Road Traffic Accident Analysis of Motorways in Pakistan

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ABSTRACT

Highway Safety is one of the most important aspects of transportation engineering as traffic accidents are unavoidable in human life. Developing nations including 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. Motorway (M-2) connecting Lahore to Islamabad, one of the major motorways of Pakistan has been selected for study. 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.

After analysis it was found that, accidents are majorly caused by careless driving (25%), dozing at wheel (23%), tyre burst (18%), brake failure (9%) and pedestrian crossing (6%). Proper traffic guidance and control system to guide road users ensuring safe movement of vehicles has been recommended and some of the low cost facilities such as pedestrian crossings underpasses near Lahore, dozing alert alarm to minimize dozing, tyre checking gauges to counter tyre burst, training to avoid brake failure, and advertisement through print and electronic media to increase awareness have also been proposed in order to improve the safety of the road and minimize the accidents.

Keywords: *Accident analysis and evaluation; Traffic safety; Motorways.*

1. INTRODUCTION

Mobility is the essence of our freedom. This is the basic layer of our modern, fast development. No progress in the mobility of our community is drowning. While mobility is a major component of the interaction in our society, it is our enemy. We have to pay a price in terms of injuries and property damage from exposure to mobility as a result of accidents. This may seem pessimistic to think that accidents related to mobility are inevitable, but really, it's true.

At the time, people prefer to manage their vehicles in the mobility, Murphy's Law prevails: anything that can go wrong will go wrong. Only full automation can prevent accidents, but people, construction and operation of automation systems. The development of the transport system has generated the power that human beings possess a high civilization on Earth. However, this growth has led to security problems that our transport system has to improve efficiency and comfort to deprive us of our lives. Attempts to solve this problem have been, and will be a lot of different areas. In particular, traffic engineers investigating accidents passionate analysis and prediction of possible accidents on our systems. The dashboard security of Pakistan is a mixed picture. In some sectors of the transport system of Pakistan, namely, air and maritime security level is equal to anyone in the world, and rail services are also offered with an acceptable degree of risk, although there are many opportunities for improvement.

Road safety is a major public health problem, when statistics show that more than 3,000 people worldwide die each day due to the death of accidents. In addition, traffic accidents result in economic losses estimated at a total cost of road accidents than U.S. $ 518 billion a year. Economic costs of great economic burden on developing countries. Reflects the cost of accidents is estimated at U.S. $ 100 million in developing countries, which is twice the annual amount of development assistance in these countries. More than 1.17 million people die annually in road accidents worldwide. About seventy percent of these deaths occur in developing countries. More than 10 million are injured or maimed every year (WHO 2004). In traffic accidents tendency of accidents is also increase with increase in vehicle population. According to Ahmed (2007), on road safety in Pakistan, estimates that between 7,000 and 10,000 people die each year in Pakistan. To better understand the extent of loss of 7,000 or 10,000 lives is 20 to 25 Boeing 747 Jumbo accidents cases per year in Pakistan alone. Imagine a protest that such a large amount of aircraft causes a collision when they occur. Accident is a quiet killer. It's so deadly, but kills quietly, while the player moves on this page to somebody dies in a traffic accident.

2. LITERATURE REVIEW

A lot of research and theories exist about the accidents and safety issues. Here our studies describes about the accidents analysis procedures and state of art practices for accident analysis. Accident data collection procedures, summarizing the data, accident cause identification and methods adopted to analyze accidents in the world have been assessed. Safety issues, accident porn location identification and remedial measures have also been discussed.

2.1 ROAD TRAFFIC ACCIDENTS

In the dictionary the word accident Literally means , a befalling; an event that takes place without one's foresight or expectation; an unseen, sudden, and unexpected event; chance; contingency; often, an undersigned and unforeseen occurrence of an afflictive or unfortunate character; a casualty; a mishap; as, to die by an accident.

"Accident" is the commonly accepted word for an occurrence involving one or more transportation vehicles in a collision that results in property damages, injury, or death. The term "accident" implies a random event that occurs for no apparent reason other than "it just happened." Have you ever been in a situation where something happened that was unintended? Your immediate reaction might have been "sorry, it was just an accident."

The word "accident" began to disappear from professional literature in the late 1960s as more science was focused on the problem. In recent years, the National Highway Traffic Safety Administration has suggested replacing the word "accident" with the word "crash" because "crash" implies that the collision could have been prevented or its effect minimized by modifying driver behavior, vehicle design (called "crashworthiness"), roadway geometry, or the traveling environment. The word "crash" is not universally accepted terminology for all transportation modes and is most common in the context of highway and traffic incidents. In this chapter both terms, "crashes" and "accidents," are used because while crashes is the preferred term, in some situations the word "accident" may be more appropriate. (Garber et al., 2009)

2.2   CAUSES OF ACCIDENTS

The occurrence of a transportation crash presents a challenge to safety investigators. In every instance the question arises, "What sequence of events or circumstances contributed to the incident that resulted in injury, loss of lives, or property damage?". In some cases the answer may be a simple one. For example, the cause of a single car crash may be that the driver fell asleep at the wheel, crossed the highway shoulder, and crashed into a tree. In other cases the answer may be complex, involving many factors that, acting together, caused the crash to occur.

Most people know that the *Titanic,* an "unsinkable" ocean liner, went to the bottom of the sea with nearly 1200 passengers and crew. Common belief is that the cause of this tragedy was that the ship struck an iceberg. However, the actual reason is much more complex and involved many factors. These include too few life boats, lack of wireless information regarding ice fields, poor judgment by the captain, an inadequate on-board warning system, overconfidence in the technology of ship construction, and flaws in the rivets that fastened the ship's steel plates.

Based on these illustrations and other similar cases it is possible to construct a general list of the categories of circumstances that could influence the occurrence of transportation crashes. If the factors that have contributed to crash events are identified, it is then possible to modify and improve the transportation system. In the future, with the reduction or elimination of the crash-causing factor, a safer transportation system is likely to result. (Garber et al., 2009)

3.   RESEARCH METHODOLOGY

Accident concentration is analyzed by the combination of accident severity at certain location; sometime financial values are also included. Despite the poverty, the developing countries the opportunities in the arts, "learn and draw lessons" work already completed by the developed countries in the field of road safety. Circumstances in developed and developing countries are different. The methodology of data analysis of the accident in the light of local factors is to determine the causes of the accident on motorways. Accident data of motorway (M-2) was obtained from the National Highway and Motorway Police (NH&MP), responsible for the administration and collection of accident data. The accident database up gradation of M-2 reflects an understanding of the importance of this fact in the Headquarter. A good accident report form was designed to include the following basic information of the accident must be registered in the recovery of equipment NH&MP. Usually it is done in two steps, as:

- Manual Filing System
- Computer Record System

3.1 SUMMARIZING ACCIDENT DATA

Accident data is used to determine the safety problems that may exist in a given site. According to Garber et al. (2009), it can be used to identify the accident at a site, from which possible causes are identified, leading to the identification of possible remedial actions. Analyses are carried out in five different ways as mentioned below:

- Causes
- Severity
- Contributing circumstances

- Environmental conditions
- Time period

3.1.1 Summary by Causes

The reason for quantitative analysis of specific causes of accidents flat roof, for example, to accelerate the emergence of animals, stroke, etc. In such a drunk driver analysis helps to prioritize the needs for corrective action. Some time there is detail about accident but the foremost question is about the key reason of occurrence. That is named as cause of accident which is the actually the root of problem.

3.1.2 Summary by Severity

The analysis helped identify the severity of each accident occurring in one of three classes of severity:

- Fatal
- Major
- Minor
- Property Damage

Fatal accidents are the leading at least one person was killed. Accidents due to serious injury but not death, is classified as major. Accident causing low level injury of any kind is minor, but the damage to vehicles includes damage to the property.

3.1.3 Summary by Contributing Elements

Each accident site appears in one of the three factors that contribute to establish a link between the accident and the impact of factors:

- Human factor
- Environmental factors
- Vehicle related factors.

3.1.4 Summary by Environmental Conditions

The analysis allowed the classification of accidents, based on conditions that existed at the time of the accident. He also helped to determine the effects of the season in case of accidents and safety deficiencies that may exist in a certain place.

3.1.5 Summary by Time Period

This analysis is the classification of incidents at different times to determine if accidents are much higher in a certain period of time. This method of summarizing data also facilitates the identification during which the occurrence of accidents above. Three different time periods are used as follows:

- Two Hourly

- Day/Night

- Monthly

3.1.6 Severity Index

A widely used statistic for the description of relative accident severity is the severity index (SI), defined as the number of fatalities per accident. For the data of the previous example, there were 7.5 fatalities in a total of 2,360 accidents. This yields a severity index is 0.0318 deaths per accident. The severity index is another statistic that should be compared with previous years and state and national norms, so that conclusions may be drawn with respect to the general severity of accidents in the subject jurisdiction.

4. DATA ANALYSIS AND RESULTS

The primary objective of the study was to investigate the conditions under which most of die accidents occurred on Motorway M-2 section between Lahore to Islamabad. In 2001, National Highway Authority handed over the enforcement to National Highway and Motorway Police (NH&MP).

The road section from Lahore to Islamabad was constructed in year 1980. Ever since no major improvements have been done and the volume of the traffic has increased manifold during the past years. The Land passes through urban towns like Kala Shah Kaku, Sheikhupura, Khanqah Dogran,Kot Sarwar, Pindi Bhattian, Salem, Lilla, Kot Momin, Kallar Kahar, Balksar, and Chakri before ending just outside the twin cities Rawalpindi and Islamabad. General alignment is a straight run and also has some sharp horizontal curves. Speed limit is 120 km/hr for light traffic and 110-90km/hr. for heavy transport vehicles.
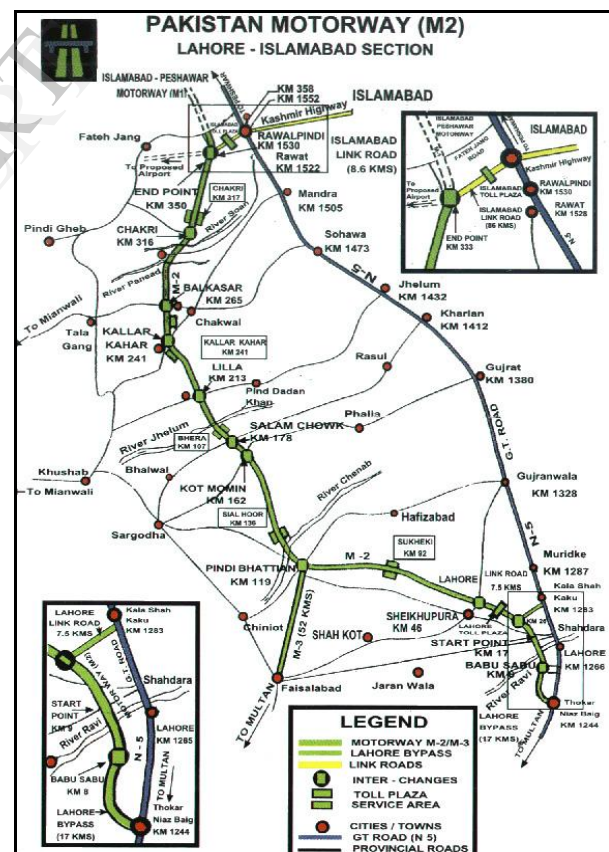

Figure 4.1: Map of Motorway (M-2) Lahore-Islamabad (Adopted from NTTFC,2010)

4.1. Time Wise Analysis

Time wise distribution of accident data enables to determine the effect of visibility, peak hour traffic and season of year on accident occurrence. The occurring periods will show the considerable factors that impact on traffic during specific timings.

4.1.1 Year Wise Analysis

Accidents are summarized according to different aspects, but simplest comparison is made through its statistics year wise.
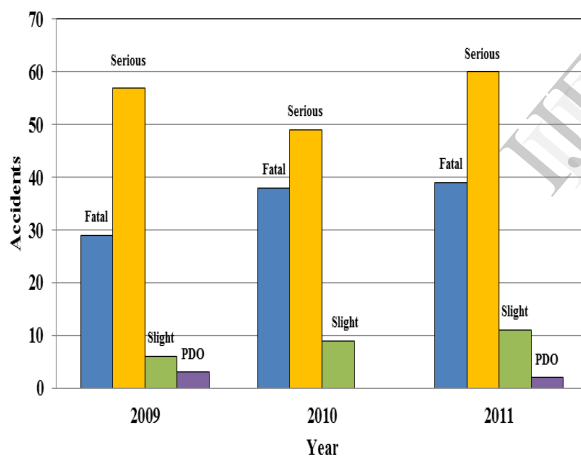

Figure 4.2: Year Wise Accidents Distribution Based on Type of Accidents on M-2

4.1.2 Month Wise Analysis

Through analysis of data, it was found out that accidents are high in summers as compare to winters. In January an average of 14 accidents are recorded and then the number are decreasing up till month of March with 26 recorded accidents.
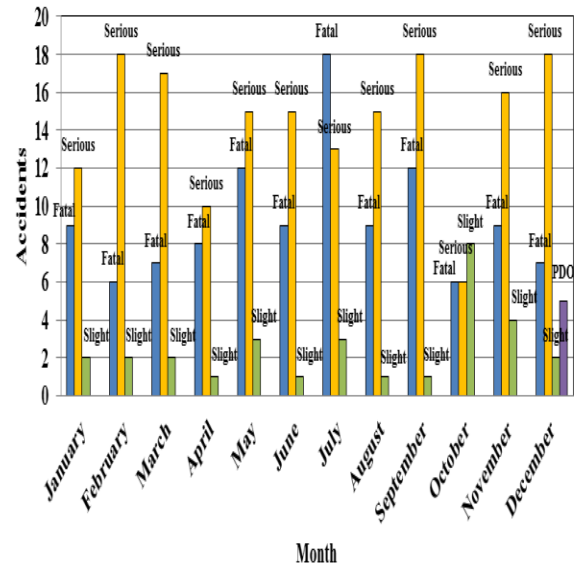
Figure 4.3: Month Wise Accidents Distribution Based on Type of Accidents on M-2

4.1.3 Day Wise Analysis

Day wise study of accident data leads to identification of maximum accident occurrence during particular days. Study of condition associated with that particular days helps determining the reasons for reoccurrences of accidents at same days.
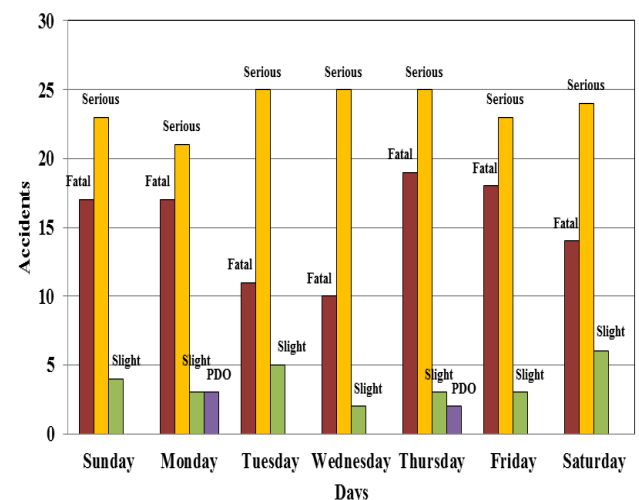

Figure 4.4: Day Wise Accidents Distribution Based on Type of Accidents on M-2

4.1.4   Day/ Night Analysis

Day time period is considered to be 0600 to 1800 hours whereas night time period is 1800 to 0600 hours. Fig 4.5 reveal 43% accident occurred during day and 57 % occurred during night that means probability of accident occurrence during day is relatively lesser than the night time.
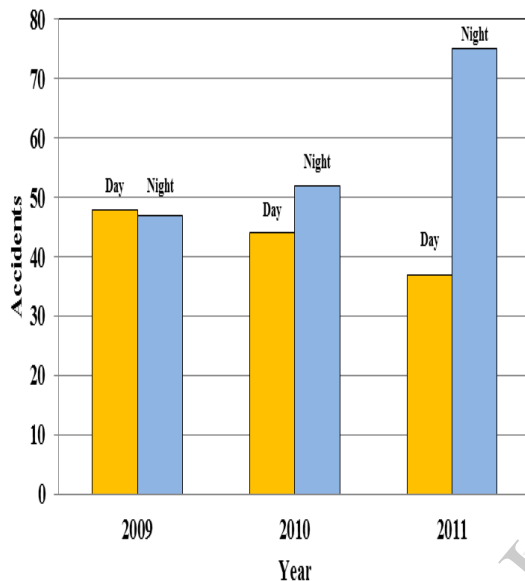

Figure 4.5: Day/Night Time Wise Analysis

4.1.5   Hour Wise Analysis.

Hour wise study of accident data leads to identification of maximum accident occurrence during particular interval of time. Study of condition associated with that particular time span helps determining the reasons for reoccurrences of accidents at same hour of the day.
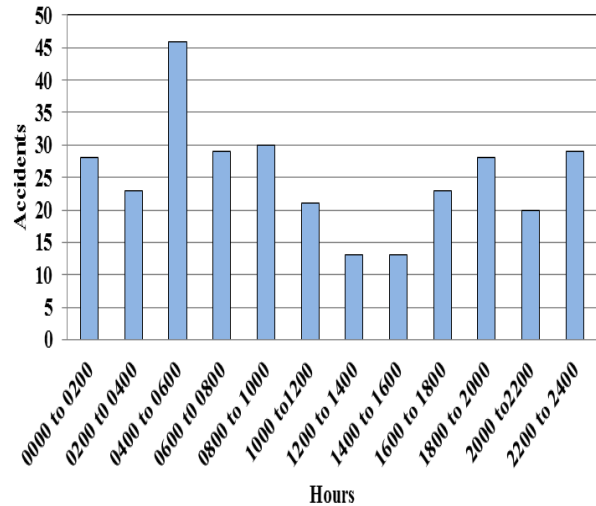

Figure 4.6: Hour wise Distribution of Accidents in the Study Stretch of M-2

In the analysis of M-2, maximum of 46 accidents occurred during 0400 to 0600 hours i.e. 15% of total accidents showing dozing impact and 30 occurred during 0800 hours to 1000 hours i.e. 10%. Fig 4.6 shows hourly trend of accidents occurrences and figures out 0000 to 0200 hours, 0200 to 0400 hours, 0400 to 0600 hours and 2200 to 2400 as hours having minimum numbers of accident, probably due to less traffic.

4.2   Sector Wise Analysis

Motorway(M-2) has been divided in two sectors,first half portion (towards Islamabad) is known as North while other half portion (towards Lahore) is known as South.North portion has slightly higher ratio of accidents than that of South. Moreover varying driving proficiency levels of different vehicle category drivers plays an importanat role in accidents.
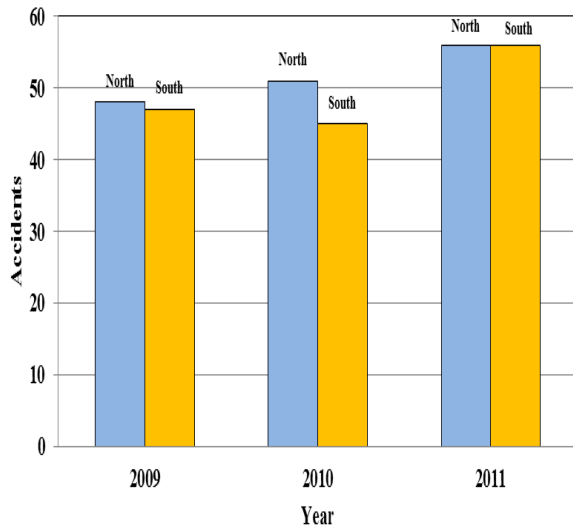
Figure 4.7: Sector Wise Distribution of Accidents in the Study Stretch of M-2.

4.3 Beat Wise Analysis

Motorway M-2 consists of 358 km which has been divided in to several sections which are known as beats of 5 to 12 beats,theses beats are easily indicator of locating accident location and study certain region of motorway.Beat 7 is 52km long from Balkasar to Lilla and contains area of salt range, so accidents are higher in this region. There are eight beats which are the specific portions, each is administrated by a DSP rank officer. Beat 5 which the first beat of Motorway (M-2) is of 38km from Islamabad to Chakri, Beat 6 is of 47 km, from Chakri to Balkasar, Beat 7 is of 52 km from Balkasar to Lilla, Beat 8 is 50km from Lila to Sial Chowk,Beat 9 is from Sial chowk to Pindi Bhattian, Beat 10 is of 37 km from Pindi-bhattian to Khanka-Dogran,Beat 11 is of 35km from Khanka-Dogran to Sheikhupura and Beat 12 is of 47km from Sheikhupura to Lahore(Shahpure Interchange).
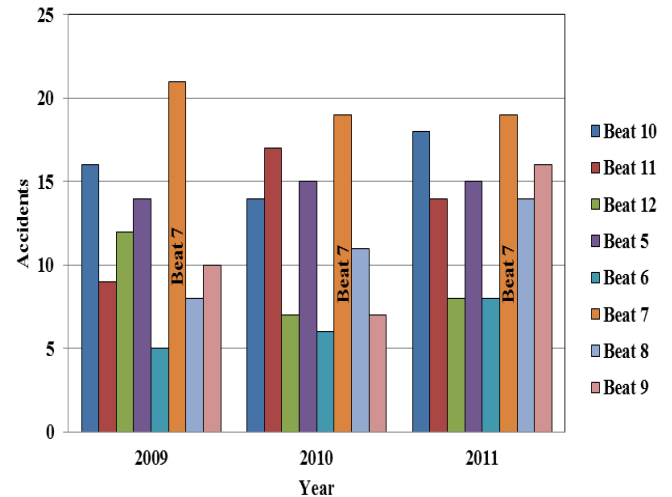

Figure 4.8: Beat Wise Distribution of Accidents in the Study Stretch of M-2.

4.4 Direction Wise Analysis

Direction of Motorway is encoded with two specfic wording Alpha and Bravo,Alpha indicates direction from Islamabad to Lahore,Bravo indicates Lahore to Islamabad.56% of accidents are on alpha direction while 46% are on bravo direction.
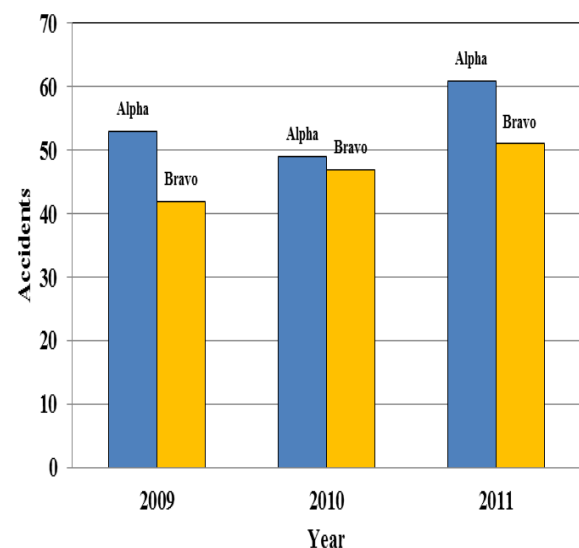

Figure 4.9: Direction Wise of Accidents in the Study Stretch of M-2.

4.5 Severity Wise Analysis

Severity analysis are helpful in determination of accident costs, assessing impact of accident on human life and property damage, most important aspect in gauging safety efficiency of transportation system.
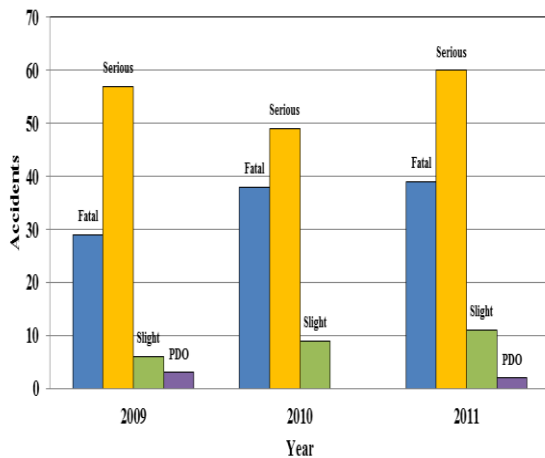

Figure 4.10: Accident Distribution Based on Accident Severity on M-2.

In the total 272 number of accidents, around 131 were recorded fatalities with 214 major injured and 386 as minor injured. The rate of fatalities is very high i.e. 18% people involved in accidents are dead.

4.6 Causality vs. Year

Casuality versus year analysis helps in finding out the relation between accident severity and years.Accident outcomes can be discussed and compared.As fatality is increasing from 2009 to 2011 and in parellel,Major or serious injury can also be compared as major injury accidents are also increasing.Results shows that fatality rate is high in pedestrian category with 35% of total fatalities recorded, than it is high in passengers with 40% and in drivers it is recorded as 6% of the total fatalities. Analysis of the injuries revealed that passenger type users are with the worst record with 80% of the total

injured. Human factors in association with the accident are termed as users and death ratio increases with the increase of highway users. Year wise facility users are increasing and different type of vehicles are using facility, but the lack of education and traffic law issues are still there, economic down fall has sustained the human education level while affectivity of safety procedure has increased this mismatch shows a clear gap between mass awareness and traffic law enforcement.
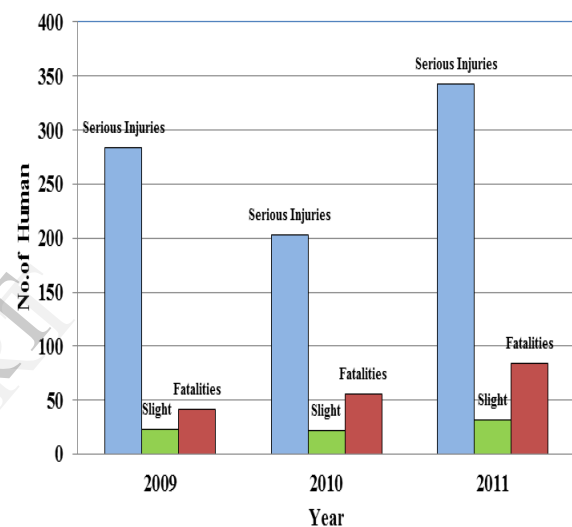

Figure 4.11: Causality Based on Accident Severity on M-2

Human involvement is described that in all accidents 10% Passengers killed, 70% passengers injured,2% pedestrian killed,5% drivers killed and 13% drivers injured.

Total Fatalities	=	182
Total Major Injuries	=	830
Total Minor Injuries	=	077

4.7 Severity Index

A widely used statistic for the description of relative accident severity is the severity index (SI), defined as the number of fatalities per accident. For the data of the previous example, there were 7.5 fatalities in a total of 2,360 accidents. This yields a severity index was 0.0318 deaths per accident. The severity index is another statistic that should be compared with previous years and state and national norms, so that conclusions may be drawn with respect to the general severity of accidents in the subject jurisdiction.

Severity Index = No of Fatalities / Total Accidents

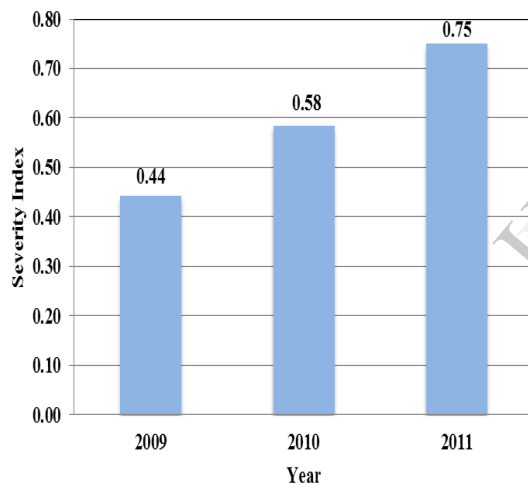SI = 182/303 = 0.60 deaths per accidents (Overall)

Figure 4.12: Severity Index for Motorway M-2(2009-2011)

Severity Index is a parameter to determine the accident severity, year wise comparison gives better information about the accidents.

The number of injuries per accidents is calculated,

Major Injured per accident = 830 / 303 = 2.73

Minor Injured per accident = 077 / 303 = 0.25

Also, the Fatalities per km are:

Fatalities per Km   = 182 / 358 = 0.50

Major Injured per km   = 830 / 358 = 2.31

Minor Injured per km   = 077 / 358 = 0.22

4.8 Collision Type Wise Analysis

This analysis is extremely useful in quantifying accidents as per their collision type. Collision factor can precisely identify the required direction of remedial efforts. Collision type shows impact of speed during study that majority of accidents are complete destruction of vehicle and total property has been damaged. Vehicle has no chance to mechanically unfit for travelling.
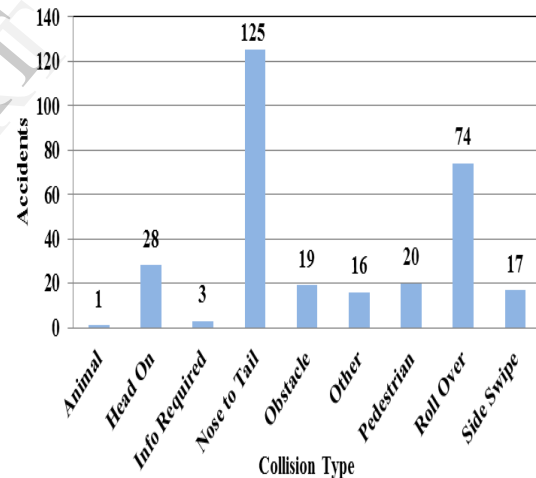

Figure 4.13: Collision Type Based on Accident Severity on M-2

Majorly accidents are collision by Nose to tail 40%,secondaly 25% Roll over,Head on is 9%,Pedestrian accidents are 7%,side swipe,obstacle 6% and 5 % are others.

4.9 Weather Wise Analysis

These analysis are carried out shown in Fig 4.14 reveals that dry weather impacts more on accidents.
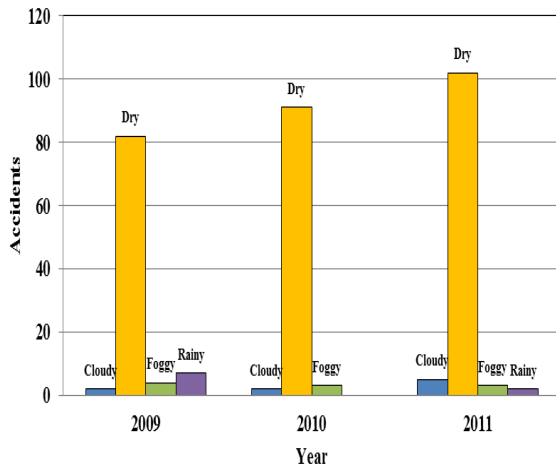
Figure 4.14: Weather Condition Based on Accident Severity on M-2

Observations indicate that cloudy weather 3%,Foggy 3%,Rainy % factors involved but major accidents are in dry weather i.e;91%.Cloudy weather 3%,Foggy 3%,Rainy % factors involved but major accidents are in dry weather i.e;91%.

4.10   Light Condition Wise Analysis

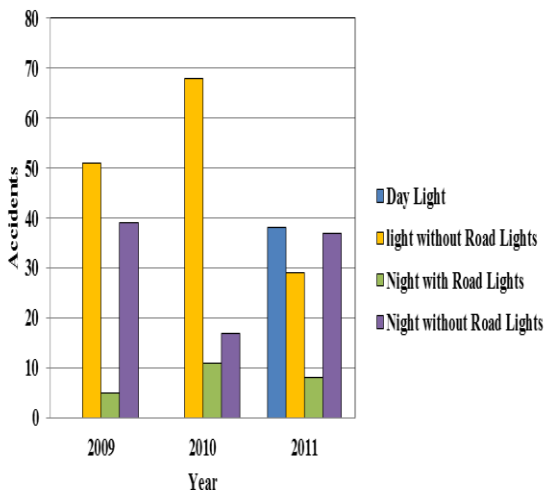Lighting conditions in accordance to vision perspective, matters a lot during driving.

Figure 4.15: Light Condition Wise Based on Accident Severity on M-2

Enviornmental factors influced by light condition are also a factor to affect on accident occurance,Light without road lights has 148 accidents,nights without road lights 93 accidents,day lights have issue 38 accidents and 24 are accidents night with road lights.Day light situatiion affected 12 % accidents,night without road light affected 8% accidents,night without road lights affected 31% accidents and 49% accedents affected by light without road lights.

4.11   Road Geometry Condition Wise Analysis

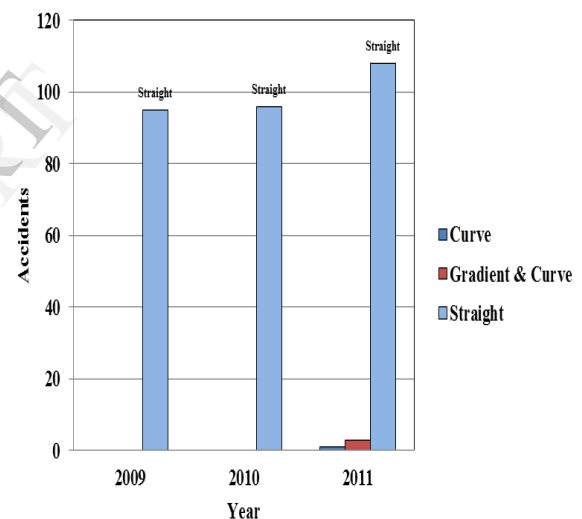Geometric design also effect on driving and causes accidents due to abnormalities.

Figure 4.16: Road Geometry Based on Accident Severity on M-2

4.12   Contributory Element Wise

There are certain reasons which contribute in an accident but key causes should be identified. Data analysis shown in Figure 4.17 gives detail of that. Careless driving, Dozing at wheel, Tyre burst and brake failure are major causes. Data is spread year wise to find seasonal effect on contributory elements. The result of data analysis from 2009 to

2011 is tabulated in Figure 4.18. Following factors were considered as major causes of accidents:
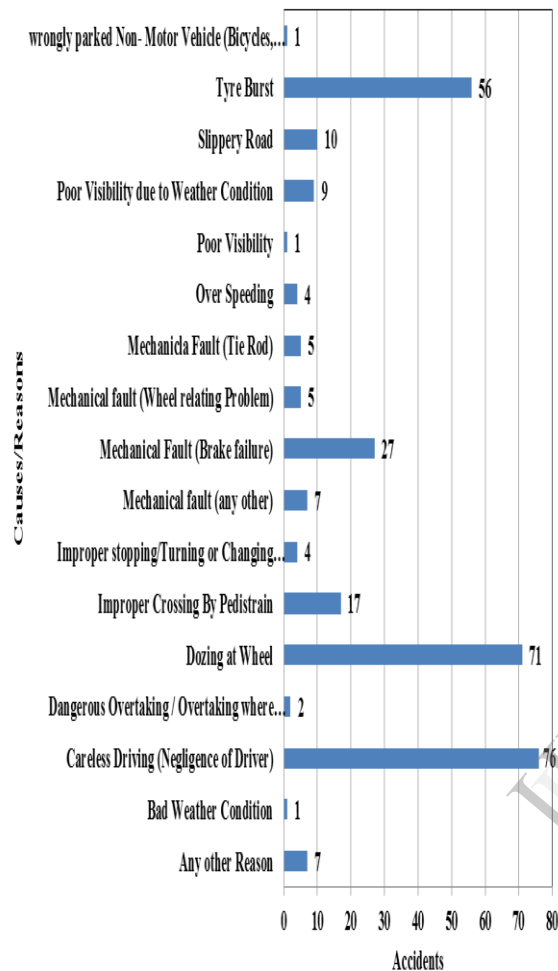

Figure 4.17: Causes of Accident Distribution Based on Accident Severity on M-2

Following is the detail of major factors: Careless Driving (23%), Dozing at wheel (21%), Tyre Burst (19%), Mechanical Fault: Brake Failure (17%) and Pedestrian crossing (2%).This shows that these are 80% contributing factors of accidents. According to year based analysis careless driving, Dozing on wheel, tyre burst and brake failure are the major cause of accidents.
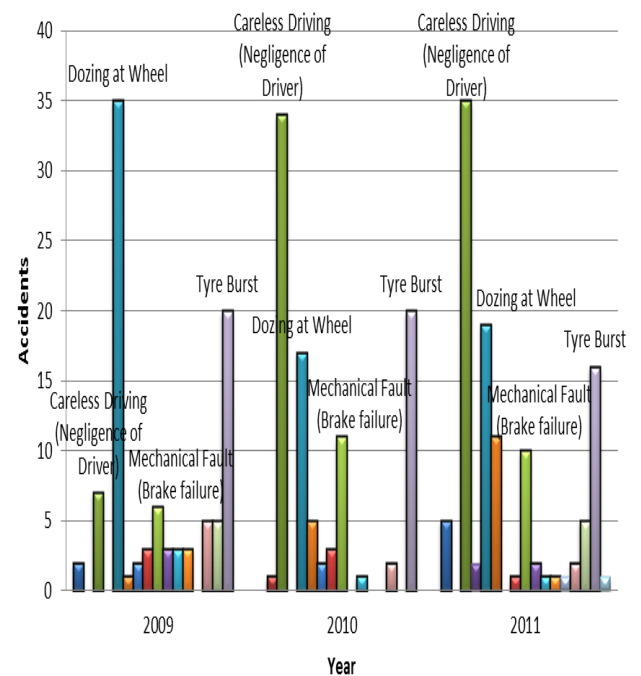

Figure 4.18: Causes of Accident Distribution Based on Accident Severity on M-2

5.   CONCLUSIONS

A well-developed infrastructure and transportation system is critical to the economic rise of a country and is a major determinant of competitiveness. Pakistan's government gives due attention to the creation of transport and communication systems for the Pakistan. Among the various modes of transport, road transport is the basis of the transport system in Pakistan, which accounts for 90% of domestic passenger and 96% of freight traffic. To create the infrastructure to support growth, the Government of Pakistan has taken major initiatives as Improvement Program for National Trade Corridor (NTCIP) to modernize and simplify trade logistics and transport in the country. The basis for the development and improvement of North-South Corridor was built in NTCIP. NTC's strategic direction is to increase efficiency by providing world-class infrastructure, supply chain efficient and

smooth interface between the public and private sectors.Detail analysis of accidents on Motorway(M-2) here are the findings of the study.

5.1 Findings of Accident Analysis

After analyzing the detail accident statistics from year 2009 to 2011, following conclusions were made in the course of the study;

Major Causes of Accidents on Motorway M-2: Top most cause of accidents on motorways is Careless Driving (25%), dozing at wheel (23%), Tyre Burst (18%), Mechanical Fault: Brake Failure (9%) and Pedestrian Crossing (6%).This shows that these are 80% contributing factors of accidents. *Light condition of Accidents on Motorway M-2:* The accidents within the region without road lights are 80%,as in the area where accidents are due to night vision issues are 31% and in day time due to some fog or weather are 49%. 95% of the motorway M-2 is without lights. **Time of Accidents on Motorway M-2:**In the night time accidents related to timing ,highest accident timing are 0400-0600AM(15%) may be due to dozing-critical timing, then 2200-2400PM (10%), then 0800-1000AM (10%), 0000-0200AM (9%), 0600-0800AM (9%), 18002000PM(9%).Timing issue is also related to traffic peak hours and drivers behavior like sleeping hours that tend to increase accidents. *Collision type of Accidents on Motorway M-2:* Nose to tail accidents are (41%), Roll over (25%), Head On (9%) and Pedestrian (7%). reflecting the drivers skill to avoid accident severity. *Severity Index*: The analysis shows that the frequency of accidents on M-2 is increasing with respect to the impact of the traffic movement are growing rapidly. Severity Index increased from 0.44 to 0.75 during year 2009 to 2011.*Fatality:* Deadly accidents on motorway M-2 are high, as 35% of all accidents. *Sector:* The sector wise portion of accidents are 51% at Northern sector while 49% at Southern sector. The upper half towards Islamabad is northern, while lower half towards Lahore is Southern. *Beat Wise:* Motorway is divided in sections called beats; beat wise accidents on motorway M-2 are Beat7, Beat10 and Beat5 higher of all accidents. *Vehicles:* Bus bombing serves as the main cause of accidents reflects the poor condition of the road vehicle users and bus bodies. *Road Condition and Speed:* However, designated speed for motorway is 120kph but also have 50kph in hilly area which is against the motorway theory, plays an important role in the recurrence of accidents at this location. Interviews with users of the highway, officials and NH&MP, and personal observations confirm this fact. *Contributing factors:* Maximum accidents attributed to human error, lack of education or speeding, as human behavior play an important role. Thus, these problems require strict administrative remedies instead of expensive engineering solutions.

5.2 COUNTERMEASURES

This conclusion requires a systematic and comprehensive approach to security issues with M-2. As in orthodox adjustment plan should focus on technology, education and enforcement, but in the matter of design, if the security is replaced by the sleek design and large M-2. Following the recommendations will help to reduce accidents and improve the safety of the M-2:

For Dozing at wheel: Second highest cause of the accidents, can be dealt with two major ways. First, awareness related to sleeping before the traveling on motorways should be increased. Second, is using the dozing alarm device. Dozing on wheel can be reduced by providing awareness to drivers to take a proper sleep before driving. Many times one has to

drive when tired. We need a safety gadget or device dose alerts to warn / inform the driver before falling asleep at the wheel. If you feel sleepy, but you have to stay on track and you just want to get to your destination without causing a serious accident..

For Tyre Burst: Third major cause of accidents is tyre burst covering (18%) of accidents. Detail awareness should be spread about taking care of tyres. Motorway police can use technology to tyre checking that all the doubted vehicles should be checked for tyre quality. For example by general look if tyre strength is suspected thus test should be conducted. The tyre testing gauge costs 3$ to 40$.At each interchange 20 devices are kept then it cost near about Rs.200000/- at the economical rate of 5$ for 400 devices.

For Brake Failure: It has the fourth highest cause of the accident having 9%.Usually it is difficult to perform individual brake check but on the other hand, brake failure causes can be identified and can be minimized. Those causes and remedies will be described in blackspot analysis.

*For Pedestrian Crossing:*Fifth most accident causes of accident having 6% .Although motorway is totally banned for pedestrian but where ever motorway passes from some village or populated area pedestrian accidents increases.

*For Light condition on Motorway M-2:*The accidents are within the region without road lights are 80%, very less area of motorway M-2 is installed with the lighting. Only 0-10km,14-16km,256km,265km,273km,344-348km are entitled with road lights. Weigh station are only entitled with the lights. Solar road lights should be installed which could be continuous source of safety as light problem could be solved. According to current market rates w.r.t NHA a solar light post costs Rs. 0.5 Million. Thus it is not possible to install as a whole on Motorway but on Salt Range it is necessary to be installed which cost near about Rs.17 Million according to NHA that can be considered. According to standards for lighting issues are solved by luminous tapes installed on curves but due to extra ordinary conditions, here lighting is recommended.

Solar lights are continuous source of light as no power shortage effects on it and for a reasonable duration theses poles can work properly. These are installed on trial basis that if worked effectively further installation will be considered.

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