



CRP 514

Geographic Information System



Term paper

Using GIS to reduce road accidents

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Abstract

With the rapid expansion of road construction and the increase of number of vehicles road traffic accidents are becoming a serious health problem, it is one of the common causes of death in the world. Nowadays, traffic safety has been a global concern. Traffic accident has been a big concern for many people and government to reduce the amount of road accident especially in Saudi Arabia it could be a big threat to this country. Geographic Information System (GIS) can be used to reduce traffic accident. This paper aims to describe how GIS can assist in the processing and analysis of accidents and how we can use GIS as a tool to reduce traffic accidents.

1. Introduction

Road traffic accidents are becoming an international concern. It is becoming a serious concern in Saudi Arabia. There has been a progressive increase in vehicle accidents within Saudi Arabia due to the increase in the number of the vehicles in the recently years. Road accident fatalities are becoming a dangerous cause for death in Saudi Arabia or even in the world. It has been estimated that over 300,000 persons die and 10-15 million persons are injured every single year in road accidents throughout the world (Ling, 2005). For example only in the united state traffic accidents have resulted in more than 42000 fatalities annually as motioned in Annual ESRI International User Conference (AEIUC, 2009). Hence it is necessary to look for serous solutions, which can reduce road accident rates. Various safety improvements in automobile itself such as restraint belt and airbag are contributing to reduce fatal accidents in the roads, but are not effective enough to reduce traffic accidents. Therefore, In order to reduce traffic accidents, it is very important to know what kind of accidents occurred where and why. Geographic Information System is used to build traffic accident databases and to record the accurate location of accident in some countries, which contribute in reducing the road accidents. So, GIS can be used to reduce the fatality of the road accidents.

2. Purpose of Paper

This papers aims to illustrate how GIS can be used to aid the reduction of road accidents, and how accident analysis plays an important part in the strategy to reduce road accidents. Nowadays Geographical Information Systems (GIS) have revolutionized applications in term of road accident processing and analysis. Finally, I will introduce some case studies regarding using GIS to reduce road accidents.

3. Sources and Information

Some research has been done for using GIS in road safety. Also, some case studies are conducted in this issue due to traffic accident risks on people. In this paper I depend on the internet to get information about using GIS to reduce road accident either books or researches. Statistical information about death due to road accidents is gotten from some of heath organizations. The lake of data is my problem in this project. So, I couldn't get data to use them with Arc GIS software.

Key words: Geographic Information system (GIS), Road Accidents, Analysis, and Database.

3. Literature Review

In recent years, GIS technology is used widely in deferent applications in transportation region. Geographic Information Systems (GIS) have been used in the past to display crash locations and produce maps. Today, the potential uses of GIS include crash data analysis. GIS-based crash data

analysis can influence the traffic safety for each engineering, enforcement, education, and emergency response. The main problem in identifying the accident black spot is both to determine the highest rate accident locations and the causes of these accidents.

4-Methodology

It is known that to reduce traffic accidents, it is very important to know:

- 1- What kind of accidents occurred?
- 2- Where the accidents occur?
- 3- And why the accident happens?

So, it necessary to build traffic accident databases which use GIS to record the accurate location of accident. Therefore, this needs coordination between police and highway department to collect the necessary data which helps to develop accident geographic information system. The methodology of this paper can be seen in the Figure 1 below, and a brief description of each phase will follow.

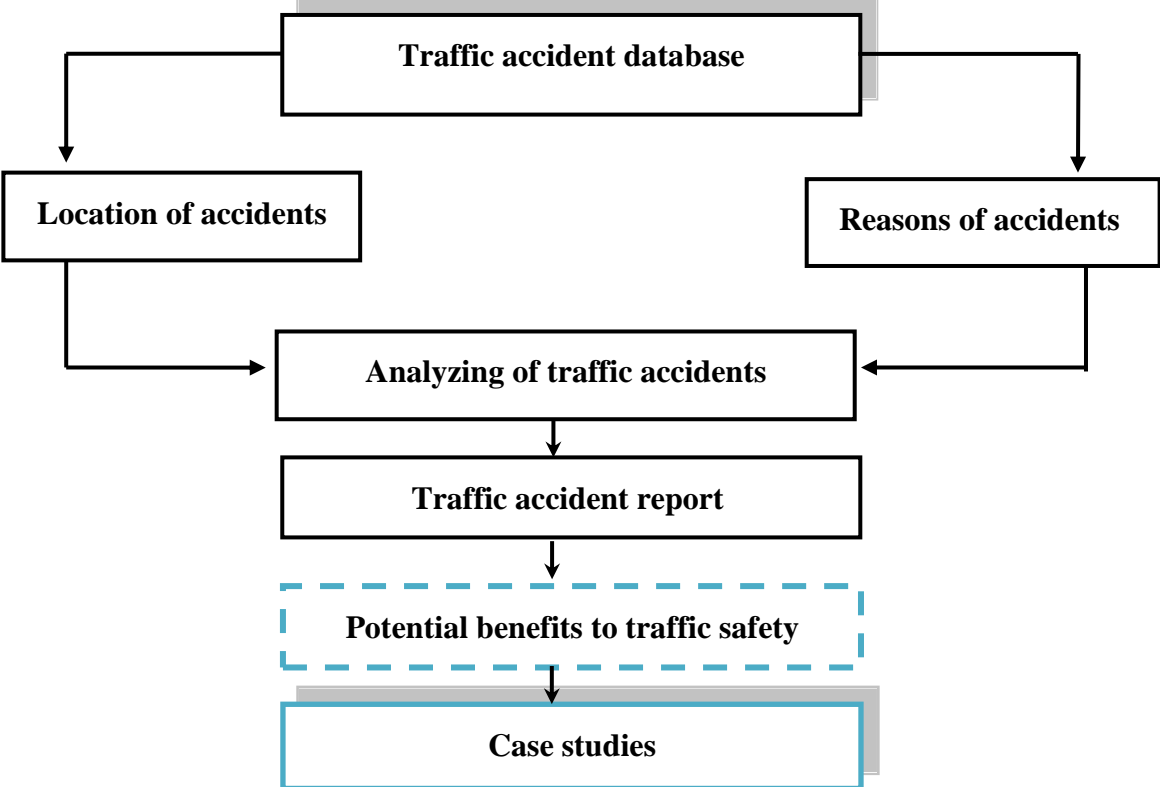


Figure1. Flow chart showing the methodology of the paper

4.1.2 Reasons of Accidents

The database should include the reasons of the accidents, which give the road engineering indicator about the mean reasons of road. There are many reasons for traffic accidents such as the drivers behavior, road topography, road alignments (intersections, vertical and horizontal curves), speed, lack of signing and marking ... etc.

4.1.3 Advantages of Using GIS

Traffic accidents data for regions are typically collected and maintained by several agencies such as federal, state, local agencies and law enforcement agencies. Therefore, you need to collect data with different formats and structures and integrate among them. In order to integrate data with other information like roadway data, GIS provides an environment to facilitate data integration, analysis, and display of results. So, it is beneficial and helpful to use GIS for porous of traffic accident analysis.

4.2 Analyzing of Traffic Accidents and Quarrying

After collecting the data we need to analysis them to determine the high crash locations, fatality of accidents and the injuries. The accident analysis should be taking as we need. For the purpose of using GIS to reduce road accidents data display, quarrying and critical accident locations are the most important features for road engineers for looking for a proper solutions to enhance road safety.

4.3 Data Display and Quarry

Data can be display different ways (tabulated, graphical, or mapping), it can be:

- i. Accident per yearly.
- ii. Accident per monthly.
- iii. Accident per location.
- iv. Accident per vehicle type.
- v. Accident per time (day time).
- vi. Accident according to type of accident.

5. Potential Benefits to Traffic Safety

Using GIS for traffic accidents data analysis can benefit traffic safety. GIS has an indirect impact to traffic safety by assisting decision makers rather than the direct impact. Miller states it best, exclaiming "... The ultimate goal is not to conduct analysis, but instead, to take actions that will reduce crash frequency or severity (Miller, 1999)".

Geographic information system road accidents will be very useful and will enhance the roads safety. It will be helpful for:

- Roadway designers
- Policy makers
- Planning
- Law enforcement
- And emergency

6. Case Study (1)

6.1 Traffic Accident in India

India is one of the countries which faced rapid growth of the accidents rate. Every year about 85000 persons are killed and about 300000 are injured due to the road accidents. One person killed every 10 minutes with rate of 3 accidents every minute (Ghosh, 2004). As the construction of the roads increase the rate of fatal accident rate becomes more dangerous. The horrify number of accidents is continuously increasing and the victim of road terror are thousands of people. The government in India start seriously thinks for a solution to deal with this problem. They start some of traffic accident studies, but all of these studies are not great helpful for traffic safety. To deal with all of road accidents data such as types of vehicle, topography of roads, location of accidents, reason of accidents and other data related to accidents you have to use Geographic Information System. GIS is supports the display and analysis of spatial data. The powerful aspect of GIS is the flexibility in modeling spatial objects to suit particular application requirement. It provides capability to store and maintain large data sets. One of these studies was traffic accident analysis for Dehradun city using GIS, which I discussed briefly below.

6.1.1 Traffic Accident Analysis for Dehradun City Using GIS

Dehradun city is the capital of Uttarakhand State has been selected for study of the traffic accident analysis. Dehradun is one of the major towns in the state. The city is very famous for its educational institutes and since. The volume of the traffic in this city becomes increased. Dehradun city in the range of Himalaya Mountains and it is considered the gateway to the Queen of hill station Mussoorie. So, those famous places attract thousands of tourists especially during the summer and winter months. The increase of tourists increases the traffic jams that cause an increase in traffic accidents in the city (Ghosh, 2004).

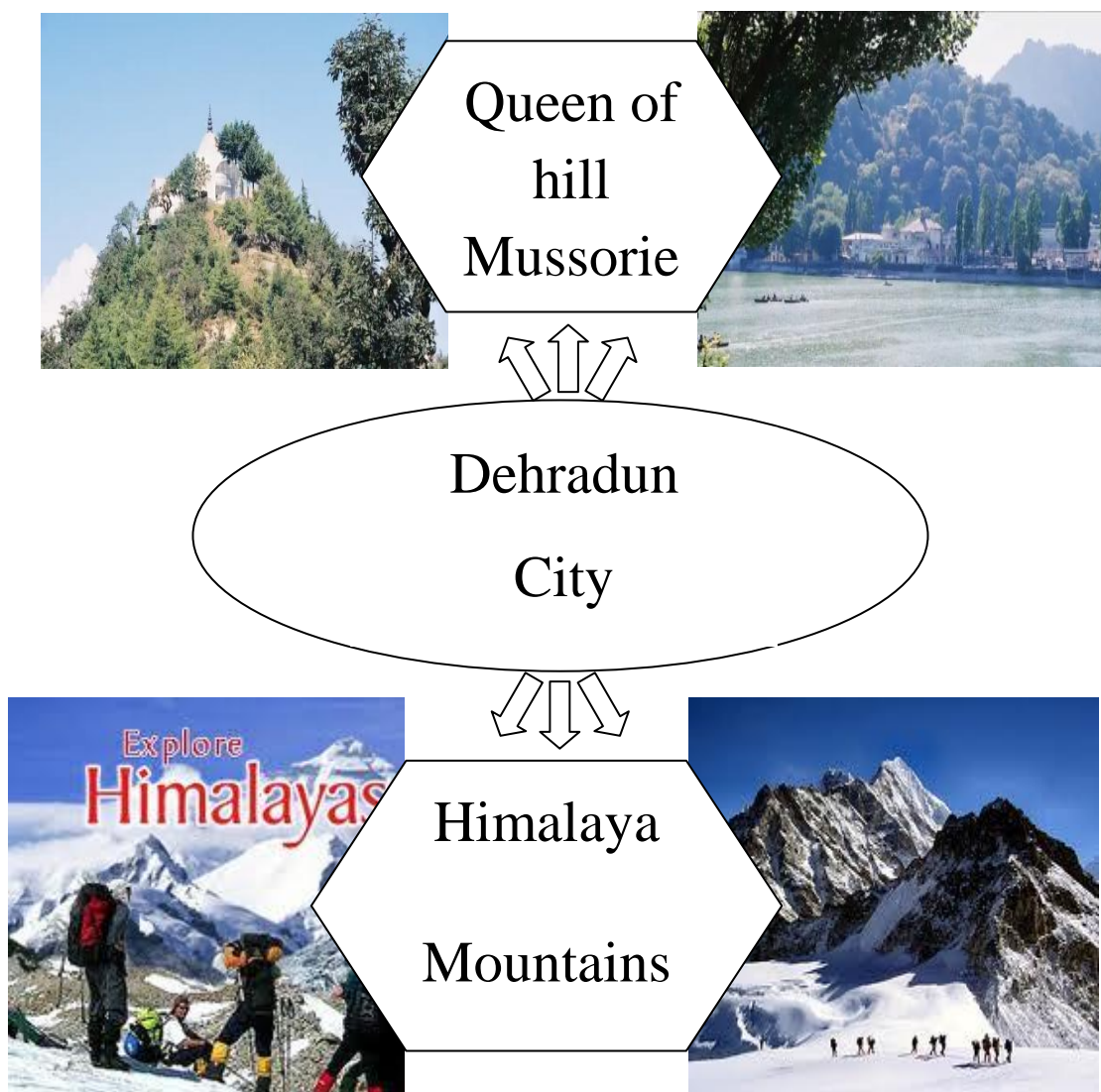


Figure3. Dehradun city is the gateway for Himalaya region and Queen of hill Mussoorie (<http://www.google.com.sa/images>).

6.1.2 Objective of the Study

The objective of the study is to study traffic accidents and analysis them according to:

- ✚ Yearly variations
- ✚ Monthly variations
- ✚ Comparative vehicle wise
- ✚ Time slot wise
- ✚ Person
- ✚ Type of accident



Figure4. Dehradun city satellite image (Google Earth)

They collect the data of the accidents in Dehradun city for five years from 1998 to 2002. Accident data has been collected from secondary sources like police stations for identification of black spots and linear stretches in Dehradun (Ghosh, 2004). Various collected data are:

- | | |
|------------------------|-----------------------|
| 1-Type of Accidents | 2-Modes Involved |
| 3- Name of the Road | 4-Police Station Area |
| 5-Time of Accident | 6-Date of Accident |
| 7-Name of Intersection | |

For the data collection they depend on topo-sheets survey (1984), Guide Map of Dehradun City (1965), IRS LISS III Satellite data, IKONOS Satellite data, and accident record from 6 Police Stations of Dehradun for the year 1998 to 2002. The field data is tabulated for each zone, Kotwali zone accident data is shown below and similar for others (Ghosh, 2004).

Sr. No.	Year	Fatal Accidents	Grievous Accidents	Minor Accidents	Non Injury	Total
Zone – Kotwali						
1	1998	16	31	12	7	66
2	1999	12	27	6	6	51
3	2000	26	30	8	9	73
4	2001	22	32	13	6	73
5	2002	21	19	12	2	54
		97	139	51	30	317

Table1. Kotwali zone accident data in Dehradun city (Ghosh, 2004)

Table1 shows the summary of accidents Data collected in Kotwali zone from Dehradun City according to FIR zone Police Station. All of the other zones accident data are collected and

tabulated similar to Kotwali zone as shown above. The updating of road network was carried out with the help of IRS LISS III and IKONOS Satellite data. They used ESRI ARC GIS to integrate the spatial and non-spatial and they used it to analysis traffic accidents in Dehradun city. The methodology adopted is shown below (Ghosh, 2004).

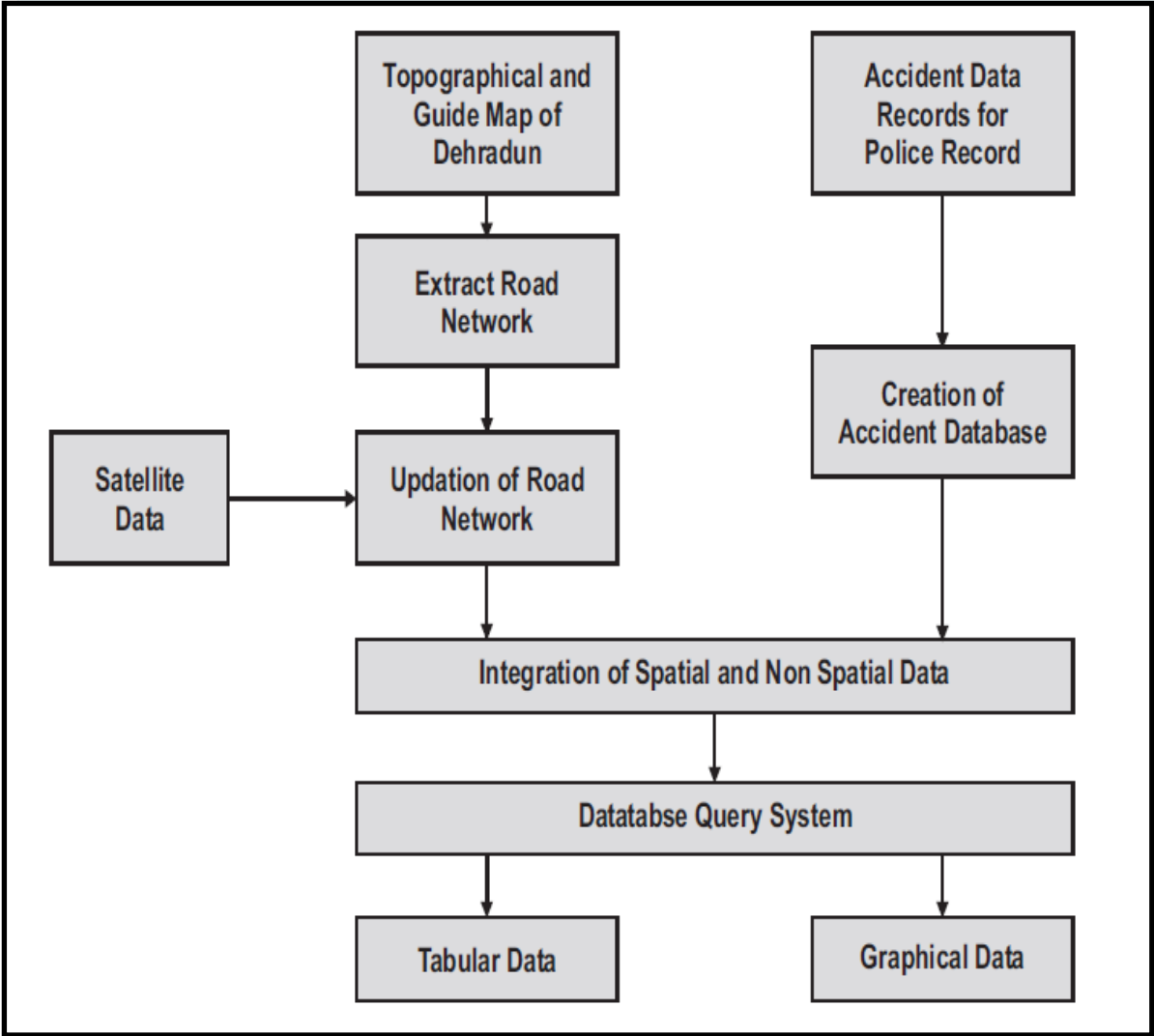


Figure5. Shows the methodology adopted in Dehradun city (Ghosh, 2004)

6.1.3 Analysis and Results

The table shows the results of the total accidents according to ESRI ARC GIS analysis (Ghosh, 2004). The collected data contains:

- ✚ Total of the accidents 699
- ✚ 41.6% grievous injuries
- ✚ 30.2% fatal injuries
- ✚ Kotwali zone is the most accident zone

Sr. No.	Zone	Total No. of Accident	Fatal Accidents	Grievous Injury	Minor Accidents	Non-Injury
1	Kotwali	317	97	139	51	30
2	Dalanwala	181	42	76	41	22
3	Cantt	107	34	41	30	2
4	Raipur	30	10	15	3	2
5	Rajpur	35	17	9	5	4
6	Clement Town	29	11	11	5	2
Total		699	211	291	135	62

Table2. Shows accidents during 1998-2002 in Dehradun city zones (Ghosh, 2004)

It is observed that the high percentage of grievous and fatal accident injuries in Dehradun, there is an urgent need to carry out proper traffic management studies in order to regulate the traffic. Also, it may be noted that the railway station, bus stand and the Paltan Bazar are located in Kotwali zone. Therefore, the rate of accidents in Kotwali zone is higher than the other zones. So, this area needs more traffic regulate and law enforcement to enhance traffic in this area (Ghosh, 2004).

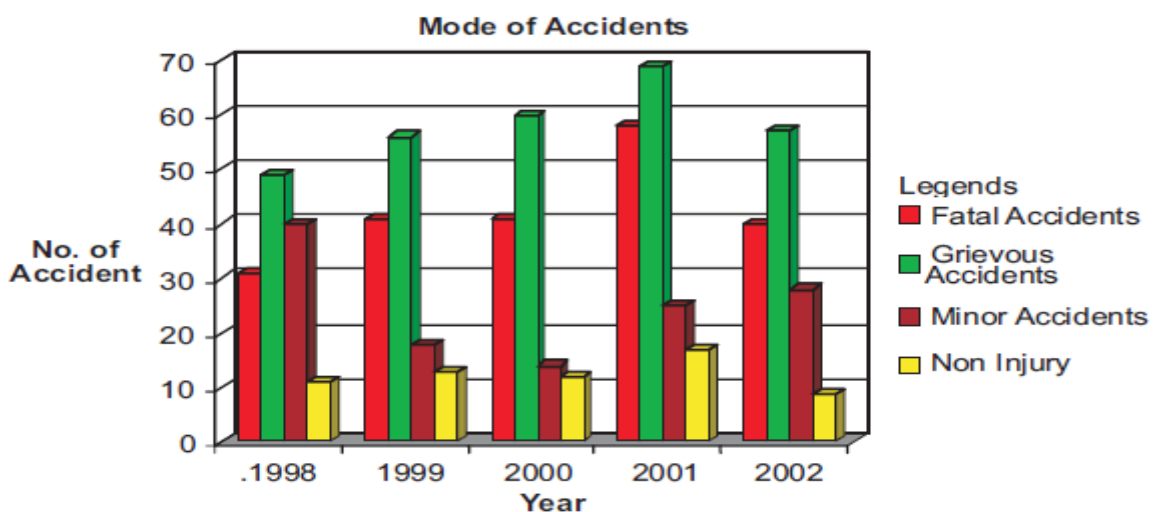


Figure6. Type of Accidents occurs in Dehradun (Ghosh, 2004)

In the previous bar chart we have seen that the number of total accidents and grievous injury is continuously raising the number of total accidents and grievous injury is continuously rising. This could be due to rise in number of vehicles plying within the city. ARC GIS displays all of the accident location and types to give the road engineers indication about high spot accident places and to take a proper solution for those dangerous places.

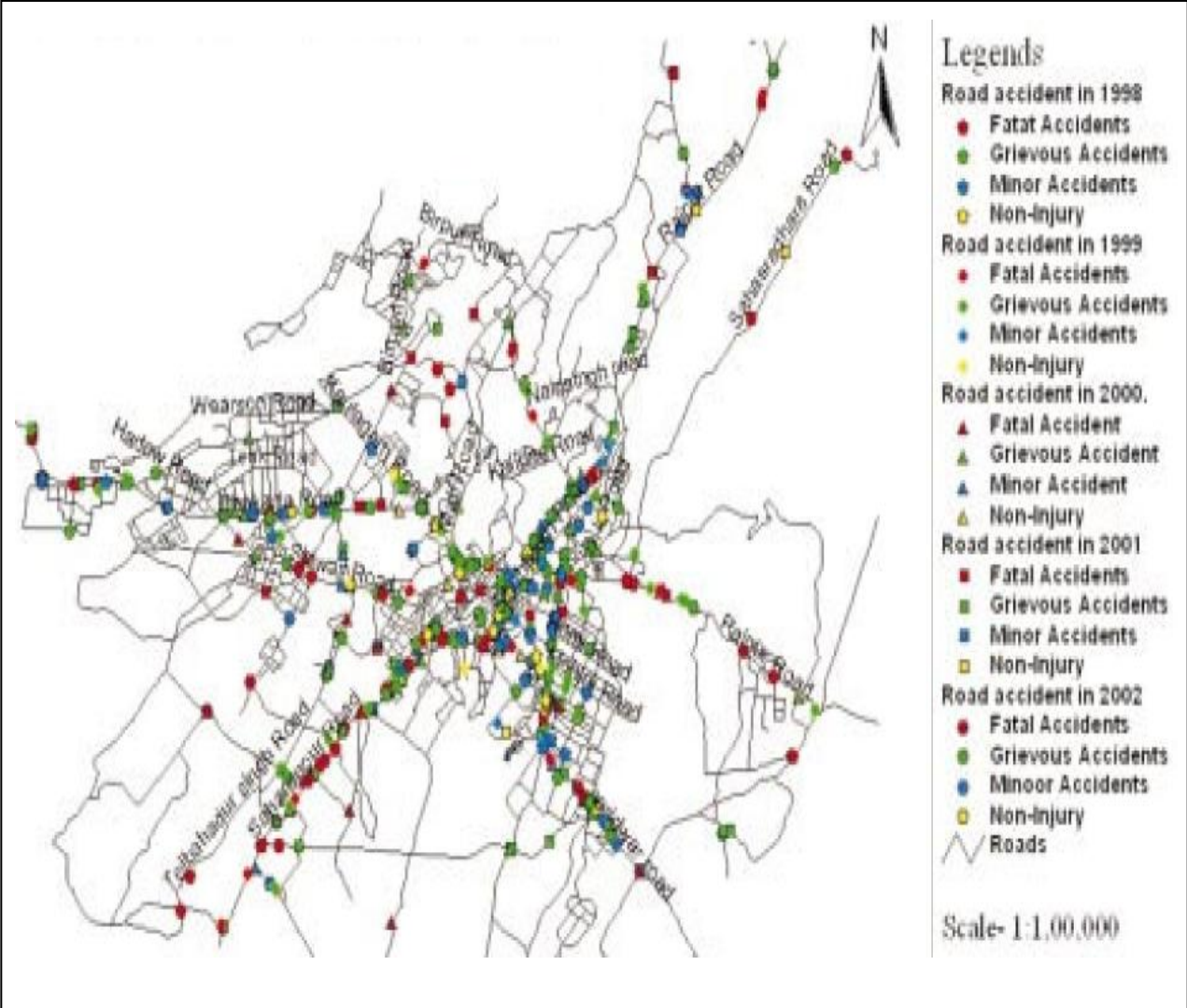


Figure7. Location and type of accidents in Dehradun (Ghosh, 2004)

Also, accidents data has been analysis according to the year months. The table below shows the distribution as per month.

It is shown that the maximum number of accidents occurs in month of May. The high number of accidents in this month could be due to the high increase of tourist vehicles, which pass through Dehradun city to Mussorie. Where Dehradun is conceders the gateway to the hill station Mussorie and to holy places likes Yamnotri, Gangotri and Kedarnath (Ghosh, 2004). So, this month needs more consideration of traffic management and regulation to reduce high rate of traffic accidents.

Sl. No	Month	No. of accident
1	January	63
2	February	62
3	March	65
4	April	64
5	May	74
6	June	58
7	July	58
8	August	47
9	September	60
10	October	42
11	November	42
12	December	55

Table3. Monthly distribution of accidents in Dehradun

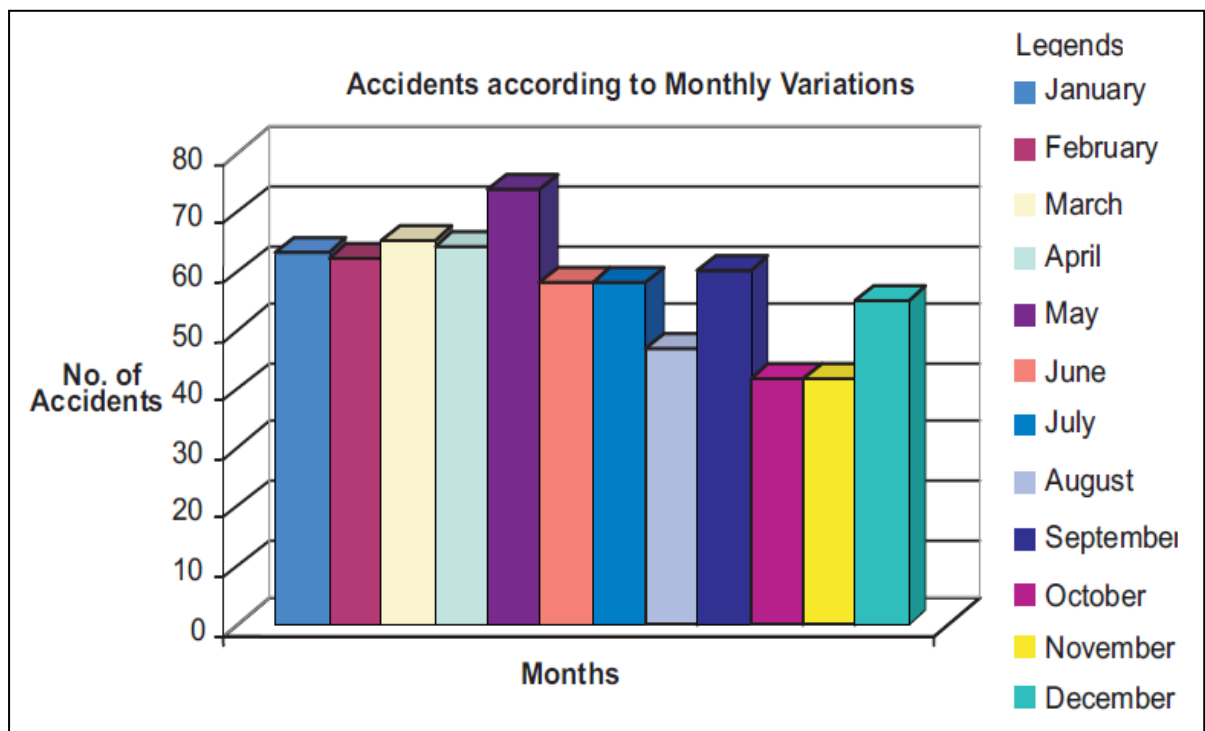


Figure8. Graphical Monthly distribution of accidents in Dehradun (Ghosh, 2004)

Analysis of accidents per type of the vehicles is established and the results are estimated as shown in the table below. The vehicles have been classified into three categories:

- ✚ Heavy Vehicles – Truck, Bus and Tractor
- ✚ Medium Vehicles – Private Car, Jeep, Van, Auto Rickshaw, Taxi
- ✚ light vehicles – Motorcycle, Scooter, Cycle

Sr. No.	Year	Heavy Vehicles	Medium Vehicles	Light Vehicle	Unknown Vehicles
1	1998	45	97	68	3
2	1999	68	103	85	13
3	2000	61	70	40	6
4	2001	54	68	54	12
5	2002	58	76	45	7
	Total	286	414	292	41

Table4. Accidents rate According to the vehicle type (Ghosh, 2004)

Medium type of vehicles is high in accidents rate as compared to other vehicles. This is due to the fact the normally tourists passing through the town are traveling in Cars, Taxis, Vans and Jeeps. Another reason for such high number of accidents involving medium and light vehicles may be due to disregard for traffic rules. The remedial measures for enforcement of traffic rules have to be strictly enforced by traffic police.

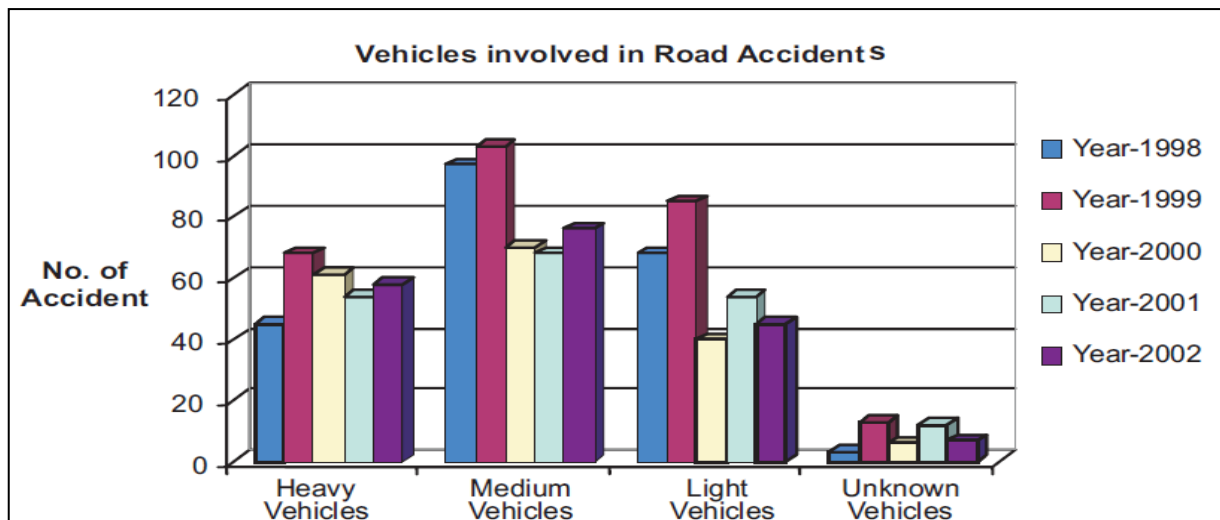


Figure9. Graphically accidents distribution as per vehicle type (Ghosh, 2004)

Analysis of accidents per Time of the day has been conducted as follows

- ✚ 6 AM to 10 AM working rush hours
- ✚ 10 AM to 2 PM noon hours
- ✚ 2 PM – 6 PM sopping rush hours
- ✚ 6 PM –10 PM evening rush hours
- ✚ 10 PM - 6 Am night hours

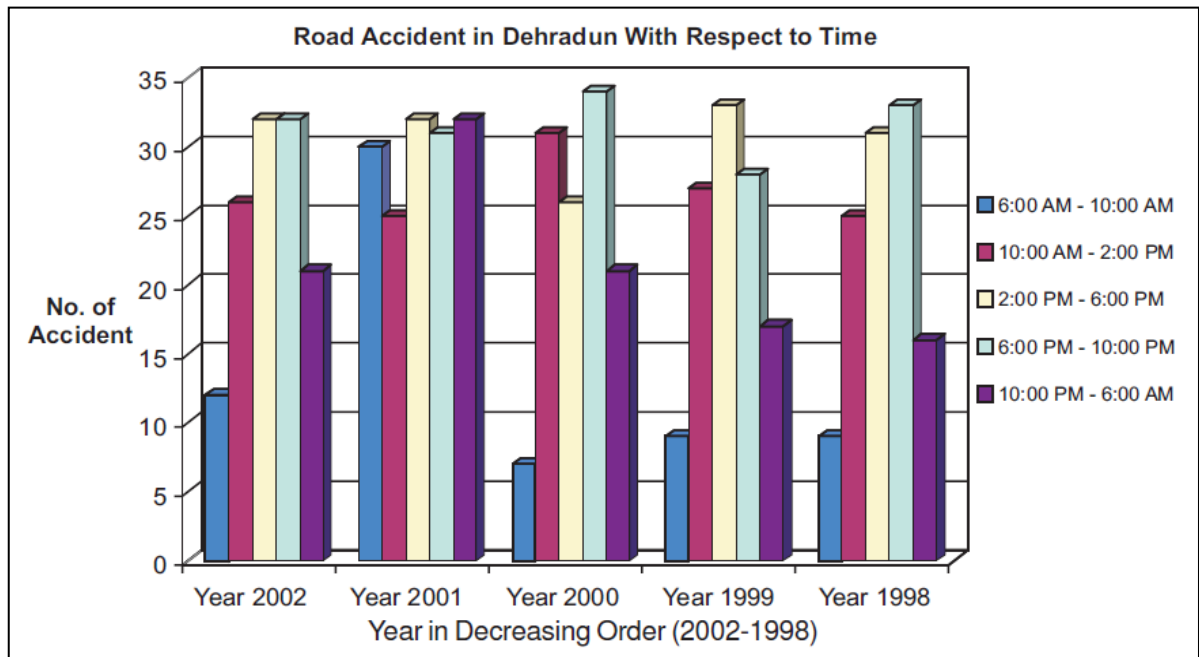


Figure10. Accident rate as per time of the day (Ghosh, 2004)

From figure11 it is clearly seen that the number of accidents during the day is more than the accident during the night. The rate of accidents during the day periods is various due to the rush hours and lack of proper traffic management. At the evening period 6 PM to 10 PM that it is may be due to insufficient street lighting.

Finally, Analysis of accidents per sex the rate of accidents by males is much higher than those of females as shown in the figure below. The majority of drivers are male in India; hence this is the vulnerable group. It is an indication that proper enforcement of driving education has to be imparted to the drivers.

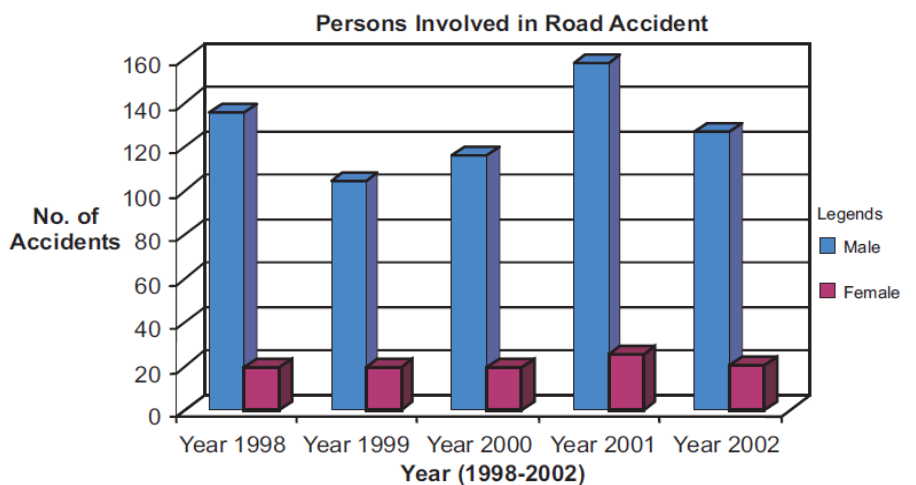


Figure11. Accident as per sex (Ghosh, 2004)

6.1.4 Conclusion for Case Study (1)

In conclusion, this study leads the Indian people especially road engineers and traffic agencies in Dehradun to look for proper solution and enhance road safety, where more than 72% of the accidents in this city are fatal and grievous injuries (Ghosh, 2004).

In general the most important notes in this study are:

- ✚ Highest accident occurs in May month, this sudden increase may be due to the increase of passing of tourists through Dehradun to Mussorie and other tourism and holy places.
- ✚ Rush hours needs more care, where people return from offices or go for shopping.
- ✚ A proper street lighting is needed.
- ✚ Education and enforcement laws are needed for drivers.

So, this study indicates that GIS is a very helpful for transportation engineers and road designers to improve and enhance existing roads or planning with better safety for new roads. Also, it helps them to make a strategy to develop road safety.

6.2 Case Study (2)

The increase of accidents deaths in United Kingdom becomes urgent issue, where the people killed due to accidents is 5 times more than those murdered. In 2000 Government of the United Kingdom is planned to set out a target for road safety for the next 10 years (Hasseea, 2003).

West Midlands is a Metropolitan county in western central of United Kingdom (Wikipedia). In 2002 injury accidents recorded in West Midlands are 10,197. Seven Authorities in West Midlands, each one of them set their one program work to reduce road accidents individually (Hasseea, 2003).



Figure12. ■ West Midlands, Wikipedia

Mott MacDonald Group (MM) has developed a GIS based accident system (JSYS) for Metropolitan Area for processing and analysis of accidents, they aim to use the system for other parts of the country (Hasseea, 2003). JSYS has proved a very useful application for road safety engineers to improve road safety after accident analysis. An internet GIS is being developed to replace JSYS (Hasseea, 2003).

6.2.1 JSYS Accident System

JSYS consists of two main modules:

- + Accident processing module for accident data entry.
- + Accident analysis module for database queries and analysis.

The JSYS program has developed using MapInfo with MapInfo's Mapbase's language (Hasseea, 2003). We discussed enough about using GIS for accident data analysis in the previous case study. So, I will not discuss any more about JSYS database analysis. JSYS help in processing of accident data. Also, JSYS perform a complex special analysis.

6.2.2 Site Monitoring

As we know that the most important issue for using GIS to reduce road accidents is monitoring. The accidents identification and investigation accident sites together with the design and implementation of remedial measures is a major part of the strategy to reduce road accidents. Site monitoring tool is one of the important tools in JSYS (Hasseea, 2003).

6.2.3 Case Study for Site Monitoring

Cannock Road between Victoria road and cross street North in Wolverhampton city is used as a case study for site monitoring, the site is shown in the figure below. The road schemes implemented by Wolverhampton city cancel. There were 152 injuries, including 13 serious injuries 3 of them are children and 139 slight injuries (Hasseea, 2003).

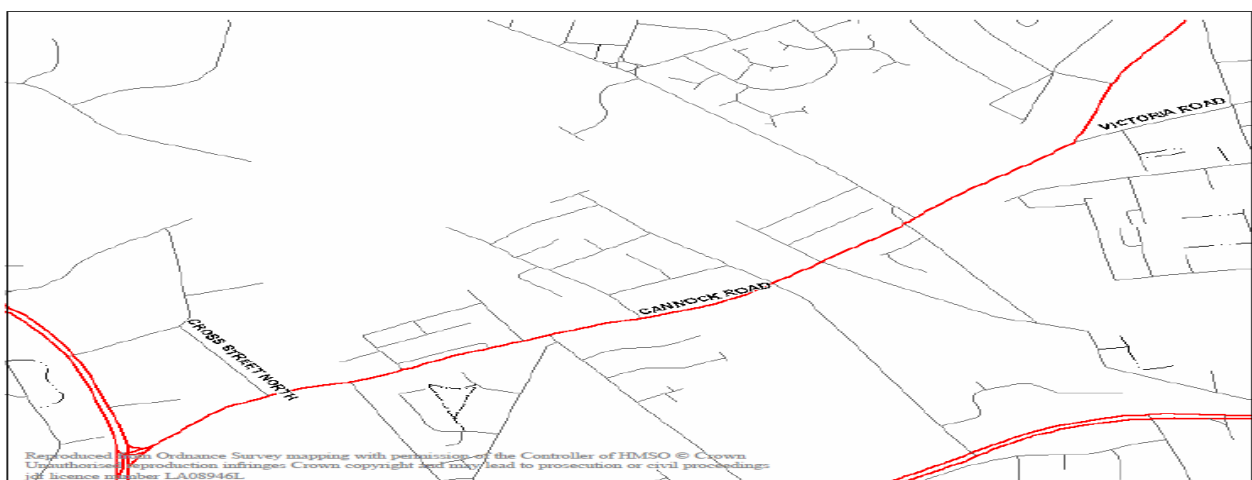


Figure13. Cannock Road between Victoria road and cross street North (Hasseea, 2003)

Using JSYS system, they found that the major causes of accidents at Cannock Road between Victoria road and cross street North in Wolverhampton city were:

- ✚ Turning conflict
- ✚ Pedestrians and vehicles conflict
- ✚ General speed of traffic
- ✚ Wet road surface problem

This portion of the road redesigned to enhance the road safety in this portion. The main components of improvements were as follows (Hasseea, 2003):

- ✚ A mini roundabout with pedestrian and cycle facilities
- ✚ Traffic signal junction with pedestrian and cycle facilities at park lane junction
- ✚ Pedestrian refuges, and street narrowing at existing crossings
- ✚ Central hatching to reduce speed
- ✚ Anti-skidding surface to reduce wet road accidents

The reduction of accidents of five years before area implementation and equivalent five years after the scheme implementation was estimated. The results as follows (Hasseea, 2003):

- ✚ 70% Reduction of killed or seriously injuries
- ✚ 80% Reduction in child killed or seriously injuries

In conclusion GIS is helpful tool in reducing the accidents. It assists the road engineers to identify the spot location of accidents and it deals with a huge amount of database of accidents such as locations, reasons, types, causality, weather condition, and other condition related to the accidents. It is simplify quarrying for engineers and evaluate the make a proper solutions to reduce the accidents.

7. Conclusion

Dealing with abundant accidents data is too difficult using paper maps allied to databases like excel spreadsheets as they do in the past. Nowadays, GIS make this issue much easier it can analysis a very huge amount of collected data with various conditions and causes of accidents even wither and road surfaces conditions. The use of GIS enables relevant accident data to be quickly processed and displayed on a map. So, GIS facilitate the road designers and engineer's mission and it helps them tremendously to identify the accidents rates, accident reasons, and accident fatality. Data analysis will be very useful to roadway designers, policy makers, decision makers, law enforcement, and emergency response. Recently, many applications have been presented that show how the time and effort required to display and analyze accident data can be effectively reduced. Finally I would like to say that the ultimate goal of using GIS is not to conduct analysis only, but how to take actions that will reduce the accident rates and severity.


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