APPLIED GIS SOFTWARE FOR IMPROVING PEDESTRIAN & BICYCLE SAFETY

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Abstract. People are important in towns. They are the foundation of the social and economic processes that drive the urban system and sustain the urban fabric. While people spend much of their time inside buildings – at home, at work, and at play – it is the movement of people, whether in vehicles or on foot, that is indicative of the vibrancy of the town. Comfort and safety are important for people movement.

The crash data in cities, provinces started with the Traffic Organization of Inner Ministry looking at access management controls on functionally classified streets. Safety is a driving factor in access management and the crash reports are the best indicator of the lack of safe roads. This paper presents the development and findings of crash data from police reports and how they are being used in Geographic Information System (GIS). This tool generates a contour map identifying areas of high crash occurrence determined by crash density and clusters of crashes involving pedestrians or bicyclists. Summary statistics of the selected zones can be generated and displayed in a table or chart form

Keywords: GIS software, pedestrian safety, ArcView, road accident, traffic characteristics, data base.

1. Introduction

People are important in towns. They are the foundation of the social and economic processes that drive the urban system and sustain the urban framework [1]. The Pedestrian & Bicycle Safety Program focuses on identifying problem areas for pedestrians and bicycles developing analysis tools that allow planners and engineers to better understand and target these problem areas and evaluating counter- measures to reduce the number of crashes involving pedestrians and bicycles.

We should take steps to try to interest users that are not GIS technical people in the use of ArcView in desktop application. One of the projects that have been developed is making accident data obtained from Tehran available to ArcView users. Safety is a driving factor in access management and crash reports are the best indicator of the lack of safe roads. This paper presents the development and findings of crash data from police reports and how they are being used in Geographic Information System (GIS).

Geographic Information System (GIS) software turns statistical data such as accidents and geographic data such as road and crash locations into meaningful information for spatial analysis and mapping. In this project GIS-based analytical techniques have been applied to a series of pedestrian and bicycle safety issues:

- Safe routes for walking to school.
- Selection of streets for bicycle routes.
- High pedestrian crash zones.

In addition, tools were developed to make it easy for non-GIS specialists to perform similar analyses. These Software will provide insight into how GIS can be used to improve pedestrian and bicycle safety, demonstrate the safety analysis tools using real-world data and provide the software code that users can adapt to fit their particular needs. The minimum requirements to run the safety analysis tools include Arc View 3.0 or higher; Network Analyst extension and Windows offices.

Route to school and bicycle applications are not in traditional roadway inventory files maintained by local transportation agencies. This data should be collected along with other roadway inventory information during database updates.

This tool uses grid and map algebra to generate a contour map identifying areas of high crash occurrence as determined by crash density and clusters of crashes involving pedestrians or bicyclists. Summary

statistics of the selected zones can be generated and displayed in a table or chart form.

2. Traffic characteristics and pedestrian safety problem in Iran

Iran has the population of approximately 69,000,000 people. We have slow but steady growth of about 1,4 %. The Inner Ministry is responsible for transportation planning in the urban area. To assure the safety of the traveling public as the population grows, we are looking for safety management standards for our main arterials.

Iranian cities are characterized by heterogeneous traffic (a mix of non-motorized and motorized modes of transport) and mixed land-use patterns. Non-motorized vehicles are owned and used by a large section of the population. Car ownership rates in Iran is low compared to those of North America and Organization for Economic Cooperation and Development countries. In 1993 car ownership was 170 cars per 1,000 residents in Iran, compared to 561 cars per 1,000 residents in North America, and 366 in OECD countries [2].

A road traffic accident is a serious problem in Iran. Road accident fatalities and injuries are increasing with no sign of being under control. Fatalities increased by 28 % compared to 2000. On average, fatalities are increased by 20 % per year. Fatality rate was 151 fatalities per million inhabitants in 2001. Pedestrians fatality rate in Iran is high when compared to international statistics. The rate in Europe is 14 pedestrians per million inhabitants; it is the lowest in the world.

General accident statistics in Iran does not provide such level of details to make any comparison. However, still it is possible to indicate that pedestrian accidents, regardless of age groups, occur more frequently in the afternoon, at daytime and under dry weather conditions. Generally, children are considered a high risk pedestrian group. This may be due to children conception and perception of traffic situations which are not always well-developed. Table shows a perspective of safety problem in Iran.

3. Advantages of this program

3.1. Safe routes to school

This program generates a walking route and associated directions for:

(1) The shortest route to school,

(2) The safest route based on hazards associated with various road and traffic elements or

(3) The preferred route (based on preferences selected by the user). The potential users of this tool are parents, school transportation officials, planners, engineers, or others responsible for the safety of schoolchildren. The users will be able to choose routes with stops along the way (e.g., a friend's house) or routes that avoid certain locations.

3.2. Bicycle-compatible routes

This tool provides two output options. The first option is similar to the safe route to school. This option generates a map and directions for the quickest or best bicycle route for an individual trip between user-selected points. The best route is based on the bicycle compatibility index (BCI), which is the calculation of the comfort of each street segment based on roadway and traffic characteristics. The comfort index is based on ratings by more than 200 bicyclists. The second output option is a color-coded map based on the bicycle compatibility index of all streets in the study area. This option can assist bicycle coordinators, planners, traffic engineers, and others in designating bicycle routes and identifying bicycle facilities that may need improvement.

3.3. High pedestrian crash zones

This program uses grid and map algebra to generate a contour map identifying the areas of high crash occurrence as determined by crash density and clusters of crashes involving pedestrians or bicyclists. Summary statistics of the selected zones can be generated and displayed in a table or chart form.

In general, this has been an enviable project. There were no complications in the use of the data and the conversion to GIS system. The conversion of the data was fairly seamless and the accident points

Growth of accident rate between 2001–2003 in Iran [3]

Year	Accident in city	Rate growth	Percent of total	Accident out of city	Rate growth	Percent of total	Total
2001	263356	-	76	83499	-	24	346855
2002	351613	33	78	96449	15	22	448066
2003	445826	26	80	109023	13	20	554849

matched well, generally within 12 m, of the road centerline.

The future plans for the data include relating two digit street code to the actual arc segments tying this to the traffic count information. This will allow us to calculate accident rates rather than using raw crash numbers for analysis.

Overall, the data received have been an invaluable aid in the planning process. The data worked out well for the safety management project and continues to be a valuable tool for application other than originally intended. This was an important lesson to us in working with other agencies and departments.

4. Development of the data

The number and cause of collisions are the main determinate of the safety of the roadway (Fig 1).

Therefore, we must be able to examine in depth the collisions that occurred along arterial roadways to determine if they could be prevented by having access control measures in place.

The Inner Ministry is responsible for collecting all of the accident information in Iran, using an extract of the City's database in files. The files were then put into ArcView GIS to create maps of specific locations or to use the databases for queries. The result could then be displayed graphically as well as in a tabular form. GIS also allows inquires on the map that is linked to the database.

The Iranian Inner Ministry has been producing an accident report annually. This report contained limited information. The type and cause of crashes were not included. Plus the location of the accidents was summarized and not detailing specifically where the crashes had occurred. The next step in the search was

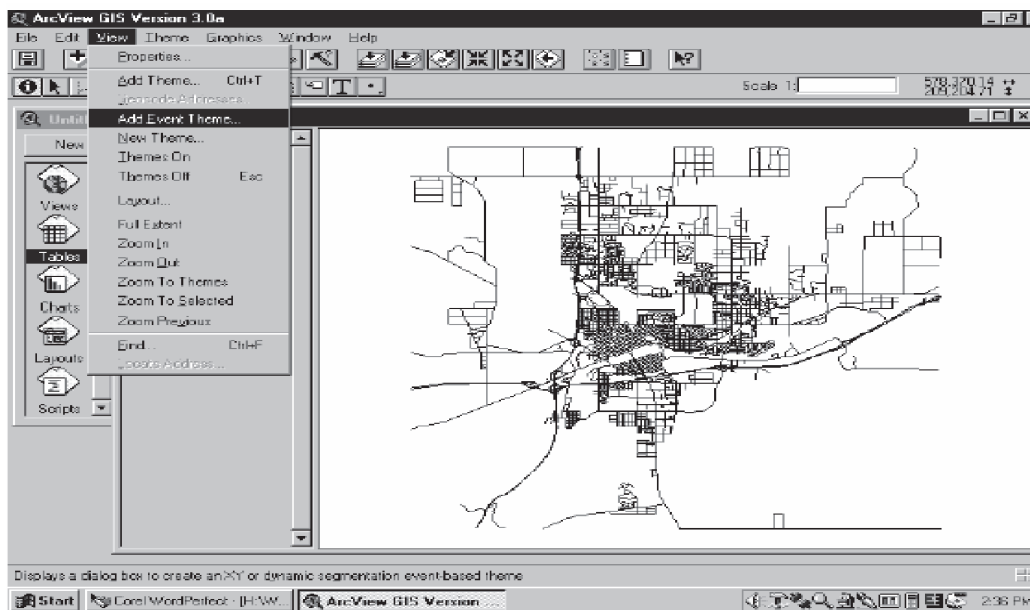**Fig 1.** Road and alley map of a district of Tehran [4]

Fig 2. The accident locations across in a city and the database connected to the map [5]
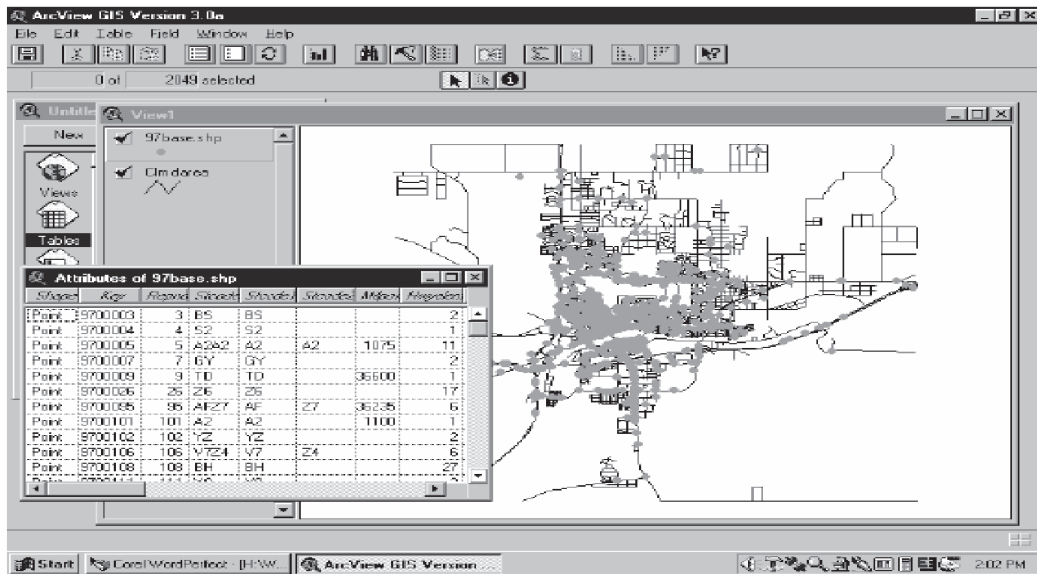
Fig 3. A ArcView program and database table of accident statistical software [5]

the Iranian Ministry of Road Transportation, Safety Branch. This office receives all accident reports countrywide. Iran is fortunate in that all police agencies including highway patrol and municipal police use the same traffic accident report form.

4.1. Construction of data base

The decision was made to use data as the basis for accident analysis. This data covers the desired geographic area and includes all police agencies. An accident must be located within 15 m on a map from the report and it is given an x ,y coordinate with a digitizer.

If the crash damage is less than $50 it is not included in the database. This eliminates small crashes from being reported and therefore they will not be in the database. Thirdly, private property accidents are not included unless related to an access or intersection onto a public roadway.

The main database is called *base*. This contains all general information about the accident such as date, time, conditions, and if available, the coordinates. The other databases called *vehicle, driver* and *person* detail each of these areas of the crash. These four databases contain a common "Key" field that keeps the data elements tied together.

Annual updates are obtained to keep the data current. The type of information that is obtained included such items as:
– number of vehicles involved
– number of injuries
– number of fatalities
– violations issued

– type and severity of injuries
– type of accident
– activity prior to the accident
– human contributing factors.

This level of details allowed a more deep analysis that was necessary for the project.

GIS platform allows a visual map connection to the database. Figure 2 shows the accident locations across a city and the database connected to the map. This allows queries to be made either from the map or from the database. This system allows various maps and charts to be made that go into the annual report production.

The *base* database is now useable in GIS to use for queries, buffering and other types of analysis. The three other databases *driver, vehicle, and person* are then linked in ArcView to the base (Fig 3). This allows all four databases to respond analytical queries [5].

5. Conclusion and recommendations

In general, this is an enviable project. There were no complications in the use of the data and the conversion to GIS system. The conversion of the data was seamless and the accident points matched well, generally within 12 m, of the road centerline. This will allow us to calculate accident rates rather than using raw crash numbers for analysis.

Overall, the data received has been an invaluable aid in the planning process. This was an important lesson to us working with other agencies and departments.
• Traffic safety education in Iran is in urgent

need of proper attention. The role of school should be over emphasized. Parents are currently the main source of information.

- Planners should be aware of pedestrian needs and behavior in traffic. This knowledge will guide them to provide safe pedestrian facilities.
- Pedestrian road infrastructure in Iran is in need of modernization to provide safe traffic environment to young generation.

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