

CHAPTER 1

INTRODUCTION

1.1 Introduction

Despite the fact that the total number of police reported accidents decreased the last few years, safety is one of the challenging issues in the transportation industry. The safety impacts issues are important because for example in 1996 were approximately 2.7 accidents occurred per million vehicle-mile traveled. New emerging technologies attempt to alleviate congestion on the roads and improve safety conditions on them. Such technologies fall into the category of Intelligent Transportation Systems (ITS) and one of them will be further analyzed in the context of this thesis. The need to evaluate the impact of traffic signal coordination (in the traffic network of Phoenix, AZ) on safety, was the reason for developing a suitable methodology in this thesis in order to answer several questions on this topic.

Intelligent Transportation Systems and traffic signal coordination smoothen traffic flow and smoother traffic flow reduces the vehicle-to-vehicle speed differences. These differences can be hypothesized to reduce the crash risk and more particularly the rear-end collision risk. How can one quantify the safety impact of traffic signal coordination? In this thesis, a safety model based on national accident database crash frequencies will be presented. Traffic smoothness can be measured in the field by a floating car equipped with Global Positioning Systems (GPS) and in simulation, based on the microscopic car-following model. The statistical accident rate model developed will include benchmark estimates of national rates of absolute crash risk by crash type and facility.

Many research groups have been involved in the development of accident models over the past few years. These models help to evaluate several alternatives related to traffic safety or in this case, to evaluate the impact of an Intelligent Transportation Systems (ITS) component, on safety. This thesis will use the results extracted from the General Estimates System (GES) database, together with some literature sources, in order to construct the statistical foundation for the development of a safety model. It is important

to investigate these safety impacts due to the fact that new ITS components (e.g. traffic signal control, variable message signs etc.) have been tested extensively for their level of safety impact. This thesis will attempt to provide a means of evaluating such ITS components by developing a safety model that will be sensitive to them.

The safety model will be incorporated in the INTEGRATION traffic model (Van Aerde,1999) and will be tested on the Phoenix traffic network and a sample network in before and after scenarios where traffic signal coordination was used as an ITS alternative to improve the safety conditions on the particular network. INTEGRATION is a dynamic microscopic traffic simulation package (see Appendix C for a description of the INTEGRATION model).

The safety model will utilize the accident rates as an input in order to calculate the accident risk on a certain facility. The biggest accident database with national accident data will be used for the purposes of this thesis. National crash databases do not quantify the impact of traffic signal coordination on crash risk. However, these national databases can serve as a benchmark for the evaluation of some alternative approaches such as:

- Site Specific before and after field studies
- Modeling Studies

The main advantage of the national crash databases is that they ensure consistency across sites due to their extended exposure level and sophisticated census.

The safety model developed will be also used for field data evaluation in order to estimate the crash risk based on data obtained from the Scottsdale/Rural road corridor in Phoenix.

At this point, it must be noted that two terms are used in this thesis to describe a collision: accident and crash. The National Highway Traffic Safety Administration (NHTSA) avoids using the term “accident” which suggests that an incident is due to random forces of nature. A “crash” on the other hand can be prevented or mitigated through driver, vehicle, roadway or environmental interventions. In this thesis both terms (“accident” and “crash”) are used because the distinction has not yet been adopted by many transportation modes or by the International community.

1.2 Background

During the period of 1988-96 there were more than 58 million crashes in the United States (U.S. DOT). An average approximately 6.5 million crashes are reported to the police each year. In 1996, the total number of crashes reached 6.8 million, a significant rise from the reported crashes of the previous four years (1992-95). Even though the fatal crashes remained almost at the same level from 1988-1994, during the last few years this type of crashes became more common and is closely relevant to the number of crashes reported. Transportation engineers have been using the existing accident databases as a benchmark in order to evaluate certain Intelligent Transportation Systems. The need to develop a safety model for the purposes of this thesis, rose from the fact that in the context of the Metropolitan Model Deployment Initiative (see description of MMDI in Chapter 5), the impact of traffic signal coordination on safety needed to be evaluated. ITS can be characterized as a combination of several key elements such as: traffic control systems that automatically adjust themselves to optimize traffic flow, emergency response coordination, freeway management systems and Advanced Traveler Information Systems (ATIS). The main focus of ITS is to optimize the current transportation system through the use of advanced technologies and new institutional arrangements. The approach in this thesis attempts to quantify the safety impacts of one of the ITS technologies, traffic signal coordination, by proposing a suitable methodology that can also be used for the evaluation of other ITS components.

1.3 Objectives of the thesis

The objectives of this thesis are mainly the following:

- Develop a safety model that is sensitive to vehicle-to-vehicle and vehicle to control interaction.
- Demonstrate the feasibility of the approach using field data and traffic simulation.

1.4 Thesis organization

Following this chapter, *chapter 2* provides a summary of the available literature in the area of safety and more specifically in the development of accident models, and accident rates. Also in chapter 2 is a brief summary of the existing accident databases. The databases serve as a main source for extracting crashes from them in order to develop crash rates. These crash rates need two major variables: the crash frequencies (are obtained from the crash databases) and the vehicle miles traveled figures (obtained from the Highway Statistics).

Chapter 3 presents the sources of data used for the development of the crash rates. Sources such as the highway statistics and extracted data from the GES database will be analyzed in order to present the foundation of the safety model that follows. Chapter 3 also includes the various accident trends for the year 1996, because these will be used as a benchmark in order to validate the results that will be presented in chapters 4 and 5.

Chapter 4 focuses on the GES database and the development of the accident rates that are used in chapter 5. Chapter 4 provides information for the database, the extraction process and the reliability of the estimates. Also in this chapter is a description of the database variables and accident rates produced. The raw accident rate data that the safety model utilizes are also presented.

Chapter 5 presents a description of the safety model and the equations that were developed. The FORTRAN code and the trends the crash rates follow. Also in chapter 5 is the evaluation of the safety model in both a field data and micro-simulation evaluation. The INTEGRATION traffic model will be used as well as a GPS floating car study.

Chapter 6 provides some conclusions from this study as well as some recommendations for further research.