Name	Waseem Khan
ID	7337
Submitted to	Engr Hamza Mustafa
subject	Gis application to civil Engineering

Final Exam mini project

Development And Analysis Of GIS Based Road Traffic Injury Database For Karachi,Pakistan

DEVELOPMENT AND ANALYSIS OF GIS-BASED ROAD TRAFFIC INJURY DATABASE FOR KARACHI, PAKISTAN

Research Associate, Road Traffic Injury Research and Prevention Center (RTIPC), Karachi

ABSTRACT

Over the last few years, the rate of road traffic accidents in Karachi has increased considerably. Many precious lives have been lost on account of this menace. In the absence of a comprehensive road traffic accidents database, the problem of road traffic accidents was not properly addressed and got worse with time. The Road Traffic Injury Research and Prevention Center was established in collaboration with Jinnah Postgraduate Medical Center, NED University of Engineering and Technology, and Aga Khan University to scale the burden of road traffic injuries and to devise prevention strategies to improve road safety.

Road traffic injury data were collected for 2007 and 2008 at five selected trauma centers by Research Assistants. Research Assistants collected and documented information from accident victims and their attendants on a standardized questionnaire. The data contained personal information of victims, accident details, vehicle information, spatial information, and medical condition of the patient.

For the year 2008, data related to 32,497 road accident victims were collected, which showed a fatality rate of 3.6%. Riders of motorcycle were identified as most vulnerable road users, constituting 60% of road traffic injuries and 39% of the fatalities. Pedestrians were 22% of the injury victims and 39% of the fatalities with highest fatality rate of 6.3% among road users.
GIS-based road traffic injury database enhance the presentation and alleviate the interpretation of the data. High risk zones can easily be identified and prioritized for implementation of accident prevention strategies. Town map of Karachi, extracted using Landsat-7 imagery of Karachi, was used for geospatial analysis of injury data. Thematic maps for road traffic injury data of different towns and roads in Karachi were created using GeoMedia Pro 6.0 and high risk zones were identified for various road users.

This paper attempts to explain framework for development of the GIS-based Road Traffic Injury Database. The paper details out the use of such tool in spatial analysis of road traffic injury patterns.

1. INTRODUCTION

Over the last few years the rate of road traffic accidents in Karachi has increased considerably. Many precious lives have been wasted on account this menace. This paper analyses Karachi Road Traffic Injury data of 2008 and presents a framework for GIS based spatial analysis of road safety parameters.

1.1 Background

Road Traffic Injury Research and Prevention Center (RTIPC) was established in collaboration with Jinnah Postgraduate Medical Center (JPMC), NED University of Engineering and Technology, and Aga Khan University Hospital, recognized by Federal Ministry of Health, Government of Pakistan. The research center is financially supported by Indus Motors (pvt) Ltd.Road Traffic Injury Research and Prevention Center is developing first ever comprehensive database for victims of road traffic accidents in Karachi, Pakistan. Previously, the police database was used officially for analysis of accidents which does not contain all important information about traffic accident victims and the accidents were highly underreported. Police database for accidents shows around 1200 injuries and 600 fatalities during 2008, while the accident injury database developed at RTIPC recorded 32,497 injuries and 1,185 fatalities during 2008. For better understanding and analysis of accidents, a comprehensive database of road traffic injuries was developed at RTIRPC.

1.2 Review of Related Work

The World report on road traffic injury prevention, jointly issued by the World Health Organization (WHO) and the World Bank, was the first major report on safety impacts of traffic related crashes. According to figures presented in this report, about 1.17 million people were killed in road accidents and about 50 million were getting injured each year (Uddin (2000)). Projections indicate that these figures will increase by about 65% over the next 20 years unless there is new commitment to prevent accidents. Data showed that over 80% of deaths in road accidents were recorded in developing regions of Africa, Asia, Latin America, and Middle East. The proportion of over 40% was in the countries of Asia-Pacific region, which had only 16% share of global vehicles. The majority of road accident victims in developing countries were pedestrians, motorcyclist, and non-motorized vehicle occupants. Costs related with traffic fatalities and injuries were significantly higher than other road user costs. In 2002, almost 3 million injuries and 42,815 fatalities occurred on U.S. roads, which resulted in an estimated $ 230 billion financial loss. The global cost of road traffic accident in developing countries was estimated by the WHO as $US 70 billion each year, corresponding to 1.0%-1.5% GNP (Uddin (2000)).

High rates of serious road traffic accidents have been reported for several Arabian Gulf countries, including the United Arab Emirates (UAE). The research was aimed to describe quantitatively the injuries and fatalities from road traffic accidents in the UAE, to identify their trends during the period 1977-1998, to compare the results with those of developed countries, and to identify the potential causes of road traffic accidents (Mohammad, et.al (2002)). The UAE accident data was obtained from the police of UAE and for comparison with international trends, the data was obtained from WHO statistics report and other published literature. Between 1985 and 1998, the severity rate (the ratio of fatalities and injuries per 1,000 crashes) increased more than three times in the UAE. The severity rate of accidents in UAE was high when compared with a number of selected countries. The causes of road crashes were not clear but the most likely cause could lie in speeding, careless driving, the changing vehicle mix on the roads and the standard of immediate care available for victims. The analysis of the gender, age structure, and road user groups of road traffic accidents during 1977-1998 revealed that 13.5% of those deaths were

among females and 86.5% were among males. A proportion (61.7%) of road traffic accident deaths among adults from the age group (15-44 yrs) was similar to their average proportion of the population (58.4%) during 1977-1998. Children aged 0-14 years accounted for 14.5% of total road traffic accident deaths, although they were involved in less than 1% of total road traffic accidents. The results showed that motor vehicle occupants accounted for 77.1% of all road traffic casualties while pedestrian and cyclist accounted for 22.9% during 1977-1998 (Mohammad, et.al (2002)).

More than 80,000 people in China die from road traffic injuries and approximately 300,000 persons suffer nonfatal injuries each year (Wang, et.al (2003)). The number of traffic injury victims has increased 10-folds and fatalities 4-fold, since 1951. Road traffic fatalities and injuries in China rose with rapid motorization. Motor vehicle increased 390-fold between 1952 and 1999. The data showed that young people (age 21-40) accounted for 46% of the fatalities and 60% of people injured in road traffic crashes in 1999. With regard to gender, male accounted for approximately three quarters of all those injured or killed in road traffic accidents in 1999. Distribution of fatalities in 1999 by road user group showed that pedestrians (26%), passengers (23%), bicyclists (16%), and motorcyclist (17%) together accounted for 82% of all road users killed in road traffic accidents. Automobile drivers accounted for 10% of the fatalities. According to the data human error, mostly driver error, accounted for more than 90% of the reported causes of road traffic crashes (Wang, et.al (2003)).

After reviewing literature related to accident analysis it was concluded that a comprehensive road traffic accident database was essentially required for analysis of accidents trends and to devise intervention strategies to improve road safety.

1.3 Objectives of the Research Project

Road Traffic Injury Research and Prevention Center was established to achieve following objectives:

1. To quantify and assess severity of road traffic accidents.

Data of road traffic accident victims reported to five major trauma centers in Karachi was collected on a standardized questionnaire. The data was compiled and analyzed to assess the magnitude and severity of road traffic injuries in Karachi, Pakistan.

2. Development of GIS-based database and geospatial analysis for roads and administrative zones in Karachi.

A GIS-based database was created for all road traffic injuries and fatalities reported to five major trauma centers in Karachi. The data was analyzed for roads and townships of Karachi to prioritize the improvement plans and intervention strategies to improve road safety.

3. Identification of vulnerable road user groups and major causes of accidents.

Road traffic injury data was reviewed and analyzed for identification of major causes of accidents that help in targeting the root causes to improve road safety. Vulnerable road user groups were identified using the injury data.

4. Detailed analysis and improvement of black spots.

High risk zones and black spots were identified and analyzed based on geospatial analysis of the accident database. The improvement plans suggested for a black spot were implemented through City District Government of Karachi to rectify the road engineering problems causing the accidents on black spots.

2. METHODOLOGY OF DATA COLLECTION AND DEVELOPMENT OF GIS-BASED ACCIDENT DATABASE

Methodology of data collection and development of GIS-based accident database is explained in this chapter of the paper.

2.1 Data Collection at Trauma Centers

The data of road traffic accident victims reported to five major trauma centers was documented on a standardized questionnaire by research assistants deployed at the trauma center. The questionnaire contains personal information about patient, location details, vehicle details, and medical information about the victim of accident. The data of accident victims was collected at five major trauma centers in Karachi, of which three were public sector hospitals and two were private sector hospitals. List of hospitals participated in this research is given below:

1. Jinnah Postgraduate Medical Center;
2. Civil Hospital Karachi;
3. Abbasi Shaheed Hospital;
4. Liaquat National Hospital;
5. Aga Khan University Hospital.

2.2 Development of GIS-based Accident Database

The accident data collected from selected trauma centers was complied and processed using spreadsheet. The location of accident established by inquiring victims, their attended, ambulance services, and police was located on Google Earth to obtain the latitude and longitude of the accident location. The coordinates of accident location were used as data attribute for analysis of accident database. Road and townships pertaining to the location of accident were identified and used as a data attribute in the accident database.

2.3 Process Cycle of Data Collection and Analysis

The data collected at trauma center was transferred to RTIPC established at Jinnah Postgraduate Medical Center for compiling and analysis. Figure 1 shows the process cycle of data collection and analysis.

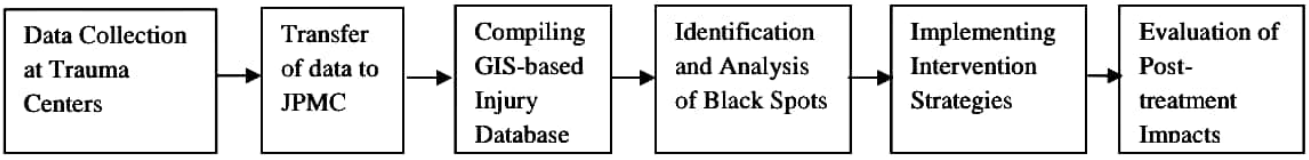

Figure 1. Process cycle of the injury data collection and analysis

3. BASIC TRENDS OF ACCIDENTS AND GEOSPATIAL ANALYSIS OF ACCIDENT DATABASE

Basic trends of road traffic injuries and fatalities are presented in this chapter. Analysis of injury database was carried out to identify vulnerable road user group, affected gender, and age group.

GIS-based locations of accidents were analyzed to identify high risk zones and black spots. The data of road traffic injury victims for 2008 was analyzed for this research paper. 32,497 road traffic injuries and 1,185 fatalities were reported to five selected trauma centers in Karachi during 2008.

3.1 Road Traffic Injuries by Gender of Accident Victim

Review of literature reveals that males are more exposed to road traffic accidents in developing countries. A similar trend was identified for the accident database developed for a mega city of developing country Pakistan. The data shows that almost 90% of road traffic victims were males while females accounted for 10% of the injury database. This is due to the dominated participation of male gender in social and economical system of Pakistan. Figure 2 shows the gender involvement in road traffic accident.

3.2 Classification of Road User Groups in Road Traffic Injury Victims

Road user affecting from road traffic accidents mostly depends on the traffic mix of a town. In Pakistan, like other developing countries, number of motorbikes has increased tremendously after reduction in price of motorcycles. Motorbike offers a relatively cheaper and faster mode of transportation in the traffic environment of Pakistan. The number of motorcycle units produced in Pakistan during 2001-2002 was 120,627, which increased almost 6-folds during 2005-06 to 751,667. The growth rate of motorcycles was 11% during 2001-2002. The highest growth rate (from 2001-02 to 2005-06) was 112% during 2003-04 and it was recorded 32% during 2005-06 (USAID (2006)). Total number of registered vehicles in Karachi was 1,809,500 in 2007 of which cars/taxi were 49.3%, motorbikes were 40.4%, public transport buses were 1.3%, loading pickups were 4.9%, rickshaws were 2.4%, and HTVs were 1.4% of the registered vehicles [Jooma, (2007), URC (2009)]. Figure 3 shows share of road users in road traffic injuries and fatalities reported in 2008.

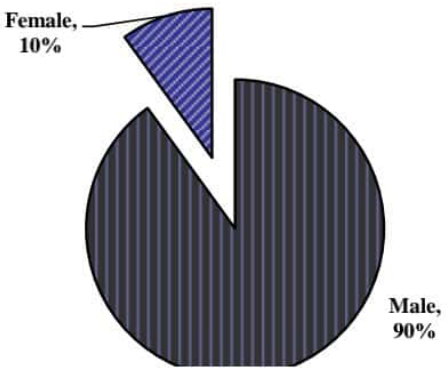

Figure 2. Gender involvement in road traffic accidents in Karachi

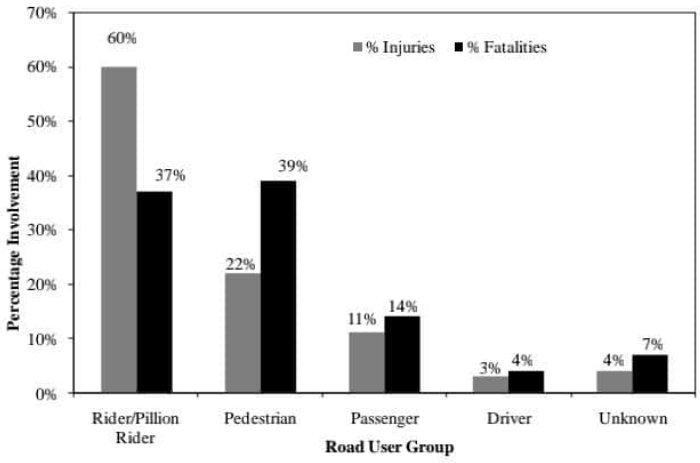

Figure 3. Road user involvement in road traffic casualties

The data shows that riders or pillion riders of motorbikes were highly affected by road traffic accidents. Motorbike riders/ pillion riders accounted for 60% of road traffic injuries and 37% of the fatalities. Pedestrian was second most affected road user group accounted for 22% of road traffic injuries and 39% percent of the fatalities. Pedestrians were identified with highest fatality

rate (6.4%) among all road users, followed by motorbike riders (2.2%). Occupants of motorized vehicles, drivers and passengers, were found comparatively safe.

3.3 Analysis of Road Users by Age Groups

The review of literature reveals that young road users are badly affected by road traffic accidents. Young road users actively participate in social and economical activates of a society. A similar trend was observed when the accident database for 2008 was analyzed. The data showed that young road users (ages between 16-30 years) were the highest in road traffic injuries and fatalities. Age groups between 16-30 years accounted for 54% of the injury data and 40% of the fatalities. Second most affected age group was between 31-45 years of age, which accounted for 21% of road traffic injuries and 26.3% of the fatalities. Young road users (age groups 16-30 and 31-45) accounted for 75% of road traffic injuries and 66% of the fatalities. It is due to the fact that most of the motorbike riders pertain to this age group of road users and motorbike riders/ pillion riders account for 60% of the injury data. The data showed that life expectancy in a road traffic accident reduces with the age of the accident victim. Road users older than 60 years of age were reported with a fatality rate of 8.7%, which is highest among all age groups while the least fatality rate was reported in age group 16-30 years (2.4%). Figure 4 shows the data of road traffic injury victims from various age groups.

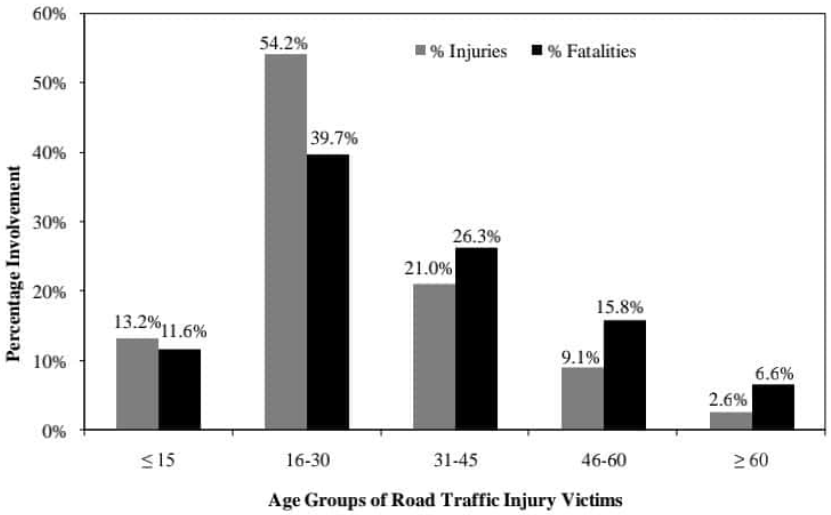

Figure 4. Road traffic injury victims by age groups

3.4 Geospatial Analysis of Accident Database for Townships in Karachi

The locations of accidents, recorded in injury recording questionnaire by interviewing patient, their attendants, ambulance services, and police, were searched on Google Earth to obtain geographical coordinates of the accident location. Latitude and longitude of accident location were used as data attribute in GIS-based accident database. Each accident was plotted individually using the coordinates of accident location obtained from Google Earth.

Landsat-7 imagery, downloaded from the United States Geological Survey (USGS) for Karachi and surrounding areas, was used to create a town map for Karachi. The town map was extracted

using Landsat-7 imagery and town location map in GeoMedia Pro 6.0 [KMCDP (2009)]. The data for each town of Karachi was extracted and used as a data attribute for geospatial analysis of road traffic accidents. Karachi is administratively divided into eighteen towns with four cantonment areas and Defense Housing Authority (DHA). Figure 5 shows a town map of Karachi extracted using Landsat-7 imagery and town map of Karachi.

Saddar town of Karachi is the central business district. The highest number of accident victims was reported from Saddar town, which were 5,100 followed by Jamshed town with 3,473 accident victims reported in 2008. Shahrah-e-Faisal, the busiest arterial in Karachi, mainly passes through Jamshed town and a small part of this road lies in Saddar town. M.A. Jinnah Road, one of the busiest arterials in Karachi, completely passes through Saddar town. Moreover, Jinnah Postgraduate Medical Center and Civil Hospital lies in Saddar town, therefore the Saddar town was reported with highest number of road traffic accident victims. Figure 6 shows thematic map of road traffic accident victims reported from townships of Karachi and Figure 7 shows the fatalities by towns of Karachi. The data for cantonment areas could not be obtained as these areas were administrated by armed forces.

Geographical presentation of accident data makes is easy to identify high risk zones that helps in prioritizing the improvement plans and helps decision makers to set priorities. Saddar and Jamshed towns were identified as high risk zones. Some more thematic maps were created for road user groups that presented high risk zones with respect to different road users.

3.5 Analysis of Roads for Road Users and Severity of Accidents

The geographical coordinates obtained using Google Earth for locations of accident were used to identify the road on which accident occurred. A road map for major roads in Karachi was also extracted using Landsat-7 imagery. The data for road traffic injuries and fatalities for major roads in Karachi was further analyzed for road users and severity of accidents. Figure 8 shows fatalities of road users on major roads of Karachi in 2008. The data shows that National Highway was reported with highest number of road traffic fatalities (105) followed by Korangi Road with 76 fatalities in 2008. Roads can be further divided into small sections to obtain accident data for these sections and that will help to prioritize the road sections for improvements.

3.6 Geospatial Analysis of Road Crashes on Major Arterials

Road crashes on major arterials are important entities in terms of overall road safety situation as well as inducing long term congestions. Figure 9 and Table 1 show GIS analysis performed to ascertain the safety conditions of major arterials of Karachi. The above analysis shows that road crashes on major arterials show a clearly observed trend which has spatial dimensions which needs to be considered in terms of devising remedial measures. All the data and analysis show capability of GIS in the analysis of traffic accidents.

4. CONCLUSIONS

A GIS-based road traffic injury database was developed at RTIPC using the injury data collected from five major trauma centers in Karachi. Details of accident and injuries were collected by research assistants deployed at selected trauma center on a standardized questionnaire.

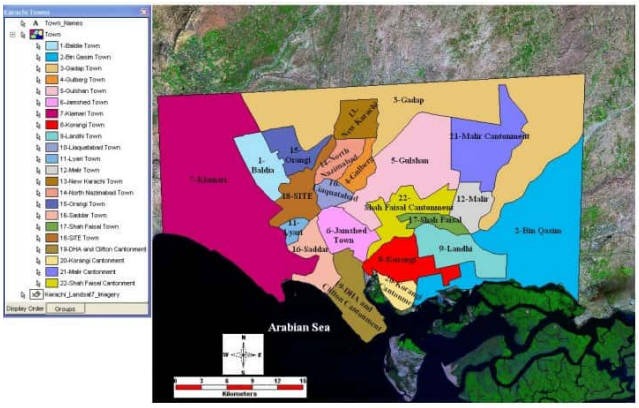

Figure 5. Town map of Karachi

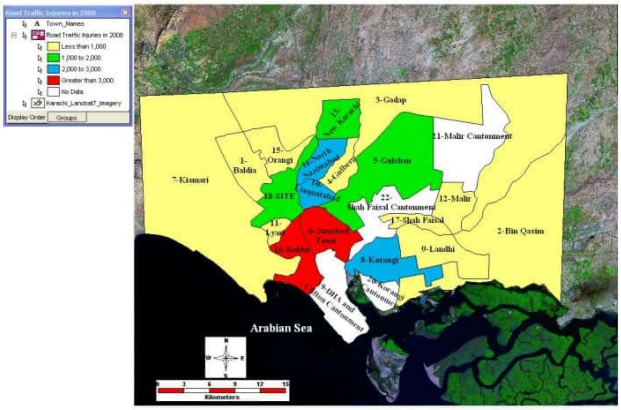

Figure 6. Spatial representation of road traffic injuries

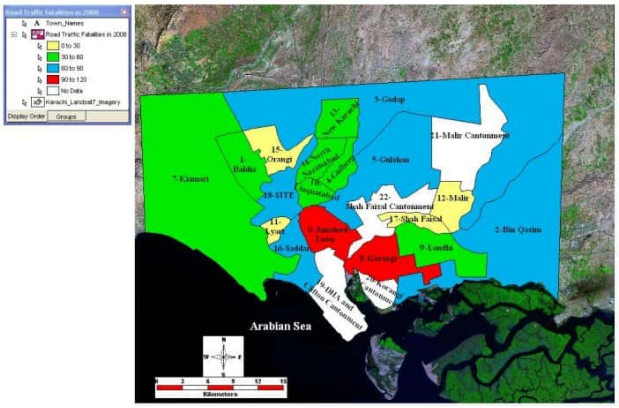

Figure 7. Spatial representation of road traffic fatalities

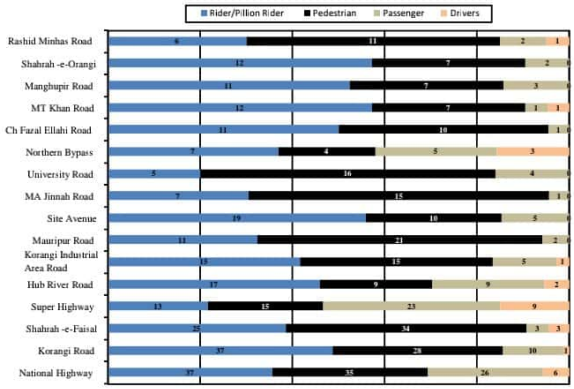

Figure 8. Fatalities on major roads of Karachi in 2008

Table 1. Analysis of road crashes on major Arterials in Karachi

Arterial	Fatalities	Severe injuries	Minor injuries	Total RTI victims
Central Ring	110	346	1,874	2,330
1st Arterial	60	358	2,190	2,608
5th Arterial	55	314	2,194	2,554
2nd Arterial	68	291	1,576	1,935
4th Arterial	70	284	1,094	1,448
3rd Arterial	26	204	552	782
II Corridor	28	138	395	561
6th Arterial	25	105	514	644
7th Arterial	23	95	260	378
Mai Kolachi Bypass	22	63	304	389
Shaheed-e-Millat Expressway	14	62	143	219
Lyari Expressway	1	14	58	73
Other Residential Streets	681	3,839	13,795	18,315
Grand Total	1,184	6,113	24,949	32,246

1st Arterial = MA Jinnah Road + Jahangir Road + Shahrah-e-Pakistan; 2nd Arterial = Shahrah-e-Faisal; 3rd Arterial = University Road
4th Arterial = Main Korangi Road + Korangi Industrial Area Road + Bahadur Yar Jang Road + Labor Square Road+ Mehran Highway
5th Arterial = Business Recorder Road + Nawab Sadiq Ali Khan Road + Sher Shah Suri Road + Ch. Fazal Elahi Road
6th Arterial = Manghopir Road; 7th Arterial = Shahrah-e-Orangi
Central Ring = Haji Ibrahim Rehmat Ullah Road+ Sir Shah Muhammad Suleman Road + Hakim Ibn-e-Sina Road, SITE Avenue + Maripur Road + MT Khan Road + Club Road

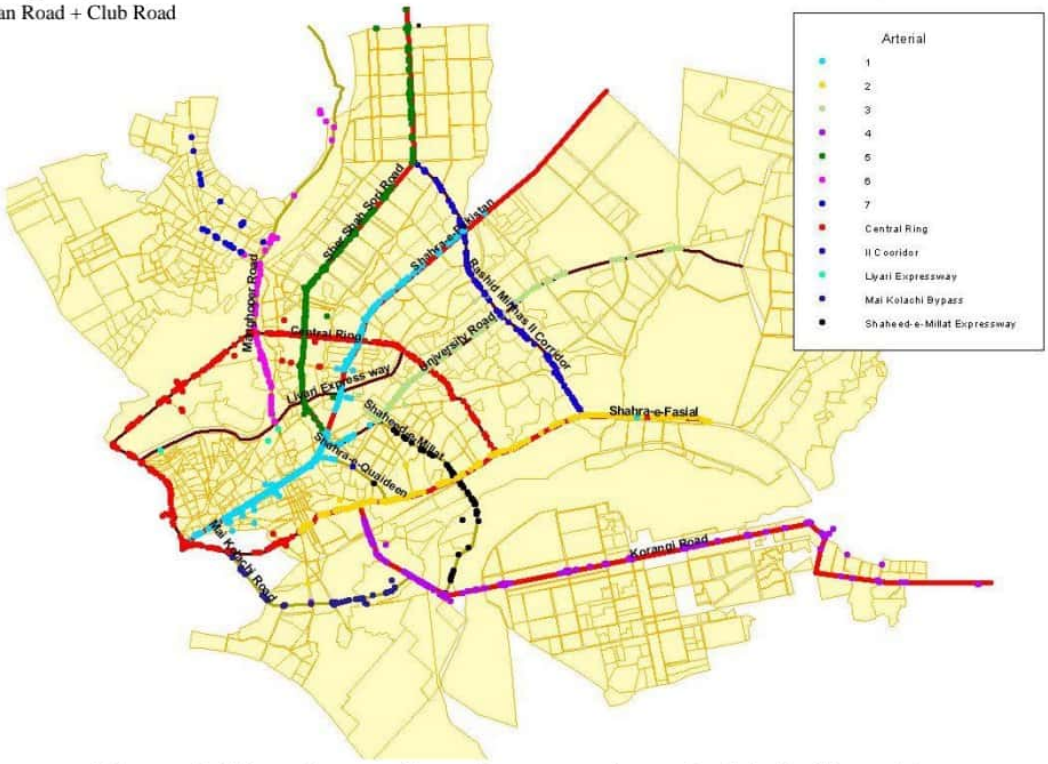

Figure 9. Mapping road crashes on major arterials in Karachi

The location of accident, established by interviewing the victim, their attendants, ambulance services, and police, was searched from Google Earth to find the geographical coordinates. These geographical coordinates were used as a data attribute to identify the town and road on which

accident occurred. A town map of Karachi extracted using Landsat-7 imagery of Karachi in GeoMedia Pro 6.0 was used for geospatial analysis of road traffic injury data for 2008.

The data of 32,497 road traffic injury victims and 1,185 fatalities reported to five selected trauma centers was analyzed for road user groups, age groups, and geospatial analysis. The data shows that male gender accounts for 90% of the injury data while females account for 10% of the injuries. Motorbike riders were identified as most vulnerable road user group constituting 60% of the injury data and 37% of the fatalities. Pedestrians were identified with the highest fatality rate of 6.4% and motorbike riders with the least fatality rate of 2.2%. Occupants of motorized vehicles accounts for 14% of the injury data and 18% of the fatalities. Road users in age group of 16-30 were identified as most vulnerable to road traffic accident which accounts for 54% of road traffic injuries and 40% of fatalities. Road users older than age of 60 years were identified with the least life expectancy in road traffic injuries having a fatality rate of 8.7%.

Geospatial analysis of accidents database significantly enhance the visualization that helps in identifying high risk zones and vulnerable road users. The GIS-based database of road traffic injuries was used in prioritizing the improvement strategies and improving road safety in high risk zones and black spots. The GIS-based accident database can also be used in ITS-based transportation system to implement intervention strategies in high risk zones and black spots.

5. REFERENCES

Uddin, W. (2007) Assessment of Transportation Related Safety and Public Health Impacts Using Remote Sensing and Geospatial Analysis Technologies. *7th Malaysian Road Conference, Kuala Lumpur, Malaysia*. July 17-19, 2007.

Mohammad, E., Nelson N. J. Owen, L., Peter, R., Abdulbari, B. (2002) Road traffic accidents in the United Arab Emirates: trends of morbidity and mortality during 1977-1998." *Accident analysis and prevention*. vol. 34, pp. 465-476.

Wang, S., Chi, G., Jing, C., Dong, X., Wu, C., Li, L. (2003) Trends in road traffic crashes and associated injury and fatality in the People's Republic of China, 1951-1999." *Inj Control Saf Promot*. Mar-Jun 2003.

USAID (2006) Policy Analysis on the Competitive Advantage of the Motorcycle Industry in Pakistan; Problems and Prospects. Competitiveness Support fund. *USAID-Ministry of Finance, Islamabad, Pakistan.* December 12, 2006.

Jooma, R. (2007) Presentation on Traffic Injuries. *Road Traffic Injury Research and Prevention Center. Karachi, Pakistan*. December 2007.

URC (2009) Total Number of Vehicles in Karachi. *Urban Resource Center.* http://www.urckarachi.org/No.%20of%20Vehicle%20till%202007.HTM. Accessed on February 23, 2009.

KMCD (2009) Town Location Map. *Karachi Mega City Development Project.* http://www.kmcdp.gos.pk/maps/location_towns.jpg. Accessed on April 24, 2008.