

CHAPTER 6

CONCLUSIONS AND RECOMMENDATIONS

6.1 Summary of the thesis

This thesis presented a safety model that captured the safety impacts of traffic signal coordination. The largest accident database in the United States was used in order to develop the statistical foundation for the development of this model. Emphasis on the extracted data was given to the following variables:

- Time of day the crash occurred.
- Crash Type (in the form of 80 pre-crash states and 14 crash categories).
- Speed Limit (in the range of 0-75 mph).
- Crash Severity (property damage only, injury severity or fatality).

A main program and three subroutines in FORTRAN code were utilized to calculate the accident risk of a facility based on its free-speed.

After the model was developed, it was tested in a micro-simulation environment. The model was incorporated in the INTEGRATION traffic model and before and after signal coordination simulation runs were completed.

Second step in the model testing was the use of field data from Scottsdale/Rural road in Phoenix, Arizona. This study was then compared with another study that was performed in the same area in Phoenix but with the use of actual crash data from the local accident database. This model is sensitive to impacts of ITS technologies. Such technologies can include traffic signal control, variable message signs and ramp metering.

6.2 Results

As described in the introduction, the main objective of this thesis was to quantify the safety impacts of traffic signal coordination. The safety model was developed with using crash data from the GES accident database. The main outcomes from this thesis were the following:

- The safety model developed successfully captured the benefits of traffic signal coordination. The micro-simulation results using the Phoenix (Scottsdale/Rural road) network indicated that after the signals were coordinated, the accident risk was decreased by almost 5%.
- Field data from Phoenix and the GPS floating car results showed that the accident risk is 2% to 23% lower for coordinated signals. The speeds were improved in the after situation where the signals were coordinated. This fact directly affected the crash rates and the probability of having a crash.
- A comparison of the field data study using the GPS floating car results and the study performed using local accident data yielded similar results by having almost the same decrease in the accident risk after the signals were coordinated.
- The GES database, despite its limitations, proved to be an efficient accident database to use for the extraction of detailed crash frequencies. Also, the highway statistics provided sufficient information regarding the vehicle miles traveled during the year 1996.
- Traffic signal coordination does have an impact on safety. As shown in chapter 5, the free speed is increased after the signals are coordinated. Because the speeds are increased, vehicles cover the same distance they had to cover before signal control, faster. By being less time on the facility, the crash risk is lower than before. However, in some cases, the risk may be less but for some accident types or higher for others, and this is directly connected with the facility speed limit.
- Table 6-1 below presents the results from the different studies examined in this thesis in a tabulated form. Only the Arizona database results provided some information for the rear-end crash risk. The percentages in Table 6-1 demonstrate the decrease in the crash risk after the signals were coordinated.

Table 6-1 Results for crash risk changes after signal coordination

Results	Field Data Results (GPS Floating cars)	Arizona Database Results	Micro-simulation results (INTEGRATION)
Average Crash Risk	2-23% lower	3-18% lower	4.9% lower
Rear-end Crash Risk	n/a	13-43%	n/a

6.3 Limitations and Database drawbacks

The General Estimates System was the primary database used for the development of the crash rates in this thesis. Despite the fact that the GES is the largest accident database available in the United States, through extensive use for the purposes of this thesis, some limitations of the database were detected. Some of the limitations were the following:

- The withdrawal of the variable that identifies the locality of each crash (i.e. urban or rural) makes the development of the crash rates more general in a sense that all crashes are combined together. Due to the fact that the highway statistics provided annual vehicle miles traveled data in urban and rural classifications makes it easier for someone to develop rates in this manner by using extracted data from the database.
- Another important limitation of the GES database is the facility type variable that is basically non-existent. Only interstates are identified and the speed limit assigned to them is very large in range (40-75 mph). For the purposes of this thesis the speed limit was used as a variable to identify the facility type but a direct variable from the database would make the analysis more accurate and efficient.
- The GES database does not include any variables that provide information for the annual vehicle miles traveled in different facility types. The highway statistics typically provide such information but they need to be included in the accident database in order for someone to extract accident frequencies and develop the rates by merging the appropriate datasets from the database.

- For the development of the accident rates, GES Variable 23 (Accident Type) was used. This variable included 80 pre-crash states but had no connection with the variable that describes the manner of collision for a crash. In the process of extracting the frequencies from the database, a standard error was carried during the process because of the non-frequent use of this variable. Police reports not always provide such detailed information regarding the pre-crash state and it is mostly based on each driver's perception or the policeman's judgement.

6.4 Further Research

Even though signal coordination is not a relatively new topic, not many studies that investigate its impact on safety, have been performed and published. Recent technological advances and emerging intelligent transportation systems impose the need for exploring the safety impacts of these systems further. Some recommendations for future research are presented below:

- As mentioned in this thesis, rear-end accidents are hypothesized to be the dominant accident type to be impacted by traffic signal coordination. This can be explored further by focusing only on rear-ends instead of having a more general approach with all accident types combined together. The GES database provides nearly 10 different rear-end accident types that can be analyzed separately. Using rates from these types, conclusions can be drawn for any possible benefits and reduction in the rear-end crash risk.
- Other databases can be used for the development of accident rates, for example local databases or even FARS for an emphasis on fatalities. The model offers the flexibility or reading any crash rates in order to estimate the accident risk of a facility.
- In terms of micro-simulation testing, intermediate networks can be used in order to investigate the safety impacts of traffic signal coordination in greater detail. For example, some sample networks can be developed having sets of traffic signals where the user can coordinate the signal and check for different levels of signal coordination, i.e. investigate the differences in accident risk for good to poor signal coordination.

- The safety model can also be implemented for testing the safety impacts of other ITS components like ramp metering or Variable Message Signs (VMS). Also, for route diversion and other applications. Due to the fact that the model utilizes national data, it can be utilized for the investigation of the safety impacts of a variety of applications. In this thesis only traffic signal coordination was investigated as a first step in testing the model and investigating the possible impacts on safety.