all the discussion and analysis is concluded and general and specific conclusions has been discussed.

Chapter 6: (Recommendations): In this chapter, different improvement alternatives of road safety devices on Mansehra to Chilas Highway N-15 have been provided to mitigate the road safety issues.

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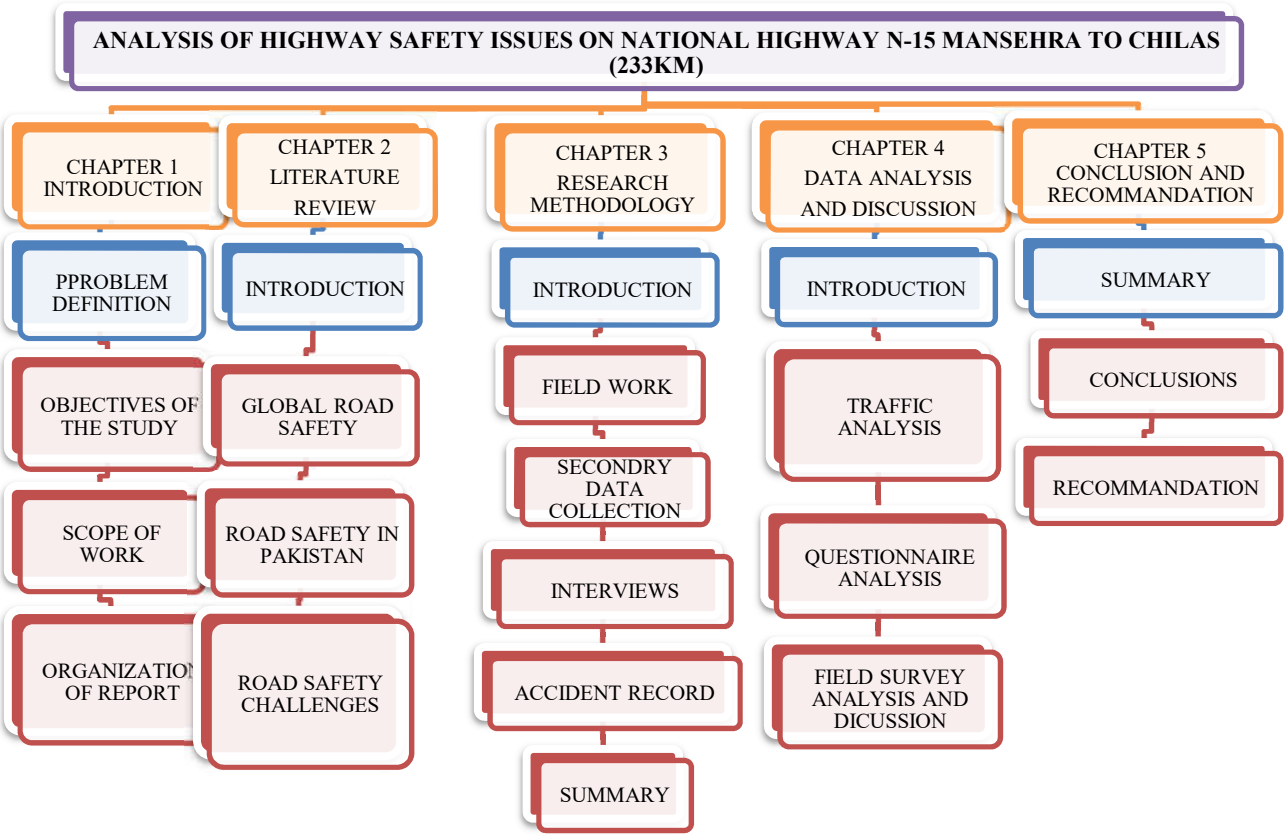


Figure 1.1: Organization of Report

Chapter 2

LITERATURE REVIEW

2.1 THE GLOBAL ROAD TRAFFIC SAFETY

According to World Health Organization (WHO) and World Bank report on "The Global Burden of Disease" (1999), deaths from non-communicable diseases is expected to climb from 28.1 million a year in 1990 to 49.7 million by 2020 (an increase in absolute numbers of 77%). Road traffic crashes will contribute significantly to this rise. According to the report, road traffic injuries are expected to move from ninth place to take third place in the rank order of disease burden by the year 2020. Road traffic injuries are a major public health problem and a leading cause of death and injury around the world. It is reported that each year nearly 1.2 million people die and millions more are injured or disabled because of road crashes, mostly in low-income and middle-income countries. It was in this regard that in 2004 the World Health

Organization (WHO) dedicated World Health Day – for the first time – to the topic of road safety, culminating in the joint launch of the World report on road traffic injury prevention, which highlights the increasing epidemic of road traffic injuries. Beside creating enormous social costs for individuals, families and communities, road traffic injuries place a heavy burden on health services and economies. The cost to countries, possibly already struggling with other development concerns, may well be 1%–2% of their gross national product. As motorization increases, road traffic crashes are a fast-growing problem, particularly in developing countries.

2.2 ROAD SAFETY ISSUES IN PAKISTAN

This paper presents the results of a qualitative study of road safety issues in Pakistan, which was carried out with the intent of developing a better understanding of the road safety profile of the country. The study is exploratory in nature, based on semi-structured interviews, and targets government officials, academics and the general driving population to investigate their perception of factors provoking deviant driving styles in the country. Interviews were tape-recorded and analyzed using a 'template analysis' technique. The analysis revealed institutional issues, execution issues, physical and operational issues, behavioral issues and those related to road safety research and accident data bank as salient themes lowering road safety standards in the country. This has suggested a need for reforms at institutional, physical and operational

levels and the need to bring change at a societal level through behavioral transformation, intensive traffic monitoring and law enforcement, along with conduction of road safety related research work.

2.3 ROAD TRAFFIC ACCIDENT ANALYSIS OF MOTORWAYS IN PAKISTAN

As the Traffic accident which cannot be avoided in human life, highway safety is the most important feature of transportation engineering. As high-speed dynamics is involved due to the advent and initialization of expressways and motorways in Pakistan a new dimensional challenges of highway safety have been confronted by the country and other developing nations. A method is presented in this study in which those location where accidents usually occurs (Black Spots) and become most accident-prone locations are identified. A major motorway of Pakistan M-2 Motorway connecting Islamabad to Lahore has been selected for this study. User attributes like lacking in education, driving skills and economic values and departmental attributes like problems in geometric design, lack of informatory and warning signage on roads and improper pedestrian crossing signs are the reasons for the accidents on roads. However, there are also some other factors, which indirectly or directly contributes to the accidents include vehicle, road, environmental factors and road users. It was found after the analysis that most of the times accidents are majorly caused by following factors:

- Driving carelessly (25%);
- Dozing at wheel (23%);
- Bursting of tires (18%);
- Failure of Brake (9%);
- Moving across of Pedestrian (6%).

Recommendation of proper guidance of traffic and its control system to ensure safe vehicular movement and some of the facilities which are low cost i.e. overhead bridges and underpasses for pedestrian crossing near Lahore, to minimize dozing, alert alarm facility, checking tire pressure gauges to prevent bursting of tires, training for how to overcome and prevent to brake failure and last but not the least to overall improve the road safety and to decrease the number of road traffic accidents, awareness among driver through electronic and print media have been proposed.

2.4 DYNAMIC CHARACTERISTICS FOR ROAD CRASHES IN DEVELOPING COUNTRIES

Transportation encompasses a broad set of policy variables, and the planning and development of transportation facilities generally raises living standards and enhances the aggregate of community values. For the efficient planning of infrastructure and the constituent facilities, road traffic accidents have its own significance and demanding validity. Outputs from the system include the movement of people and traffic modes, improvement and deterioration of the physical environment as well. In contrast to all these factors, crash prevention is indirectly linked with the time of the occurrence or related incident. This corresponds to the spatial organization, circulation, visual properties, resources and symbolic properties. This paper focuses on road traffic accidents of Karachi, Pakistan involving several types of road users in different timings of the day (24 hrs). Possible root causes with significant recommended measures is the extensive dimension of this research study. Deliberate number of crash implications perceived by the application of ANOVA (Analysis of Variance) in the comparative analysis of three years data record. It is quite evident from the analytical data record that rate of severity is directly linked with the increase in insufficient illumination during dusk and dark timings. The positive progressive impact of time on traffic accidents is probably one of the important dimensions that will control the magnitude of the casualties.

2.5 ROAD SAFETY IN INDIA: CHALLENGES AND OPPORTUNITIES

The present report was designed to analyze the traffic safety situation in India, and to identify countermeasures for areas in which the total harm caused by crashes can be substantially and readily reduced. The report focuses on two aspects of traffic safety in India: challenges and opportunities. The first part of the report provides a comprehensive analysis of the current traffic safety situation in India. It is pointed out in this analysis that fatality rates have increased both on highways and in urban areas during the past few years. Theoretical models suggest that the number of fatalities in India is not likely to start to decline for many years to come unless new policies are implemented. Based on the present analysis, the following six areas are identified as having potential for substantially reducing fatalities in India: (1) pedestrians and other non-motorists in urban areas, (2) pedestrians, other non-motorists, and slow vehicles on highways, (3) motorcycles and small cars in urban areas, (4) over-involvement of trucks and buses, (5)

nighttime driving, and (6) wrong-way drivers on divided highways. The second part of the report outlines several promising countermeasures for each of these six areas. The third part of the report presents a brief comparison of major traffic safety challenges in India and China.

2.6 ROAD TRAFFIC SAFETY IN GHANA

With the Ghana's management and organization of activities regarding road safety, year 1988 marked as the turning point. With the funding of World Bank Transport Rehabilitation Project (TRP) in year 1988 Ghana Road Safety Project (GRSP) was launched. To increase the skills, capabilities and knowledge of Ghanaian administration, organization and professional to effectively tackle the road safety problems of the country is the primary objective of launching GRSP.

In 1996, among 29 African countries, Ghana ranked ninth in terms of fatalities per 10,000 vehicles. Ghana's fatality rate of around 36 per 10,000 vehicles in 1996 dropped to 18.76 per 10,000 vehicles in 2006. It is estimated that road traffic crashes costs Ghana about 1.6 % of her GDP. In view of the magnitude of the problem of road traffic crashes and fatalities, the National Road Safety Commission (NRSC) was established in 1999 through an Act of Parliament (Act 567). Among other functions, the Act mandates the NRSC with the responsibility of developing, promoting and coordinating road safety activities in Ghana.

In planning schemes for safety of road traffic, the use Road Accident Investigation (RAI) is recommended by Road Safety Manual. To implement the appropriate mitigation measures on road safety and to detect the deficiencies in infrastructure of road that influences the occurrence of an accident, road engineers seeks help from RAI.

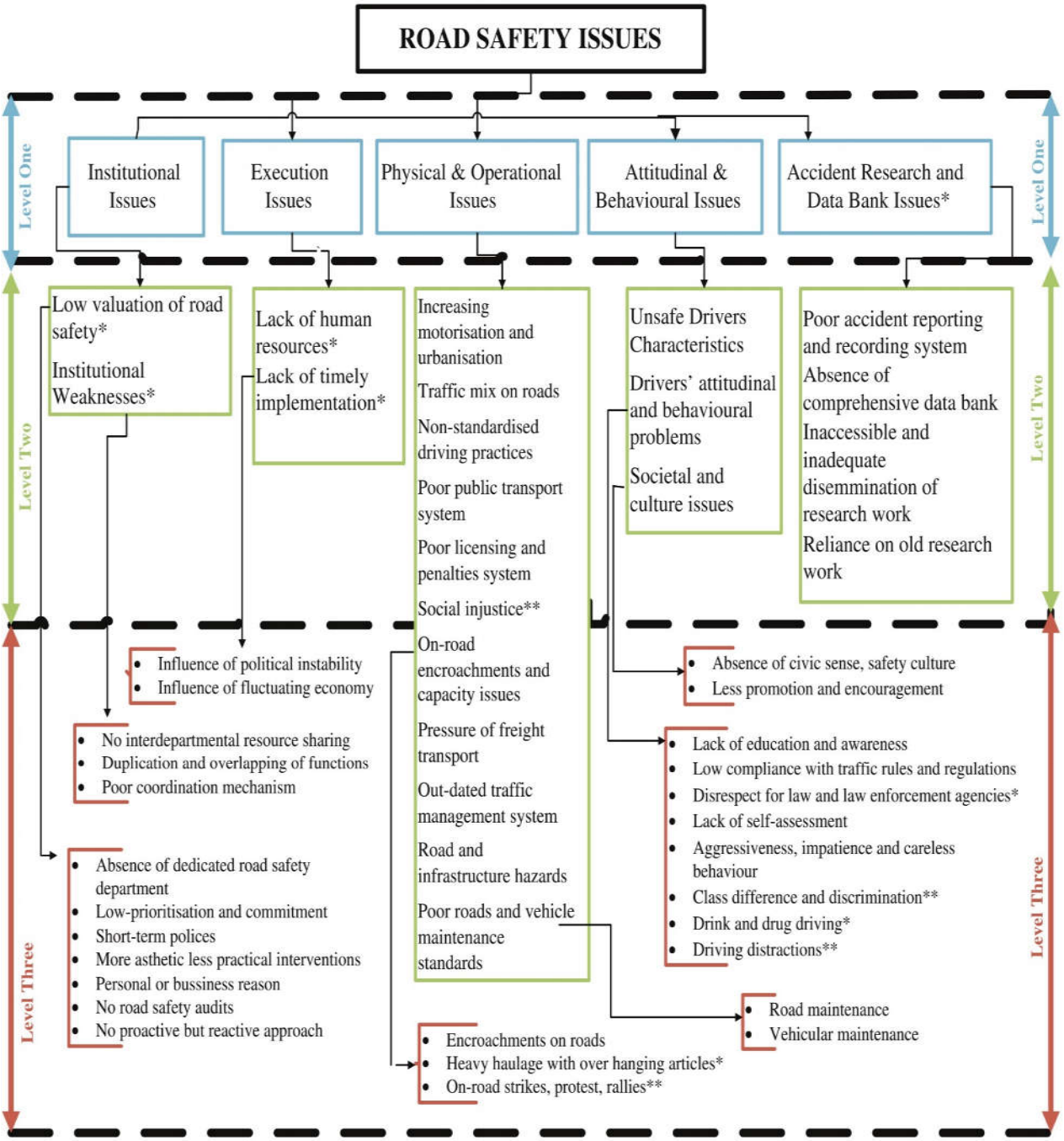


Figure 2.1: Illustrates the findings subdivision of various levels defined by the Transportation Planning and Technology.

Chapter 3

MEDOTHOLOGY

The methodology of the study consists of following steps:

- Literature Review
- Data Collection
- Data Analysis
- Problem Identification
- Remedial Measures

3.1 DEFINITION OF TRAFFIC

Traffic can be defined as animal driven vehicle, motorcycle, bicycle, cars, buses, trucks and pedestrian movement. etc. altogether using the specific ROW (right of way) and any transportation mode. Vehicular and road traffic (LTV, HTV) will be our focus in this project so there will be only non-motorized and motorized vehicular discussion excluding pedestrians.

People using private vehicles they own, vehicles used for commercial purpose, transport for public, para-transit vehicles and animal driven vehicles are included in this. Road traffic consists of all these types of vehicles because to move from one place to another place their mode of travel is road.

3.2 FIELD WORK

3.2.1 Study of Subject Route (National Highway N-15)

Existing Geometry:

The whole geometry of the subject project/route is surveyed. The total of 233Km study area is surveyed and each portion of the road is studied, captured and monitored.

This analysis has been carried out with the sole purpose of identifying safety issues with the newly constructed road sections of N-15 Mansehra to Chilas. Any recommendation made in this report for safety improvement, should be studied further before implementation.

This report documents the process, findings and recommendations for Road Safety Issues/Road Safety Audit (RSA) on Mansehra-Chilas Road (N-15) project in Khyber Pakhtunkhwa, Pakistan. The objective of the Research was to identify safety issues with the roadway so those could be eliminated.

There are very sharp curves which become black spots on the road also at many areas there is very less sight distance to see the upcoming vehicle from the opposite side. There is a critical concern over this safety hazard as sharp curves and less sight distance can have collision with opposite moving vehicular traffic and with the road side features which currently does not have even any warning sign and not any convex vehicular safety mirror at the edges. During the research and field study of the subject route significant deficiencies in geometric design particularly horizontal alignment and roadside design were also found. To overcome these hazards appropriate measures to warn drivers of sharp horizontal curves with restricted sight distance should be taken. Overtaking should be prohibited at those locations. The road also has a lot of steep vertical grades ranging from 4000ft to 14000ft which causes safety and operational problems due to slow movement of heavy vehicle on upgrade and longer braking distance needed by loaded truck on down grade. Consider converting shoulder to climbing lane in these areas.

It is the understanding that functional classification of this road is “Rural Principal Arterial”, however, road passes through many recreational (tourist attractive), commercial/sub-urban areas as well. It is recommended to develop Access Management plan for this road to avoid future safety and operation problems and to maintain intended function of the road particularly for Mansehra to Balakot section of this project. No street lighting was provided on this road. While unlit rural arterial is accepted practice, consider providing Street lights at geometrically challenging locations and at commercial/sub-urban areas to alert drivers of potential danger or conflict with pedestrian. Existing Road Bumps if warranted should be converted to road humps with warning sign and retroreflective pavement markings installed on hump to alert drivers of their presentence.

Road side steep cut/fore slope is a safety hazard and errant vehicles need to be protected from falling from the road into deep ravine particularly along Balakot to Chilas section. Also, drainage design and road side design needs to be designed considering safety conscious design

concept (Forgiving Roads) considering typical road users' behaviors. As AASHTO is the applicable design code for this project, designer/contractor should certify that all Roadside design including roadside drainage facilities are designed/constructed in compliance with latest version of "AASHTO Highway Drainage Guidelines" and "AASHTO Roadside Design Guide".

While construction on these audited sections is substantially completed, the contractor yet needs to install signs on the road. The contract drawings do not provide detailed signing plan. The designer/contractor is encouraged to consult latest international manuals of Uniform Traffic Control Devices such as US MUTCD in designing/implementing traffic control plans including signing and markings.

As a next step to this RSA, NHA should develop a strategy to address safety issues identified in this report in consultation with designer and contractor of the project.

3.3 TRAFFIC COUNTS

3.3.1 Classified Traffic Volume Counts

Traffic volume counts were taken from National Highway Authority NHA a government of Pakistan department, M/s National Engineering Services Pakistan NESPAK (Pvt.) Ltd. a well-known consulting firm of Pakistan who have done the traffic counts and consultant for the rehabilitation and maintenance for the Mansehra-Naran-Jalkhad route of N-15 and M/s Republic Engineering Corporation REC (Pvt.) Ltd. another firm which undertook the initial feasibility study, detailed design and design review and construction supervision of the subject route. The counts were of 24 hrs. The counts are tabulated below.

Table 3.1: Traffic counts for all directions for Mansehra to Chilas N-15 highway

Location/Direction	Motor Cycler	Car/ Taxi/ Suzuki	Jeep/ Pajero	Hiace Wagon	Flying Coach	Public Bus	Loader/ Pick-up	Truck 2-Axle	Truck 3-Axle	Tractor with Trolley	Total
Station at Balakot & direction towards Naran	116	1522	165	130	67	34	40	90	22	16	**2202**
Station at Kaghan & direction towards Mansehra	96	1312	107	101	58	24	25	68	16	8	**1815**
Station at Naran & direction towards Babusar	66	400	65	15	7	1	25	40	9	1	**629**
Station at Babusar & direction towards Naran	49	364	51	13	6	1	19	26	5	1	**535**
Station at Chilas & direction towards Kaghan	27	111	20	3	3	0	9	13	2	0	**188**

3.4 SPEED MEASUREMENTS

To assess typical speed levels pertaining in human settlements on the highway, spot speed measurements were also conducted from Mansehra to Chilas. The average vehicle speeds were taken at the in/out 50km/h. Vehicles in both directions were measured for different classes of vehicles. Only free-flowing vehicles were measured.

3.5 INTERVIEWS

Spot interviews using pre-prepared questionnaires were conducted with drivers throughout the Mansehra to Chilas section of N-15. Their responses to specific questions on the questionnaire relating to the use, and the appropriateness of the road traffic safety measures installed on the road were noted.

The interview template was designed to begin with very basic questions asking participants their opinion about the status of road safety, emerging road safety issues on N-15, road safety policies operational at the national highway N-15. This was followed by questions concerning the part of responsibility between drivers and government to improve the situation. Then they were asked about the type and cause of incident, to address the topic particularly in relation to the role played by the drivers and the transport and traffic system of the country. The

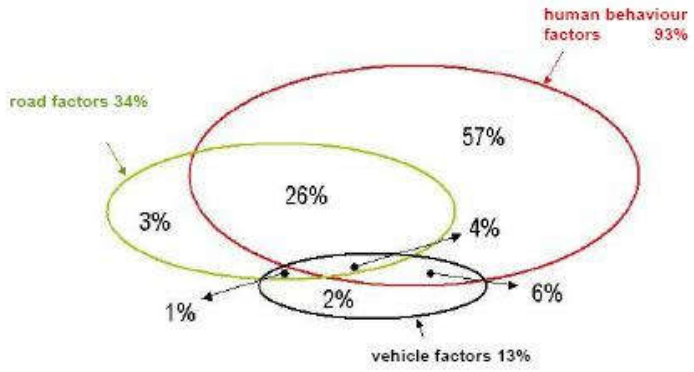
conclusion of interview is done by asking them to recommend the mitigation measures that could improve the road safety status in Pakistan **(Appendix B).**

3.6 PLANNING ROAD TRAFFIC SAFETY SCHEMES

Large buses, trucks and heavy goods vehicles maneuver were observed throughout the study route. Additionally, observations of entry maneuver for all vehicles were made. Studs, cateys and rumble strips approach characteristics were observed and noted. Road shoulder and bus stop/lay-by use along the highway were observed in addition.

3.7 PLANNING ROAD TRAFFIC SAFETY SCHEMES

The Road Safety Manual, recommends the use of Road Accident Investigation (RAI) in planning the schemes for road traffic safety. Road Engineers seeks help from the RAI to detect



(Source: PIARC Road Safety Manual, 2003)

Figure 3.1: Road traffic crash contributing factors

the amount deficiencies of infrastructure of road that influence the occurrence of an accident, and to guide them in the application of appropriate measures for improvement.

The Mansehra-Chilas road project sought to address road traffic safety concerns by provision of traffic calming measures in human activity zones and to some extent, improvement in road geometric layout in non-human activity zones which had been identified as accident prone.

3.8 VEHICLE SPEED AND ROAD CRASH AND SEVERITY

During survey and consulting with the patrolling police it is came to know that on Mansehra –Chilas Road the percentage of driver who exceeded the speed limit is approx. 94% through the villages/areas. The average speed was between 35% and 65% above the speed limit in some areas while some areas like Gittidas the lowest speed measured was 50% above the limit and the highest 100% above the 50Km/h posted speed limit.

Undoubtedly, major problem is excessive speed on the Mansehra – Chilas road, and thus poor safety conditions on the road is contributed by excessive speed.

United States studies showed that one of the severe problem is motor-vehicle-pedestrian collision. In 1998, almost 69,000 people were injured and about 5,220 people were killed in road incidents. Pedestrian crashes were also a major problem in US. Nationally, pedestrian fatalities were 12.6% of total fatalities. One reason for Such higher rate of these fatalities is due to high vehicular speed is one of the major reason.

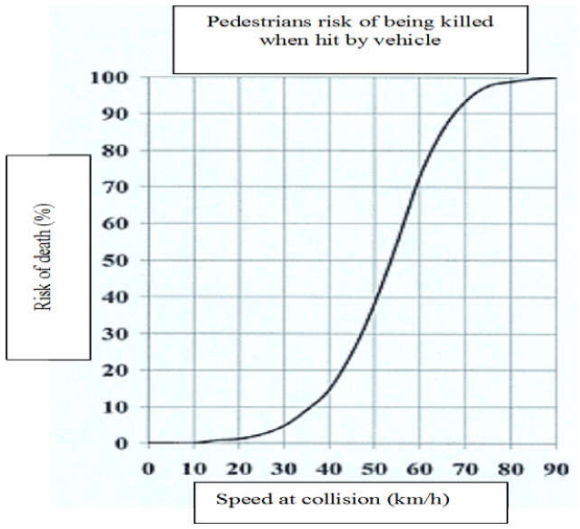


Figure 3.2: Speed Vs Risk of Death Graph

Lowered travel speeds safety benefits include:

- Hazards recognition time increased (PERT)
- Reduced distance travelled while reacting to hazards
- Reduced SSD stopping sight distance of the vehicle after braking

- Increased other road user's perception reaction time
- Greater chance for other road users to avoid a collision
- Probability for a Driver to lose vehicle control reduced.

3.9 TRAFFIC CALMING MEASURES ON NATIONAL HIGHWAY N-15 MANSEHRA DISTRICT (KPK)

The "Highway Safety Manual" and "Road Safety Guidelines" assists as the standard for traffic calming devices design and installation on the national highways, motorways and expressways.

3.9.1 Types of Traffic Calming Measures

Several types of traffic calming measures are commonly used on KPK roads. They are:

1. Road Humps
2. Studs
3. Cat eyes
4. Medians
5. Informatory signage
6. Pre-warnings and Warning signs

3.9.2 Types of Traffic Calming Measures

One of the most effective device used for traffic calming is road hump. It has low cost and if they used they can have a large effect in reducing traffic accidents. They should be used only on roads with less than or equal 50Km/h speed limit, through town/village areas for instance where pedestrian is moving across the highways. They can be used in circular or trapezoidal hump profiles. On roads with heavy bus traffic speed cushions could be used. On N-15 there were humps given on the locations where population are in surrounding.

3.9.3 Humps with zebra crossing

Zebra crossing could be placed on trapezoidal hump top as these are not regulated with signal to protect the pedestrian. The flat–topped speed humps are used to enable the pedestrian for safe crossing as they are used to slow down the vehicle. On entire route pedestrian crossing

from the side villages and town were not given and pedestrians should cross the road on their own risk.

3.9.4 Studs

For speed reduction studs are used on many places. They do not reduce speed significantly but are effective in combination with road-humps. They can also be used as traffic diverters. They are usually laid as multiple groups pattern.

3.9.5 Pre-Warnings

The purpose of pre-warnings is to warn drivers about a hazard, settlement or speed limit ahead and ensure that they are aware of the need to slow down.

A review of the findings and recommendations contained in the audit report was made during the design studies stage of the Mansehra – Chilas Road rehabilitation project in a bid to identify issues contributing to the poor road traffic safety situation associated with the highway. Proposals were made in the designs towards addressing these issues during the construction stage. modifications were made to the original designs because of the safety audits conducted during construction.

3.10 SECONDARY DATA COLLECTION

3.10.1 Accident Records

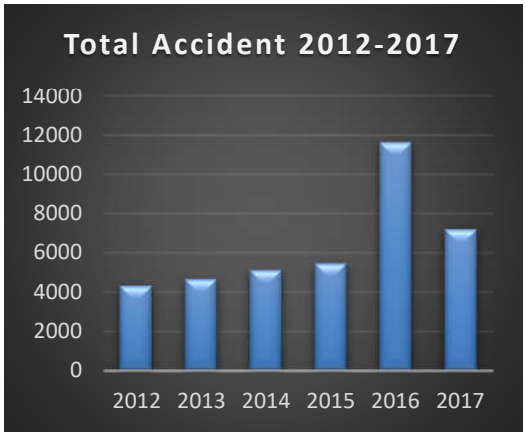
Accident records for the Mansehra - Chilas highway for the period 2012-2016 were collected from the King Abdullah Teaching Hospital (KATH) Mansehra and Ayub Medical College (AMC) Abbottabad and almost all the Basic Health Units (BHU), District Head Quarters (DHQ) and Tehsil Head Quarters (THQ).

The year 2015 marked the turning point with the organization and management of road safety activities in Mansehra. Table 2.1 below shows an overview of road crash statistics in Mansehra District for the period 2012-2017.This chapter explains the laboratory characterization of aggregates and bitumen for the preparation of bituminous paving mixes. Those materials that satisfied the standard specifications were used for bituminous mix preparation. The volumetric properties of bituminous mix have been calculated and OBC were determined. The testing

procedure adopted for the permanent deformation testing of bituminous mix specimens has been explained.

Table 3.2. Accident Counts for Mansehra – Chilas Highway (2012-2017)

Year	Accidents (12 Months)
2012	4328
2013	4678
2014	5127
2015	5474
2016	11636
2017	7213
Total	38456



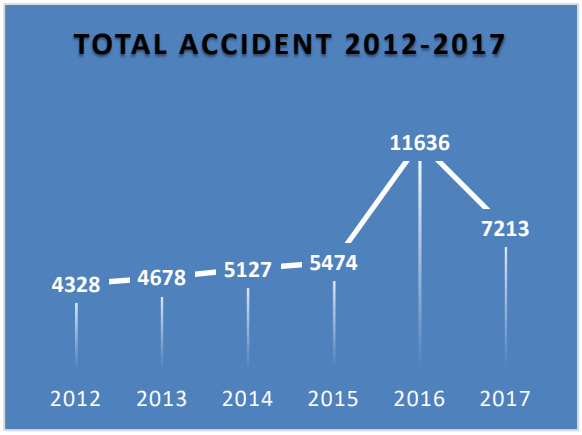


Figure 3.3: Accident Counts for Year 2012-2017

3.10.2 Accidents Records of Different Areas of Study Route:

Table 3.3 Accident records of Villages

Location	Accidents
THQ Balakot	2556
CH Kaghan	692
BHU Paras	171
BHU Naran	788
BHU Mohandri	68
RHC Kiwai	225

Accident Location Identification:

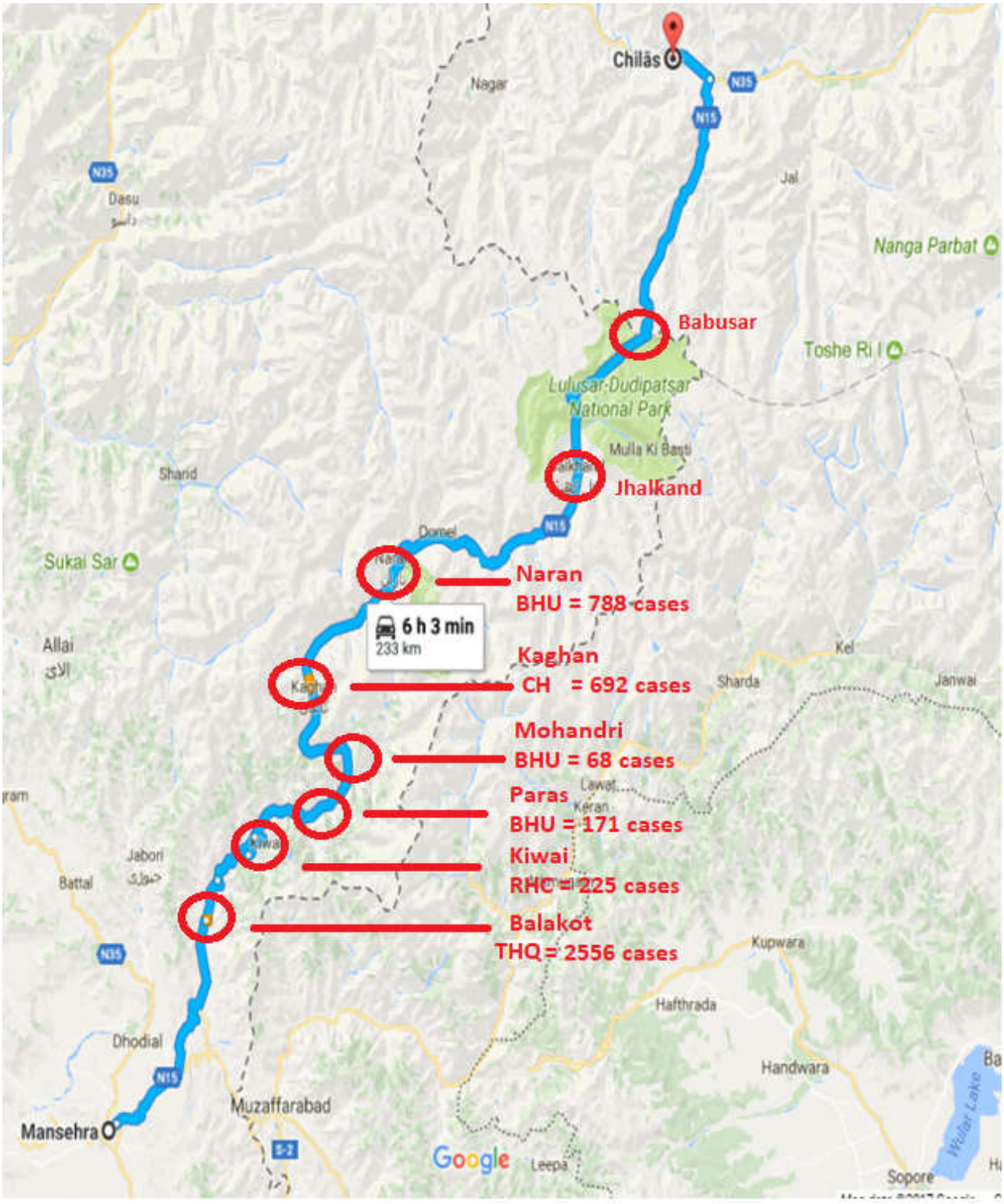


Figure 3.4: Map showing location wise incident cases recorded in relevant Heath units and quarters.

Chapter 4

DATA COMPILATION AND ANALYSIS

4.1 TRAFFIC ANALYSIS

To carry out the traffic analysis and evaluations of traffic, data is the basic need. It is collected from different departments firms i.e. M/s National Engineering Services Pakistan (Pvt.) Ltd.- NESPAK and Republic Engineering Corporation REC (Pvt.) Ltd. who did traffic volume data collection on this route i.e. Mansehra – Chilas National Highway N-15. All data cannot be directly analyzed which is collected related to a specific facility user. So, in this chapter, data is collected and then utilized according to our needs.

Table 4.1: Traffic Counts of National Highway N-15

Location/Direction	Motor Cycler	Car/ Taxi/ Suzuki	Jeep/ Pajero	Hiace Wagon	Flying Coach	Public Bus	Loader/ Pick-up	Truck 2-Axle	Truck 3-Axle	Tractor with Trolley	Total
Station at Balakot & direction towards Naran	116	1522	165	130	67	34	40	90	22	16	**2202**
Station at Kaghan & direction towards Mansehra	96	1312	107	101	58	24	25	68	16	8	**1815**
Station at Naran & direction towards Babusar	66	400	65	15	7	1	25	40	9	1	**629**
Station at Babusar & direction towards Naran	49	364	51	13	6	1	19	26	5	1	**535**
Station at Chilas & direction towards Kaghan	27	111	20	3	3	0	9	13	2	0	**188**

4.2 QUESTIONNAIRE ANALYSIS

The widely used software name stands so Statistical Package for the Social Analysis. SPSS is a program for statistical analysis in social sciences. Statistics included in the base software.

Types of Statistics:

- Descriptive statistics
- Frequency statistics

The 'template analysis' technique was adopted to explore the data. The term refers to a way of thematically analyzing the qualitative data and is a widely used approach in qualitative research. The method allows the researcher the flexibility of tailoring the technique to their own needs. For the present study, first, interviews were transcribed and all the relevant information within the scope of the research study identified.

The output of the analysis is explained below:

Type of Incident

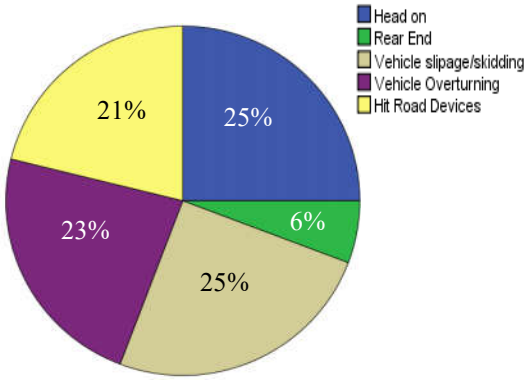


Figure 4.1: Type of Incident Chart

Cause of Incident

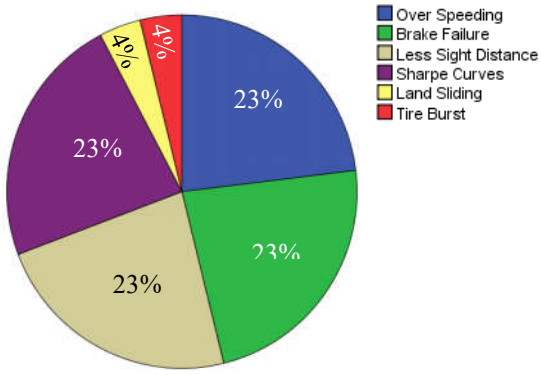


Figure 4.2: Cause of Incident Chart

Person Involved in the Incident

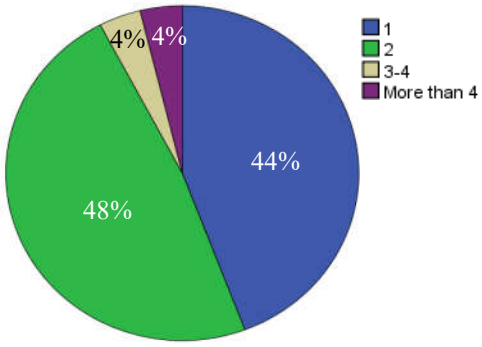


Figure 4.3: Vehicles involved in Incident Chart

Vehicles Involved in the Incident

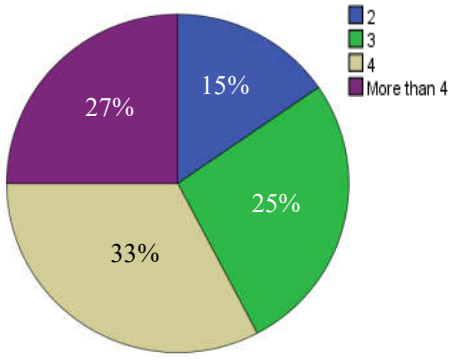


Figure 4.4: Persons involved in Incident Chart

Person Injured in the Incident

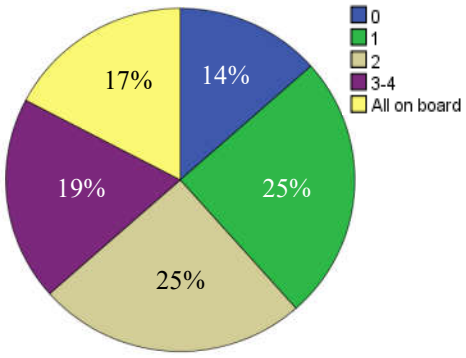


Figure 4.5 Person Injured in Incident Chart

Person Died in the Incident

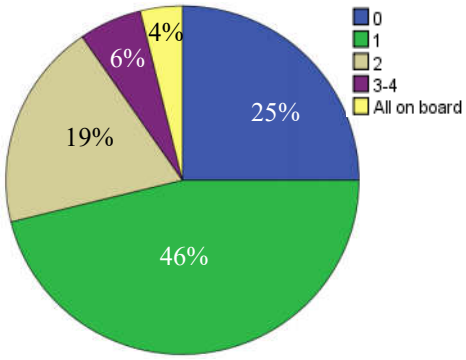


Figure 4.6: Persons Died in Incident Chart

Person Injured in the Incident

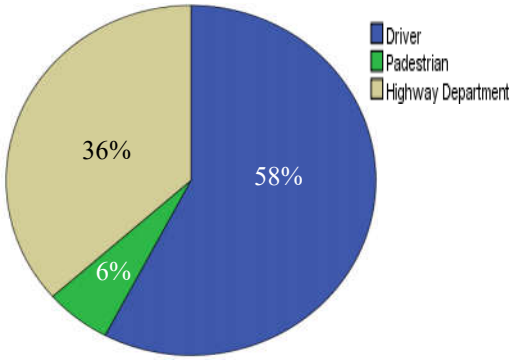


Figure 4.7: Responsible for Incident Chart

Person Died in the Incident

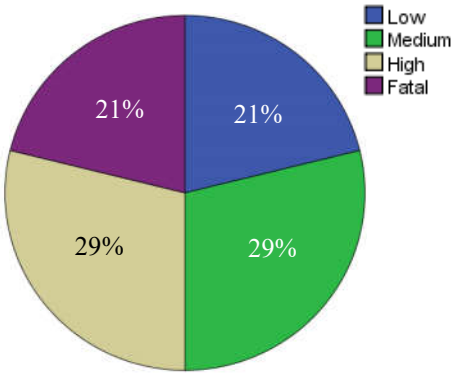


Figure 4.8: Severity of Incident Chart

Person Injured in the Incident

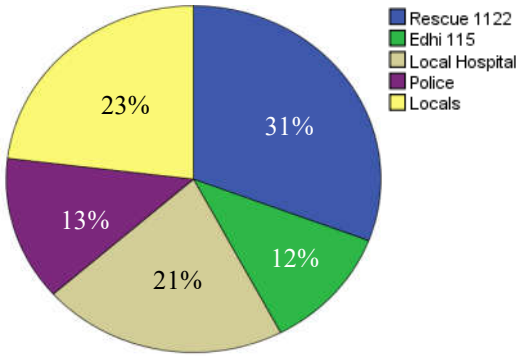


Figure 4.9: First Aid Chart

Person Died in the Incident

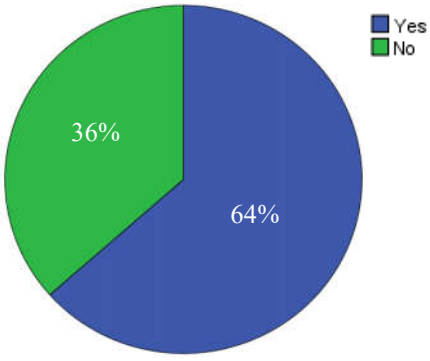


Figure 4.10: IMR&S Chart

Person Injured in the Incident

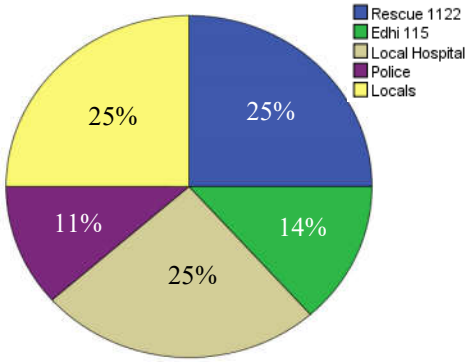


Figure 4.11: Type of IMR&S Chart

Person Died in the Incident

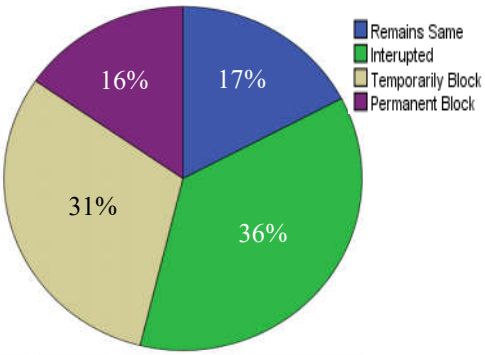


Figure 4.12: Traffic Condition Chart

Does the driver has Driving License

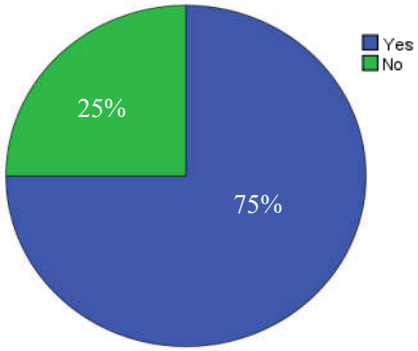


Figure 4.13: License Chart

4.2.1 Results of Descriptive Analysis

Type of Incident: Figure 6.15.1 shows that 25% of accident were of "Head On" collision 6% were of Read End collision 25% collision due to vehicle slippage/skidding while 23% and 21% were of Vehicle Overturning and Vehicle Hit Road Devices respectively.

Cause of Incident: Figure 6.15.3 shows that 23% of indents causes include "Over Speeding", "Brake Failure", "Less Sight Distance" and due to "Sharp Curves" respectively while 4% were due to "Land Sliding" and "Tire Bursting" respectively.

Vehicles Involved in the Incident: Figure 6.15.3 shows that 44% cases found in which only "1" vehicle is involved and in 48% cases "2" vehicles were involved while in 4% cases involved "3-4" and "More than 4" vehicle involvement.

Person Involved in the Incident: Figure 6.15.3 shows that 15% cases found in which only "1" person was involved and in 27% cases "2" persons were involved while in 33% cases involved "3-4" and 25% cases involved "More than 4" persons.

Person Injured in the Incident: Figure 6.15.3 shows that 14% cases found in which no one was injured in the incident, in 25% cases only "1" person was injured, 25% cases involve "2" persons injury while 19% cases involved injury of "3-4" persons and 17% cases involves the injury of "More than 4" persons.

Person Dead in the Incident: Figure 6.15.3 shows that 25% cases found in which no one was killed in 46% cases "1" person was killed, 19% cases involve "2" persons death while 6% cases involved death of "3-4" persons and 4% cases involved the death of "More than 4" persons.

Who is Responsible for the Incident: Figure 6.15.3 shows that in 58% cases "Driver" were found responsible for the incident, in 6% cases "Pedestrian" were found responsible for the incident and in 39% cases the "Highway Department" found responsible for the incident.

Severity of the Incident: Figure 6.15.3 shows that in 21% cases severity of the incident was "Low", in 29% cases it was "Medium" while 29% cases were of "High" severity and in 21% cases the incident was "Fatal".

To whom people call for help: Figure 6.15.3 shows that in 31% cases people called "Rescue 1122" for help, in about 16% cases people called "Edhi 116" in 21% cases "Local Hospital" came for help and in 14% case "Police" was called while in 23% case "Local" in surrounding came to rescue.

Incident Management System and Response: Figure 6.15.3 shows that in 64% cases "IMR" was given to the injured and in 36% cases it was not.

Type of IMSR: Figure 6.15.3 shows that in 25% cases IMR given in the form of "Rescue 1122" in about 14% it was given as "Edhi 116" in 25% cases response was from "Local Hospital" and in 11% case "Police" came for IMR while in 25% case "Local" in surrounding responded to the incident.

Road Traffic Condition after incident: Figure 6.15.3 shows that in 17% cases the traffic conditions "Remains Same", in 37% cases traffic was "Interrupted" but cleared after some interval while in 31% cases the road was "Temporarily Blocked" and in 15% case the traffic was "Jammed" and create problem for the users.

Does the driver has driving License: Figure 6.15.3 shows that 75% people involved in incident have their "Driving License" while remaining 25% have not.

4.3 ROAD CONDITION SURVEY/ ANALYSIS

Specific resources used in this audit include:

- Project PC1
- Contract Drawings
- Field review
- Still Photographs of the study area
- Videos of the study area
- Interview of patrolling officers and public

Scope of Audit and Audit Process

The objective of this RSA as mentioned in the contract document of the project is to "determine conformity of project road with the safety requirements and good engineering practice". This post construction stage Audit has been carried out in accordance with the best international practices of RSA.

Site visits were conducted from May 10th to May 20th from 6am morning to 5pm. During field visit days weather was sunny and traffic conditions were normal for the time of the day. The team has examined the newly constructed road from road safety perspective only.

Problem statements for all identified safety issues along with recommendations are presented in following sections. Findings of the audit were grouped as general safety concerns applicable to all sections and then specific safety concerns for each section. Few photographs/sketches have been added for illustrative purpose only in the report to visualize the identified problems and/or proposed solutions.

Findings

Fade Pavement Marking

Pavement markings used were already faded.

Burhwai

Batakundi

Kiwai

Mohandri

Figure 4.14- existing faded pavement marking on Project Road

Connection of and barrier and guard rail unconnected guard rail

Barriers were not connected with guide rail which is safety hazard.

Paras

Kaghan

Balakot

Figure 4.15 - guide rail and concrete barrier disconnect and unconnected guard rail along the route

Safety Rest Areas

There are no safety rest areas along this new route. This will force truck drivers to pull over on shoulder for rest which will create hazard for the moving traffic.

Gantry Sign Post

Rigid sign posts that are close to travel lane are fixed object and safety hazard if not protected.

Figure 4.17: Existing gantry sign post in Chilas

Figure 4.16: Existing gantry sign post on N-15.

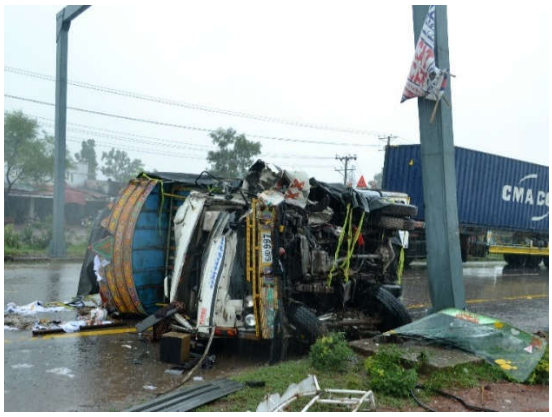


Figure 4.18: Truck's collision with gantry sign post on N-15 near Mansehra

Steep Foreslope

1V:2H foreslope is provided which is not traversable for an errant vehicle leaving the roadway and will cause overturn of the vehicle. These fore slopes are currently unprotected regardless of the depth of fore slope.

Babusar

Naran

Kaghan

Figure 4.19: Showing Steep Foreslope

Reduced visibility at night

The entire length of the road will be unlit. Statistics indicate that night time crash rates are higher than day time crash rates. This may be attributed to reduced visibility at night.

Figure 4.20: illustrates the problem of poor visibility at night on a rural road (not project road)

Guide Rail End Design

Guide rail ends as currently installed are fixed object and safety hazard for moving traffic.

Balakot

Mansehra

Figure 4.21: Existing guard rail end design on N-15 Mansehra-Naran-Jalkhand-Chilas Road project i.e. Balakot

Speed Bumps

Speed bumps are installed at populated areas and commercial areas. These were without warning marking and sign. Speed bumps are rarely visible to the traffic and may cause safety issues.

Figure 4.22: Existing speed bumps installed along the Route i.e. Mansehra

Rigid sign post

Rigid sign posts that are close to travel lane are fixed object and may cause safety hazard.

Overtaking Prohibition marking

Single solid line was provided to restrict overtaking at horizontal curves. This may not convey message positively to drivers about the overtaking prohibition.

Intersection Control

This problem is observed in the section from Mansehra to Balakot. No traffic control device is installed at the intersections. As ROW is not assigned traffic of minor street may enter intersection unsafely.

Kilometer Post

Concrete Kilometer Posts are fixed object and can cause a severe crash in case of vehicle leaving the roadway.

Figure 4.23: Existing rigid kilometer post on route i.e. Balakot

Protection of culverts

Culverts were remained unprotected which is safety hazard.

Electricity Pole

Electricity pole is located next to travel lane on a horizontal curve which is in path of vehicle natural trajectory and pose safety hazard.

Figure 4.24: illustrates light pole along the road within vehicles trajectory (Mansehra)

Pavement width at Horizontal Curves

In horizontal curves, the radius followed by vehicle front wheels is larger than the radius of its rear wheels which increases the width swept. Moreover, the difficulty in negotiating the curve increases the risk of encroachment in opposite lane which may cause head-on collision. Current design does not appear to provide wider lanes at curves.

Figure 4.25: illustrates problem with vehicle negotiating the curve (Batakundi)
Note: car has encroached into opposite traffic lane

Causeway

Problem Statement

Rainfall may cause hydroplaning due to which vehicle may lose control and fall in ravine. Erosion was observed at causeway edges which may cause failure in the pavement structure.

Figure 4.27: illustrates the erosion problem (non-project)

Figure 4.26: Causeway constructed (Enroute Naran)

Fixed objects

Certain structures along road are Fixed objects which is safety hazard.

Figure 4.28-Illustrates fixed object at section (Non-project)

Figure 4.29-Illustrates fixed object at section (Chilas)

Discontinued Guide rail

Guide rail was discontinued at various locations along the section which is a safety hazard.

Figure 4.30: illustrates the discontinued guide rail (Naran)

Steep Vertical grades

Vertical grades ranging up to 6.90% which will cause safety problems due to slow moving of heavy vehicles on upgrade and longer braking distance on downgrade.

Sharp horizontal curves

Sight distance at sharp horizontal curves is not sufficient and will cause safety problems.

Kiwai

En-route- Kaghan

Figure 4.31: illustrates the sight distance problem

Batakundi

Balakot

Figure 4.32- illustrates the Sharp Curve
which Causes Accident curve on N-15

Land Sliding

Land sliding at many locations along the route cause safety problems. Especially when it rains large sand dune and boulder often slides down and cause damage to moving vehicles.

Kaghan

Naran

Gittidas

Figure 4.33: Illustrates land sliding blocking row

Concrete/Stone Masonry Barriers

Barriers are installed along the route on the edges to protect the vehicle falling off the edge but the vehicles hit the barriers and fall along with the barrier. Their strength is not measured. Barriers were not installed they are just putted there having no foundation and they can easily break when hit with an HTV.

Figure 4.34: Installed Barriers along the edges (Also Broken from corners i.e. Burhwai)

4.4 ROAD TRAFFIC CRASH RECORDS

The road traffic crashes (accidents) characteristics for the Mansehra to Chilas highway is summarized for the period 2012-2017 and presented below in graphs.

Year 2012:

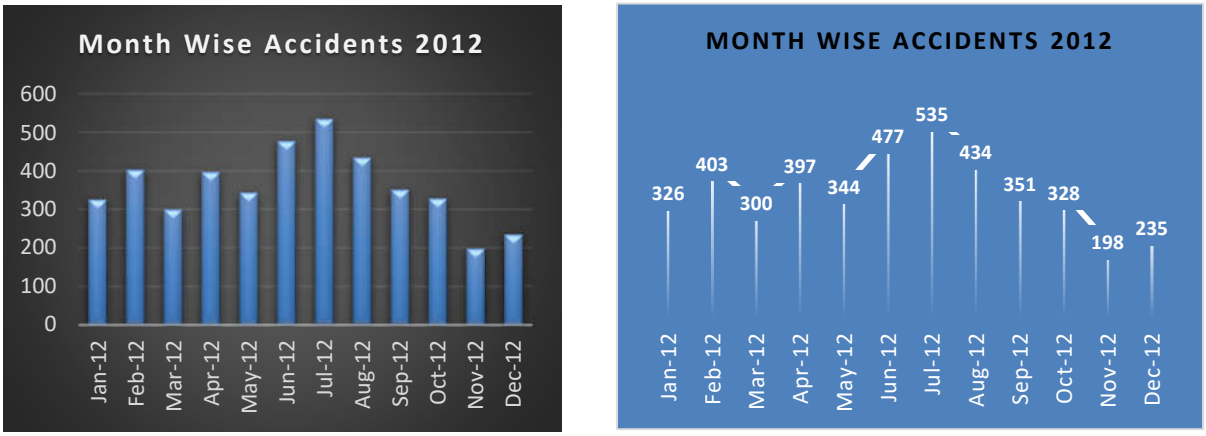


Fig. 4.35: Month wise Traffic Accident of Year 2012

Year 2013:

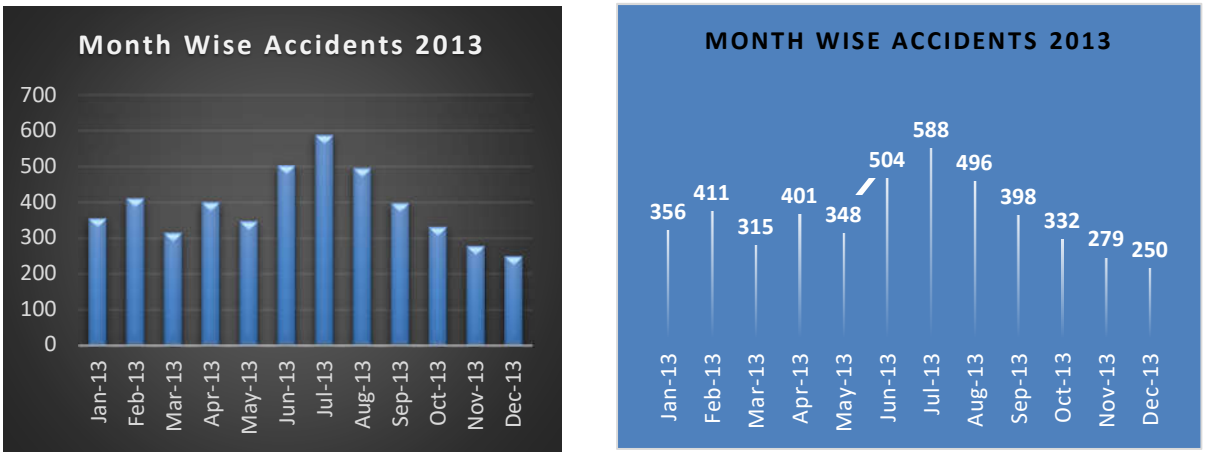


Fig. 4.36: Month wise Traffic Accident of Year 2013

Year 2014:

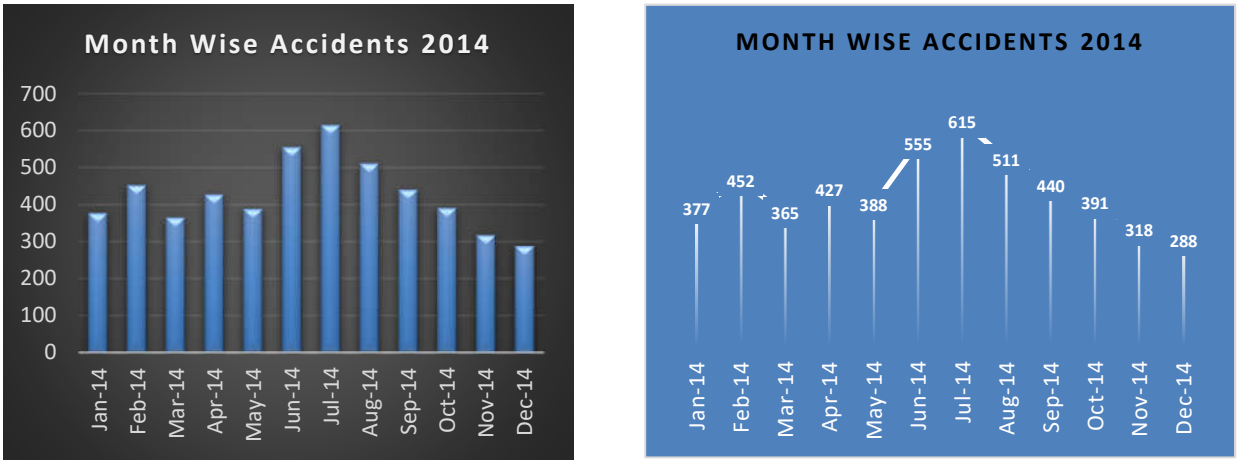


Fig. 4.37: Month wise Traffic Accident of Year 2014

Year 2015:

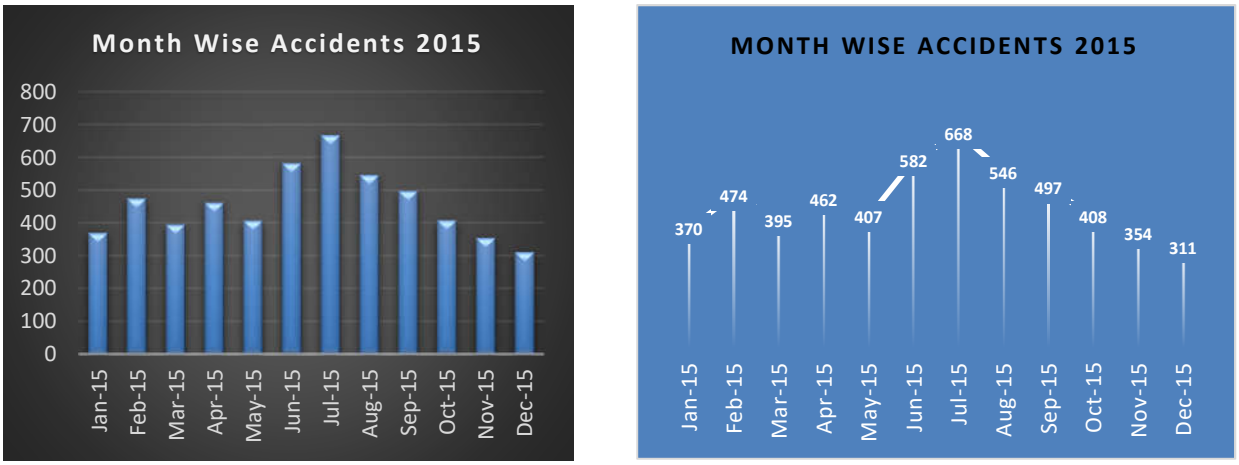


Fig. 4.38: Month wise Traffic Accident of Year 2015

Year 2016:

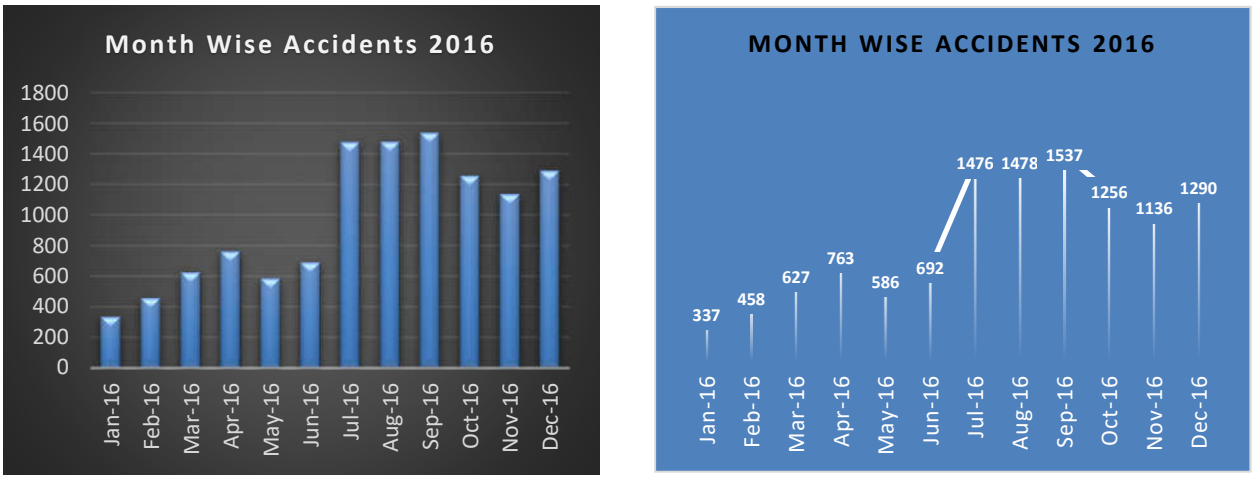


Fig. 4.39: Month wise Traffic Accident of Year 2016

Year 2017:

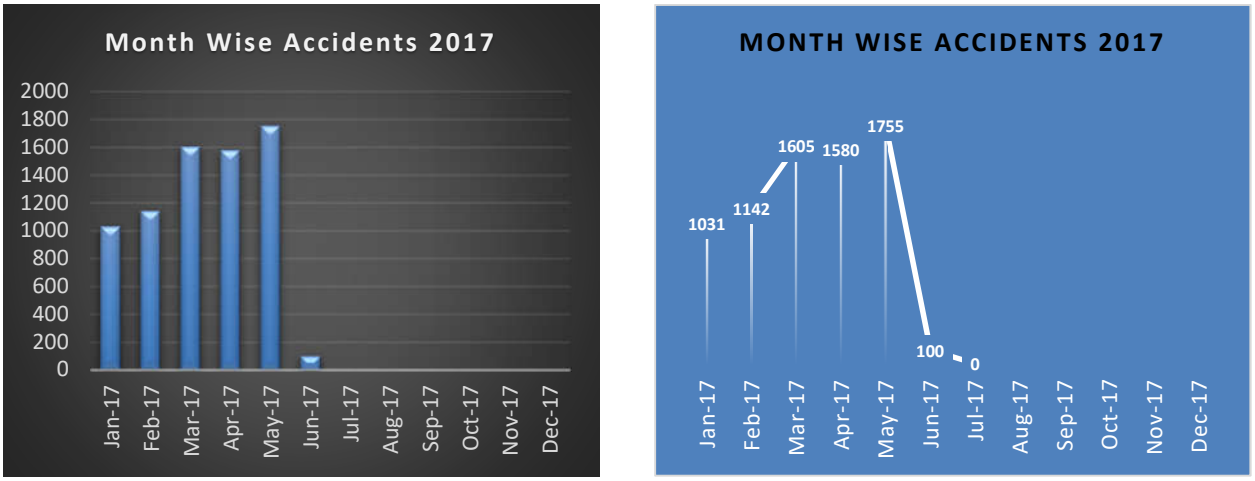


Fig. 4.40: Month wise Traffic Accident of Year 2017

4.4.1 Crash Severity

From Table 2, a total of 38,456 crashes were recorded for the period 2012-2017, of which 7476 (19.4%) were fatal, and 19,228 (50.3%) we are injury crashes. On year-by-year basis, years 2016 recorded the highest number of fatal crashes with 2262 such events. Year 2012 recorded the least with 841 fatal crashes. Year 2016 recorded the highest injury crashes with 5818 events, and Year 2012 with 2164 injury crashes. The highest recorded crashes of 11636 were in year

2016, and the least of 4328 in year 2012. In general, the trends indicate a sinusoidal pattern for all crashes. Appendix C-Figure C1 is a graphical illustration of the severity trends.

4.4.2 Causality Injuries

Casualties recorded from 2012 to 2017 totalled 26,704 of which 7476 (28.0%) were fatal. Yearly fatalities records indicate year 2016 as having the highest number of 2262 persons, followed by year 2015 with 1064 persons. Year 2012 recorded the least fatalities of 841 persons. Year 2016 recorded 5818 injured persons, the highest for the entire 6 years, whereas year 2012 recorded the least with 2164 injured persons. Passengers (tourist) have remained at the top of the casualty classes over the years, peaking in year 2016 with 5818 injured persons.

4.4.3 Vehicle travel speed

Vehicle speeds were measured at different location like Mansehra to Balakot section and Balakot to Kaghan section. The speed averages of 70Km/h. The speed breaker (studs) are about 2Km apart. The other sections i.e. Naran to Babusar as the /grade increases due to mountainous portion the average speed comes out 40-50Km/h. The last section of the route i.e. Babusar to Chilas there is an increase in downward slope as the height decreases from 14000ft to 4000ft the speed is 30-35Km/h.

4.4.4 Driver Interviews

The results of the 100 drivers interviewed via questionnaire regarding the presence of road safety devices, speed reducing devices, incident cases and there causes on the highway were discussed above.

4.5 ROAD TRAFFIC CRASH RECORDS

Field observations indicated a fair degree of proper use of road safety measures and facilities provided on the highway. Generally, drivers used the walkways, shoulders and crossing points especially within the divided dual carriageway section from Mansehra to Balakot. It was noted that few vehicles gave way to the pedestrians at the designated crossings. Due to the low vehicle speeds within the crowded areas pedestrians can identify gaps which allow them to cross conveniently. Similar observations were made in the case of towns along the two-lane single

carriageway section between Balakot to Kaghan. Pedestrians crossed one lane took advantage of the lower speeds in-between the studs and speed tables.

Truck maneuvers around the road is also dangerous. Buses and heavy trucks are moving in between the lanes as it is two dual carriageways and no separate lane for them. Sometimes Drivers exhibited patience in getting in-lane at the lane-narrowing sections approaching the curves and crossings.

Smaller vehicles sometimes sneaked in front of slower moving heavy vehicles when approaching the roundabouts instead of waiting or soliciting gaps from those already in lane.

Turning movements within the areas between Kaghan and Naran appear to be safe as the turning vehicles take refuge within the area between the vertical and horizontal curves before crossing or joining the opposite lane.

It was also observed that several road signs and road studs (cat eyes) are either damaged, defaced or vandalized. Flattening deformation of the 50Km/h rumble strips is prevalent in most places and has rendered the strips less effective. The ramps of the speed tables were also observed to be fast deteriorating. Several pedestrian crossing markings are faded. Photographs of some field observations are presented in above discussion.

4.6 DISCUSSION ON ROAD TRAFFIC CRASHES

The road traffic crash records for the Mansehra-Chilas highway show significant increase in the crash numbers and severity from 2015 to 2017, after the rehabilitation of N-15 highway. The years 2012 and 2013 constituted the best performing years. This may be due to intense traffic regulation and direction as well as relatively low speeds imposed by the construction on traffic. A sharp rise in crash events was witnessed towards the end of the maintenance and rehabilitation works period i.e. 2016. This may be attributed to the situation when road surface works had been substantially completed but without the installation physical speed reducers such as speed table and rumble strips, leading to excessive speeds and resultant crashes. Without the installation of the speed reducers within towns along the highway thereafter, a Significant increase in crash rate was observed in 2016 & 2017 and much higher than year 2012 & 2013 levels. This however was disappointingly short-lived as a sharp rise was witnessed in the initial months of year 2017 with fatal and severe injury crashes almost equaling those of 2016.

Hit-pedestrian crash is the very less collision type but it also resulting fatalities and hospitalized injuries. Analysis of the records shows that the Mansehra-Chilas section of the national highway N-15 is a major contributor to the post-construction increase in road traffic crashes observed. Head-on and vehicle skidding collisions types are the dominant collision types. The former's trend shows a consistent increase in fatal and hospitalized injuries over the analysis period. It also shows increase in fatalities after the rehabilitation of N-15.

From the crash records, it is evident that tourist/travelers continue to be the most vulnerable group of road users on the Mansehra - Chilas highway despite the institution of elaborate traffic calming measures within settlements along the highway.

Crash records analysis for this section of the highway in the whole Khyber Pakhtunkhwa District i.e. the Mansehra to Chilas road section shows the highest crash per kilometer per year. It was already a prominent section for road crashes but this rate increased in last 2-3 years after the rehabilitation and maintenance of the road which is not much safer for the user due to lack of highway safety/traffic calming and safety devices throughout the section. This situation should however be considered against the backdrop that this section of the highway has about twice or thrice the traffic volume as the remaining KPK district main roads. As this section experiencing intense tourism because of the attractive beauty and awesome weather of the northern section of Pakistan. Though the installed speed tables/studs on this section fairly controlled the highway for all categories of vehicles by the installation. However, the sharp turns, convex mirrors and gateway speed limit signs appear to be fast losing their effectiveness as speeds continue to exceed posted limits.

Chapter 5

CONCLUSION

5.1 GENERAL CONCLUSIONS

5.1.1 Institutional Issues

Today, there is no policy in the country about road safety and integrated transport that could be implemented. At federal level Road safety is left to the responsibility of many department of transport planning and at local and provincial level on regional and provisional authorities, whereas, traffic wardens and police are only responsible for its implementation. Currently, no department in the country is exclusively devoted to deal issues of road safety issues.

The current practice relating to any improvement or modification in the road environment, for example, the introduction of new lanes, provision of speed humps or the location of signs and signals is carried out without any systematic checks to evaluate its impact on the safe operation of traffic.

5.1.2 Poor Accident Reporting and Recording System

The findings for this section neatly breakdown into ‘absence of comprehensive road accident data bank’, ‘inaccessible and inadequate dissemination of road safety research work’ and ‘reliance on old research work and studies’. Most of the experts were found to be concerned about the poor accident recording and lack of a reporting mechanism. They mentioned that the police do very few on the spot investigations of accidents.

5.2 CONSLUSIONS SPECIFIC TO STUDY ROUTE

This qualitative study that require further investigation which has explored many serious problems. The gaps in the institutional framework of the country have created a situation in which effort is disjointed due to duplication and overlapping of functions. The study has also explored attitudes one of the important and major factor “safe driving” that influence the behavior of driver in Pakistan among the individuals. Due to the lack of knowledge and

understanding of local road safety issues, the country has no other option except to rely solely on international agencies and therefore, it is still struggling to achieve a better road safety arena.

The study findings have revealed that any of the road safety measures in the present scenario would prove futile unless accompanied by intensive traffic monitoring and law enforcement such as traffic wardens and speed cameras. There is also a dire need of mapping and disseminating the research work carried out in the country.

Based on the results of this study, the following may be drawn:

1. Making road safer for users as number of road traffic crashes are on increasing trend.
2. The Naran-Babusar section of the highway due to its high-grade nature is the major contributor to the increased crash rate.
3. The Mansehra-Balakot section which low grade is relatively less in crashes ratio.
4. The most dominant causality class along the section is Passengers.
5. Posted speed limit signs and 40-45Km/h rumble strips appear to be fast losing their effectiveness in reducing speeds.
6. One of the effective speed reducing device along the corridor is speed hump/tables.
7. Faded pavement marking at many locations make the road user crosses the lane limits at locations like Kiwai, Mohandri etc.
8. Heavy traffic vehicles drivers usually park their vehicles along the carriage way of the study route due to non-availability of Safety areas.
9. Visibility at the study is at night is very less and often cause accident and vehicle falling off the hill.
10. Gantry post and other static devices (like Electric pole, Kilometer post) observed violating the standard practice for installing static devices along the road i.e. at Balakot, Kaghan at various locations in Chilas.
11. Horizontal curves are dangerous at various locations (i.e. Kiwai, Paras, Mohandri, Gittidas, Burhwai) and causes head on collision.
12. Foreslope is not as per standard and at locations i.e. Mohandri, Paras steep foreslope was observed and with just skidding fatal incident occur.
13. Land sliding is one of the main problem observed on the study route and this got even worse when it rains.

Chapter 6

RECOMMENDATIONS

6.1 ROAD SAFETY AND GEOMETRIC DESIGN

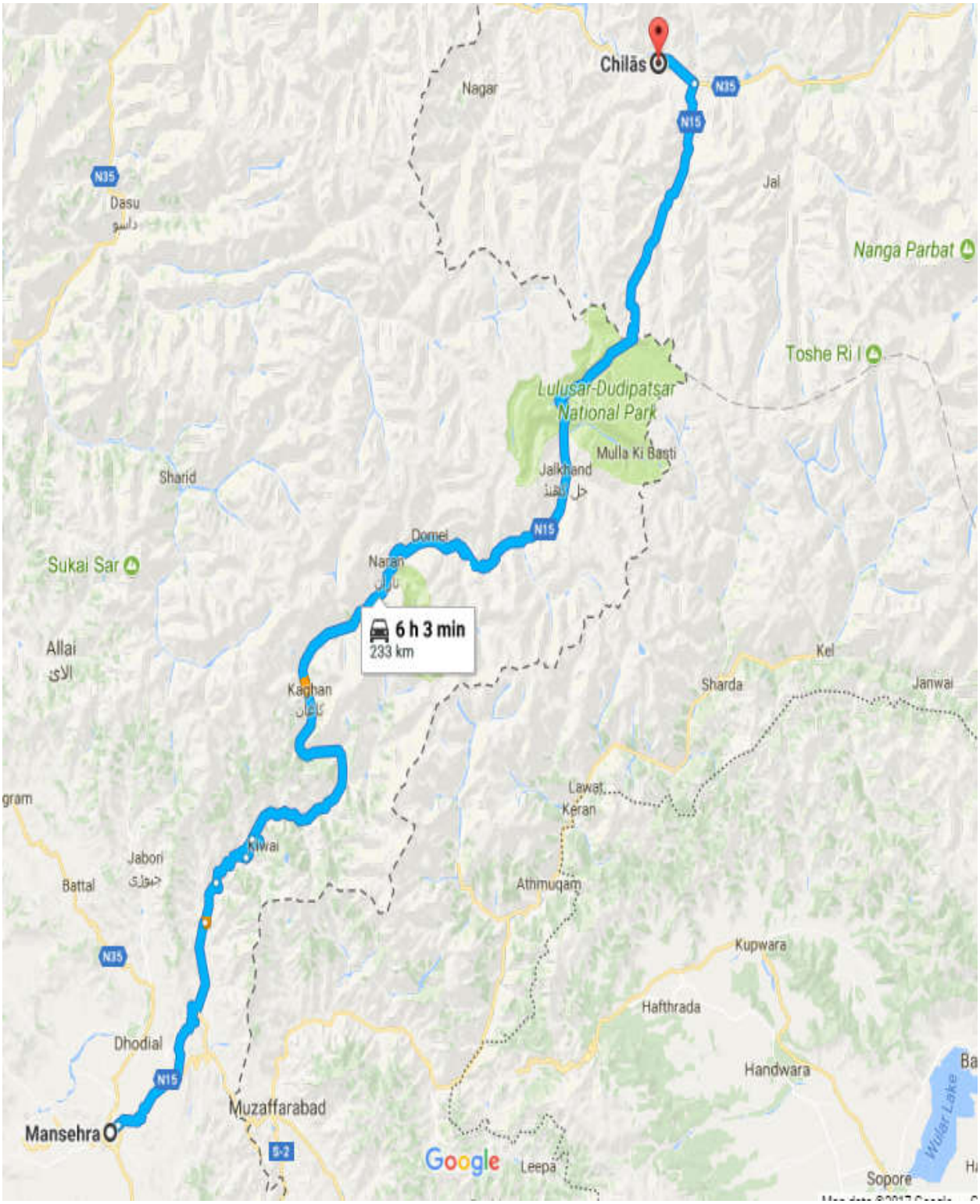
- To further enhance road safety, various curves like at Balakot, Kiwai & Mohandri must be improved by increasing their radii because these are low grade areas and vehicles crosses the speed limit i.e. 60Km/h.
- Appropriate design speed of 60-65Km/h at less slope areas of the study route i.e. Balakot, Kiwai, Mohandri, Paras and 35-40Km/h at steep slope areas like Naran, Gittidas, Behsal and Babusar.
- Adopting minimum stopping sight distance at various location i.e. Near Balakot, Kiwai, Kaghan where sight distance was not enough and causes serious accidents.
- For both driving public and resident along the corridor the education for Road safety should be carried out on continuous basis.

Below are recommendations proposed for the issues and problems observed on the study route.

- Location like Mansehra, Balakot, Kiwai, Kaghan, Naran and Burhwai where pavement marking starts fading. Durable materials for pavement marking such as epoxies, tapes and preformed thermoplastics may be used to avoid the fading away of the road along the route and it is observed at various
- Safety rest areas provide safety rest areas at appropriate intervals along the route (i.e. in Naran) where HTV stops along the route. Relaxation is mandatory on long routes therefore rest areas are provided so that drivers can relief their fatigue.
- At various location in Chilas gantry sign posts were located on the carriageway. These posts should be provided away from the moving traffic and it should be protected.
- Steep foreslope is observed at many locations like Naran, Kaghan, Paras, Lulusar and Enroute Chilas. Flattening the foreslope or install guide rail to protected errant vehicles from falling/overturning.

- Various locations which are populated like (Mansehra city, Balakot, Kaghan and Naran) where speed bumps are installed but they are not visible to road users. They should be reflectorized and warning sign s should be placed.
- Installing lights at locations where increased driver attention is demanded by highway geometry like locations of sharp curves (at Balakot, Paras, Kiwai).
- Provide double solid lines with centerline rumble strips to discourage overtaking at these locations.
- Poles were also identified at populated areas like (city roads of Mansehra, Kaghan and Naran). Relocate the electricity pole to a safer location.
- Fixed objects were observed at various locations on the straight stretches as well as on curves (i.e. Balakot, Jalkhand, Batakundi, Behsal and Enroute Chilas). Protect fixed object from moving traffic by an appropriate impact attenuator system.
- Unprotected and not as per limit steep foreslope was observed at location like (Paras, Mohandri, Babusar, Chilas) and install guide rail to protect errant vehicle from falling.
- Install mirrors to make opposing traffic visible at sharp curves like Balakot, Kiwai & Mohandri and Paras.
- Land sliding is observed on almost the entire portion but more specifically in Naran and Kaghan valleys and mostly in the rainy season. It can be protected by constructing proper retaining walls, wire meshes and proper informatory signs should also be installed to warns the driver about the effected zone.
- Concrete barriers are installed on almost the entire length of the study route. They should be replaced with guard rails. The strength of guard rails is measured but this concrete barriers or stone masonry barriers strength is not measured. The use of these barriers should be discouraged.

APPENDIX A


Chilās
Nagar
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Lulusar-Dudipatsar
National Park
Mulla Ki Basti
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جبوڑی
Battal
Athmuqam
Kupwara
Hafthrada
Handwara
Dhodial
Muzaffarabad
Mansehra
S-2
Google
Leepa
Sopore
Wular Lake

APPENDIX B

Survey Performa for "Road Safety Issues on National Highway N-15 Mansehra-Chilas (233Km)"					
National Institute of Transportation, NIT **National University Of Science and Technology , NUST, Islamabad**					
Name		*Date*		*Time*	
Weather		*Location*		*Direction*	
Questionnaire					
Type of incidents?					
a) Head on			b) Rear End		
c) Vehicle Slipage/Skidding			d) Vehicle Overturning		
e) Vehicle Hit Road Devices			f) None		
Cause of Incident?					
a) Over Speeding			b) Less Sight Distance		
c) Break Failure			d) Land Sliding		
e) Sharp Curves			f) Tyre Burst		
Vehicle involve in the incident?					
a) 1			b) 2		
c) 3-4			d) More than 4		
Persons containing vehicle?					
a) 2			b) 3		
c) 4			d) More than 4		
Persons injured?					
a) 1			b) 2		
c) 3-4			d) All involved in the incident		
Persons died?					
a) 1			b) 2		
c) 3-4			d) All involved in the incident		
Responsibility of the incident?					
a) Driver			b) Padestrian		
c) Highway Department					
Incidents severity?					
a) Low			b) Medium		
c) High			d) Fatal		
To whom people call for help?					
a) Rescue 1122			b) Edhi 115		
c) Local Hospital			d) Police		
e) Local					
IMS&R provided or not?					
a) Yes			b) No		
Type of IMS&R provided?					
a) Rescue 1122			b) Edhi 115		
c) Local Hospital			d) Police		
e) Local					
What happened to road/traffic condition after incident?					
a) Remains Same			b) Interrupted		
c) Temporarily Blocked			d) Permnent Block		
Driving License					
a) Yes			b) No		

APPENDIX C

GLOSSARY OF TERMS USED IN THIS REPORT

Access Management: Access management, when used in traffic and traffic engineering circles, generally refers to the regulation of interchanges, intersections, driveways and median openings to a roadway. Its objectives are to enable access to land uses while maintaining roadway safety and mobility through controlling access location, design, spacing and operation. This is particularly important for major roadways intended to provide efficient service to through-traffic movements.

Advisory speed signs: The advisory speed is a relative value that, for most vehicles, under WET pavement conditions, provides an adequate margin of safety and is reasonably comfortable for most drivers.

Breakaway Post: Breakaway post is designed and constructed to break or yield when struck by a vehicle. The term "breakaway" refers to crash-tested devices that break or bend upon impact.

Causeway: A causeway is a paved submersible structure with or without openings (vents) which allows flood to pass through and/or over it.

Driver fatigue: Two “types” of fatigue are important to driving. Physical fatigue is the result of physically demanding duties that exhaust one’s muscles resulting in longer reaction times and inaccurate or incorrect responses. With respect to driving, mental fatigue is the more common and serious physiological state that impairs cognitive abilities and reduces driver alertness, focus, attentiveness and the capacity to make decisions essential to driving.

Fore slope: Slope on fill areas from shoulder to bottom of slope is called foreslope or an upward slope of a mountain.

Forgiving road is de ned as a road that is designed and built in such a way as to interfere with or block the development of driving errors and to avoid or mitigate negative consequences of driving errors, allowing the driver to regain control and either stop or return to the travel lane without injury or damage.

Functional Classification: Roads are classified according to their primary function-mobility for through trips or access to adjacent lands. A four-class system is used to designate roads (principal arterials, minor arterials, collectors, local streets).

Guard Rail or Guide rail sometimes referred to as guide rail or railing, is a system designed to keep people or vehicles from (in most cases unintentionally) straying into dangerous or off-limits areas.

Loon U-Turn When the median of a road is too narrow to allow for a U turn, pavement is widened in the opposite direction of travel to accommodate u turn. This widened pavement is known as a "bulb out" or a "loon" (from the pavement's aerial resemblance to the aquatic bird). Such a design is sometimes referred to as a Michigan loon.

No Passing Zones: No passing zones are on hills or curves where you cannot see far enough ahead to pass safely. Two-lane roads may have “no passing zones” marked with a SOLID YELLOW LINE. You must complete passing before you enter the no passing zone.

Off Tracking: In horizontal curves, the radius followed by vehicle front wheels is larger than the radius of its rear wheels which increases the width swept. Off-Tracking is a condition that takes place when the wheels of the trailer of a typical semi tractor-trailer combination do not follow the same path as those of the tractor portion. This is a well-known phenomenon, which is most pronounced in tight, low-speed turns and can result in a collision with either oncoming vehicles or those traveling alongside the truck.

Parking Management: Parking management refers to various policies and programs that result in more efficient use of parking resources. Parking management can be an effective tool for local government to reduce traffic and associated emissions in congested areas by encouraging travelers to use modes other than driving alone.

Road safety: Road safety refers to methods and measures for reducing the risk of a person using the road network being killed or seriously injured. Typical users of a road include pedestrians, cyclists, motorists, their passengers, passengers of on-road public transport and road workers. Best-practices in modern road safety strategies focus on preventing severe injury and death from vehicle crashes despite human fallibility. Whereas, previous road safety paradigms assumed compliance with traffic regulations. Safe road design is now about providing a

forgiving road environment which ensures drivers error does not result in fatality or severe injury in case of a road crash and vehicle speeds will be within the human tolerances for severe injury and death wherever conflict points exist. Furthermore, the highest possible degree of safety shall be ensured when transporting goods by road. It is of vital importance to monitor and validate the road transportation safety, including comprehensive checks on drivers, vehicles and road infrastructure. The basic strategy of a Safe System approach is to ensure that in the event of a crash, the impact energies remain below the threshold likely to produce either death or severe injury. This threshold will vary from crash scenario to crash scenario, depending upon the level of protection offered to the road users involved.

Road Safety Audit: RSA is a formal safety performance examination of an existing or future road or intersection by an independent qualified audit team. It qualitatively estimates and reports on potential road safety issues and identifies opportunities for improvements in safety for all road users.

Rumble Strips: Rumble strips, also known as sleeper lines, rumple strips and audible lines" boards, are a road safety feature to alert inattentive drivers of potential danger, by causing a tactile vibration and audible rumbling transmitted through the wheels into the vehicle interior. A rumble strip is applied along the direction of travel following an edge line or centerline, to alert drivers when they drift from their lane. Rumble strips may also be installed in a series across the direction of travel, to warn drivers of a stop or slow down ahead, or of an approaching danger spot such as sharp horizontal curve.

Safety Conscious Design: Safety conscious design focuses on design policies and technologies that (1) reduce the likelihood of a road crash and (2) reduce the severity of the crash that occur. Safety conscious design represents explicit evaluation of the safety consequences associated with design alternatives.

Safety Rest Area: “Safety Rest Area” means a location created or designated to permit a driver to exit the main highway traffic lanes for stopping to reduce driver fatigue, attend to vehicle or load needs, etc. Safety Rest Areas are public facilities providing minimal services, toilets and parking only.

Sight Distance Triangle: The driver of a vehicle approaching or departing from an intersection should have an unobstructed view of the intersection, including any traffic control

devices, and sufficient lengths along the intersecting roadway to permit the driver to anticipate and avoid potential collisions. These unobstructed views form triangular areas known as sight triangles.

Safe Curve Speed Indicator: The safe driving speed for any curve is quickly and accurately determined with the "SCSI" mounted in the engineer's car. The scale reads zero when the car is level, and will show "tilt" up to 25 degrees on each side. The scale is red beyond +/-10 degrees to denote danger zones. The "SCSI" was designed by Slope-Meter in accordance with the specifications of the Minnesota Highway Dept. Traffic Division and is used nation-wide by highway and traffic engineers.

Stopping Sight distance: Stopping sight distance is one of several types of sight distance used in road design. It is a near worst-case distance a vehicle driver needs to be able to see in order have room to stop before colliding with something in the roadway, such as a pedestrian in a crosswalk, a stopped vehicle, or road debris. Insufficient sight distance can adversely affect the safety or operations of a roadway or intersection.

Stopping sight distance is the distance traveled during the two phases of stopping a vehicle: perception reaction time (PRT), and maneuver time (MT). Perception-reaction time is the time it takes for a road user to realize that a reaction is needed due to a road condition, decided what maneuver is appropriate (in this case, stopping the vehicle), and start the maneuver (taking the foot off the accelerator and depressing the brake pedal). Maneuver time is the time it takes to complete the maneuver (decelerating and coming to a stop). The distance driven during perception-reaction time and maneuver time is the sight distance needed.

The design standards of the American Association of State Highway and Transportation Officials (AASHTO) allow 1.5 seconds for perception time and 1.0 second for reaction time.

The values of stopping sight distance used in design represent a near worst-case situation. For design, a conservative distance is needed to allow a vehicle traveling at design speed to stop before reaching a stationary object in its path. A generous amount of time is given for the perception-reaction process, and a low rate of deceleration is used. The design sight distance allows a below-average driver to stop in time to avoid a collision in most cases.

Single Carriageway: A two-lane road or two-lane highway is a single carriageway with one lane for each direction with no central reservation (North American English: median) to separate opposing flows of traffic. A single-track road has a single lane with passing places for traffic in both directions. Road traffic safety is generally worse for high-speed single carriageways than for dual carriageways (North American English: divided highways), due to the lack of separation between traffic moving in opposing directions.

Speed Bump: A rounded ridge built crosswise into the pavement of a road or driveway to force vehicles to slow down.

Speed Hump: A traffic-calming device that is a longer, flatter version of a speed bump; also called road hump.

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