Chapter 5
A Motor Vehicle Safety Planning Support System: The Houston Experience

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5.1 Introduction

Planning Support Systems (PSS) have long been used for motor vehicle safety in order to improve roadways or implement programs for drivers. Usually called *crash information systems*, traffic safety specialists have long assumed that improvements come about through timely information on motor vehicle crashes and analysis of that information. Frequently referred to as a 'data driven' methodology, the analysis of motor vehicle crashes is the basis upon which many, if not most, improvements to the traffic system have come about in the USA, Europe and elsewhere. In the last decade, the use of geographic information systems (GIS) has brought a much needed spatial dimension to crash analysis and widened the analytical and policy tools available for safety planners and traffic engineers.

In this chapter, a motor vehicle safety PSS that was developed in Houston, Texas for safety planning is described. The limitations of such a system are explained and the mechanisms for dovetailing information with expert opinion in order to address both the behavioural as well as the physical road characteristics affecting traffic safety are outlined.

5.2 A Major Public Health Problem

Fatalities and injuries from motor vehicle crashes are a major public health problem. In 2005, there were 43,443 deaths in the United States (U.S.) resulting from motor vehicle crashes (NHTSA 2007). While the fatality rate per 100 million vehicle miles traveled (VMT) has been decreasing consistently and is the lowest on record (1.45 per 100 million VMT), motor vehicle accidents are still a major source of death in

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S. Geertman, J. Stillwell (eds.), *Planning Support Systems Best Practice and New Methods*,
DOI 10.1007/978-1-4020-8952-7_5

the U.S. and elsewhere (NHTSA 2005). In fact, in 2004 in the U.S., fatalities from motor vehicle crashes was the third leading cause of death for males and the sixth leading cause of death for females (DHHS 2006: Table 307). Fatalities from motor vehicle crashes are the leading cause of death for all ages from age 1 through to age 44 (DHHS 2006: Table 32). The comparison is for fatalities from 'unintentional injuries', which includes most deaths from injury and poisoning. The category excludes homicides (including legal intervention), suicides, deaths for which none of these categories can be determined and war deaths (NSC 2007: pp. 8–9). The National Safety Council estimates that motor vehicle crashes cost about $237.7 billion a year (in 2005 dollars) from medical treatment, wage and productivity losses, administrative expenses, property damage and employer costs (NSC 2007, p. 7). This is in addition to the pain and suffering experienced by motor vehicle injury victims and their friends and relatives. In short, motor vehicle crashes are a major public health problem.

On a per capita basis, fatal crash rates are higher in the U.S. than most other developed countries though this comparison does not consider actual vehicle exposure (Scotland 1998; Peden *et al.* 2002; NationMaster.com 2007). Other studies show very low fatality rates relative to vehicle exposure for the U.S. when compared to other countries (Jacobs 1986; DSA 2005; Best 2007).

Over time, safety has consistently improved. In 1950, the age-adjusted mortality rate from motor vehicle crashes was 24.6 per 100,000 persons while it was 15.2 in 2004 (DHHS 2006: Table 320). Improvements to roadways and vehicles, increased seat belt use and alcohol enforcement have been major factors underlying the decline with a lesser influence on behavioural changes from drivers (Baxter 2006). Unfortunately, the decline has leveled off since about 2000, suggesting that additional measures will be needed, more tailored to drivers than to roadways (Chakiris 2006).

5.3 Crash Analysis as a Basis for Road Safety Decision Making

5.3.1 Federal U.S. Safety Programs

In the U.S. and many other countries, crash analysis is required as a basis for making roadway improvements. The Highway Safety Act of 1966 (23 U.S.C. Chap. 4) and the Highway Safety Act of 1973 (23 U.S.C. 152) established a requirement to reduce injuries, deaths and property damage from motor vehicle crashes through the development or upgrading of traffic record systems, traffic engineering studies, the development of technical guides for States and local highway agencies, work zone safety projects, the encouragement of the use of safety belts and child safety seats, roadway safety public outreach campaigns, enforcement to reduce impaired drivers, enforcement programs to combat drivers who speed or drive impaired, and enforcement to reduce aggressive driving (FHWA 1999).

The 1973 law, in particular, required that each State conduct and systematically maintain a survey of all highways to identify hazardous locations that may constitute a danger to vehicles and to pedestrians. Priorities for the correction of these hazards are required and a schedule of projects for their improvement must be established. The law established a benefit-cost methodology for identifying safety project locations and for assigning priorities. The Act provided mandates for States and an earmarked funding source for safety improvements. States could not use the excuse of lack of funding to avoid having to improve the safety of the highways.

5.3.2 Methodology for Safety Improvements

There is a formal methodology for funding safety improvements using Federal funds. Known as the *Highway Safety Improvement Program* (HSIP), there are four steps that are required for receiving Federal aid to improve safety on the roadways (FHWA 1981). Briefly, they are:

- the maintaining of crash and highway information for all jurisdictions at the State level;
- the requirement that the State identify hazardous locations on the basis of crash experience or crash potential;
- the requirement that an engineering study be conducted of hazardous locations to develop safety improvement projects; and
- the requirement that priorities be established based on a benefit-cost methodology for identifying the potential reduction in crashes from an improvement compared to the cost of the improvement.

This methodology is common throughout the U.S. and, to some extent, is used throughout the world. However, given the decentralized nature of planning in the U.S., compared to most countries, the use of the HSIP methodology is at the discretion of local decision makers. An extensive discussion of this methodology as applied to a crash hot spot in the East End of Houston can be found in the following source (H-GAC 2004).

5.4 The Greater Houston Motor Vehicle Safety PSS

5.4.1 Safety in the Houston Region

Between 2001 and the present, a motor vehicle safety PSS was developed at the Houston-Galveston Area Council (H-GAC), the metropolitan planning organization for the greater Houston region. The Houston metropolitan area has a severe safety problem. Between 1999 and 2001 in the eight-county region, there were 252,241 serious crashes, an average of 84,080 a year. From these crashes, 1,882 persons were killed and 281,914 persons were injured. The crashes accounted for 26 per cent of all serious crashes in the State of Texas during that period compared to a 22 per cent share of the State's population and a 21 per cent share of the State's VMT (H-GAC 2007a).

The likelihood of a driver in the region being involved in a fatal or injury crash in the region was 36 per cent higher than the State of Texas average and 149 per cent higher than the U.S. average. The region leads the State of Texas in virtually every type of crash and leads the nation in alcohol-related fatalities per capita (NHTSA 2005).

5.4.2 Geo-Coding Motor Vehicle Crashes

Starting in 2001, a GIS-based database was established that identified all serious crashes in the region (Levine 2006a). The data were obtained from the Crash Records Bureau of the Texas Department of Public Safety, the agency vested with compiling crash information for every jurisdiction in the state of Texas (DPS 2007). Texas State law requires that all crashes involving fatalities, injuries, or property damage in excess of $1,000 be reported to the local police. The local police department will then send copies to the Texas Crash Records Bureau if it meets the criteria of having fatalities, injuries or serious property damage (defined as one or more vehicles being towed from the crash scene). Because of delays in releasing information, data were only obtained on those crashes occurring between 1998 and 2001.

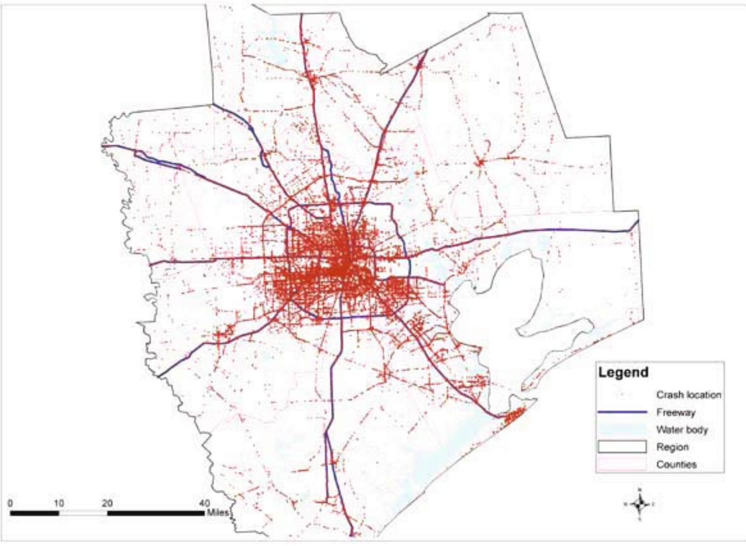

Fig. 5.1 Speeding crashes in the Greater Houston Region

The data were geo-coded according to a methodology that was developed initially in Honolulu (Levine *et al.* 1995a,b; Levine and Kim 1999). Approximately 82 per cent of the crashes were geo-coded with accuracy being around 91 per cent. Accuracy was tested by drawing a sample of 500 geo-coded crashes and examining the records to see whether they had been correctly located. Both matching and accuracy improved towards the centre of the region. For example, in the City of Houston, 90 per cent of the crashes were matched with 94 per cent accuracy. Once geo-coded, crashes or subsets of the crashes could be displayed. For example, Fig. 5.1 shows a map of all speeding crashes in the region.

5.4.3 A Data and Analysis-Driven PSS

Figure 5.2 illustrates a conceptual view of the motor vehicle safety PSS. At the root of the system is the geo-coded crash data. It is shown as two stages: the raw data collected from the Texas Crash Records Bureau and the geo-coding process that identifies the approximate location of the crash. The crashes can be then linked by a GIS to other information, such as roadway inventory, traffic volume information, land use data, EMS reports and even hospital reports. The aim is to widen the contextual information for understanding safety data in order to explore possible interventions.

Building on the basic spatial data and associated links is spatial analysis. Among these are hot spot analysis, crash risk analysis, spatial-temporal analysis (e.g. hot spots or crash risk by time of day) and visualization of crashes throughout the region; the latter is useful for a region-wide view of safety or a view of safety along a particular major arterial road. There is also an increasing interest in forecasting crashes based on expected mitigations. These analyses help identify high volume and high risk locations as well as place these locations in a broader context. The tools themselves may be part of a broader analytical focus. The analysis allows a number of applications, including routine reports that would be issued on a regular

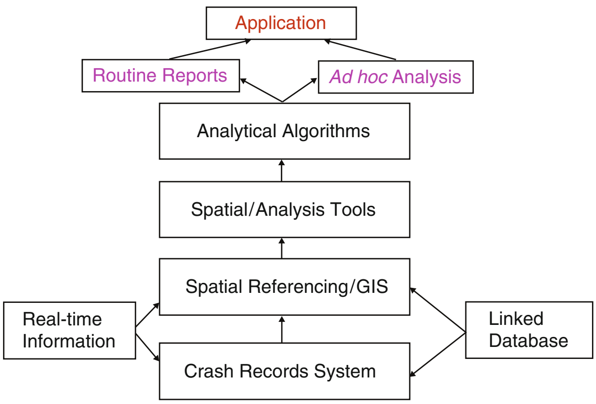

Fig. 5.2 A conceptual motor vehicle safety PSS

basis and *ad hoc* reports that are created to address a specific issue. The important point is that the spatial data and GIS are essential parts of the PSS, but the system also includes analytical tools and expert opinion.

5.5 Uses of the Greater Houston Motor Vehicle Safety PSS

The Greater Houston motor vehicle safety PSS has been used extensively in safety planning efforts. The following discusses three major applications of it.

5.5.1 Safety Reports

First, it was used for producing safety reports that were then placed on a safety web page (H-GAC 2007a). More than 40 reports were issued between 2001 and 2007. The most common type was an examination of safety along particular roadways. Typically, these were three to five page reports summarizing the number of crashes, their severity, major hot spots and crash risk. They were usually initiated by a request from a local government. A second type of report examined particular types of crashes, such as red light running crashes or pedestrian crashes. These reports have been widely distributed. Local governments, community groups and consulting organizations frequently use the reports as background material in framing policies or proposed actions. The reports also affected actual decisions made to improve safety. For example, in 2006, the City of Houston adopted photo enforcement for the running of red lights. The motor vehicle safety PSS was used to inform the City about the location of intersections with the most red light running crashes. The City used the information along with more recent data from their own database to identify 50 intersections throughout the city where red light running crashes were most likely to occur (H-GAC 2006; Stein and Dahnke 2006).

5.5.2 Identification of Hazardous Locations

Second, the motor vehicle safety PSS was used to identify specific locations where safety engineering studies could be implemented, following the HSIP methodology described above. An analytical tool used for this purpose was *CrimeStat* (Levine 2007). *CrimeStat* is a stand-alone program that was developed with funding from the National Institute of Justice and is available for free at http://www.icpsr.umich.edu/crimestat. The program interacts with most desktop GIS packages and calculates various statistics about the distribution of incidents, many of which can be displayed in a GIS. These include spatial distribution statistics, hot spot identification, risk analysis of incidents and space-time interaction statistics. There are also a

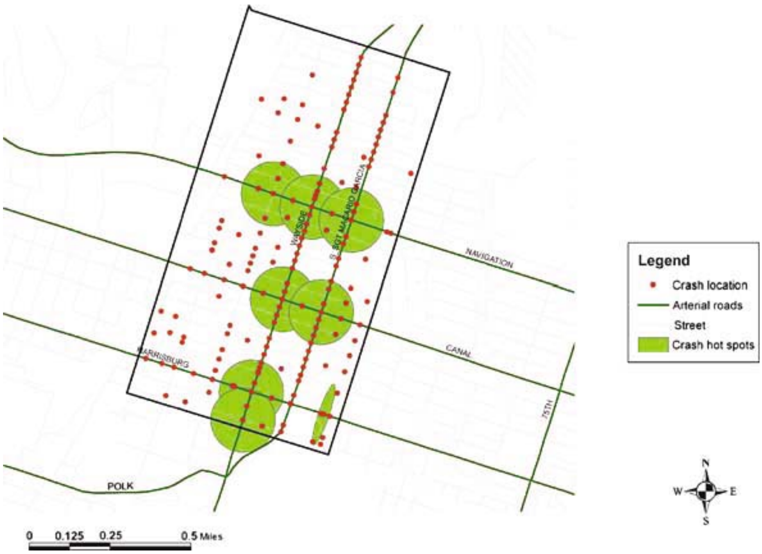

Fig. 5.3 Crash hot spots in East End of Houston

number of tools specific to law enforcement, including a full travel demand module for modelling crime travel. There are, of course, other programs that can be used for spatial analysis of crashes, but *CrimeStat* was developed with both crime and crash analysis in mind.

For crash analysis, mostly the hot spot routines were used to identify small areas with a high concentration of crashes. Figure 5.3 illustrates eight crash hot spots identified in the safety engineering study for the East End of Houston. The particular algorithm was a nearest neighbour hierarchical clustering routine that looks

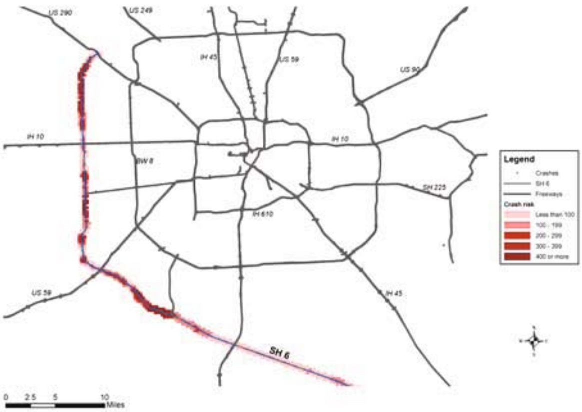

Fig. 5.4 Crash risk on State Highway 6, 1999-2001 (See also Plate 13 in the Colour Plate Section)

for pairs of points that are closer than a threshold and then groups these together in clusters (Levine 2007). The advantage of a hot spot approach over a frequency count of the number of crashes at each location is that it can include nearby crashes that both contribute to and are by-products of the hot spot. For example, in Fig. 5.3 the hot spots are centered on particular major intersections but also include crashes on the approaches to the intersections.

A second type of analysis that goes into the identification of hazardous locations is the identification of locations of high crash risk (crashes relative to traffic volume). When the volume of traffic approaches exceeds the capacity of the road to handle the traffic, crashes tend to occur. Thus, it is important to analyze crash risk, too, usually defined in units of crashes per 100 million VMT. Figure 5.4 shows crash risk along a major suburban arterial, State Highway 6. Again, the *CrimeStat* program was used to interpolate the crashes relative to the VMT. The particular algorithm interpolates both the number of crashes and the VMT to a fine grid using a smoothing algorithm. It then divides the interpolation of crashes by the interpolation of VMT (Levine 2007); the ratio is then multiplied by 100 million. Finally, Fig. 5.5 shows crash hot spots and crash risk along a segment of Westheimer Road, a major arterial in the Houston region. The map plots crashes per 100 million VMT and shows a difference between high crash locations, which typically are adjacent to the freeways because of the bottleneck of traffic from entry and exits ramps, and high crash risk locations some of which are away from the freeways and are often characterized by intersections with poor traffic control.

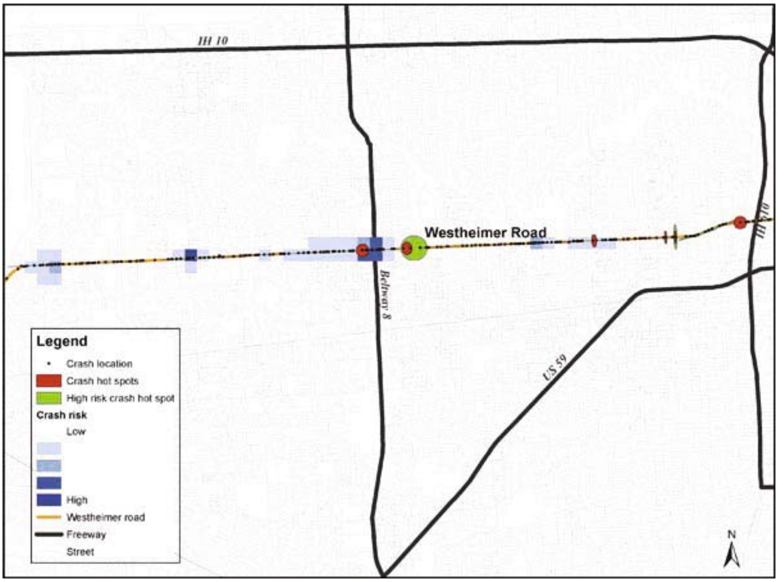

Fig. 5.5 Crash hot spots and crash risk on Westheimer Road (See also Plate 14 in the Colour Plate Section)

5.5.3 Safety Engineering Projects

Third, the motor vehicle safety PSS was used to develop safety engineering studies using hot spot analysis as the basis for selecting locations. The process involved establishing a partnership with local governments and with other relevant parties. Typically, discussions were held with the local government to establish a commitment, a funding stream, and a time line. Since the number of hot spots was almost always greater than the resources available, priority locations had to be established. Once agreed upon, there was still a need to establish the funding split between the regional agency and the local government and setting up advisory groups.

In the 2001–2007 time frame, five safety engineering studies were implemented. The first was a study of two intersections along a major arterial in Houston (Westheimer Road). The second was the East End safety study that involved examining all crashes within an area that was slightly less than one square mile. There were about 90 intersections within the study area, though about 10 accounted for most of the crashes. A third study involved studying five intersections in the City of Pasadena, a suburban community near Houston. A fourth study examined 13 intersections in the City of Galveston, an urbanized island about 50 miles from Houston, and a fifth study studied 12 intersections in the City of Sugar Land, another suburban city in the Houston region. These studies can be read on the H-GAC safety web page (H-GAC 2007a).

In all of these studies, the basic HSIP methodology discussed above was followed. The consultant first gathered all crash reports for a multi-year period. At the minimum, three years' worth of data were used. Second, *collision diagrams* were produced. These drawings indicate directionality and impact locations for the crashes. Additional data were obtained to provide contextual information about the crashes, in particular traffic counts, vehicle movements and signal timing. The consultant then examined contributing factors that are listed on the police report. Typically, these are behavioural factors such as driving too fast for the conditions, running a red light or changing lanes without regard for adjacent vehicles. The purpose is to establish a crash pattern that can then be mitigated. Fourth, the consultant then proposed various mitigation factors, which were then subjected to a formal benefit-to-cost analysis.

The methodology is aimed at identifying low cost improvements that will have substantial benefits. For example, at one intersection in the City of Houston, the consultant demonstrated that re-painting lane markings would reduce the number of crashes at that intersection by about 15 per cent with very little cost. At another intersection in the City of Houston, the proposal was to make a far left lane on a one-way street into a left turn only lane to minimize conflicts with vehicles in the second-to-the-left lane. At another intersection in the City of Sugar Land, it was proposed to create two dedicated left turn lanes because of the volume of traffic had grown beyond the capacity of the existing one left turn lane. At another intersection in the City of Galveston, crashes were occurring because vehicles were moving quickly to the left in order to make a left turn on to a major arterial; the consultants proposed putting lane signs much earlier on the approach to the intersection.

In short, this approach systematically mines the crash data in order to establish low cost improvements that can substantially reduce crashes. In practice, a benefit-to-cost ratio of 3:1 (meaning that the value of the benefits are at least three times the value of the costs) is considered the minimum criteria for choosing a particular measure. Many of the recommended measures had much higher benefit-to-cost ratios.

5.6 Advantages and Limitations of the HSIP Methodology

Even though the HSIP methodology has been around for more than 30 years, the Greater Houston motor vehicle safety PSS has allowed the metropolitan area to be scanned to identify all possible hazardous locations and to prioritize them. This is a major advance since the methodology was historically applied only when individual intersections or road segments were brought to the attention of transportation planners or engineers. The HSIP methodology, in turn, generally identifies low cost improvements, such as better signage, re-striping of lane markings, improved signal timing or re-location of lanes. If combined with routine maintenance, such a methodology can significantly reduce the number and severity of crashes on the road system. To a large extent, this has happened anyway as the roadway system has been improved over the decades. But, a more systematic integration of safety analysis with maintenance could provide a cost effective solution to safety improvement.

5.6.1 Ignoring of Behavioural Issues

The biggest disadvantage of this approach is that it is limited primarily to improvements on the road system and does not address the driver behaviour problems associated with crashes. Poor design of a roadway or inadequate traffic management of an intersection can contribute to crashes, but the crash is still a function of driver behaviour. For example, according to the Houston crash reports, 39 per cent of crashes occurring between 1999 and 2001 involved speeding; 20 per cent involved failing to yield the right of way; 19 per cent involved failing to stop at a red light or a stop sign; 7 per cent involved driving under the influence of alcohol or drugs; and 3 per cent involved following too close (H-GAC 2007b: p. 4). Almost 90 per cent of the crashes are caused by the behaviour of drivers, rather than defects in the roadways per se, though there may be interactions.

When the characteristics of drivers involved in crashes were examined, it was very clear that certain types of individuals were more likely to be involved in motor vehicle crashes than others. Teenage drivers were involved in 21 per cent of all crashes; their share of the driving age population is 9 per cent. Further, in the suburban areas of the Houston metropolitan region, the percentage of crashes involving teenagers was substantially higher than in the central city, typically in the 26–29 per cent range (H-GAC 2007b: p. 5). Males were more likely to be involved in serious crashes than females and there is a growing body of evidence suggesting that bad driving is a repetitive behaviour. For example, drivers who are convicted of drunk driving were more likely to have been involved in previous drunk driving behaviour (Roth 2006). Several studies have shown that drivers convicted of running red lights were more likely to have been convicted of previous red light running incidents (IIHS 2007; Schultz 2001).

Thus, the approach outlined above is too narrowly focused on the roadway system and not sufficiently on the driver. The roadway system is very important and improvements to it have been, and certainly will continue to be, important in improving safety. But, it is not the only factor.

5.7 Establishment of a Regional Safety Council

Consequently, in 2005, a decision was made to create a Regional Safety Council (RSC) in order to advise elected officials about actions that should be taken to improve safety. The RSC was made up of safety specialists from transportation, law enforcement, medicine, public health, trucking, insurance, business, safety advocacy, and safety research organizations. During its first year, the RSC set up individual committees to focus on four specific safety topics: (i) alcohol-related crashes; (ii) aggressive driving; (iii) freight safety; and (iv) safety information systems. At the end of the year, the RSC released a report that outlined major recommendations for improving safety in the region (H-GAC 2007b).

The Greater Houston motor vehicle safety PSS played a critical role in providing background information to the RSC. First, it provided basic facts on the extent of the problem and indicated what types of drivers were involved. Second, it provided locational information on the major hot spots and, third, it provided information that was used to estimate the cost of crashes. This approach provided a broader perspective on safety than the roadway-only orientation of the HSIP methodology. Planning and safety engineering was put into a framework of providing infrastructure that would facilitate education and enforcement efforts, rather than as a sole solution to safety problems. The recommendations focused on the interaction between driver behaviour and the roadway system. For example, one recommendation was to set up several safety corridors in the region in which enforcement, education and engineering would be focused. In each corridor, driver education programs would be targeted towards nearby high school students and would emphasize driving risk factors, particularly driving under the influence of alcohol (Wise 2006; Henk 2006). Engineering would be utilized to upgrade the intersections and segments along the corridor. In short, the safety corridor will involve the integrated contributions of engineering, education and enforcement in order to improve safety.

Another recommendation focused on distributing dynamic speed signs throughout the region to reduce speeding. If placed on roads with a sizeable number of crashes involving speeding, this technology would be a very cost effective way to improve safety. Several recommendations focused on reducing drunk driving. Ignition interlock devices are attached to the starter mechanism of vehicles. To start the engine, drivers have to blow into the device and be free of alcohol in their breath. Such devices are mandated by Texas law for those individuals convicted of a second or subsequent Driving While Intoxicated (DWI) offence at a high Blood Alcohol Content level of 0.15 or higher or for minors convicted of driving with any alcohol in their bloodstream. Nevertheless, only about 15 per cent of those persons eligible for such a condition were assigned it by their judges. The RSC recommended the expansion of this technology to the maximum and the development of educational efforts among the legal community to ensure enforcement of the law.

Another anti-DWI proposal recommended forbidding servers of alcohol in establishments from drinking while on the job (Copeland 2006; Davies 2006). Another measure addressed the ‘intoxicants clause’ in Texas law (and in many other States) that allows insurance companies to withhold payments for crashes in which there is drunk driving. One of the side consequences of this law is that hospital administrators are reluctant to order blood alcohol tests for motor vehicle crash victims who are brought into the emergency rooms even if it is clear that they were single drivers who had been drinking. The result is that many of these persons are treated and sent home without any legal actions being taken, only to repeat their behaviour later on.

Another anti-drunk driving recommendation was to identify and study both the hot spots where DWI crashes occurred and the residence location of drivers convicted of DWI. Most crash data that is released only includes information on the location of the crash, not where drivers live. But, some preliminary studies have indicated that drunk drivers may be concentrated in certain neighbourhoods with a sizeable number of bars and liquor stores and it may be possible to implement intervention programs in those neighborhoods (Canter *et al.* 2005). Other recommendations addressed truck safety and improving education to the trucking community, to elected officials, and to the public at large; Borchardt and Corder 2006; Curry 2006). Also, the RSC recommended improving data collection and the sharing of data across agencies (Benz 2006; Levine 2006b).

In short, the Regional Safety Council proposed a wide variety of different measures for improving safety. The motor vehicle safety PSS was important in providing information on the location and conditions associated with the crashes. But, the information needed to be placed in a larger, behavioural context in order to lead to decisions that have some chance of being effective.

5.8 Conclusions and Future Directions

The Greater Houston motor vehicle safety PSS has been successful in so far as it has identified safety problems in the region in a systematic way and has directed decisions towards improving safety, particularly at intersections where safety problems are severe. It was one of the first regional safety planning efforts in the country and has been highlighted in conference presentations and articles (Levine 2006a). Other regional transportation agencies in the country are adopting safety planning and the Houston system has been held up as a model (Washington *et al.* 2006).

There are key requirements to make such a program effective, though. First, the safety data need to be of high quality. Crash data contain lots of errors, primarily from poor data collection. Police officers are under extreme pressure to manage a motor vehicle crash, involving safely securing the road, ensuring that EMS vehicles come to the scene, making sure that the crashed vehicles are removed, overseeing the clean up after the crash and documenting the crash in a report. Filling out a crash form has the lowest priority in this sequence and is usually done after the crash scene has been cleared. That information is condensed and abbreviated is all too understandable. Nevertheless, the consequence is that there is incomplete information in reports which makes analysis difficult. There are a lot of efforts underway to improve the data collection process (NCHRP 2005; AECOM *et al.* 2002).

Second, the data needs to be timely. Unfortunately, at the time in which the Regional Safety Council met, the Texas Crash Records Bureau had released only data through 2001. The time delay meant that there was not current information about the state of safety, making it difficult to evaluate the effect of various mitigation measures. For example, in 2002, the Texas State Legislature implemented restrictions on teenage drivers that required a driver under 18 to be accompanied by a person 18 or over and that also restricted hours of driving. Without 2002 or 2003 data, however, it was unclear whether this legislation had been effective in reducing teenage crashes. Efforts are being addressed to improve the situation, not only in Texas but elsewhere in the country (Baxter 2006). The Federal Government provides funds for crash information systems and is accelerating its importance after years of neglect. In Texas, a new crash records management system is being implemented with accelerated processing of crash records and with all crash locations being geo-coded for use in a GIS; this will facilitate the use of crash data by regional planning agencies who can immediately map the crashes with their GIS programs. Prior to this, H-GAC had been the only regional agency in the State of Texas to have done this.

A third issue concerns the ability to link crash data with other information, particularly EMS records and hospital admission data. The importance lies in documenting the true costs of motor vehicle crashes as well as being able to evaluate the effects of certain policies (e.g. helmet use by motorcyclists, proper seatbelt use by young children). However, most medical providers are reluctant to share these data for a variety of reasons (concerns about privacy, fear of liability, competitiveness among medical providers). The National Highway Traffic Safety Administration pioneered efforts at linking crash data with medical records, but there is still a lot of resistance to doing this on a regular basis, especially at the local level (NHTSA 1997). A legal basis for data sharing needs to be established that will require actions at State or national levels.

Fourth, in addition to the data quality issues, there is the importance of analysis and spatial analysis in particular. Showing an elected official a map with thousands of dots on it representing the location of motor vehicle crashes is good for 'shock value', but can lead to inaction because the problem will be seen as overwhelming. On the other hand, showing a map with hot spots clearly identified can help focus on actions that can improve safety at those locations. In this case, the problem seems more contained and the hot spots point towards priorities that can be taken to improve safety. A statistical tool, such as *CrimeStat,* is invaluable in identifying high priority areas.

Fifth, and most important, political 'buy in' by local and State government agencies, elected officials, community groups and businesses is necessary in order to develop a framework for making decisions. Data and sophisticated analysis will not, in and of themselves, lead to decisions and implementation unless there is political support. In regards to traffic safety, funding is not that much of a problem because it can be shown that most safety improvements pay for themselves in a short time period. But, encouraging safety 'partnerships' of relevant players is essential for building support to allow decisions to be made to support safety.

Obviously, this depends on the type of decisions. Roadway improvements are generally not very controversial unless they involve major rebuilding of a roadway. However, imposing stricter enforcement or funding safety education programs will be more challenging as elected officials will find lots of reasons not to do anything. For example, the RSC's recommendation to identify the residence locations of drunk drivers involved in crashes was met by resistance by several elected officials who feared the consequences of such information on real estate values. Of course, other elected officials saw in this recommendation the need to address a serious public health problem; they were less concerned about the perception of their neighborhood and more on reducing the number of drunk drivers on the road. Not all the recommendations are accepted without controversy.

Further, some obvious measures are completely unacceptable politically. For instance, teenagers have a much higher likelihood of being involved in crashes than older age groups with the youngest drivers (aged 16 and 17) having much higher crash likelihoods than older teenagers (IIHS 2005). Because of this, many countries have established a minimum age requirement of 18 for a driver's license in order to reduce the likelihood of crashes. In the U.S., however, with very few exceptions, State legislatures are unwilling to impose a minimum age requirement of 18 for fear of alienating middle-class parents. Getting a driver's license at age 16 is considered a 'rite of passage' by U.S. teenagers and few elected officials want to be involved in advocating a policy that, while saving lives, would incur hostility by many of their parents. The consequence is that thousands of 16 and 17 year olds are involved in crashes each year, a condition that could be corrected with a change in policy. Frequently, recommendations which seem solid because they are based on evidence run up against other needs of elected officials. The RSC did not even bother to make such a recommendation in its first year report even though the majority of its members would have fully supported such an action.

This creates a dilemma for a traffic safety planning program. On the one hand, the public expects the roads to be safe. There is almost a universal acceptance of road safety and a commitment to improve safety. But, typically, safety is not a theme that organizes community groups. Most people perceive it as a ubiquitous problem and one not prone to easy fixes. A major exception is *Mothers Against Drunk Driving*, a national community-based organization that has been extremely effective in advocating for reductions in alcohol-related driving behaviour (MADD 2007).

In my experience, many elected officials see safety improvements as a 'high risk/low benefit' policy to support. If they have been in office, then they might become embarrassed by information that shows a high level of crashes in their districts. If they are new to their office, there is not an immediate political gain to be had from supporting safety. Further, identifying areas that are unsafe poses a potential risk to them because of possible backlash from their supporters and from business owners. For them, it is often a 'no win' proposition. Thus, in spite of the fact that safety improvements will generally pay for themselves, many elected officials avoid such issues.

On the other hand, creating a high visibility advisory body with specialists from a variety of fields (especially from medicine and law) can provide credibility and support for tough actions that need to be taken to reduce the number and severity of motor vehicle crashes. Such a body can provide extensive expertise allowing crash information and a substantial knowledge base of research on traffic safety to be used to make recommendations (NHTSA and GHSA 2006). It becomes more difficult for elected officials to avoid addressing safety issues when they have high visibility experts making recommendations. By and large, the recommendations of the RSC have been accepted by elected officials as it has provided a 'road map' for systematically improving safety in the region. It is still early in the process, but most of the recommendations are slowly being implemented.

In this effort, creating a safety planning support system, such as the Greater Houston motor vehicle safety PSS, can be an important tool in providing information that allows an advisory body to make recommendations based on knowledge and information.

But, it is only a tool. Such a system must be imbedded in a larger analytical framework that goes beyond the data that has been collected and which addresses the behavioural issues involved in traffic safety. Identifying hot spots and hazardous locations is but a first step to improving safety. Engineering improvements can be implemented at those locations to some extent. But, usually, increased enforcement is necessary for further improving safety. For example, lengthening the timing of a yellow light at a signalized intersection can reduce the number of persons who run the red light by allowing those vehicles to pass those who are just at the intersection when the light turns red. But, only enforcement can truly cut back on the more aggressive drivers who will run the red light from a substantial distance when the light turns red. There is not a simple engineering 'fix' for those types of drivers. Engineering improvements at intersections typically will reduce crashes by 20–30 per cent (H-GAC 2004). Further reductions will come about only through increased enforcement and public education.

Also, the information provided by a motor vehicle safety PSS needs to be interpreted to be meaningful, typically by people who have years of experience of working in safety fields. For example, the use of booster seats by children aged 5–9 is considered a high priority in the U.S. because fatality rates have dropped dramatically among 0–4 year olds but have decreased only slightly among 5–9 year olds. The reason is that, apparently, many parents put their children in adult seat belts as soon as they outgrow their infant seatbelts, not recognizing that a 5–9 year old child is not protected by an adult belt and could even be harmed by it. In Texas, the State Legislature has, to date, avoided requiring parents to use booster seat belts for fear of being 'too regulatory'. Thus, bodies such as the RSC and other safety organizations have been advocating for changes in the law. Using statistics on passenger fatality rates by age and, even, film footage showing how adult seatbelts do not protect young children, safety advocates will eventually get the Legislature to pass such a law. But, it will take time to convey this knowledge and explain why the current situation is not acceptable. In short, safety facts need to be interpreted and explained to decision makers in order to translate into actions that can improve safety.

Thus, the real PSS is a set of cumulative experiences about safety, a knowledge base of research about what works and what does not, and a timely and high quality crash information system that can provide data, analysis, and insights into the extent of the problem. It is the combination of information and experience that represents the greatest possibility for providing meaningful recommendations to improve traffic safety.

Future research needs to focus on three main issues. First is the obtaining of 'real time' information on the road system and on crashes. Many large cities have implemented camera systems for monitoring roadways with automated data collection on traffic volumes and speeds. When that information is combined with crash data, it will become possible to monitor crash risk on an ongoing basis and, thereby, refine further the identification of priorities, as well as allow much quicker emergency response.

A second priority is to better understand the connections between land use and crashes. Some relationships are obvious, such as a concentration of crashes in the central business district and in other commercial areas. But, there are more subtle relationships that need to be explored. A first one is in understanding where drivers who are involved in crashes live. Another is in understanding the relationship of crashes to drinking places and the potential for creating transit and para-transit services. A third is in understanding environments that encourage speeding. Predictive modelling might be important in this endeavour, but such models have to be used carefully. Predictive crash models are good for producing a system-wide model but are less useful for understanding specific locations. Traffic engineers have resorted to tables of expected crash reductions for particular engineering improvements (H-GAC 2004), but there are no such tables for modelling land use and social interventions. Research needs to be done to understand how modifying an environment (e.g. restricting access points around a shopping centre) or modifying the behaviour of participants in that environment (e.g. providing flexible para-transit services around areas with bars and nightclubs) can improve safety.

A third priority is to understand the legal impediments for enforcing drunk driving. Crashes from drunk driving are the most severe traffic safety problem, accounting for more than 40 per cent of all motor vehicle fatalities. The Federal Government and most States have enacted many measures to reduce this problem, including severe penalties for repeat behaviour, required treatment for teenagers and drivers convicted of multiple DWI offences, the requirement of ignition interlock devices and other measures. Yet, there are many legal obstacles that remain, including restrictions on sobriety testing, unwillingness to conduct autopsies on drivers who were killed and the insurance industry-supported intoxicants' laws. In this sense, the problem is not so much on the nature of the PSS, but on the implementation of measures that need to be taken to reduce the problem. As usual, social acceptance and politics in the broadest sense are the critical variables for implementing safety improvements. A motor vehicle safety PSS can be invaluable in identifying the problems and pointing towards certain solutions. But, it still takes legislative bodies having the courage to propose strong actions to improve safety that will lead to real changes.

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