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Feasibility of Modeling the Relationship Between Seat Belt Program Inputs and Outcomes

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Mary T. Byrd was the NHTSA project manager.

16. Abstract

The objective of this project was to determine the feasibility of building a model that could be used as a decision-making tool for State Highway Safety Offices (SHSOs) to help predict how resource adjustments may affect seat belt use (both positively and negatively) to avoid inadvertent negative effects on seat belt use rates and unrestrained fatalities. To accomplish this objective, the study focused on 1) exploring the existence, availability, and quality of data needed to build a useful model; 2) preparing a description of the types of models that may be worth exploring given the data that are likely available; and 3) discussing the implications of the findings for future model development. The present study examined only the initial feasibility of a seat belt predictive model. Ultimately, the feasibility of any model can only be determined by developing a model and assessing the validity and reliability of that model by comparing the model output with what occurs after specific decisions are made. The present study involved determining the initial step in that process by assessing whether data and modeling techniques exist that could support a viable model. The overall conclusion of the study was that while the available evidence points to potential feasibility, it is not clear that the input variables would provide sufficient precision to create a useful predictive model due to limitations regarding what is available to the SHSOs.

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ACRONYMS

DOT	Department of Transportation
EMS	Emergency Medical Services
FARS	Fatality Analysis Reporting System
HVE	High Visibility Enforcement
NHTSA	National Highway Traffic Safety Administration
SEM	Structural Equation Modeling
SHSO	State (Governor's) Highway Safety Office
VMT	Vehicle Miles Traveled

BACKGROUND

State seat belt surveys show changes in observed seat belt use over time (Pickrell, 2017). Understanding why States experience these fluctuations is a complex task given how many programmatic and environmental elements may change within a State. These fluctuations could result from variability due to sampling, changes in seat belt use observation techniques or staff, or from an influx of newly licensed drivers.

Populations are always in a state of flux as old residents leave and new ones enter for a variety of reasons. The same is true of the driving population. New, young drivers are always entering the driving population, and older drivers may move or stop driving. Additional factors, such as fuel costs and vehicle affordability, may also lead to changes in the driving population.

In addition to these population factors, highway safety programs may influence seat belt use through programmatic changes. Such adjustments may include changes in funding and program activity levels for communications, education, and enforcement. Adjusting resources within a program as problems shift and new ones are identified is a key practice for effectively deploying limited resources. However, it can sometimes be challenging to gauge if and how resources should be shifted to produce programming that is both efficient and effective.

A Formula/Model for Predicting Seat Belt Use Rates

A decision-making tool would use a formula to predict how certain actions (i.e., program inputs) taken by the State would affect seat belt use (i.e., program outcomes). Such a tool, or "model," would allow a State Highway Safety Office (SHSO) to examine how adjusting various input factors would likely affect the seat belt use rate in the State. In the past, such models have focused on how to increase seat belt use in States. The results of these efforts have found a variety of factors that appear to be related to higher seat belt use rates, such as the implementation of a primary seat belt law and higher seat belt fines (Shults, Nichols, Dinh-Zarr, Sleet, & Elder, 2004). For example, a State could look at this research and conclude that if it shifted from a secondary seat belt law to a primary law it could expect on average an 8-percentage-point increase in seat belt use (Farmer & Williams, 2005). For States that have achieved very high levels of use, however, such models focused on increasing seat belt use are of little use, primarily because these high-use States have already implemented most of the recommended strategies.

OBJECTIVE

The objective of this project was to determine the feasibility of building a model that could help predict how resource adjustments by SHSOs may affect seat belt use (both positively and negatively) to guide resource allocation decisions that support efficient programs with continued growth. To accomplish this objective, the study:

1. Explored the existence, availability, and quality of data needed to build a useful model;
2. Described the types of models that may be worth exploring given the data that are likely available; and
3. Discussed the implications of the findings for future model development.

METHOD

Selecting States

This feasibility study assessed the availability, accessibility, and quality of the data needed to build a model by speaking with representatives from States. Researchers selected a group of States from those that had achieved a statewide use rate above 90 percent. These States were from 8 of the 10 NHTSA Regions and included Alabama, California, Indiana, Iowa, New Jersey, Nevada, Maryland, and Washington.

Identifying Potential Data/Variables and Factors of Interest

Researchers established a list of data and variables that could be used in the model and might be available from the States. The present effort focused on establishing feasibility of building a model, but did not include selecting a specific model type, actual model building, or model acceptability by potential users. The list of candidate data and variables, therefore, had to cover the potential needs for a variety of types of mathematical models from simple correlations to more sophisticated predictive models.

A fundamental component of any model, regardless of the type and complexity, is to have input and outcome variables. Input or independent variables make up program components and can be changed or controlled, and outcome or dependent variables are program products like increased seat belt use and reduced fatalities. The lists below cover the outcome (Table 1) and input (Table 2) variables that researchers identified and discussed with the States.

Table 1. Potential Outcome/Dependent Variables

Outcome/Dependent Variables	Description
Annual Statewide Seat Belt Observations	NHTSA required (23 U.S.C. 157) annual seat belt observations collected in person
Automated Seat Belt Observations	Example: Captured by traffic cameras
Local Seat Belt Observations	Example: Seat belt observations conducted by local police agencies
Other Statewide Observations	Example: Any other statewide efforts not funded as part of the annual statewide observations reported to NHTSA
Other Seat Belt Observations	Example: Rear seat belt, child safety seat, teen seat belt, and nighttime use
Unbelted Fatalities	Unbelted fatality data before it is sent to the Fatality Analysis Reporting System (FARS)
All Fatalities	All fatality data before it is sent to FARS

Table 2. Potential Input/Independent Variables

Input/Independent Variables	Description
Traffic Citations	During grant periods; during non-grant periods
Crashes	Fatalities; Injuries; property damage only
Emergency Medical Services (EMS) Response Times	Example: Time to crash; time to hospital
Hospital Data	Example: Trauma registry data; patient outcomes
Crash Reports	Hard and electronic copies of police crash reports
Vehicle Miles Traveled (VMT)	Actual measured VMT on roadways
SHSO Information and Activities	Structure budget; grant expenditures; staffing; research activities; management approach; highway safety meetings and conferences; grant enforcement activities; paid media; earned media; public awareness; law enforcement perception and opinions
Legislation	Example: History of seat belt legislation; other legislation that may be relevant
Socioeconomic and Demographic Factors	Statewide measures of changes in socioeconomics and demographics over time

Vehicle Information	Example: Department of Motor Vehicles records of registrations
Diversion Programs	Example: Data on seat belt and alcohol diversion programs operating in the State
Driver Training Programs	Example: Data on public and private driver education programs in the State; graduated driver licensing

There are a variety of other factors that could potentially impact both the usefulness and application of a model in the States. Contextual factors that may influence the application of a model would likely not be used as inputs to the model itself but are important to consider when assessing the feasibility and usefulness of a model. Questions on contextual factors in a State included:

- How much discretion does the SHSO have over how highway safety money is spent?
- How stable has the overall SHSO budget been from year to year?
- How much emphasis does the State's general public put on highway safety as a societal/health concern?
- How much emphasis do the State's policymakers put on highway safety as a societal/health concern?
- How much support for occupant protection is there from the Governor and legislature?
- How much support is received from the private sector for highway safety efforts?
- Are there groups that actively lobby against occupant protection laws and activities in the State? If yes, how many?
- What is the general public's perception of law enforcement in the State?
- How much do the SHSO's decisions and actions impact seat belt use in the State?

Contacting Participant States

Once States agreed to participate, the list of discussion topics was sent to the SHSO. Calls were scheduled with the appropriate SHSO staff member who could provide the most relevant and detailed information. Each of the calls followed a semi-structured script designed to elicit the needed information about the availability and characteristics of the data of interest.

Data Readiness Ratings

Researchers attempted to determine if the data were available and ready to use or, if not readily available, how much effort would be needed to make the data available for use in a model. Researchers rated each variable using the 6-point scale described below.

1. **Not possible or not permitted**

   Data item cannot be obtained, either because it defies reasonable measurement, it would be prohibitively expensive, or prevailing laws and regulations prohibit its collection.

2. **Not currently collected, but possible**

   Data item either has never been collected or was collected at some time in the past and then discontinued. Collection and use in a model are feasible but would require developing and implementing a totally new data collection system.

3. **Collected in the State, but not accessed or used by the SHSO**

   Data item is routinely collected by some entity or entities in the State but not used by the SHSO and cannot be obtained from the collectors. Use in a model would require establishing a separate liaison with the collecting agency either directly or through the SHSO.

4. **Available at SHSO but not in usable form**

   Data item is collected by the SHSO or obtained from another agency in the State but is only available in a form or format that would be incompatible with a model. Use in the model would therefore require not only acquiring the data but also significant processing or transformation/conversion.

5. **Available from the SHSO in a usable form**

   Data item is collected or obtained by the SHSO and is stored in a retrievable form that must be preprocessed to create a variable for use in a model.

6. **Available from the SHSO in ready form**

   Data item is collected or obtained by the SHSO and is stored in a retrievable and immediately usable form.

RESULTS

This section presents the availability and readiness of variables deemed of value for modeling seat belt use in each of the participant States. The results are presented separately for input and outcome variables. Figure 2 provides a summary of the readiness ratings for the various data elements.

Ready to Go

Variables ready to go today with little cost (rating 5–6):

Outcome/Dependent Variables

- Annual Statewide Seat Belt Observations
- Unbelted Fatalities
- All Fatalities

Input/Independent Variables

- Citations (Grant Periods)
- Injury
- VMT
- Structure
- Budget
- Grant Expenditures
- Staffing
- Highway Safety Meetings/Conferences
- Grant Enforcement Activities
- Paid Media
- Earned Media
- Public Awareness

Will Take Some Time

Variables that will take a couple years to develop with moderate cost (rating 3–4):

Outcome/Dependent Variables

- Other Belt Observations
- Local Belt Observations

Input/Independent Variables

- Citations (Non-Grant Periods)
- Property Damage
- EMS Response Times
- Hospital Data
- Crash Reports
- Research
- Management Approach

Needs Extensive Work

Variables that will take extensive work and a long time to develop with high cost (rating 1–2):

Outcome/Dependent Variables

- Automated Seat Belt Observations
- Other Statewide Observations

Input/Independent Variables

- Law Enforcement Opinions

Figure 2. Data Readiness

Outcome/Dependent Variables

Tables 3 to 9 contain the data readiness rating for possible outcome/dependent variables for each State. Descriptions of the rationale behind the ratings are provided below each table.

Table 3. Annual Statewide Seat Belt Observations

	AL	CA	IA	IN	MD	NJ	NV	WA
Annual Statewide Seat Belt Observations	5	6	6	6	6	6	6	6

In all eight States, annual statewide seat belt observations are conducted by contractors. These contractors put together the sampling plans following NHTSA guidelines, conduct the observations with their own teams of observers, and prepare the data for the States. The contractors tend to change every few years, and the observation locations and protocols change as the sampling requirements are modified. The SHSO stores the data in a retrievable and immediately usable form in seven of the eight States. Some minor effort would be needed in one State to obtain the raw data for past years, which is why it received a rating of 5 for this variable. The values reported for seat belt use could be biased over time by factors such as changes in contractor or measurement location. As such, a model would need to take into consideration changes in observation teams and protocols that may occur and that could be responsible for any variability in reported seat belt use. To the extent these factors can be taken into consideration, the annual statewide seat belt observations could potentially be useful as an outcome variable for a model.

Table 4. Automated Seat Belt Observations

	AL	CA	IA	IN	MD	NJ	NV	WA
Automated Seat Belt Observations	2	1	2	2	2	1	1	1

In half of the States examined, automated seat belt observations, such as those captured by traffic cameras, are not permitted because of State or local laws. It is not clear if automated observations could be collected solely for research purposes in those States. The other four States are not currently collecting any automated seat belt observation data. While automated seat belt observations would offer an opportunity to collect large samples of actual seat belt use at all times of the day, it does not appear that they are currently feasible to include as an outcome measure.

Table 5. Local Belt Observations

	AL	CA	IA	IN	MD	NJ	NV	WA
Local Seat Belt Observations	2	2	4	6	5	2	4	3

Local seat belt observations (e.g., seat belt observations conducted by local police agencies) are available in four of the States. During *Click It or Ticket* campaigns in Indiana, local participating police agencies collect pre- and post-seat belt surveys and send that information to the State. The data are available and ready to use. In Maryland, seat belt observations are collected across the State at locations that are not included in the annual reported sample. These observations are collected by the same survey observers that conduct the statewide survey. Some nighttime and back seat observations are also collected in Maryland, but retrieving the raw data would likely require moderate effort. In Iowa, seat belt observations are collected in some locations twice a year (usually in March and August). These data, however, are not readily available in a usable form and would require effort to compile. In Nevada, law enforcement grantees are occasionally asked to collect seat belt observations at specific locations. In the remaining States, no local seat belt observations are collected on a regular basis. The inconsistent collection periods and training protocols for most observers means that it is unlikely that local observations would be useful as a model outcome variable.

Table 6. Other Statewide Observations

	AL	CA	IA	IN	MD	NJ	NV	WA
Other Statewide Observations	2	2	2	6	5	2	2	2

Other statewide observations would only be available in Indiana and Maryland. These observations are not federally initiated, are collected by local police departments as part of reporting requirements for State grants, and are only available from agencies that received grants. Since only grantees conduct these observations, the results may not be representative of the entire State. The other States said it would be possible to collect other statewide observational data not funded by NHTSA but doing so would require substantial effort. Statewide observations other than those collected as part of the annual survey do not appear feasible in most States.

Table 7. Other Seat Belt Observations

	AL	CA	IA	IN	MD	NJ	NV	WA
Other Belt Observations	5	6	6	6	3	6	4	2

Five of the eight States do have other types of seat belt observations, such as rear seat belt, child safety seat, teen seat belt, and nighttime use. Annual child safety seat observations are readily available in Alabama (since 2002), California, and Iowa. In Maryland and New Jersey, child safety seat observations have been collected in the past, but the data are not readily available. In Maryland, some seat belt use data are available from hospital records, although the information is limited. In New Jersey, rear seat belt observations are conducted annually. Teen seat belt observations may also be available in California. In Nevada, child passenger surveys and observations of seat belt use in rural areas are occasionally conducted. The lack of consistency across States limits the usefulness of other types of seat belt observations.

Table 8. Unbelted Fatalities

	AL	CA	IA	IN	MD	NJ	NV	WA
Unbelted Fatalities	5	4	5	6	6	4	5	6

Seven of the eight States have ready access to real-time unbelted fatality data and summary reports already written, but only three have the data in a format that is likely to be immediately available and useable in a model. Three other States could get the data fairly quickly, but it might require some minor work to get the data in a format that would be usable in a model. In California and New Jersey, other State agencies collect unbelted fatality data, and the SHSO would have to access it from those other sources, which could take some time and effort. It is important to note that this variable concerns fatality data that is up-to-date versus the FARS database, which tends to be delayed 12 to 18 months due to the thoroughness of the FARS data acquisition and cleaning processes.

Based on the conversations with the States, unbelted fatalities represent an opportunity to have an outcome variable that is independent of human observation. Additional measures, such as the percentage of total fatalities in which the person was unbelted and unbelted fatalities per million miles traveled, would also need to be considered. It is important to note that both the raw number of unbelted fatalities and unbelted fatality rates can be influenced by outside factors, such as improvements in vehicle safety systems or an increase in drunk driving. As such, it is always important to note that many factors can influence any type of fatality data independent of observed/actual seat belt use across a population.

Table 9: All Fatalities

	AL	CA	IA	IN	MD	NJ	NV	WA
All Fatalities	5	4	5	6	6	4	5	6

The readiness of all real-time fatality data followed the same pattern as unbelted fatalities because the data come from the same databases in each of the States. Data on all fatalities are subject to the same issues discussed above for unbelted fatalities as well as the fact that they are confounded by the belted fatalities.

Input/Independent Variables

Tables 10 to 13 summarize the readiness of the input/independent variables of interest for use in a model. The same 6-point data-readiness scale was used for these variables.

Table 10: Citations

	AL	CA	IA	IN	MD	NJ	NV	WA
Grant Periods	4	3	6	6	5	6	6	5
Non-grant Periods	4	2	3	4	5	2	3	4

Citation counts during grant periods are readily accessible in Iowa, Indiana, Maryland, New Jersey, and Nevada. In Iowa and New Jersey, citation data can be obtained from tables available in annual reports. The *Operation Pull Over* database in Indiana allows real-time access to grant citation data. Nevada has a single citation system, and data acquired during grant periods are readily available. Maryland collects information on traffic citations, but it would require some minor effort to extract the information needed for a model. Washington can also provide grant citation counts with some minimal effort. In Alabama, the Community Traffic Safety Program (CTSP) developed the CTSP Online Reporting Engine, an online reporting database for traffic enforcement activities. The program began in 2015 and has summary data for citations from 2004 to the present, but data before 2015 would require some time and cost to query. California did not have grant citation data readily available but could likely obtain the information with some substantial effort.

For non-grant periods, none of the States had seat belt citation data that would be readily available in a usable form. In Maryland, the Crash Outcome Data Evaluation System managed by the University of Maryland, School of Medicine allows access to a State-based data system that includes traffic citations and would require minor effort to gather the necessary data. In Alabama, the Electronic Citations Generation and Processing System allows some web-based analyses based on information from recent years. In Washington, citation data during non-grant periods is available from the Administrative Office of the Courts and State Patrol, but extracting the data could potentially be time consuming. In Iowa, the Department of Human Rights can access traffic citations as needed, but it would require substantial work to get that data in ready form. Despite having a single citation database, Nevada generally does not monitor seat belt citations during non-grant periods, and it would require substantial work to process and analyze the data.

Based on these findings, citations during grant periods could be potentially useful as an input variable to see if the outcome variables change as a function of the number of seat belt (or other) citations issued during grant periods. Other variables, such as number of contacts and citations per hour, could likely also be gathered for grant periods and used as model inputs.

Table 11. Crashes and Traffic Information

	AL	CA	IA	IN	MD	NJ	NV	WA
Fatalities	5	6	6	6	6	6	5	6
Injury	5	6	4	6	6	6	5	6
Property Damage	5	3	4	6	3	6	3	6
EMS Response Times	3	3	3	2	6	2	3	3
Hospital Data	2	3	2	3	6	2	3	6
Crash Reports	3	2	3	4	3	4	3	6
VMT	3	5	6	3	6	2	5	6

Table 11 covers a variety of crash, hospital, and traffic data that could potentially be used as inputs/covariates to a model predicting observed seat belt use and/or fatalities. For example, it could be important for any model to consider driver, occupant, and crash characteristics obtained from crash reports for fatality, injury, and property-damage-only crashes since this could be highly related to the outcomes of interest. Similarly, EMS data (e.g., response times) and information obtained from hospital data could be highly related to crash survival rates, which could indirectly impact any fatality measures. VMT is an important variable to consider when talking about crash outcomes per VMT.

As before, fatality data are readily available in the States. Crash data on injury crashes is also readily available in most of the States, but several States indicated that property-damage-only crash data could be difficult to obtain.

Information on EMS response times is only currently available in Maryland in annual reports to the State. Alabama has some data on EMS response times for fatalities and is starting to collect the information for other crash types. Indiana has received a grant from the Department of Homeland Security to gather EMS response time data, but this effort has just begun.

Hospital data are only readily available in Maryland and Washington. In both States, hospital data can be gathered from annual reports. In California, the Public Health Department has some data available, but it would take effort to acquire the information in a usable form. Indiana recently received a Department of Health and Human Services grant to improve their trauma registry. Nevada is currently working on implementing a system to acquire EMS and hospital data.

Hard-copy crash reports are only readily available in Washington, where the reports can be obtained from the State Department of Transportation (DOT) and State Patrol databases. In Alabama, there is crash summary data available in the Alabama Law Enforcement Agency's reports, but copies of actual reports may be difficult and time consuming to obtain. In California, the California Highway Patrol maintains crash data and reports on crashes, but these reports may be difficult to obtain. In Iowa, DOT maintains crash records but not in a user-friendly form. In Indiana, Indiana University–Purdue University Indianapolis publishes crash information in the form of fact sheets and county profiles. Indiana is currently revising crash report forms to be more accurate. Although crash reports are available in Maryland, the data is not user-friendly. New Jersey had been collecting and processing crash reports for 3 years, but this report processing has been discontinued.

VMT data are readily available in five of the eight States. Alabama, Indiana, and New Jersey indicated that data are collected in the State but are likely not easy to retrieve in a form that would be usable in a model.

The above findings suggest that information from fatal crashes, injury crashes, and VMT would likely be available for use as input variables for a model.

Table 12. SHSO Information and Activities

	AL	CA	IA	IN	MD	NJ	NV	WA
Structure	6	6	6	4	5	6	6	5
Budget	6	6	4	6	6	6	6	6
Grant Expenditures	6	6	6	4	6	6	6	5
Staffing	6	5	6	4	6	4	6	5
Research	5	6	4	6	6	3	2	5
Management Approach	3	6	2	3	4	6	2	6
Highway Safety Meetings/ Conferences	6	4	6	6	5	4	4	6
Grant Enforcement Activities	6	6	4	6	6	6	6	4
Paid Media	6	6	6	6	6	2	6	4
Earned Media	6	5	6	6	6	2	6	4
Public Awareness	6	6	6	2	5	6	6	3
Law Enforcement Opinions	2	2	2	4	2	2	2	3

Table 12 provides ratings of data readiness for items concerning the operation of the SHSOs themselves and the nature of their activities. Overall, information related to each SHSO's organizational structure, budget, grant expenditures, and staffing is readily available. Most of this information is included in each State's Highway Safety Plan, which is presented to NHTSA annually.

In five of the eight States, information on research that the SHSO has funded is readily available. Research topics include roadside surveys (Pacific Institute for Research and Evaluation, 2014) and driving behavior surveys (Washington Traffic Safety Commission, 2014). In Nevada, the State DOT, but not the SHSO, funds some research projects. California, New Jersey, and Washington all have detailed documentation of their management approach, although much of this information is anecdotal in nature and would have to be gathered from staff members with long tenure with the organizations. Five of the States reported keeping good records of highway safety events they sponsor (e.g., conferences, statewide meetings) and attendees. In Washington, these records are readily available for the past 5 years. The three States where the information was less available reported that the data were generally in some form (e.g., paper records) that would require some effort to collate and code.

Information on grant enforcement activities (e.g., hours, contacts) is readily available in almost all States in the study. Iowa and Washington indicated the information is available but would require some effort to retrieve in a form that would be usable for a model.

Information on paid and earned media promoted by the SHSO is available in all of the States except New Jersey. In Washington, the information is available only for the last 5 years. In New Jersey, data on paid and earned media are not currently available.

Information on public awareness is readily available in Alabama, California, Iowa, Maryland, Nevada, and New Jersey. For more than 14 years, Alabama has been conducting an annual phone survey on a myriad of highway safety topics. In New Jersey, Fairleigh Dickinson University conducts annual phone surveys. Nevada has been conducting surveys on public awareness for about 5 to 7 years. In Indiana and Washington, the information is either unavailable or difficult to access.

Information on law enforcement personnel's opinions about highway safety is absent in all studied States. In Indiana, some data may be accessible through the Law Enforcement Liaison office.

Much of the information in this section is obtainable from the State Highway Safety Plans submitted to NHTSA or as part of other State publications. As such, most would require reviewing the documents for the desired time periods and manually extracting the information in a form suitable for use as inputs to a model.

Table 13. Other General

	AL	CA	IA	IN	MD	NJ	NV	WA
Legislation	5	3	3	3	2	6	5	5
Economic/ Demographic Factors	3	2	2	2	3	2	4	3
Vehicle Information	4	3	6	3	6	3	2	5
Diversion Programs	1	1	2	3	2	3	3	3
Driver Training	3	4	4	3	3	3	3	6

Table 13 provides ratings on other general variables of interest. Alabama and New Jersey have reports on relevant legislative activities that are readily available. Nevada and Washington also have data on legislative activities that can be accessed with some effort. Data on relevant legislative activities exist in California, Indiana, and Iowa, but the data may be time consuming to access.

In all States in the study, economic and demographic information associated with seat belt use is very limited. In Alabama, some self-reported information may be collected in awareness surveys. In Maryland, observational information on drivers' race/ethnicity is available on police-stop forms.

Information about vehicle registrations is available in each of the States but generally requires coordination with another State agency that manages the registrations. Iowa, Maryland, and Washington did appear to have some type of information available for seat belt use by vehicle type, but it is not clear if this information would be useful for a model.

In all the States included in this report, information on traffic safety diversion programs is either nonexistent or very difficult to retrieve.

Information on driver training programs is readily available only in Washington. Alabama, California, and Indiana indicated the information likely exists in other agencies, but accessing the information would be difficult.

In summary, much of the input variable information lies outside the purview of the SHSOs, which means additional effort would be required to access and gather the desired data. Substantial effort may also be required to prepare the data in a form that would be usable for a model.

Contextual Variables

This section summarizes several issues for which the State officials involved in the discussions were asked to provide their opinions on various topics that could be important when considering the relationships among the input and outcome variables and how a model may, or may not, be useful in a State. It is important to note that this information only covers their opinions on the current environments in the States. Collecting these data retrospectively would be virtually impossible, or at least very unreliable, given turnover in the various offices and the fact that such questioning would rely on the memory of the staff member answering. The primary goal of these items was to determine if it was even possible to gather such information that might be useful for a model and to add context as to how a model may be useful in a State. The items would have to be collected repeatedly in the future and from a wider sample of State officials for the information to be given serious consideration for inclusion in an actual model.

The officials reached in each of the eight States reported that the SHSO has significant discretion (within NHTSA guidelines) as to how highway safety money can be spent. They also reported that their overall budgets, as well as specific seat belt program budgets, have been stable or very stable over the years. This suggests that SHSOs would have the flexibility and funding to modify their activities to fit any suggestions that may come from the use of a model.

The next series of questions asked the State officials to provide their opinions regarding how much emphasis the State's general public and policymakers put on highway safety as a health/societal concern. Only one State reported that the public put a high emphasis on highway safety, and no State reported policymakers as having a high emphasis on highway safety as a societal/health concern. Several of the States did report, however, that the Governor's office and the legislature did support highway safety efforts. Similarly, some States reported high support for highway safety from the private sector, while others reported little to no support from the private sector. None of the States appear to have any groups lobbying against seat belt laws. Nevada noted that there does not appear to be anyone lobbying against the passage of a primary seat belt law, but there is also no real support to change the current secondary seat belt law.

The SHSO officials also felt that the general public has a largely positive perception of law enforcement in their States. In total, these results suggest that there would likely be little opposition to any changes in SHSO programmatic activities that resulted from the use of a model to help guide those undertakings.

The final item was an evaluation of how much each SHSO representative thought his or her agency could impact highway safety in the State. Except for those from a single State, officials from all seven other States expressed their belief that the SHSO's decisions and actions could have a positive impact on seat belt use in their State.

While of interest, the information gathered from this portion of the conversations is only of use as input to a model if it were available consistently across States for the same time period as the outcome variables of interest. It is likely inappropriate and potentially risky to guess at the historical opinions of the legislature and general public. Such information could only be used in the model itself if it was collected prospectively through consistently applied surveys of the legislature and public, which might be difficult to accomplish in many States. Still, the above contextual information suggests that a model would be well received by the SHSOs and of use in the programmatic decision-making efforts.

Seat Belt Predictive Model

In general, the SHSOs had good records of their own activities (e.g., citations during grant periods, staffing, budget). While some of the SHSOs coordinated considerably with other agencies that held certain pieces of potentially interesting data (e.g., VMT, vehicle registrations, crashes), other SHSOs had not established this level of coordination with the outside agencies. As such, multiple model variables would need to be obtained to develop proper input variables for a model. It is possible that the extra effort required could disqualify the use of those variables. Overall, however, the discussions with the SHSOs suggest that at least some outcome and input variables would be readily available for an effort to build a model. This feasibility study revealed the availability of both quantitative as well as qualitative data. Therefore, strictly from the standpoint of the availability of a variety of valid input and output variables, it would be feasible to move forward with an effort to build a predictive model. Some additional elements, however, still need to be considered to assess overall model feasibility.

Based on the conversations with State officials, the outcome data likely available and ready for model building includes the statewide annual observations of seat belt use, unbelted fatalities, and, fatalities in general. No other outcome/dependent measures of seat belt use are being collected on a consistent enough basis across the States to be usable in a model. Nevertheless, multiple potential input variables do appear to be feasible for inclusion in a model because enough States appear to have the same type information readily available for a reasonable number of years in the past. Given the availability of some appropriate data as building blocks, it becomes of interest to examine if one or more modeling techniques exist that could use the available data. The section below describes multiple potential approaches to model building that may be possible given what the study could ascertain regarding data availability and readiness.

Possible Analytical Approaches

Quantitative Methods

Quantitative models could be used to predict measurable changes in the outcome variables (e.g., seat belt use, unbelted fatalities) as a function of other numerical (quantitative) variables that experienced change over time. For instance, quantitative models could be built to predict changes in unbelted fatalities over time (e.g., decrease/increase in the annual number of fatalities associated with a failure to use a restraint). This would be as a function of annual changes in one or more input/independent variables for which good quantitative data are available (e.g., citations during grant periods, paid media expenditures, VMT).

There are several quantitative frameworks that could be used. For instance, a predictive model could be built by applying the Structural Equation Modeling (SEM) technique. The use of SEM has gained notable popularity among researchers both for its utility in exploring relationships beyond what is possible with Analysis of Variance (ANOVA) or multiple regression analyses. In addition, this technique can be applied to a variety of traffic safety situations (Romano, Scherer, Fell, & Taylor, 2015; Romano, Scherer, & Taylor, 2016; Scherer, Harrell, & Romano, 2015), including seat belt use (Dunlop & Romer, 2010; Okamura, Fujita, Kihira, Kosuge, & Mitsui, 2012). Thus, SEM could be applied to examine the contribution of different factors, such as level of law enforcement, media campaigns, and economic status, to seat belt use and unbelted fatalities.

To be effective, quantitative predictive models such as SEM would require that measurable changes in the outcome variables (e.g., seat belt use, unbelted fatalities) can be accurately modeled as a function of a set of numerical (quantitative) variables. Although our study indicates the feasibility of building such a model, it also points out data uncertainties that could affect the predictive ability and utility of the model. The scope of this study did not include the detailed examination of databases. The possibility always exists that any database could contain limitations to the variables needed for the quantitative predictive model, which would lessen the precision and accuracy of any model.

Mixed Methods

As discussed above, the study inquiries appear to indicate that building quantitative predictive models is feasible. Concern about the potential accuracy of the quantitative predictions, however, remains given the uncertainties surrounding the quality of the actual data States may be able to provide. Contextual (qualitative) information could be used to address this concern.

Analytical approaches that integrate, analyze, and/or interpret both quantitative and qualitative data are called mixed methods approaches (Johnson, Onwuegbuzie, & Turner, 2007). For instance, one mixed methods approach would involve (1) building and testing a quantitative model from which numerical (quantitative) predictions of the outcome variables (e.g., seat belt use/fatalities) are obtained using a SEM approach and (2) subsequently analyzing qualitative variables to add context and enhance the interpretation of the model results. This mixed methods approach, described as an explanatory sequential approach (QUAN-QUAL), would allow model users (e.g., State officials) to obtain numerical predictive estimates of seat belt use and unbelted fatalities while using qualitative information and expert opinion to account for uncertainties in accuracy and facilitate an interpretation of specific changes in trends.

MODEL FEASIBILITY: SUMMARY ASSESSMENT

The goal of this study involved assessing the initial feasibility of developing a predictive model relating SHSO decisions and actions to the outcome of the seat belt program. If such a model were feasible, it could represent an important decision-making tool for highway safety officials. Ultimately, the feasibility of any model can only be determined by assessing its actual validity and reliability. That cannot be accomplished until a model is actually developed and employed, and its output compared in a rigorous manner with what actually occurs after specific decisions are made. The present study involved determining the initial step in that process. That is, assessing whether data and modeling techniques exist that could support a viable model.

Output and Input Variables

Previous sections described the availability and readiness of data and information relevant to model building based on discussions conducted with State officials. Researchers undertook no direct evaluation of the availability or quality of actual databases. Thus, judgments concerning issues potentially fundamental to model feasibility, such as the quality of key variables (e.g., actual rates of missing entries), could be made based on only limited information. This is not atypical in an initial feasibility assessment but must be taken into account by the reader when considering the conclusions of the authors with respect to model feasibility in the remainder of this section.

The results of this effort indicate that outcome measures appropriate to the objectives of the model under study do, in fact, exist. The specific outcome or dependent measures identified as potentially usable in a model include the statewide annual observations of seat belt use, unbelted fatalities, and fatalities in general. The States examined do not collect other outcome/dependent measures of seat belt use on a sufficiently consistent basis to support a viable model. All States are likely to continue collecting both statewide observations and a tally of unbelted fatalities for the foreseeable future. As such, they represent the most likely choices for model outcome measures.

The situation is also promising with respect to input or independent variables. Researchers identified several potential input variables for which multiple States collect and maintain similar information and have been doing so for some time. In particular, the SHSOs had good records of many variables related to their own activities (e.g., citations during grant periods, staffing, budget) that could potentially predict changes in seat belt use rates.

Based on discussions with the selected group of eight States, the situation is not as clear with respect to potentially useful input variables collected by agencies other than the SHSO. While some of the SHSOs reported significant coordination with other agencies that held certain pieces of potentially interesting data (e.g., VMT, vehicle registrations, crashes), other SHSOs reported little or no existing activities that would facilitate cross-agency data collection. As such, the feasibility of using these additional types of input variables is currently uncertain because of the unknown level of effort needed to obtain and process them into proper input variables for a seat belt model.

In summary, strictly from the standpoint of the existence and ready availability of some valid input and output variables, it should be feasible to move forward with an effort to build a predictive model meeting the objectives of relating SHSO decision-making to possible effects on seat belt use. However, it is not clear that the input variables will provide sufficient precision to create a useful predictive model due to limitations regarding what is available to the SHSOs. For example, the SHSOs only have citations during grant periods when citations throughout the year is a better measure of overall enforcement effort.

Compatible Modeling Techniques

The availability of valid input and outcome variables is only one part of model feasibility. A second issue relates to whether one or more appropriate modeling techniques exist to achieve the desired prediction. Ultimately, only building and validating a model can answer this question. However, based on the judgment of the researchers and the identification of multiple potential techniques, there is moderate likelihood of executing an approach compatible with the data. The extent of the predictive accuracy of any developed model remains an open question.

Discussion

The present study examined only the initial feasibility of a seat belt predictive model. The overall conclusion of the researchers is that while the available evidence points to potential feasibility, it is not clear that the input variables would provide sufficient precision to create a useful predictive model due to limitations regarding what is available to the SHSOs.

In the process of reaching that conclusion, several likely limitations and operational characteristics of any resulting model became known.

1. **Model could be useful for predicting trends resulting from SHSO decision-making but not specific seat belt use/unbelted fatalities levels.**

   The quality of a predictive model can be expressed by its accuracy and precision. Accuracy relates to the likelihood that the model's predictions point in the right direction (e.g., an increase in seat belt use). Precision relates to the specificity of the model—how close to the true change would the prediction be.

   Concerns about the precision of the predictive model could be alleviated by performing sensitivity analyses. Rather than aiming to obtain single predictive values, model operators could run predictive models under alternative assumptions reflecting minimum and maximum expected (forecasted) input conditions to obtain a range of outcomes. Thus, by providing a range of predictive outcomes (rather than point estimates), State officials could use the predictive model to visualize a broad set of possible future scenarios.

2. **Any resulting model is best viewed as an additional decision-making tool.**

   The inherent characteristics of any resulting model suggest that it cannot be used as an ultimate decision-making resource. Similar to other probabilistic techniques, it is best viewed in an advisory or confirmatory role along with other tools and the experience of the specialists in the SHSOs. For instance, it is possible that among the range of future outcomes predicted by the model, some would be favorable (e.g., increase in seat belt use) while others neutral or negative. In that case, model outcomes alone will be difficult to interpret. To reduce uncertainty, additional information may be needed. State officials may have to rely on contextual/mediating information specific to that State at that time as well as their own expertise to obtain a more precise interpretation of the range of outcomes.

3. **It may not be possible to build a model to predict seat belt use for some driver subgroups of interest (e.g., age, gender).**

   Because many States appear not to include observations on specific groups of vehicle occupants, building a seat belt use predictive model for driver subgroups based on seat belt observations may not be possible. However, building a seat belt use predictive model based on unbelted fatalities may be possible. Information on seat belt use by vehicle occupants' demographics is readily available in fatality records and, therefore, also available for model building. A major limitation, however, is that the number of fatalities (unbelted or not) may not be large enough to examine some subgroups of interests.

   In addition, even if there are a large enough number of fatalities, building a precise predictive model may not be possible due to limitations in the input variables. Building precise seat belt models for specific groups requires these groups to be identified in both the input and output variables. Such a parallel identification may not always be possible. A remedy for this hypothetical limitation could be achieved through group redefinition (e.g., by collapsing age groups), as long as a new and meaningful group definition exists.

4. **Acceptance of a model as part of SHSO decision-making is unknown.**

   This study focused on the basics of model feasibility and not on its acceptance or likely use by SHSOs. As such, it is not possible to predict whether the availability of a model as a decision tool, regardless of its accuracy and precision, will prompt widespread use. More input on this is needed as one of the next steps if model building is pursued further.

Possible Next Steps to Further Refine Feasibility

1. **Learn from State officials what model features would induce them to accept and use a seat belt use predictive model.**

   Before any model building is suggested and/or attempted, it will be extremely important to learn from State officials what model features would prompt them to use and trust such a model. A widespread reluctance of SHSO officials to make use of a model regardless of its characteristics would cast doubt on the utility of any further development efforts.

   Knowing which model features are attractive to State officials, is crucial for future model development. The steps in an acceptability study would include:

   - Developing comprehensive descriptions of alternative models that researchers can use to obtain reactions from SHSO officials;
   - Conducting a series of in-depth interviews with State officials to discuss model acceptability and further clarify the accessibility and cost of the identified input and outcome variables—best to include all States in these interviews;
   - Analyzing the resulting data to assess whether such a model would be used with sufficient regularity to warrant its detailed development;

- Analyzing the data to develop an accurate estimate of the cost of universal data acquisition and
- Identifying detailed model content and operating characteristics necessary to satisfy the user population and promote its widespread use.

2. Estimate cost of building and validating an acceptable and usable model.

The initial step would identify the set of features needed to make a seat belt predictive model attractive to State officials and the cost of data acquisition. The next logical step would be a detailed estimate of the cost of developing and maintaining such a model. Experienced model builders would have to assess the cost to obtain the data set and to apply one or more model building and validation techniques. This step depends on the experience and judgment of the researchers/model builders to derive estimates that bound the extent of the development effort to account for the uncertainties inherent in any such exercise.

3. Build and validate a prototype.

Assuming an acceptable seat belt predictive model is theoretically and budgetary feasible, the next step would involve developing and validating a model prototype. The likely steps include selecting at least 20 years of historical data from a subset of States for model building and then assessing the precision of the model using another subset of States for validation as well as any new years of data in the development States.

REFERENCES

Dunlop, S. M., & Romer, D. (2010). Associations between adolescent seatbelt non-use, normative perceptions and screen media exposure: results from a national US survey. *Injury Prevention, 16*(5), 315-320.

Farmer, C. M., & Williams, A. F. (2005). Effect on fatality risk of changing from secondary to primary seat belt enforcement. *Journal of Safety Research, 36*(2), 189-194.

Johnson, R. B., Onwuegbuzie, A. J., & Turner, L. A. (2007). Toward a definition of mixed methods research. *Journal of Mixed Methods Research, 1*(2), 112-133.

Okamura, K., Fujita, G., Kihira, M., Kosuge, R., & Mitsui, T. (2012). Predicting motivational determinants of seatbelt non-use in the front seat: A field study. *Transportation Research Part F: Traffic Psychology and Behaviour, 15*(5), 502-513.

Pacific Institute for Research and Evaluation. (2014). Washington State Roadside Survey. Olympia, WA: Washington Traffic Safety Commission.

Pickrell, T. (2017, May). Seat belt use in 2016—Use rates in the States and Territories (Traffic Safety Facts Crash•Stats. Report No. DOT HS 812 417). Washington, DC: National Highway Traffic Safety Administration.

Romano, E., Scherer, M., Fell, J., & Taylor, E. (2015). A comprehensive examination of U.S. laws enacted to reduce alcohol-related crashes among underage drivers. *Journal of Safety Research, 55*, 213-221. doi: 10.1016/j.jsr.2015.08.001

Romano, E., Scherer, M., & Taylor, E. (2016). Developing and Implementing a Tool to Evaluate and Improve Underage Drinking and Driving Policies - National Criminal Justice Reference Service. Calverton, MD: Pacific Institute for Research and Evaluation. Retrieved from: https://www.ncjrs.gov/pdffiles1/ojjdp/grants/250438.pdf

Scherer, M., Harrell, P., & Romano, E. (2015). Marijuana and other substance use among motor vehicle operators: A latent class analysis. *Journal of Studies on Alcohol and Drugs, 76*(6), 916-923. doi: http://dx.doi.org/10.15288/jsad.2015.76.916

Shults, R. A., Nichols, J. L., Dinh-Zarr, T. B., Sleet, D. A., & Elder, R. W. (2004). Effectiveness of primary enforcement safety belt laws and enhanced enforcement of safety belt laws: a summary of the Guide to Community Preventive Services systematic reviews. *Journal of Safety Research, 35*(2), 189-196.

Washington Traffic Safety Commission. (2014). Washington State: Driver Attitudes, Knowledge, and Awareness Survey 2012. Olympia, WA: Washington Traffic Safety Commission.

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