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Transportation Safety in Virginia: Positive Changes And Future Prospects

Nouran Hakami

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A thesis submitted in partial fulfillment of the requirements for the degree of Master of Urban and Regional Planning at Virginia Commonwealth University

By

Nouran Hakami

Master of Urban and Regional Planning

Director:

Xueming (Jimmy) Chen

Associate Professor

Virginia Commonwealth University

L. Douglas Wilder School of Government and Public Affairs

Richmond, Virginia

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Abstract

TRANSPORTATION SAFETY IN VIRGINIA: POSITIVE CHANGES AND FUTURE PROSPECTS

By Nouran Hakami, MS.

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Major Director: Xueming (Jimmy) Chen ,Associate Professor, L. Douglas Wilder School of Government and Public Affairs

Measured by the level of transportation safety, the Commonwealth of Virginia stands out from all the States because despite increased need for mobility, it manages to maintain its safety indices at exceptionally good levels. In many respects we can attribute this success to the comprehensive Strategic Highway Safety Plan of Virginia (SHSP), which is, as concluded from the analysis of its analogues, among the best in the US. The programs and policies described in this document embrace all aspects of transportation safety and create a harmonious system. To assess the effectiveness of the SHSP, this thesis used correlation and regression analysis based on statistical data from the years 2004 – 2011 in Virginia Department of Transportation (VDOT), and Virginia Department of Motor Vehicles (DMV) documents.

The performed calculations showed very positive trends with gradual reduction, in crash and death rates. It was also found that citizens would use private vehicles more often in the future without making conditions worse on the highways. Instead, drivers tend to be more careful and responsible. Analysis also reveals a rising level of drunken driving incidents, a finding substantiated by literature review, chiefly planning reports and economic analysis. The current transportation policy I does not adequately address this issue. The correlation between allocation of funds and performance indicators showed it would be more effective to invest in research projects on safety rather than in "safety" itself (i.e. construction of roads). Unfortunately, in difficult times, governments usually cut research projects.

Finally, Virginia is on the verge of a new transportation era, when the structure of driving cohorts will change, and decisions about building new highways will have to be balanced between technical and ecological considerations.

Chapter 1

Introduction

General overview of the problem: The number of crashes has been constantly increasing in the US, and as a result, governments work hard to improve safety. With the help of a revised and improved transportation policy and system, and the latest technologies and innovations in road architecture, Virginia accounts for less than 2% of the 2010 national total of 32,788 road fatalities, itself the lowest since 1949.

Several factors account for the decrease in crashes. Firstly, vehicles became considerably safer. Secondly, through the Safe, Accountable, Flexible and Efficient Transportation Equity Act: Legacy for Users, the federal government has invested in transportation safety, encouraging state governments' efforts to improve road safety...

In Virginia, the state has designed and implemented the Highway Safety Strategic Plan, which considers the various aspects that affect road safety.

Purpose of the research: This study assesses the importance of transportation safety planning in Virginia in decreasing the number of fatal car crashes and other road accidents by analyzing the Strategic Highway Safety Plan of Virginia (2012 – 2016). Using correlation methods, it identifies the factors that most significantly influence transportation safety in Virginia. Analysis of efforts by other states and countries identifies the most vital safety issues and discusses possible solutions.

Contribution of the author and uniqueness of the research: The value of the work can be summed up in the following statements:

- The work presents a comprehensive analysis of several Highway Safety Strategic Plans and gives an idea of what an “ideal” document should look like.
- The methodology of the research is presented as a set of mathematical techniques in order to assess the effectiveness of the programs and make predictions about highway safety ,in most works surveys are used, which makes them rather subjective. Statistical approach using regressive and correlation analysis can be characterized as explicit and unbiased.
- The study examines the least highlighted issues – allocation of funds and tax policy; most works focus on law enforcement and infrastructure. This makes the recommendations and results of the research especially valuable.

All the calculations and analyses presented in the paper were made by the author.

Chapter 2

Literature Review

This part of my work reviews documents related to the safety of transportation of the Commonwealth of Virginia and other States, mainly Safety Plans released by the Departments of transportation.

Along with the health and education, safety of passengers and drivers on the roads is one of the highest concerns of the US Government. An entire Chapter in the US Code is devoted to highway safety. According to §402 USC23, the ultimate goals of the guidelines and safety programs designed are aimed at reducing injuries and deaths, improvement of the procedures and performance of drivers.

The central part of the Transportation Safety Program is the Strategic Highway Safety Plan, a specific document which contains analysis of the weak points of each State in terms of transportation safety, reveals the reasons and defines procedures and measures to improve the situation. . Although every document has the same goal, each of them is specific due to the peculiarities of the economies, climate and even mentality of the drivers.

1-Transportation safety: According to Hole, et al (2011), transportation safety is an active complex system, involving, apart from material elements (road and transport), interdisciplinary studies (psychology, law etc.), legal regulation and other tools. However, the most important characteristic of the transportation safety is that its carriers are all the citizens, which means that positive result can be achieved only through cooperation of all parts of the system.

The development of technology changes lifestyles and increases our need for mobility, at the same time giving society all the necessary engineering tools for accelerating it. Unfortunately, the non-technical aspect of transportation fails to keep up with the advance of vehicles. The growing concern about this issue is obvious even from the structure of the Transportation Statistics Annual Reports. For example, the 1998 Report placed transportation safety after the economic considerations. Twelve years later, expenditures followed the safety Chapter, and the whole report was focused on the improvement of performance.

Button and Hensher (2005) make very interesting statements about the transportation safety levels in USA, Canada, New Zealand and Australia. For example, they claim that regardless of the tremendous effort US makes towards achieving high levels of safety, the country will face increased transport-related casualties. While today most of the victims are between 1 and 45 years old, especially, children under 13 (Massachusetts Highway Strategic Safety Plan, 2006), the elderly will become the most vulnerable group of the population, In contrast, and largely due to long-time monitoring and effective regulations, the transportation policies of Canada, Australia and New Zealand will show a high safety level.

In the global prospective, the US level of transportation safety takes the intermediate position. According to the UNECE Transport Review (2008), regardless of the obvious presence of the need, regulations and requirements, transportation safety is still strongly dependent on the so-called "human factor.", and mentality. For example, Kazakhstan reports an "unacceptably high" transport-related number of deaths, while the Netherlands considers any casualty as a result of a transport accident as unacceptable. Russia blames its numerous losses of drivers and pedestrians on the former Soviet traffic policy, and while it has improved, it is still worse than the EU average. Swedish experts attribute high safety levels to the technical reliability of the transport, while the African region finds the situation nearly hopeless from both technological and regulatory perspectives... Obviously, the level of safety

is strongly connected with the level of economy of the country which significantly influences the state of the roads and vehicles themselves, as well as the attitude of the road police to their responsibilities.

2 - Strategic Highway Safety Plans (SHSP): A typical SHSP contains the following information:

- Background giving the statistics on highway-related fatalities in the State and other general information;
- Description of the planning process;
- Actual strategies. The areas where exceptional attention is needed are also stressed;
- Technical moment – implementation of the Plan, funding, reporting, etc.

Sometimes the Plan may contain specific considerations about the private transportation or elements of security.

3 - Montana Comprehensive Highway Safety Plan (CHSP): The document was issued in September 2006. Yet in the Executive Statement Director of Montana Department of Transportation underlines the exceptional importance of CHSP due to the poor situation on the highways in the State. The Mission statement reads as "All highway users in Montana arrive safely at their destinations". Such a basic formulation of the goal reveals the seriousness of the highway problems in Montana, which is supported by the statistics according to which in 2005 more than 22,000 crashes were reported in the State. Among the major concerns the Department of Transportation names impaired driving, American Indians, young drivers, and the state of rural roads the statistics about highway accidents in Montana can be found in Table 2.2.

TABLE2.2 –Road statistics on Montana versus US (2004 – 2005)

Parameters	USA*	Montana*	Virginia***
Fatalities per 100000 population	14.52	24.47	12.52
Alcohol-related fatalities	39%	46% **	36%
Fatalities due to young drivers per 1000 licensees	1.01	1.18	0.96
Fatalities due to American Indians	9.9%	13.5%	unknown
Crashes in rural areas (single vehicle run-off-the-road)	40%	90%	68%

*Based on data taken from *Drive and Stay Alive, 2003; Montana CHSP, 2006; 2004 Drunk Driving Statistics*

**Second highest among all States

***From http://vaperforms.virginia.gov/indicators/publicsafety/trafficfatalities.php, http://www.dmv.state.va.us/webdoc/pdf/vacrashfacts_05.pdf and http://www.iihs.org/iihs/topics/t/general-statistics/fatalityfacts/state-by-state-overview/2005

A very specific issue is the low usage of the safety belts in the State, which in the CHSP is reflected as the No.1 concern. Three-quarters of the highway crash victims didn't use their seatbelts. The other two major concerns of the State are drunk driving and crashes caused by Native Americans which are strongly interrelated (two- thirds of accidents involving Native Americans were due to drunk driving).

The undoubted strength of CHSP, from my point of view, is the way in which the authorities of the State address the Native Americans driving problem. Although generally the Plan can be described as constraining and enforcing, the actions plan with respect to American Indians implies discussions, communications and educating.

4 - Massachusetts Strategic Highway Safety Plan: The level of transportation safety in Massachusetts contrasts sharply with that of Montana, because the rate of highway-related fatalities here is twice as low as the average in the USA. However, safety belt use is much lower than the average, which explains why drivers are the overwhelming majority of the road victims.

Though the situation on the roads in the Massachusetts is much better than in the previously discussed State, it still demands improvement, because according to the statistic the fatality rate has been on more or less the same level during at least 10 past years (0.85±0.6 deaths per 100 million VMT, Massachusetts SHSP, 2006).

Private cars account for most of the crashes on the highways... The main factors behind the fatalities are impaired driving (alcohol), lane departure and speeding, which are 2 to 4 percent higher than the national average.

The Massachusetts SHSP is a mature, well-structured and comprehensive document approaching the definition of specific objectives in a sophisticated, gradual way. Based on statistics and other data, it first identifies several "emphasis areas". Then, through the advanced organizational structure, or "participation", it allocates responsibilities and establishes the planning schedule, which encourages all the stakeholders to participate in choosing the best strategies. It is not surprising that the Mission statement of the SP is very focused and specific. It reads as "Develop, promote, implement, and evaluate data-driven, multidisciplinary strategies to maximize safety for users of the roadway system".

The approach to the strategy selection in Massachusetts SHSP deserves attention. First of all, the strategies are classified according to the problematic issues they address. The Plan also provides the detailed explanation and description for each of them. Responsibilities are also very carefully defined. It stresses research and education about

– Alcohol-impaired driving, seatbelt use, high-risk transportation etc. However, this can be considered as both the strength and the weakness of the plan. The more alarming the fatality rate, the stricter the measures should be.

5 - North Dakota Strategic Highway Safety Plan: The Mission Statement – "Providing a transportation system that safely moves people and goods" – is very basic, and reflects the absence of an effective transportation system The same can be concluded from

the fields of concern outlined in the SP: making road crossing easier, improving safety of cyclists, designing safer highway work zones, improving the design of highway intersections etc. One of the central ideas of North Dakota SHSP is increasing survivability by means of improvement of the emergency service, especially in the rural areas. It is rather hard, however, to call this SP revolutionary for it doesn't introduce any exclusive decisions or programs.

6 - Oklahoma Strategic Highway Safety Plan: Like Montana, the State was facing a road safety crisis at the time of SP development. The fatality rate was about 18% higher than the national average. It is logical that the strategic planning team was multidisciplinary. And its Mission Statement resembles that of r Massachusetts. The SP itself is very interesting because it is the only document among those discussed that focuses on the psychological aspect of highway safety. Its primary emphasis area is defined as influencing impaired and aggressive drivers, and as I see this as an undeniable strength, I would like to discuss this issue a bit more.

Although it is not exactly stated in the SP, I assume that aggressive drivers and poor driving statistic in the rural areas are interrelated. The crash rates on the rural roadways in Oklahoma happen 14% more often than on average in the US. The difference is that in these accidents the main factor in not alcohol (drunk driving rates have always been relatively low in the State), but speeding, failure to yield and fatigue or distraction of drivers. Here Oklahoma considerably exceeds the national level (5 to 15%).

The main strategy the experts chose is preventing drunk driving, which seems a bit illogical with respect to the above discussed positive trend. Another solution the local authorities see in the education of drivers which is fully justified, as well as using the help of the media for achieving this goal. What this plan obviously lacks, from my point of view, is

the help of psychology expertise which could make a valuable contribution in identifying reasons for aggressive driving, assessing the state of drivers etc.

7 - Idaho Strategic Highway Safety Plan: Maybe because of the previous experience (we consider in the work the SHSP of 2010), but the document has a new look. , with pictures, graphs and diagrams, to help to educate the average citizen. Even the Mission Statement may sound like a motto ("Every Life Counts"). The structure of the Plan is very simple: "Definition – Problem – Goal – Strategies", with every Problem proved statistically. Although it is very well-organized, the Plan, unfortunately, does not give any idea about the level of highway safety compared to the national average. However, this weakness is merely technical, and the document effectively serves the public.

8 - Washington State's Strategic Highway Safety Plan: Even though this document is the peer of the above analyzed, they are completely different. It also uses the technique of approachability, but more moderately. This SP though does not have a traditional distinct Mission Statement. Its primary goal, Target Zero, is declared in its title. However ambitious it may seem, current trends show that it is possible. The fatality rates related to highways are considerably lower here than on average in the country (0.94 vs. 1.27 per million VMT, as of 2008). Another very special characteristic of the plan is the considerable period it covers – 20 years--, when traditionally planning is reasonable for 3 – 5 years, which I count as a disadvantage of this SP. The SP is not a Strategy. It's more flexible, and, more important, demands more or less detailed description of steps planned to be made in order to realize the objectives. Planning for 20 years in advance is hardly possible because transportation is politically sensitive.

The strategies (which in this document are referred to as Priority Levels), place emphasis on impaired driving, and calls for a variety of approaches. It seems that every aspect of the problem is tackled: cross-cultural training; law enforcement; reviewing the

taxes; monitoring etc. I would like to draw your attention to legal and economic solutions, because they are going to affect not only the drivers, but retailers of alcohol. This point makes the SHSP outstanding.

9 - Commonwealth of Virginia's Strategic Highway Safety Plan: Here I am going to review two SPs, 2006 – 2010 and 2012 – 2016.

2006 – 2010 SP: In 2004 – 2005 the death rate due to transportation in Virginia was about 12 people per 100,000 which is very close to the nation's average of 14.5. Having chosen a broad and complex mission ("To save lives and to reduce injuries from motor vehicle crashes in Virginia through the integration of education, enforcement, engineering, and emergency response actions"), Virginia's Surface Transportation Safety Executive Committee focused on reducing aggressive driving.

Generally speaking, this SP is organized as a research work with some theoretical points about highway safety. The major problem is also discussed thoroughly, and the authors conclude that though the number of injuries from speed-related accidents decreases, it occurs mainly because the fatality rate rises. To reduce unsafe behaviors, it calls for a broad media campaign and stricter enforcement measures.

The reviewed document of **2012 – 2016** demonstrates significant achievement of the Commonwealth's goals: number of transportation-related fatalities reduced by 23% and number of injuries by remarkable 45% since 2006. This proves the effectiveness and comprehensiveness of the chosen strategies. The Mission Statement, although a bit changed, expresses the same idea, but now it is more focused on making Zero Deaths a strategy. The current SP still concentrates on the problem of aggressive driving, but the tangible improvement allows for considering other problems (roadway departure, data processing etc. more specifically.

An updated SP shows the evolution of the highway safety culture of the Commonwealth citizens.

10 - Comparison of the Strategic Plans: When reviewing the SHSPs, one can find the following consistent patterns:

- The worse the situation on the highway, the more emphasis is placed on the enforcement measures;
- The most successful States implement the "4 E's" safety strategy (Engineering, Education, Enforcement and Emergency), or at least, declare the multidisciplinary approach;
- In vast majority of cases, the human factor is critical
- No SP from the number of the reviewed ones can be described as "ideal".

From the review of the SPs it is possible to derive the "formula", or the essential elements of the most effective Strategic Plan, which is shown in the Table 2.3.

TABLE 2.3 -The essential elements of the most effective Strategic Plan

Key element	Function
Validity period, not more than 5 years	To make the progress gradual and steady
Concise Mission Statement	To outline the most important targets for the estimated period and to focus on them
Well-designed charts for statistics	To make the improvements (or degradation) more obvious; poor statistics should not be hidden behind complicated tables
Major objectives split into action plans	To explain which measures must be taken or programs implemented in order to reach the goal
Attention to achievements in research	To ensure the progress

TABLE2.4 – Comparison of the Highway Safety Strategic Plans

Name of the State	Peculiarity of the State (in terms of highway safety)	Level of transportation safety	Mission Statement	Primary Emphasis Area	Key Strategy	Strength of SP	Weakness of SP
Virginia (current SHSP)	Safety culture tremendously improving	High	To save lives and reduce motor vehicle crashes and injuries through a data-driven, strategic approach that uses enforcement, education, engineering, and emergency response strategies.	Speeding	Engineering upgrade	Strategies well-structured, responsibilities well-defined	No specific programs described
Montana	Licensed drivers under 16	Poor	All highway users arrive safely to their destinations	Safety belt use	Enforcement	Constructive dialogue with Native Americans	Emphasis on information rather than improvement (high-incidence locations)
Idaho	Highway safety rapidly increasing	High	Toward Zero Deaths, Every Life Counts	Aggressive driving	Education	Concise, bright, penetrable	Information about the State's highway safety on a national scale not provided
Washington	Trend to zero fatality rate	High	-	Impaired driving	Legal enforcement and monitoring	Economic and legal actions against alcohol retailers and producers	Big planning period; "zero" goal
Massachusetts	Stable and low transport-related fatality rate	High	Develop, promote, implement, and evaluate data-driven, multidisciplinary strategies to maximize safety for users of the roadway system	Data systems	Education and research	Very detailed and well-organized	Little attention to enforcement
North Dakota	Fatality rate significantly decreased during past 20 years	High	Providing a transportation system that safely moves people and goods	Infrastructure	Upgrade	Data-driven	Rather neutral, "average" SHSP
Oklahoma	Unsafe rural roadways	Poor	Develop, implement, and evaluate a data-driven, multidisciplinary process to maximize road safety through widespread collaboration, integrating Engineering, Enforcement, Education, and Emergency Services	Unsafe behaviors	Legal enforcement	Discusses the personal aspect of the problem	Psychological help is not considered as a strategy

The review of documents and studies in the field of highway safety enables me to make the following conclusions:

- For the US, transportation safety is a very significant issue. The whole Chapter 4 (Title 23) of the US Codes is devoted to it;
- Transportation safety is neither a study nor a requirement. It is a living system capable of evolving. Transportation security is a quality that completes the safety system;
- As long as people are the safety culture carriers, human factor in the highway incidents is of paramount importance. Study of the reasons and choice of the measures should be interdisciplinary;
- Strategic Highway Safety Plan is a useful document capable of giving deep insight into the problems and peculiarities of the State. A good SP includes distinct Mission Statement, problems' statement, discrete solutions, well-structured and classified approaches, description of implemented programs and supports each thesis with statistics. An easily read and understood SP is an asset;
- The SHSP of the Commonwealth of Virginia has been extremely successful and shows how society can succeed in encouraging responsible highway users. However, there always is the room for improvement, and Virginia's SHSP would benefit from the good practices described in Table 3.

Chapter 3

Methodology

This chapter is devoted to quantitative research of transportation safety in Virginia using descriptive and experimental research. The input data for the calculations were taken from the documents presented in the official websites of Virginia Department of Transportation and Virginia Department of Motor Vehicles, and from other Internet sources.

Methods for data analysis: The study had two directions: assessment of the feasibility of the goals stated in the SHSP via discovering trends (regression analysis), and finding correlations between statistical data. The results of the latter can be used for the assessment of the safety projects' efficiency and for discovering trends and connections. The analysis was focused on the drivers of all age groups; pedestrians were not considered.

Analysis

1 - Feasibility of the Strategic Plan. Virginia Highway Safety Plan (FY 2014 Report) states the following goals to be achieved by 2016:

Fatalities –	760	Unrestrained Passenger Vehicle Occupant Fatalities –	286
Serious Injuries –	9061	Drunk Driving Fatalities –	211
Fatalities/100M VMT –	0.93	Speed-Related Fatalities –	257
Urban Fatalities (per 100M VMT) –	0.72	Motorcycle Fatalities –	73
Rural Fatalities (per 100M VMT) –	1.05	Unhelmeted Motorcycle Fatalities –	1
Fatalities involving Drivers under 20	88	Pedestrian Fatalities –	96

The highlighted performance indicators are those used in the analysis.

For the indicators the statistic was picked from the SHSP 2012 – 2016 and FY 2014 Report for the years 2001 – 2012. Based on the statistics, the extrapolation was performed in order to find a trend. When a system formed by the data was linear, we used a simple interpolation. When the data formed a non-linear system (i.e. having several peaks), a polynomial extrapolation was used (Boslaugh& Watters, 2008). The degree of a polynomial was chosen so as to reach the highest value of reliability of the result ($R^2 \rightarrow 1$). The trend allowed making a short-term prediction (1 year).

The result is presented in the Fig. 3.1 – 3.5 together with the regression equations. The dotted lines in the graphs designate the desirable values of the key performance indicators.

a) **Trends in the number of severe injuries among all groups of drivers:** It appears that the number of severe injuries has been demonstrating an invariable decline during the past 11 years, so it can be well described with the linear function. The reliability of the predicted further decline is rather high; consequently, the planned value is highly likely to be achieved.

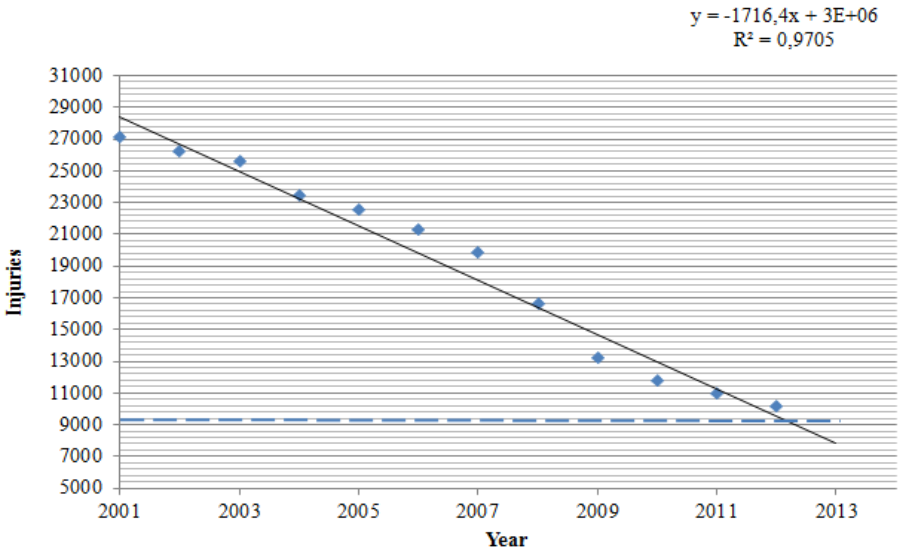


FIG. 3.1 – Severe Injuries

b) **Trend in the number of deaths related to transportation among all population groups:** The analysis has shown that the polynomial function (6th degree) describes this trend the best. The forecast revealed that in the forthcoming years we can face a further decline in the number of fatalities, so the SHSP goal is achievable.

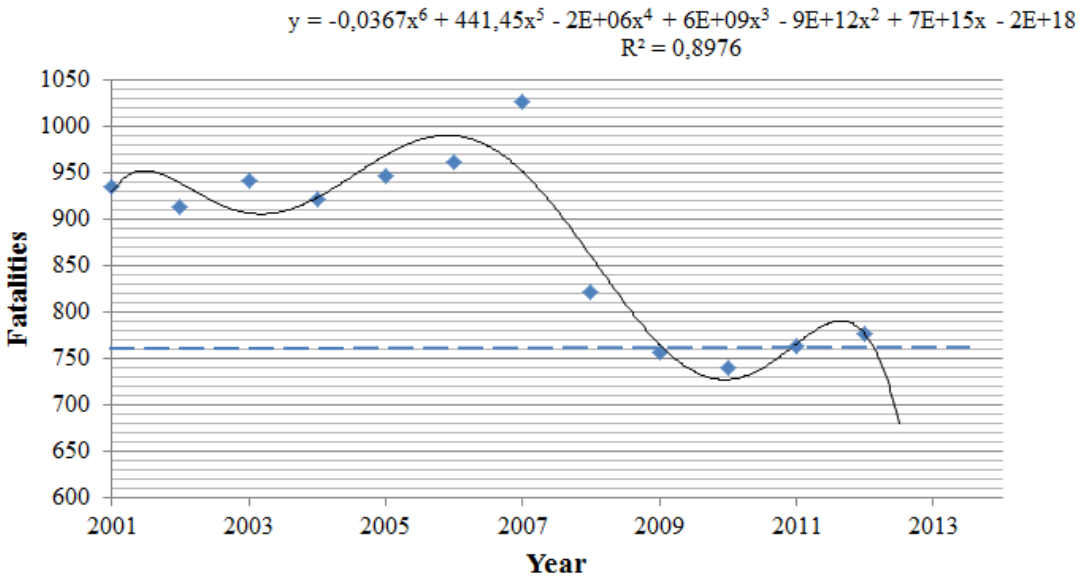


FIG. 3.2 – Traffic-related Deaths

c) Fatalities involving drivers under 20:

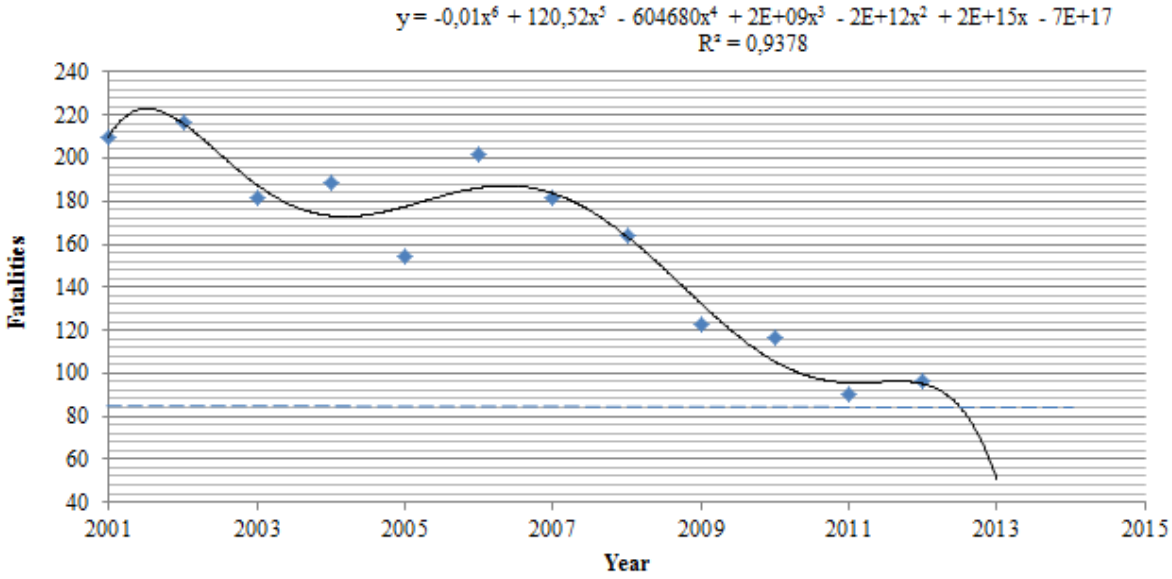


FIG. 3.3– Fatalities Involving Drivers Under 20

Like in the previous statistics, polynomial function describes the number of fatalities among young drivers, and here we can expect a decline as well, which makes it possible to lose the maximum of 88 teen lives in the nearest years.

d) **Speeding-related fatalities among all groups of population:** After having peaked in 2007, speeding in Virginia is now more or less steadily becoming a less common phenomenon, which can be seen from the graph. The planned value is only several points lower than the one achieved in 2012, so the goal is real.

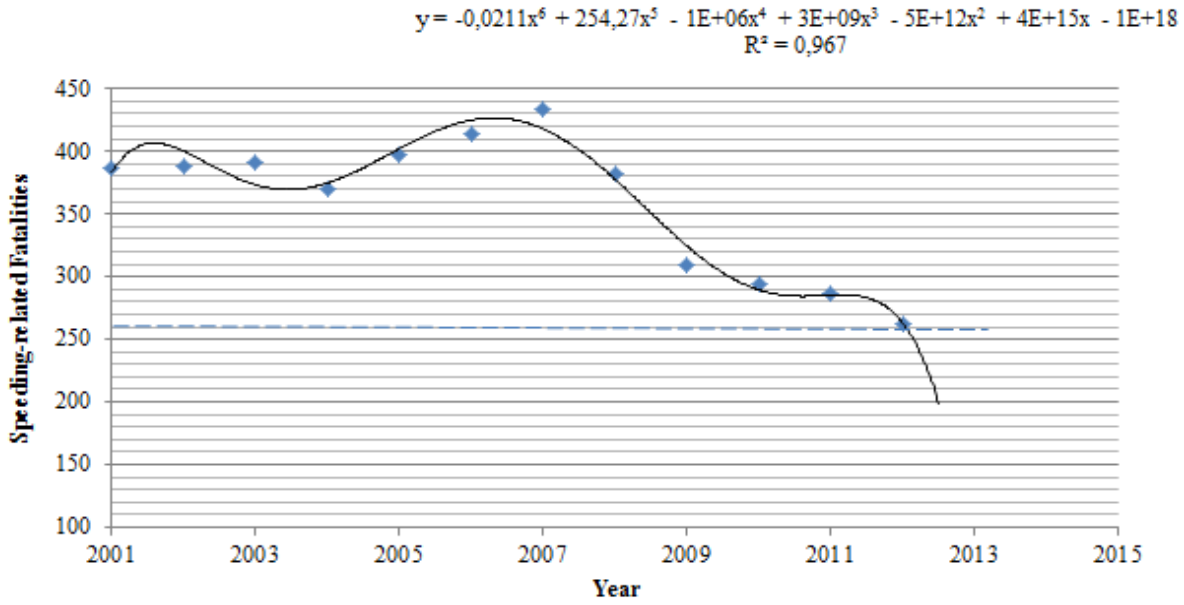


FIG. 3.4 – Speeding-related Fatalities

e) ***Trend in the number of alcohol-impaired driving fatalities:*** The results of an analysis of this part of the data were quite unexpected, because the polynomial function predicted the rise in the number of drunk-driving victims, which means that the planned performance indicator is unlikely to be achieved.

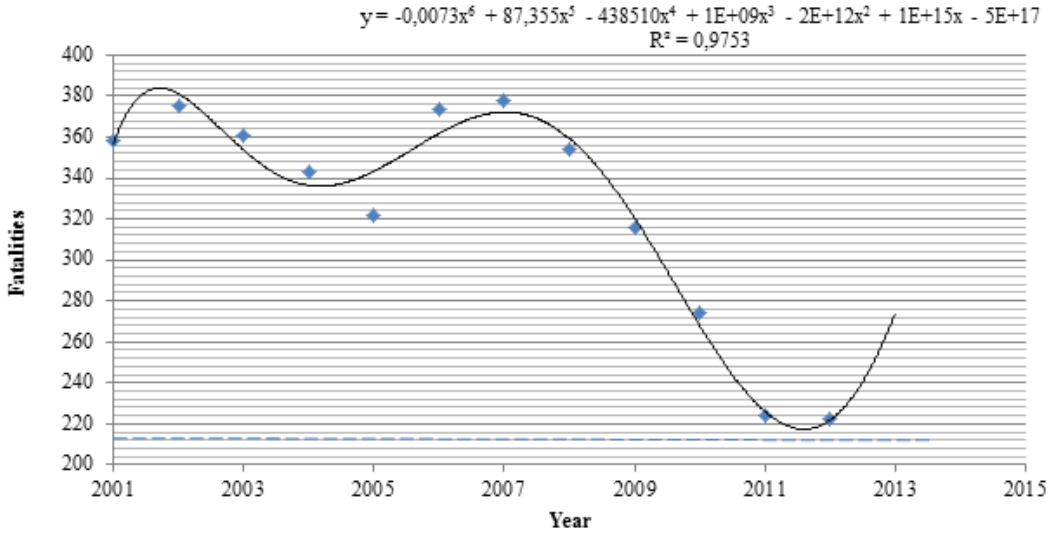


FIG. 3.5 – Alcohol-Impaired Driving Fatalities

From the practical point of view this assumes that current policies addressing drunk-driving are inadequate, and require toughening.

If we show all the fatalities data in one graph (Fig. 3.6), we will see a distinct splash of traffic-related deaths in 2007. Although it is hard to name the cause of this phenomenon without a thorough investigation, I assume that it may reflect some socio-economic factors.

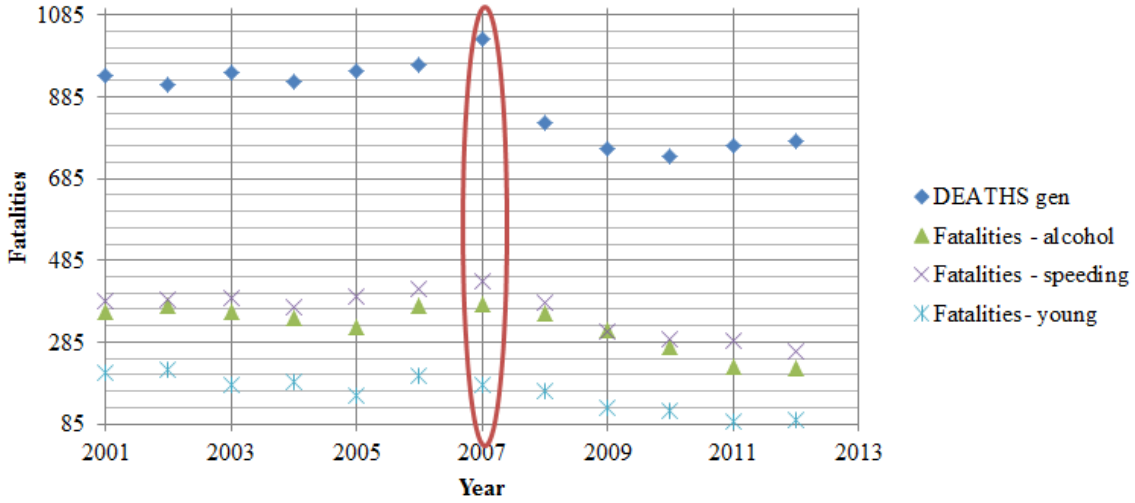


FIG. 3.6 – Peak of Fatalities

2 - Correlation between the data: This type of analysis is very useful to see how two variables influence each other. As this approach is quantitative, the result is presented as a figure from which, however, we can draw a qualitative conclusion. The basis of the correlational analysis is the two qualities that the correlation possesses: direction and magnitude. The numeric expression of these characteristic is what forms the final judgment.

(Scott, W., & VanderStoep, D. D. J., 2009).

Correlation coefficient r (or Pearson's product moment coefficient) is a measure which defines how strong and in what way two variables impact each other. The correlation coefficient can be calculated according to the following formula:

$$r = \frac{\sum xy - \frac{1}{n}(\sum x)(\sum y)}{(n-1)S_x S_y}$$

Where *x* and *y* stand for the investigated parameters, S_x, S_y are sample standard deviations for *x* and *y* correspondingly, *n* is number of samples, and *n-1* is the degree of freedom (DF).

Sample standard deviations show how each sample deviates from the mean, and it can be calculated according to the formulas:

$$S_x = \sqrt{\frac{\sum x^2 - \frac{(\sum x)^2}{n}}{n-1}}$$

$$S_y = \sqrt{\frac{\sum y^2 - \frac{(\sum y)^2}{n}}{n-1}}$$

Correlation coefficient can reveal positive (variables increase or decrease simultaneously) or negative (while one variable decreases, the other one increases) direction of the connection.

The next essential step is the assessment of the significance of correlation coefficient by means of calculating of the *t*-factor (Student's coefficient) and its comparison to the standard

values for the chosen level of significance. In this work we assume that the significance should be at least 0.95 (or $\alpha \leq 0.05$). The formula is:

$$t = \frac{r\sqrt{(n-2)}}{\sqrt{(1-r^2)}}$$

If the *t*-criterion shows that the value of *r* is significant, we transform the quantitative measure of the latter into the qualitative description according to the Cheddock's scale (closeness connection factors):

$$0.1 < \mathrm{r} < 0.3 - \text{weak}$$

$$0.3 < \mathrm{r} < 0.5 - \text{moderate}$$

$$0.5 < \mathrm{r} < 0.7 - \text{appreciable}$$

$$0.7 < \mathrm{r} < 0.9 - \text{high}$$

$$\mathrm{r} > 0.9 - \text{very high}$$

The following tables present the results for the correlation analysis. To make it more demonstrative, I divided it into two groups: human-related and economic.

a) **Human-related correlations:** This part of analysis allows understanding general trends in transportation safety. It was assumed that number of crashes *(y)* can depend on the population growth *(x)*. The results of calculations are presented in the table below (data from 2001 – 2012).

TABLE 3.1 – Total number of crashes vs. population growth.

S_x	S_y	r	t
300024.9	15381.9	-0.749	-3.578
Significant for p=99.5% High invert correlation			

The result means that despite the significant growth of population in Virginia (which is a fact), the number of crashes declines, which is the positive trend. However, we cannot say that with the decline in the population number we will have more crashes. Also, the number of road incidents cannot reduce infinitely, as well as the population can grow only to some limit. This is the disadvantage of the methodology, which will be discussed later.

In an attempt to find out if the severity of crashes is changing, I correlated number of fatalities with the total number of crashes (Table 3.2), which gave me an opportunity to assume that the fatalities fall with the improvement of safety, i.e. the car accidents are becoming neither more nor less lethal.

TABLE 3.2 – Number of deaths vs. number of deaths crashes

S_x	S_y	r	t
15381.9	97.4	0.911	7.004
Significant for p=99.95% Very high straight correlation			

b) **Correlations based on economic aspect:** The statistic provided by Virginia's DMV and DOT is more than enough to assess the adequacy of transportation safety programs and effectiveness of money allocation. According to VDOT Financial Reports, during 2004 – 2011 the Commonwealth invested significant sums into several projects, of biggest interest to this research, include road maintenance, and research and planning. Which of them was more effective can be seen from the Tables 3.3 – 3.8.

TABLE 3.3 – Investments in highway maintenance vs. total number of crashes

S_x	S_y	r	t
141.6	16275.7	-0.365	-1.038
Insignificant (significant for p=80%)			

TABLE 3.4 – Investments in highway maintenance vs. Virginia MVC cost.

S_x	S_y	r	t
84.7	289.9	0.13	0.26
Insignificant			

TABLE 3.5 – Investments in highway maintenance vs. fatalities among young drivers.

S_x	S_y	r	t
141.6	41.3	-0.63	-2.160
Significant for p=96% Appreciable invert correlation			

TABLE 3.6 – Investments in planning and research vs. total number of crashes.

S_x	S_y	r	t
10.72	16275.7	-0.677	-2.438
Significant for p=97.5% Appreciable invert correlation			

TABLE 3.7 – Investments in planning and research vs. Virginia MVC cost.

S_x	S_y	r	t
11.84	289.9	-0.56	-1.355
Insignificant			

TABLE 3.8 – Investments in planning and research vs. fatalities among young drivers.

S_x	S_y	r	t
10.72	41.34	-0.59	-1.944
Significant for p=95% Appreciable invert correlation			

In the tables, MVC stands for motor vehicle crash cost which is the cost of damage caused by the motor vehicle. The increase of this indicator is highly undesirable, because approximately 9% of damage is compensated at the cost of public revenues (US Department of Transportation, 2010).

From these data we can conclude several points. First of all, investments in the infrastructure are insignificant in the number of crashes or the damage caused by them. However, research and planning pays back appreciably: the more we spend on it, the less crashes happen. As for the impact of these two variables on the fatalities of drivers under 20, both of them are significant, so investments in highways and research can reduce this performance indicator.

Finally, it was very interesting to find out whether the traffic can be reduced by rising gasoline prices. For this, I expected the invert (inverse??)correlation which would mean reduction of registered vehicles (we all know that the prices rarely drop); however, the

correlation was straight (Table 3.9) which means that the traffic is sensitive to the social factors and are dictated rather by the lifestyle, and gas prices must skyrocket to make the drivers become pedestrians.

TABLE 3.9 – Retail gas prices vs. number of registered vehicles

S_x	S_y	r	t
0.704	405267.5	0.923	7.575
Significant for p=99.95% Very high straight correlation			

Strengths of the methodology: The main advantage of the chosen statistical analysis is its simplicity. Making a prediction is also important in this case because it allows with a certain degree of reliability to determine if the target is realistic, and to make this prediction math-based. With the tools like correlation and prediction of the data behavior, it is possible not only to correct our mistakes, but also to discover new connections between phenomena, thus improving performance.

Weaknesses of the methodology: Statistical analysis works best when several different techniques are applied, one checking another, which allows developing a balanced view on the problem. When used separately, these tools can sometimes lead to misinterpretation of the result. For example, trends are only reliable when an appropriate function is used (smooth data is extrapolated by smooth functions, and for non-smooth a non-smooth function is used). When the data is subject to random error, and all the data related to human behavior is exactly like this, the trend doesn't work very well, so the researcher cannot fully rely on the results (Boslaugh & Watters, 2008).

As for correlation, it is a well-known practice when the sample is big, and the bigger the sample the more accurate the result. In this particular case I had to work with the samples of

maximum 12 components, and in some cases even 9 or 6. As long as I was determined to obtain the possibly most reliable result, the value of α I chose was 0.05, which significantly limited the investigation. It is probable that some correlations were significant, but the lack of data prevented them from being taken into account. On the other hand, a relaxed level of consistency can result in appearance of "pseudo-related" parameters.

Finally, it is vital to determine the dependent parameter. . For example, in case of correlation between the growth of population and number of crashes it is clear that the first variable determines the second one, because it is highly unlikely that crashes determine how many people are born in the area. But when it comes to relation between gas prices and number of vehicles, it is much harder to define the dependent. Do people buy more cars despite growing gas prices, or does the gas become more expensive because people purchase more cars? Anyway, the performed analysis allows only for drawing the general picture of the situation, and every particular detail of today's situation on the roads needs to be thoroughly investigated.

Conclusions: After having completed the analysis I can conclude the following:

- VDOT and DMV make a lot of data (including financial) open to public which proves their transparency and genuine concern about transportation safety;
- The best way to analyze the data is regression and correlation. The first allows for making predictions in terms of attainability of the goals, while the second determines the key factors that influence the performance indicators;
- Extrapolation of the statistical data proved that 4 out of 5 goals declared by the SHSP can be achieved, but the alcohol-impaired driving requires more thought-out measures;

- Analysis of the financial aspect showed that it is more beneficial to invest in research and planning than in the roads themselves;
- The results of this study cannot be taken as definitive due to an element of unpredictability introduced by the human factor.

Chapter 4

Results and Discussion

In this chapter I am going to discuss the results of the calculations made in Chapter 3 and explain the figures and trends obtained. Also, I am going to compare them with the prevailing trends in other regions.

After we analyzed the data in Chapter 3 the extrapolation of the statistical data proved that 4 out of 5 goals declared by the SHSP can be achieved.

It appears that the number of severe injuries has been demonstrating an invariable decline during the past 11 years. The reliability of the predicted further decline is rather high; consequently, the planned value is highly likely to be achieved.

Also, for the number of deaths related to transportation among all population groups the forecast revealed that in the forthcoming years we will see a further decline in the number of fatalities, so the SHSP goal is achievable. However, the results of an analysis of the number of alcohol-impaired driving fatalities were quite unexpected, because the polynomial function predicted the rise in the number of drunk-driving victims, which means that the planned performance indicator is unlikely to be achieved.

The analysis conducted revealed the three major road safety related problems in Virginia:

1. Current policy against alcohol-impaired driving is not effective enough to reduce the number of fatalities to the planned level;

2. More money should be invested into research and planning, because such investment has significant impact on the transportation safety;

3. Due to the constant growth of population, and, consequent increase in number of registered vehicles, the Commonwealth needs to implement exclusive long- range safety policies.

4.1 Addressing Problem No.1: Anti-alcohol-impaired-driving Campaigns

Statistics given in Virginia SHSP says that most of the drunk drivers are males between 26 and 35. . With the alcohol level in the blood of 0.08%, the driver is considered as influenced by alcohol. Another reason for being charged with alcohol-impaired driving is the open container with alcohol placed within the driver's reach.

The measures against such dangerous drivers' behaviors are fines, license revocation, imprisonment and forfeiture of the vehicle. Depending on the severity of the offense and on the alcohol level, the fine can vary from $200 to $1000 and above, and the imprisonment can vary from ten days to six months, sometimes more. As we can see, all of them are focused on drivers. However, alcohol retailers contribute to drunk-driving fatalities. Washington State directly addresses this issue, and has managed a considerable drop in alcohol-related crashes.

The main strategy implemented by the State is the Integrated Systems Approach, which implies a multi-disciplinary team working on the solution. According to SHSP, the main focal points of the working group are societal and legal factors. The problem is approached from three perspectives:

- Treatment of offenders;
- Enforcement of laws related to impaired driving;
- Influencing alcohol retailers.

Washington SHSP is particularly focused on increasing the tax on beer in the State.

The connection between the alcohol tax policy and the alcohol-related harms has been studied thoroughly by many sociologists, economists and others since 1970's – 1980's in the works of Bruun et al., Cook and Tauchen, Rachal et al. and others. Depending on the severity of the problem, peculiarities of the economy and legal traditions, different countries used various preventive measures, some of which are given below (Anderson & Baumberg, 2006).

Lowering blood alcohol concentration (BAC) levels: This measure transfers more drivers from "law-abiding" to "offenders". It is widely practiced all around the world and gives positive results. In Australia, for instance, BAC was reduced from 0.8 to 0.5 g/L, and in some countries of the EU BAC now is as low as 0.2 g/L. In the US the 0.2 g/L limit for young and inexperienced drivers is implemented; however, such an approach is to some extent preconceived, especially in respect to inexperienced drivers. It is doubtful that alcohol consumption has to do with driving experience; the rate and severity of alcohol intoxication depends more on the physiological peculiarities of an individual than on the year when they got their driving licenses. So, when it comes to safety, no difference should be made between the drunk drivers, because a car crash can lead to fatalities in any case. Another disadvantage of lowering BAC mentioned in the work is the "wearing-off" of the effectiveness of the measure. The authors explain it by the fact that the drivers get used to the new levels and quickly figure out that the probability of their detection is moderate. In fact, drivers drink to the level that assures their "law-abidance", but still consume alcohol before getting behind the wheel. The "legal" amount of alcohol (0.2 g/L, or 0.02%) is equal to 1 glass of table wine or 1 bottle of beer, and sometimes even these can be too much.

License suspension: This policy seems to be one of the most logical and effective, because today people depend so much on transport that they seem very unlikely to risk their mobility. However, this measure is also criticized. The researchers agree that the period of the "law-abidance" ends shortly after the return of the license, and that neither this measure nor even imprisonment can be characterized as educational. From this we may conclude that license suspension must be accompanied by adequate education programs.

Alcohol lock: This advanced technical measure for preventing people from driving after having consumed alcohol blocks the ignition when it detects high breath alcohol concentration. It was introduced in Sweden some 25 years ago and, as far as it can be seen from the works (Anderson & Baumberg, 2006; Anderson et al., 2009) is mostly used in the EU. The obvious positive aspect of the antilock is that it physically prevents a person from driving, and does not appeal to their feeling of responsibility, which is also alcohol-impaired. A drawback of the antilock is its price. Also, the authors mention that after the devices have been removed, it became obvious that avoiding driving after drinking alcohol did not become a habit.

Education and communications: Responsible drinking can be advertised using various techniques such as public announcements, counter-advertising, social media advertisements, and even moderate drinking guidelines providing information on how alcohol influences the organism. Education courses at school are held mostly for the teenagers just soon after they receive driving licenses. The effectiveness of these policies, however, strongly depends on the personality of the driver, their social background, etc. Being introduced in the form of information, statistics, advice and slogans, they leave the ultimate decision to be made by the driver.

Alcohol price and taxation: It cannot be denied that money is still the most powerful driver behind human behavior and the strongest motivator. The economic Law of Demand says that the more popular products become more expensive. However, the price can only increase to the certain threshold value, and when it is exceeded, the consumers finds it more beneficial not to use this product. In other words, by increasing the excise tax, the government can regulate the drinking habits in the country.

The tax is usually increased with respect to the elasticity of alcohol prices, which means the response we get from the increase (percentage of reduction in consumption). If the goal is to raise the revenue, then the inelastic items are affected. In case of impaired driving, the government pursues the behavior altering goal, for which the elastic alcohol beverages must be made more expensive (ICAP Report, 2006). The aforementioned Report operates the data obtained in 2004 by World Health Organization, according to which most of the highway incidents with fatalities happen due to the beer consumption by the driver, and this beverage must be the first one to be extra-taxed. The effectiveness of such policy can be illustrated by the research on the changes in drinking habits in connection with prices by Heeb et al (2003), Coate& Grossman (1988), and Chaloupka et al. (2002), and they can be summarized as follows:

1) Increased alcohol prices significantly reduce consumption among heavy drinkers and adolescents;
2) Increased alcohol prices reduce severity of intoxications;
3) The severity of motor-vehicle injuries reduced by 11 – 31%;
4) The number of drink drivers aged 18 and younger reduced by 1/3.

This policy was recently realized through Healthy People 2010 Agenda (Elder, et al., 2010), which, among other things, is targeted at reducing motor-vehicle fatalities. Fig. 4.1 shows

the concept of the policy (red block presents an intervention, green boxes describe intermediate outcome, and blue boxes present the health outcome).

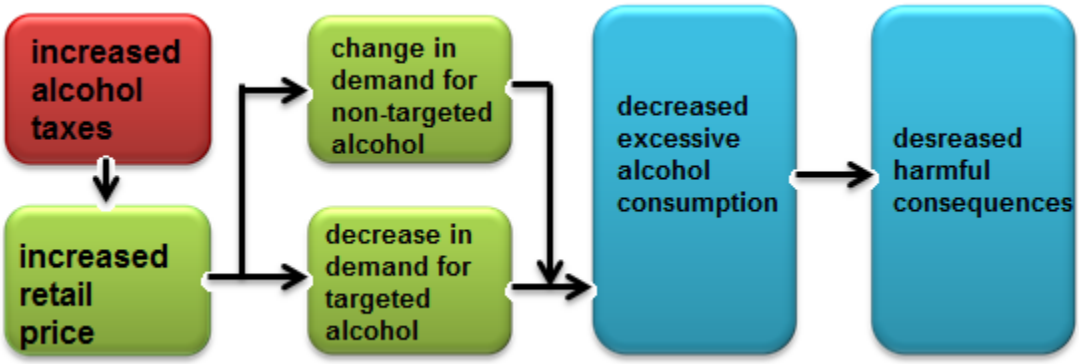


FIG. 4.1 – Excise Tax Policy Concept*

*From *Anderson, P., Chisholm, D., &Fuhr, D. C. (2009). Effectiveness and cost-effectiveness of policies and programmers to reduce the harm caused by alcohol. Lancet; 373: 2234 – 2246*

However, rising prices due to inflation, reduces the impact of higher taxes on alcohol, and thus the preventive function. Furthermore excise taxes are not often reviewed, so with time they are eroded by the inflation, which is illustrated by Table 4.1.

TABLE 4.1 – Alcohol Excise Tax Erosion*

	Average tax, 1966 ($ per gallon)	Average tax, 2001 ($ per gallon)	Median tax, 2001 ($ per gallon)	Current tax (in 1996 dollars)	Factual difference in tax between 1966 and 2001
Beer	0.12	0.24	0.19	0.05	-58%
Wine	0.37	0.74	0.60	0.14	-62%
Distilled Spirits	2.04	3.62	3.30	0.68	-67%

*Based on data presented by *Community Anti-Drug Coalitions of America*

From the data presented in the Table we can observe "wear-off" of the policy. Erosion differs among the States (FIG. 4.2). For Virginia it is between 50 and 75%, and for Washington

State it is zero (!), which perfectly illustrates the success of policies presented in the Target Zero Safety Plan.

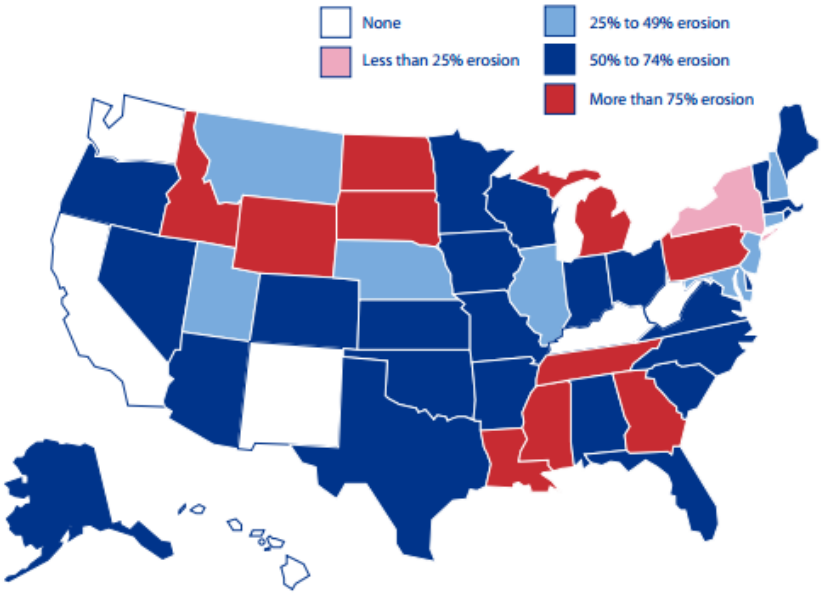


FIG. 4.2 – Excise Tax Erosion, 1968 – 2000*

*Data presented by *University of Minnesota, 2000*

According to the Federation of Tax Administrators, the excise tax in Virginia has been the same for at least 15 years. The tax rate per gallon of beer here is $0.26, while, for example, in Mississippi it is $0.426, in North Dakota – $0.617, and in Tennessee $1.15. Though the excise beer tax in Virginia is not the lowest across the US (in Wyoming they pay just $0.02 per gallon), it definitely needs revision.

4.2 Addressing Problem No.2: Importance of Research and Planning

It is impossible to overestimate the role of research and planning in transportation safety. All the data, based on which the decisions regarding transportation policy are made, is obtained through research. However, research in highway safety is not limited only to statistics and trends. Today, it is multidisciplinary (including medicine, engineering, probabilistic analysis etc.), and

even more important, is neither passive nor *a posteriori*, but aimed at making highly-precise predictions and structuring knowledge. The structure of the research team for the highway safety in the US looks as it is shown in the FIG. 4.3.

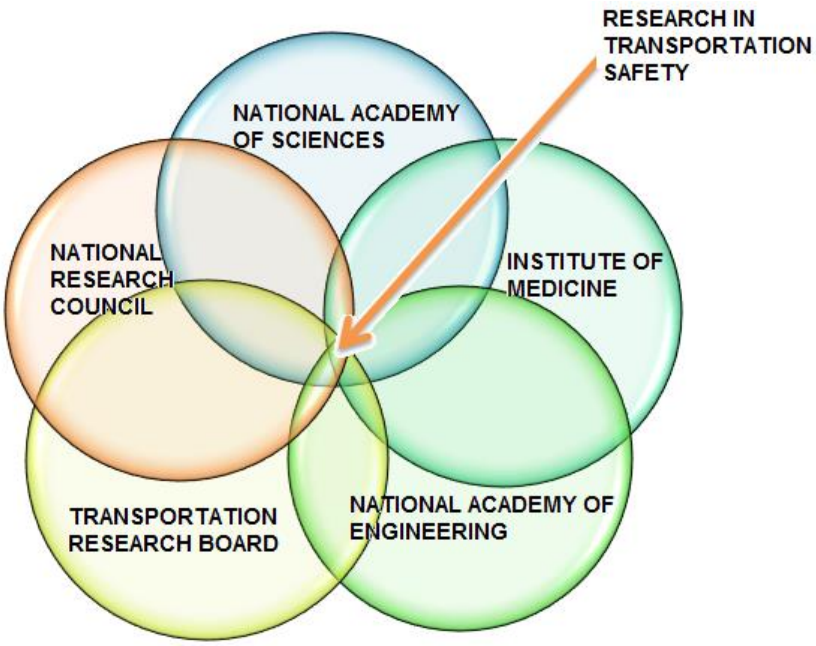


FIG. 4.3 – Contributors to Research in Highway Safety*

*Based on material presented in*TransportationResearchBoardSpecialReport 292, 2008*

The Report presents an unexpected view on the highway safety problems. It has always been widely believed that individual safety culture, or safety wisdom, is the determinant of low motor-vehicle-related fatalities and injuries. Today, however, technologies, vehicles and even drivers themselves change so rapidly, that it appears that the highway is becoming a medium where one cannot rely only on his own decisions, experience and caution. It is obvious that the driver depends on the state of the highway, the weather and on other drivers, and only research and planning can take into account all these factors. The main tasks of research and planning are the following:

1. Providing maximal description of current state of transportation safety and establishing connections between all its elements;
2. Update of information, analysis, making reliable predictions and setting feasible goals (in the form of Strategic Highway Safety Plans);
3. Identifying lessons learned and sharing best practices;
4. Cost saving by reducing MVC cost and optimal allocation of resources;
5. Reducing the number of injuries and fatalities.

The research is organized in several stages, the first of which is identifying the key issues to be addressed. Notably, this stage is based on the results of preliminary research. The next stage is finding out the areas in which the problems overlap. This is rather important, because by solving one problem the research border can improve situations in several areas. Next, after having analyzed all the available resources, researchers choose the most effective ways of data gathering. Processed data is transformed into a strategy. However, researchers face many difficulties today, most connected with changing technologies. First of all, the areas of research are challenging and more advanced, and the analysis is becoming more complicated and multipara meter. Forming a good team is also a problem for the same reason.

In this work I would like to discuss the problem of prioritizing areas of research more in detail. The Government Accountability Office issued a highway research report that specifically discusses the important, but under budgeted research areas, from which the acuteness of the problem becomes obvious. According to the report, in 2003 the technical coordinating committees on highway safety research identified 106 (!) possible research projects, 56 of which were considered necessary. The rest were eliminated. The 56 projects were reviewed so that only

the “vital” research on each remained... However, even such “surgery” was not enough to fit the projects in the budget, and 4 were left without funding.

To be funded, each project must address at least 1 of the 4 goals:

- Safety: aimed at improving drivers’ performance;
- Renewal: using technologies that allow production of durable facilities and establishment of long-term programs;
- Reliability: minimization of the negative impact of unpredictable factors;
- Capacity: addressing the problem with respect to the tendency to population (and number of vehicles) growth.

According to GAO, 10,248, interim co- funding, the preferences of Department of Transportation, are distributed among the projects as shown in FIG. 4.4 (as of 2003).

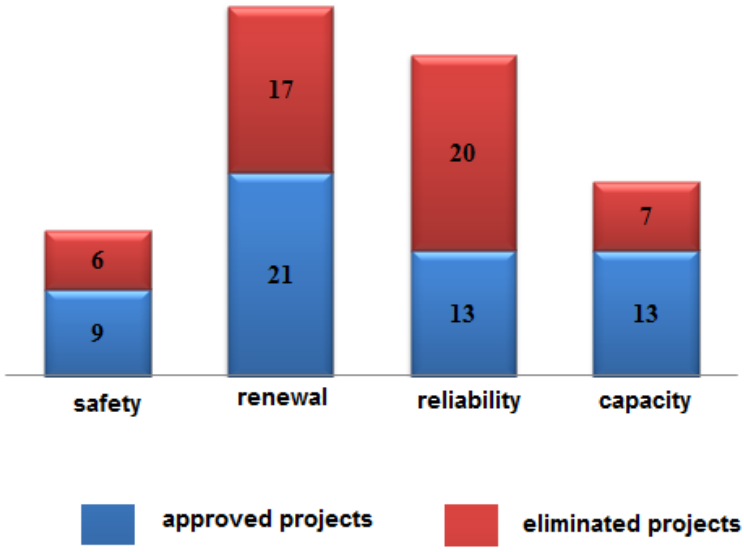
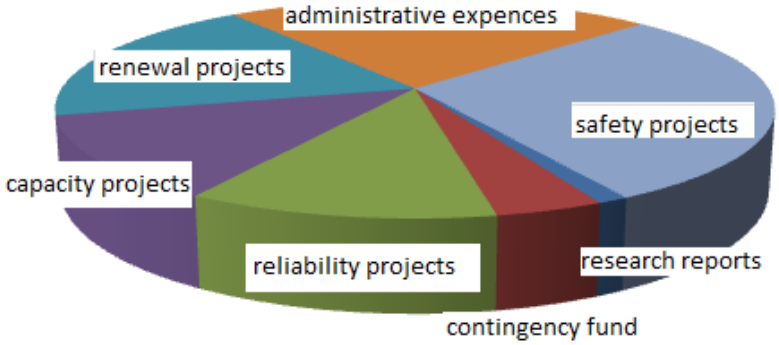


FIG. 4.4 – Approved and Eliminated projects in Different Research Areas

As we can see from the diagram, the least attention is paid to the projects mostly concentrated on safety issues, which is a big disadvantage for the Department of Transportation.

Also, the area where most projects were rejected is Reliability. Generally, we can notice reluctance to implement the project of non-engineering research; this, however, can be explained by high cost of their implementation (FIG. 4.5).



Expenses (see chart)

FIG. 4.5 – Allocation of Funding

A significant sum of money is spent annually for administrative purposes, and everything possible should be done to minimize this sum. Finally, the last drawback of research funding is under budgeting. According to GAO-10-248, as of December 2009, the projects were funded at the level of 27% of the recommended level.

4.3 AddressingProblem No.3: Increasing Highway Capacity In View of Population Growth

In 2007 in Virginia comprehensive research resulted in a document containing socioeconomic and travel demand forecasts for the Commonwealth until2035.

The data was obtained using almost the same methods used for checking the feasibility of the programs ,but for the larger samples. Then, the results were extrapolated for each part of the

Commonwealth, and with an appreciable uncertainty, we may expect the following changes in Virginia during the next 20 years:

1. Stable and significant increase of population to 10.3 million (compared to 8.2 million today). The maximal prediction is 11 million people;
2. Stable and significant (by 48%) increase in salaries, which means that the cars will become more affordable;
3. If the same pace of highways construction is kept as between 1984 and 2007, this will not be enough to meet the needs of growing population;
4. Affordability of travelling will increase.

Although at first glance these forecasts seem to bring significant benefits for the population (for example, reduction of bus fares, availability of remote places etc.), they will also form the four most important problems that Virginia will have to address in the nearest future. First, the excessive number of vehicles on the roads will result in significant increase inCO_2 emissions, which will demand an adequate response in the form of limitations of transit through highly-urbanized areas so as to decrease the density of transport. Secondly, increase of life quality will change the structure of the "driving" population, in that more mature drivers will appear on the highways who will automatically become potential victims due to more complicated highway conditions and capabilities of their age. This issue will need a sophisticated approach, maybe in the form of refresher courses for older drivers. Next, construction of the new highways will need land, most probably taken from the agricultural or recreation sectors, which may impair Virginia's ecology and economy. Finally, a big problem is the expected higher speed of the vehicles to minimize road congestions.

With respect to the problems that I pointed out, I assume that in the next 20 years Virginia's Department of Transportation will need to improve the structure of SHSP so as to make its implementation more effective. In terms of designing policies, the Department will face challenging tasks and will have to switch from merely "human-oriented" problems (alcohol-impaired driving etc.) to more global interdisciplinary issues.

Having summed up all the results of my research, I can make the following conclusions.

1. Based on the statistical predictions, I can assume that Virginia SHSP will be unable to meet the goal of reducing the number of fatalities connected with alcohol-impaired driving, which means that current measures (fines, license revocations etc.) are ineffective. The research discovered that this trend is common for many regions. A good solution to the problem could be implementation of the alcohol locks, but this will mean a massive equipping campaign which is not only expensive, but also has no educational aspect. As the best solution to this problem, I see the increase of the
2. Alcohol excise taxes. Research has shown that during the past 40 years the tax has decreased approximately by half. Although high retail alcohol prices are unlikely to influence drinking habits of moderate alcohol consumers, they will sufficiently limit the opportunity for teenagers to buy alcohol which may have positive effects on the highway safety.
3. When coupled with the analysis of the official reports, my calculations of the correlation between investments in research and number of injuries prove the thesis that this is one of the most effective ways to improve transportation safety. However, as noted above, the allocation of the research and planning budget is problematic. Nearly half of the projects are rejected and the rest are realized in the shortened mode

due to the excessive administration costs. This means that the structure of the system must be re-considered so that the funding becomes more targeted.

4. However bright and optimistic predictions about population growth and the rapid infrastructure development in Virginia may be, they are associated with high risks for the economy, environment and population. Significant increase in the number of vehicles means that the transportation safety is under threat. The insufficient highway safety culture will impede the development of the infrastructure, and taking into account that the growth of population is irreversible, Virginia risks facing the collapse of the transportation system. Only well-thought technical, legal and educational policies can lead to harmonious development of the safe and effective transportation system.

Chapter 5

Conclusions

Having analyzed the transportation safety programs developed by Virginia Department of Transportation, I can conclude the following. First, the priorities of the Commonwealth with respect to highway safety are congruent with the State's general goals, which are clearly stated in the Strategic Highway Safety Plan. When compared to other States and to the US average indices, the rate of Virginia's progress in achieving high level of safety can be described as outstanding.

The central aim of all the programs we have investigated has been to establish safe-travel conditions in Virginia. They embrace the full range of existing highway problems – impaired driving, mature driving, crashes involving drivers under 20, and usage of safety belts. Each of these issues include others minor issues. For example, impaired driving includes aggressive driving, and drinking and driving issues. Aggressive driving is becoming a growing issue in Virginia. This term refers to egregious violations of road rules ; the driver who speeds, weaves in and out of traffic, not using turn signal at the same time, and may use "hand gestures" that are less than polite.

Virginia DOT has also developed various guides for "proper" drivers in order to protect them from aggressive ones. Thus, they propose to always make sure that all the passengers in the vehicle are buckled up. According to the experts, it is the best defense against an aggressive driver. Also they advise to not engage the other driver, and not react to provocation, to avoid eye

contact, nor make any gestures to further aggravate the situation. Safe drivers should do their best to get away from the aggressive driver safety, and call local law enforcement or dial #77 on the interstate to report the behavior to the state police, providing, location, direction of travel, and the license plate number. In a case of been followed, it is useful to drive to a police station or to a busy public place. They advise never driving home or getting out of the car during an incident. If an aggressive driver is involved in a crash farther down the road, it is useful to stop a safe distance from the crash scene, waiting for the police arrive, and reporting the witnessed driving behavior. This advice, when followed, has helped people handle challenges on the highways and consequently the number of casualties and crashes resulting from aggressive driving decreased.

While addressing issues of alcohol-impaired driving, DoT focuses on responsibility. In order to decrease the incidents of alcohol-related crashes they enacted some of the toughest driving under the Influence laws in the country. What is more, the Virginia Highway Safety Office and Law Enforcement aim to continue to spearhead programs in order to take drivers under the influence off the road. For instance, they designed a multi-state program to hold Driving under the Influence checkpoints every week. The program is meant to motivate drivers not to take in alcohol, because it can have inevitable outcomes.

The DMV has published information on alcohol consumption. “Blood alcohol content (BAC) is the amount of alcohol in a persons’ body as measured by the weight of the alcohol in a certain volume of blood. Alcohol is absorbed directly through the walls of the stomach and the small intestine. It goes into the blood stream, traveling throughout the body and to the brain. Alcohol is a quickly absorbed and can be measured within 30 to 70 minutes after a person has had a drink.” This information is publicized to inform drivers about the quick effect of alcohol

consumption. . As little as one drink on an empty stomach can impair the ability to drive safely. What is more, a driver with a BAC of 0.15 is over 300 times more likely to be involved in a fatal crash. Due to such restrictions and high fines or even loss of license, they managed to reduce drunk driving. (You should eliminate the following material)

But as my research shows, currently implemented measures against drunk driving are not enough to reduce the number of crashes. Taking into consideration the coherence and adequacy of Virginia SHAP we may conclude that the Commonwealth is now at the stage when more coordination of DoT and government is needed. Drinking must be limited by other measures like tax rate increase, as done in some other States.

Also, the priorities in funding projects should be changed. According to the statistical analysis performed in this work, I can assume that the more effective way to make highways safer is to invest more in research – gathering statistical data, calculations on safety assessment, search for new technologies and engineering designs etc. These investments are capable of changing the fundamentals of transportation safety and are thus long-term.

Finally, its comparatively safe highways create favorable conditions for encouraging drivers to use their vehicles more often. Any improvement of the system at the end can lead to its overloading and collapse. That is why we consider it vital for the Commonwealth to re-consider their long-term strategies and to re-assess the possible threats. In the nearest future transportation will change its structure, and its impact will be more tangible as it will affect economy, urban and natural systems.

However, the predictions made in this research for the Commonwealth are largely optimistic. We are convinced that Virginia will continue the transport safety policy programs and

planning, and in the future the Commonwealth will obtain more benefits, inspiring other regions to adopt Virginia's as best-practices.

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