

ANALYSIS OF ROAD ACCIDENT: A CASE STUDY IN HISAR TEHSIL

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DECLARATION



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CERTIFICATE

I hereby certify that the work which is being presented in the Dissertation entitled “**Analysis of Road Accident: A Case Study in Hisar Tehsil**” in partial fulfillment of the requirement for the award of degree of **Master of Technology** and submitted in Department of Civil Engineering, Lovely Professional University, Punjab is an authentic record of my own work carried out during period of Pre-Dissertation under the supervision of **Mr. Ajay Kumar, Assistant Professor**, Department of Civil Engineering, Lovely Professional University, Punjab.

The matter presented in this Dissertation has not been submitted by me anywhere for the award of any other degree or to any other institute. .

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ABSTRACT

‘Accidents are not natural but they are caused’ is a common cliché in the area of traffic safety. Thus, if accidents are caused by some, surely the ones responsible for could be identified and appropriate remedial measures developed and implemented to the extent feasible. India has a road network of 3.3 million km consisting of National Highway (NH), State Highway (SH), Major District Roads (MDR) and Other District roads (ODR). National Highways constitute 2% of the total road length and carries more than 40% of passenger traffic and 85% of goods traffic has registered more accidents accounting for 20%, as compared to other roads. In Hisar total road length is 2221 kms from which NH65 and NH10 passes through. Vehicle crashes are a major concern in rapidly growing urban agglomerations. They also have attracted the attention of researchers, academicians, and policy makers. A large body of research literature exists that throws light on the magnitude of this problem and also indicates the interventions required. Road traffic accident (RTA), a cause of unnatural death is the third major preventable one amongst all deaths. The aim of the work described in this thesis was to obtain a greater understanding of the problem of road accidents in Hisar. The social importance of road accidents in this city were identified by comparing deaths from road accidents with deaths from diseases thought to be of concern. Trends in fatality and casualty rates over various ten-year periods will determine and states showing abnormalities identified. Reasons for these abnormalities were investigated using disaggregated data from those states concerned. Fatality rates found to be related to levels of vehicle ownership, the higher the vehicle ownership the lower the fatality rate. A detailed study was made of road accidents in Hisar. Factors that might be contributory to the high accident rates are that Hisar is coming under developing cities were studied and due to the increasing of motor vehicle population, the accidents come more. From the study till, it can be concluded that this National Highway section needs improvement from safety point of view. A large number of accidents have been occurring over such an area of Hisar-Sirsa road and Hisar-Delhi Bypass road mainly. Proper traffic guidance and control system to guide road users ensuring safe movement of vehicles has been recommended and some of the facilities such as pedestrian crossings and median openings, acceleration and deceleration lanes were re-designed in order to improve the safety of the road and minimize the accidents.

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LIST OF ABBREVIATIONS

NH	National Highway
SH	State Highway
MDR	Major District Road
ODR	Other District Road
WHO	World Health Organization
RTA	Road Traffic Accident
PIA	Personal Injury Accident
TRL	Transportation Research Laboratory
MOUD	Ministry Of Urban Development
NHAI	National Authority Of India
PWD	Public Works Department

INTRODUCTION

1.1 RESEARCH BACKGROUND

Accidents on road have majorly emerged as one of the biggest cause of danger or caution in the world for the past few years. It is found to be the 9th leading cause of death in 2004 and it will be predicted that by 2030 it will be the 5th leading cause of death as by current rate of death. It is found that India has surpassed China for recording the highest no. of people killed in 2008 and around 1.2 lakh people exaggerated by this rate. With the study it is found that in road accidents 37.1% people involved as cause of unnatural cause of accident in the country. In a fact I found that Nagaland has very low figure of no. of accidents in the country as a state but number of persons killed with per lakh population and per10000 motor vehicle, the major brutality was highest for this state. Mizoram has 2nd highest rate of severity of road accidents. For the accidents the number of road accidents brutality with per lakh population of India goes up 39.8 in 2004 as compare to 42.5 in 2010, as the increasing rate of difference is 3.3 between the years 2004 -2010. According to the year 2010, Goa has found to be the most accidental state of road accidents per lakh population i.e. 267. As compare to 2005 to 2010, number of deaths on roads has risen up with 8.6 in 2005 to 11.4 in 2010 across all states of India. According to the year 2010, the highest no. of persons killed on road found to be in Tamil Nadu i.e. 23 as per lakh of population, than in Goa i.e. 19.1 than in Haryana i.e. 18.9. With the various studies for the accidents it is found that the accidents on roads are not due to natural cause but it is found that it will occur due to of carelessness and ignorance of road safety criteria. Environmental factor also plays a big role in cause of accidents on roads like Fog in winter seasons etc. This thesis lays emphasis on accident studies on the National Highway 10 & National Highway 65 and other areas for studies which is passes through the Hisar Tehsil. For finding the major role of accidents occur on these highways several steps has to be taken for the road safety programmed and understanding the deep of the problem. The first step is to be taken that good and real data has to be collected with real crashes on roads that second is we have to understand the variability of the data and what is the reason behind the accidents and injuries and what would be the possible steps to outcome to avoid these accidents. The main focus of this study is to reveal the methodology development and find relation with population and accidents.

1.2 PROBLEM STATEMENT

There has been a great variability for the use of various methods to collect the information related to accidents and crash issues throughout Hisar Tehsil. With a reason say unfortunately the methods that transportation professionals do not know when and how these methods applied to evaluate the crash fatalities. In between 2001-2011 about 430 lost their lives in highway crashes and about 1651 were injured (source: Haryana Police Department, Hisar). Accidents occur on link roads more in day time and less in night time as compare to it, but several accidents occur on national highway and state highways also which would be taken as black spot area for the study on which the width of the road, road marking areas shouldn't develop, condition of the road that is uneven has been taken; this is a major black spot of this area taken as length of probably 40kms form hisar city where many accidents were occurred on NH65 and around 65 km length of NH10 has been carried. Highway crash related deaths and injuries are a major Haryana (Hisar) public health issue, despite the progress that has been made during the past 40 years to improve highway safety through safer vehicles, safer roadsides and more responsible drivers. The fatality rate is high from because of the increasing of motor vehicle population. There has been a great challenge for the transportation engineers to do more for improving the highways so that no more fatalities occur. The more insights would be intersections on areas of highways and streets producing conflicts among vehicles and pedestrians because of entering and crossing of vehicles or pedestrians. To obey the law of safety fatalities and injuries will reduce and can be vary through a combination of efforts, including the careful use of good roads design, vehicle traffic engineering, great traffic safety laws and regulations with consistent enforcement efforts to sustain the education of drivers and pedestrians and a give self motivation among drivers and pedestrians. It has to be found that about 3 million intersection related crashes or accidents occurs on Indian highways. For the area of safety, accidents involving emergency vehicles in terms of as medical emergency or fire rescue incidents play a significant role for giving the best response. In the case of a crash involving an emergency vehicle the personnel would not be able to meet the standards for a quick response to the scene of the emergency set by the departments. Computerized crash analysis systems should applied in which crash data, roadway inventory data, and traffic operations data can be merged and it is used in many States and municipalities to identify problem locations and assess the effectiveness of implemented countermeasures. For addition, the system will allow the traffic engineers to access various types of supplemental

information without leaving their desks. Scanned versions of an officer's handwritten crash report can be examined to provide detailed information that may not be contained in the crash event table. Routes and crashes can be overlaid with scanned aerial photography to provide the engineer with a better understanding of the development and roadway configuration of a particular study area, and images from the video log can be scrutinized to provide an even more detailed view of the roadway.

1.3 OBJECTIVES OF STUDY

- To study the various collapse characteristics in Hisar Tehsil causes the more accidents on the roads.
- To identify the population and road traffic trends in Hisar Tehsil.
- To derive a model for the relationship between road traffic accidents and population in Hisar Tehsil with regression analysis method.
- To analyze the causes of accidents and occurring on the roads and to find accident prone area.
- To develop strategies to reduce the rate of accident.
- To analyze the accident in day/night time and apply the possible solutions to reduce these crashes.
- To analyze the study which has already done and after studies for crashes and give the best improvement in the problem.

1.4 SCOPE OF RESEARCH

The aim of this research is to develop accident prediction model with the help of regression method and to combine spatially-based crash analyses and road safety investigations and to identify the major black spots for the road accidents as to give remedial measures. The scope of this research is limited to the crash data available for the limited period of time from 2001-2011. While there are many factors that are believed to influence accident analysis and crash characteristics and various behaviors of human factors, the scope of this study is to solve all the problems related to accidents which will take probably less no of crash or collision on the roads takes place. Different methods to adopt by government of Haryana by which the improvement on roads in Hisar will occur and solve the black spot areas by improving bad road conditions and take the major influences to solve the fatalities on road accident.

1.5 STUDY SYNTHESIS

Chapter 1 includes introduction in which research background of the study has been told then problem statement has to be carried out for the accidents after that need of the study is given to present the layout of the thesis and after that research scope is develop for the study.

Chapters 2 includes literature review in which various research papers is studied and gives the summary of each of the research papers and then explain the basic theories related to the study for the accident and identifies the black spot areas and various crash characteristics.

Chapter 3 includes methodology in which one method is majorly applied to develop the future prediction model with the relation of accidents occurring on the roads and population with the help of regression analysis and basic interview and data collection method is applied.

Chapter 4 includes analysis of data collection (Case Study of Hisar) in which I studied the background of Hisar (road network, population, causes of accidents).

Chapter 5 includes results and analysis of data collected.

Chapter 6 includes conclusions and references.

LITERATURE REVIEW

2.1 GENERAL

For the calamity or accident related study there is number of researches build up on the issue of road safety enlargement in India. It has been found that in the develop countries and cities also the road transportation area are found to be some different with respect to India because there are various issues awaiting related to road sector in India by which many works for perfection on roads left out. In India there is a major issue related to population or persons as well as motor means of transportation like as the population increases it's obvious that motor vehicle need has to be increasing. So without customized road techniques and no upgrading on roads infrastructure causes the road accident more and more in India. The various reasons are found to be for the accidents are no use of proper protection guards during driving a vehicle, sometimes failure of road techniques. So in this literature review various research papers are studied and give the summary of each of the research papers and then explain the basic theories related to the study for the mishap.

2.2 STUDY OF RESEARCH PAPERS

M.C.Taylor et al. (2000) gives a study on driver's effect on speeding of vehicles frequency on the roads. In his study results and conclusions have been taken together and told that when speed is high on roads the accidents occurrence is more on roads. They suggests that for the safety measures it is important to take safe measures to reduce the speeds on highways while driving and give the suggestions to the drivers to follow the rules of safety on roads so that accident occurrence on the roads are less. They recommends that to allow the accident reduction technique authorities have to take major steps to reduce the accidents on the roads so that in future less risky situations will take place and the scope for sinking the accidents on roads characterized by speed managements to reduce the accident rates on the roads. By their study they found that by educating the persons about the accidents safety on roads it should important that proper road markings on the roads should given and takes the best corrective measures to the safety purpose. So their study reveals that accidents rates are very high in non developing

countries and cities where no improvement on roads takes place and many dangerous situations will occur if no actions take place to reduce them.

Steptoe et al. (2002) with their study on the road crashes they found that road accidents are the major issue now a days as an increasing cause of death in world. They studied about the more primary reasons of the accidents are high speed driving vehicles by the drivers so that sometimes they have no control on the vehicles and leads it to collapse, sometimes vehicle is overloaded and the tyre of the vehicle explode out leading a reason of the accident, drinking while driving is most common reason of road disaster. They also revealed that injuries occur in an accident difference between younger persons and elder persons are more on roads as compare to both. They concludes that major issue related to the accidents on the roads are due to drivers fault and even no improvement on roads are the major issues of the accidents and suggests the various methods like which varies with the population of area and accident rates so that a model can be develop to reduce the accidents on the roads.

B.Srinivas Rao (2005) emphasis on accident studies on the national highway of forty kilometer in length between Anakapalli and Vishakhapatnam that is situated in Andhra Pradesh, India. After the collections of data he concluded that the main motive of the accidents on roads are due to vehicle driver's error and is the simple reason found for the crashes. These accidents occur by the driver's faults like poor reflection of the road, drinking while driving, inexperienced driver, taken drugs while driving are the major factors that revealed from the study. From safety point of view they suggest the redesigning of the pavements etc. He found that the accidents occurring by the trucks are 24% on the roads and other issues are also a major concern for the accidents. The reasons for the accidents are found to be the shoulders extra width, no cutting of trees that are outside of their range and covering the road size, no visible markings are provided on the pavements, pedestrians crossing facility are not provided and many more. He accomplished that the National Highway section needs improvement from safety point of view. Proper safety lectures and guidance are provided by the government and ensure the safely moving vehicles should recommend for the safety point of view. Lack of awareness of the driver to drive a vehicle should not be permitted on the road and shoulders width providing should be in definite size and cutting of trees bushes are also a part of safety contour. Suitable land markings are provided on the roads so that decrease in accidents should develop on roads and take suggestive measures as a major concern for the drivers. No heavy loaded vehicles should permit on these

highways as a leading cause of accidents and registered vehicles are allowed on the highways specially.

Eksler et al. (2008) a well known researcher, with his study road accidents have major role of death in countries and in future if no proper action takes place than it would be very dangerous cause of the death in future aspects. They concluded that accidents takes place on the roads due to by vehicular problem, by no improvement on roads and many other reasons related to these accidents. Lack of suggestions by the engineers and no proper marking develop on the roads and vehicle design problems density of the area and many other factors are related to the crashes occur on the roads. According to him environmental factors have a major role in accidents and to improvement in its various safety measures should be given as a method for less occurring deaths on the road as by the accidents.

P.S.Kharola et al. (2010) gives the study on the safety of the traffic and transport system in city. With their study they use the micro analysis system to find out the accident crashes and find the flow of pattern involved by the public buses in the city. While during the findings they found some important structures for the fatality in city. According to their analysis they suggest the engineers to take some important and serious steps to reduce such dangerous crashes on the roads. Their paper gives a very strong suggestions that change of design of the bus by improving some various important pints like automatic closing of the doors and windows, safer bus fronting, separated infrastructures for the bicycle and pedestrian crossing provided with proper markings on the roads establish the reasons to reduce the accident causes on the roads and it will be very helpful for safety point of view and less destructive will occur on the roads so that as much as lesser accidents on the roads.

Deepak Sharma (2011) gives a study on the accidents on road in Gujarat Anand a case study revealed for reducing the accidents on the roads. His highlighting on study with retrospective survey interview method to find out the road traffic accident and conducted the analysis with accident data theoretically. He gives the study of road accidents and submits their research for a period of six months. In their study found that males had increased risk of transport injuries as compared to females. In their study also reported that pedestrians were mostly injured by motorized two wheelers. Four wheelers are caused fatality by 23.2 percent. Same results submit by his mate Patil found that pedestrians are included in the accidents injured by

most of the two or four wheelers. They concluded that with the education for the accident related should give and take a major role to reduce the accident rates so that less no of hazards occurs as much as can. By their study they suggest various issues that would be taken by all persons and policy makers who design those pavements and roads which would not be low standard.

Er.Abhay Kote (2012) emphasis study on analyzing the causes of accident on major roads in India by using the example of a section of National Highway 50 in the federal state of Maharashtra in consideration of design, building and traffic engineering 2012-13. The engineering approach is used and road accident analysis is carried out on NH 50 in the federal state of Maharashtra, India, to recognize the reasons of the accidents. Due to the restrictions of the available data category based on method of most relevant method is used. The locations for the accident is found to be the black spot area and marked on the map with their high accident rates. Uncomplicated before and after model is used and stepwise dealing is suggested by Short-term, Mid-term and long term tricks which suits the needs of the identified locations. In their conclusion Maharashtra shows the lack of uneducational visions for accident analysis. Collision diagrams are drawn and day analysis as well as time is the vital stats for their accident studies. Also Impact of the before and after studies could not be evaluated due to theoretical nature of the work. He suggests future area for the research such as development of centralized accident data collection and monitoring system which can help in the accident analysis to control the accident rate.

P.Shruthi et al. (2013) gives the study on road accident fatality in a metropolitan city in South India. They studied that road traffic accident (RTA) is the third major hazardous cause of death among all. They conducted the study in Bangalore in December 2012 with an objective to study the financial, demographic and injuries profile prototype of roads to study the various effects of road accidents. In their study they found that four wheelers like buses, tempos, cars, trucks involved in the most accidents occurring on the roads and the second one is found to be the two wheelers as 19.56 in percentage. They suggests separate provision for pedestrian walkways and safe pedestrian crossings is an effective, affordable and sustainable strategy, supplemented with designation of one-way streets, good street lighting, and traffic calming measures in high-risk areas. By creating the public awareness by involving the local residents, schools and school teachers can also be sought out to reduce the sufferers on the roads. Vehicular standards for the

commuter carrying buses and trucks that needs to be regulated as to the maximum passengers allowed and the materials used and about the safety provision to the passengers to suggest the minimum occurrence of hazards.

M Patel et al. (2013) gives the study on new methodology for determining accident and injury contributing factors, and its application to road accidents on the expressway on Mumbai Pune. They applied a new methodology i.e. Venn diagram analysis and gives a broader standpoint on the probable factors, and combinations of factors, contributing both to the occurrence of a crash and to sustaining injuries in that crash. The methodology was applied to two hundred fourteen accidents on the Mumbai–Pune expressway for the application of use on Venn diagram. According to them this methodology can help identify effective vehicle and infrastructure related solutions for preventing accidents and mitigating injuries in India. The use of the new methodology to examine crashes on the Mumbai–Pune Expressway shed light on the influences of vehicles and infrastructure. They found that human factors and vehicle factors were found to have the highest influence on the occurrence of accidents on roads.

A.N.Dehury et al. (2013) gives the study on analysis of road accidents on NH55 and draw a model to reduce these, the study shows that major cases of fatalities are due to trucks. The found that the main cause of accidents are due to high density, non restriction of speed, On street parking, shoulder drop-off, edge drop, old cinch trees on shoulder, visibility restriction etc. they adopted the method of regressions for predicting the future accident growths and to analyze visual effects of accident fatalities and provide major functions to stop the hazardous situations to develop the future prediction model for the accident so that it helps to plan the safety procedure conducted on the roads.

Dr. Tom V. Mathew (2014) gives the study on accident, provides an important subject of highway safety and accident studies. With their study everything a traffic engineer does, from field studies, planning and design; to control operation is related to the provision of the safety system for vehicular travel. With his study gives an insight of how the analysis of traffic accident can be done from the standpoint to reduce it by designing proper safety measure. With his study he studied the various collisions occur at spot of accident, studied poisson impact theory (to find the how much speed vehicle derived before collision and proposes the speed that how should be the speed of vehicle for saving the collision). Energy theory derives the concept that there is

decrease in kinetic energy with the work done against the skid resistance i.e. to propose the skid resistance of surface will ease to stop the accidents on road.

2.3 BASIC DEFINITIONS

2.3.1 Injury of fatal or fatal injury in which an accident involving at least one fatality and any victim who dies within 30 days of the accident as a result of the injuries due to the accident is counted as a fatal injury or fatalities.

2.3.2 Very serious injury in which an accident with no fatalities occurrence but with at least one or more victims have hospitalized for 24 hours or more.

2.3.3 Short or minor injury an accident in which victims suffer minor injuries which are treated on scene (first aid) or in a hospital as an outpatient and takes a first aid suggestion from docs.

2.3.4 Zero Injury an accident in which no injuries are sustained by any of the involved persons or with the vehicle.

2.3.5 Per hundred thousand vehicle fatality which shows ratio of fatalities and motor vehicle. However, it ignores non- motorized transport and other indicators of exposure or goods.

2.3.6 Fatality of road traffic any person killed immediately or dying within 30 days as a result of an injury accident is known as road traffic fatality.

2.4 GENERAL REASONS OR CAUSES OF ACCIDENTS

1. Vehicle over speed
2. Driving with alcohol
3. Distracted variations to drivers
4. Jumping of Red amber light
5. Seat belts/Helmets avoidance

2.4.1 Vehicle by over speed in over speeding most of the fatal accidents occurs due to this. As study revealed that is a person given a chance to adopt the infinity speed he or she would

definite achieve this target. Over speeding is that when one vehicle is behind the second vehicle and the back vehicle wants to adopt or wants to move faster than him or takes over speeding that will cause as an over speeding of vehicle the causes of accidents will develop more. It gives the casualty rate high for the accident and crashes of the vehicle involvement. Faster vehicles are more prone to accident than the slower one and the severity of accident will also be more in case of faster the severity of accident will also be more in case of faster vehicles. Higher the speed, greater the risk. At high speed the vehicle needs greater distance to stop i.e. braking distance. A slower vehicle comes to halt immediately while faster one takes long way to stop and also skids a long distance due to law of motion. A vehicle moving on high speed will have greater impact during the crash and hence will cause more injuries. Sometimes it will difficult to judge the speed of the upcoming vehicle and we thought as we will definitely overtake the vehicle as a false judgment it causes the accident at high that will be dangerous for all.

2.4.2 Driving with alcohol the most common cause of accidents now a day's develop. Consumption on of alcohol is unfortunate but when it mixes with driving it will be very dangerous. Alcohol reduces the reaction time of the person which will enrollment in accident more. Alcohol dampens fear and incites humans to take risks. All these factors while driving cause accidents and many a times it proves fatal. Apart from the alcohol many drugs, medicines overdose are also including in this and cause a major effect on road accident.

2.4.3 Distracted variations to drivers in this while driving could be minor but it can cause major accidents. Distractions could be outside or inside the vehicle. The major distraction now days are talking on mobile phone while driving. Operate of talking on phone occupies major section of brain and the smaller part handles the driving skills. This division of brain hampers reaction time and ability of judgment. This becomes one of the reasons of crashes. One ought to not attend telephone calls while driving. If the call is urgent one should pull out nearby the road and attend the call. Some of the distractions on road are:

Animals on the roads hanging around, various extra speed breakers, and posters of ugly faces are the reasons of the distractions.

These helps the driver should not be distracted due to these things and diminish speed to remain safe during diversions and other kind of external distractions.

2.4.4 Jumping of red amber light It is a most common sight at road intersections or on single lane city roads that vehicles cross without caring for the light. Obviously, the main motive behind Red light jumping is saving time according to people. The common reason reveals that the stopping on the red lights are the wastage of time and fuel so in many cases people don't bother to cross the red light and as cause of this many accidents should occur A red light jumper not only saves his life but also the safety of other road users so that no hazardous situation happens to them. As a major concern everyone gets late for their house or office or their destination but for reaching fast it's not good to cross the safety limits of the roads and by challan they should punish but hampers his ability to judge the ongoing traffic and quite often crashes. So it has to found that red light jumping is found to be major cause of accidents on roads.

2.4.5 Seat belts/helmets avoidance the main reason for the accidents found to be the that avoiding of safety gears like seat belts, helmets etc but use of seat belts in four wheelers are now compulsory and if anyone doesn't obey this rule they should penalty for this and heavy fine should implied. Wearing seat belts and helmets doubles the chances of survival in a serious accident. Safety gears helps us to protect ourselves life and decreased in helping the fatalities like injuries or deaths occurring on road due to the accidents or crashes.

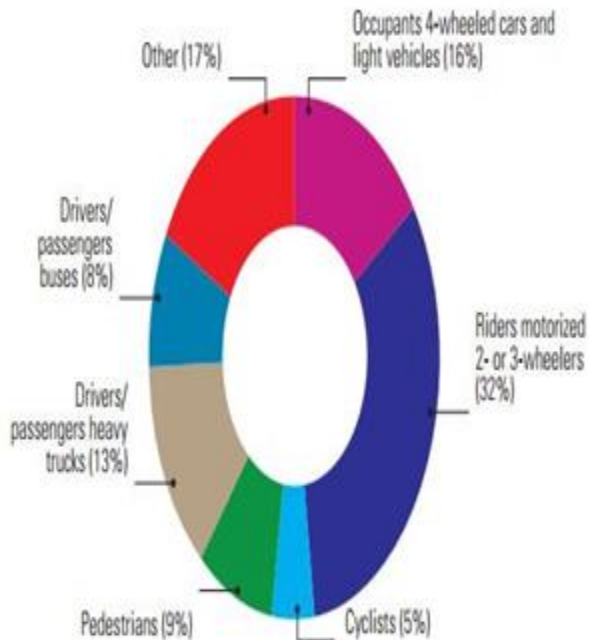
2.5 BASIC ISSUES EXPLANATION

2.5.1 Mean by an accident in which the participation of two vehicles and a hazardous crash occur or which causes damage to the property of the driver or person that is called an accident.

Accidents by PI (personal injury):

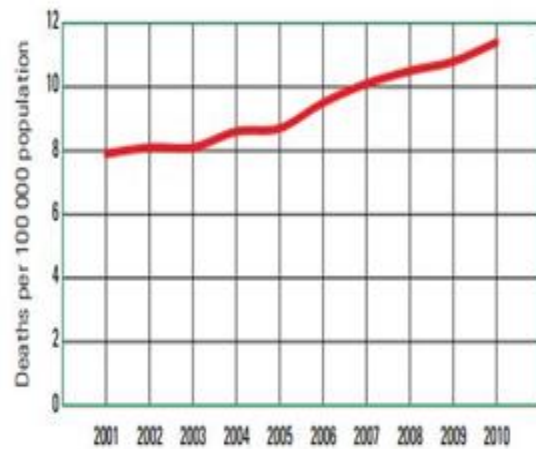
- It would take place the highways like NH, SH etc.
- Involvement of one of more vehicles causes an accident.
- In which participation of at least one person to injury.

DEATHS BY ROAD USER CATEGORY



Source: 2010, Ministry of Road Transport and Highways, Transport Research Wing.

TRENDS IN ROAD TRAFFIC DEATHS



Source: Road Accidents in India, 2009, Ministry of Road Transport and Highways, Transport Research Wing, Government of India.

INDIA

Source: 2010 Ministry of Road Transport and Highways, Transport Research Wing

Figure 2.1 Deaths by road user category and graph of traffic deaths.

2.5.1.1 Own (self) report accident: are those reports by which drivers are used to be concerned in asking by the questionnaire or by self interview for the accidents. According to the transportation research laboratory (TRL), they define that an accident is that incident or occurrence in which more than one vehicle is involved in the persons lead to injury or damage to their property while crashes. In some cases drivers have to take care the responsibility of the accident due to in not exceeding the period of 3 years priority to survey date. The reasons involved in the accidents in the way do not involve in the injury and the damage causes due to accidents. Researches shows that out of 100 that 20 percent accidents happening due to personal injury accidents (PIA) and involve as rate of fatal accidents or major serious accidents. It is important to be noted that self accidents are noted as serious accidents involvements. Accident involves injury to the persons, damage to the property of the owner etc.

2.5.2 Mean by speed

As a mentioned in the name as speed, so it struck in our mind that talking about the vehicular speed of ongoing on the roads, different persons have different views on the speed related queries about going too fast and so slow on the roads asses the no. of factors including the road environment. A reading tool named speedometer helps to check the how much speed is travelling by the vehicle on the road by this speedometer we can enhance or take suggestive measure to reduce the fatality rates. Various speed suggestions on the roads suggests by traffic culture department as shown in table 2.1 so as to aware the speed for the vehicles. Speed varies different on different roads. So it is very important to take suggestive measures to reduce the fatalities on roads so that accidents will reduce on the roads and no more fatalities or crashes occur in future aspects.

Table 2.1 Speed Limits for the type of roads

ROAD TYPE	SPEED PROVIDE LOWEST COST (KM/H)
HIGHWAY	95
7m WIDE ROAD	60
11m WIDE ROAD	70
13m WIDE ROAD	80

Source: SGD (Traffic Culture 1, 1999)

- As enlighten further two types of speed variation are collected as:

1. Speed on the spot
2. Time of journey say journey timing

2.5.2.1 Speed on the spot is that speed of a vehicle by which individual vehicle measured a spot or area on the road. The first common thing is used to measure the speed on the roads for the accident related studies and then used for the approved data for the collection of speed on the roads as taken care of suggestive measures giving to the drivers and method employed to collect most speedy speed data described in the Para. Speed would be measure for the vehicles by speedometer yield a distributions speed curves so that variations in speed would find out.

Speed distributions whether in space or time contain prosperity of information which can be captured by means of a number of statistical parameters describing the characteristics of the distribution. The most familiar parameter of a distribution is the average (or mean), but this is not the only statistic of value in research and application. In road design, the observe over the last two decades has been for engineers to use what is known as the 85th percentile speed of traffic. The 85th percentile is the speed at or below which 85 per cent of drivers drive, and is thus a measure of the higher speed end of the distribution on a particular road.

The amount by which the 85th percentile exceeds the mean speed will depend on the extend of the speed distribution. The most common measure used to characterize the spread or variability of speeds found on any road is the standard deviation of the speed distribution.

The coefficient of variation is then the ratio of the standard deviation to the mean a dimensionless number describing the shape of the distribution.

Speed limits of various States in India shown in table 2.2 so as to get knowledge of the speed limits on various traits to be followed.

2.5.2.2 Journey timings are that time determined by average speed of vehicle between the two points separated by some expected distance. The safe and efficient operation of vehicles on the road depends very much on the visibility of the road ahead of the driver the geometric design of the road should be done such that any obstruction on the road length could be visible to the driver from some distance ahead is the sight distance. Journey times relates with the journey of origin to destination with noted as how much time it will to destination form the point of start so that average no of passing vehicles journey should be noted as compare to speed limits for the vehicles. A report has to be submitted by the researchers so that predicted vehicular journey timings should develop and make sure to be for the patterns of roads design as to take care of motor vehicle consumptions on the roads.

Table 2.2 Limit of speed in various states of India

State	Motorcycle	Light motor vehicle	Medium passenger Vehicle	Medium goods vehicle	Heavy vehicle	Vehicle pulling 1 trailer	Vehicle pulling multiple trailer	All other vehicles
Andhra Pradesh	50	None	65	65	40/50	60	50	30
Maharashtra	50	None	65	65	65	50	50	50
Delhi	30-70	25-50	20-40	20-40	20/40	20-40	20-40	20/40
Uttar Pradesh	40	40	40	40	30/40	20-40	20-40	None
Haryana	30/50	50	40/65	40/65	60	35-60	40-60	20/30
Karnataka	50	None	60	60	None	40-60	40-60	None
Punjab	35/50	50/70	45/50/65	45/50/65	None	None	None	30
Tamil Nadu	50	65	None	None	None	None	None	None
Kerala	50	60/70	None	None	None	None	None	None

Source: Ministry of Road Transport and Highways Transport Research Wing 2010

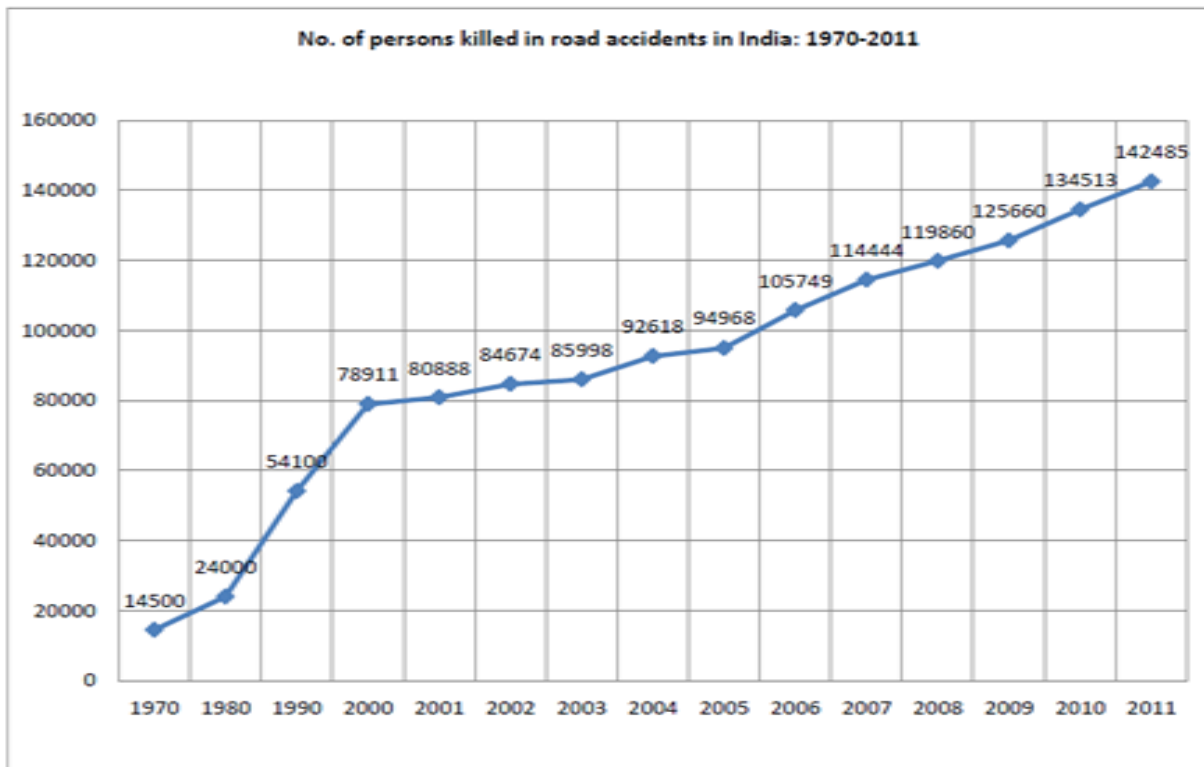
2.6 ROAD DISASTER IN INDIA

An exciting fact which can be seen is that while the state of Nagaland had very low figures of number of accidents and number of people killed per lakh population and per ten thousand motor vehicles, the severity of road accidents was the highest for Nagaland. Road accidents have majorly emerged as one of the biggest cause of danger or caution in the world for the past few years. It is found to be the 9th leading cause of death in 2004 and it will be predicted that by 2030 it will be the 5th leading cause of death as by current rate of death. It is found that India has surpassed China for recording the highest no. of people killed in 2008 and around 1.2 lakh people affected by this rate. With the study it is found that in road accidents 37.1% people involved as cause of unnatural cause of accident in the country. In a fact I found that Nagaland has very low figure of no. of accidents in the country as a state but number of persons killed with per lakh population and per10000 motor vehicle, the major severity was highest for this state. Mizoram has 2nd highest rate of brutality of road accidents.

For the accidents the number of road accidents severity with per lakh population of India goes up 39.8 in 2004 as contrast to 42.5 in 2010, as the increasing rate of difference is 3.3 between the years 2004 -2010. According to the year 2010, Goa has found to be the most accidental state of road accidents per lakh population i.e. 267; Pondicherry has low of 1.6 reported by Nagaland i.e. 115. As contrast to 2005 to 2010, number of deaths on roads has risen up with 8.6 in 2005 to 11.4 in 2010 across all states of India. According to the year 2010, the highest no. of persons killed on road found to be in Tamil Nadu i.e. 23 as per lakh of population, than in Goa i.e. 19.1 than in Haryana i.e. 18.9.

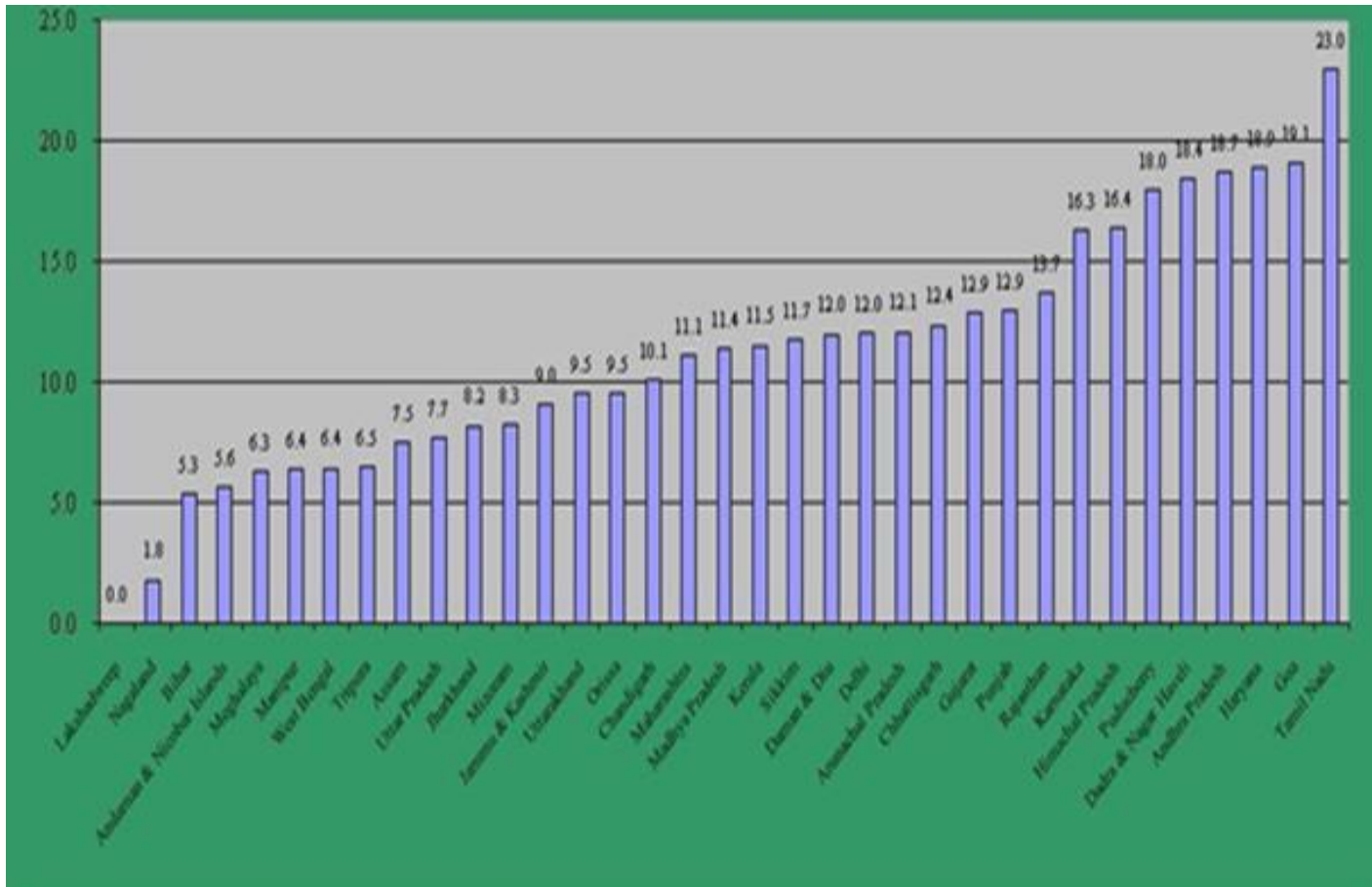
With the various studies for the accidents it is found that the accidents on roads are not due to natural cause but it is found that it will occur due to of lack of care and unawareness of road safety criteria.

The sufferers on this account has increased about 9.5 times between 1970 to 2011 showing by chart as shown in figure 2.2



Source: Ministry of Road Transport and Highways Transport Research Wing 2011

Figure 2.2 No of persons killed in India by road calamity



Sources: Ministry of Road Transport and Highways Transport Research Wing 2010 (New Delhi)

Figure 2.3 No of persons killed in per lakh population in India (state wise)

2.7 SOME MODE OF ACCIDENTS ON ROADS

2.7.1 Effect of Drivers it includes over speeding, rash driving, dinking during driving, violation of rules, overloading of their trucks.

2.7.2 Effect of Pedestrians it includes carelessness while walking, crosses at wrong place while not using the carriageways, jaywalkers.

2.7.3 Effect of Passengers it includes while vehicle is in motion projecting their body outside the vehicle, catching a running vehicle etc is the major contributes in accidents.

2.7.4 Effect of Vehicles old vehicles with no maintained like failure in breaks, tyre burst out, overloading of vehicles etc are the major attributes of accidents.

2.7.5 Effect of Road conditions includes uneven patches, potholes; road markings not provided, road merging anywhere etc are the causes of accidents.

2.7.6 Effect of Weather conditions includes Fog, snow, heavy rainfall, wind storms, hail storms etc.

2.8 FACTORS WHICH AFFECT THE ACCIDENTS IN HISAR

2.8.1 Situation of Weather

Inconvenient weather conditions which affect the vehicle equipments are shown as

1. Humus or humidity
2. Condition in Temperature
3. Condition in Fog
4. Rain fall or fall
5. Other Conditions

2.8.1.1 Humus more or extreme humidity causes the extinction of negative effects on drivers during drive and leading them to the detracting from attention on the roads or road marking proper as a cause of accident. Also in Hisar humidity percentage is high, the vehicle equipments of which resistance to corrosion is low rendering to corrosion and become useless after a short time and moving fast to the risky situation.

2.8.1.2 Condition in Temperature as the temperature low in Hisar and elevation is higher than sea level and roads passing region have an effect on pavement causes a accidental site. In winter ice variation is up and as a result it causes ice up and becomes an important risk factor on traffic accidents.

2.8.1.3 Fog the main cause of accident at critical heat changes time the moisture in the air become fog as hanging in the air. Fog absorbs flowing of lights to the bearing and diffuses it. Hence while driving, visibility range decreases and the discernment of coming vehicles from opposite direction. The possibility of making accident of a fog light broken car appears. Fog has affected a larger area for accident prone on which many hazardous situations develop.

2.8.1.4 Rain Fall In the case of rain fall in an event depending on the thickness of the water layer on the road and the profile of the tire decrease the force acting on tire. This event, the water cleat between tire and road, is called aqua-planning. This event happens more easily in rough profile

tire and bald tire. If my car tyre is burst out enough than the chances of accidents is more enough.

2.8.1.5 Other condition Beside the climatologically circumstances, the physical conditions are important factors in the increase of traffic accidents. Highway markers, directly contact with the out environment insightful surface are exposed to sunlight, ultraviolet light, rain, humidity and different temperatures. Because of this air conditions roads signs wear in time. It is inescapable to make an accident in the case of not recognizing of this tattered road signs.

2.8.2 Humanity factor

The prevalent portion in causing traffic accidents is the human factor. Human failure can be analyzed in two titles.

1. Self or personal effect
2. Psychologically effects

2.8.2.1 Self or Personal Effects include experience, age, gender, physiology, education, alcohol, exhaustion, sleeplessness, taking medicine, drug using is taken as factors affecting to personal effects of human failure in accidents. Inexperienced drivers who enter into traffic cause a lot of accidents because of the lack of experience. Beside this, in our country as a outcome of lack of effective driver education course, traffic giants are bring up rather than educated and receptive drivers.

2.8.2.2 Psychologically effects include psychological effects also play an important role in traffic accidents. As long as drivers, who get used to drinking alcohol, flaming up on high speed, behave negative attitudes towards other drivers ,in other words, sickly characters , are on highways, traffic accidents are inevitable. Other factors like being delicate, miserable, sadness and feeling of personal show off and using of stolen vehicles are some of the psychological factors that directly affect accidents. Physiological effects being high weighted in front of steering wheel causes early exhaustion. It is also observed that reflexes are getting weaken and slower in high weighted drivers.

As a result, it is unavoidable not to happen accidents while the driver is incompetent and ineffective in the cases of instantaneous gear shifting. Hearing disorders are especially effective factors in local traffic.

Table 2.3 Accident Affected People on Roads by Age Wise

Age	Death Rate In % Age
1-14	7.4%
15-24	30.3%
25-65	51.9%
ABOVE 65	10.4%

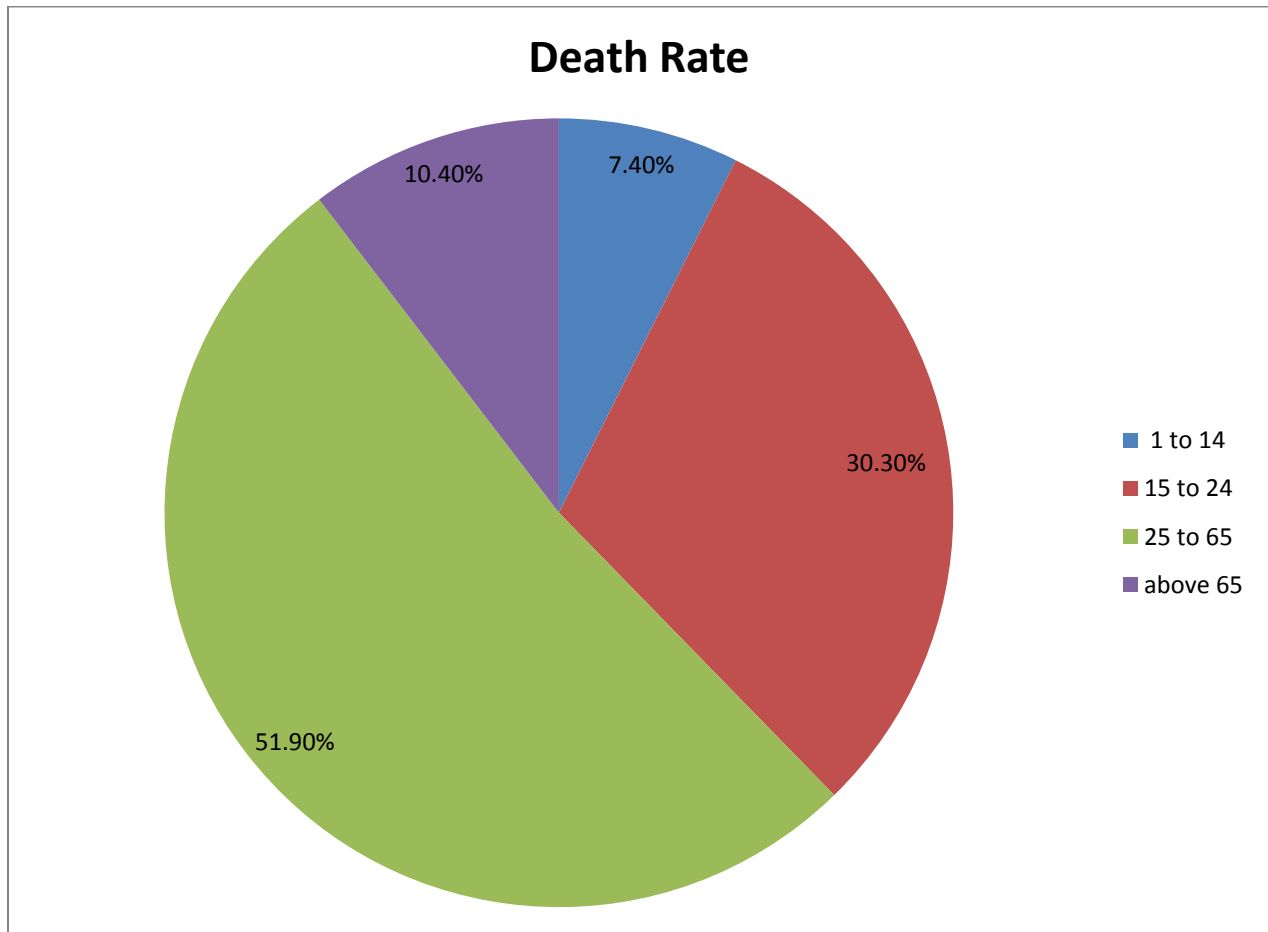


Figure 2.4 Pie chart of accident affected people on roads by age wise.

2.9 ROAD ACCIDENTS IN HARYANA

Table 2.4 Accident Statistics of Haryana

Year	Accidents	Death	Injured
2006	10314	4012	9118
2007	11998	4415	10288
2008	11128	4494	10570
2009	11195	4603	10481
2010	11195	4719	9905
2011	11128	4762	9727
2012	10065	4446	9452
2013	10314	4383	9182

Source: Haryana Police Department, 2013

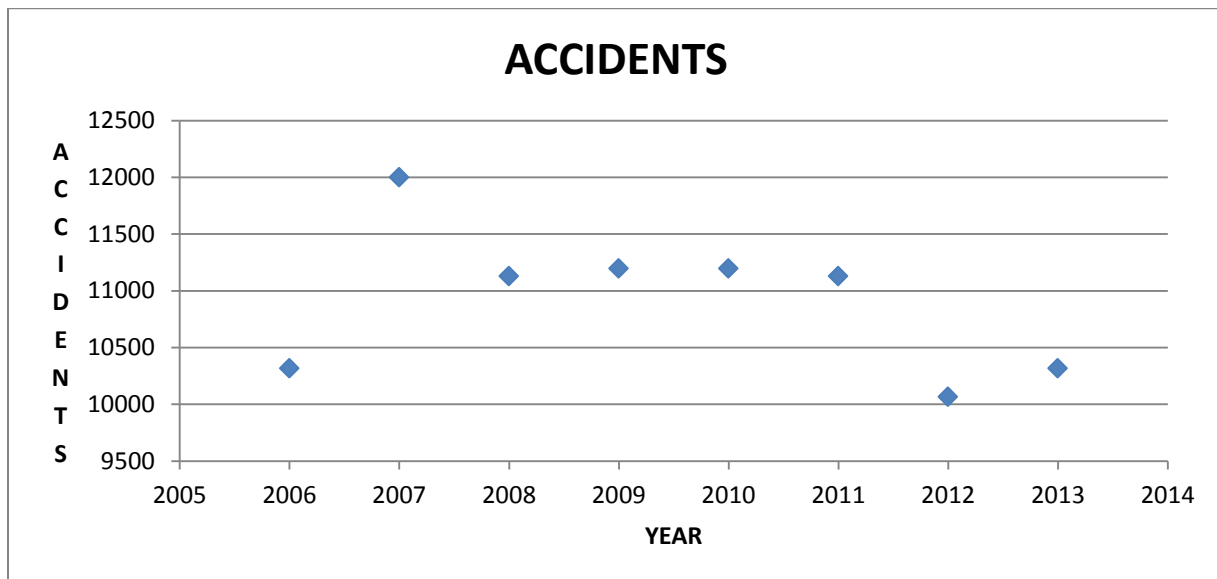


Figure 2.5 Scatter plots of accidents in Haryana.

These stats shows the no of accidents occurred in Haryana, The accident data received from the districts is compiled in this unit for onward submission to the Ministry of Shipping, Road Transport & Highways, Govt. of India, Haryana. Since the formation of Haryana state, there has been a significant growth in the road transportation sector of Haryana.

As on year 2001, around 23000 km of roads connect to villages and cities in Haryana state and with its neighbor states. At present more than 99.88 percentages of villages are connected by metalled roads and road density is around 63.8 km per 100 sq. km area. Length of different types of roads in Haryana State is as follows:

- **National Highways: 1,346 km**
- **State Highways: 2,559 km**
- **Major District Roads: 1,569 km**
- **Other Distt. & village roads: 14,730 km**
- **Other roads: 2,852 km**

2.10 BLACK SPOT AREA

The main process of identifying or improving the black spot area by following some steps of a road network that is composed of several activities as shown in figure 2.6.



Figure 2.6 Black spot flow chart.

- **Identifying the black spots** Is the procedure to locate the black spots on road that is very dangerous for occurrence of accidents.
- **Diagnosing** is the process to develop the study on what are the problem facings and what are the accident contributing factor for each of the black spots which is identified.
- **Finding the countermeasures** implies a methodical analysis to design suitable countermeasures for each black spot, based on actual problems and deficiencies.
- **Estimating the effects** is the process to estimate the safety effects (and if necessary also other effects) and costs of suitable countermeasures.
- **By Prioritizing** implies finding the best action plan (or investment program), according to some defined criteria, and based on estimated effects and costs as well as budget restrictions.
- **By applying the implementation** is the actual realization of the prioritized measures included in the action plan.
- **Then Following up and evaluation** is the last and very important step, which aim is to assess the actual results (effects and costs).

2.11 BLACK SPOT LOCATION IN HISAR

- NH 10 and NH 65, comprises the location of Black Spot near Hisar – Sirsa road near BSF Camp.
- Hisar- Balsamand road near filling station of Hindustan Petroleum.
- Bypass Road of Hisar- Delhi near Guru Jambheshwar University and near Hisar-Cantt road.

2.12 REASONS FOR SITE SELECTION AND CAUSES OF ACCIDENT

2.12.1 Road Conditions The condition of roads is very bad means no improvement has been carried out since last 4 years for the highways (uneven patches, potholes).

2.12.1.1 Potholes is a type of failure in asphalt pavement that caused by presence of excess water on the pavement soil structure gather on the road and the presence of traffic passing over these pavement affected the area.

How the pavement weakens and then how vehicle load affect the area

Firstly water to the underlying structure weakens the supporting soil and traffic then fatigues and breaks the poorly supported asphalt surface in the affected area. Continue action of traffic

passing on these affected underlying soil structure ejects both pavement and soil structure to create potholes on the pavements.



Figure 2.6 Potholes on road.



Figure 2.7 Bad road conditions with various potholes.

2.12.1.2 Uneven patches uneven patches are lying on the pavements and by showing one of the pictures that shows temporary patching of pothole where the resources are disintegrated due to the stroke of vehicle tyres. The loose materials is very dangerous to other road users especially two wheelers.



Figure 2.8 Road debris by filling to cover potholes temporary.

This road debris occurred on the roads to fill the potholes temporary which causes the accident rate high for two wheelers more. Because when vehicle travel on the road it will directly contribute to accident either by losing control to their vehicle or sometimes affects the tyre of the vehicle i.e. tyre burst out and occurrence of accident will more. On these highways where fast moving vehicles travel with a various speed and when sudden brake apply on these pavements skidding of vehicles occur more and damage the vehicle or increasing accident rate of people.

2.12.1.3 Low shoulder on Hisar-Delhi Bypass road



Figure 2.9 Eroded shoulder with the pavement.



Figure 2.10 Low shoulder with road debris along it with cutting bushes.

Shoulders are provided for an emergency stopping lane to the motorists and other two wheelers. In the first picture shoulder is eroded and makes a very possible occurrence of traffic accident. And in the second picture low shoulder has merge the occurrence of traffic accident.

2.12.1.4 Unavailability of Road Markings As we can see on these roads no proper markings are provided and this makes very dangerous to the person travelling on the roads. Above picture as we can see that there is blind turn and no warning sign is available to warn person travelling on the road. So this is also the major reason of road traffic accident on Hisar-Delhi Bypass highway. **Apart from these road conditions two major factors that includes the road traffic accident in Hisar i.e.**

Growth of Vehicles

Growth of Population

Human Factors As Explained Earlier

2.13 CLOSURE

The literature review has suggested the various studies on the accident related scenario on various researches and proposed the methodology for the layout for the thesis. So it has been decided to use the statistical studies on accidents and with further studies regression analysis will be done for predicting the future accidents and will try to give remedial suggestions to reducing the accidents occurring on the roads. With the help of analyzing the data in the data collections scenario and various failures of pavements will suggest recommendations to reduce the accidents on the chosen black spot for the study of thesis.

METHODOLOGY

3.1 GENERAL

All the study of the accidents related has capitalized by different parameters and suggests various things to develop or improve on these crashes. After the parameters well known analyzed they corrective measures and patterns should suggest for the safety point of view. Various methods apply for reducing the accident rates on the roads by which it help for reducing the fatality rate. The records maintained by road transportation were obtained for 11 years (2001-2011). The Public welfare department and transportation research laboratory maintains records of all major crashes involving the rate of crashes. Maintenance of these records helps to reveal the scenario of whole report and hence develop the strategies to make a good model. Police also maintains the accidents record and they have much record to be collected for future. The analysis then claimed to be collected for accidents and then will be used as a future perspective. Important and useful information collected form police and various other transportation departments for the study of accident related data. Some interviews from friends, officers form police, and the victims will also take individually to collect the data for the road accidents. Sometimes in many cases fine or useful information could not collect then these cases put as under readings.

3.2 METHODS USE FOR COLLECTING DATA

The research is based on the analysis of data and other information gathered primarily from the following sources:

3.2.1 Data Collected by various discussions or by other source The data relating to number of road accidents, causes of these accidents, types of vehicles involved, age profile of the victims at all India level as well as Hisar have been collected from the official websites of various government departments and by self made attempts throughout the city departments. Besides, data relating to action taken by Haryana Traffic Police while taken as destructing the traffic rules, like penalties obligation, data related to strength of Haryana Traffic Police, road network and population of Hisar; information relating to measures taken for improving road safety by different government departments at

national and state level were obtained from related department either through RTI or by personally visiting the department.

The data used for the analysis will be obtained from an interview survey carried out of the area of Hisar Tehsil. Following approach and methodology will be used in the study:

- Study of the literature across all India level and Especially in Hisar Tehsil.
- Case study has to be done for the collection of data.
- After that data is to collected, then reading or analysis and then interpretation done.
- Then final results will discuss.
- And finally conclusions will made and give suggestive measures to solve the problem.

3.2.3 A linear regression model will used to analyze the dynamics of changes, variations and interruptions in road traffic accidents and population growth of Hisar Tehsil through data.

3.3 REGRESSION ANALYSIS

Regression analysis implies that for any of the technique that used for developing the model and analyzing various variables so as to focus on the relationship between the dependent variable with the independent variable. More importantly it helps us to reveal to find out or understand the various typical value of coefficient of the dependent variable changes when one of the independent variable has to changes or vary with other. The traffic engineer is commonly faced with the problems of predicting the relationship between two or more variable, for this many examples of such situations in areas: the total no of twist produce in area is seeing to depend upon some variable such as family income, family size and composition etc. a large data have been giving the no of trips on the one hand and value of family income, size, employment and it reveals the study as can a relationship be determined between two variables?

The technique of predicting the value of one variable is called as dependent variable and from measurements called independent variable and whole is called as regression variable. If the relationship between dependent variable and independent variable is linear then it is called as linear regression. If the independent variables are two or more in number then it is called as multiple linear regressions. In the theory of normal distribution the most important point is to be consider as variable of continues variable is normal distribution. In the cases of estimating the target as a function of independent variable then is called as regression function.

The generating regression analysis method should be employed on the best practice on the form of data collecting process and how it relates to regression analysis approach and how to fix the problems with the help of this method as a big consult. In this thesis regression analysis is used to develop a regression model so to find out the future model for reducing the accidents occurring on the roads. Regression analysis can be done with the help of Microsoft excel sheet. To find the equations of the regressions we have to know the independent variable and dependent variable. So in many applications regression method is used to reveal the model of development in variations. For relating the thesis, some assumptions should be made for the regression analysis. The sample must be collected as population of the city and the accident occurs on the roads.

The sample must be collected as population and accident and the assumptions are as:

- All the independent variable has to be independent of each other and no correlation is to carry out between them.
- For this all variables have to be normally distributed.
- Then all variables are continuous.
- Then a linear relationship occurs or exists between dependent and independent variable.

3.4 SOURCE OF THE DATA

The study relied heavily on secondary data obtained from the National Road Safety Commission of Haryana and the data of accident related will be collected from various police stations of Hisar Tehsil and population data will be collected from city population department in Hisar near Mini Sectreiate Ajad Nagar road. The data specifically comprised of time series data on yearly road traffic accidents and corresponding population values for Hisar Tehsil covering the period 2001 to 2011. Details of the data will be presented after the collection of the data related to thesis.

3.5 DATA ANALYSES METHOD

Data analyses will be performed using Microsoft excel in computer. Firstly collect the data related to the accident and population of the Tehsil. Then after that put these data on the excel sheet as an independent variable and dependent variable. Then by selecting the y value called accident values or independent values and shown in the data analysis option as same for population as dependent variable x. then after selecting the regression analysis option we can

easily find the outputs for the regressions and coefficient of determination. And by the help of these equations we can easily find out the equation of regressions.

3.6 DEVELOPMENT OF MODEL AND ASSUMPTIONS

The following assumptions as applied to fitting regression models were verified.

- A linear relationship must develop between the variable x and y. and in case of accidents of roads it could be easily finding solutions.
- The errors will develop as a term out to zero in the long run access.
- The variations of errors have to be constant with all observations.
- The errors that calculated should not be auto correlated.

3.7 MODEL PREPRATION

The constants can be solved in the following manner:

$$Y = a + bX$$

Y= Independent variable

X= Dependent variable

a, b = Output of regression

3.8 VALIDATION OF THE MODEL

- By calculating the Coefficient of Determination i.e. R²
- By organizing of results as total no of accidents find by the model with the data obtained from traffic police of Haryana.

Coefficient of Determination (R²): It is defined as a ratio of the explained variance to the total variation of the independent variable y. The value of R² lies between 0 and 1, the nearer it is to 1, and the better is the model.

Errors: Then the predictable errors should calculate.

DATA COLLECTION**4.1 INTRODUCTION**

This chapter shows the data collected from various fields and various accident related data. The population of Hisar has enlarged, almost, by five times from 1951 to 1991. In 1951 its population was, nearly 37000 persons, which in 1961, reached up to 63222 persons i.e. an increase of 72.06%, during 1961-1971 it enlarged to 91437 persons i.e. an increase of 48.51% and during the decade 1971-1981 it registered an increase of 53.59%. According to census 2011 Hisar Tehsil has a population of above 3.5 lakh persons. However the total population within the urbanized limits accounts for nearly 377886 nearly lacs as most of the villages has become part of the city. Apart from the above 15,000 population of cantonment is also dependent upon the city services. The industrial and residential development near the cantonment has further added to the number of dependants. It is in this context that Hisar has been identified as a Counter Magnet to Delhi in the Regional Plan for the National Capital Region and is expected to have a population of 10.00 lacs by the year 2021 AD.

TABLE 4.1 Population of Hisar Tehsil

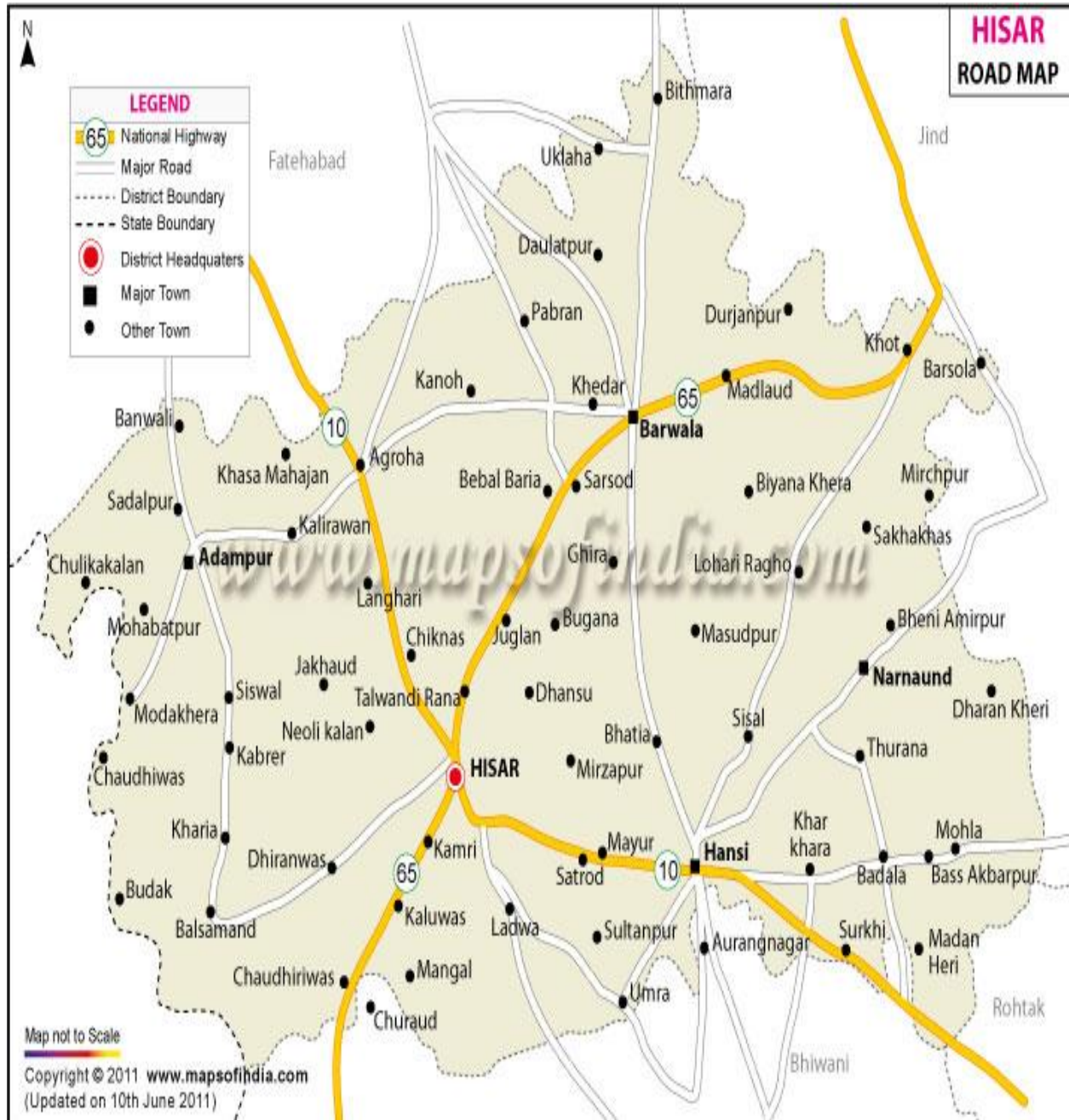
TEHSIL/TALUKA	MALE	FEMALE	TOTAL POPULATION
HISAR	166623	140270	301249
ADAMPUR	13452	12079	25531
AGROHA	4068	3654	7722
BARWALA	22593	20791	43384
TOTAL	206736	176794	377886

Source: Mini Sectreiate Hisar, 2011

4.2 ROAD NETWORK

Road network comprises of expressways, national highways, state highways, major district and other district roads. The road network is being developed and maintained by NHAI, PWD (B&R). In the Hisar region, there are two National Highways (NH10 &NH65). Apart from these highways, some Major District Roads and Other District Roads also serve in strengthening the

regional road network. Hisar comprises whole mettaled road with a total length of 2108 kms, according to the Public Works Department, Buildings and Road branch, Chandigarh.



Source: Public works department, Hisar 2011

Map 4.1 Road map of Hisar

4.2.1 Road network of Haryana and Hisar The following data is showing the length of the road networks in Haryana and Hisar i.e. showing the length of National Highways, State Highways, MDR and ODR.

Table 4.2 Road Network of Haryana

National Highway	1957km
State Highway	2064km
Major District Road	1455km
Other District Road	20287km
Total Length	25763km

Source: PWD B&R Hisar provisional division no.1

Table 4.3 Road Network of Hisar Roads

National Highways	144km
State Highways	193km
Major District Roads	91km
Other District Roads	1680km
Total Length	2108km

Source: PWD B&R Hisar provisional division no.1

4.3 GROWTH OF MOTOR VEHICLES

There has been a very quick growth of motor vehicles population in Hisar in last few decades as we can show in the table no 4.4. The no of motor vehicles has rapidly increasing year by year and mostly growth I found in the two wheelers. On the other hand, the increasing trends in the number of personalized vehicles reveal that the public transport has not been able to provide the essential of mobility of the people at big. This has been shows the enormous pressure on the infrastructure of the road which has seen a growth of vehicles more n more year by year. Public transport systems have not been able to keep rapidity with the quick and considerable increases in demand over the past few years. Growth of motor vehicle population affects the infrastructure of road and by this rapid growth the accident situation occurs on the road. The table no 4.4 shows the various transports vehicle growth increasing year by year.

Table 4.4 Growth of motor vehicle population of Hisar

Vehicle Type	2004	2006	2008	2011
Bus	1238	1380	1481	1513
Car	10818	11345	11590	31782
Jeep	467	653	763	865
Tractor	1403	1698	1791	1989
Truck	1312	1496	1595	1678
Taxi	147	257	345	478
Auto rickshaw	2883	3009	3897	4578
Two wheelers	134785	136768	136879	138459
Minibus	297	369	399	489
Total	153350	156975	158740	181831

Source: Hisar police station according to serial no 1469-OA

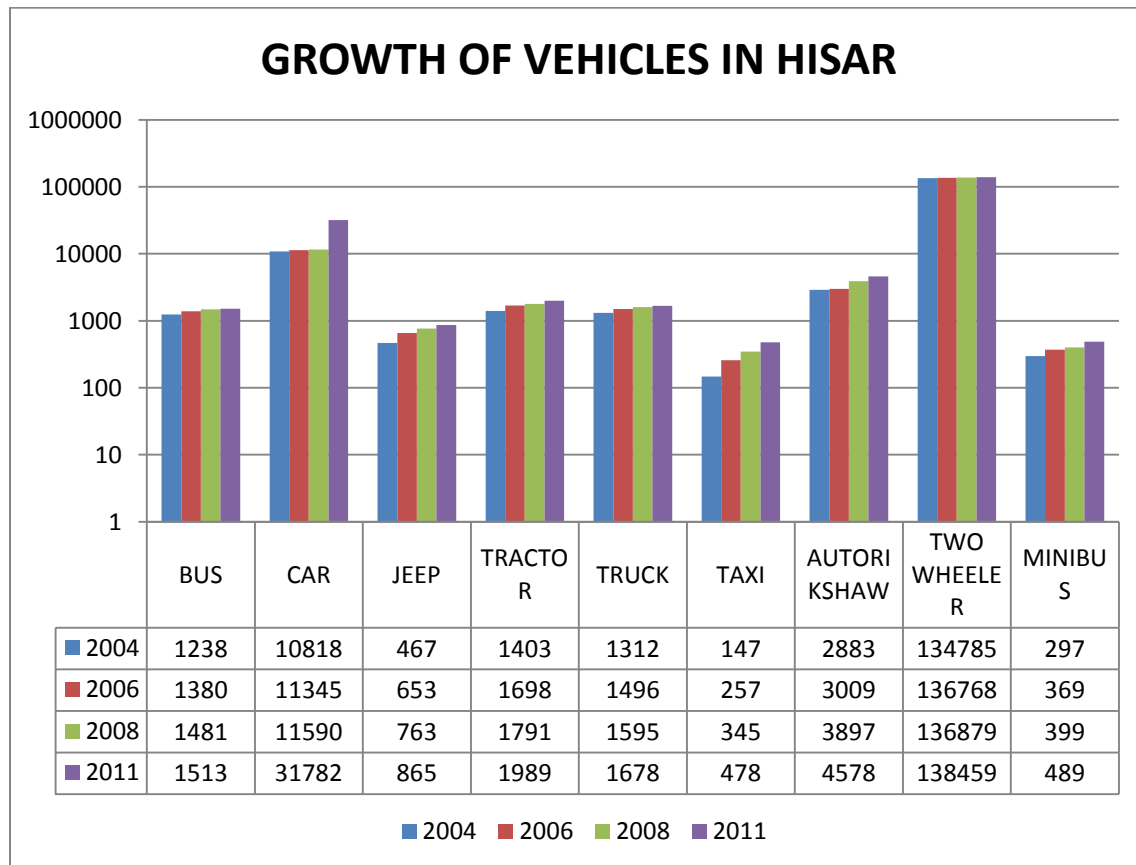


Figure 4.1 Growth of motor vehicles in Hisar.

4.4 ROAD ACCIDENT DATA Road accident data comprises Hisar Tehsil (Hisar, Adampur, Barwala and Agroha). In the road accident data it shows year wise accident of various areas from period 2001-2011 and shows death and injured people with total accidents.

4.4.1 Data showing the accidents in Hisar only.

Table 4.5 Year Wise Accident from 2001 to 2011 in Hisar

Year	Total Accident	Death	Injured
2001	46	11	35
2002	49	12	37
2003	51	7	44
2004	54	15	39
2005	83	18	65
2006	51	13	38
2007	58	16	42
2008	54	12	42
2009	52	11	41
2010	43	6	37
2011	44	11	33

Source: Hisar police station serial no 1460-OA

Table 4.6 Name of Particular Accident Site Time in Hisar

Time	Day	Night
National Highway	95	230
State Highway	10	20
Link Road	50	75
Approach Roads	35	70
Total	1274	326

Source: Hisar police station serial no 1460-OA

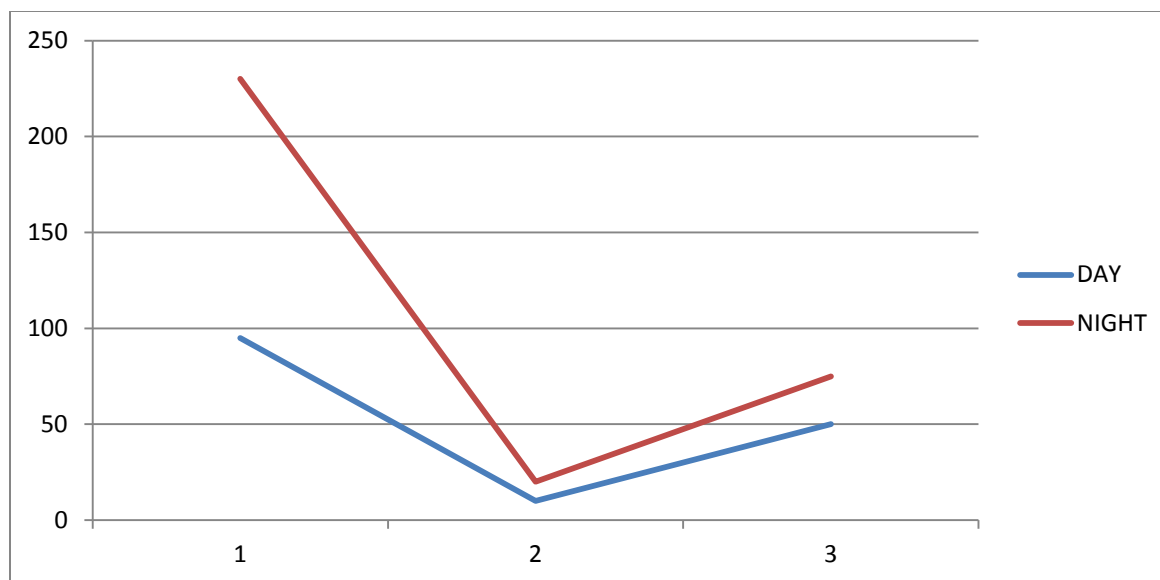


Figure 4.2 Line chart of accident time of Hisar.

Table 4.7 Total No of Accidents on Road by Following Transport Mode for Period 2001-2011

Vehicle	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Bus	11	8	10	8	10	10	9	10	12	15	14
Truck	34	26	34	33	34	43	46	50	42	45	45
Car	12	16	21	21	50	43	47	35	35	40	40
Jeep	31	14	22	30	28	19	21	15	23	24	30
Bike	15	7	5	13	15	14	11	15	19	15	15
Tractor	6	11	10	13	5	15	21	10	13	10	12
Auto	10	3	7	1	11	9	9	5	3	7	5

Source: Hisar police station serial no 1460-OA

4.4.2 Data showing the no of accidents in Adampur.

Table 4.8 Year Wise No of Accidents in Adampur from 2001-2011

Year	Total Accident	Death	Injured
2001	20	6	16
2002	15	5	10
2003	14	1	13
2004	19	6	13
2005	20	4	16
2006	10	7	12
2007	19	5	14
2008	26	7	30
2009	21	9	14
2010	20	9	14
2011	28	9	26

Source: Adampur police station serial no 1713-SA

Table 4.9 Name of Particular Accident Site Time in Adampur

Time	Day	Night
National Highway	-	-
State Highway	-	-
Link Roads	130	43
Approach Roads	34	15
Total	164	58

Source: Adampur police station serial no 1713-SA

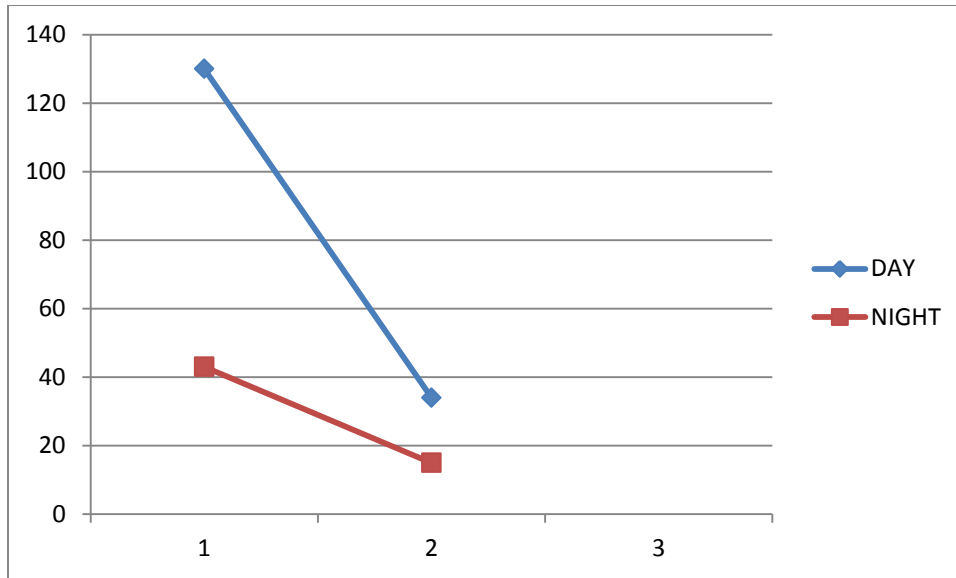


Figure 4.3 Line chart of accident time of Adampur

Table 4.10 Total No of Accidents on Road by Following Transport Mode for Period 2001-2011

Vehicle	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Bus	3	4	-	1	5	-	2	5	1	2	2
Truck	2	-	4	8	-	3	4	1	3	1	1
Car	-	-	-	-	1	-	-	-	3	1	5
Jeep	7	4	1	3	12	2	5	15	9	12	8
Bike	2	3	6	5	1	3	6	5	2	5	8
Tractor	6	4	2	2	1	2	2	-	1	-	4
Auto	10	3	7	1	11	9	9	5	3	7	5

Source: Adampur police station serial no 1713-SA

4.4.3 Data shows no of accident occur in Agroha.

Table 4.11 Year Wise No of Accidents in Agroha from 2001-2011

Year	Total Accident	Death	Injured
2001	34	23	36
2002	36	12	88
2003	24	8	25
2004	38	10	53
2005	29	5	45
2006	46	17	51
2007	35	16	49
2008	27	12	38
2009	31	9	40
2010	28	16	23
2011	33	13	56
Total	361	141	504

Source: Agroha police station serial no 57-RTI

Table 4.12 Name of Particular Accident Site Time in Agroha

Time	Day	Night
National Highway	140	61
State Highway	-	-
Link Roads	30	18
Approach Roads	35	77

Source: Agroha police station serial no 57-RTI

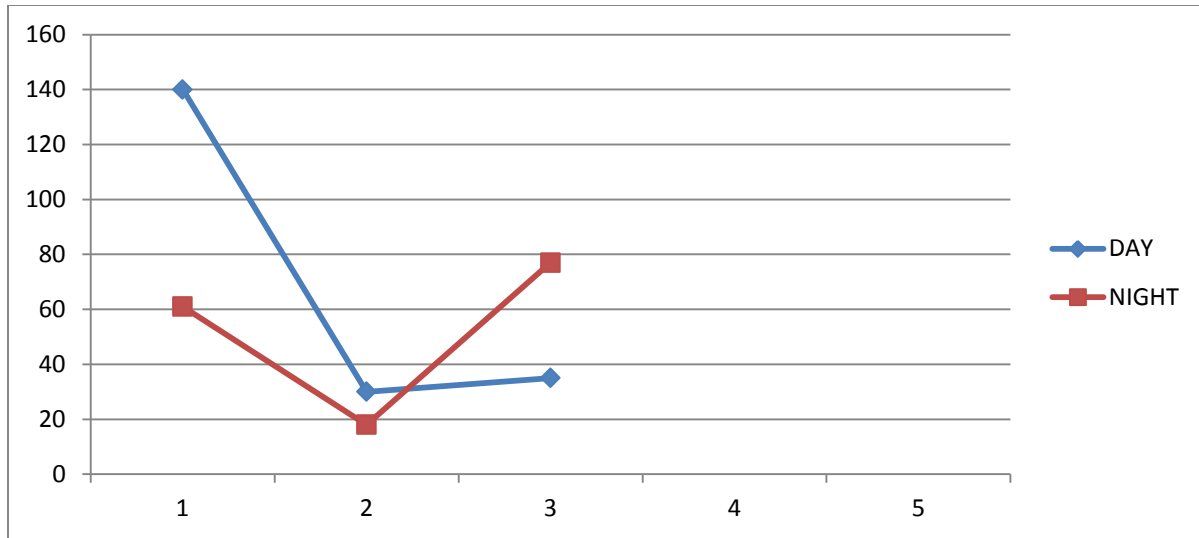


Figure 4.4 Line chart of accident time in Agroha

Table 4.13 Total No of Accidents on Road by Following Transport Mode for Period 2001-2011

Vehicle	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Bus	4	3	3	3	2	1	1	7	1	1	7
Truck	16	10	4	6	6	13	10	3	6	11	5
Car	2	14	2	10	6	5	6	7	8	11	9
Jeep	4	1	5	8	3	9	9	1	5	2	1
Bike	1	1	0	1	2	4	1	1	1	1	7
Tractor	1	0	2	3	3	3	2	1	5	0	3
Auto	0	3	0	2	2	2	1	3	2	1	0

Source: Agroha police station serial no 57-RTI

4.4.4 Data shows no of accidents in Barwala.

Table 4.14 Year Wise No of Accidents in Barwala from 2001-2011

Year	Total Accident	Death	Injured
2001	19	7	12
2002	18	6	12
2003	21	8	13
2004	31	11	20
2005	27	13	14
2006	35	16	19
2007	36	15	21
2008	42	20	22
2009	52	29	23
2010	72	40	32
2011	74	31	43

Source: Barwala police station serial no 1375-SPIO

Table 4.15 Name of Particular Accident Site Time in Barwala

Time	Day	Night
National Highway	-	-
State Highway	120	190
Link Roads	10	17
Approach Roads	40	50

Source: Barwala police station serial no 1375-SPIO

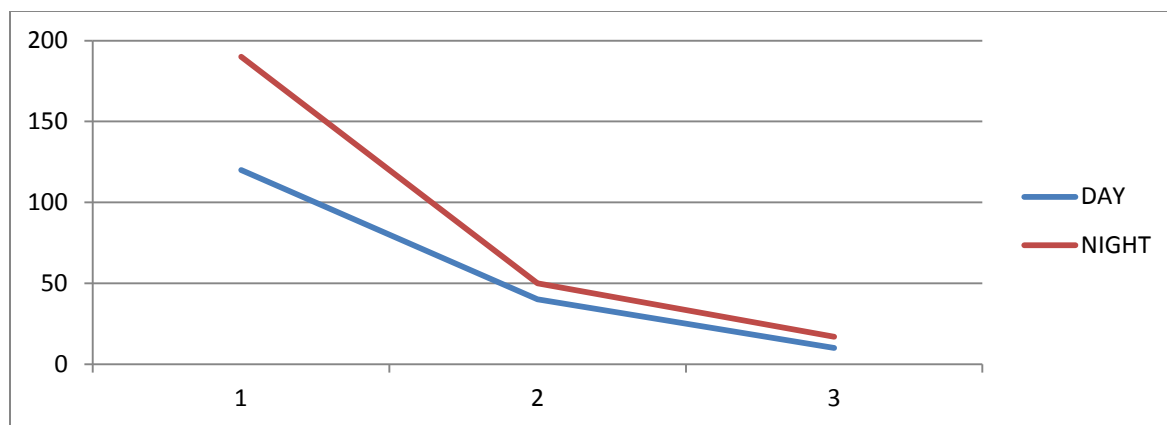


Figure 4.4 Line chart of accident time of Barwala

Table 4.16 Total No of Accidents on Road by Following Transport Mode from Period 2001-2011

Vehicle	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Bus	5	3	2	3	3	1	3	1	4	3	3
Truck	3	4	2	5	3	4	2	2	4	4	7
Car	-	2	3	2	5	4	4	7	8	8	8
Jeep	6	3	5	10	8	12	15	16	21	32	32
Bike	1	3	6	6	8	7	6	11	15	18	18
Tractor	1	1	-	3	-	6	2	4	-	3	3
Auto	2	1	-	-	-	-	-	-	-	2	1

Source: Barwala police station serial no 1375-SPIO

4.4.5 Data Shows The Number of Accidents in HISAR TEHSIL.

Table 4.17 Year Wise Accidents from 2001 to 2010 in Hisar Tehsil

Year	Total Accident	Death	Injured
2001	119	36	95
2002	85	22	97
2003	109	35	103
2004	119	35	111
2005	153	41	145
2006	157	40	287
2007	164	39	214
2008	140	30	120
2009	147	57	147
2010	156	45	152
2011	161	50	180

Source: Hisar police station serial no 521-28

Table 4.18 Name of Particular Accident Site Time in Hisar Tehsil

Time	Day	Night
National Highway	448	101
State Highway	211	51
Link Road	615	84
Total	1274	326

Source: Hisar police station serial no 521-28

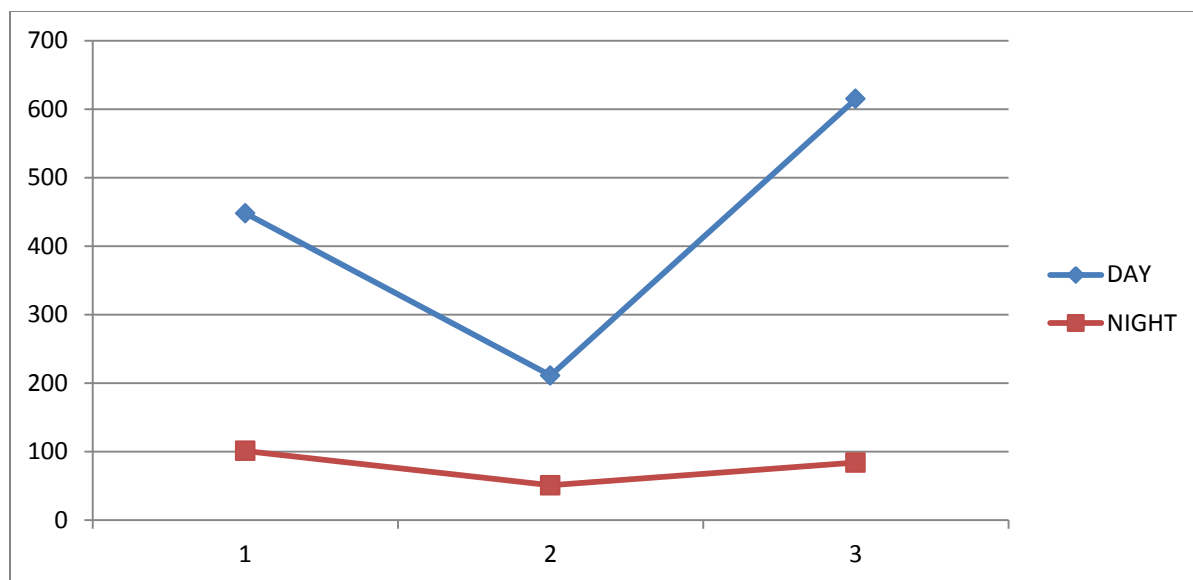


Figure 4.6 line chart of accident time of Hisar Tehsil

Table 4.19 Total No of Accidents on Road by Following Transport Mode for Period 2001-2011

Vehicle	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Bus	11	8	10	8	10	10	9	10	12	15	14
Truck	34	26	34	33	34	43	46	50	42	45	45
Car	12	16	21	21	50	43	47	35	35	40	40
Jeep	31	14	22	30	28	19	21	15	23	24	30
Bike	15	7	5	13	15	14	11	15	19	15	15
Tractor	6	11	10	13	5	15	21	10	13	10	12
Auto	10	3	7	1	11	9	9	5	3	7	5

RESULTS AND ANALYSIS

5.1 GENERAL

This chapter deals with the results and discussions from the data provided in the chapter 4. From various accidents reason, provide some remedial measures to solve the conditions of accident prone sites and relate the prediction model with the relation of population of the Hisar and accidents occur in the period from 2001-2011.

5.2 ANALYSIS OF HISAR- BALSAMAND ROAD

5.2.1 The layout of Hisar - Balsamand road is given as below in figure no.5.1 Two median openings provided for the convenience of filling fuel at an interval of about 20 m both sides. Therefore, the road users move in the wrong direction to fill the fuel and have resulted in increase in accidents.

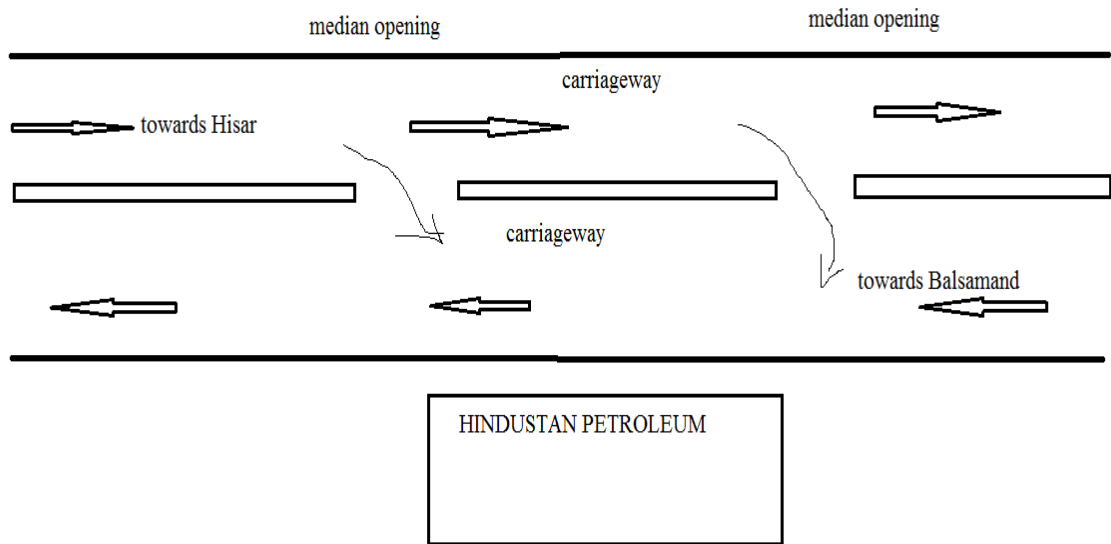


Figure 5.1 shows the layout of the accident prone area on Hisar-Balsamand Road

REMEDIAL MEASURES

As we can see that there are two median openings available on both sides, so first of all it would be suggested to NHAI to close both median openings to minimize the accidents, and provide the facility of fuel filling facility on other side too so that mainly in foggy conditions it will be creating less hazardous location.

Fog reflectors the use of fog reflectors is very important in that area because rain and fog reduce driver's ability to see the road and vehicles coming towards him. The car window always fogged up in these conditions. This area has very affected by rain and fog both dangerously and it's very important to install retro reflective safety device i.e. called as cat's eye also so as to reduce the accident rate on this road.



Figure 5.2 shows how the road looks like after reflectors being installed

5.2.2 Condition of road various potholes found on this road that would be dangerous for the vehicles and people travelling on the road. The potholes would be properly fixed so as to decrease hazard situation on that road.

REMEDIAL MEASURES

To fix the potholes proper steps has to be taken:

Step 1 Clean the area to be repaired form loose materials or debris properly.

Step 2 Pour the QPR pothole repair directly from the container or machine.

Step 3 once we have approx a 2 inch base, use a tamp tool to compact the material in the hole.

Step 4after compacting the material, once again fill the QPR and compaction will either be done by bulldozers.



Figure 5.3 shows how it looks like after repairing the pothole

5.3 ANALYSIS OF HISAR- DELHI ROAD

5.3.1 Unavailability of shoulders as we saw earlier in the chapter 2 figure no 2.9 and 2.10, there is unavailability of shoulders and no proper safety guidance has provided.

REMEDIAL MEASURES

First of all there should be installed proper sign of low shoulder and construct the shoulders by Municipal Corporation of Hisar so that the accident prone site will be prevent.



Figure 5.4 shows how the proper sign should install for shoulders

5.3.2 Unavailability of road markings as we saw in the figure 2.9 and 2.10 there is no road markings available on these roads hence as a result accident prediction area will develop more and on that site many accident occur also.

REMEDIAL MEASURES

First of all provide road surface markings on these highways, provide centre lines for separation of traffic moving in opposite direction. As per IRC recommendations figure 5.5 and 5.6 shows the dimensions.

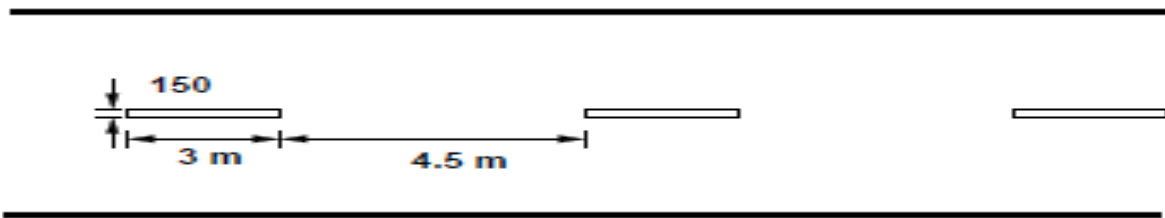


Figure 5.5 centre line markings for two lane roads

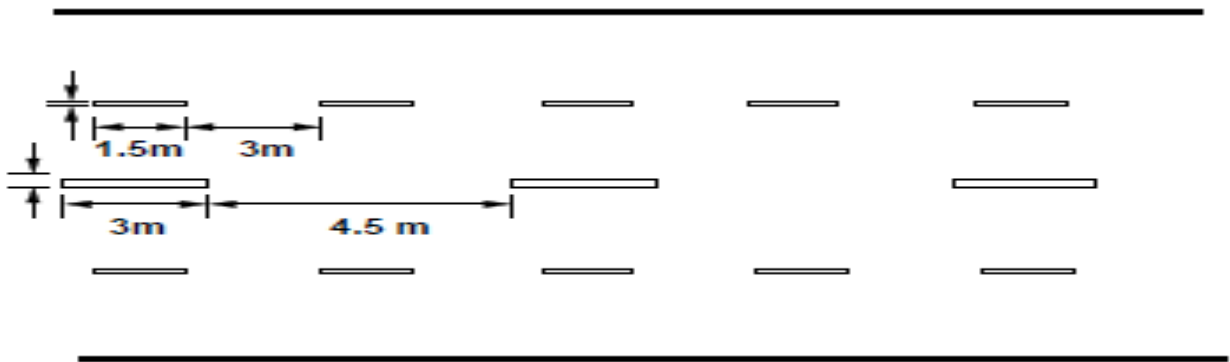


Figure 5.6 centre line and lane markings for a four lane road

5.4 EXPLORATORY DATA ANALYSIS (REGRESSION ANALYSIS)

Figure 5.7 is the scatter plot showing the relationship between number of road traffic accidents and population in Hisar Tehsil. It can be seen from the scatter plot that there exists a logical visible pattern in the data resulting in the existence of a relationship between the two variables. As the population grows by year to year, it grows along with the number or the rate road traffic accidents indicating a positive relationship between these variables. On the other hand, the magnitude of the relationship is given by correlation coefficient in the following analysis.

Table 5.1 Showing Population and Accident Relation Data

Year	Accidents	Population
2001	119	280352
2002	85	280652
2003	109	289652
2004	119	296560
2005	153	301368
2006	157	324598
2007	164	347586
2008	140	356376
2009	147	358778
2010	156	368476
2011	161	377886

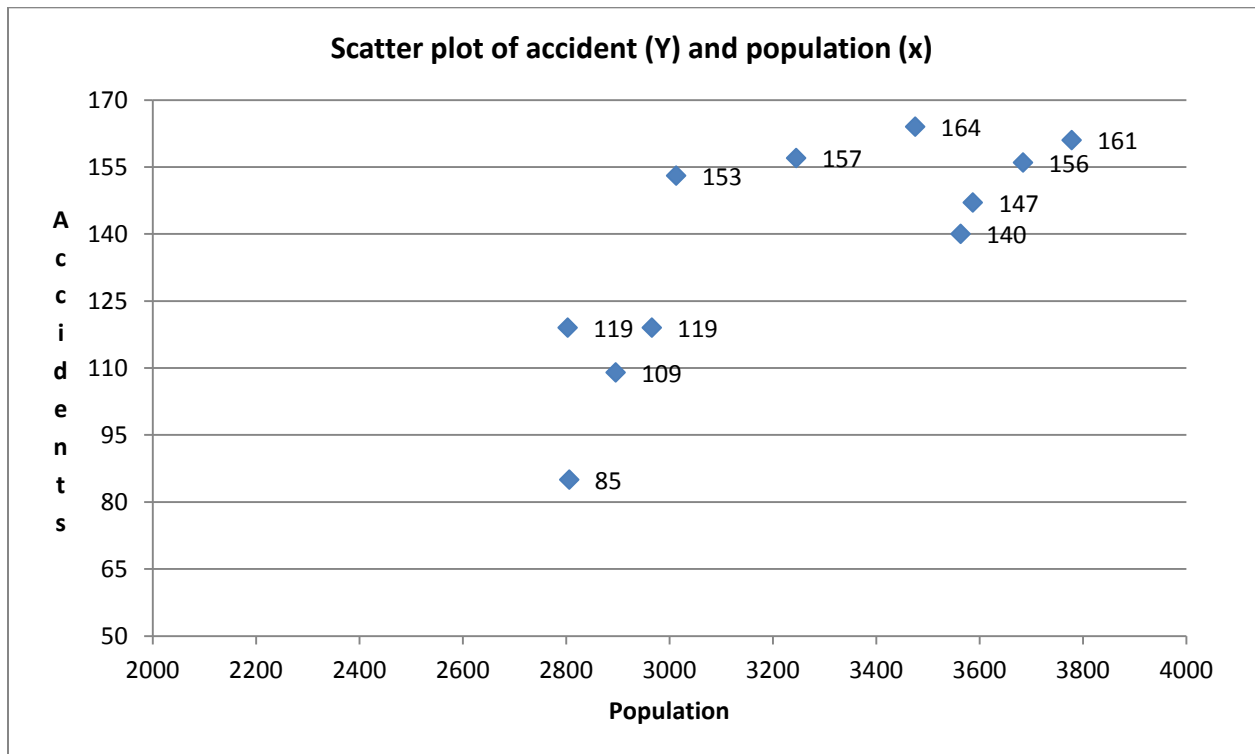


Figure 5.7 is the scatter plot showing the relationship between number of road traffic accidents and population in Hisar Tehsil

5.4.1 SUMMARY OUTPUTS: REGRESSION STATISTICS

Table 5.2 Summary Outputs of Regression Statistics

<i>Multiple R</i>	<i>0.770542329</i>
<i>R Square</i>	<i>0.59373548</i>
<i>Adjusted R Square</i>	<i>0.548594978</i>
<i>Standard Error</i>	<i>17.21629301</i>
<i>Observations</i>	<i>11</i>

Table 5.3 Summary of regression coefficients

<i>Predictor</i>	<i>Coef</i>	<i>SE Coef</i>	<i>P</i>	<i>R- sq</i>	<i>R-sq (adj)</i>
<i>Intercept/Constant</i>	<i>-35.27</i>	<i>47.86</i>	<i>0.479</i>	<i>0.593</i>	<i>0.548</i>
<i>Pop x</i>	<i>0.000529795</i>	<i>0.000146081</i>	<i>0.00551</i>		

The Table 5.3 on top of reports the regression coefficients and other vital statistics, which are interpreted as flows:

The regression model, which establishes the relationship between total yearly accidents from the period 2001-2011 and population, is thus given as:

$$Y = - 35.27 + 0.00005X$$

Where Y = the total number of accidents in year from period 2001-2011

X = the total yearly population.

The value of -35.27 is interpreted in the absolute term will be the total number of year by year accidents when total population is set to be zero and all the additional factors are held as constant, at the same time as the coefficient of X of 0.00005 is the rate or magnitude of change in the number of hazards or accidents as a result of a change in the population. Its +tive sign is the hint of the fact that there is positive association between the road accidents and the population and it has already mentioned above with the scatter plotting diagram. Yet again, the p-values shows that the constant term is irrelevant since it is greater than the chosen alpha level of 0.05, at the same time as that of the predictor variable (X) of 0.00551 shows a highly significant even though it quite smaller, with approximately 0 standard error. Additionally, the coefficient of determination (R-sq) of 59.3% indicates that for the period under study based on the available

data, population is able to account for 59.3%% of the changes in accidents in the country with only 40.7% not being explained by population nevertheless somewhat by other variables which were not included in the study. The adjusted coefficient of determination R-sq (adj) of 54.8 indicates that the model specifically has an explanatory power of 54.8% exclusively adjusted for the degrees of freedom with consider to the explanatory variable. As a result that population as an explanatory variable did not improve the model more than expected by chance.

5.4.2 ANOVA/ ANALYSIS OF VARIANCE

The Anova or analysis of variance data is used to check the hypothesis for this study and the data related to variance as shown below

Table 5.4 Analysis of Variance

<i>Source</i>	<i>Df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>Significance F</i>	<i>P</i>
<i>Regression</i>	<i>1</i>	<i>3898.575114</i>	<i>3898.575114</i>	<i>13.1531</i>	<i>0.005513769</i>	<i>0.00551</i>
<i>Residual</i>	<i>9</i>	<i>2667.606704</i>	<i>296.4007449</i>			
<i>Total</i>	<i>10</i>	<i>6566.181818</i>				

Null Hypothesis (Ho): According to null hypothesis we assume to be there is no significant relationship between road traffic accidents and growth of population in Hisar.

Alternative Hypothesis (H1): According to it, there is a significant relationship between road traffic accident and population growth in Hisar.

Result: The P-value in the table has value 0.00551 as reported in the variance table and shows that test is significant at 0.05; as a result e fail to accept to accept the null hypothesis and find that there is a great relationship between traafic accidents on roads and population in Hisar.

5.5 ANALYSIS OF ACCIDENT STUDY

5.5.1 Death rate based population the traffic accident to life in an area is expressed as the number of traffic fatalities per 100000 populations. This rate reflects the accident coverage for entire area.

The formula is:

$$R = (Bn \times 100000)/P$$

Where R = death rate/ million population

Bn = total no of accidents in a year

P = population of the area

Table 5.5 Death rate based on population of Hisar Tehsil

Year	Total no of traffic death in a year (<i>Bn</i>)	Population (P)	Death rate (R)
2001	36	280352	12.83
2002	22	280652	7.83
2003	35	289652	12.08
2004	35	296560	11.80
2005	41	301368	13.60
2006	40	324598	12.32
2007	39	347586	11.22
2008	30	356376	8.41
2009	57	358778	15.88
2010	45	368476	12.21
2011	50	377886	13.23

Indicates rate of death based on population of Hisar Tehsil from the period 2001- 2011, ranging between 7.83 and 15.88. It is indicating that death rate has variation with increasing or decreasing between the periods 2001-2011. This may be due to the fact that Hisar Municipal Corporation adopted and partially implemented recommendations and carried out improvements in geometric of the road- widening of roads, providing proper shoulders, installation of traffic control devices etc.

5.5.2 Death rate based on Motor Vehicle Population The traffic accident to life in a community can also be expressed as the number of traffic fatalities per 10000 vehicles registered. This rate reflects the accident exposure for entire area and is similar to death rate based on population.

The formula is:

$$R = (Bn \times 100000)/Mn$$

Where R = death rate/10000 vehicle registration

Bn = total no of traffic deaths in a year

Mn = no of motor vehicles register in an area

Table 5.6 Death rate based on motor vehicle population

Year	Total no of traffic death in a year (<i>Bn</i>)	Motor vehicle population (<i>Mn</i>)	Death rate (R)
2004	35	153350	22.82
2006	40	156975	25.48
2008	30	158740	18.89
2011	50	181831	27.49

Indicates rate of death based on motor vehicle population from the period 2004-2011, ranging between 18.89 and 27.49. It is indicating that death rate is increasing year by year as the population of motor vehicle increased. This may be due to lack of provision an attributed to poor

illumination and absence of warning measures such as delineation and retro-reflective materials. The lack of improper road geometric designs would also be the main factor affected.

5.6 SPECIFIC LOCATION OBSERVATIONS

Specific location observations are presenting below with photographs taken during safety audit and various failures will be shown in the images so as to take proper care for safety purpose on the location Hisar-Balsamand, Hisar-Sirsa highway. Many obstructions and failures have been discussed with the help of these images so that possible solutions will give to improve the accident prone area.



Figure 5.8 Specific locations for observation studies

Drain covers are provided so that pedestrians can walk safely, hence gap between roads and drain edge should be filled so that no hazard will occur.



Unauthorized median opening, to improve this problem first of all provide proper sign board should be installed.



In the left side image, open median is available and object marker is missing and also pavement marking missing.

In the right side image, soil should be removed from the carriageway.

CONCLUSIONS**6.1 GENERAL**

In the present study various studies has been carried out for the accident related studies and give the best possible solutions to improve the accident prone sites so as to decrease the accidents occurring on the highways. With the help of regression analysis accident prediction model developed and studied various construction failure or many more.

6.2 CONCLUSIONS

For the accident analysis on road, it can be concluded that the accidents occurs in day time most as compare to night time, but the accident severity is very high in Hisar Tehsil. This may also be recognized to poor illumination during rain and fog in winter seasons most and unavailability of road markings and signs also and absence of warning measures such as delineations and retro reflective material. It can also be seen from the analysis that growth of motor vehicles is also contributed to majority accidents and two wheelers have more contribution to accidents more this is because due to discontinues service road leading to wrong side movement of traffic to avoid long detours. Poorly designed roads from the adjacent area of the highways are also leading to more conflicts between local traffic and heavy traffic like loaded by goods. From the data mainly road parameters like shoulders, road markings, median opening, and carriageway conditions are main parameters of causing road accidents.

Based on analysis and interpretations, the study revealed that there is strong correlation between the road traffic accidents and population of Hisar Tehsil especially population growth accounts 59.30% of the changes in number of accidents in Hisar Tehsil. It shows that as the population increases the more accident will increase.

Secondly, an attempt for the relationship was found to be $Y = - 35.27 + 0.00005X$ which is significant at 5% significance level and has a good fit as a model to help in future to forecast the accident occur with the relation of population of Hisar Tehsil. It is recommended that to further refine the model developed in this study with taken as various other variables to get more realistic image for predicting the accidents. But we cannot exactly predict future trends by using models and theories but it is a very handy tool for the planners to take remedial measures.

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