Masters Theses 1911 - February 2014

Dissertations and Theses

January 2007

A Comparative Evaluation of Crash Data Quality Identification Methods

Arianna M. Mickee

University of Massachusetts Amherst, amickee@gmail.com

Follow this and additional works at: http://scholarworks.umass.edu/theses

A COMPARATIVE EVALUATION OF CRASH DATA QUALITY IDENTIFICATION METHODS

A Thesis Presented

by

ARIANNA M. MICKEE

Submitted to the Graduate School of the
University of Massachusetts Amherst in partial fulfillment
of the requirements for the degree of

MASTER OF SCIENCE IN CIVIL ENGINEERING

May 2008

Civil and Environmental Engineering

A COMPARATIVE EVALUATION OF CRASH DATA QUALITY IDENTIFICATION METHODS

A Thesis Presented

by

ARIANNA M. MICKEE

Approved as to style and content by:

_____

Michael A. Knodler, Jr., Chair

_____

John Collura, Member

_____

Richard Palmer, Department Head
Civil and Environmental Engineering

ACKNOWLEDGMENTS

I would first and foremost like to thank my family and friends who have supported me this past year and a half while I have been completeing my research. I would especially like to thank my mother and father who have provided me with the strength and dedication needed to complete this thesis. I would also like to thank Emmanuel Seguin for having confidence in my abilities and pushing me to be the engineer I am today.

I would like to thank my advisor, Dr. Michael A. Knodler, Jr., for all the help he provided me on my thesis and for the way he guided me to be a better enginner. I would also like to thank the UMass Transportation Center for all the help they provided me since my undergraduate career.

I would like to thank the staff of UMassSafe for all the help they have given me over the past year and for providing me with the data quality information, which made this research possible. I would especially like to thank Ms. Robin Riessman for all her help and guidance pertaining to data quality issues. I truly am grateful.

ABSTRACT

A COMPARATIVE EVALUATION OF CRASH DATA QUALITY
IDENTIFICATION METHODS

MAY 2008

ARIANNA M. MICKEE, B.S.C.E,, UNIVERSITY OF MASSACHUSETTS
AMHERST

M.S.C.E., UNIVERSITY OF MASSACHUSETTS AMHERST

Directed by: Professor Michael A Knodler, Jr.

Throughout the United States federal and state agencies use crash data in order to properly plan safety improvements within their areas. Unfortunately since 2000, transportation professionals have noticed a significant lack of reliable crash data in some states. These issues have a multitude of causes and therefore there are many solutions to these issues. In order to determine what courses of action need to be taken in order to address these issues, many state and federal government agencies have been conducting studies using various methods.

This thesis compares three basic methods used to identify crash data quality issues facing transportation professionals. The three methods evaluated are surveys, audits and focus groups. These three methods are currently practiced by professionals to gain insight to crash data quality issues. Unfortunately, the methods are often used inappropriately and inefficiently to determine data quality issues. The purpose of this thesis is to describe what valuable information can be obtained by using these methods as well as what information cannot be obtained. The results of three projects were

employed in the evaluation of these methods. These projects include the Massachusetts

Highway Departments Crash Data Quality Project, the Commercial Motor Vehicle

Crash Data Quality Project, and finally, the Police Outreach Survey. In the end, these

projects help determine the usefulness of these methods in terms of their ability to

identify data quality issues and efficient and cost effective solutions to address these

issues.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

Over the course of the last few years, crash data quality has been an important issue across the United States. The information obtained on a state's crash report form is typically entered into computerized data systems. The data is then pulled from the system and used to determine which safety projects should receive more funding within that state. However, in order to ensure the data retrieved from the system was correct, the federal government conducts statistical analysis for each state by evaluating the accuracy of the information in the electronic system. The focus of this thesis is the evaluation of different methods associated with collecting information on data quality to minimize costs while maximizing the amount of information available to solve the issues with data quality.

The Massachusetts Executive Office of Transportation's Cooperative Research Program provided funding for a grant that focused on an audit process to identify and detail data quality issues in the Massachusetts Crash Data System (CDS). In 2001, the Commonwealth of Massachusetts created and revised a new crash report form in order to obtain all the necessary information the federal Department of Transportation required and implemented a new Crash Data System (CDS). The main data issues included poor location information, poor data quality for engineering-related fields, a high rate of missing injury severity data, and data entry errors.

Since 2006, Massachusetts has been in "poor" standing with the Federal Motor Carrier Safety Administration. This was mainly due to the failure to meet the measures the organization has set for data quality. The two measures where the state received a

poor rating was for crash accuracy and crash timeliness. Basically, a high percentage of the commercial motor vehicle crash reports were submitted by police officers past the timeliness threshold and contained insufficient information to identify the vehicle and owner.

In order to obtain the information on these issues, a series of crash data quality identification methods were used. In both of the data quality projects described above, a form of an audit was performed to retrieve data. For the commercial motor vehicle data quality project, a focus group was formed to obtain all available information from police officers who filled out the crash form. Lastly, there was a short survey, known as the Police Outreach Survey, which was performed by UMassSafe from the beginning of September 2007 through the end of December 2007.

Problem Statement

Throughout the United States there has been great variability in the use of various methods to collect information related to crash data quality issues. Unfortunately, a problem with these methods has been that transportation professionals often do not know when or how these methods should be used to evaluate data quality issues. In this thesis, these methods are described and evaluated based on the information obtained for each specific project. The goal of this thesis is to describe in detail when these identification methods should be used and what information can be retrieved from these methods along with what information cannot be obtained. This information has helped states efficiently and cost-effectively allocate funds for research and thus eliminate spending on unnecessary studies.

Research Objectives

An objective of this research is to identify key factors gained for data quality issues and to evaluate the use of each methods in order to specify future use and what type of information was gained from the methods. Another objective of this research is to determine how these methods can be used by transportation professionals in a cost effective and efficient manner in order to allocate time or funds on research appropriately.

Scope

The scope of this research was to determine what data quality identification methods should be used to obtain important transportation information for later use. Various data was viewed in many different perspectives from actual crash reports to talking to police officers about the difficulties with filling out sections of the crash report. The three projects used in this thesis for evaluation were the Massachusetts Highway Departments Crash Data Quality Project, the Commercial Motor Vehicle Crash Data Quality Project, and the Police Outreach Survey. The goal of these three projects was to help Massachusetts with their crash data quality issues that have occurred over the course of the last few years. These projects helped identify what information the identification methods are good at obtaining and also when the methods are not useful to professionals at all for data quality issues.

CHAPTER 2

BACKGROUND

In order to identify and evaluate the effectiveness of each method presented, a clear understanding of what the methods were must be clarified as well as how these methods were commonly used and what advantages and disadvantages were typical for these methods. The three methods included audits, focus groups, and surveys. Within each method's general description, there is information on what forms of these methods were used for each project. Following the method's details, a brief overview of each of the projects was presented in order to understand the importance of data quality.

<u>Audits</u>

An audit can be generally defined as an evaluation of an individual, a group, a company, a system, a product, or a process which is done in order to obtain the soundness and dependability of information and provide an overall evaluation of how a system works (1). A transportation audit was considered to be a "transportation engineering and planning study that involves a thorough review of the existing conditions as well as a consideration of a number of potential approaches to improve the safety, mobility and quality of our transportation systems which include vehicular traffic as well as pedestrian and bicycle safety in a given neighborhood" (2). For the Crash Data Quality project, what was known as a performance audit was performed on both paper and electronic crash reports from January 2005 to December 2005. Paper reports were considered to be a hard copy crash report that have been completed and submitted by police officers. These reports were often submitted by local police officers since the

Massachusetts State Police (MSP) has an electronic submittal system for their crash reports. The electronically submitted reports were sent directly to the Registry of Motor Vehicles upon completion without any type of paper trail. In this case, a performance audit referred to an examination of a system in order to determine if the system of filling out crash reports was effective and efficient (1). For the Commercial Motor Vehicle Data Quality project, an information technology audit was performed by examining the technology infrastructure of the data systems in order to ascertain the systems effectiveness and reliability (1). This was done by comparing the submittal and overall accuracy of the three crash data systems for commercial motor vehicles.

Before performing an audit, there were some general advantages and disadvantages that were associated with this method. One of the advantages of performing a transportation audit was the detailed statistical information that could be found because it allowed analysts to focus on specific areas in order to improve data quality. Another advantage of audits was that individuals from many different professions, from police officers who fill out the crash report to MassHighway engineers who used the data obtained from the crash reports, work together to find the inconsistencies that are common to all crash reports. Unfortunately, a big disadvantage was that an audit was based on a random sampling of crash reports and cannot be free of error. Therefore, the sample selected may not fully represent all crash reports (1). However, there are ways to minimize these disadvantages so that the information obtained from an audit is dependable and accurate.

The process of performing an audit is fairly basic because the process includes collecting the crash data from its source and analyzing the data for inconsistencies. Even

though this process many seem basic, it took an abundance of time and energy to reach the results. For each project, a methodology was devised in order to get the information and evaluate the data. The methodologies specified what information the researcher wanted to get from the audit and how the audit took place. These methodologies can be found later in the thesis.

Focus Groups

There are many ways to use focus groups in order to obtain the information an individual may be looking for. A focus group can be defined as "a form of qualitative research in which a group of people are asked about their attitude towards a product, service, concept, advertisement, idea, or packaging" (3). A focus group typically involves six to ten individuals who are unfamiliar with each other yet have common interests or characteristics and they have been brought together by a moderator (4). A focus group is typically used to obtain information on data quality issues that ordinarily cannot be answered by statistics alone. Basically, researchers and analysts can learn the causation of missing elements from a crash report instead of just what is missing and how often. For the Commercial Motor Vehicle Data Quality project, a dual moderator focus group will be conducted involving local and state police officers who fill out the crash report form. A dual moderator focus group occurs when two moderators participate in a focus group in which one ensures the session is moving according to schedule while the other makes sure all the topics outlined have been covered and answered to the best of the participants' abilities (3). Hopefully, these officers can help

provide some insight on the difficulties with filling out the truck and bus section of the crash report form, where commercial motor vehicle information should be placed.

As with any method of obtaining information, there are many advantages and disadvantages when performing focus groups. First, the advantages of focus groups will be discussed. The first advantage is that focus groups conducted in a traditional method can produce accurate information and are commonly less expensive than other forms of research (3). Focus groups also generate group dynamics by producing spontaneous reactions and ideas brought out by other group members (5). Basically, one person's idea can allow another participant to build on that same idea and so on. In general, focus groups usually can be conducted more easily than many other methods to obtaining information and require much less preparation (4). Focus groups also allow researchers to interact with the participants and give the researchers the ability to receive non-verbal responses in this format. Finally, one of the greatest advantages of a focus group is that the results can be understood with ease and the results can be provided to others without complications (4). In the end, focus groups can provide useful information to researchers with small budgets.

Unfortunately, there are many disadvantages when using focus groups to obtain information. One significant disadvantage is that bias could be caused by either the participants or moderator in a focus group and the results would therefore be unreliable (5). Another disadvantage is that the moderator could lose control of the group of people and the topic could therefore be lost and the results would be irrelevant (3). Also, the sample of individuals is not large enough to represent the population as a whole and the results would be for the group only (3). Finally, a focus group can sometimes produce

chaotic data which makes data analysis more difficult (4). A researcher must therefore

be very careful when conducting a focus group so that the information obtained pertains

to the subject and is reliable.

Before choosing to use a focus group, a researcher or analyst must know what

information a typical focus group can provide and what it cannot. Focus groups can

provide a researcher with the following five things (4):

i. Information on how groups of people think or feel about a particular topic
ii. Greater insight into why certain opinions are held
iii. Ways to improve the planning and design of new programs
iv. A means of evaluating existing programs
v. Insights for developing strategies for outreach

However, focus groups cannot validate information about the participants or changes

over time as well as they cannot provide generalization for populations based on the

sample's responses (4). In the end, focus groups can be a useful tool to gain information

when they are controlled and used properly.

In order to conduct a productive and beneficial focus group, a basic process

should be followed. In order to facilitate the session, there are seven guidelines that need

to be ascertained which are listed below (6):

i. The major goal of facilitation is collecting useful information to meet the goal of meeting
ii. Introduce yourself and the co-facilitator, if used.
iii. Explain the means to record the session.
iv. Carefully word each question before addressing them to the group.
v. After each question is answered, carefully reflect back upon a summary of what you heard.
vi. Ensure even participation. Make sure everyone is discussing the matter evenly and that one or two people are not dominating the meeting.
vii. Closing the session by thanking them for their participation.

After the session has concluded, all of the facilitators shall sit down together and listen to the recording or review the session, make any additional notes to clarify any confusion, and write down all observations made during the session if it had not previously been noted (6). If the guidelines listed above are followed, then the focus group should have successful and reliable results.

Surveys

Surveys are a very fundamental way of obtaining information from a group of people with similar characteristics. A survey can be defined as "a system for collecting information to describe, compare, or explain knowledge, attitudes, and behavior" (7). A survey is a way of collecting information on a particular subject without a face-to-face interview as with a focus group. Surveys ask an individual's opinion on a particular subject and can be in either paper or electronic form. The Police Outreach Survey was designed to determine the difficulties concerning crash reporting and data-collection and to identify potential impediments to modifying this system (9). A survey, such as the Police Outreach Survey, that collects no numerical information can be considered a survey with a nominal scale (8).

An advantage that can be gained by the use of a survey for transportation purposes is that participants are more likely to be honest because the survey is usually anonymous. In contrast, this feature can also be a disadvantage if the survey if not taken seriously. Another advantage of conducting a survey is that it provides statistical information as well as opinionated responses in a short questionnaire. A major disadvantage when conducting a survey is that all responses are voluntary and some

individuals simply do not care to fill the form out and the results can then be skewed. Overall, surveys can be useful to gain information both statistically and individually, but the accuracy is determined by how the participants respond.

A researcher must have certain skills in order to conduct a successful survey. These skills include formatting study designs and sampling frames, developing instruments, supervising data collection, entry and manipulation, applying descriptive and inferential statistics, and interpreting the results and preparing the reports (7). If a researcher does not have these skills, it will be very difficult to conduct a productive survey.

There are some features to a survey a researcher/analyst must have incorporated into their survey to ensure reliability and validity. The features listed below should be in every survey:

    i.   Specific objective
    ii.   Straightforward questions
    iii.   Sound research design
    iv.   Sound choice of population or sample;
    v.   Reliable and valid survey instruments;
    vi.   Appropriate analysis;
    vii.   Accurate reporting of survey results; and
    viii.   Reasonable resources

Most of the best surveys conducted in the transportation field have these feature incorporated into the surveys design.

Now that an understanding has been achieved for each of the methods, each project has been described below as well as the methods that will be used to obtain the data quality information.

MassHighway Department Crash Data Quality

When a crash occurs in Massachusetts, a police officer collects the information from the crash and records the information on the crash report form. An example of the crash reporting form can be seen in Appendix A. Highway safety stakeholders in Massachusetts use the information obtained from a crash form to improve highway safety within the state. The completed crash report form is submitted to the Registry of Motor Vehicles (RMV) and the basic information is entered into a data system. The information in the data system is used by MassHighway to propose engineering improvements and to implement programs to reduce crash severity and crash frequency. One of the major uses of crash data in Massachusetts is the creation of the 'Top 1000 High Crash Locations' list, which help identify areas within the state that need safety improvements.

In 2001, Massachusetts implemented a new Crash Data System at the RMV and issued a new crash report form in order to improve the way crash data is collected, stored, and accessed. In recent years, significant data quality issues have emerged as a result of these changes. These issues include a high rate of missing injury severity data, poor location information, poor data quality for engineering-related fields, and data entry errors (10).

In order to determine which crash locations are given priority for improvements, the crash severity and crash frequency data is collected and analyzed. Unfortunately, injury severity data is missing from a crash report approximately 25% of time, which makes it extremely difficult to accurately identify high crash locations in the state (10). Crash severity helps determine high crash locations by differentiating between locations

with an abundance of crashes with low severity and locations where a small amount of crashes occurred, but the crash severity was high. In all, the severity of a crash can help establish which crash locations have a high priority for safety improvements.

Crash location information gathered from crash reports varies from street addresses to exit ramps. Officers will occasionally put insufficient information in the location section of the crash form, but will provide more accurate information in the narrative section of the form or in the crash diagram. While this is helpful to identify the location of the crash, information in the narrative and diagram are not inputted into CDS and therefore MassHighway has no way of accessing the more accurate location information (10). Crash location information is used by MassHighway to determine high crash locations and other locations where safety improvements are necessary. It is crucial to receive accurate location information for future planning of any highway safety improvements in Massachusetts.

There are some fields on the crash report form that are missing, even though they do not have high percentages of missing information. These fields include work zone information and traffic control device information. This information often supplements the crash location and severity information in order to determine what engineering changes are required to improve safety at these locations (10). If a traffic control device has been identified on the crash report form, MassHighway also needs to know if the device was working properly in order to determine if it was the possible cause of the crash. Therefore, these fields need to be reported as accurately as possible for engineering uses.

There are several types of data entry errors that occur between a crash and when the crash report information is obtained by MassHighway. Occasionally, data error occurs at the crash site when the officer is filling out the paper crash report form and when the officer transfers the information into a computer system (10). If a crash report is submitted electronically, the report is electronically submitted to the RMV. Unfortunately, a majority of crash reports are submitted in paper form through the mail. Data entry errors can occur when the RMV personnel enter the information from a paper crash report into CDS. At this stage, the data entry errors that occur usually produce duplicate reports, incorrectly reported information, and poor data quality (10). By decreasing the number of data entry errors that occur, accurate data can be provided to be used by MassHighway.

Overall, accurate crash data information is crucial to MassHighway for safety improvement purposes. If the information on a crash report form is either incorrect or missing, it makes the decision process difficult and impedes the identification and implementation of safety improvements throughout the state (10). If Massachusetts' goal is to reduce crash frequency and severity, the data quality issues presented must be comprehended and rectified.

Commercial Motor Vehicle Crash Data Quality

A major goal for the Federal Motor Carrier Safety Administration (FMCSA) is to improve the data quality of state-reported crashes and roadside inspections. Currently, "states are required to provide standard information about Commercial Motor Vehicle (CMV) reportable crashes and roadside inspections to FMCSA, which use these data to

evaluate the completeness, timeliness, accuracy, and consistency of these data" (11).

Based on the data a state provides to the Motor Carrier Management Information

System (MCMIS), FMCSA will issue a state a State Safety Data Quality (SSDQ) rating.

The state bases the SSDQ rating on the following 6 measures (12):

1. <u>Fatal Crash Completeness Measure</u>: This measure compares the number of large trucks involved in fatal crashes that are reported to MCMIS against the number of cases in the Fatality Analysis Reporting System (FARS) for the most recent calendar year.

2. <u>Crash Timeliness Measure</u>: This measure compares the percent of state-reported crashes involving large trucks and buses that are uploaded within the 90-day requirement.

3. <u>Inspection Timeliness Measure</u>: This measure compares the percent of state-reported inspections involving large trucks and buses that are uploaded within the 21-day requirement.

4. <u>Crash Accuracy Measure</u>: This measure examines the percent of interstate carriers and intrastate hazardous material carrier's records for 12 months where the motor carrier information on the crash record matched a motor carrier in the MCMIS Census file.

5. <u>Inspection Accuracy Measure</u>: This measure examines the percent of interstate carriers and intrastate hazardous material carrier's inspection records for 12 months where the motor carrier information on the inspection report matched a motor carrier in the MCMIS Census file.

6. <u>Crash Consistency Overriding Indicator</u>: A state receives a "red flag" (automatic overall grade of "Poor") if it reports less than half of the number of crash records for the most recent year based on an average of the previous three years. This is an indication of a major and immediate problem with the state's crash reporting system

Using these six measures, FMCSA will rate a state either "Good", "Fair", or "Poor". In

order to receive a "Good" SSDQ rating, a state must have at least one of the measures

rated good and none of the other five can be considered poor. A state will receive a

"fair" grade from FMCSA if one of the six measures is considered "Poor". If a state receives more than one "Poor" measure, then the state will receive a "Poor" grade. A state that receives a red flag for the crash consistency overriding indicator measure will immediately receive a "Poor" grade from FMCSA no matter what the other ratings may be.

Since July 2006, the SSDQ rating for Massachusetts has been "Poor" because Massachusetts has received a "Poor" rating on crash timeliness and crash accuracy. Figure 1 should the most resent ratings issues by the FMCSA. For the crash timeliness measure, FMCSA will give a state a "Poor" rating if less than 60% of all CMV reported crashes were submitted within 90 days. A state will receive a "Fair" rating for the crash timeliness measure if between 60% and 84% of the CMV crash reports are submitted within the 90 day threshold. If a state submits more than 85% of its CMV crash reports within 90 days, the state will receive a "Good" rating for the crash timeliness measure. In order to determine a state's crash timeliness rating, FMCSA uses one full year of data (12 months) excluding the most recent quarter. For example, the SSDQ rating for June 2007 used the data from MCMIS ranging from April 1, 2006 to March 31, 2007. As of June 2007, Massachusetts submitted 46% of CMV crash reports within the 90 day requirement.

Figure 1: FMCSA SSDQ Rating for Massachusetts as of July 2007

For the crash accuracy measure, FMCSA will give a state a "Poor" rating if less than 85% of reported crashes that involved interstate carriers and intrastate hazardous material carriers matched to a carrier in MCMIS. A state will receive a "Fair" rating for the crash accuracy measure if between 85% and 94% of the CMV crash reports that involved interstate carriers and intrastate hazardous material carriers matched to a carrier in MCMIS. If a state submits more than 95% of its CMV crash reports that involved interstate carriers and intrastate hazardous material carriers matched to a carrier in MCMIS, the state will receive a "Good" rating for the crash timeliness measure. In order to determine a state's crash accuracy rating, FMCSA uses one full year of data (12 months) excluding the most recent quarter, which is the same for the crash timeliness measure. As of June 2007, Massachusetts submitted 79% of CMV crash reports that involved interstate carriers and intrastate hazardous material carriers matched to a carrier in MCMIS.

The "Poor" ratings Massachusetts has received for the crash timeliness measure and crash accuracy measure highlight the need to improve the data quality in the state. A continuation of "Poor" ratings from FMCSA will decrease the amount of much needed

Federal grants given to Massachusetts. In order to improve the state's data quality, extensive analysis must be conducted on crash reporting timelines, crash reporting accuracy, and crash reporting underreporting. A focus group will also be conducted with local and state police officers who fill out crash reports in order to determine why these crash measure thresholds are not being attained.

Police Outreach Survey

In order to understand all perspectives of the data quality issues in Massachusetts, a Police Outreach Survey will be created and sent out to all of the state and local police departments throughout the state. The purpose of the survey is to obtain information pertaining to accuracy, timeliness, completeness and consistency from the police officers who fill out crash reports. The intention of the survey is to understand what some of the impediments may be for officers when filling out a crash report form and how these obstacles affect data quality issues. The survey will assist the RMV in obtaining an understanding of the following (9):

- Why are state and local police officers not sending in crash reports; if they are submitting reports, what prevents the reports from being accurate, complete, and consistent?
- Why are the crash reports not being submitted in a timely manner?
- Do state and local police officers have concerns with the current form and/or the data elements requested?
- Are state and local police agencies are interested in the electronic submission of crash reports?
- Would state and local police agencies be open to using a state-supplied crash data reporting system or Web site?

The results of this survey will aid in any changes that need to occur on the crash report form or in the crash data systems. Hopefully, any potential challenges that affect data quality in Massachusetts can be resolved by understanding why these data quality issues occur and eventually, how to improve the accuracy, timeliness, completeness, and consistency of crash reports.

CHAPTER 3

PROJECT AND METHODS

In this chapter, the data quality evaluation methods used in the three crash data quality projects are described. These three projects are the CMV Data Quality focus group, the CMV Audit, the MassHighway Department Data Quality Audit and the Police Outreach. The methodologies are provided in great detail and relate to the individual project goals from each project.

Commercial Motor Vehicle Crash Data Quality Focus Group

The purpose of this focus group is to gain more information from police officers about what the obstacles are with CMV crash reporting. The information obtained during this focus group will be used to improve crash reporting and the quality of data being gathered. For the focus group, ten to twelve police officers will be asked to participate, but the officers selected must fill the following requirements (13):

- Officers of varied size police departments;
- Mix of local and state police;
- Traffic officers or other officers that investigate crashes regularly; and
- Officers that do investigate truck and bus crashes but are not on the Massachusetts State Police Truck and Bus Team.

The goal of the focus group is to acquire the perspectives and opinions from law enforcement on the collection and entry of truck and bus crash data, how the truck and bus section of the crash reporting form is utilized and what improvements can be made to the crash reporting form, and the challenges that impede police officers in ascertaining the crash data. The participating officers will be congregated together and

the focus group can be conducted using the guidelines and questions presented in the following sections.

1. Introduction

In this portion of the guide, the moderators will introduce themselves and state the purpose of the focus group. It is imperative that the participants know the importance of CMV data quality and that the results of the focus group will be summarized. This informs the police officers that what is said during the focus group will remain anonymous so they will be more likely to answer honestly. The objective of the focus group will then be provided. "The primary objective is to gain insight from law enforcement personnel regarding (13):

- How the truck and bus crash data are collected, entered, and transferred;
- The use of the truck and bus section of the crash report form in the field; and
- Possible improvements to the truck and bus section of the crash report form."

The police officers should be informed that the information collected from the focus group will provide an understanding about the difficulties when investigating and reporting truck and bus crashes in Massachusetts. The information will also include how the crash form and system might need to be changed and how the data quality for trucks and buses can be improved overall.

2. Disclosers

In order to have a successful focus group, the moderators must inform the police officers that they can speak freely and honestly so that they feel as comfortable as possible. Guidelines will be provided by the moderators to the participants concerning the session. The moderators should notify the police officers that there are no right or wrong answers and that they are encouraged to offer their opinion

whether it is positive or negative. The session will be audio-taped and the police officers should be reminded that their identity will be completely confidential. The tapes will be used for analysis only and the reports will be based off the results from the recorded tape. Once the police officers have been told the disclosers, the moderators will proceed to the participants' introductions.

3. Participants' Introductions

The moderators will rotate around the room and ask each police officer to introduce themselves. The introductions will include the police officers name and rank, the police department they are stationed, how long they have been in law enforcement, and finally how often do they report truck and bus crashes. Once all the officers have been introduced to the moderators and each other, the session questions will commence.

4. Discussion Questions

In this portion of the focus group, the moderators will begin to introduce the discussion questions to the police officers. The moderator will first begin with a short introductory discussion, followed by a transition discussion. The police officers will then be asked questions about accuracy and quality, completeness, and crash report timeliness. Each section has been broken down in order to transition through each topic easily (13).

   a. Introduction Questions
      - What training have you received in order to fill out a crash report form?
      - Was there any specific training on the truck and bus section of the crash report form?

- Have you had any recent training since you became an officer on the crash report form? If so, what kind of training did you receive (web, instructional, etc)?

b. Transition Questions

- During the last truck and bus crash you reported, what was the first concern that went through your mind when you advanced toward the scene of the crash?
- Do you fill the crash report out at the scene of the crash or after the crash has been cleared? If you fill the form out after the scene has been cleared, do you do it in the cruiser or back at the station?
- When the crash involves a truck or bus, when do you fill the crash report form out and how does it differ from filling out the form for other crashes not involving trucks or buses?
- Do you use the crash report form that was revised in 2001 when you go to the crash scene? If not, is there a truck and bus section on your version of the crash report form?
- Do you complete the whole truck and bus section at the scene or are some fields left blank and filled in later?

c. Accuracy and Quality Questions

- On the crash report form, the vehicle configuration code (Field 20) describes what type of vehicle was involved in the crash and a truck and bus is indicated by using between code 4 and 13. Is it difficult to identify the vehicle code easily for a CMV crash?
- If the crash report form is not filled out at the crash scene, how do you record the information?
- Is it easy to fill out the truck and bus section of the crash report form? If not, why? Are there any fields that are difficult to identify?
- At the crash scene, how do you typically identify the truck or bus? Can you often identify the US DOT number, state number, or carrier information? Are there any challenges associated with collecting this information?
- How do you think the truck and bus information written on a crash report form is used?
- Overall, are there any suggestions you have that will help improve the truck and bus section of the crash report form?

d. Completeness Questions

- Is filling out a truck and bus crash report more time consuming compared to filling out other crash reports? If so, how and why?
- When the vehicle configuration code identifies a truck or bus has been involved in the crash, why is the truck and bus section left blank?
- What changes to the crash report form would make it easier to fill out the truck and bus section?
- From you experience, what would increase the likelihood that the truck and bus section is filled out?

e. Timeliness Questions

- Once a crash report has been completed, how is the report submitted to the RMV? Are there any procedures associated with submitting a crash report? If so, what are they?
- Has a crash report ever been sent back to you? Has it happened to other officers? Why?
- How is the report sent to the RMV from your station and who is responsible for sending out the crash report? When do reports get sent out? Once a week? A month?
- What will increase the likelihood that CMV crash reports are submitted the federal system within 90 days? Any suggestions on improving the submittal process?

5. Summary

After all of the questions have been discussed, the moderators should briefly restate the key responses to the police offices. The moderator will ask if any other information that could help improve the CMV crash data quality issues. Once all information has been restated and additional notes have been added, the moderator can conclude the session.

6. Conclusion

In closing the session out, the moderators will thank the police officers for their participation. The police officers should know that their help in improving the state's data quality issues is much appreciated.

Once the focus group has concluded and the officers have been dismissed, the moderators and note taker should sit down and review the session. They can briefly review the tape record and any additional notes. During this period of time, it is crucial for the moderators and note taker to discuss the moods that took place in the session for better analysis. The results of the focus group will them be written up into a report format and a copy of the moderators guide has been provided in Appendix B.

Commercial Motor Vehicle Crash Data Quality Audit

The purpose of this audit is to gain more statistical information from data systems about what the obstacles are with CMV crash reporting. The information obtained during this audit will be used to improve crash reporting and the quality of data being gathered.

A. Methodology: Crash Completeness Measure

Using data from the CDS, SafetyNet, and MCMIS, two critical variables which influence underreporting were evaluated (16):

1. Accepted by MCSAP and MCMIS; and
2. Crash Severity.

The results of UMassSafe's analysis are presented later in this paper. The following section details the basic methodology and criteria used to evaluate factors affecting crash underreporting.

It is imperative to understand what crash underreporting is, and why it is important. Crash underreporting is the difference between the actual number of CMV crashes and the number of CMV crash reports submitted (16).

Crash underreporting was analyzed using four years of data from 2003 to 2006 (16). It must be noted that the CDS data for 2006 should be considered preliminary information as this year of data has not yet been closed by the Registry of Motor Vehicles (RMV). The data were first divided into four groups which represents each year of data (16). The paper crash reports (which were all crash reports, not just CMV crash reports) were first analyzed using the crash report status code from CDS (16). The paper crash reports are reports not submitted electronically to CDS and most of the paper reports have been submitted by local police. The local police paper crash reports were analyzed by looking for the number of reports within each year that had an 'S' code (16). The 'S' code represents the number of reports that were sent back to the author for correction. The paper crash reports that were sent back for each year were then analyzed by the local police departments that submitted them.

The CMV crash reports for 2003 to 2006 were then analyzed using two different definitions for commercial motor vehicles. The first definition used was a "crash with a crash report number that links to a MCMIS crash report (11). The second definition

used was a "crash involving a vehicle with a vehicle configuration code of 4, 5, 6, 7, 8, 9, 10, 11, 12, or 13 where at least one vehicle was towed or someone was injured." (11)

Other variables were also incorporated into the investigation, including information on the acceptance of the report by MCSAP and MCMIS and crash severity (16). Below, each factor is individuated and defined to provide a fuller understanding of this analysis (16).

1. <u>Accepted by MCSAP and MCMIS</u>

The CMV crashes for each of the four years were analyzed first by the number of MCSAP crash reports in CDS compared to the total number of CDS CMV crash reports. The percentage of CMV CDS crash reports accepted by MCSAP was analyzed by dividing the number of MCSAP accepted crash reports from CDS by the total number of CMV crash reports in CDS for that year.

2. <u>Crash Severity</u>

The CMV crash reports were analyzed for each year of data obtained by the crash severity. The crash severity was first separated into seven categories: fatal injury, no injury, non-fatal injuries with include incapacitating, non-incapacitating, and possible, unknown, and deceased not caused by crash. The number of CMV crash reports were sorted and analyzed into the crash severity categories listed above. The seven crash severity categories were then grouped into four major categories for each year and the CMV crash reports were sorted and analyzed into the new groupings. The four aggregate crash severities include fatal injuries, non-fatal injuries, property damage only, and an unknown/other category.

Every analysis produced results that will be beneficial when recommendations

are being made to the state. The results will benefit the state and contribute to improved

underreporting performance on behalf of state and local police departments by urging

police departments to submit all CMV crash reports.

B. Methodology: Crash Timeliness Measure

Using data from the CDS, SafetyNet, and MCMIS, five critical variables which

influence timeliness were evaluated (16):

1. Police department type (state versus local);
2. Type of vehicle (including trucks and buses);
3. Inter- or intra-state vehicles;v
4. Vehicle registration state and carrier state; and
5. Location of CMV crashes in Massachusetts (by regions).

The results of UMassSafe's analysis are presented later in this paper. The following

section details the basic methodology and criteria used to evaluate factors affecting the

crash timeliness measure.

Before methodology can be discussed, it is imperative to understand what

timeliness is, and why it is important (16). The FMCSA defines the crash timeliness

measure as follows: "This measure compares the percent of state-reported crashes

involving large trucks and buses that are uploaded within the 90-day requirement (12)."

Therefore, crash reports must be submitted to MCMIS within 90 days to meet the

requirement set by FMCSA.

FMCSA uses crash data obtained by MCMIS to determine a state's crash

timeliness measure. A state must submit 85% or more of its commercial motor vehicle

crash reports to the MCMIS within 90 days to receive a favorable rating (12). On-time

submission of 60% or more of a state's crash reports warrants a fair rating. In order to

receive a fair rating, a state must have 60% or more of it crash reports turned into

MCMIS within 90 days of the crash (12).

As of June 2007, the Commonwealth of Massachusetts has received a poor

rating for crash reporting timeliness due to an on-time crash report submission rate of

40% (16). The state's rating fell from fair to poor as in July of 2006, and has remained

there ever since (16). In collaboration with multiple state and federal agencies,

Massachusetts has been working to improve its crash reporting timeliness rating by

investigating and correcting the factors that affect it adversely. This analysis will

provide information in an effort to help Massachusetts to better address issues which

result in these poor timeliness ratings.

According to FMCSA, the crash reporting timeliness measure is established

defined as the difference between the date of the crash and the date the report was first

uploaded into MCMIS (12).

The crash reporting timeliness measure was analyzed by year, quarter, and

month. For crashes occurring from January 2006 to April 2007, the data were first

divided into two groups: reports submitted within the 90-day requirement, and those

submitted afterward (with those reports submitted on the 90th day considered to have

been submitted in a timely manner) (16). The percentage for timeliness within a group

was then determined based for each of the temporal groups given above (year, quarter,

and month) and graphed to demonstrate overall trends (16).

Other variables were also incorporated into the investigation, including information on crash location, crash report police department of origination, type of vehicle, vehicle registration state, and classification of vehicle (i.e. interstate or intrastate) Subsets of data within these categories were also analyzed. For example, the crash reports were aggregated between crash reports filed by local versus state police, as well as by barrack in Massachusetts. Below, each factor is individuated and defined to provide a fuller understanding of this analysis (16).

1. Location

The data provided location information, including the city and county in which the crash occurred and which police department reported to the scene. For the purposes of this study, the county in which the crash occurred was used as the location constraint because it was the most efficient way to group the data. The results, including information regarding which counties have the highest/lowest commercial motor vehicle crash rates and the most/least favorable timeliness measures, could be providing additional information as the state attempts to improve its crash timeliness rating.

2. Police Departments

There was extensive analysis done on the police departments who submit the crash reports. The departments were first separated into two groups: local and state police. Each group was then evaluated using the timeliness measure. "Locals" were divided into two categories based on the number of crash reports they submitted: low

volume (three reports or less) and higher volume (more than three crash reports). The Massachusetts State Police's (MSP) group was examined according to their seven troop barracks.

3. Types of Trucks and Buses

The analysis examining the differences between trucks and buses was relatively basic.   The commercial motor vehicle crashes reported in January 2006 and April 2007 were separated   by vehicle type (truck or bus). There were two subsets of bus data: buses carrying 9 to 15 passengers and buses carrying more than 15 passengers (with bus drivers included as passengers). Trucks were separated into multiple categories based on number of axles, tires, and trailers. The crash reporting timeliness measure was examined for each truck sub-section.   Additionally, the number of reports submitted and the average number of days between incident and reportage was examined for each of these sub-sets.

4. State Registration and Carrier State of Vehicle

The state registration and carrier state analysis involved assessing two prime factors: the vehicle license plates involved in the CMV crashes in Massachusetts and vehicles carrier state. For the first analysis, the crash reports were separated into two groups based on their vehicle license plate: out-of-state vehicles and in-state vehicle. The two groups were compared by number of crash reports in each group. To determine the second factor entailed determining the carrier state that the vehicle

was from. The in- and out-of-state groups were then separately analyzed to discover

the number of crash reports per group and their relative timeliness.

5. Classification of Vehicle (Interstate vs. Intrastate)

Out of all the analysis done with regard to measuring timeliness, this analysis was

the basic and yielded interesting results. Using vehicle license state data from crash

reports, vehicles were grouped according to interstate or intrastate licenses. The

crash reports were analyzed as well as the crash report timeliness for each group.

Every analysis produced results that will be beneficial when recommendations are being

made to the state. The results will benefit the state and contribute to improved

timeliness performance on behalf of state and local police departments by

recommending departments where police training needs to take place and how the state

can help police departments complete the crash form in an accurate and timely manner.

C. Methodology: Crash Accuracy Measure

UMassSafe has been gathering information related to commercial motor vehicle

accuracy. Using data from the CDS, SafetyNet, and MCMIS, six critical variables which

influence accuracy were evaluated (16):

1. US DOT number;
2. Carrier name and address;
3. Police Type;
4. Region;
5. Crash Severity; and
6. Vehicle Classification.

The results of UMassSafe's analysis are presented later in this paper. The following section details the basic methodology and criteria used to evaluate factors affecting the crash accuracy measure.

It is imperative to understand what crash accuracy is, and why it is important. The FMCSA defines the crash timeliness measure as follows: "This measure examines the percent of interstate carriers and intrastate hazardous material carrier's records for 12 months where the motor carrier information on the crash record matched a motor carrier in the MCMIS Census file (12)."

FMCSA uses crash data obtained by MCMIS to determine a state's crash accuracy measure. In order to achieve a good rating from FMCSA, the percentage of reports that match must be 95% or greater to meet the FMCSA threshold (12). A matched report is a crash report in SafetyNet which looks at where the motor carrier information on the crash record did not match a motor carrier in the MCMIS census file (12). The motor carrier information includes US DOT number and the carrier name and address.

Since May 2006, Massachusetts has received a poor rating for crash reporting accuracy due to a match submission rate of approximately 75% (16). In collaboration with multiple state and federal agencies, Massachusetts has been working to improve its crash reporting accuracy rating by investigating and correcting the factors that affect it adversely. This analysis will provide information in an effort to help Massachusetts to better address issues which result in these poor accuracy ratings.

The crash reporting accuracy measure was analyzed by year and month. For crashes occurring from January 2006 to April 2007, the data were first divided into three

groupings: complete, intrastate, and non-matches (16). The complete matches consisted

of crash reports the US DOT number or the carrier information was matched to the

FCMSA census file (16). The intrastate category is motor carriers that travel exclusively

to the state the carrier is registered to (16). The percentage for accuracy within a group

was then determined based for each of the temporal groups given above (year and

month) and graphed to demonstrate overall trends (16).

Other variables were also incorporated into the investigation, including

information on US DOT numbers, carrier information, injury status, and classification

of vehicle (i.e. truck or bus) (16). Subsets of data within these categories were also

analyzed.   Below, each factor is individuated and defined to provide a fuller

understanding of this analysis (16).

1. US DOT

The US DOT is a unique identifying number that interstate motor carriers are given

for identification purposes. In the first part of the analysis, the US DOT numbers

were compared between the Crash Data System (CDS) and SafetyNet. The second

analysis compared the US DOT number between SafetyNet and MCMIS. The

results for both analyses included the percentage of reports where the US DOT

numbers matched between the two systems, when the information was left empty,

and when the US DOT numbers differed between systems.

2. Carrier Information

There was an extensive analysis done on the carrier information provided on the

crash reports. This analysis focused extensively on the carrier name and address.

The information was first separated into by the three data systems the information was retrieved from. The three data systems include the Crash Data System (CDS) from the Registry of Motor Vehicles (RMV), the Massachusetts State Police data system called SafetyNet, and from the federal database known as the Motor Carrier Management Information System (MCMIS). Each group was then evaluated using the accuracy measure by comparing the information between the systems. Therefore, the data was analyzed between the two systems to see the changes that occurred between those systems. In the first analysis, the carrier information was compared between CDS and SafetyNet. The second analysis compared the carrier information between SafetyNet and MCMIS for any changes in information.

3. <u>Police Type</u>

An analysis was conducted for the police departments who submit the crash reports. The departments were first separated into two groups: local and state police. Each group was then evaluated using the accuracy measure for 2006 and 2007.

4. <u>Regions</u>

The data provided location information, including: the city and county in which the crash occurred and which police department reported to the scene. For the purposes of this study, the counties in which the crash occurred in were separated into five regions throughout Massachusetts for 2006 and 2007 because it was the most efficient way to group the data. The results, including information regarding which regions have submitted the highest/lowest commercial motor vehicle crash records and which regions have the most/least favorable accuracy measures, could be

providing additional information as the state attempts to improve its crash accuracy rating.

5. Crash Severity

For the 2006 and 2007 data, the crash reports were separated into three categories of crash severity: fatality, injury, and property damage only. The numbers of crash reports within each group were then analyzed by the accuracy measure.

6. Vehicle Classification

The analysis examining the differences between trucks and buses was relatively basic. The commercial motor vehicle crashes reported in 2006 and 2007 were separated by vehicle type (truck or bus). The categories were then analyzed using the accuracy measure by comparing their interstate matches to the non-matches within each group.

Every analysis produced results that will be beneficial when recommendations are being made to the state. The results will benefit the state and contribute to improved timeliness performance on behalf of state and local police departments by recommending departments where police training needs to take place and how the state can help police departments complete the crash form in a accurate and timely manner.

MassHighway Department Data Quality Audit

The goal of this project is to provide an understanding of the data used by the MassHighway Department and ways to improve the quality of this data. In order to meet these goals, two objectives must be researched (10):

1. Identify and detail data quality issues inherent in the CDS database to establish a framework for implementing changes aimed at improving crash data quality. This will include the data collection (local police and MSP), data transfer (local police, MSP and RMV), and data entry (local police, MSP and RMV) processes.

2. Based on information gathered through the data quality problem identification and audit process, create a data quality improvement plan of action for implementation in Massachusetts.

The tasks associated with meeting these objectives will focus on the police crash report form instead of the operator form (10). One of the tasks of this project is to conduct a paper and electronic audit of police crash reports.

A crash data audit will be conducted on crash reports from 2005 so that fields that are filled in incorrectly or have poor data can be identified (10). Paper copies of the crash reports will be provided by the Registry of Motor Vehicles (RMV). A stratified random sampling of the crash reports submitted in 2005 will occur to help characterize what fields are filled in incorrectly or result in poor data (10). The audit sampling will be based on the tactics used in 2001 to examine 1999 crash data. Once the sample of crash reports have been selected and copied, the audit will focus on data collection, data transfer, and data entry.

Data collection is the procedure police take when filling in a crash report form (10). This will help determine the completeness and accuracy when filling out crash report forms. Data transfer refers to how the report is submitted to the RMV (10). There two types of crash report: paper and electronic. An electronic crash report is filled out on a computer and once the report is completed, the file is submitted to the RMV electronically (10). A paper report is either a complete crash report form filled in or the information is typed into the computer and the crash report is printed out (10).

Nevertheless, these reports are sent in via mail or fax to the RMV which is then typed into the Crash Data System (CDS). This process of submitting the crash reports form will be audited to see what problems can occur in the transfer process (10). In reference to data entry, there are a multitude of opportunities where crash report information can be entered incorrectly. This can occur when police collect the information at the scene, when they fill in the crash report on a computerized system, or when the RMV enters the paper report's crash information (10). The two basic errors that occur are typos or interpretation errors.

The audit will also evaluate different aspects of the crash report for completeness and accuracy. The following steps will occur during the audit process (10).

- A comparison of location information will be conducted to compare the information collected in the CDS database as it is provided to MassHighway with the location information available through the collision diagram and the narrative. This will include a review of the data collection, data transfer, and data entry processes specific to location information. This will provide a better understanding of how additional location information collected in these two sections of the crash report may complement the information recorded in the database to provide a more comprehensive set of location identifiers.

- Analyze distribution of data in each field to identify fields with a high percentage of missing values as a method of determining which fields may not be completed to the fullest extent possible. This process may also identify fields that are well-completed but may be completed incorrectly.

- A review of the data entry screens used by Massachusetts State Police will be included as part of the audit process. We can determine whether the system is user friendly and intuitive and recommend how that user interface might be implemented

at the local police level. In addition, recommendations for "tweaks" to the interface to improve usability will be provided.

- Conduct a survey of police departments (both State police and local police) to understand how the data are collected, entered and transferred. This will include a comparison of police notes entered in the official report away from the scene of the crash. In cases where it is possible to compare notes from past crashes with the appropriate crash report form, this will be done. All departments participating in the survey will be asked to keep "notes" for a certain period of time and those notes will then be compared to the appropriate crash report form.

Once all data have been collected, a team of experts will gather and look at each crash report for the characteristics listed above (10). These experts will include UMassSafe staff, MassHighway engineers, RMV specialists, and local and state police representatives. Once all the analysis has been completed, a report of the results will be drafted and an action plan will be created in order to address the data quality issues in Massachusetts.

Police Outreach Survey

The purpose of the Police Outreach Survey is to improve the quality of data including accuracy, completeness, consistency, and timeliness by surveying police officers as to what the challenges are when completing a crash report. Also, the intention of this survey is to determine the difficulties associated with the crash data reporting system (9). In order for the survey to be successful, at least 60% of the survey sent out to police officers must be returned, which is approximately 230 state and local

police departments (9). Additionally, 20% of the responses should be received within a month of the survey going out.

The survey will be grouped into four sections: general information, timeliness, accuracy, and crash data collection systems (9). The survey will be distributed to supervisory police officers who are responsible for the crash reports within their department (9). The police officers will need to provide contact information in order to avoid duplication of surveys from police departments. However, it will be made clear on the survey that personal information will not be distributed, but will be complied into one report of results.

The general section of the survey will include questions such as the number of crash reports submitted from each city/town, the department's crash reporting procedure, who submits the crash reports to the RMV, what type of submittal system does the department use (paper or electronic), and if reports have been returned to the officers from the RMV (9). The timeliness sections will comprise of questions involving topics such as length of time officers typically take to submit reports to supervisors, length of time to submit a crash report to the RMV for police departments, and average time it takes for officers within the department to complete crash reports (9). The accuracy section of the survey will ask what type of Record Management System (RMS) the department uses, if any, what fields in the crash report are confusing, and the difficulties associated with accurate documentation of a crash location (9). Lastly, the crash data collection systems includes questions on what types of data collection systems police officers prefer, what type of training is need to complete crash reports

effectively and efficiently, and what information would police departments like to be able to retrieve from these data systems (9).

Overall, the survey should take approximately 30 minutes long and the questions will include multiple choice, fill in the blank, and short answer questions. In the end, the information obtained from this survey will better help Massachusetts to improve data quality within the commonwealth. A copy of the survey has been provided in Appendix C.

CHAPTER 4

DATA ANALYSIS

In this section, the results of the projects have been presented in relevance to the methods they discuss. In all, the results presented within this section have been briefly discussed and only the significant results have been shown in within these four sections. The full review of results can be seen in the results and recommendations portions of each project. This section reviews the relevant results to determine the findings of this thesis.

Commercial Motor Vehicle Crash Data Quality Focus Group

In this portion of the CMV project, UMassSafe conducted a focus group with 10 state and local police officers of various backgrounds on May 25, 2007 in Lawrence, Massachusetts. The officers within this group were from the Essex County area, which has the highest number of crashes within Massachusetts (15). The group of officers consisted of 5 local and 5 state police. Even though two of the local police officers had truck and bus training, these officers deal with crashes of various types and are not on the Massachusetts State Police (MSP) Truck and Bus Team (15). These officers were guided by the moderator to answer questions about the accuracy, timeliness, and completeness in regard to crash reporting, specifically for truck and bus crashes (15). A copy of the truck and bus section of the crash been provided in Figure 2 shown below.

Figure 2: Crash Report Form: Truck and Bus Section

The moderator began the focus group with a brief introduction to the officer by describing the purpose of the CMV project. Once the goals of the project and the focus group were discussed, the moderators expressed their gratitude in advance and explained the importance of honesty. As long as the officers remained anonymous, the officers could be as open as possible (15). After the moderators introduced themselves, the group of officers was asked to provide their names (excluding ranks if possible), where they were stationed, and how long they had been investigating crashes. Once the group introductions were complete, the moderator began the focus group and asked questions in the following order (15):

1. Introductory (5 minutes)
2. Transition (10 minutes)
3. Accuracy and Quality (20 minutes)
4. Completeness (20 minutes)
5. Report Submittal (20 minutes)
6. Summary (10 minutes)
7. Conclusion (less than 5 minutes)

The data obtained from the focus group will be categorized into sections based on responses dealing with timeliness, completeness, accuracy, training and suggestions.

Before the data can be analyzed, the magnitudes for the number of respondents were

defined and shown below (15):

- Few or Some- represent a limited number of responses such as 3 or 4 officers (about 30%);
- Many- represent approximately half of the group responded (about 50%); and
- Most- refers to over three quarters of the group responded similarly (over 75%).

The first section that will be discussed is the findings on the officers training.

Training

Within this section, the officers were asked general questions related to the type

of training they received overall. The group of participants was asked initially what

training they received on crash reporting. "The responses from the officers were similar

across the board: they did not receive any formal crash report form training for either

motor vehicle or commercial motor vehicle crashes" (15). For the most part, the

participants training on crash reporting consisted of shadowing an officer early in their

career and obtaining driver/vehicle information. Additionally, the group of officers

indicated that they had received no training on the new crash report released in 2002

(15). Many of the officer's obtained additional knowledge and experience with the crash

report form by ensuring they have collected all critical information pertaining to the

crash (15). If the officer does not obtain enough information at the crime scene, most of

the officers said they need to spend unnecessary time hunting down the critical data for

the crash. Unfortunately, some of the local police officer's indicated that officers in

other sections of the force, such as drug enforcement, have never filled out a crash

report, and therefore, do not know what information needs to be ascertained (15). The

state police officers present stated that their officers had very little training in regard to crash reporting and they rely heavily on their truck and bus team for commercial motor vehicle crashes (15). In all, the officers present had little to no experience with crash reporting, especially when it comes to truck and bus crashes.

Accuracy

The officers were then asked a series of questions relating to the accuracy of crash reporting and what challenges they encounter in obtaining accurate information at a crash scene. Most of the officers indicated various uses for crash report data, but they did not know the importance of accurate data. The local police stated that they want to accurately report crashes but the lack of training makes it difficult for officers to properly complete the form (15). Unfortunately, state police officers responded that they would like to accurately report crashes, but when information was difficult to obtain for a crash, they would discard the crash report. The state police officers used the term "broom" for this instance (15). In general, most of the officers indicated that the accuracy of a crash report depended upon the severity of a crash (15). Basically, less information was filled out accurately on a crash report form for less severe crashes compared to crashes where a fatality was involved. This was apparent for truck and bus crashes also. The state police officers said for a serious crash, they relied heavily upon the truck and bus team to ascertain all necessary information for the crash report form (15). Unfortunately, the local police within the state can either call the MSP truck and bus team or they can fill out the form to the best of their abilities. When CMV crash reporting is involved, most of the officers responded that it was difficult for them to

correctly complete the truck and bus section of the crash report form because of their lack of training and it is difficult for them to locate the truck and bus information (15). Often, the officers left the fields empty in the truck and bus section, but put the information in the narrative and diagram if they thought it was important. Additionally, the officers cited the United States Department of Transportation (US DOT) number particularly difficult to locate because officers have to get the information from the truck drivers and cannot check to see if the numbers are correct (15). Most of the officers said that it was difficult to determine the correct carrier information because trucks get leased by different companies and drivers often do not have the paperwork confirming carrier information. The greatest difficulty the officers addressed within the focus group session was that they do not know which fields were critical and if the fields were highlighted and required to fill in, they would find a way to get the information (15). Lastly, the officers expressed their frustration within the group that they cannot issue citations to commercial motor vehicle drivers and hoped that they could cite for at least minor infractions (15). In all, officers specified the lack of training and the lack of indicating important fields within the section were the major issues in regard to accuracy of CMV crash reporting.

Completeness

Primarily, most of the participants stated that it was easy to collect vehicle information in non-commercial motor vehicle crashes because the information can be obtained from the license plate (vehicle registration) or the license number (15). The officers would then bring those numbers back to the station and obtain the rest of the

driver and vehicle information. Unfortunately, most of the officers stated that this was

quite different for CMV crashes because they have to trust the information the truck or

bus driver provides since there is no formal registration for trucks (15). Therefore, the

officers could not verify the information and when they go back to the station, it was

often difficult for them to obtain the correct information to complete the crash report.

When the moderators asked the officers why the truck and bus section was often left

blank, the officer responded that there were no indicators in the vehicle information

section that referred to the truck and bus section and therefore was often forgotten (15).

If a check box or note were put within the section to remind officers to fill out the

section, the officers believed the section would be completed more often than not (15).

Again, the officers expressed their eagerness to complete the crash report forms

correctly and completely, but that was often difficult to do since they lacked the training.

Since it was difficult for the officers to obtain information relating to CMV crashes, the

truck and bus section was often left completely blank (15). The moderator then inquired

about the length of time it took to complete a crash report and the frequency of

reportable crashes they handled. The group unanimously said a crash report normally

would take them between 45 minutes and an hour to complete (15). The local officers

indicated that they would take as much time as they needed to obtain the correct

information for the crash report except that they were criticized by superiors if the report

would take them too long (15). On the other hand, the state police stated that the forms

were completed as little as possible because it would take too long to input the

information into their computer system (15). When it came to the frequency of

reportable crashes within a shift, the local police responded that an average of four cases

would occur in one shift while the state police stated that it was between six or seven

crash per shift (15). Most of the officers agreed that two separate crash report forms, one

for regular crashes and another for CMV crash reporting, would only confuse and

frustrate officers (15). In all, the officers tried to complete the CMV crash report

completely, but it was often difficult for them to accomplish it properly.

Timeliness

In this section of the focus group, the two different types of officers often had

different responses based on the procedures of their department. In general, most of the

local officers responded that they typically filled out the crash report form and a

different person at the station would input the data and send the crash report to the RMV

(15). The officers stated that they often finished and submitted their crash reports within

a week or so from the crash date. The state police responded that they enter the crash

information into their computerized database (RAMS) and the report is electronically

sent to a supervisor who checks the report and submits it to the RMV (15). The state

police officers indicated their grievances about RAMS and they often did not want to

enter additional information. When trucks or buses were involved in a crash, the state

police stated they would not report the crashes because there was too much information

to input and they often lacked information (15). In the end, it was somewhat unknown

why crash reports were not submitted in a timely manner, but the officers did provide

suggestion on how to speed up the submittal process.

Suggestions

Overall, the police officers participating in the focus group provided suggestion on how the crash reporting process could be improved, especially for CMV crashes. In general, most of the officers indicated that if proper training was provided for the entire crash report, they would be able to collect the crash information efficiently (15). The training suggestions also specified training on the truck and bus section of the crash report form and what should be placed in each field. The officers seemed to prefer the online or at station training sessions suggested by the moderators (15). There were many suggestions for addressing the accuracy of crash reports. In particular, the state police officers indicated that if the requirements and training were provided to high level officers who in return would train their subordinates, then the crash report would be completed accurately (15). Additionally, the officers stated that if the vehicle and US DOT numbers were easier to locate, such as fixing the location on the vehicle or registration, then the accuracy of the report would be improved (15). The participants expressed a great interest in obtaining a cheat sheet for the CMV section of the crash report form to properly complete the report with valid information (15). When referring to crash report completeness, the officers stated that better defined choices for fields, better defined required areas of the form, and better technology would improve the overall completeness of crash reports (15). Again, the officers expressed the need for training in order to improve the completeness of crash reports, especially referring to CMV crashes (15). The few recommendations the officer gave for improving the timeliness of the crash report submittal process included highlighting important fields

on the form (RAMS), obtaining technology to scan in information, and to standardize

the location for the US DOT numbers on vehicles (15).

Overall, the focus group obtained information on crash reporting, specifically for

commercial motor vehicles, and the recommendations of the officers on how the system

could improve. The focus group also was able to provide the same information from

two different points of view: the local and state police. The local police provided

information based on the crash report form or the departments unique crash form while

the state police provided information pertaining to their computerized database known

as RAMS. The outcomes pertaining to this thesis have been presented in the results

section of this research.

Commercial Motor Vehicle Crash Data Quality Audit

In this section, the data obtained from an audit of three different CMV data

systems was conducted by UMassSafe in the summer of 2007. The purpose of this audit

was to obtain information on the timeliness, completeness, and accuracy characteristics

related to crash reporting (16). As previously mentioned, Massachusetts crash reporting

timeliness and accuracy had been considerably lower than the requirements set by the

Federal Motor Carrier Safety Administration (FMCSA) and therefore, the state had a

poor overall rating for CMV crashes (16). The three databases being compared were the

RMV database (CDS), the state's database known as SafetyNet, and the federal database

(MCMIS) (16).The results of the audited systems were categorized into three sections

for CMV crash reporting: completeness, timeliness, and accuracy.

Completeness

Within this section, the CMV data was compared between CDS and MCMIS with a focus on crash underreporting for 2006 and 2007. Underreporting is when a state has significantly less crash reports within CDS when compared to MCMIS, which would suggest that a number of crashes were not reported (16). Fortunately, there were CMV crashes in the CDS database compared to the MCMIS database, but further examination was suggested in the final report.

Timeliness

In order to determine why the state falls short of the timeliness measure for CMV crash reporting, the number of days between the crash date and submittal to MCMIS for 2006 and 2007 were compared against the FMCSA requirement. As the report shows in Figure 3 and Table 1, the timeliness measure was quite low throughout 2006 but began to steadily increase throughout 2007 (16).

Figure 3: CMV Crash Reporting Timeliness by Months for Massachusetts from January 2006 to March 2007

TABLE 1: CMV Crash Reporting Timeliness by Months For Massachusetts from January 2006 to March 2007

Month	Number of CMV crash reports submitted within 90 days	% of CMV Crash Reports submitted within 90 days	Number of CMV crash reports submitted after 90 days	% of CMV Crash Reports submitted after 90 days
Jan-06	31	21%	117	79%
Feb-06	32	3%	86	97%
Mar-06	2	2%	117	98%
Apr-06	0	0%	44	100%
May-06	0	0%	64	100%
Jun-06	1	2%	54	98%
Jul-06	6	14%	37	86%
Aug-06	28	54%	24	46%
Sep-06	24	51%	23	49%
Oct-06	29	49%	30	51%
Nov-06	27	45%	33	55%
Dec-06	52	60%	34	40%
Jan-07	71	83%	86	17%
Feb-07	89	98%	2	2%
Mar-07	79	99%	1	1%

*This represents data from January to March 2007

Basically, the percentage of reports in 2006 submitted within the 90 day requirement was considerably less than percentage of report required by FMCSA. The percentage of crash reports submitted in 2007 began to increase. The timeliness measure was analyzed by the following characteristics:

1. Regions of Massachusetts- five total;
2. Police type- state or local; and
3. Crash severity- injury status.

Within the Commonwealth, the central portion of the state, which included Worcester and Leominster, had the lowest timeliness percentages compared to the rest of the regions (16). Also, local police had a higher timeliness percentage compared to state police, with Troop D having the lowest timeliness rate within the state police sections

(16). Finally, it was apparently that as the severity of a crash increased, the submittal

time would also increase (16). A major reason for the poor rating for the timeliness

measure was discussed which involved the backup of electronic crash reports from the

MSP to the RMV (16). This reason also explained why the rating slowly began to

increase in 2007 once the system had been updated. In all, the timeliness measure

slowly improved between 2006 and the beginning of 2007.

Accuracy

The accuracy of a crash report was found by determining the number of cases

where the US DOT number obtained at the crash did not match a number in the MCMIS

database. Since the beginning of 2006, the match rate of these two numbers had

significantly declined below the FMCSA requirement (16). Fortunately, the match rate

began to increase at the beginning of 2007. The accuracy measure was also categorized

by characteristics similar to the timeliness measure and the characteristics are shown

below (16):

1. Regions of Massachusetts- five total;
2. Police type- state or local;
3. Truck versus Bus crashes; and
4. Missing fields.

By analyzing the databases, the southwest region of the state had the lowest match rate

compared to the rest of Massachusetts (16). In this case, the local police had a lower

match rate when compared to the state police (16). This result was the exact opposite of

the timeliness measure and would be expected since the state police seemed to have

more resources compared to local police. Also, crashes involving buses had higher

match rates compared to crashes involving trucks (16). The number of trucks in crashes was significantly higher than bus crashes which could account for the lower rates. Lastly, when all three databases were compared based on US DOT number, it was apparent that the US DOT number was empty over 30% in CDS compared to SafetyNet and MCMIS (16). Therefore, the US DOT was usually found after the crash was entered into CDS and then entered into SafetyNet.

In the end, the audit provided significant statistical results concerning the current data quality issues in Massachusetts. The analysis included information pertaining to timeliness, completeness, and accuracy. Also, each section presents the results along with the possible reasons for the declining rating for Massachusetts. As of January 2008, the Commonwealth has elevated its CMV rating from "poor" to "good" because of the improvement of the accuracy and timeliness measures. The audit portion of this project has been briefly summarized in the paragraphs above.

MassHighway Department Crash Data Quality Audit

Within this section, the results of the MHD Data Quality Audit that was conducted between the Summer of 2007 and Fall of 2007 will be discussed. In the spring, approximately 1,000 crash reports were sampled from the RMV warehouse. These reports include both paper and electronic crash reports from both state and local police. In the table presented below, the crash reports were categorized by paper and electronic reports as well as state and local police (17).

TABLE 2. Sample Size by Audit Strata

Agency Type	Report Type	Sample Size
State Police	Electronic	264
State Police	Paper	246
Local Police	Electronic	103
Local Police	Paper	270

Once the reports were copied at the RMV, they were duplicated one time in order to allow both members of the audit teams to review the crash report simultaneously. In all, eight audit meetings were conducted at the Millbury State Police Station. Over the course of these eight audits, various representatives from the RMV, MHD, UMassSafe, MSP, and local police spent many hours reviewing each of the 1,000 crash reports. These crash reports were reviewed for consistency and adequacy for each field of the reports. Using Microsoft Access, a main database was created for all responses based on their unique identifying crash report number known as a batch key (17). The database was complied and the results of the audit will be discussed, categorized in the following manner (17):

- Crash
- Location
- Vehicle
- Non-Motorist
- General

For the sections where numerical representation of adequacy is presented, only the results where the percentage of adequate reports is less than 85% will be discussed.

Crash Information

Within this section, there were approximately 6 significant results (less than 85%) associated with crash information. The first of the results deals with the state

police electronically submitted crash reports because the number of injuries field was either left blank or was incorrect (17). This suggests that there is a transmission problem between the RAMS system and the RMV. The diagrams provided on the crash reports were sufficient approximately 67% of the time (17). These insufficiencies were mainly attributed to the lack of a north arrow on the diagram or the lack of the street name. The traffic control device functioning code was adequate only 72% of the time which is mainly attributed to the lack of a traffic control device and when a device was marked as not functioning when it should not be (i.e. yield sign) (17). Surprisingly, the time of the crash was only adequate 80% of the time. For the most part, the number was often not represented in military time and the time of day was not specified (am or pm) (17). Lastly, the "number of injured" field was adequate 84% of the time because the number in the field did not match the count on the form (17). Overall, the insufficiencies relating to the crash information section have been identified and recommendations were developed by UMassSafe based on this information.

Location Information

In this section, the location information was categorized into five sections: Address Method, Intersection Method, Exit Ramp Method, Mile Marker Method, and Narrative/Diagram. In the table presented below, all of the crash reports reviewed were separated using the four methods listed above, for which their percentages are provided, and the percentage of adequacy was also presented for each category (17).

TABLE 3. Percentages for Location Information

Method	Percent of All Crash Reports	Adequacy Percent
Address Method	34%	64%
Intersection Method	31%	76%
Exit Ramp Method	25%	72%
Mile Marker Method	10%	75%

The main factor contributing to the low adequacy percentage when the address method

was used was the lack of address information on the crash report (17). For the

intersection method, this information usually had a missing or inadequate cross street

and the actual location information provided on the crash report should have been

reported using the intersection method (17). In reference to the exit ramp method, the

distance on the ramp was often missing or inadequate for the location of the crash (17).

The lack of necessary information contributed to the poor adequacy percentage when the

mile marker method was used (17). Finally, the narrative and/or diagram provided

additional location information approximately 18% of the time (17). Often, if a crash

could not be located based on the information in the location section alone, the narrative

and diagram usually provided some information in order to help locate the crash.

Vehicle Information

Within this section, three fields will be discussed in association with vehicle

information since they had adequacy percentages lower than 85%. With the lowest

adequacy percentage, driver's license restriction was only adequate 42% of the time and

this was mainly because a letter code was used instead of a numbered code (17). The

"number of occupants" and "registration type" fields were completed adequately 81% of

the time. When the "number of occupants" field was inadequate, it was usually because

the field was missing from the crash report altogether. The code entered into the "registration type" field was commonly invalid and caused the percentage of adequacy to be lower than expected. In all, there seemed to be a vendor issue which caused most of the insufficiencies mentioned within this section.

Non-Motorist Information

Throughout the audit review, a non-motorist involved in a crash was not present often. In the table shown below, the percentages of adequacy (under 85%) for 6 of the non-motorists fields have been presented (17).

TABLE 4. Percentage of Adequacy Among Reports

Non-Motorist Fields	Percentage of Adequacy Among Reports
Safety System	62%
Injury Status	67%
Condition	76%
Type	76%
Action	81%
Location	81%

Overall, the difference of these percentages only range approximately 20% and recommendations for these insufficiencies have been addressed within the results of the project report.

General Information

Within this section, there were general topics discussed by the audit team members in relevance to the review of the crash reports. One of the major issues discussed by the audit members was that some of the crash reports reviewed appeared to

have been non-reportable crashes (17). What this indicates is that there were no injuries,

no vehicles towed and the damage was most likely less than the $1,000 requirement.

Another interesting observation made by the audit teams was that when the crash was a

hit-and-run crash, the group, including the officers, were not sure which vehicle should

be marked as the hit-and-run vehicle (17). Typically, the vehicle that fled the scene was

the vehicle marked as the hit-and-run, but there was little to no information provided for

these types of crashes. In addition, the audit team members noticed the difficulty

officers had with the sequence of events portion of the report. The list shown below

provides suggestion on why this could be a difficulty and how to improve the field (17).

- There appeared to be confusion about the completion of this field in regards to crashes with no collision.
- Add "Collision with disabled vehicle" option to the form in order to indicate a crash involving a broken down vehicle.
- Officers were confused by whether the codes should be specific for each vehicle involved in the crash or if the codes should be filled in with regard to the entire crash. Basically, should the codes be specific for each vehicle involved (different code for each vehicle) or should the codes represent the actions of the entire crash (same codes for each vehicle).

The audit group also noticed that officers had difficulty locating a crash on a ramp on

the actual diagram (17). This supports the notion that locating a crash on a ramp was

very difficult for all police officers. The airbag switch code was also a field that was

significantly lacking with valuable information (17). As most of the police officers

during the audit mentioned, the code was usually missing because it was difficult to

determine and the code seemed ambiguous to the audit members as to its relevance. The

audit members also noticed that the entire non-motorist section was difficult for officers

to complete correctly (17). Officers explained that this was mainly due to the lack of

clarity of how the section should be completed. The number of injured was often not completed by officers on the crash report reviewed by audit members (17). It appeared that this was actually a big issue because persons involved in crashes often appeared to have no injuries, but later on received medical treatment of some type. Lastly, there were four coding and or layout issues participants mentioned during the audit and these issues are listed below (17).

1. License Class Code: The letter class was often used instead of the code number. There should be an "Out of State" option for officers to choose since license classes were different between states. There should also be and "unlicensed driver" option for license class since it is left blank otherwise. Also, the audit members noticed this field was often left blank on electronic reports and therefore, the system itself needed to be reviewed and tweaked.
2. Vehicle Towed Code: Typically on electronic reports, the towed section was usually completed with either a 1 or 2 codes when it should be filled in with a yes or no. This could also be addressed by reviewing the system itself and tweaking the output for this code.
3. Since "other" was an option on several of the codes, there should be a space provided in order to provide more information on the subject.
4. With specific concentration on electronic reports, vehicles are occasionally not labeled on the diagram and caused confusion when reviewing the crash report. When a report was submitted from the Swampscott barracks, the non-motorist section was at the top of the report and not part of the vehicle 2, which defied the participant's expectation. For consistency purposes, it was recommended that this section be moved. When a report was submitted from the Framingham barracks, the north arrow was missing most of the time and this could be due to a system error that needed to be addressed.

In all, the audit provided not only what field police were having difficulty filling in properly and accurately, but also why some of these issues occur. After investigating these issues thoroughly, audit member were also able to provide recommendations in order to address these issues. In conclusion, the issue discovered within this audit varied and each issue was addressed within the result of the project.

Police Outreach Survey

In collaboration with the Registry of Motor Vehicles (RMV) for Massachusetts, UMassSafe was contracted to develop a survey. The Police Outreach Survey was designed to collect crash reporting information from local and state police departments within Massachusetts. The intention of the survey was to obtain information pertaining to the current collection of crash data, the challenges with collecting this information, and possible ways the state can improve the crash reporting process (14). In addition to crash data collection, the survey involved questions on crash reporting timeliness, accuracy, consistency, and completeness.

Once the survey was finalized, the RMV sent a copy of the survey to every local and state police department within the state. The survey was sent to all of the chiefs of police for each local police department, which was obtained by the Chiefs of Police Association of Massachusetts (14). The state police departments, also known as barracks, were issued the survey in quite a different manner. In Massachusetts, the state police barracks are coordinated into 7 Troops, which are based on their geographical location. Therefore, the police major's for each troop were initially issued the survey and it was disseminated down to the individual barracks by these majors.

The first set of surveys was sent out through the mail in September of 2007 and an online form was created for those departments who preferred to submit their responses electronically. The survey was conducted between September 2007 and the end of December of the same year. In all, 274 surveys were received within this time frame resulting in 252 of the 351 local police departments and all 7 state police troops responding (14). The number of responses and the number of departments are

inconsistent because more than one survey was received from a department or troop but the surveys were completed by different officers. Therefore, the survey responses were relevant when gathering information on crash reporting and the police department or troop were only counted once. This mainly occurred within the state police responses because some of the individual barracks responded within the same troop (14). In the end, UMassSafe had a response rate of 71%, which was well above the 60% that was required by the contract (14). As stated previously, the survey consisted of a variety of questions ranging from "yes or no question" to "open response questions". The results of the survey were categorized in the following manner:

1. General Information
2. Timeliness
3. Accuracy/Completeness
4. Crash Data Collection Systems

The unexpected results will be discussed according to which category they belong to.

General Information

Within this section, the survey asked a total of five questions that focused on the departments procedures and outcomes in relevance to crash reporting. The first question under this category dealt with the number of reports submitted by a department in 2006. Approximately 60% of the departments submitted 300 or less crash report in 2006 and only about 10% of the department submitted over 1,000 crash reports within the same timeframe (14). When the police departments were asked about how crash reports are submitted to the RMV, approximately 60% of the departments agreed that they submit their report in the following manner (14).

"Officer records data at scene on form, report entered by same officer into a

Records Management System (RMS). Print RMS report sent to RMV (14)."

Another significant question within this category relates to who actually submits the

crash report form to the RMV. Over 60% of the officers responded that their

administrative staff submits the crash report to the registry (14). Finally, the survey

asked if crash reports were ever returned to a police department for additional

information and if so, what the timeframe was for report re-submittal. Of the surveys,

66% of the respondents answered that their department has received a crash report back

and over 70% responded that it took a week or less to resubmit the crash report

(UMASS PO).

Timeliness

Within this section, six questions were purposed regarding crash reporting

timeliness and ways to improve timeliness at the departmental level. When officers were

surveyed about the length of time it took to fill out the police report and submit it to the

RMV, over 60% responded that it was submitted within a one week period of time (14).

The police departments were also asked the frequency in which all crash reports within

their respective departments were submitted to the RMV. Of the responses,

approximately 39% answered that reports are submitted weekly to the RMV from the

police department and 27% responded that reports are submitted monthly (14). Once the

timeframe for report submittal was inquired about, the officers were asked how long it

took to fill out a crash report by two different types of crashes: minor and major. A

"minor crash" was considered to be a crash with property damage only or a crash where

1-2 vehicles were involved. On the other hand, a major crash was considered to be a crash where multiple vehicles were involved or a crash that involved injuries. For minor crashes, 51% of the officers responded that it took 10-30 minutes to complete a crash report and 32% responded that it took between 31 and 45 minutes to complete a crash report (14). When major crashes were considered, 32% of the respondents indicated that it took between 45 and 60 minutes to complete a crash report while 39% indicated that it took over an hour to complete a crash report under these circumstances (14). Another question within this section inquired about the review of crash reports and the frequency in which crash reports are returned by supervisors. Of the respondents, 80% of the officers replied that a supervisor reviews the crash report and 89% of the officers replied that a crash report has been sent back for correction before submittal to the RMV (14). Lastly, the survey asked whether the officers had any idea on how to submit reports in a timely fashion. Approximately 55% of the respondents indicated that reports would be submitted quicker if electronic or direct submission, which includes online, mail or fax, were available to their department (14). In the end, these responses provided valuable timeliness information and information on ways the submittal process could be improved.

Accuracy/Completeness

Out of the entire survey, this section had the highest number of questions with 9 questions and the most open-ended questions. This section contained question pertaining to a variety of topics ranging from the type of form each department uses to the technology supplied within their cruisers. As stated previously, the crash report form

was changed in 2002 without report numbers and issued to all police departments within the state. Although this main crash report has been issued, approximately 90% of the police departments have their own unique report number for crashes according to the survey responses (14). On the newly updated form, 72% of the respondents indicated that the crash report form was clear and none of the fields were confusing or unnecessary (14). The police department was also surveyed about the minimum cost for property damage. According to state laws, the minimum cost for property damage is $1,000, which was set over two decades ago, and with the rising cost to repair vehicles, more crashes are reported because of this fixed value. Unexpectedly, 55% of the officers who responded indicated that the minimum should be raised and 53% of those responses indicated that the minimum should be between $2,500 and $3,000 (14). The survey also asked questiosn concerning location information. The officers were asked about the difficulties with locating crashes on the form and whether they had access to global-positioning systems (GPS) at a crash. Approximately 77% of the officers responded that there were no difficulties when providing location information for a crash and 91% responded that their cruisers were not equipped with GPS (14).Finally, the police departments were then asked about the clarity of the truck and bus section of the crash report form in which 87% of the respondents replied that the truck and bus section was clear and concise (14). From the responses given on the survey, it appears that the officers indicated no difficulties with the form and that the minimum cost for property damage before the crash is reportable should be raised above the current amount of $1,000. Within this section, only a few of the significant questions were reviewed.

Crash Data Collection Systems

Within this last section, six questions were asked pertaining to the training of the officers, the preferred submission system for the department, the use of crash data on the departmental level, and any overall suggestions officers may have had on how to improve the crash reporting process. Out of all the respondents, approximately 91% indicated that officers within their department had received training on crash reporting and 77% indicated that training was given on the RMS system (14). If additional training was provided to departments on crash reporting, approximately 92% of the departments responded that they would provide the training to their staff (14). Next, the survey inquired about the preferred method of cash report submission. From the responses provided on the surveys, about 45% of the departments would prefer to electronically submit crash reports to the RMV using the current technology while 26% would prefer a new RMS technology for electronic submittal purposes (14). If crash data were provided to departments, over 60% of the departments would use this data (14). Finally, the officers provided a variety of suggestions regarding the entire crash reporting process and how it can be improved. For the most part, the officers responded that the crash report form should be revised or made shorter and more technologies should be provided to the officer, such as GPS, which was about 41% of the responses (14).

Overall, the survey provided vital information on the crash reporting process, but there were some inconsistencies within the report that should be reviewed. The critical information provided on the survey was how the officers wanted crash reporting to

improve, which could be for a variety of reasons. In the end, the survey provided

opinion based answers within a structured document.

CHAPTER 5

RESULTS

In this section, the results of each method have been discussed in great detail in relevance to their respective projects. A series of advantages and disadvantages were provided for each method based on the projects they pertained to. After these characteristics had been discussed, recommendations had been given for each method which involved how each method should be performed and what factors needed to be included in order to use the method successfully. The overall results of this thesis have been presented in the following sections.

Commercial Motor Vehicle Crash Data Quality Focus Group

In May 2007, UMassSafe conducted a focus group pertaining to commercial motor vehicles. In all, 5 state police officers and 5 local police officers participated in the focus group and most of these officers had experience with crash reporting, occasionally with truck and bus crashes, but did not have specific truck and bus crash reporting training (15). Two of the local police officer that attended the focus groups were part of their department truck and bus reporting section, but since they were not from the Massachusetts Truck and Bus team, they were asked to participate (15). Overall, the focus group provided information that could help eliminate the crash data quality issues in regard to commercial motor vehicles faced in Massachusetts. However, the focus group's information would not necessarily help other states with their crash data quality issues. Therefore, the advantages and disadvantages that follow were created for the use of focus groups in regard to general crash data quality issues. After

these characteristics were discussed, recommendations were drafted in order to conduct

cost-effective and efficient crash data quality focus groups.

Focus Group Advantages

It was determined that there were four overall advantages of conducting a focus

group in regard to crash reporting and in order to improve crash data quality. These

advantages have been provided below.

1. Obtains experience based responses within a face to face conversation.
2. Topics can be discussed using a "building block' system.
3. Obtains time-frame characteristics and time management information.
4. Obtains similarities and differences between groups of individuals.

The first advantage of conducting focus groups was that it obtains responses

based on experience in person and within a small group. When participants are asked

questions, they often explain their reasoning on a subject by indicating examples of

experience.

The second advantage was that a "building block" system occurs when a focus

group has been performed properly. The "building block" system occurs when ideas or

other comments are based on a previous comment or idea provided by another within

the group. Therefore, ideas that previously would not have been thought of in other

methods are easily addressed in a focus group.

Focus groups also obtain information pertaining to timeframes and time

management. In this case, officer provided information on how long they had been on

the force, how long it takes to complete regular crash reports, and how long it takes to

complete a CMV crash report (15). Focus groups provide a variety of timeframe and

time management characteristics because of the different type of police involved. From the CMV focus group findings, UMassSafe concluded that it takes local police officers much longer to complete crash reports than state police officers and that most local police departments do not have electronic submittal capabilities or programs (15). Therefore, focus groups can obtain vital time related information that is difficult to obtain using previous methods.

Lastly, focus groups obtain the similarities and differences between groups. Usually when a focus group has been conducted, many different people from different backgrounds with a variety of experiences have been asked to participate. For this focus group, UMassSafe was able to compare state and local agencies based on crash reporting history and the issues these officers have faced (15). Overall, the differences between groups are easier to identify than the similarities because they are more apparent within a group setting (disagreements).

These advantages can help focus group moderators obtain vital information other methods cannot provide. But at the same time, these focus groups can have equal or greater disadvantages that will be discussed in the following section.

Focus Group Disadvantages

While focus groups can be very beneficial for finding opinionated and experience-based results, this method can also take up time and precious resources necessary to find results. These disadvantages can be generally applied to all focus groups. From the CMV focus group, three general disadvantages were identified in relevance to surveys and these disadvantages are listed below.

1. Lack of honesty can be portrayed by group.
2. Non-responsive participants can affect the results of the focus group.
3. Participants can easily stray off topic.

Within a closed setting, participants may not be as honest as they perceive to be to the moderators. This can be mainly due to friction between the individual people within the group. For example, the local and state police officers responses may have been slightly exaggerated because of the friction between the two groups (15). When participants are trying to "up" other participants, then they may feel the need to stretch the truth more than if they were in a setting with individuals with similar backgrounds. Also, participants may discuss ideas based off what they believe the moderators want to hear. This information will skew the results of the focus group, and make it difficult to obtain information on the real issues.

A major disadvantage associated with focus groups deals with the non-responsive participants. In the CMV focus group case, some of the less seasoned state police officers did not respond to the moderator's questions and were somewhat rude to the moderators because they did not see the need for such a meeting (15). Since the non-responsive participants usually provide no additional information, it would be difficult to have unbiased results since the rest of the participants would provide all the information.

Lastly, a disadvantage of focus groups would be that participants can easily get of the main topic of discussion. This happens occasionally when a "building block" system is used. If the moderator was unable to keep the group on task, the focus group has then turned into a "runaway train" which provides no information on the relevant

topics. Therefore, the moderator needs to maintain control of the focus group while allowing participants to answer freely.

These advantages and disadvantages show that useful information can be obtained from focus groups, but also shows how focus groups can easily be lead off course. To ensure that a focus group would be conducted in a cost effective manner, a set of guidelines has been provided in the following section.

Cost Effective Focus Groups

Seven factors that should be included in the creation of a focus group have been listed below. These factors were inspired from the CMV focus group that was recently conducted. These characteristics are vital in conducting a successful and beneficial focus group.

1. An equal number of participants from all affiliated groups.
2. Participants should be gathered from a general region.
3. Moderator's guide should have general topics of discussion only.
4. Ensure participants' responses will remain anonymous.
5. Provide ways to relieve possible friction between opposing groups.
6. For documentation purposes, tape record the focus group session.
7. After the session has been concluded and participants have left, moderators should analyze results.

In order to obtain results from a true representative sample, participants of the focus group should be chosen very carefully. When multiple groups of people are involved within a focus group sample, it is essential to obtain an equal number of participants from all groups. This is essential for two reasons. The first reason is that some groups of people may not be heard if other groups overpower them in the focus group discussion. Secondly, a focus group would be conducted to obtain results that represent a group(s)

of people. If one group is underrepresented at a focus group, then the findings would be considered inaccurate. Also, in order to gain accurate results, the members of the focus group should be from the same general region. For the results to be not only accurate but easily understood, participants from one general area may have certain issues on crash reporting while participants from another area may encounter different issues related to crash reporting. Therefore, to ensure consistency, focus group participants should be from a general geographic area.

The moderator's guide should be brief and only a few pages long. The topics discussed within this guide should be on general topics of discussion. There can be specific questions if necessary, but moderators should avoid creating an intricate outline with a series of questions. Also, the moderator should state at the beginning and conclusion of the focus group that all responses will remain anonymous. This will reassure participants that what is spoken during the focus group will not make it back to their superiors and get them into trouble. Next, the moderators should provide some type of ice breakers to relieve any friction between different groups. In many cases, separate groups affiliated with the meeting often have issues with each other and this can often lead to a non-productive session or a dispute that encompasses the entire session. In order to obtain all vital information produced from the focus group, the entire discussion should be tape recorded by the moderators. The group must be assured again that the information provided by individuals will remain anonymous even though the discussion has been tape recorded. The tape will be a supplementary tool, which will be used in the last step and for later purposes, for a focus group because it will inform moderators of any information that has been omitted. Lastly, the moderators (and any

note takers) should sit down and discuss the results of the focus group immediately after the discussion has concluded. This will ensure that no information has been left out or forgotten. It would be a suggestion that the tape should be reviewed during this discussion to fully obtain all relevant results.

Overall, focus groups can provide essential information pertaining to crash data quality issues for transportation professionals. In the CMV focus group, officers were allowed to express their opinions in regard to CMV crash reporting (and general crash reporting) and ways they would like the system to improve (15). Therefore, focus groups obtain opinionated and experience based responses that can effectively improve areas of interest, but only when they are conducted efficiently and cost-effectively.

Commercial Motor Vehicle Crash Data Quality Audit

During the summer of 2007, UMassSafe conducted an audit on three databases which contain commercial motor vehicle data. The three systems included the RMV's database, the state database known as SafetyNet, and the federal database known as MCMIS (16). The results of the audit provided valuable information in regard to the issues with CMV data obtained in Massachusetts (16). The audit performed revealed advantages and disadvantages in regard to crash data quality issues. After these characteristics were discussed, recommendations were drafted in order to conduct a cost-effective and efficient crash data quality audit.

Audit Advantages

It was determined that there were four overall advantages of conducting an audit in regard to crash reporting and in order to improve crash data quality. These advantages have been provided below.

1. Provided reliable statistical information with sufficient resources.
2. Electronic database created easy analysis.
3. Allows researchers to review all the information available.
4. Described in detail what issues occur with data.

When an audit is performed upon data, the resulting data provides statistical information. Unlike the survey and focus group, an audit evaluates the actual data obtained for review. In the CMV audit, UMassSafe evaluated the CMV databases for completeness, accuracy and timeliness criteria to determine the possible reasons these issues occur (16).

In order to easily evaluate the data, the electronic database provided easy access for analysis. Previously, a manual review of data would have occurred in order to obtain information in regard to the data issues. With the new technology available, data can be entered in a computerized system and the information can be complied or sorted in any way the researcher would like.

An audit provides the ability to analyze all the information available in order to determine what the issues are and suggestions of how they can be addressed. In the CMV audit, UMassSafe reviewed all the information pertained in the CMV section of the crash report form in all three systems in order to determine the differences between the databases and what issues occur with the data (16). The electronic database allows a researcher to analyze the data in a variety of ways with ease.

Lastly, an audit can describe in detail what issues occur within a data set. An audit can provide information on omitted information as well as information that would be inaccurate. In the CMV audit, UMassSafe determined how thorough the data was completed and how accurate the data was (16). The details provided through an audit also lead to reliable recommendations on how to address issues with data.

These advantages allow auditors to obtain vital information other methods cannot provide. But at the same time, these audits can have equal or greater disadvantages that will be discussed in the following section.

Audit Disadvantages

While audits can be very beneficial for finding statistical results, this method can also take up time and precious resources necessary to find results. These disadvantages can be generally applied to all audits. From the CMV audit, three general disadvantages were identified in relevance to audits and these disadvantages are listed below.

1. Audits do not provide experience based information.
2. Audits can occasionally be time consuming and costly.
3. Some audits analyses can be irrelevant or inaccurate.

Audits lack the ability to obtain experience based information from people who actually participate in the subject at hand. Since this information has been unavailable, auditors often find it difficult to obtain reasons on why these issues occur, which would be difficult to provide valuable recommendations on how to correct these issues.

Depending upon how audits are conducted, this method can be time consuming and costly when not conducted in an efficient manner. When the CMV audit was consulted, many of the fields reviewed showed no data issues and therefore, the further

analysis of this data would be useless (16). If the information has not significant value, there should be no further analysis on this data unless specifically required within a contract.

Finally, some audits can be irrelevant or inaccurate because of the actual way the information is supposed to be entered. In some instances, fields on a crash report form are supposed to be empty intentionally, but it is difficult to analyze this section for when the field should be correctly filled in. Therefore, any analysis upon these sections would prove to be unimportant and irrelevant. In the CMV audit, this occurred rarely, but when it did occur the auditors had difficulty determining the findings for these fields (16).

These advantages and disadvantages provide information that can not only be obtained from audits, but also how they can deceive auditors. To ensure that an audit would be conducted in a cost effective manner, a set of guidelines has been provided in the following section.

Cost Effective Audit

From the CMV audit conducted, six factors that should be included in the creation of an audit have been listed below. These characteristics are vital in conducting a successful and beneficial audit.

1. Allow audit to be conducted completely through a computerized system.
2. An outline should be created prior to the audit in order to guide the auditors.
3. Audits should be performed by one person for consistency or by a few people using the same guidelines.
4. Review each and every field or criteria in order to determine significance.
5. Provide significant results only.
6. Set a timeframe in which audit should be completed.

In order to perform an audit, all data should be provided within an electronic database. This will allow auditors to review data without the additional paper copies and this will also save a significant amount of time. An outline should also be created so that the auditor can have a guide. Instead of the auditors randomly "fishing" for important information, the guide will help determine what fields or sections should be analyzed and how they should be analyzed in order to be efficient. For the audit to remain consistent, one or a few people should participant in the audit. These individuals should be somehow affiliated with the purpose of the audit and throughout the audit approximately 80% of the participants should remain the same.

In order to be thorough, each and every relevant field should be analyzed for significant information related to the data issues. If all of the relevant fields are not reviewed, then the auditors could have missed vital information that could be pertinent towards the issues addressed within the purpose of the audit. Once the analysis has been completed, the only results that should be discussed are the significant results. Significance should be decided prior to analysis. This is essential because auditors may have too many or too few results based on the significance level. Finally, a timeframe should be set for the audit in order to be cost effective. If individuals spend unnecessary time auditing the data, then it would cost more to pay the individuals to continue evaluating the data then if the audit had been completed in less time. Also, this allows the auditors to evaluate the relevant data first and if there was extra time, the auditor's could evaluate other factors for significance.

Overall, audits can provide essential information pertaining to crash data quality issues for transportation professionals. Audits provide statistical information that can

effectively improve areas of interest, but only when they are conducted efficiently and cost-effectively.

MassHighway Department Crash Data Quality Audit

Over several months in 2007, UMassSafe conducted an audit on crash reports from 2005 to determine what data quality issues Massachusetts has. The audit members included representatives from the MassHighway Department, UMassSafe, the RMV and both state and local police departments (17). In all, 8 audit meetings were conducted where approximately 1,000 crash reports were manually reviewed and the responses were entered into an electronic database (17). Once the audit has been completed, the results were compiled electronically through and presented in the previous section of this thesis. The audit performed revealed advantages and disadvantages in regard to crash data quality issues. After these characteristics were discussed, recommendations were drafted on how to conduct a cost-effective and efficient crash data quality audit.

Audit Advantages

It was determined that there were three overall advantages of conducting an audit in regard to general crash reporting and in order to improve crash data quality. These advantages have been provided below.

1. Provided reliable statistical information with sufficient resources.
2. Allows researchers to review all the information available.
3. Described in detail what issues occur with data.

An audit is essential for obtaining statistical information related to general crash data quality issues. In this case, each field on the crash report form was reviewed for

adequacy and it was noted when the field was empty but was supposed to contain information. In this case, consistency was a key aspect when reviewing the crash reports since so many different individuals were involved in the audit process (17). Therefore, a list should be created to show how to correctly answer irregular fields and what issues the audit members faced when conducting the review.

In order for the results to be truly representative of the sample, each and every field of relevance was reviewed on the crash reports. The electronic database created allowed auditors to provide a review of each field for their adequacy (17). Once the audit has been completed, the electronic database can be complied and sorted in any way the researchers would like. The auditors can then evaluate the significance of the results based off the reviews completed during the audit.

Once the auditors have reviewed and analyzed the data obtained from the audit, they can describe in great detail what issues occur. In this case, many issues were found with missing fields on the crash reports and suggestions were made by the group on how the crash report forms and systems can be improved (17). The auditors can then determine what actions should be taken in order to correct or minimize the issues addressed during the audit and after the data analysis.

These advantages can auditors obtain vital information other methods cannot provide. But at the same time, these audits can have equal or greater disadvantages that will be discussed in the following section.

Audit Disadvantages

While audits can be very beneficial for finding statistical results, this method can also take up time and precious resources necessary to find results. These disadvantages can be generally applied to all audits. From the MHD data quality audit, three general disadvantages were identified in relevance to audits and these disadvantages are listed below.

1. Audits do not provide experience based information.
2. Audits can be time consuming and costly.
3. Auditors can often be inconsistent with responses.

One of the major disadvantages associated with audits was that audits do not obtain experience based responses. In other methods, individuals affiliated with the data collected provide insight as to why certain data issues occur. Audits can only ascertain what issues actually occur and they can occasionally provide suggestions on how these issues can be improved or corrected. Without the understanding of why these issues occur, it would be difficult to draw up recommendations for implementing solutions to these problems.

When a group audit has been performed, it was time consuming and costly for auditors. In this case, there were eight audit sessions conducted where individuals reviewed the crash reports over several hours (6-7 hours) and on average there were 8 participants from various affiliated departments involved (10 or more on a few occasions) (17). The participants had to usually drive an hour or more to participate in the MHD crash data quality audit and breakfast and lunch was provided. Audits use many valuable resources compared to other methods and should be used only when it would be absolutely necessary.

Lastly, the responses from one audit team reviewing the crash reports can be inconsistent from other audit team. For instance, it often was not discovered if a field should be considered adequate under certain circumstances until a few crash reports were reviewed by the group (17). Therefore, some of the reports reviewed would have inconsistent answers from those reviewed after the topic had been discussed. Also, depending upon the representatives reviewing the crash reports, some auditors may find errors and inconsistencies compared to other groups reviewing similar crash reports,

These advantages and disadvantages provide information that can be obtained from audits. While audits provide an abundance of information, the validity of these results should be reviewed for any inconsistencies that could have occurred during the audit process. To ensure that an audit would be conducted in a cost effective manner, a set of guidelines has been provided in the following section.

Cost Effective Audits

From the MHD crash data quality audit conducted, six factors that should be included in the creation of an audit have been listed below. These characteristics are vital in conducting a successful and beneficial audit.

1. An outline should be created prior to the audit in order to guide the auditors.
2. All responses should be entered into an electronic database.
3. Audits should be performed with consistency using the same guidelines.
4. Review each and every relevant characteristic in order to determine significance.
5. Provide significant results only.
6. Set a timeframe in which the audit should be completed.

Before an audit can be performed, an outline should be created to guide all of the auditors through the audit process. This outline should entail why and how the audit will generally be performed by the group. The importance of the project should be emphasized throughout the guidelines.

When the audit has been prepared, an electronic database should be created for the auditors to enter results and any additional comments. For some of the auditors, this could be difficult if they are unfamiliar with the database program and there should be an introductory session performed at least once for the group. The database will aid in the compilation of the results in order to determine what issues occur within the data set. Also, the group should go through several crash reports together before separating into smaller teams. This will help ensure consistency among the group.Guidelines should also be created for the data entry system. As long as the group as a whole responds to challenges in a systematic way, then the results will be reliable, consistent and valuable in determining what issues occur.

When performing the audit, participants should evaluate all relevant factors for adequacy. This will be incorporated into the electronic database when applicable. The factors should be reviewed both independently as well as part of a whole in order to obtain true representation of the total sample. For example, a code on the crash report form could be correct for the field, but it could be inconsistent with the rest of the crash report (17). Once the results have been complied, only the significant results should be presented. A significance level should be set prior to analysis and adjusted if needed. This will ensure that a sufficient amount of results will be provided to stakeholders instead of too many or too few results that present major issues. Lastly, a timeframe

should be set before the audit has been performed to ensure sufficient review time without wasting precious resources. Four audit days should be sufficient time to review all necessary information provided, but this does not include the results period. If it takes more than four days to prepare and evaluate the information in an audit, then it can be concluded that the auditors are not using their time efficiently.

Overall, audits can provide essential information pertaining to crash data quality issues for transportation professionals. Audits provide statistical information that can effectively improve areas of interest, but only when they are conducted efficiently and cost-effectively.

Police Outreach Survey

The Police Outreach Survey was conducted by UMassSafe between September 2007 and December 2007. The survey achieved over a 70% response rate from local and state police departments which is well above the required 60% (14). The results of the survey provided valuable information from police officers in order to determine what crash data quality issues occur and why. Overall, the survey provided information that can help eliminate the crash data quality issues faced in Massachusetts, but it does not help other states with crash data quality issues. Therefore, the advantages and disadvantages were created for the use of surveys in regard to crash data quality issues. After these characteristics were discussed, recommendations were drafted in order to conduct cost-effective and efficient crash data quality surveys.

Survey Advantages

The overall results of the survey provided specific information relating to

Massachusetts crash data quality issues and police officers'suggestions on how these

issues can be improved. From the Police Outreach Survey, four general advantages were

identified in relevance to surveys and these advantages are listed below.

1. Responses are honest and opinionated in relevance to the questions asked.
2. Successful response rate from participants.
3. Time-specific information easily obtained.
4. Concrete and in-depth suggestions.

The first major advantage of performing surveys in order to determine crash data

quality issues was that the respondents were given the ability to express their opinions

freely. In this case, police officersexpressed their frustration with the crash report form

and crash reporting in general (14). When the respondents feel comfortable enough to

express their feelings, responses will be more honest and therefore more reliable.

Another advantage mentioned was a successful response rate from participants.

When most surveys have been conducted, there is a required response rate in order to

guarantee a representation of the total sample. When the response rate was greater than

the required amount, the survey was considered successful. If the response rate had not

been reached, the results would have been considered invalid since it would not have

been representative of the sample.

It is often difficult to obtain time-specific information through conventional

methods. Fortunately, surveys can obtain this type of information such as timeframes

relating to crash reporting. Since participants are more likely to be honest on the

surveys, researchers can accurately determine timeframes pertaining to the subject of interest.

Surveys are one of the few methods that can provide experience based responses. In accordance with these results, surveys also provide suggestions based on experience. When participants suggest recommendations, these suggestions can be considered more valuable than recommendations from administrative staff because they are based off of experience. The suggestions provided are typically in-depth and solid recommendations that will be more helpful than harmful to the task at hand. In this survey, officers provided suggestions on how to improve the submittal process, training, and the overall crash reporting system.

These advantages can help survey providers obtain vital information other methods cannot provide. But at the same time, these surveys can have equal or greater disadvantages that will be discussed in the following section.

Survey Disadvantages

While surveys can be very beneficial for finding opinionated and experienced based results, this method can also take up time and precious resources necessary to find results. These disadvantages can be generally applied to all surveys including surveys used to determine crash data quality issues within a state of federal departments of transportation. From the Police Outreach Survey, four general disadvantages were identified in relevance to surveys and these disadvantages are listed below.

1. Difficult to receive surveys back in a timely manner.
2. Difficulty to obtain participants.
3. Difficulty with compiling results to certain questions.

4. Difficulty with effectively and efficiently asking questions.

When surveys are conducted, there are certain requirements to receive surveys back in timely manner. In the case of the Police Outreach Survey, there were two percentage-time requirements: at least 20% of surveys received within one month of distribution and overall 60% response rate by the end on the survey (14). This can be difficult to obtain when respondents do not respond within a timely manner due to a lack of time or because they are unwilling to participate. In the first two cases, the researchers conducting surveys must constantly communicate with participants in order to guarantee a sufficient number of responses and this takes up an abundance of time.

The third and fourth disadvantages listed above are also connected together. Depending upon the types of questions the surveys asks it can be difficult for researchers to compile results, especially for open-ended questions. When participants are allowed to freely respond to a question, they can often ramble and there can be great variability in responses which means difficulty in categorizing responses. Also, if the questions on the survey are not asked in an effective or efficient manner, it can lead to inconsistent responses or responses not intended to answer the questions. These questions can also be confusing for respondents to answer and the results would be inaccurate and invalid.

In the end, the advantages and disadvantage of a survey can often balance out and surveys can be both beneficial and harmful for obtaining valuable results. In the following section, the general guidelines for conducting a cost effective survey are presented.

Cost Effective Surveys

From the Police Outreach Survey, there are six characteristics that should be included in the creation of a survey that will be discussed within this section. The six characteristics are listed below.

1. Surveys should be primarily, it not entirely, completed through online or electronic formats.
2. Surveys should have easy questions that can be answered in less than 20 minutes.
3. Surveys should avoid open-ended questions as much as possible.
4. The survey database should allow researchers and participants to edit answers and remove duplicate surveys from the same person.
5. If possible, surveys should be created with participants to remain anonymous through any method possible.
6. Surveys should have the ability to obtain and sustain an appropriate sample size.

In order to decrease time and the amount of money needed to perform surveys, a cost effective and efficient method to conduct the survey would be to make the survey strictly electronic and complete through website or sent through email. This eliminates any paper copies necessary when conducting previous surveys, and nowadays individuals can easily access the World Wide Web. In order to guarantee a successful response rate, the survey should be comprised of short answer and multiple choice questions for easy completion (less than 20 minutes) and to encourage participants to respond. This also allows ease in the analysis of data once the survey has been completed. Therefore, the survey should avoid open ended questions whenever possible. Often, open-ended questions take longer to answer compared to other types of questions and these questions allow more variability. These types of questions can be difficult to analyze and sometimes difficult to answer for participants. It also allows participants to

discuss unrelated topics within these areas, this occurrs less often with more limited questions.

During the Police Outreach Survey, it was difficult for researchers to delete duplicate surveys and edit survey responses within the database. In order to conduct a successful survey, the database in which responses are entered (usually done automatically) can be edited or at the very least have the ability to delete duplicate reports. In most cases, participants would like to remain anonymous when responding to surveys. For the Police Outreach Survey, officers were asked to provide not only the departments in which they were responding from, but also their names, phone numbers and emails (14). This was done in order to avoid duplication of reports from the same person and to account for which department participated in the survey. The participants should be asked some questions for identification purposes on the researchers end, but all personal information should be discarded since it can be considered unnecessary. Lastly, the conductors of the survey should create a survey that will allow them to secure a specific sample size. If the surveys are distributed to too many individuals or groups, then there is a less likely chance of achieving the required response rate. If the survey was distributed to a secure sample size, participants may be more likely to respond. If the surveys are too complicated or confusing, participants are less likely to answer the surevey altogether. Therefore, the survey should be easy to complete and yet effective in collecting out the necessary information in order to achieve the necessary response rate.

Overall, surveys can provide essential information pertaining to crash data quality issues for transportation professionals. In the Police Outreach Survey, officers

were allowed to express their feelings in regard to crash reporting and ways they would like the system to improve (14). Therefore, surveys obtain opinionated and reliable responses that can effectively improve areas of interest, but only when they are conducted efficiently and cost-effectively.

CHAPTER 6

SUMMARY AND CONCLUSIONS

Based upon the evaluations presented in this thesis, several conclusions have been made. For each method, a summary has been provided below of what type of information can be obtained using these methods and the importance of using these methods efficiently.

Surveys provide reliable opinionated responses from participants that not only detail what issues occur, but also suggest recommendations that will improve the system overall. A survey has the ability to obtain experience based responses which are often vital to discovering issues that cannot be addressed through statistical analysis. Unfortunately, if the response rate, which is set prior to the survey being dispersed, has not been met, then the results of the survey may not effectively represent the total sample. If this occurs, the survey results will be useless for transportation professional utilization. When the survey method has been chosen to determine data quality issues, the major recommendation would be that the survey be completely electronic in order to be cost effective.

Focus groups provide experience based responses that offer details into what issues occur and how these issues can be improved or corrected entirely. The difference between a focus group and a survey is that focus groups obtain information pertaining to why the issues occur. The major advantage of performing a focus group would be the use of the "building block" system in order to draw additional ideas from participants. Unfortunately, participants occasionally try to beat or "up" opposing participants by exaggerating the truths which in turn supplies inaccurate information to moderators. If

the focus group method has been chosen to evaluate data quality issues, it was suggested that participants should be equally represented, they should remain anonymous, and that the entire session be taped for documentation purposes.

Audits generally gather statistical information that identifies in detail what data quality issues occur and possible remedies to these issues. Audits should evaluate each and every relevant field that may ascertain any challenges with data in an efficient manner. The major disadvantage of performing audit would be that they do not acquire information pertaining to why the issues occur and exactly what could improve or correct these issues. Also, audits can be extremely time consuming and costly compared to the other methods described above. The greatest benefit received from an audit would be the intricate details pertaining to data quality issues which in essence can provide suggestions to how these issues can be improved individually. One of the major recommendations for individuals who want to perform an audit would be that the audit results only contain the significant results because too many results can be misleading and take the focus away from the simportant issues. An audit should also be conducted electronically whenever possible whether it is during the data analysis process or during the compilation of responses.

In conclusion, crash data quality is vital to state and federal agencies since it is used for a variety of reasons. Crash data, which is information obtained from a crash report, is typically used to locate high crash locations within states and where other improvements need to be made along the roadways. Therefore, the distribution of funding for projects from federal, state, and local agencies is dependent in part upon this data. If the crash data is not reliable, it is difficult for transportation professionals to

portion monies for safety improvements. In all, the quality of crash data is important to all transportation related fields because it allows professionals to make improvements in order to save lives, which supports one of the biggest goals set in the United States. These methods can be used to determine what data issues occur, why they occur, how the issues can be improved, and overall recommendations on how the system can be improved as a whole. In the end, these methods, when used correctly and appropriately, help transportation professionals save lives along the roadways within the United States.

APPENDICES

APPENDIX A

CRASH REPORT FORM

Crash Diagram: ie: → 1   → 2   → ♀

If Crash Did Not Occur on a Public Way:

❏ Off-Street Parking Lot

❏ Garage

❏ Mall/Shopping Center

❏ Other Private Way

Indicate North by Arrow

Crash Narrative:

Witnesses:

Name (Last, First, Middle)	Address	Phone #	Statement

Property Damage:

Owner (Last, First, Middle)	Address	Phone #	34-Type	Description of Damaged Property

Truck and Bus Information: Registration # _____ (From Vehicle Section)

Carrier Name _____ Carrier Issuing Authority Code   **35**

Address _____ City _____ St _____ Zip _____

US DOT #: _____ State Number _____ Issuing State _____ ICC #: _____ Interstate   **36**

Cargo Body Type Code **37**   Gross Vehicle Weight **38**

Trailer Reg #: _____ Reg Type _____ Reg State _____ Reg Year _____ Trailer Length **39**

Hazmat Information:

Placard **40**   Material 1 digit # **41**   Material Name _____ Material 4 digit # _____ Release code **42**

Police Officer Name (Please Print)   Signature   ID/Badge #   Department   Precinct/Barracks   Date

CDP1 11·24·00

CMV FOCUS GROUP MODERATOR GUIDE

1. Introduction

    Hello, my name is _____

    Massachusetts has received a CMV grant to improve the quality of the commercial motor vehicle crash data. The first step is to understand what the challenges are with collecting good data – data that is complete, timely, accurate and consistent. You have been invited here to discuss Commercial Vehicle Crash Data and the Commonwealth of Massachusetts Motor Vehicle Crash Report Form. We want to hear what you have to say… nothing you say will be discussed **outside** of here… We will summarize the findings in a report with recommendations for changes to the report, process and/or system. We are interested in developing an understanding of police officers challenges completing the crash report including such elements as when, where and why.

Objectives and Agenda

    Our purpose today is to talk about crash data, specifically the truck and bus section of the police crash report form. Our primary objective is to gain insight from law enforcement personnel regarding:

    - How the truck and bus crash data, are collected, entered and transferred;

    - The use of the truck and bus section of the crash report form in the field; and

    - Possible improvements to the truck and bus section of the crash report form.

    The information gathered will help us understand more about the challenges with investigating and reporting tuck and bus crashes, how we might change the form and system and how to improve the quality of truck and bus crash data.

    Good data is the key to identifying potentially unsafe carriers and drivers. The more complete, timely and accurate our data is and the more efficient our data systems are, the better our ability to prevent crashes and violations.

2. Disclosers – Open Discussion

    This section should confirm open communication.

    We are here to learn from you. We need you to be honest and direct regarding the challenges you face in reporting truck and bus crashes. Before we begin the discussion, I would like to go over a few basic ground rules.

Some basic information for this to go smoothly:

- Positive or negative responses are both ok!

- This is not a test – There is no right or wrong answers just your answers.

- We really want you to give us YOUR opinion about this process so that we can gain a better understanding of how to improve this.

- This session is being audio-taped which allows you, as moderators, to focus on you, rather than trying to jot down specific details about the discussion. Please speak in a voice as loud as mine, so that the microphone can pick it up. When reviewing the audio tape and writing the report, we will not identify anyone.

- We will prepare a report using the tapes. Our report will not refer to any one of you by name. By assuring your anonymity, we hope that you will speak openly and candidly about today's topic.

- We encourage you to share your opinions with the group, but please avoid side conversations while other participants are speaking.

- In addition, remember, there are not any right or wrong answers, so feel free to offer both positive and negative viewpoints.

3. Participants Introduction
This section should introduce participants to each other and the moderator

Opening Questions:

- Please tell us who you are, what City/Town you work in and how long have you been a Police Officer?

- How often are you called to crashes involving trucks and buses?

4. Discussion Questions
This section should clearly get to the objectives through progressive questions.

4.1 Introductory

Objective: *Start talking about the subject and have them feel comfortable with the topic. The objective is to create some common ground and discussion that will link the group together and free the conversation.*

Time – 5 minutes maximum

- Let's start by talking about something you are all familiar with - filling out crash reports. When you first became an officer, who trained you to fill out a crash form? Mentor? Formal? Local? State? Any specific training to truck and bus?

- Since then have you had any recent training?

  Web, instructional, meeting, discussions?

4.2 - Transition

Objective: These questions will move the conversation towards the key questions below. This should open the framework for specific questions.

Time – 10 minutes maximum

- Please think back to the last truck or bus crash you reported. When you approached the truck or bus crash, what was your first concern?

- At what point, while you are addressing a crash, do you begin filling out the Crash Report Form? Is this different then how and when you fill out a crash report for a crash not involving a truck or bus?

  When you approach the crash? After? In the cruiser or at the station?

- Where on the form did you start entering truck and bus information from the crash? Are there key fields that you begin with in the truck and bus section? Do you leave some fields for later?

4.3 – Accuracy and Quality

*Objective: **The aim of these questions is to identify <u>accuracy and quality</u> issues that create problems with the crash data and specifically truck and bus crash data.***

Time – 20 minutes maximum

- In order to identify a truck or bus crash on the report Field 20 must indicate a Vehicle configuration code between 4 and 13. Do you feel that you can identify the categories that apply to the crash easily from this list? Do you think others in your department can? If not, what are the challenges?

- If you wait until later in your shift or after the crash to fill out the form, do you make notes or rely on memory?

- In your opinion, does the Truck and Bus Information section contain fields that are easy to identify?

- What fields seem difficult to locate or identify?

- How do you (and others) find the US DOT number, state number, carrier etc?

- Is there anything that you could suggest from your personal experience that may improve the likelihood that this section is filled out?

- How do you think this data is used?

4.4 – Completeness

Objective: **The aim of these questions is to discuss _completeness_ or why are the truck and bus crashes often underreported. As we discussed earlier, the vehicle configuration often indicates a bus or truck and yet the truck and bus sections are often left blank.**

Time - 20 minutes maximum

- In your opinion, what is different about truck and bus reporting and other crash reporting?

- Are they more time consuming?

- Why do officers leave the truck and bus section blank even though the vehicle configuration was an X or X?

- What changes could the RMV make to the form to address these challenges? MSP? Local Police?

- Is there anything that you could suggest from your local personal experience that may improve the likelihood that this section is filled out?

4.5 – *Objective: Report Submittal*

Objective: The aim of these questions is to discuss the process of review and report distribution to the RMV when the form has been completed.

Time - 20 minutes maximum

- After the crash report form is completed, what are the department procedures to process and submit the form to the RMV? State Police? Local Police?

- What is the internal process that was set up for the crash reporting? Does a supervisor need to approve it? Is it ever sent back to you or other officers? Why?

- Who submits the report to the RMV? How often to the reports get sent over to the RMV?

- As we discussed earlier, truck and bus crashes need to be entered into the state and then federal system within 90 days. What can we do to improve the speed with which these crash reports get to the RMV from the police departments?

- How would you suggest improving the submission process?

4.6 Summary

Objective: In these questions, it will be important to close out the discussion but still leave open room for thoughts or opinions not addressed in the key questions and to identify if there are strong feelings on any one section.

Time – 10 minutes maximum

- Is there anything that we have not asked that you think we should chat about specific to the crash report form and process? How about specific to the quality of the data?

The moderator will provide a review of the biggest problems they described.

- Do you have any other ideas about the crash data quality problems and how to address them?

- Are there any other changes you would like to see made to the form (specific to the truck and bus) or the process (paper or electronic)?

5. Conclusion
This section should bring the group to conclusion

Moderators Good-Bye

Thank you for coming – We really appreciate your input and could not do this without you.

POLICE OUTREACH SURVEY

Police Outreach Survey On Crash Reporting

The Massachusetts Executive Office of Public Safety and Security's (EOPSS) Highway Safety Division (HSD) and the Executive Office of Transportation's (EOT) Registry of Motor Vehicles (RMV) are working to improve the way crash data are collected and used in Massachusetts. Our mission is to streamline crash data collection and improve the timeliness, accuracy, completeness of police-collected crash data. This survey was designed to determine the challenges associated with current crash report data-collection procedures and to identify potential opportunities to modifying this system. The information gathered will be used to guide statewide improvements in the crash data collection and submission process.

We need your help.

Please have **one** representative from your department with crash reporting experience and supervisory responsibility for your crash reports take the survey below. The survey consists of 27 questions and takes about 20 minutes to complete. Responses can be faxed to UMassSafe at 413 577 1036 or filled out online at http://www.ecs.umass.edu/umasssafe/survey.htm. You may also participate by calling UMassSafe at (413) 577-1035 for a telephone interview. We need all surveys by October 30th in order to assist the RMV in developing improved data collection processes.

UMassSafe will provide a summary of the survey results to the RMV and invite respondents to a meeting to discuss the findings. Survey responses will be provided to EOPSS' Highway Safety Division and EOTS Registry of Motor Vehicles with individual names and police departments blacked out.

Feel free to call (413 577 1035) or email (riessman@ecs.umass.edu) Robin Riessman at UMassSafe with any questions.

Police Outreach Survey On Crash Reporting

Please have **one** representative from your department with crash reporting experience and supervisory responsibility for your crash reports take the survey below. The survey consists of 27 questions and takes about 20 minutes to complete.

Please provide the contact information of the person completing the survey:

Name of police department/troop: _____

Officer name: _____

Officer phone number and email address: _____

Are you the person within your department who is responsible for overseeing the collection and reviewing of crash reports? Yes ☐ No ☐

If No, please name that person so that we may create a contact list for future communications regarding crash data and reporting: _____

GENERAL INFORMATION

1. How many crashes requiring completion and submission of crash reports to the RMV occurred in your city/town in calendar year 2006? _____

    Is this number an approximation or an actual, verified number? Estimation ☐ Verified Number ☐

2. Which process described below most closely resembles your department's crash reporting procedure?
    a) Investigating officer records data at scene on crash form. Handwritten/photocopied form sent to the RMV.
    b) Officer records data at scene on form, report entered by same officer into Records Management System (RMS). Printed RMS report sent to RMV.
    c) Officer records data at the scene then enters it into the Records Management System (RMS) at the department after which it is electronically submitted.
    d) Officer records data at scene on crash form. Report entered by clerical staff into RMS, printed RMS report sent to RMV.
    e) Officer records data directly into cruiser computer at scene. Data uploaded to department's RMS, **printed** or **electronic** report sent to RMV.
    f) Other:_____

    If your response to question 2 was a):

    Can you tell us why? Your department has no electronic system ☐ Your department has no RMS vendor ☐ Form completed on-site of crash ☐ Other: _____

    If a handwritten report is sent to the RMV, is it the original or a photocopy? Original ☐ Photocopy ☐ N/A ☐

3. If your department does not submit crash reports to the RMV, please provide a brief explanation as to why:_____
    _____

    Is there anything the RMV can do to facilitate crash report submissions from your department? Please provide your suggestions:_____
    _____

4. Who submits the crash report to the RMV?

    Officer ☐ Supervisor ☐ Administrative Staff ☐ Other: _____

5. Is a crash report from your department ever returned from the RMV for additional information? Yes ☐ No ☐`

If YES, does your department have a consistent procedure for handling returned crash reports?
Please explain: _____

Does your department have an internal crash reporting tracking process to ensure that returned crash reports are re-submitted to the RMV? Yes ☐ No ☐
How long does it take to re-submit these returned crash reports? _____

TIMELINESS

Currently, the RMV receives crash report data approximately 90-120 days after the date of any given crash. In order to expedite this time frame, the RMV seeks to understand the crash report creation and submission process.

6. At what point are crash reports (paper or electronic) completed? Rank from "most often" (1) to "least often" (4):

Immediately after the crash ___

At the end of the same day ___

One or two days later ___

Once a week ___

Other ____

7. From the date of the crash, about how long does it take officers in your department to fill out the paper crash form or enter the information electronically, have it processed by the police and forwarded to the RMV? _____

8. At what frequency does your police department send crash reports to the RMV?
Daily ☐ Weekly ☐ Monthly ☐ Quarterly ☐ Other ☐ _____

9. On average, how long does it take officers in your department to complete a (paper or digital) crash form?

Minor (property damage only, 1-2 vehicles) crash? **Major** (injuries, multiple vehicles) crash?

Minor		Major	
About 10-30 minutes	☐	About 10-30 minutes	☐
31-45 minutes	☐	31-45 minutes	☐
45-60 minutes	☐	45-60 minutes	☐
Over an hour	☐	Over an hour	☐

10. Are crash report data reviewed by a supervisor prior to submission to the RMV? Yes ☐ No ☐

If YES, what does the supervisor check for? (If NO, proceed to question 13.)

_____

Are the data ever sent back to the officer for correction before being submitted to the RMV?
Yes ☐ No ☐
If YES, for what types of problems? _____

_____

11. Do you have any suggestions as to how crash report data could get from your department to the RMV in a timelier manner?

_____

_____

ACCURACY/COMPLETENESS

12. If an RMS is used for crash data reporting in your department, do officers follow a consistent editing procedure to ensure that inaccurate or incomplete information is not submitted to the RMV?
Yes ☐ No ☐
If YES, provide a brief description of the procedure: _____
_____

13. Does your department have and use unique crash/incident report numbers? Yes ☐ No ☐

14. Are there specific fields on the crash report form that you find confusing or unnecessary? \
Yes ☐ No ☐
If YES, detail which field(s) and why?
Field _____ Why _____
Field _____ Why _____
Field _____ Why _____

15. The Commonwealth of Massachusetts strategic Highway Safety Plan lists speeding, impaired driving, and safety belt/child safety seat use as three critical factors related to traffic safety. What are the barriers for collecting and reporting accurate data on these factors?
a) Speeding:
_____

b) Impaired driving:
_____

c) Safety belt/child safety seat usage:
_____

Do you have any suggestions for improved collection/reportage of this information?
_____

16. Do you think the property damage minimum should be increased from $1,000?
Yes ☐   No ☐
If YES, what should the minimum property damage be increased to?_____

17. Are there difficulties associated with accurately documenting crash location?
Yes ☐ No ☐
If YES, what would help provide more exact crash location information? _____
_____

18. Do your department's cruisers come equipped with global-positioning systems (GPS) technology?
Yes ☐ No ☐
 If GPS were made available to all police cruisers, would your department be willing to use it to locate every crash?
Yes ☐ No ☐ If NO, why not? _____

19. The current definition for injury severity based on the Minimum Model Uniform Crash Criteria (MMUCC) uses the KABCO injury scale: fatal injury, incapacitating injury, non-incapacitating injury, possible injury and no injury. This information is frequently missing from crash reports, and we   are   trying   to   figure   out   why.   Any   thoughts?
_____
_____
_____

20. When a crash involves a truck/bus, additional information is collected in a separate section of a crash report form. Is the "Truck/Bus" section clear and concise? Yes ☐ No ☐
If NO, why not? _____

CRASH DATA COLLECTION SYSTEMS

21. Has all your appropriate staff received training on crash reporting and/or using your RMS' crash reporting function?
Crash Reporting   Yes ☐ No ☐   **RMS System**   Yes ☐ No ☐

22. If additional crash report training was available, would you provide it to your staff? Yes ☐ No ☐
If YES, which kind of training would you prefer?
a)   Online training ☐
b)   Trainer that comes to your department ☐
c)   Training materials (e.g. video, curriculum, etc) for your use internally ☐
d)   The option to send staff to training at MSP or MPTC academies ☐

23. Given the choices listed below, which crash report submission system would you prefer?
a)   Hardcopy (paper) report submission to RMV ☐
b)   Electronic submission of reports to RMV using your current RMS technology ☐
c)   New, RMS-compatible software that allows electronic entry, analysis, and submission of crash reports to RMV ☐
d)   Electronic report creation and submission to RMV via secure website ☐
e)   Other/none; please specify: _____

24. In your opinion, what are the most immediate needs to improving crash data collection in MA:
a)   Improved training Yes ☐ No ☐
b)   Modifying the crash form Yes ☐ No ☐
c)   Changing/improving your department's internal RMS Yes ☐ No ☐
d)   Other _____

25. If crash data were made available to compare your data to other departments across the state, would it be of use to your department? Yes ☐   No ☐

26. The primary purposes of gathering crash data include improving roadway safety, including enforcement initiatives, and obtaining Federal and State support to improve roadway safety. Bearing this in mind, do you have any suggestions to improve the overall crash reporting and data collection process? _____
_____

_____
_____
_____

27. How long did it take you to complete this survey? _____

Responses can be faxed to UMassSafe at 413 577 1036 or filled out online at http://www.ecs.umass.edu/umasssafe/survey.htm by October 30th.

Thank you! This information will be of great assistance as the EOPSS-HSD AND EOT-RMV, and others create a strategic plan to improve the crash data system, as well as collection and storage of crash data throughout Massachusetts.

REFERENCES

1. Wikipedia. *Audit.* Last Modified: 06-July-2007. http://en.wikipedia.org/wiki/audit

2. District Department of Transportation. *District of Columbia Transportation Audit Guidelines 2006.* Last Modified: 21-Feb-2006. http://www.ddot.dc.gov/ddot/lib/ddot/services/traffic_audits/transportationaudits_2006-02-21.pdf

3. Wikipedia. *Focus Groups.* Last Modified: 13-June-2007. http://en.wikipedia.ord/wiki/Focus_group

4. Marczak, Mark and Meg Sewell. *Using Focus Groups for Evaluation.* The University of Arizona Tucson. Accessed: 10-July-2007. http://ag.arizona.edu/fcs/cyfernet/cyfar/focus.htm

5. Nielsen, Jacob. *The Use and Misuse of Focus Groups.* Accessed: 10-July-2007. http://www.useit.com/papers/focusgroups.html

6. McNamara, Carter. *Basics of Conducting Focus Groups.* Accessed: 10-July-2007. http://www.managementhelp.org/evaluatn/focusgrp.htm

7. Fink, Arlene. *The Survey Handbook*. SAGE Publications, Inc. Thousand Oaks, California. Copyright1995.

8. Fink, Arlene. *How to Analyze Survey Data*. SAGE Publications, Inc. Thousand Oaks, California. Copyright1995.

9. UMassSafe. *Police Outreach Survey*. UMassSafe, INC. Copyright 2007.

10. UMassSafe. *Improving Crash Data Quality in Massachusetts*. UMassSafe, INC. Copyright 2005.

11. UMassSafe. *Improving Commercial Motor Vehicle Crash Data Quality in Massachusetts.* UMassSafe, INC. Copyright 2007.

12. State Safety Data Quality. *Methodology for Rating State Crash and Inspection Data Reporting.* Federal Motor Carrier Safety Administration. Copyright June 2007.

13. UMassSafe. *Focus Groups Moderators Guide: Improving Crash Data Quality in Massachusetts*. UMassSafe, INC. Copyright 2005.

14. UMassSafe. *Police Outreach Survey on Crash Reporting: An Examination of Issues Related to Timeliness, Accuracy/Completeness, and Crash Data Collection.* UMassSafe, INC. Copyright January 2008.

15. UMassSafe. *Improving Commercial Motor Vehicle Crash Data Quality in Massachusetts Focus Group Findings.* UMassSafe, INC. Copyright 2007.

16. UMassSafe. *Improving Commercial Motor Vehicle Crash Data Quality in Massachusetts Audit Findings.* UMassSafe, INC. Copyright 2007.

17. UMassSafe. *Improving MassHighway Department Crash Data Quality in Massachusetts Audit Findings.* UMassSafe, INC. Copyright February 2008.