CHAPTER 3
SOURCES OF DATA AND HIGHWAY STATISTICS

3.1 Introduction

This chapter presents a background on some of the data that were used for the purposes of this thesis. Such data include road mileage and the number of vehicle miles traveled. Also included in this chapter is an overview of the national accident trends and statistics for the past decade with a focus on year 1996. It is important to note at this point that not all data presented below were used in the development of the accident rates. Part of the data presented served as a fundamental background in order to understand the national trends and definitions of various variables closely related with the development of the accident rates. In order to construct the statistical foundation for the development of the safety model, a variety of sources were considered as a source of data. Such sources included the Highway Statistics (U.S. DOT, 1996), loop counts along Scottsdale/Rural Road in Phoenix, Arizona and the National Transportation Statistics Annual Reports (U.S.DOT, 1997). It is important to emphasize that all the data presented in this thesis refer to the year 1996 that was fully available at the beginning of this study. The context of this chapter includes sections with comparisons of reported accidents during the past years, accident rates and highway mileage with vehicle miles traveled on different facility classes in the U.S. territories. Highway statistics are required in order to match the frequencies produced by the database, to exposure.

The purpose for presenting the trends is primarily to have trends from other sources to provide a benchmark for evaluating approach. Also, the approach presented in the thesis will demonstrate the computation of accident risk based on crash frequency and VMT.

3.2 National Transportation Statistics

In this section, some background statistics for the U.S. transportation network are presented. Data were drawn from the GES and FARS databases and from publications of the Bureau of Transportation Statistics (U.S.DOT).

3.2.1 The existing transportation network in the United States

The roadway extent and characteristics are hereby examined before analyzing in more detail the development of the accident rates. The United States transportation network is the largest network in the world. In 1996, the U.S. transportation system served 265 million people and supported 4.4 trillion passenger miles (BTS, 1997). Many factors influence the expansion and growth of this network such as population increase, economy expansion, higher consumer incomes and vehicle availability.

According to the Bureau of Transportation Statistics (BTS, 1997) the public roads in the transportation network in 1996 included 46,036 miles of Interstate highways, 112,467 miles of other National Highway System (NHS) roads and 3.8 million miles of other roads. Almost 134 million vehicles (passenger cars and motorcycles) existed in the system during 1996, as opposed to less than 93 million in the 70's (BTS, 1997). In terms of vehicle miles, these increased from 1.1 trillion Vehicle Miles Traveled (VMT) in the 70's, to 2.5 trillion VMT in 1996. Finally, the passenger miles by mode also rapidly increased from 2.1 trillion in 1970 to 3.9 trillion in 1996. This information is important when dealing with safety issues in transportation since the roadway extent serves as a denominator when one needs to calculate the number of crashes per vehicle miles traveled on a specific roadway or facility type.

3.2.2 Facility Types

As mentioned in the literature review, many studies involving the development of accident rates and models focused on a particular facility type, i.e. arterials. For the

purposes of this study, the roadway system was divided into five facility types, following the definitions used by the U.S. Department of Transportation as follows:

Interstates are limited access divided facilities of at least four lanes, designated by the Federal Highway Administration as part of the Interstate System.

Principal Arterials are major streets or highways serving high volume traffic corridor movements that connect major generators of travel.

Minor Arterials are streets and highways linking cities and larger towns in rural areas in distributing trips to small geographic areas in urban areas.

Collectors in rural areas are routes serving intra-county, rather than statewide travel. In urban areas are streets providing direct access to neighborhoods as well as direct access to arterials.

Locals are those roads and streets whose primary purpose is feeding higher order systems, providing access with little or no through traffic.

The above definitions were taken into account when calculating accident rates. Due to the fact that the GES database does not specify the facility on which the crash occurred, the speed limit served as a surrogate for the facility type. These particular speed limits will be furthermore explained in Chapter 4 when the crash rates are presented.

3.2.3 Urban Vs Rural

The terms urban and rural are widely used when developing accident rates in general. However, the GES database development team removed the urban and rural variable as of 1997 because of lack of information from the police in order to classify if a crash occurred on a rural or urban facility. Due to this fact, the analysis performed in this thesis did not distinguish between urban and rural facilities. The term urban is mainly used to denote the Federal-aid legislation definition of an area. Areas denoted as urban must include an urban population of 50,000 or more. However, such classifications are fixed by State and local officials after the approval of the Secretary of Transportation. By classifying accident data by urban versus rural, a more detailed and complete comparison can be performed and this amount of detail can produce significant results for a safety study.

3.2.4 Roadway Mileage

As mentioned before, the transportation network in the United States is expanding rapidly year by year. The total mileage figures for 1996 were used for this thesis.

Table 3-1 below presents the total road length by facility type for both urban and rural classifications. These figures were then grouped in a total of five facility types in order to combine the rural and urban and determine a basis for the development of the accident rates that will be presented in Chapter 4. Table 3-2 presents the summarized data.

Table 3-1 Public road length in 1996 (numbers in miles)

Rural	
Interstate	32,818
Other Principal Arterial	98,131
Minor Arterial	137,359
Major Collector	432,118
Minor Collector	273,193
Local	2,119,154
Total	**3,092,773**
Urban	
Interstate	13,218
Other Freeways & Expressways	9,022
Other Principal Arterial	52,973
Minor Arterial	89,022
Collector	87,918
Local	574,524
Total	**826,677**

Table 3-2 Grouped results for road mileage in 1996

Facility	**Total Mileage (miles)**
Interstates	46,036
Principal Arterials and Expressways	160,126
Minor Arterials	226,381
Collectors	793,229
Locals	2,693,678
Total	**3,919,450**

3.2.5 Vehicle Miles Traveled

Despite the fact that the total mileage increased only 1.5 percent from 1980 to 1996, the total number of vehicles using the highways has increased much faster and there were nearly 50 million more highway vehicles in 1996 than in 1980, a 30 percent increase (BTS, 1998). This significant increase in the number of vehicles increased the total vehicle miles traveled during that year. As presented in Table 3-3 below, there was a significant increase (78 percent) in the urban VMT and 43 percent in the rural VMT. Overall, the total VMT from 1980 to 1996 more than doubled. Also urban interstate VMT increased at the fastest rate over the period 1980-1996, an average of almost 5 percent annually. However, the majority of the VMT was carried by both major and minor arterials.

Table 3-3 Vehicle Miles Traveled by Functional Highway Class: 1980 and 1996

Facility	1980	1996	Percent Change 1980-96
Urban			
Interstate	161,242	351,937	118.3
Other Arterials	484,189	833,623	72.2
Collectors	83,043	128,501	54.7
Locals	126,791	208,078	64.1
Total	855,265	1,522,139	78
Rural			
Interstate	135,084	232,447	42.9
Other Arterials	262,774	378,812	72.1
Collectors	189,468	241,037	44.2
Locals	84,704	107,767	27.2
Total	672,030	960,063	27.2
Grand Total	***1527295***	***2482202***	***62.5***

Examining the trend for even earlier years, according to the Office of Highway Management the annual VMT increased rapidly, (more than 245 percent) between 1960, and 1996. The VMT is a major factor that influences the accident rate. Figure 3-1 below shows this significant trend, characterized by a linear relation between each year and the annual VMT.

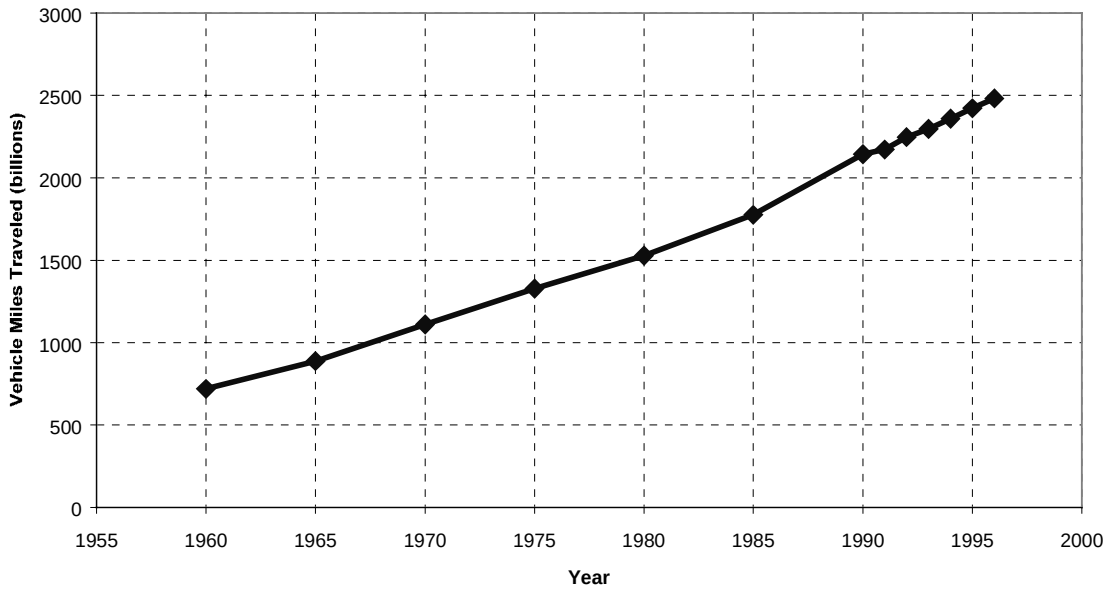

Figure 3-1 Vehicle Miles Traveled, 1960-1996

After emphasizing the importance of the number of vehicle miles traveled in the transportation network, as they were presented by the Bureau of Transportation Statistics, the figures were again grouped in order to serve the purposes of this thesis and assist in the development of the various accident rates on different facility types. In Table 3-4 below the VMT is shown in terms of six facility types and rural urban classifications. Again, the majority of the VMT belongs to the urban classification with the Interstates to carrying the majority of the traffic. As discussed in the previous section, five facility types were used with the data grouped together without urban or rural classifications. These figures are hereby presented in Table 3.5 where the total VMT in the United States during 1996 appears to be 2.4 trillion vehicle miles traveled with Interstates and principal or minor arterials to carry more than 50 percent of the total VMT.

Table 3-4 Vehicle Miles Traveled in 1996 (numbers in millions)

Rural	
Interstate	232,447
Other Principal Arterial	221,356
Minor Arterial	157,456
Major Collector	190,926
Minor Collector	50,111
Local	107,767
Total	**960,063**
Urban	
Interstate	351,937
Other Freeways & Expressways	157,412
Other Principal Arterial	377,720
Minor Arterial	298,491
Collector	128,501
Local	208,078
Total	**1,522,139**

Table 3-5 Grouped results for Vehicle Miles Traveled (VMT) in 1996

Facility	**Total VMT (in millions)**
Interstates	584,384
Principal Arterials and Expressways	756,488
Minor Arterials	455,947
Collectors	369,538
Locals	315,845
Total	**2,482,202,000,000**

3.3 National Accident Statistics

Every year the Bureau of Transportation Statistics publishes several documents that summarize various transportation safety issues. In this section, some of the available data will be discussed, together with some summarized tables that were produced using accident databases like the GES and FARS. Also, the above data will be analyzed in more detail, in terms of the different accident types, crash severities and the time-of-day of accident occurrence.

3.3.1 Police Reported Accidents – Trends

Over the last decade, the number of police reported accidents varied significantly. Numbers for police reported accidents experienced a decline from 1988 up to 1992 when a rise started that brought the number back to the same level during 1996. Figure 3-2 below illustrates the trend that the total numbers followed during the past decade.

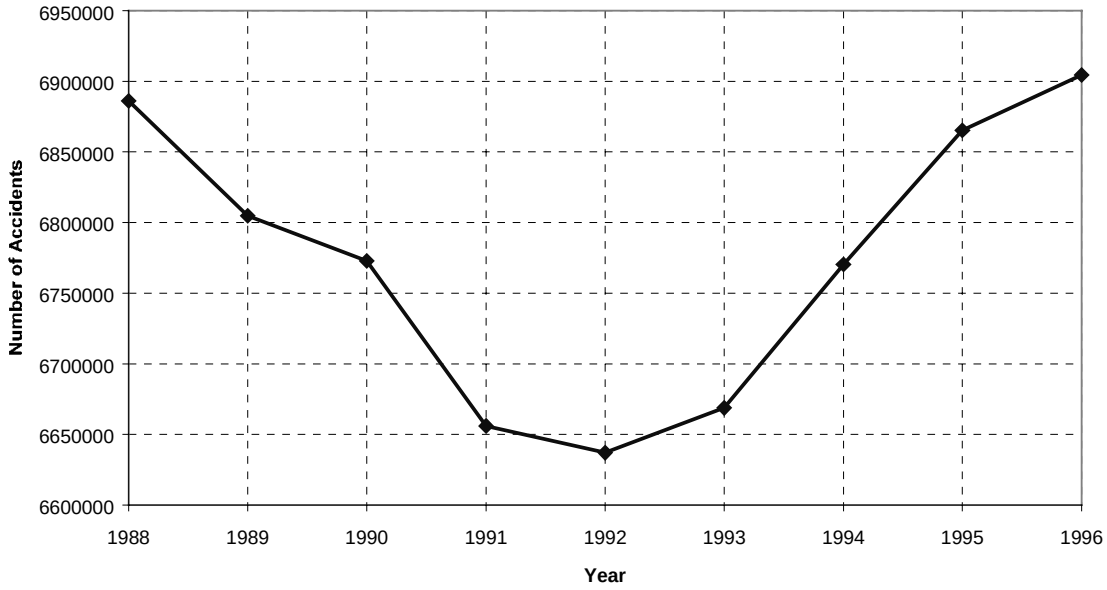

Figure 3-2 Police reported accidents for 1988-96 in the U.S.

If we examine these figures closer, we can observe the different components of total reported accidents in the United States. The total figure consists of property damage only, fatal and injury accidents as seen in Table 3-6 below.

Table 3-6 Crashes by Crash Severity, 1988-1996

Year	Fatal	(Fatal) %	Injury	(Injury) %	Property Damage Only (PDO)	(PDO) %	Total
1988	42,130	0.61	2,233,000	32.4	4,611,000	67.0	6,886,130
1989	40,741	0.60	2,153,000	31.6	4,459,000	65.5	6,804,742
1990	39,836	0.59	2,122,000	31.3	4,309,000	63.6	6,772,838
1991	36,937	0.55	2,008,000	30.2	4,073,000	61.2	6,655,940
1992	34,942	0.53	1,991,000	30.0	3,974,000	59.9	6,636,946
1993	35,780	0.54	2,022,000	30.3	4,048,000	60.7	6,668,785
1994	36,254	0.54	2,123,000	31.4	4,336,000	64.0	6,700,260
1995	37,241	0.54	2,217,000	32.3	4,446,000	64.8	6,865,248
1996	37,351	0.54	2,256,000	32.7	4,548,000	65.9	6,904,359
Average	**37,912**	**0.60**	**2,125,000**	**31.4**	**4,311,556**	**63.6**	**6,773,916**

It is evident from Table 3-6 above that there is an almost constant trend in the reported accidents during the last ten years. An average of 64 percent of the police reported accidents involve property damage only when another 32 are injury-related accidents. These crash severities will be analyzed in more detail in the following chapters. All the above crash severities were considered for the development of the safety model. Fatal cases will be described in more detail in the next section. Modern in-vehicle technology and state-of-the-art equipment improved the safety conditions of vehicles, especially the last few years. This impacted the trends in property damage only crashes between the years 1996-98 with more optimistic figures expected.

3.3.2 Fatal Crashes in 1996

Traffic fatalities account for more than 90 percent of transportation-related fatalities (NHTSA, 1997). Fortunately the numbers in fatalities were reduced the last few years with a fatality rate of 1.7 fatalities per 100 million vehicle miles of travel since 1992, as compared to 2.4 in 1987 (NHTSA, 1997). Some statistics that were drawn from the Fatality Analysis Reporting System (FARS) for the year 1996, indicate the major injury severity was the fatal injury with more than 37,000 cases. Different injury severity levels are reported each year by NHTSA .These fatal crashes occur mostly between midday and

midnight as shown in Figure 3-3 below. Many cases also occur during the early morning hours and especially the 1:00-2:00 am range.

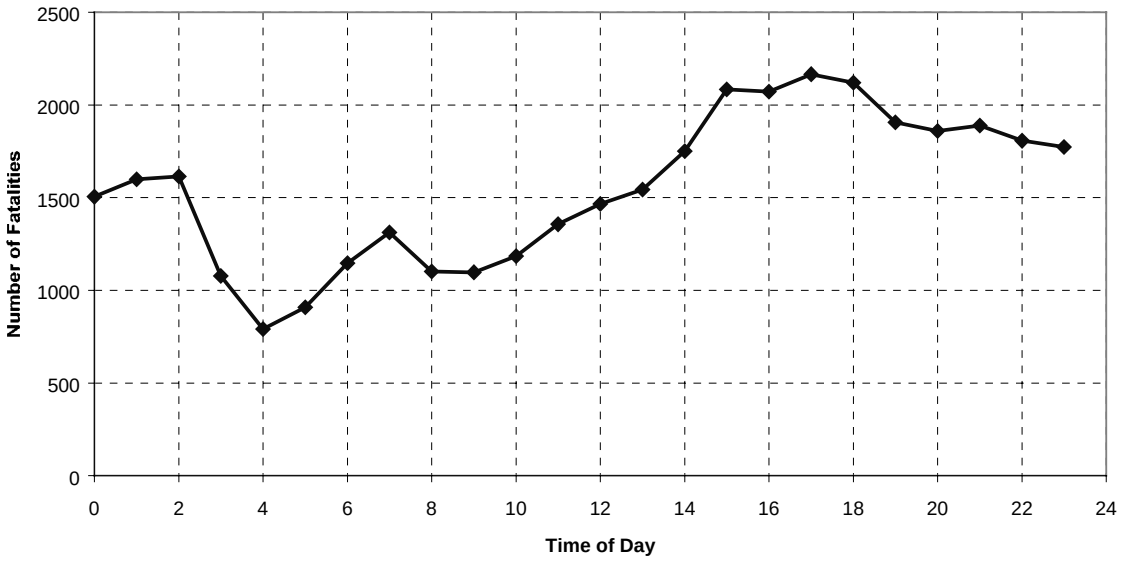

Figure 3-3 Number of fatalities per time-of-day in 1996 (FARS)

3.3.3 Crashes by manner of collision in 1996

The National Highway Traffic Safety Administration categorizes the accidents each year by manner of collision in general. The most common types are rear-end, head-on, angle, sideswipes, pedestrian, pedal-cyclist and other single vehicle accidents.

Figure 3-4 below illustrates the above-mentioned manners of collision. The rear-end crashes together with angle crashes dominate. This is very important, considering the fact that these two cases and particularly rear-end cases will be furthermore analyzed in this thesis.

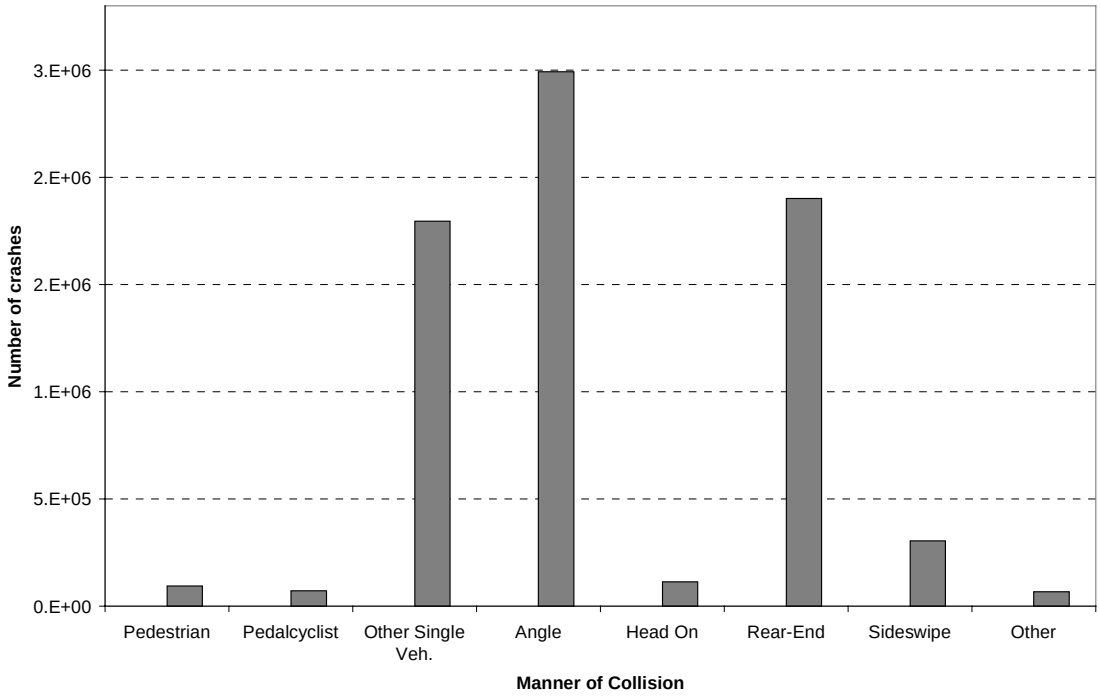

Figure 3-4 Crashes by Manner of Collision in 1996

3.3.4 Crashes by accident type in 1996

In the effort to develop the statistical foundation for the safety model, both the manner of collision and accident type were used. In order though to analyze the accident types further and examine the effects of each particular type, these will be furthermore described into 80 more types.

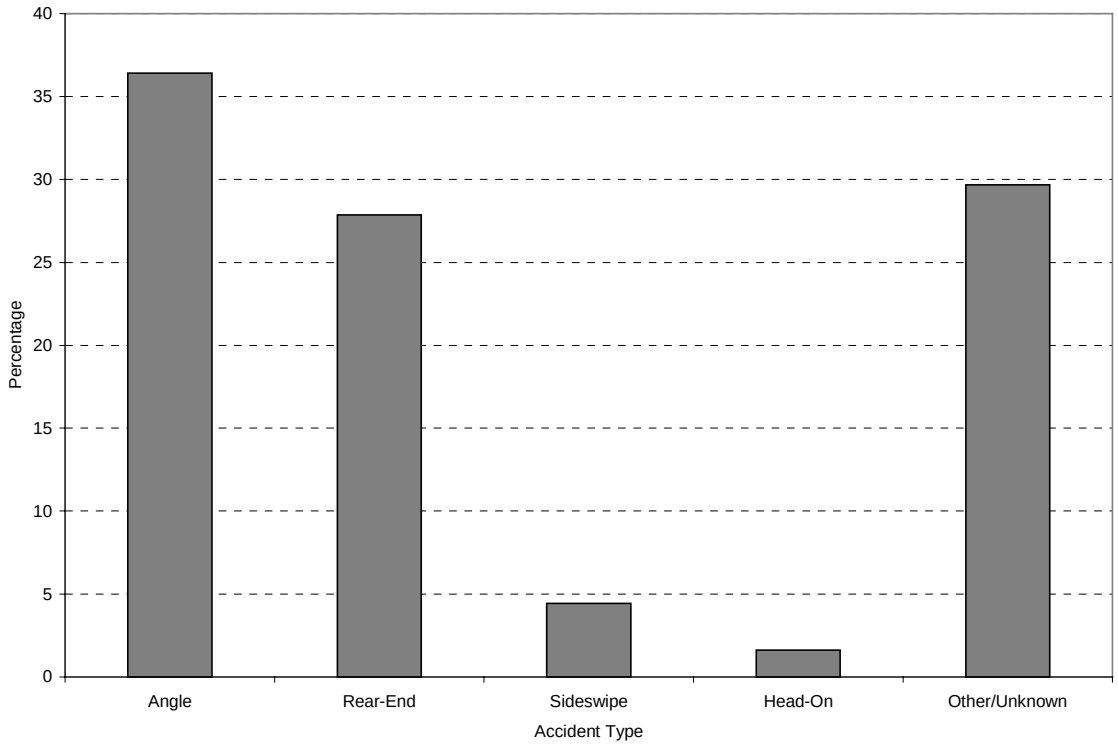

Figure 3-5 Police Reported Accidents-Distribution by Accident Type for 1996

As observed in Figure 3-5 above, the rear end and angle crashes dominant with rear-end to be of primary importance as a common crash type as opposed to the angle cases where one or more crash types and patterns are involved.

3.3.5 Crashes by Speed Limit in 1996

The speed limit is one of the most important factors that serve as a surrogate for the facility type. For example, for speed limits above 45 mph, the facility type is either a principal arterial or an Interstate. From Figure 3-6 below, the majority of the crashes occur on speed limits between 35-40 mph with fewer crashes on higher speed limits and almost the same for lower, i.e. on collectors or locals.

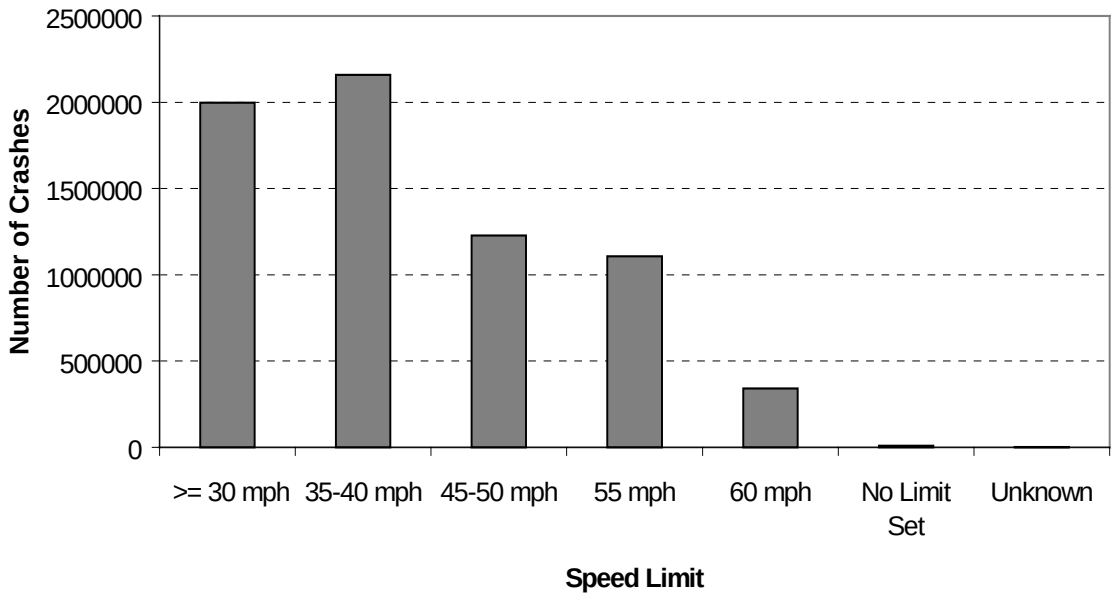

Figure 3-6 Distribution of crashes by speed limit in 1996

3.3.6 Crashes by time-of-day

Something that we also need to examine in the coming chapters is the time-of-day that the crashes occur and what is the distribution during peak and off peak hours. Figure 3-7 below presents the trend for 1996 (BTS, 1997). It is observed that there are more crashes reported during the afternoon peak during the interval of 3-6 p.m. For the rest of the day, the numbers are very close with the only exception, the midday peak from noon to 3 p.m. that experienced more than a million crashes during 1996.

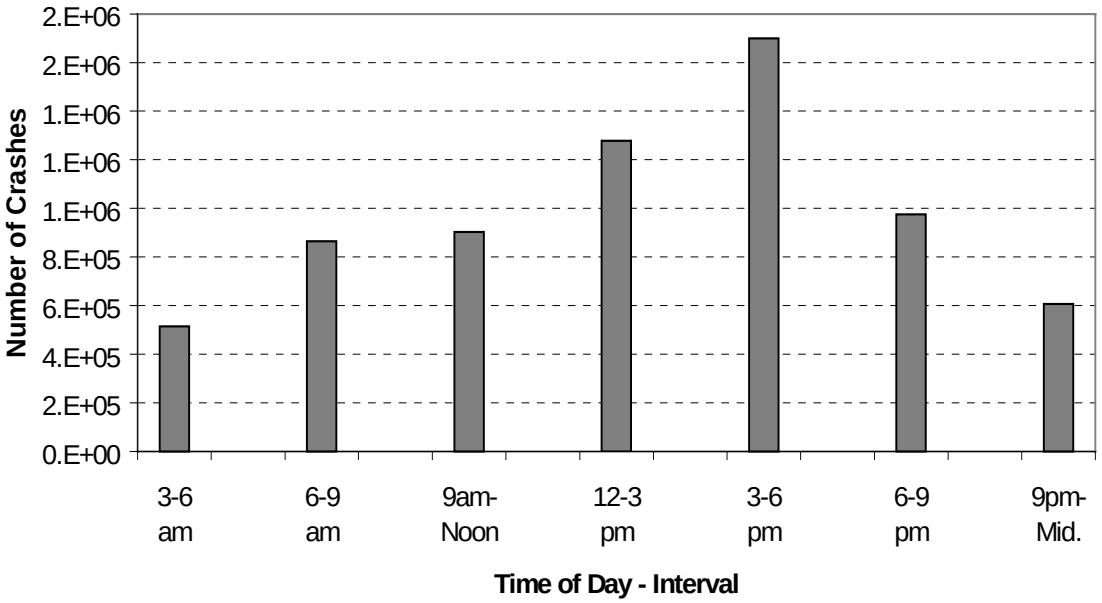

Figure 3-7 Crashes by Time-of-Day in 1996

It will be shown in chapter 5 that the midday period is very important in terms of the risk in being involved in an accident.

3.4 Hour Versus Speed Limit

Using the GES 1996 file and the Traffic Safety Facts 1996 (BTS, 1997) the distribution of crashes per time-of-day and speed limit was investigated. This particular task needed to be executed before proceeding to the development of the rates as the distribution of the crashes would serve as a benchmark in order to explain the trend followed. Figure 3-8

presents the distribution of crashes per speed limit for the time of the day during the year 1996.

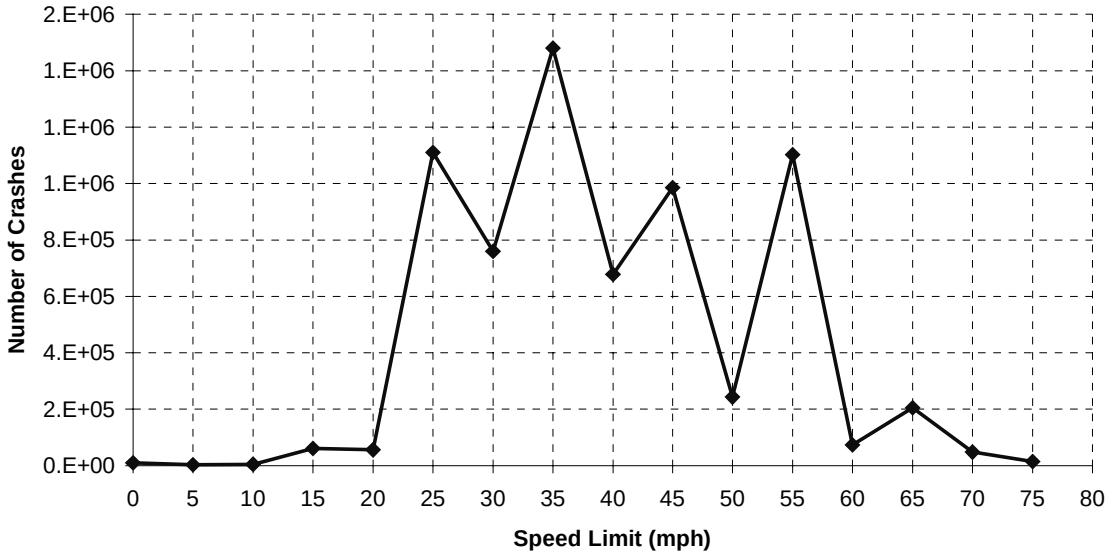

Figure 3-8 Crashes per speed limit in 1996

Figure 3-8 above, illustrates that the majority of the crashes are reported at posted speed limits of 25, 35, 45 and 55 mph whereas less crashes are reported in speed limits such as 30, 40, 50 and 60 mph. This is due to the fact that speed limits of 25, 35, 45 and 55 are more common than the rest. However, it is also observed that most of the crashes fall within the range of 25-55 mph with higher speed limits to experiencing less crashes.

3.5 Summary

In this chapter, some of the highway statistics were presented together with some accident trends. Such data include the figures of vehicle miles traveled (VMT) in the United States, during 1996 when the crash data were extracted. VMT numbers aid in the development of accident rates by utilizing the accident frequencies extracted from the GES database. Some of the most significant trends were also presented, i.e. the number of crashes as a function of speed, time-of-day and accident type or manner of collision.

Finally, the characteristics of the transportation network and the roadway mileage and VMT aid the user to understand the specific behavior of some of the safety issues related with the development of crash rates. The data presented in this chapter will be further utilized in chapters 4 and 5 where the safety model is described and tested in field data and a micro-simulation environment.