BENEFIT-COST ASSESSMENT OF THE COMMERCIAL VEHICLE INFORMATION SYSTEMS AND NETWORKS (CVISN) IN MARYLAND

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16. Abstract

This objective of this study is to answer questions regarding the net benefits of CVISN deployment by the State of Maryland. The hypothesis is that the net benefits of CVISN deployment are positive and large but vary among system components and between the state and the motor carrier industry. The methodology consists of both quantitative and qualitative analyses of the benefits and costs of the CVISN project. Costs and benefits are discounted to a present value over the economic life of the project. Two alternatives are the basis of comparative analysis: CVISN deployment of an agreed-upon configuration and preservation of the status quo.

The study offers a comprehensive analysis of the benefits accrued and costs incurred for CVISN-related activities to Maryland state regulatory agencies and commercial motor carriers. The benefits and costs are assessed with regard to both agency and carrier interests, and the impact of CVISN on credential processing and safety enforcement is explored in detail. The quantitative analysis is conducted in terms of Benefit/Cost Ratios and Net Present Values (NPV). In addition, qualitative analysis is offered for the following areas in which the benefits and costs of CVISN cannot be assigned dollar values: cost reduction benefit, societal benefit, increase in revenue benefit, and economic benefits to Maryland.

The benefit/cost analysis attests to the economic feasibility of the CVISN project. The B/C ratios range from 3.28 to 4.68 for the worst and best case estimates for the benefits modeled. The NPVs range from $76 million to $123 million. For agencies and carriers, the worst case B/C ratios are 1.45 and 6.67, respectively. Due to the competitive nature of the commercial vehicle industry, the benefits accrued by carriers will be passed on to receivers, shippers, and, eventually, the consumers and citizens of Maryland.

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Benefit-Cost Assessment of CVISN in Maryland

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BENEFIT-COST ASSESSMENT OF CVISN IN MARYLAND

1.0. INTRODUCTION

The Commercial Vehicle Information Systems and Networks program (CVISN) is an integration of information systems and networks designed to enhance motor carrier and roadway safety and improve the performance of commercial vehicle operations and state regulation. CVISN includes information systems owned and operated by governments, carriers and other stakeholders. Maryland and Virginia are the two CVISN prototype states designated by the federal government. Also, eight pilot states were selected to implement CVISN. The purpose of the prototype/pilot program is to demonstrate the operational feasibility, efficiency and effectiveness of CVISN concepts and systems.

The CVISN Baseline Study of Processes, a study previously conducted by Morgan State University's National Transportation Center, provided the current or "baseline" condition for the State of Maryland's interaction with and regulation of the motor carrier industry. The study also implied that significant benefits from CVISN deployment would result. The benefits of CVISN would consist of decreased numbers of unsafe carriers and drivers, increased revenues and decreased costs for the state, and increased efficiency for carriers. However, it is unclear whether the benefits of CVISN would outweigh the costs of deploying such a system and is not quite clear what the distribution of those benefits would be. For example, a study of Intelligent Transportation Systems/Commercial Vehicle Operations (ITS/CVO) for the National Governors' Association found that benefits do not exceed costs for roadside management systems, while in most cases they do for electronic credential processing systems (Rubel, 1998). It should be noted that this study acknowledged its limited scope in analyzing *states' fiscal impacts only* and did not take into account safety benefits and benefits to carriers. A true benefit-cost or economic analysis of a capital project determines the net benefits to all of society, not just the fiscal impacts to the one making the investment.

This study titled "Benefit-Cost Assessment of CVISN in Maryland" attempts to answer the questions regarding the net benefits of CVISN deployment by the state. The hypothesis is as follows: the net benefits of CVISN deployment are positive and large, but vary among system components and between the state and motor carrier industry. The study team, consisting of Morgan State University faculty and student assistants, conducted a comprehensive evaluation using accepted methodology in determining the validity of this hypothesis.

The rest of the document is organized as shown in the table of contents. Three separate safety benefits are modeled: a) due to identifying high-risk carries, b) due to weighing more vehicles, and c) due to pre-clearing vehicles at weigh facilities. Each of these two benefits is described in a separate section. Results of three benefit/cost sensitivity analyses are shown in Appendix A, B, and C. Appendix A shows the benefit/cost results of CVISN, assuming that the weigh-in-motion costs are sunk. In other words, CVISN is analyzed "in isolation" from the weigh-in-motion investment decision, initially a decision that was made independent of CVISN deployment. Results based on sensitivity analysis of two assumptions related to transponders are shown in Appendix B and C. Appendix B describes the benefit/cost results for a transponder acceptance of at most 50% for commercial vehicles that travel routes with weigh and inspection facilities, a level that assumes hesitancy on the part of the motor carrier industry to participate in CVISN. Appendix C describes the benefit-cost results when the transponder cost is assumed to be $100 and $250 instead of the consensus market price of $45. This analysis encompasses any other reasonable costs of transponder utilization or change in market conditions.

2.0. BENEFIT-COST ANALYSIS METHODOLOGY

The methodology consists of quantitative and qualitative analyses of the benefits and costs of the CVISN project. Traditional quantitative analyses of benefits and costs for transportation projects compare the time and cost savings to users and operators of a project with the investment and maintenance costs. Typically, several alternatives are compared. Costs and benefits are discounted to a present value over the economic life of the project. For this project, there are essentially two alternatives, a CVISN deployment of an agreed-upon configuration compared with the status quo.

The study team's survey data on savings in costs and time for the motor carrier industry and state agencies, will be utilized to calculate the benefits. The team will also quantify the safety benefits from CVISN enhanced weigh-in-motion (WIM) and motor carrier inspection using data modeled in other studies (e.g., Moses and Savage, 1997) and apply them to the baseline data. As such, the study is in synchronization with Battelle's (1997) recommendations for B/C analysis for CVISN. Costs consist of CVISN investment, maintenance and operating costs to the state. In addition, costs to the motor carrier industry for system components, e.g., transponders, and computers for CVISN derived credential processing activities and safety compliance activities are added to the list (see detailed listing below). All benefits and costs are reported in 1998 dollars.

Costs of CVISN	Benefits of CVISN
State CVISN investment costs ($)	Savings in agency time
(computer network and new inspection facilities)	Savings in agency costs ($)
State maintenance and operating costs ($)	Savings in motor carrier operating time ($)
Motor carrier CVISN component costs ($)	Savings in motor carrier operating costs ($)
(transponders, computers and software)	Net safety benefits (CVISN enhanced road-side inspection for out-of-service placement and identifying overweight vehicles) ($)

Costs are assumed to occur at the beginning of the year and benefits at the end. The investment costs to the state will consist of weighing facilities costs and computer network costs attributed to deploying CVISN. These costs will occur in year 0, the beginning of the economic life. The total CVISN project is assumed to have an economic life of 10 years because that is an appropriate time period for such a technology-based project. However, certain components of the CVISN project have fewer years of "life" while others have more. The work stations portion of the network is assumed to have an economic life of 5 years. Thus, there will be a computer network reinvestment at the end of year 5. There will be reinvestments in other computers in years 3 and 8. That portion of the CVISN project consisting of road segments and structures for roadside inspections and WIM actually has an economic life of 20 years. As a result, the road segments and structures will have a salvage value of 50 percent of initial investment at the end of year 10. There will be operating and maintenance costs starting in year 0 and ending in year 9, projected to be 10 percent per year. Annual benefits will start in year 1 and end in year 10.

Several adjustments have to be made to the estimated annual benefits and to some of the motor carrier costs. According to the study for the National Governors' Association, the magnitude of benefits associated with ITS/CVO systems, such as CVISN, will be proportional to motor carrier participation. The study also points out that participation in CVO will lag behind deployment of these systems. The relationship between deployment and motor carrier participation is assumed to be an exponential one; that is, the participation increases at very low rates in the early years and at extremely high rates in the later years of the system's economic life, a ten year period. This relationship assumes that at first, few carriers participate, but as the advantages of CVO become apparent to the industry, the rate of participation dramatically increases up to the very end. The effect of this assumption is that the benefits will be small in the early years and quite large in the latter years of the system's economic life.

The study team believes that this relationship is a sigmoid or s-curve, rather than an exponential relationship. According to long-standing geography and marketing literature, the diffusion or acceptance of a technological innovation throughout geographic space displays an s-curve plot between the percentage of acceptance and time. In other words, the rate of participation in CVISN would increase slowly at first, increase dramatically in the middle years as CVISN technology "catches on", and level off in the later years, as few remaining carriers accept the technology. This assumption is particularly appropriate in light of the survey data and the fact that the magnitudes of benefits and costs are based on the number of trucks and buses in the motor carrier fleet. The industry consists of few large firms with large motor carrier fleets and a large number of small firms with small fleets. Given that large firms already use some CVO technology, they all would likely participate in CVISN by the middle years, accepting the technology for their large fleets. Small firms would also contribute to this rapid growth in the middle years, but would probably lag the large firms. The remaining small firms would participate in CVISN in the later years, resulting in a slowing in the rate of participation.

The assumption of an s-curve relationship means significant benefits of the system will occur early in the economic life. The team's technology acceptance curve model, based on the perception of benefits to users, appears similar to the sigmoid curve, except for the fact that several very large carriers already own computers. These carriers would most likely immediately accept the technology. This factor would accelerate the acceptance of technology in the very first year. This acceptance of technology would keep on increasing dramatically until the end of the middle years.

The study team will use the standard OMB real rate of 7 % (excluding inflation) for discounting the benefits and costs. Since a real discount rate is used, the benefits and costs are not adjusted for inflation. The measures of economic worth for this study are the Net Present Value (NPV) and the Benefit/Cost (B/C) ratio. NPV, essentially a measure of net benefits, is the most accepted measure by economic analysts, while B/C ratio is the one most widely recognized and understood by the public. A positive NPV and a B/C ratio greater than one indicate that an investment is economically worthwhile, because benefits exceed the costs.

Benefit-cost analyses often have a distribution of costs and benefits assessment included in them. For the CVISN project analyses, the team will determine the economic measures for electronic credential processing activities and the WIM/roadside inspection components of CVISN. In addition, the distribution of benefits and costs between the state and motor carrier industry will be shown.

Qualitative analyses are usually a verbal accounting of any "costs and benefits" for which dollar values can not be assigned. Examples are the environmental and social impacts of a project. For this project the team will discuss those impacts as well as safety implications that can not be readily quantified.

The study team assumes that the annual increase in motor carrier traffic on Maryland roads will be 3 %, reflecting the recent historic increases per year. This assumption is also consistent with the projected increase in motor carrier fleet sizes derived from the study team's industry surveys. Enhanced inspection will yield increased revenue in the early years but will then deter safety infractions.

Because the CVISN project has so many unique and undefined aspects to it and similar systems with proven "track records" do not exist elsewhere, it is necessary to make various assumptions as to the values of time and cost savings and system costs, the rate of acceptance of technologies by carriers, the percentages of unsafe motor carriers affected, and the safety benefits attributed to it. In light of such uncertainty, a sensitivity analysis of results will be done, involving ranges of benefit and cost values and discount rates, in order to see how sensitive the results are to the assumptions underlying them. There is an extensive literature review of studies on ITS/CVO that have already been done for the National Governors' Association, Federal Highway Administration Office of Motor Carriers, American Trucking Associations Foundation (ATA Foundation), USDOT and ITS America. These studies provide the context for the benefit-cost evaluation as well as the basis for the qualitative portion of the study.

3.0. LITERATURE REVIEW

There has been a significant amount of research concerning the topic of ITS benefits and costs. Since CVO was assumed to be one of the first deployments of ITS, there is a body of literature on studies of its net benefits. For example, ITS America, the premier public/private partnership supporting ITS deployment, sponsored a study of the costs and benefits of public sector investments in CVO and other ITS technologies. The overall B/C ratio for CVO was 2.1 (Sen, 1998). Yet, there is wide variation in the scope and rigor of such studies, primarily because of data limitations (few CVO projects have been in operation) and because the objectives, stakeholders, and audiences for the studies differ.

The study for the National Governors' Association consisted of a comparison of eight states' CVO deployment. Electronic credential processing systems for seven states had savings to investment ratios greater than one - some many times greater (Rubel, 1998). For roadside management systems, the ratios were all well below one, implying that such systems are not worth the investment. The large investment costs of roadside management systems are a major cause of these results. However, as stated earlier, this study limited its analysis to state agency savings compared to state expenditures and did not consider safety benefits or benefits to motor carriers. The study also pointed out that the benefits are highly dependent on the level of carrier participation and that participation lags deployment. As participation increases, the savings to investment ratio can be expected to increase.

Safety benefits should be counted in an evaluation of CVO, because such technologies can reduce the private and societal costs of accidents. The benefits from programs that regulate motor carrier safety appear to be substantial. A study by Northwestern University of the Office of Motor Carriers' programs safety benefits focused on roadside inspections and compliance reviews (Moses and Savage, 1997). This study calculated the full annual benefits and costs of the two programs in 1992 dollars. According to the authors, the reviews program generated $1 billion in net benefits or a B/C ratio over 4. A sensitivity analysis calculated a range in B/C from 3.4 to 5.5. Conversely, under the most favorable assumptions, the inspection program B/C ratios range from .87 to 1.26. The net benefits may thus be slightly negative to slightly positive. The authors conclude that the compliance reviews program is a low-cost, highly efficient program and that federal resources should be reallocated from roadside inspections to compliance reviews. The roadside inspections program is a high-cost program for both government and motor carriers. The authors state that "serious questions can be raised as to whether the roadside inspection program makes a positive contribution to society at all." They do concede that “new technologies” could shorten inspections and allow inspectors to concentrate activities on carriers with poor safety performance.

A more recent study of the Office of Motor Carrier programs seems to confirm the findings of Moses and Savage, but the methodologies and calculated values differ (Sienicki, 1998). Two models were developed to analyze the inspections and compliance review programs, and they calculated safety benefits only. The research team estimated total 1996 benefits from roadside inspections of $86 million in crashes avoided, while the compliance reviews generated $580 million in benefits from crashes avoided. These results imply that safety roadside inspections again generate small benefits.

One may conclude from these results that enhancing compliance reviews through ITS/CVO should result in tremendous benefits to society, since the net benefits of the program are so large that incremental investments in it would continue to generate large incremental returns. The inspections program is another matter. Moses and Savage wonder if the program makes any positive contribution. However, it should be understood that at least the infrastructure costs of roadside inspections are “sunk”; that is, they are no longer a consideration in any future investment decision. Only the costs of ITS/CVO enhancements to roadside inspections should be compared to the benefits attributed to the enhancements and could suntil result in significant time savings and safety benefits to an existing program. For example, a Colorado study of electronic clearance technologies at weigh and inspection stations yielded a b/c ratio of 10.0 for motor carriers (Booz-Allen & Hamilton, 1994).

A study sponsored by the ATA Foundation undertook an extensive benefit/cost analysis of CVO from the point of view of compliance cost to motor carriers (ATA Foundation, 1996; Mitretek, 1996). The study limited its scope of evaluation to costs and benefits to the motor carrier industry only. For purposes of the study the motor carrier industry was grouped into small (1-10 power units), medium (11-99 power units) and large (100+ power units) firms. The B/C ratios generally increased from small to large firms. The ratios for commercial vehicle administrative processes ranged from 1.0 to 19.8, electronic screening from 1.9 to 6.5, and automated roadside safety inspection from 1.3 to 1.4.

All of these results imply that the net benefits of ITS/CVO may indeed be large, and it may be safe to conclude that CVISN deployment by the State of Maryland is economically worthwhile. Yet, none of the studies in the literature evaluates comprehensively the costs and benefits of CVO, and certainly none is specific to the case of deploying CVISN in Maryland.

4.0. DISCUSSION AND REVIEW

This study is a comprehensive study of the benefits accrued and costs incurred for CVISN-related activities to Maryland state regulatory agencies and commercial motor carriers. First, the overall cost and benefit of credential processing and safety enforcement to all CVISN participants is presented in Section 4.1. An in-depth analysis of the costs and benefits to CVISN stakeholders (Maryland State regulatory agencies and commercial motor carriers) and in terms of CVISN-related activities (credential processing and safety enforcement) are presented next. The purpose of these analyses is to identify the major beneficiaries for the CVISN project and differentiate the impact of CVISN on the two activities of credential processing and safety enforcement. Sections 4.2 and 4.3 present the benefit/cost analysis for the activity of credential processing and safety, respectively. Sections 4.4 and 4.5 present the benefit/cost analysis for the Maryland agency and the motor carrier stakeholders, respectively.

The results clearly show that CVISN project has merit for credential processing as well as for safety enforcement activities. Moreover, the Benefit/Cost (B/C) ratios are positive for the state of Maryland as well as for the carriers.

4.1. CVISN Overall Benefit-Cost Analysis

The B/C ratios and the NPVs for the CVISN project are shown in Table 4.1(A). The table includes benefits and costs to Maryland regulatory agencies and carriers. This analysis includes benefits and costs for credential processing and safety enforcement activities. For the discount rate of 7%, the B/C ratios of CVISN range from 3.28 to 4.68. The corresponding NPVs range from approximately $76 million to $123 million. All NPVs are expressed in terms of 1998 dollars. The table also shows the B/C ratios and the NPVs for 6% and 8% discount rates. At these discount rates, the B/C ratio varies from 3.38 to 3.17 at the low end.

The key assumptions used by the Benefit/Cost Analysis are as follows:

- System will be completely operational at the beginning of Year 2001.
- All benefits are accrued starting with the Year 2001.
- Starting in the Year 2000, state regulatory agencies will start incurring costs by making capital and other investments in different CVISN-related technologies.
- Carriers will start incurring costs as they begin to participate in the program from the Year 2001. The rate at which carriers will participate is based on a Growth model. This model is grounded on the motor carriers' perceptions and beliefs about the value of such technologies to them. These beliefs are

based on an extensive and comprehensive survey of Maryland-based carriers conducted by The National Transportation Center at Morgan State University.
- All benefits to society are attributed to the state of Maryland and hence to the regulatory agencies who make the investment decision. The major benefit of CVISN to society is a reduction in accidents, leading to a reduction in fatalities, injuries, property damage, and delays to other traffic.

Table 4.1(A). The Low and High Benefit/Cost Ratio (B/C) and the Net Present Value (NPV) for the Overall CVISN Project at Different Discount Rates

DISCOUNT RATE		6%	7%	8%
Low	B/C	3.38	3.28	3.17
	NPV	$83,231,468	$76,040,108	$69,524,005
High	B/C	4.83	4.68	4.53
	NPV	$133,901,031	$122,900,418	$112,917,657

As shown in the above table, the benefits of CVISN far outweigh the costs of deploying such a system. It should be noted that these numbers are based on conservative estimates. Similarly, the growth rate assumed by the model is also conservative. If more carriers initially participate than what has been assumed in the study, then the benefits and the NPV will also increase. For more carriers to participate, motor carriers need to be educated and made aware of the significant benefits of this program. These benefits are described in Section 4.5.

The study has captured the following benefits:

- benefits to carriers and related state agencies due to automated credential processing.
- time-saving benefits to motor carriers due to WIM and pre-clearance of legal and safe vehicles and drivers.
- benefits to society due to identification of potential high-risk carriers through inspection activities. It is assumed that CVISN will identify all vehicles equipped with a transponder.
- benefits to society due to identifying all illegally overweight carriers who otherwise may have caused accidents.

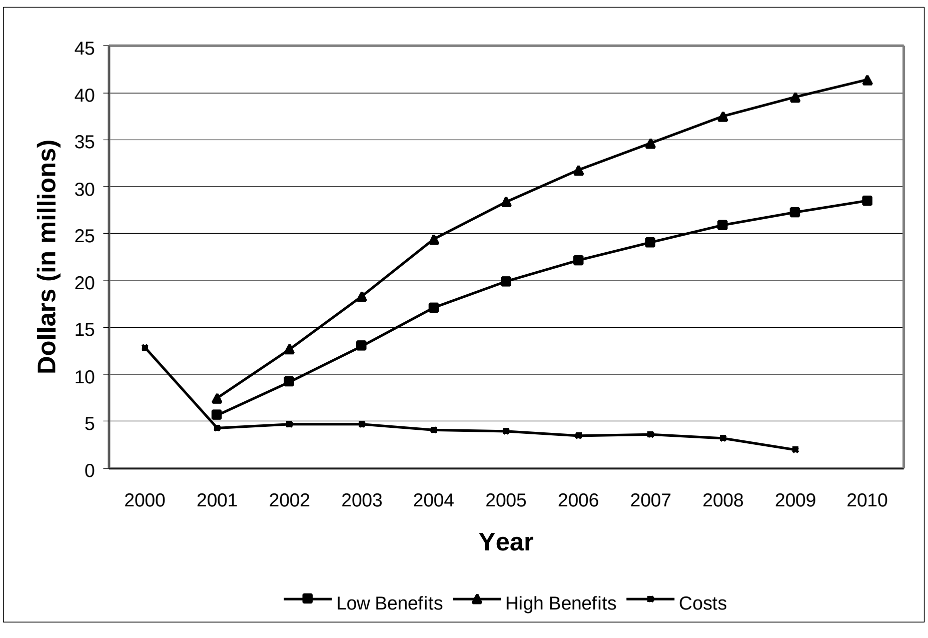
There are several additional benefits that have not been captured:

- fiscal benefits to state safety agencies due to automated identification of high-risk vehicles and/or drivers, and pre-clearance of commercial vehicles.
- increased IRP and IFTA revenues due to increased monitoring of carrier activities.
- benefits due to identifying high-risk vehicles/and or drivers based on the ASPEN system.

- improved business environment for motor carriers which will make the state more competitive in attracting other business.
- decreased credential processing costs to agencies due to the integration of information systems from deployment of CVISN. This integration will lessen the use of resources devoted to redundant systems.
- less reconstruction and maintenance to highways since all overweight motor carriers will be detected.
- enhanced safety since fewer trucks will enter a weigh and inspection station, thereby lessening the number of merges of commercial vehicles into the highway.
- enhanced on-time delivery of goods by motor carrier.
- fuel savings and, consequently, reduced emissions and particulate from exhaust due to pre-clearance.
- decrease in noise pollution at weigh and inspection stations in populated areas due to pre-clearance.
- less wear and tear to brakes and other associated motor vehicle components from no longer having to accelerate and decelerate at weigh stations.

Figure 4.1(a) shows the total costs and benefits of the CVISN program for each of the 10 years of the project's life. The low- and high-end benefits of CVISN are plotted in Figure 4.1(a). Year 2000 would require an initial investment of approximately $11 million by the state. This investment provides the impetus for subsequent investments by the carriers as well as marginal operational and maintenance investments by agencies for the project's duration. Even at the low end, benefits to carriers and agencies outweigh the costs incurred by them. The benefits continue to increase during the project's life.

Figure 4.1(a). Low and High Benefits for CVISN Program for the Economic Life



4.2 CVISN Credential Processing Benefit Cost Analysis

Implementation of the automated and electronic credential processing component of CVISN will result in more efficient processing of commercial motor carrier credentials by Maryland regulatory agencies. This section discusses in detail the benefits and costs to Maryland regulatory agencies and commercial motor carriers for *credential processing only*. The key assumptions used to isolate this Benefit/Cost Analysis for *credential processing* only for both the commercial motor carriers and Maryland state regulatory agencies are as follows:

- Maryland State regulatory agencies involved in credential processing are Motor Vehicle Administration and Maryland Comptroller of the Treasury. A detailed discussion on these costs is given in Section 5.1, while Section 5.4 gives a detailed discussion of the benefits of *automated credential processing* accrued by these state regulatory agencies.

- The CVISN-related *credential processing* cost for commercial motor vehicles is the cost of computer and communications hardware. A detailed discussion on these costs is given in Section 5.3, while Section 5.4 gives a detailed discussion of the benefits of *automated credential processing* accrued by these commercial motor carriers.

Table 4.2 (A) shows the B/C ratios and the NPVs for the CVISN-related credential processing activities only. For the discount rate of 7%, the B/C ratios of CVISN range from 1.98 to 2.92. The corresponding NPVs range from approximately $13 million to $26 million. All NPVs are expressed in terms of 1998 dollars. The table also shows the B/C ratios and the NPVs for 6% and 8% discount rates. As shown, even at these discount rates, the B/C ratio varies from 3.00 to 1.93 at the low end.

Table 4.2 (A). The Low and High Benefit/Cost Ratio (B/C) and the Net Present Value (NPV) for the CVISN project (for *credential processing* activities only) at different discount rates

DISCOUNT RATE		6%	7%	8%
Low	B/C	2.03	1.98	1.93
	NPV	$14,593,201	$13,192,371	$11,928,375
High	B/C	3.00	2.92	2.85
	NPV	$28,378,045	$25,956,265	$23,762,151

As shown in the above table, the benefits of CVISN for *credential processing only* outweigh the costs for deploying such a system. It should be noted that these numbers are based on conservative estimates. Similarly, the growth rate assumed by the model is

also conservative. If more motor carriers participate initially to a greater degree than what has been assumed in the study, then benefits and hence the B/C ratio and the NPV will also increase. For more carriers to participate, the motor carriers need to be educated and made aware of the significant benefits to them, of this program.
Figure 4.2 (A) shows the present value of the total benefits (both low and high) and the total costs to Maryland State regulatory agencies and commercial motor carriers for *credential processing only* from Year 2000 to Year 2010. As shown, the total costs for both the state regulatory agencies and commercial motor carriers are high in the early years and decrease in the later years. Conversely, both the low and high values of total benefits are low in the early years and then gradually increase as the program continues. However, as shown in Table 4.2 (A), the NPV for both the low and high values at 7% discount rate are positive and approximately equal $13 million and $26 million respectively. This implies that for *credential processing activities* only, CVISN promises to be potentially beneficial to both Maryland state regulatory agencies and commercial motor carriers. In conclusion, it is worthwhile to implement the automated credential processing components of CVISN.

It should be noted that the B/C ratios for credential processing activities for small carriers would be lower than for large carriers. This is because, for large carriers, the cost of computer and communications hardware and software can be apportioned across more vehicles. However, the scope of this Benefit Cost Analysis (BCA) and its underlying models is limited to addressing the impacts of CVISN to the overall motor carrier industry and not to different segments of industry.

Figure 4.2 (a). Present Values of Low and High Benefits and Costs of CVISN Program (credential processing only).

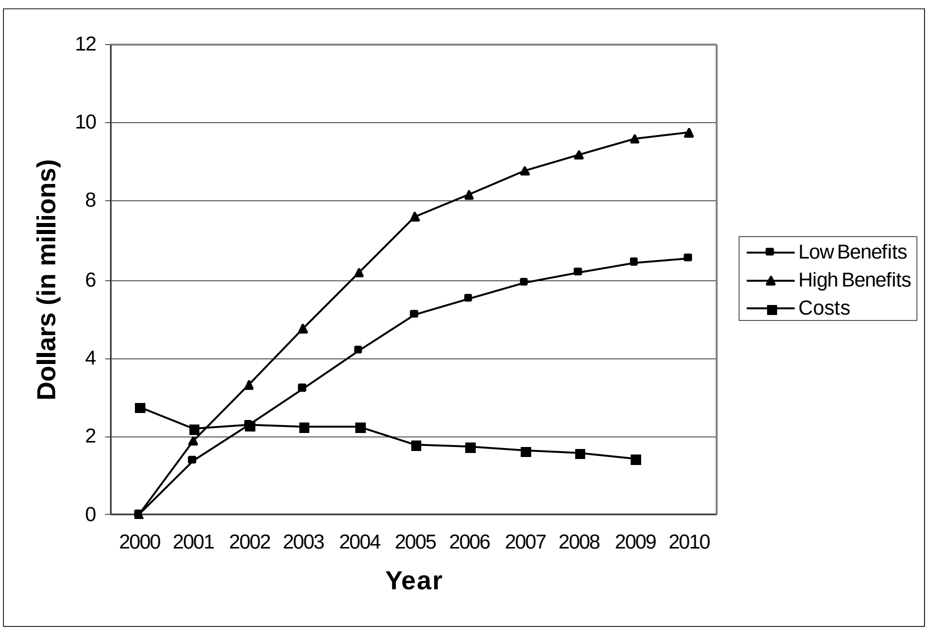


Figure 4.2 (b) shows the distribution of total costs incurred due to the implementation of *CVISN-related credential processing activities* only. As shown, Maryland state regulatory agencies incur 62% of the total costs, while the commercial motor carriers would bear 38% of the total costs.

Figure 4.2 (b). Distribution of Total Costs for Credential Processing Activities Only.

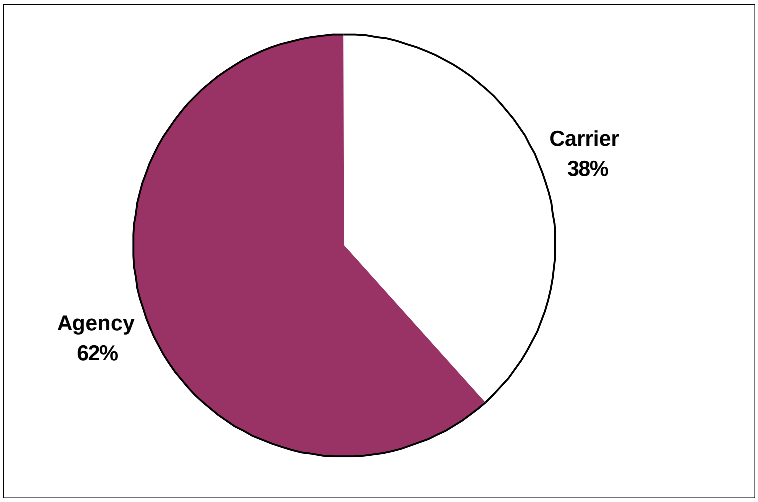


Figure 4.2 (c) shows the distribution of total benefits at the low end, accrued due to the implementation of *CVISN-related credential processing activities* only. As shown, of the total benefits, commercial motor carriers have a very significant share of 88%. However, it should be noted that the total benefits are an aggregate number for *all* commercial motor carriers. Thus the share of a single motor carrier will be much smaller. A closer examination of the data reveals that automated credentials processing allows both the commercial motor carriers and the two Maryland state agencies to benefit through a more efficient and productive process.

Figure 4.2 (c). Distribution of Total Benefits (Low) for Credential Processing Activities.

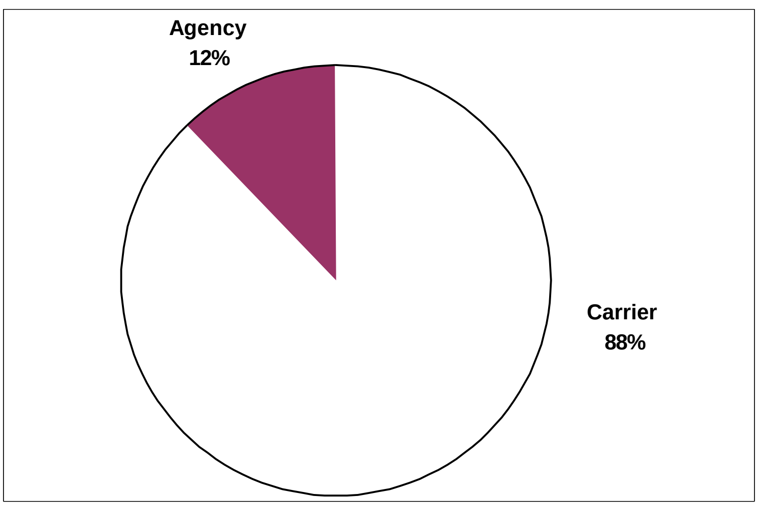
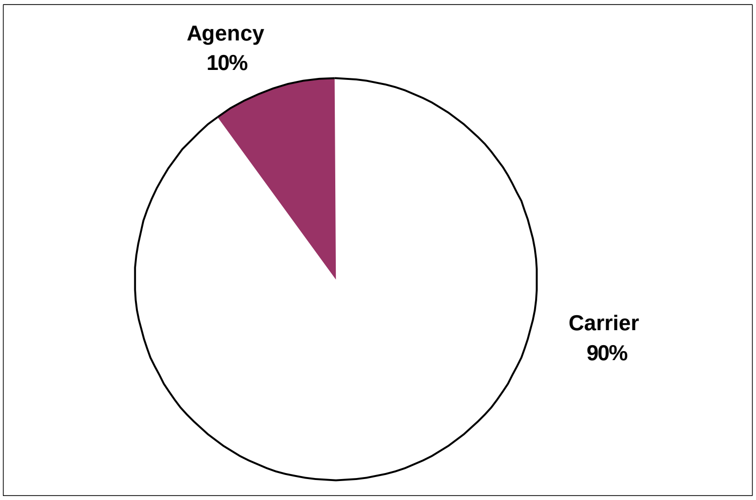


Figure 4.2 (d) shows the same distribution of benefits at the other extreme. As expected, the larger proportion of carriers has increased the share of total benefits due to the automated credential process to 90%.

Figure 4.2 (d). Distribution of Total Benefits (High) for Credential Processing Activities.



4.3. CVISN Safety and Enforcement Benefit-Cost Analysis

Safety is an integral and important feature of CVISN. The analysis explains benefits resulting from the state's investment in the safety aspects of CVISN. Such benefits include decreased accidents and legally bypassing time-consuming weigh and inspection activities for pre-cleared carriers. These and additional benefits are described below.

4.3.1. Accident Reduction due to CVISN

Two factors that result in decreased accidents are modeled in this study: a) high-risk vehicle and/or driver identification and b) identification of more illegally overweight vehicles. These factors are described next.

CVISN will help identify high-risk carriers that have had a history of out-of-service vehicles and/or drivers and/or higher accident rates. High-risk carriers and/or drivers are identified by means of tracking history of out-of-service violations for vehicles and drivers and/or higher accident rates. Such carriers and drivers have been known to cause a majority of accidents and pose a hazard to society. Vehicles and/or drivers that are in violation of federal and state regulations may be placed out-of-service until the violation is corrected. The accident rate due to commercial vehicles will decrease, assuming that carriers who have transponders can be identified for safety enforcement. Carriers that do not have transponders will not profit from the state's investment in CVISN. Conversely, carriers who use a transponder benefit significantly, as shown below.

CVISN will also identify illegally overweight carriers. These carriers may be more likely to contribute to accidents. Weigh-in-motion scales (WIM), a sizable investment of CVISN, will allow more vehicles to be weighed. Therefore, more illegally overweight vehicles will be identified, possibly resulting in a decrease in the accident rate.

4.3.2. Travel-time Benefits of CVISN

Vehicles with a read and write transponder meeting legal requirements may be allowed to travel at mainline speeds at weigh stations, as a result of the transponder exchanging data with the CVSIN system. This is referred to as pre-clearance of the vehicle and driver. Legal requirements for pre-clearance of a vehicle are as follows: 1) the vehicle is within the weight limits, and 2) the vehicle credentials have been checked to verify that the vehicle has IFTA permits, IRP registrations, and that fuel taxes have been paid. Pre-clearance also requires that the vehicle and/or driver to be cleared by the automated inspection system. Electronic screening will be initially based on carrier based data associated with credentials and safety. When data security issues are addressed and technology standards set (e.g., DSRC), comfort levels associated with the use of data on vehicles and drivers can be included in the roadside screening process.

4.3.3. *Benefit-Cost Values of Safety Investments in CVISN*

Figure 4.3.2(a) shows benefits at the low end due to each of the three benefit components described earlier. Pre-clearance benefits predominate over the inspection and overweight identification benefits by at least a factor of 3 during the latter years of the project.

Figure 4.3.2(b) shows the benefits that are accrued to the stakeholders of CVISN. Approximately 66% of safety benefits accrue to carriers. These benefits are due to pre-clearance of vehicles and drivers, allowing the carrier to by-pass the weighing station. The agency/societal benefit (a reduction in accidents) is much smaller (by a factor of 3) compared to the benefits that accrue to carriers.

Figure 4.3.2(a). Benefits of Safety Investments in CVISN Over the Economic Life

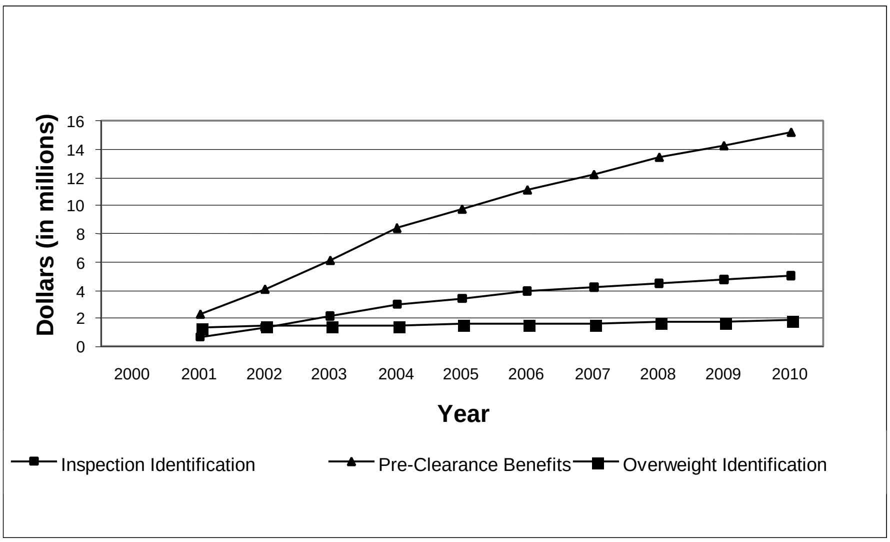
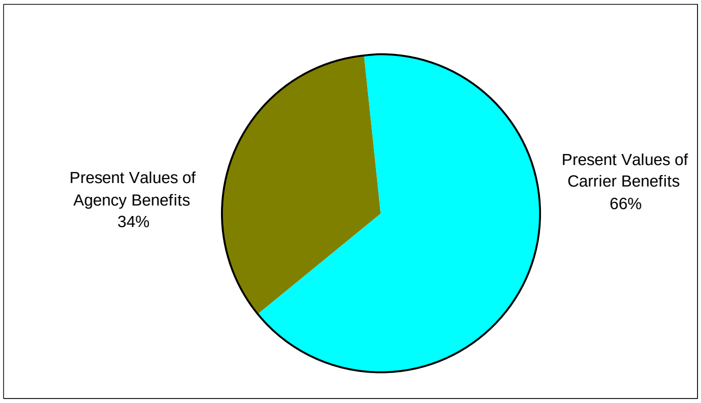


Figure 4.3.2(b). Distribution of Benefits Accrued to Carriers and Agencies for Safety Investments in CVISN



Costs are incurred by the safety and enforcement agencies and carriers. Safety and enforcement agencies include MSP, MdTA, SHA, and MDE. Significant costs are those that are related to installation of WIMs, reconstruction of ramps, transponder readers, and electronic signs.

The cost incurred by the carriers is the one-time cost of the transponders. Figure 4.3.2(c) shows the costs incurred by the carriers for transponders over the ten years of the project life. Costs initially rise as carriers adopt transponders. The costs to the carrier decline during the later stages of the project, since most carriers will have already adopted transponders. Additional costs include replacement costs of transponders due to failures in a mobile environment.

Figure 4.3.2(c). Costs Incurred by Carriers for Purchase and Replacement of Transponders

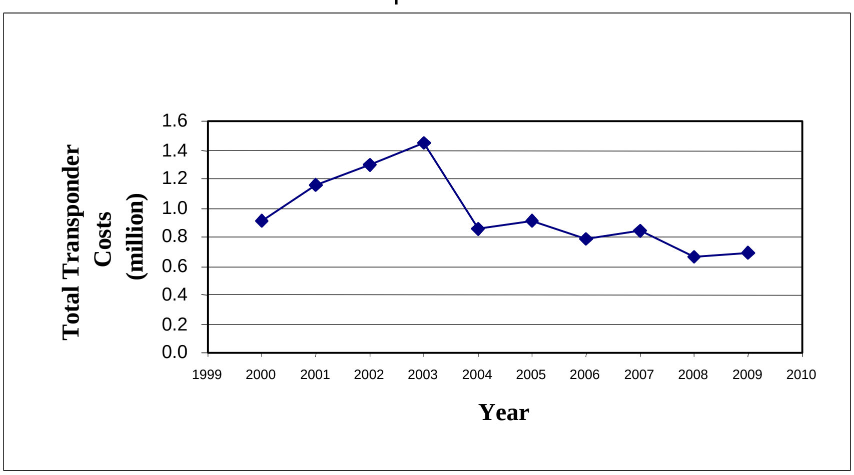


Figure 4.3.2(d) shows the distribution of costs for safety related investments incurred by the carriers and agencies. As is evident from the figure, agencies incur almost 3 times more costs when compared to carriers. At the same time, agencies accrue only one-third of all safety related benefits (see Figure 4.3.2(b)). Thus, the B/C ratio of carriers is approximately 9 times higher when compared to agencies for safety related activities.

Figure 4.3.2(d). The Distribution of Costs Incurred by Carriers and Agencies for Safety Related Investments in CVISN

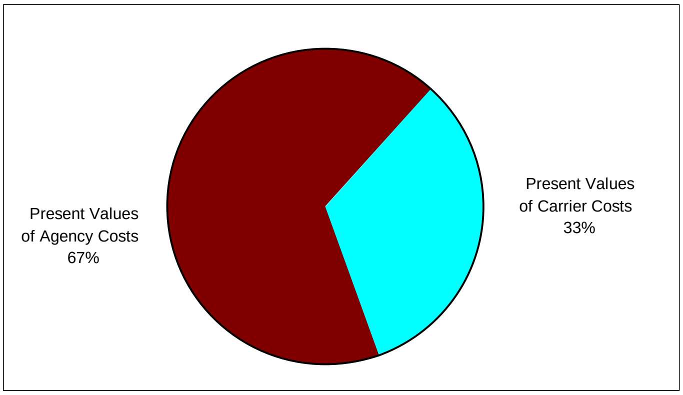


Figure 4.3.2(e) shows the total benefits accrued (at the low end) and total costs incurred due to safety investments in CVISN. The benefits clearly outweigh the costs.

Figure 4.3.2(e). Benefits (at low end) Accrued and Costs Incurred as a Result of Investment in Safety Related Activities for CVISN

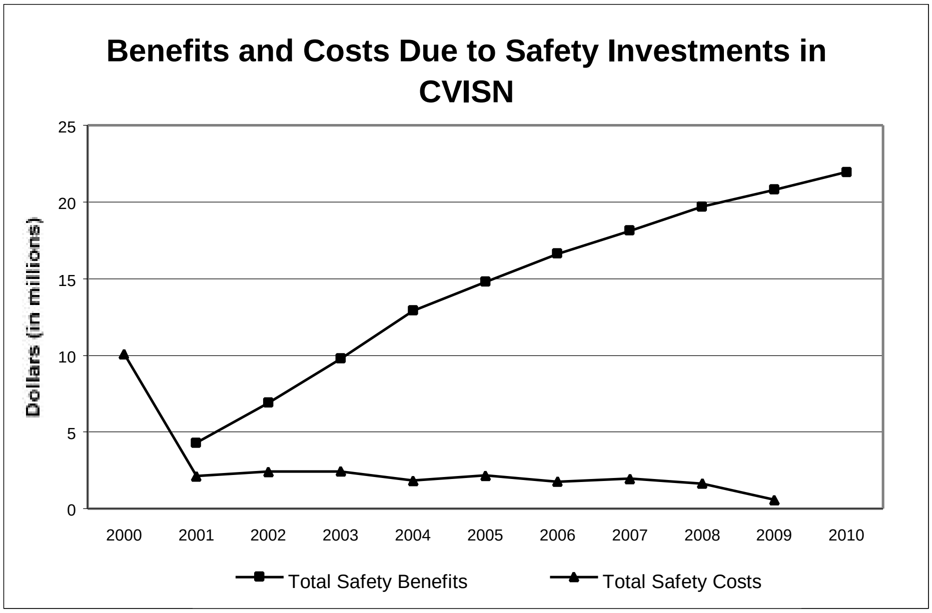


Table 4.3.2(A) shows the B/C Ratios and NPVs for the safety and enforcement activities of CVISN. For the discount rate of 7%, the B/C ratios of safety and enforcement activities range from 4.15 to 5.86. Corresponding net present values range from approximately $63 million to $97 million. The table also shows the B/C ratio and the NPV for 6% and 8% discount rates. Even at these discount rates, the B/C ratio varies from 4.31 to 4.01 at the low end. Clearly, CVISN is a worthwhile investment in the area of safety.

Table 4.3.2(A). Low and High Benefit/Cost Ratio (B/C) and the Net Present Value (NPV) for Safety and Enforcement Activities of CVISN Project at Different Discount Rates

DISCOUNT RATE		6%	7%	8%
Low	B/C	4.31	4.15	4.01
	NPV	$68,638,267	$62,847,737	$57,595,630
High	B/C	6.08	5.86	5.65
	NPV	$105,522,986	$96,944,153	$89,155,506

This study has not quantified the benefits due to identifying high-risk vehicles and/or drivers by the ASPEN system once they have entered the weigh station. Moreover, reduced reconstruction and maintenance of highways due to identification of more overweight motor carriers also has not been quantified. This study is also conservative with respect to the costs that carriers incur for transponders, as will be described in Section 5.3. There are several other benefits discussed in the Section 4.1 that can not be quantified. Thus, the results as shown above are conservative with regard to safety investment decisions.

4.4. CVISN State Agencies Benefit-Cost Analysis

The state of Maryland has taken the initiative to evaluate CVISN. As a prototype state, Maryland has been in the forefront of evaluating the benefits and costs of CVISN.

Several benefits, tangible as well as intangible, accrue to MVA, Comptroller's Office, SHA, MSP, MdTA, MDE, MPA, PSC, and Maryland citizens. This analysis quantitatively models three significant benefits to the state of Maryland. The state of Maryland will henceforth be referred to as state agencies, since the agencies are making the investment decision and are funded by the tax dollars of Maryland citizens. Benefits include cost reduction of credential processing activities and reduction in accidents. The latter is composed of two separate factors: a) identification of high-risk vehicle and/or driver, and b) identification of more illegally overweight vehicles. Benefits of credential processing activities are detailed in Section 5.4. The accident reduction benefits are described in Section 4.3.

Figure 4.4(a) shows benefits at the low end due to each of the three benefit components described earlier. During the initial stages, all three benefits have similar contributions. However, during the middle and the final stages of the project, the inspection identification benefit dominates the other two benefits. This is primarily due to the fact that during the project's latter stages, transponders become prevalent. The CVISN identification system is able to identify more and more high-risk vehicles and/or drivers.

Figure 4.4(a). Benefits (at Low End) Accrued to State Agencies for CVISN Program

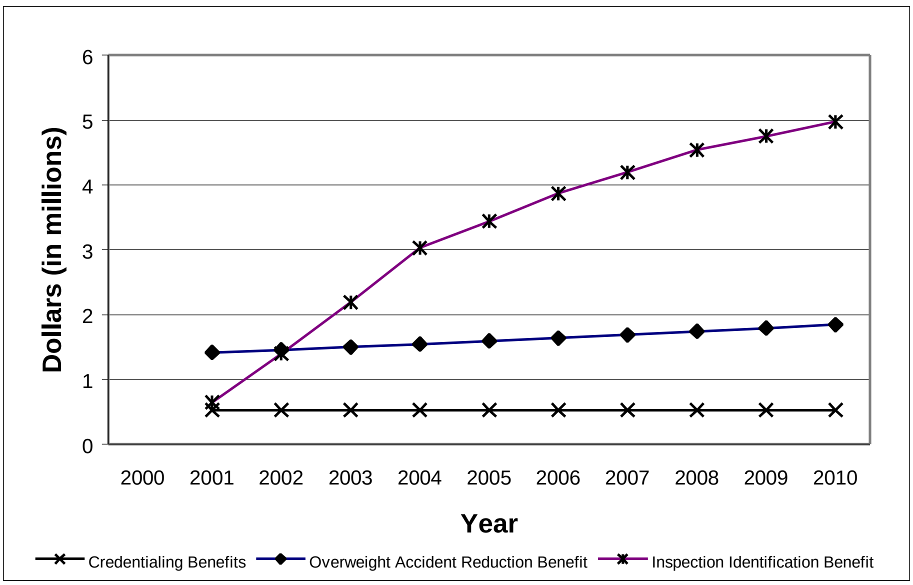
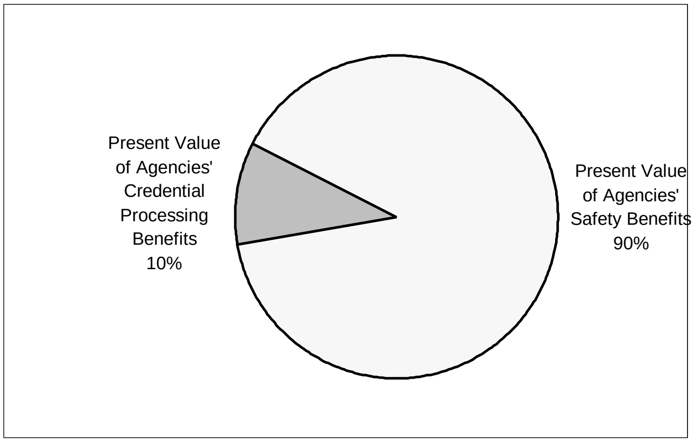


Figure 4.4(b) shows the distribution of benefits to state agencies. Approximately 90% of the benefits are accrued by a reduction in accidents while 10% of the benefits are accrued from credential processing activities.

Figure 4.4(b). The Distribution of Benefits due to Credential Processing Activities and Safety and Enforcement Activities Accrued to Agencies



Significant costs for credential processing activities and safety and enforcement activities are incurred by agencies. Major costs related to credential processing activities are the communication costs, the cost to integrate to the mainframe system, and the salaries and wages of two computer professionals. Major costs related to safety are those that are related to the installation of WIMs, reconstruction of ramps, transponder readers, and electronic signs.

Figure 4.4(c) shows the distribution of costs incurred to state agencies for credential processing and safety and enforcement investments. Approximately two-thirds of the costs incurred are due to investments in safety and enforcement activities.

Figure 4.4(c). The Distribution of Credential Processing Costs and Safety Enforcement Costs Incurred by Agencies

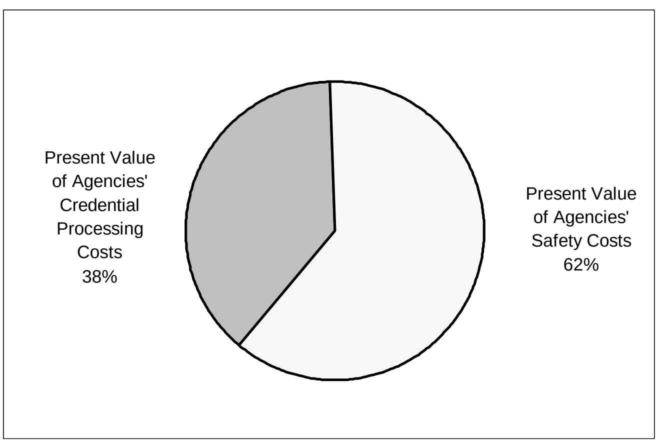


Figure 4.4(d) shows the total benefits (at the low end) accrued and the total costs incurred to the state agencies for CVISN. The benefits outweigh the total costs for each of the 10 years of the CVISN project life.

Figure 4.4(d). Benefits (at the Low End) Accrued to and Costs Incurred by State Agencies for CVISN Program

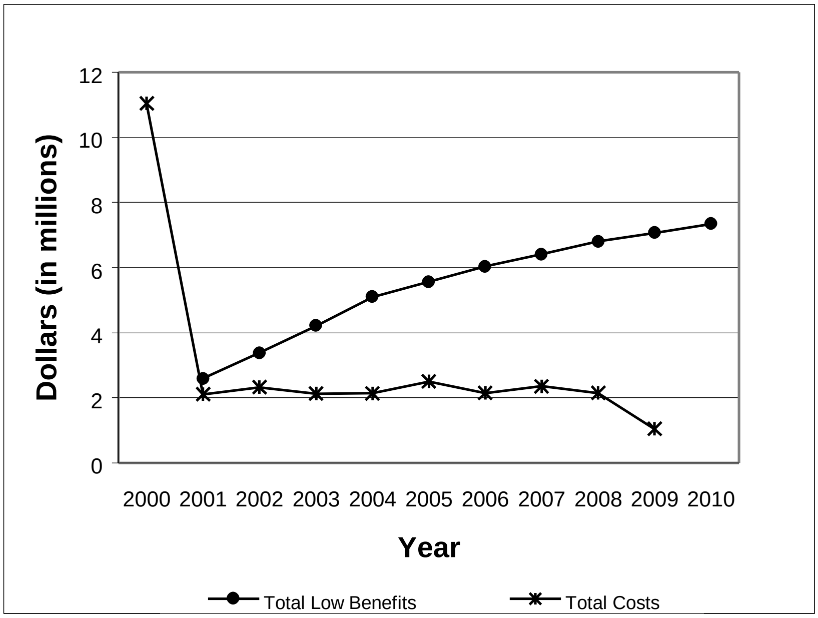


Table 4.4(A) shows the Benefit/Cost Ratio (B/C) and the NPV for the agencies' investment in CVISN. For the discount rate of 7%, the B/C ratios of credential processing and safety and enforcement activities for the agencies range from 1.45 to 1.61. The corresponding NPVs range from approximately $10 million to $13 million. All NPV values are expressed in terms of 1998 dollars. The table also shows the B/C ratio and the NPV for 6% and 8% discount rates. Even at these discount rates, the B/C ratio varies from 1.50 to 1.41 at the low end. CVISN is a worthwhile investment for the state agencies.

Table 4.4(A). Low and High Benefit/Cost Ratio (B/C) and the Net Present Value (NPV) to State Agencies for Investment in the CVISN Project at Different Discount Rates

DISCOUNT RATE		6%	7%	8%
Low	B/C	1.50	1.45	1.41
	NPV	$11,363,142	$9,883,724	$8,553,489
High	B/C	1.66	1.61	1.56
	NPV	$14,915,853	$13,198,248	$11,649,953

This study has not quantified the benefits for increased IRP and IFTA revenues due to increased monitoring of carrier activities nor decreased credential processing costs to agencies. The integration of information systems from deployment of CVISN will lessen the use of resources devoted to redundant systems. Moreover, several safety benefits have not been quantified e.g., identification of high-risk vehicles and/or drivers by the ASPEN system once they have entered the weigh station, and the reduction of reconstruction and maintenance to highways caused by wear from overweight vehicles. Several other benefits that can not be quantified are discussed in Section 4.1. Thus, the results shown above are conservatives with regard to the CVISN investment decision when the decision is taken only for the benefits accrued to and costs incurred by state agencies.

4.5 CVISN Commercial Motor Carriers Benefit Cost Analysis

The implementation of CVISN in Maryland has significant impacts on commercial motor carrier operations. This section discusses in detail the benefits and costs to Maryland commercial motor carriers for all CVISN-related activities of credential processing and safety enforcement. The key assumptions used to isolate this Benefit/Cost Analysis for commercial motor carriers only for both the credential processing and safety enforcement activities are as follows:

- The total CVISN-related cost for commercial motor vehicles is the cost of computer and communications hardware and the transponder unit. A detailed discussion on these costs is given in Section 5.3.
- The benefits of CVISN-related *credential processing* activities to commercial motor vehicles are the savings in administrative costs. A detailed discussion of these benefits is given in Section 5.4.2.
- The benefits of CVISN related to *safety enforcement* activities for commercial motor vehicles are the timesaving at automated weigh and inspection facilities and the increased safety of Maryland highways. Detailed discussions of these safety benefits are given in Section 5.5.

Table 4.5 (A) shows the B/C ratios and the NPVs for the CVISN project, which includes the benefits and costs to *commercial motor carriers only*. For the discount rate of 7%, the B/C ratios of CVISN range from 6.67 to 10.41. The corresponding NPVs range from approximately $66 million to $110 million. All NPVs are expressed in terms of 1998 dollars. The table also shows the B/C ratio and the NPV for 6% and 8% discount rates. Even at these discount rates, the B/C ratio varies from 10.71 to 6.49 at the low end.

Table 4.5 (A). The Low and High Benefit/Cost Ratio (B/C) and the Net Present Value (NPV) for the CVISN project for *commercial motor carriers,* at different discount rates

DISCOUNT RATE		6%	7%	8%
Low	B/C	6.86	6.67	6.49
	NPV	$71,868,326	$66,156,384	$60,970,516
High	B/C	10.71	10.41	10.12
	NPV	$118,985,179	$109,702,171	$101,267,704

As shown in the above table, the benefits of CVISN for *commercial motor carriers* far outweigh the costs for deploying such a system. This analysis shows that the B/C ratios and the NPVs are higher for commercial motor carriers when compared with Maryland state regulatory agencies. The two key factors contributing to these values are as follows: a) the significant amount of timesaving gained by commercial motor carriers due to the implementation of technology-based CVISN solutions by the state regulatory agencies; and b) the synergy achieved by the use of a transponder unit by motor carriers and *WIMs* by state agencies that allow commercial vehicles to be weighed at mainline speeds. It should be noted that these numbers are based on conservative estimates. Similarly, the growth rate assumed by the model is also conservative. If more motor carriers participate initially than what has been assumed in the study, then benefits and hence the B/C ratio and the NPV will increase. For more motor carriers to participate, carriers need to be educated and made aware of the significant benefits of the CVISN program.

Figure 4.5 (a) shows the present value of the total benefits (both low and high) and total costs to *commercial motor carriers* only for both credentials processing and safety enforcement activities from Year 2000 to Year 2010. As shown, both the low and high total benefits outweigh the total costs to commercial motor carriers for participating in the CVISN program. As noted earlier in Table 4.5 (A), the NPV for both the low and high values at the 7% discount rate are positive and approximately equal $66 million and $110 million, respectively. This implies that for commercial motor carriers, CVISN has the potential to be potentially extremely beneficial. Hence, it is worthwhile for carriers to adopt the different technology-based solutions implied by implementation of CVISN. The results also strongly suggest that using some resources to educate and raise awareness of the significant benefits of the CVISN program among motor carriers would be advantageous to the state.

Figure 4.5 (a). Low and High Total Benefits and Total Costs of CVISN Program (for commercial motor carriers only)

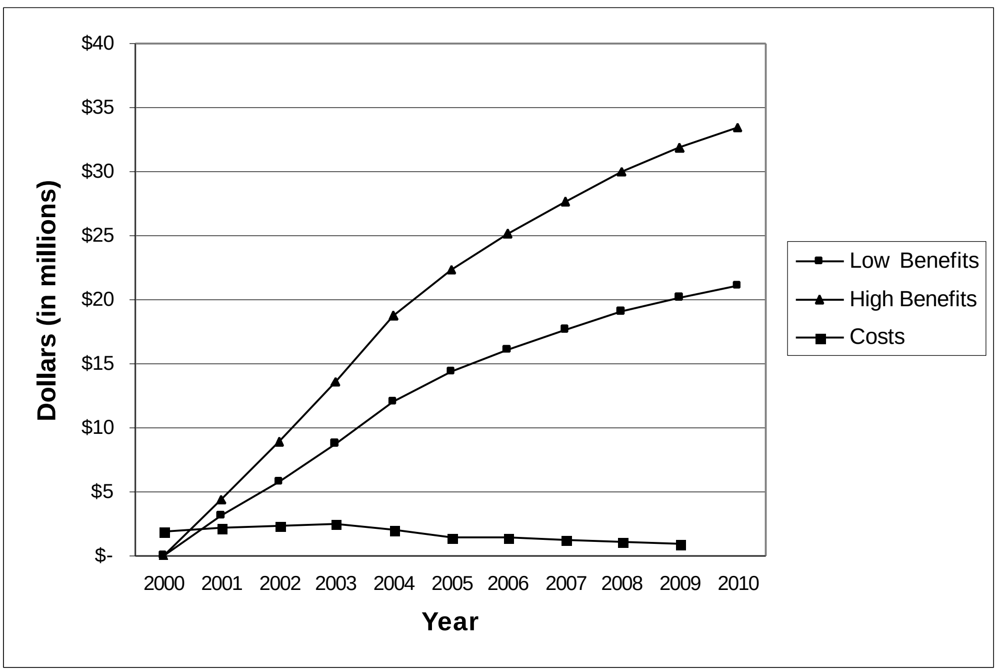


Figure 4.5 (b) shows the distribution of total costs incurred by commercial motor carriers for their participation in all CVISN related activities of credential processing and safety enforcement. As shown, of the total costs, the share of automated credential processes for commercial motor carriers is slightly lower at 44%. Commercial motor carriers will need to purchase computer and communications hardware to support their credential processing activities and a transponder unit to participate in the CVISN safety enforcement component. This is discussed in more detail in Section 5.5. Although the cost of a transponder unit is much lower in comparison to the computer and communications hardware, it should be noted that motor carriers need only one computer and modem to support their credential processing activities, while their vehicles will need one transponder unit for every motor vehicle or power unit. Additionally, it should be noted that the B/C ratios for credential processing activities, and consequently, the overall B/C ratios for small carriers would be lower than for large carriers. This is because, for large carriers, the cost of computer and communications hardware and software can be apportioned across more vehicles. However, the scope of this analysis and its underlying models is limited to addressing the impacts of CVISN to the overall motor carrier industry and not to different segments of industry.

Figure 4.5 (b). Distribution of Total Costs for Commercial Motor Carriers' CVISN Related Activities.

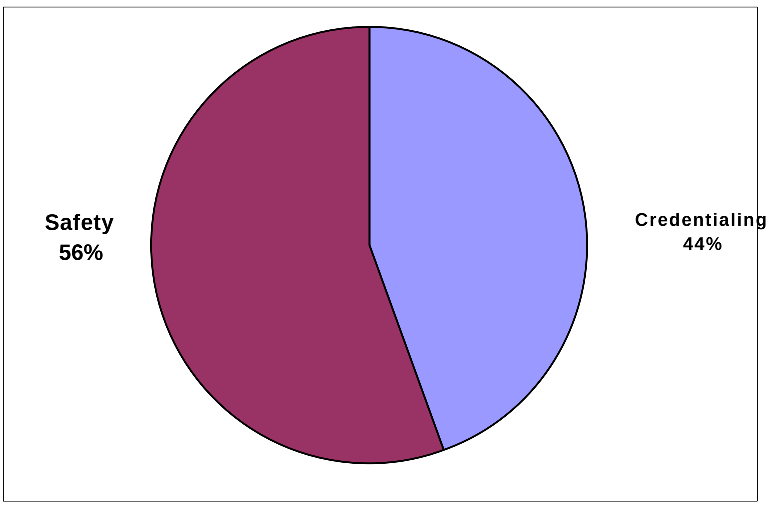


Figure 4.5 (c) shows the distribution of total benefits at the low end, accrued to the commercial motor carriers for their participation in all CVISN-related activities of credential processing and safety enforcement. As shown, of the total benefits accrued, commercial motor carriers' safety benefits have a high share of 70%. A closer analysis of

the data shows that this is due to the significant amount of savings to motor carriers who are get pre-clearance at mainline speeds and thus are able to bypass Weigh and Inspection facilities equipped with WIMs and transponder readers. As noted earlier, the smaller size carrier would have a lower share of the total benefits as compared with large carriers. This is because, for large carriers, the benefits of both credential processing and safety enforcement activities get multiplied by the total number of credentials and the number of vehicles in their fleet.

Figure 4.5 (c). Distribution of Total Benefits (Low) for Commercial Motor Carriers' CVISN Related Activities.

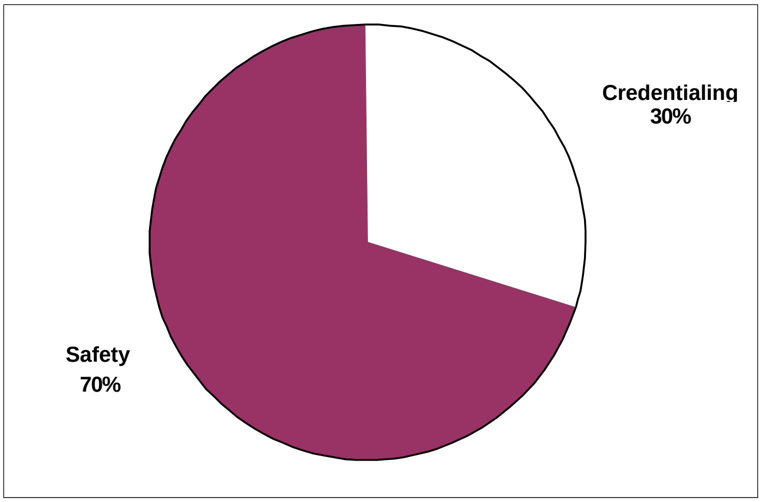
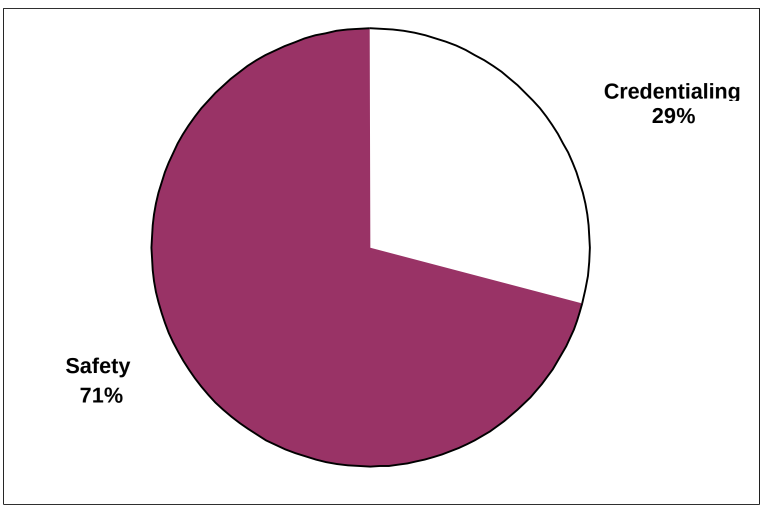


Figure 4.5 (d) shows the distributions of these total benefits at the high end. This figure is consistent with the earlier Figure 4.5 (c), with the share of the safety benefits increasing slightly to 71%.

Figure 4.5 (d). Distribution of Total Benefits (High) for Commercial Motor Carriers' CVISN Related Activities.



5.0. CVISN BENEFITS AND COSTS MODEL

This section discusses in great detail the different models that were developed and used in this BCA. The benefits and costs models for each of the different stakeholders of CVISN, i.e. the Maryland state regulatory agencies and the commercial motor carrier, for both the activities of credential processing and safety enforcement are developed. Additionally, in section 5.2 we discuss the Growth model for the rate of adoption of technology by the motor carrier industry. The following sections also present the theories, concepts, and assumptions used for each of the different quantitative models developed for this BCA.

5.1. Agency Costs

This section shows the capital and operating costs incurred for implementing the different components of CVISN for the nine Maryland agencies performing commercial vehicle transportation related activities. The nine different agencies discussed are as follows:

i) MDOT, TSO – Maryland Department of Transportation, The Secretary's Office;
ii) SHA – State Highway Administration;
iii) MPA – Maryland Port Administration;
iv) MVA – Motor Vehicle Administration;
v) MDTA – Maryland Transportation Authority Police;
vi) MDE – Maryland Department of the Environment;
vii) PSC – Public Service Commission;
viii) COMPTR – Comptroller of the Treasury;
ix) MSP – Maryland State Police – Commercial Vehicle Enforcement Division;

5.1.1. Maryland State Regulatory Agencies

The nine **Maryland** agencies studied for the Benefit Cost Analysis and a brief description of their major functions relating to CVISN are as follows:

- **Maryland Department of Transportation, The Secretary's Office (MDOT, TSO)** oversees the overall implementation and evaluation of the CVISN project in Maryland.

- **Maryland State Highway Administration (SHA)** issues Hauling Permits for Oversize and Overweight (OS/OW) vehicles, manages the statewide commercial vehicle weigh and inspection facility program, analyzes and interprets accident data and police reports concerning violations, and manages the statewide Motor Carrier Safety Assistance Program.

- **Maryland Port Administration's (MPA)** Intermodal Services manages the transportation activities of the Port of Baltimore.

- **Maryland Motor Vehicle Administration (MVA)** issues International Registration Plan (IRP) titles and registrations, Commercial Drivers License (CDL), intrastate commercial vehicle registrations, as well as operating and maintaining all vehicle and driver record information.

- **Maryland Transportation Authority (MdTA)** regulates the Size, Weight, and Load Programs as well as the Motor Carrier Safety Program on the state's seven toll roads.
- **Maryland Department of the Environment (MDE)** issues Controlled Hazardous Substances (CHS) Permits, oversees the certification of CHS drivers, responds to transportation-related incidents involving hazardous materials, and conducts inspections and surveys of carriers, shipping facilities, and drivers involved in the transportation of hazardous materials.
- **Public Service Commission's (PSC)** Transportation Division enforces laws and regulations pertaining to the safety and inspection of commercial vehicles that carry 16 or more passengers. It also enforces liability insurance limits, operation schedules, rates, and service of transportation companies (except railroads) operating in intrastate commerce in Maryland.
- **Comptroller of the Treasury (COMPTR)** issues International Fuel Tax Agreement (IFTA) licenses and registrations with IFTA decals and temporary trip permits, conducts random audits of IFTA member accounts, and collects taxes.
- **Maryland State Police (MSP) Commercial Vehicle Enforcement Division (C.V.E.D)** regulates the following programs: the Size, Weight, and Load Programs; the Motor Carrier Safety Program on Maryland Highways; and the Preventive Maintenance Program.

For the purpose of this study, depending on the tasks performed, agencies are classified into two main categories: *credential processing* and *safety enforcement*. The agencies whose tasks can be broadly classified as credential processing are as follows: Motor Vehicle Administration and Maryland Comptroller of the Treasury. The agencies whose tasks mainly involve safety enforcement and safety related activities are as follows: State Highway Administration, Public Service Commission, Maryland Transportation Authority, Maryland State Police, and Maryland Department of the Environment. The responsibilities of The Secretary's Office cover the overall CVISN project while the Maryland Port Administration is responsible for the overall management of transportation activities and providing general information regarding both credential processing and safety. Hence, their costs are assumed to be equally distributed across both credential processing and safety enforcement activities.

5.1.2. Maryland State Regulatory Agencies Cost Data

Table 5.1.2 (A) shows the overall operating and capital costs by year for the economic life of the project, from the years 2000 to 2009*,* for each of the *nine state agencies* involved in *CVISN*-related activities. These costs are classified broadly as costs for credential processing and safety using the classification scheme discussed in the preceding paragraph. Tables 5.1.2 (B) and 5.1.2 (C) shows the *overall capital and operating costs* *by year* from 2000 to 2009 for each of the *nine state agencies* involved in *CVISN*-related credential processing and safety activities respectively. Ms. Patrice Harris at the Maryland Department of Transportation obtained the cost data for each of the nine state agencies.

Table 5.1.2 (A). Overall CVISN Capital and Operating Costs for Maryland State Regulatory Agencies for Years 2000-2009

Year Agency	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
MDOT, TSO	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000
SHA	6,374,800	575,800	575,800	575,800	575,800	616,800	575,800	575,800	575,800	575,800
MPA	24,837	24,866	25,980	27,233	28,569	29,042	29,528	29,528	29,528	29,528
MVA	1,543,439	998,055	1,078,569	1,008,149	1,013,651	1,015,598	1,017,580	1,093,192	1,017,580	1,017,580
MDTA	1,790,000	154,000	154,000	154,000	154,000	250,000	154,000	154,000	154,000	154,000
MDE	13,500		13,500			13,500		13,500		
PSC	13,500		13,500			13,500		13,500		
COMPTR	177,900					77,900				
MSP	163,652	44,930	151,366	50,354	53,304	175,555	55,418	159,218	55,418	55,418
TOTALS	**10,351,628**	**2,047,651**	**2,262,715**	**2,065,536**	**2,075,324**	**2,441,895**	**2,082,326**	**2,288,738**	**2,082,326**	**2,082,326**

Table 5.1.2 (B). Overall CVISN Capital and Operating Costs for Maryland State Regulatory Agencies for Years 2000-2009.
(*For Credential Processing Activities only)*

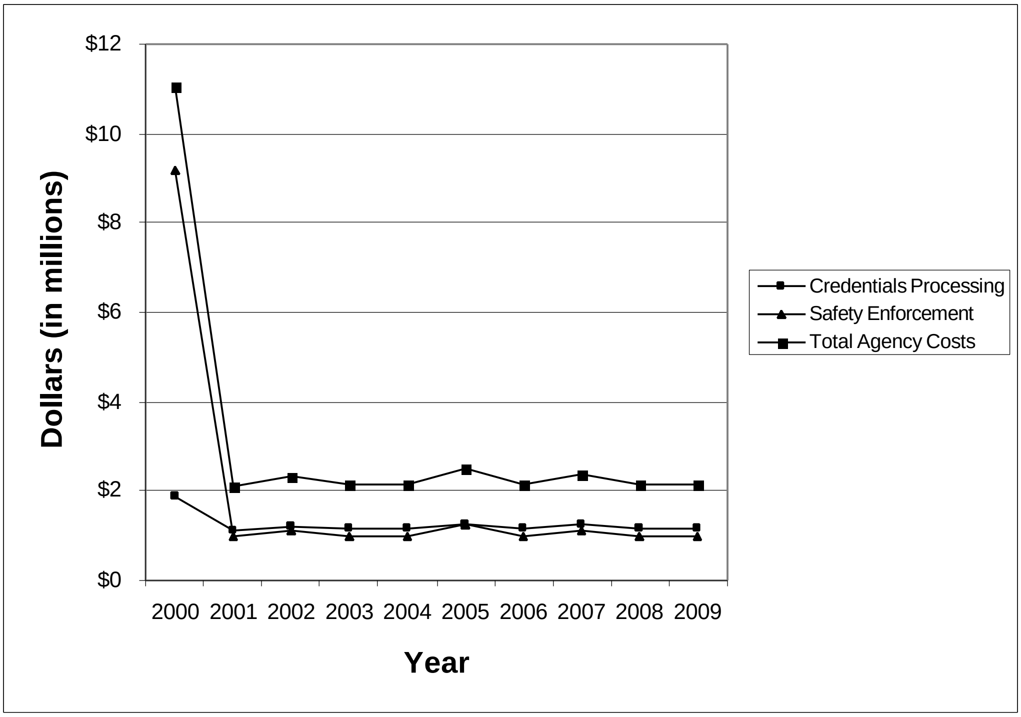
Year / Agency	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
MDOT, TSO	125,000	125,000	125,000	125,000	125,000	125,000	125,000	125,000	125,000	125,000
MPA	12,419	12,433	12,990	13,617	14,285	14,521	14,764	14,764	14,764	14,764
MVA	1,543,439	998,055	1,078,569	1,008,149	1,013,651	1,015,598	1,017,580	1,093,192	1,017,580	1,017,580
COMPTR	177,900	0	0	0	0	77,900	0	0	0	0
TOTALS	**1,858,758**	**1,135,488**	**1,216,559**	**1,146,766**	**1,152,936**	**1,233,019**	**1,157,344**	**1,232,956**	**1,157,344**	**1,157,344**

Table 5.1.2 (C). Overall CVISN Capital and Operating Costs for Maryland State Regulatory Agencies for Years 2000-2009.
(*For Safety Enforcement Activities only)*

Year / Agency	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
MDOT, TSO	125,000	125,000	125,000	125,000	125,000	125,000	125,000	125,000	125,000	125,000
SHA	6,374,800	575,800	575,800	575,800	575,800	616,800	575,800	575,800	575,800	575,800
MPA	12,419	12,433	12,990	13,617	14,285	14,521	14,764	14,764	14,764	14,764
MDTA	1,790,000	154,000	154,000	154,000	154,000	250,000	154,000	154,000	154,000	154,000
MDE	13,500	0	13,500	0	0	13,500	0	13,500	0	0
PSC	13,500	0	13,500	0	0	13,500	0	13,500	0	0
MSP	163,652	44,930	151,366	50,354	53,304	175,555	55,418	159,218	55,418	55,418
TOTALS	**8,492,871**	**912,163**	**1,046,156**	**918,771**	**922,389**	**1,208,876**	**924,982**	**1,055,782**	**924,982**	**924,982**

Figure 5.1.2 (a) shows the total operating and capital costs by year from 2000 to 2009 for all the Maryland state regulatory agencies. It also shows the total costs incurred by the state agencies for each of the two major CVISN-related activities of credential processing and safety enforcement.

Figure 5.1.2 (a). Present Values of Total Costs for Maryland State Regulatory Agencies for all CVISN-Related Activities.



For each of the nine state agencies, all CVISN-related costs were broadly classified as one of the following cost objects:

Table 5.1.2 (D). Cost Objects for Maryland State Regulatory Agencies for all CVISN Related Activities.

Budgeted Staffing - PIN & Contractual
Salaries, Wages, Benefits
Technical & Special Fees
Communications
Travel
Fuel & Utilities
Motor Vehicle Operations
Contractual Services
Supplies & Material
Equipment Replacement
Equipment Additional
Grants, Subsidies & Contributions
Fixed Charges
Land & Structures
Overhead

The cost estimated for Year 2000 is based in 1998 dollars. The costs for the remaining nine years are calculated using the base cost for the Year 2000 and the following assumptions:

i) Operating and Maintenance costs are 10% of the capital costs;

ii) Computer and communications hardware and software update costs are incurred every five years;

iii) Costs of WIM (including ramp construction costs) at roadside weigh and inspection facilities are included;

iv) Economic life of WIM-related ramp and pavement is 20 years; this implies that the salvage value of WIM is 50% at the end of 10 years or the period of study for this analysis.

Table 5.1.2 (E) shows the total capital costs incurred in the Year 2000. These costs are incurred at only three of the nine agencies.

Table 5.1.2 (E). Total Capital Costs for Maryland State Regulatory Agencies for all CVISN Related Activities for Fiscal Year 2000.

	Cumulative	SHA	MVA	MDTA
Capital Costs	7,798,000	5,758,000	500,000	1,540,000

5.2. Growth Model

The main assumption of the Benefit Cost Model is that net benefits and costs accrued to motor carriers and state agencies due to the deployment of CVISN are in direct proportion to the level of participation of motor carriers and their implementation of the proposed technology-based solutions. As the level of carrier participation in the program increases, there is a corresponding increase in total benefits and costs. Hence, it is important to model the level of carrier participation as the program grows. This study assumes that as awareness of the CVISN program and associated advantages increases, motor carrier participation in the program increases.

According to a study by Rubel (1998) for the National Governor's Association (NGA), motor carrier participation in ITS/CVO systems will lag behind the deployment of these systems. The NGA study assumes that the deployment of ITS/CVO increases exponentially over the system's economic life, starting with 0% in year 0, increasing to 30% in year 5, and then rapidly increasing to 100% in year 10. This relationship assumes that at first few carriers participate, but with increased deployment of CVISN, the rate of participation dramatically increases until the end of the system's economic life of ten years.

5.2.1. Assumptions

On the other hand, this study assumes that at first few carriers participate, but as the advantages of ITS/CVO become apparent to the industry, the rate of participation increases *reasonably* until the end of the system's economic life of ten years. In addition, this BCA assumed that all the systems related to CVISN will be fully deployed by the beginning of year 2001. This implies that the benefits due to the system will start from year 2001 and will be in direct proportion to the level of participation of motor carriers. For this BCA, capital and other CVISN-related costs for the state agencies will be incurred from Year 2000.

The costs to motor carriers for deploying CVISN technologies is assumed to be in direct proportion to the level of their participation. In other words, when motor carrier decides to participate in the CVISN program, they will incur expenses for the purchase of the necessary hardware and software that will help them to take advantage of the benefits that CVISN has to offer.

The level of motor carrier participation in the CVISN program is based on a model that is built using data from a survey of Maryland-based motor carriers conducted in 1998 as a part of this study. This survey asked users about the types of technologies (ranging from cellular phone to the use of Internet) that they currently use and their perceptions of the potential values for the different automated electronic services to be implemented by the Maryland State Agencies. Survey respondents were asked to select the potential value for the different automated electronic services on a scale of *1* through *5,* where *1* implies that the service has *no value* and *5* implies that respondents perceive such services to be extremely valuable to their business. Using respondents' replies concerning the perceived values for these kinds of services, a *growth model* for the *adoption of technology* by the carriers is constructed.

5.2.2. Growth Model for Technology Adoption Rate

The key assumption of the growth model is that the adoption rate of technology is a direct function of the respondents' perceived value of the technological solutions. In other words, that the respondents' perceived value of technology is assumed to greatly influence the rate at which motor carriers would adopt technology.

For respondents who perceive the value of the different automated electronic services as *extremely high*, it is reasonable to assume that they would have the highest rate for the adoption of technology. On the other extreme, for respondents who perceive no value for the different automated electronic services, it is reasonable to assume that they will have the slowest rate for the acceptance of technology. However, it is believed that these motor carriers would suntil be forced to adopt some of the electronic services, albeit at the slowest rate among all respondents, for a variety of different reasons. For example, as the use of technology becomes more prevalent, economic survival in the industry may require a carrier to adopt some of the technological solutions. However, the model further assumes that although the time period for the model of *ten* years may be sufficient time during which business competitive pressures and the prevailing technological, economical, and business environments would force the most disinterested carriers to adopt some of the technological solutions, not all carriers will adopt technology. It is therefore assumed that, even after ten years, this group of carriers will have a maximum adoption rate of 86.30%. This is based on the fact that 86.30% of survey respondents indicated that they currently have FAX capabilities (which can be considered an essential communication technology for a business). It is important to note that the model is conservative and assumes that even for the most enthusiastic supporters of technology the adoption rate reaches a maximum of 95%.

The following Table 5.2.2 (A) gives the different values used to obtain the technology adoption rate. The first column is the potential value of technology as perceived by the respondent on a scale of 1 through *5,* where *1* implies that the service has *no value* while

5 means that the respondents perceive such services to be extremely valuable to their businesses. The second column gives the percentage of respondents who selected the corresponding potential value of technology. The next two columns show the periods in which the *five* groups of respondents would start and complete the process of technology adoption. The last column shows the percentage (of that group) who would have adopted the proposed technological solutions by the end date. It is also assumed that the rate of growth for each group is linear. It should be noted that the overall conclusion is that the technology adoption rate across the five groups decreases as the respondents' perception for the value of the automated electronic services decreases. For example, 43.09% of the respondents indicated that they perceive technology as being extremely valuable for their business. Hence, it is assumed that they will start adopting technology in an enthusiastic manner beginning Year 1. By Year 5, 95% of this group would have adopted this technology. Similarly, only 3.72% of the respondents give some value (potential value equals *2)* to technology. It is therefore assumed that they will start adopting technology later, i.e. in Year 2, and their rate of adoption will be much slower, with 90% of the group adopting technology by year 10. The rest of the table reads in a similar fashion.

Table 5.2.2 (A) Survey Results and Values Used for Computing the Technology Adoption Rate.

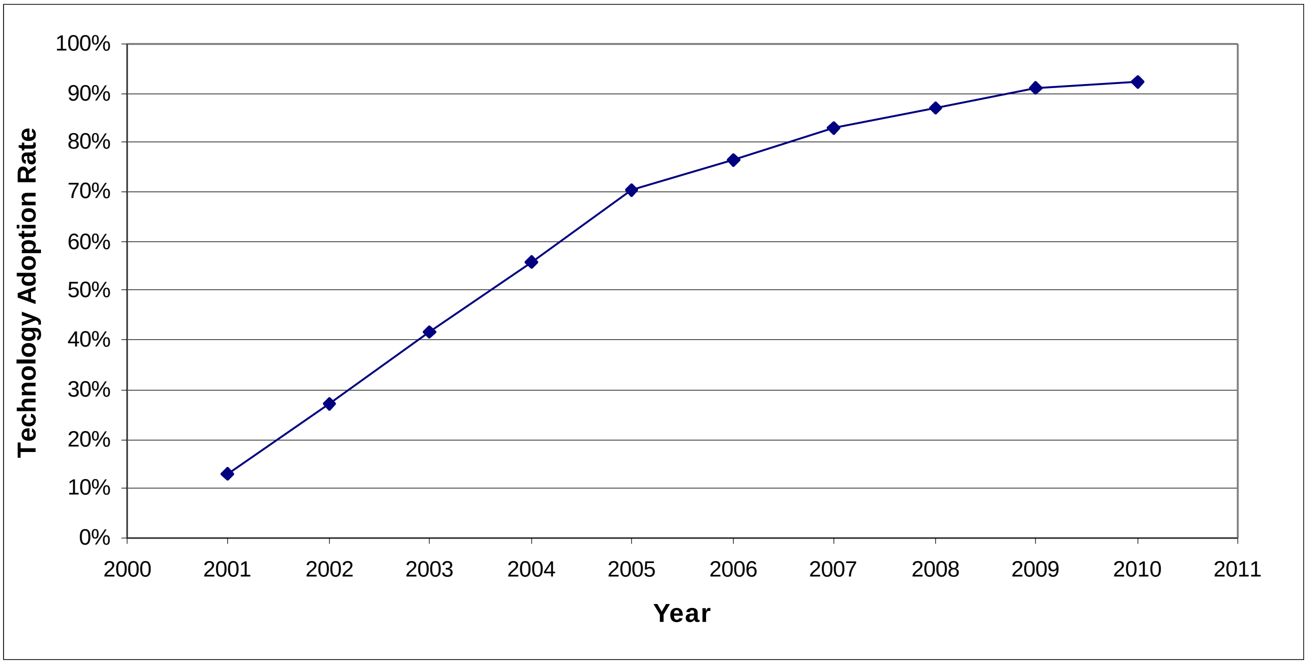
Potential Value of Technology	Percent of Respondents	Technology Adoption Start Date	Technology Adoption End Date	*Percent Adopting Technology*
5	43.09%	1	5	95%
4	15.96%	1	7	95%
3	25.00%	1	9	90%
2	3.72%	2	10	90%
1	12.23%	2	10	86.30%

Based on the above survey data and assumptions, the overall rate for the adoption of technology is calculated by aggregating the technology adoption rate across each of the *five groups* for each of the ten years. The overall percent of carriers adopting technology for each of the ten years is shown in Table 5.2.2 (B) and Figure 5.2.2 (a).

Table 5.2.2 (B). The Technology Adoption Rate for Maryland Commercial Motor Carriers for the Economic Life of the CVISN project.

Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Percent Adopting Technology	12.85	27.24	41.64	56.04	70.44	76.65	82.86	86.90	90.95	92.49

Figure 5.2.2 (a). The Technology Adoption Rate for Maryland Commercial Motor Carriers for the Economic Life of the CVISN project.

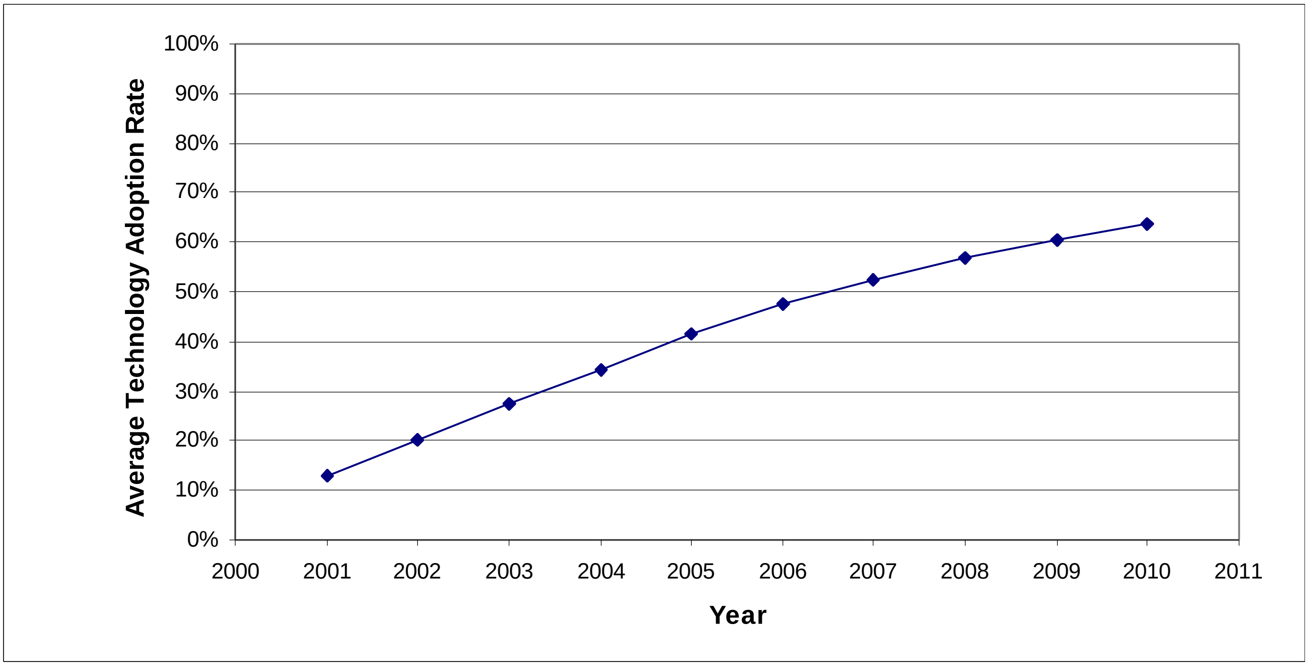


The average technology adoption rate or the average number of commercial motor carriers that will adopt the technology for the years 2001-2010 is calculated using the technology adoption rate given in Table 5.2.2 (B). Hence, the analysis assumes that the average number of motor carriers adopting technology 27.25% in the first three years, 41.65% in the first five years, and 63.81% for the economic life. This is shown in Table 5.2.2 (C) and Figure 5.2.2 (b).

Table 5.2.2 (C). The Average Technology Adoption Rate for Maryland Commercial Motor Carriers for the Economic Life of the CVISN project.

Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Average Percent Adopting Technology	12.85	20.05	27.24	34.44	41.64	47.48	52.53	56.83	60.62	63.81

Figure 5.2.2 (b). The Average Technology Adoption Rate for Maryland Commercial Motor Carriers for the Economic Life of the CVISN project.



5.3 Motor Carrier Costs

This section shows the costs incurred by the motor carriers for their participation in the CVISN program. As discussed in the earlier sections, the benefits incurred to both the motor carriers and state regulatory agencies directly correlate with the level of motor carrier participation and the implementation of proposed technology-based solutions. As motor carrier participation increases, carriers would incur associated costs but reap the benefits too. It should be noted that motor carriers only incur a *one-time* cost of purchasing the necessary computer and communications hardware and software and the transponder unit. However, motor carriers also start receiving program benefits when they begin participating actively in the program. Further, they accrue these benefits for every year they continue to participate in the program without incurring any other additional costs.

5.3.1. Model Assumptions

The key assumption for our BCA model is that motor carriers will begin to participate in the CVISN program from the Year 2000 and that the motor carrier rate of participation or the technology adoption rate (TA) follows the growth model as discussed in detail in Section 5.2. In other words, our model assumes that motor carriers will incur costs when they decide to actively participate in the program.

5.3.2. Cost Model for Computer and Communications Hardware and Software

Our model presumes that motor carriers will purchase the computer and communications hardware and software to profit from the advantages of speed and accuracy presented by automated electronic credential processing. Using the computer and communications hardware and software, under the CVISN program, motor carriers would be able to interact with all the Maryland state regulatory agencies for all of their credential processing functions. Furthermore, motor carriers would also be able to obtain online information on the current status of their application. Although motor carriers have the option of using their computer equipment to support their other business requirements and functions, 100% of the hardware costs is attributed to CVISN. Based on current market prices, the cost of each computer is assumed to be $1,200. Additionally, the model takes into consideration that currently 38% of the motor carriers own a computer with a modem. This is based on a comprehensive survey of the motor carrier industry (1998) conducted by The National Transportation Center at Morgan State University.

Computer hardware may need to be replaced due to failure and/or damage. The model uses a computer failure rate of *two percent* for every year beginning with the second year of the purchase. For example, if 100 motor carriers purchase a computer in Year 2001, then the model assumes that two of these will fail in Year 2002, another two of the motor carriers will need to replace their computer equipment in Year 2003, and so on. This failure rate, therefore, increases the total costs to the motor carriers.

The population of commercial motor carriers (MC) is obtained from the 1992 Maryland TIUS survey conducted by the Census Bureau (TIUS, 1992). The population of commercial motor carriers for each of the remaining years is calculated using an annual growth rate of 3%. This is a conservative estimate and is consistent with the growth rates of 3.16% reported by a survey of commercial motor carriers conducted by The National Transportation Center at Morgan State University (1998).

The annual total cost of computer equipment ($TC_{computer}$) to the motor carrier is calculated using the technology adoption rate (TA) for the total number of commercial motor carriers (MC) is as follows:

$$TC_{computer} = f\,(P_{computer})\,(TA)\,(MC).$$

where, $P_{computer}$ is unit price of a computer and a modem, and
f is the failure rate of computer hardware.

5.3.3. Cost Model for Transponders

The model also presumes that motor carriers will purchase the transponder unit for efficient transportation of their cargo and increased safety on Maryland highways. This is due to the fact that these units will enable a *legal* motor carrier to obtain pre-clearance and bypass a weigh and inspection facility. The transponder unit is fundamental to the concept of a *paperless truck* and will contain information regarding key parameters relevant to routine roadside inspection operations. These parameters include carrier ID, vehicle ID for all vehicle components, driver ID, trip ID, specially regulated load flag (if applicable), results of the last screening, summary of last inspection, and others. The use of these transponder units will enable safety enforcement agencies to focus their resources on high-risk motor carriers and drivers. Such agencies would then be able to conduct inspections and audits to provide incentives for carriers and drivers to improve, while enabling the legal and compliant motor carriers and drivers to conduct their business in a safer and more efficient environment. Additionally, the motor carriers could also use information stored on the transponder to support their proprietary applications such as vehicle and cargo location, driver performance, and others. Based on a report by Samuel (1998), the cost of the transponder unit is assumed to be $45.

For the analysis, it is assumed that the computer hardware has a failure rate of *two percent*, while the transponder unit is assumed to have a failure rate of *five percent*. The transponder unit is assumed to have a higher failure rate since it is on-board the moving motor vehicle and hence more vulnerable to failures due to various reasons including battery failure, abuse, and accidents. Just as in the earlier example of the computer equipment, this failure rate of the transponder unit will increase the total costs borne by the motor carriers.

The population (V) of commercial motor vehicles is obtained from the 1992 Maryland TIUS survey conducted by the Census Bureau (TIUS, 1992). The population of the commercial motor vehicles for each of the remaining years is calculated using an annual growth rate of 3%. The annual total cost of a transponder unit ($TC_{transponder}$) to the motor carrier is calculated using the technology adoption rate (TA) for the total number of commercial motor vehicles (V) is as follows:

$$TC_{transponder} = f\,(P_{transponder})\,(TA)\,(V)$$

where, $P_{transponder}$ is the unit price of a transponder unit, and
f is the failure rate of a transponder unit.

The safety and pre-clearance benefits due to the transponder unit to commercial motor carriers are discussed in detail Section 5.5. These benefits are assumed to accrue only to those motor carriers that use highways having weigh and inspection facilities. It is clear that these do not include the entire population of commercial motor vehicles in Maryland. Motor carriers that do not use these highways will have no incentives or reasons to purchase transponders. In lieu of hard data for the percentage of commercial vehicles using highways with weigh and inspection facilities, the model assumes that the entire population of commercial vehicles in Maryland will buy transponders at the growth rate shown in Section 5.2. This is extremely conservative, since only those motor carriers that travel these highways with weigh and inspection facilities will need to buy transponders.

Thus, the actual transponder penetration rate and the actual costs incurred to motor carriers for transponders will be much lower than those used by our cost model. For example, if only 50% of commercial motor vehicles use highways with weigh and inspection facilities, then the actual and the average transponder adoption rates will be lower. These actual and the average transponder adoption rates are shown in Tables 5.3.3 (A) and 5.3.3 (B) respectively.

Table 5.3.3 (A). The Technology Adoption Rate for Maryland Commercial Motor Carriers for the Economic Life of the CVISN project (50% of commercial motor vehicles use highways with weigh and inspection facilities).

Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Percent Adopting Technology	6.43	13.62	20.82	28.02	35.22	38.33	41.43	43.45	45.48	46.25

Table 5.3.3 (B). The Average Technology Adoption Rate for Maryland Commercial Motor Carriers for the Economic Life of the CVISN project (50% of commercial motor vehicles use highways with weigh and inspection facilities).

Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Average Percent Adopting Technology	6.43	10.03	13.62	17.22	20.82	23.74	26.27	28.42	30.31	31.91

Hence, the BCA model assumes that transponder costs are incurred by all commercial motor vehicles while the transponder benefits accrue only to those commercial vehicles that use highways having weigh and inspection facilities. This implies that the B/C ratio and the NPVs calculated by the BCA are conservative estimates.

5.3.4. Motor Carrier Cost Data

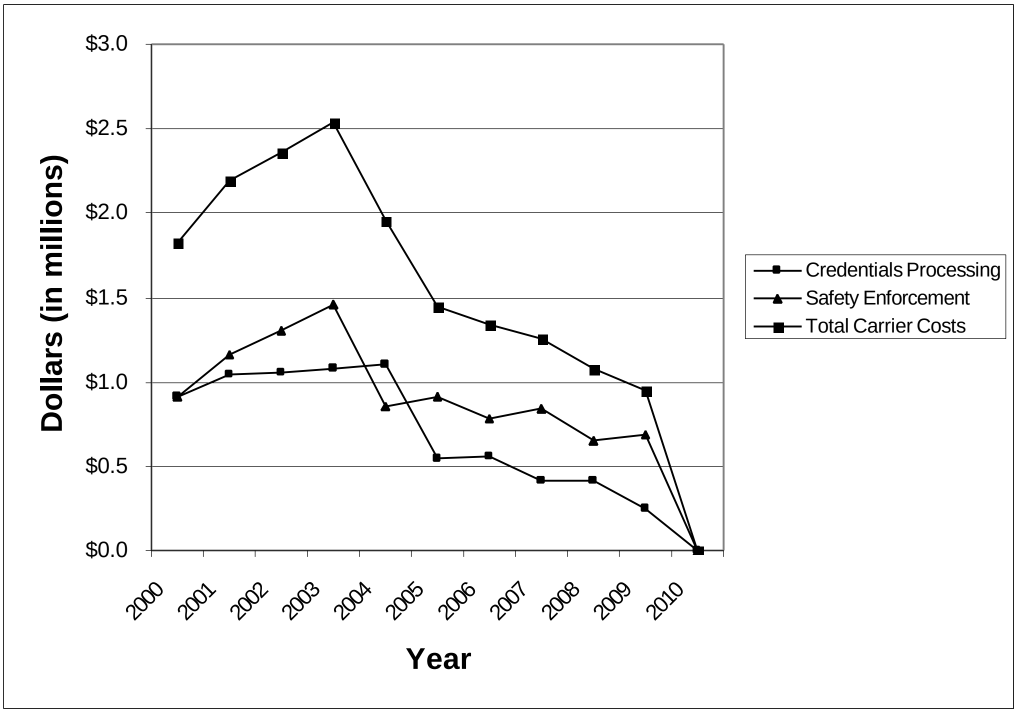
The following Table 5.3.4 (A) gives the *present value* for total cost incurred by commercial motor carriers for all CVISN related activities of credential processing and safety enforcement.

Table 5.3.4 (A). The Present Value for Commercial Motor Carriers for all CVISN-Related Activities at Different Discount Rates.

DISCOUNT RATE **CVISN Activity**	6%	7%	8%
Credentials Processing	$5,423,121	$5,171,437	$4,936,067
Safety	$6,834,426	$6,488,119	$6,166,037
Total	$12,257,546	$11,659,556	$11,102,104

Figure 5.3.4 (a) shows present values (in million dollars) for total costs incurred by participating commercial motor carriers for both CVISN related activities of credential processing and safety enforcement for each of the years from Year 2000 to Year 2010. As shown, initially the participation cost for motor carriers increases and then drops sharply. This is because, as stated earlier, motor carriers only incur these costs for the first time they are buying the equipment. Subsequently, they may incur additional costs only if their equipment fails.

Figure 5.3.4 (a). Present Values of Total Costs for Commercial Motor Carriers for all CVISN Related Activities.



5.4. Credential Processing Benefits

5.4.1. Maryland State Regulatory Agencies Benefits

This section shows benefits accrued by Maryland state agencies due to the implementation of the different components of CVISN for credential processing. The agencies whose tasks can be broadly classified as credential processing are as follows: Motor Vehicle Administration and Maryland Comptroller of the Treasury. A brief description of their major functions relating to CVISN and the different types of credentials (permits, registrations, decals, and others) they issue are as follows:

- **Maryland Motor Vehicle Administration (MVA)** issues International Registration Plan (IRP) titles and registrations, Commercial Drivers License (CDL), intrastate commercial vehicle registrations, as well as operating and maintaining all vehicle and driver record information.

- **Comptroller of the Treasury (COMPTR)** issues International Fuel Tax Agreement (IFTA) licenses and registrations with IFTA decals and temporary trip permits, conducts random audits of IFTA member accounts, and collects taxes.

Implementation of the different components of CVISN will reduce costs for regulatory agencies for several reasons. Major reasons for this are the impact of electronic data communications and the role of technology. A study has shown that Electronic Data Interchange (EDI) would save state agencies between $25-$35 per transaction. This is due to the fact that information currently being collected will be entered by the carrier or will be generated from historical data.

State officials would realize time saving benefits and the ease of sharing information between agencies. For example, if the carrier requires information regarding the status of an application for a credential, the information would be easily accessible. Processing and storing information electronically would also improve data accuracy, completeness, and integrity. This will further help state agencies process carrier applications more efficiently. The following section discusses several examples that illustrate the different ways in which these agencies can benefit.

5.4.1.1. Maryland Motor Vehicle Administration (MVA) - IRP

The International Registration Plan (IRP) section of the MVA administers registrations for commercial vehicles. The revenue collected by MVA from its 6500 IRP accounts was approximately 36 million dollars in 1996, of which $10 million was disbursed to other states that participate in the IRP apportionment program. MVA's staff performs various activities related to registration (initial registration, renewals, amendments, processing of one-time trip permits, collecting and disbursing money from/to other states and accounting functions). For registrations, the staff relies primarily on two non-integrated computerized systems (MVA database and VISTA). Due to lack of adequate staff, MVA is unable to conduct audits on its accounts. A class of its permits (trip permits) is purchased by a few clearinghouse wire services. Considerable savings can be achieved by processing these transactions electronically and providing automated access to its system for large customers.

5.4.1.2. Comptroller of the Treasury - IFTA

The two main functions of the International Fuel Tax Agreement (IFTA) program are 1) to issue an IFTA license and registration with decals, and 2) to collect appropriate fuel taxes from carriers who qualify for an IFTA license and decals. The two primary agencies involved with Maryland-IFTA processing are: The Maryland Comptroller's Office, located in Annapolis, and The Regional Processing Center in New York (RPC-NY). At the Maryland Comptroller's Office, the two units that are directly responsible for IFTA processing are the Motor Fuel Tax Unit (MFTU) and the Revenue Administration Division (RAD). Additionally, the staff at the Comptroller of the Treasury will also perform random audits on IFTA member accounts selected according to some per-specified criteria.

In 1996, Maryland-IFTA collected $270,361 from the sale of IFTA decals (at $7.00 per two decal set) from the 5500 active accounts within its jurisdiction. IFTA has a staff located at its central office and also personnel located at 20 field locations. They are responsible for performing various activities related to IFTA registration (initial, supplemental, and renewal), tax collection, and audits. Currently all IFTA registration application forms are processed manually and thus are subject to human error. Through automating the registration process, timesavings would be realized while human error could be minimized. Additionally, the IFTA staff at the field locations would be able to have online access to the central customer database and hence be able to operate more efficiently and effectively.

5.4.1.3 Maryland State Regulatory Agencies Benefits Model

A detailed analysis by the National Governor's Association (Rubel, 1998) has shown state agencies could have a benefit/cost ratio of 1:1 to 7:1 for electronic credentials processing. A comprehensive report by Apogee/Hagler Bailly, which is a compilation of several past studies and findings from ITS deployments, summarizes the COVE study. This study reports that state agencies responsible for administering credentials and permits could see a reduction of 33 to 40 percent in administrative costs if these services are offered electronically.

For the BCA, it is assumed that administrative costs consist of personnel costs at these agencies. However, other administrative costs such as communications and travel costs are not included in our BCA. Additionally, if fewer staff could be required at these agencies due to enhanced productivity, an additional decrease in other costs such as office space could produce additional capital cost savings. This could also lead to a further reduction in other related costs such as computer hardware and software, fuel and utilities, and others. This implies that the benefits due to electronic credential processing calculated by the model are a low estimate and a conservative figure.

In addition, this benefits model does not include the benefits that could be derived, as motor carrier participation in the CVISN program increases, the number of carriers that rely on existing current *manual* systems decreases, thus freeing up additional resources and reducing expenses of maintaining dual compliance systems.

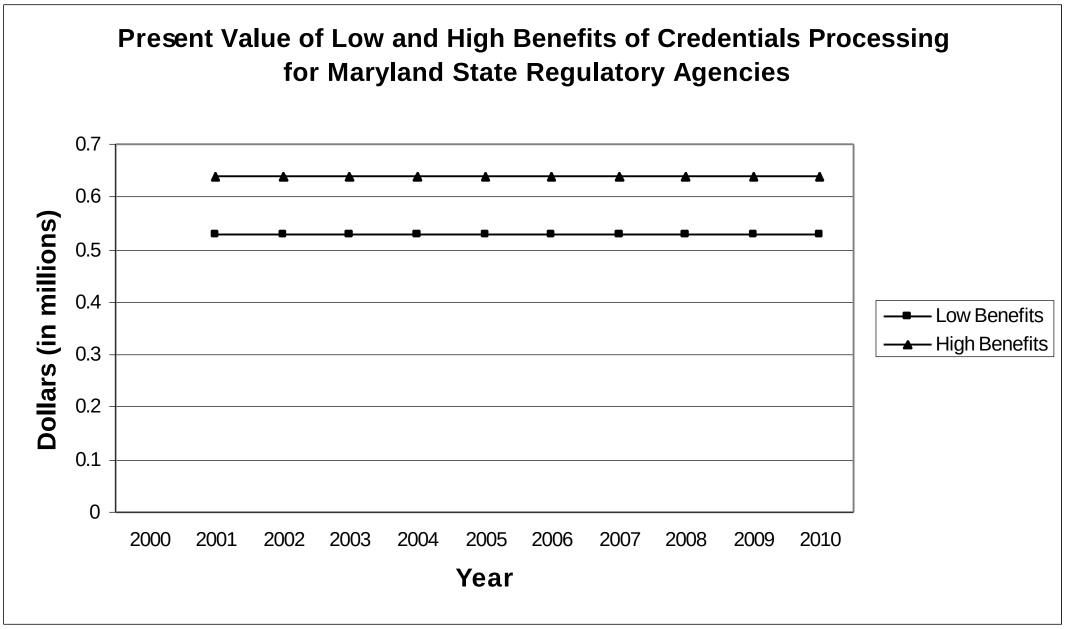
The following Table 5.4.1.3 (A) gives the *present value* for benefits accrued by the state agencies for credential processing activities. These benefits are calculated for both the low and the high values of 33% and 40% respectively.

Table 5.4.1.3 (A). The Low and High Present Value for Credential Processing Activities Only for Maryland State Agencies at Different Discount Rates.

DISCOUNT RATE	6%	7%	8%
Worst Case	$3,451,643	$3,232,554	$3,031,342
Best Case	$4,183,810	$3,918,247	$3,674,354

Figure 5.4.1.3 (a) shows present values (in million dollars) for both the high and low benefits accrued by the state agencies for credential processing activities for each of the years from Year 2000 to Year 2010. As expected, they are constant and represent savings of 33 percent and 40 percent in administrative costs at these agencies.

Figure 5.4.1.3 (a). Present Values of Low and High Benefits of Credentials Processing Activities for Maryland State Regulatory Agencies.



5.4.2. Commercial Motor Carrier Benefits

This section shows the benefits accrued by the Maryland commercial motor carriers due to their participation in the CVISN program and the related state regulatory agencies' implementation of the different components of CVISN for credential processing. This model accounts for the interaction of commercial motor carriers with two Maryland State regulatory agencies, Motor Vehicle Administration and Maryland Comptroller of the Treasury, for their credential processing needs. A brief description of their major functions relating to CVISN and the different types of credentials (permits, registrations, decals, and others) they issue to commercial motor carriers are as follows:

- **Maryland Motor Vehicle Administration (MVA)** issues International Registration Plan (IRP) titles and registrations, Commercial Drivers License (CDL), intrastate commercial vehicle registrations, as well as operating and maintaining all vehicle and driver record information.

- **Comptroller of the Treasury (COMPTR)** issues International Fuel Tax Agreement (IFTA) licenses and registrations with IFTA decals and temporary trip permits, conducts random audits of IFTA member accounts, and collects taxes.

5.4.2.1. <u>Carrier Perceptions of Electronic Credentials Processing</u>

Automation of the different components of CVISN by the Maryland state regulatory agencies will reduce administrative costs for a commercial motor carrier for several reasons. A major reason for this is the impact of electronic data communications and the role of technology. A comprehensive survey by The National Transportation Center at Morgan State University (1998) reports that motor carriers have indicated that they would prefer to use the automated credential processing services. They perceive that these services could enhance their productivity and improve the efficiency of the transactions. According to this survey, 37% of the respondents currently have Internet access while 10% of them have EDI (electronic data interchange) capabilities. The survey respondents were given the option to state their preference for Internet or EDI – based electronic credentials processing services. Overall, the survey respondents perceived a higher potential value for using the Internet versus EDI. Additionally, both EDI as well as Internet users believe that Internet has a higher potential value for their business.

5.4.2.2. <u>Assumptions</u>

A detailed report by Proper and Cheslow (October, 1997), which builds upon empirical results from field operations of deployed systems reports on The Automated Mileage and Stateline Crossing Operation (AMASCOT) evaluation. The AMASCOT evaluation by Maze et al (1996) estimated that motor carriers could see a reduction of 33 to 50 percent in administrative costs if these credential processing services are offered electronically.

For our BCA, we assume that administrative costs, consisting of personnel costs at these commercial motor carriers, vary depending on the size of the carrier. For small size carriers with different fleet sizes, we calculate the average hourly pay using the base wage data of selected positions from the Occupational Employment and Wage Data Report by the Maryland Department of Labor (1996). The criteria for selecting the type of position and the corresponding hourly pay are such that they would be commensurate with the type of activities required for obtaining the necessary credentials. For motor carriers with small fleet sizes it is reasonable to assume that the owner/operator would be performing all the administrative tasks. Alternatively, for motor carriers with more than five vehicles in their fleet, it is assumed that they would have clerical or other administrative support staff responsible for their credential processing activities.

The wage data given in this report is for 1996; hence, the hourly base wage rate for 1998 is obtained by using the Maryland's personal income growth rate of 4.7% for 1996 and 5.4% for 1997. Hancock (1998) reported this data in the Baltimore Sun and also reported that the national personal income growth rate for 1997 was much higher at 5.8%. The average hourly base wage for 1998 is then the average of the hourly base wage rate of the positions shown in the following tables. The model assumes that fringe benefits are 22% of the base pay. Tables 5.4.2.2 (A) and 5.4.2.2 (B) gives the wage data used to calculate the hourly wage rate for administrative costs for motor carriers with small fleet sizes and motor carriers with more than five vehicles in their fleet respectively.

Table 5.4.2.2 (A). Small Fleet Size Wage Data
1996 Occupational Employment and Wage Data Maryland

OES Code	Position	1996	1997	1998
		Inflation	4.70%	5.40%
			Hourly Wages	
21999	All Other Management Support Workers	18.38	19.24	20.28
19999	All Other Mangers and Administrators	19.86	20.79	21.91
15023	Communications, Transportation, and Utilities Operations Manager	19.94	20.87	22.00
			Hourly Wage	21.40
		Fringe Benefits	22%	4.71
			Total Hourly Wage	26.11

Table 5.4.2.2 (B). Medium and Large Fleet Size Wage Data
1996 Occupational Employment and Wage Data Maryland

OES Code	Position	1996	1997	1998
		Inflation	4.70%	5.40%
			Hourly Wage Rate	
59999	All Other Clerical and Administrative Support Workers	12.08	12.64	13.33
21999	All Other Management Support Workers	18.38	19.24	20.28
19999	All Other Mangers and Administrators	19.86	20.79	21.91
58099	All Other Material Recording, Scheduling, and Distributing Workers	11.77	12.32	12.98
97899	All Other Transportation and Related Workers	11.70	12.24	12.91
56002	Billing, Posting and Calculating Machine Operators	9.22	9.65	10.17
15023	Communications, Transportation, and Utilities Operations Manager	19.94	20.87	22.00
			Hourly Wage	16.23
		Fringe Benefits	22%	3.57
			Total Hourly Wage	19.80

However, we do not include other administrative costs such as communications and travel costs. Further, if fewer staff is required because of enhanced productivity, there could be an additional decrease in other costs, such as for office space; hence, there could be additional capital cost savings. This would also lead to a further reduction in other related costs such as computer hardware and software, fuel and utilities, and others. This implies that the benefits due to electronic credential processing calculated by our model are a low estimate and a conservative figure.

The total number of hours spent annually by commercial motor carriers on CVISN related credentials processing activities is modeled using data from a survey of Maryland-based motor carriers conducted in 1998 as part of this study. As shown in Table 5.4.2.2 (C), the total number of hours spent annually by commercial motor carriers on CVISN-related credentials processing activities ranges from 31.91 hours/year for motor carriers with less than five vehicles in their fleet to 128.15 hours/years for motor carriers with more than twenty-five vehicles in their fleet.

Table 5.4.2.2 (C). Average Hours Spent Annually by Maryland-based Commercial Motor Carriers for CVISN-related Credentials Processing Activities.

	Number of Vehicles in Fleet.		
	1-5	6-24	> 25
Average Annual Hours/Company	31.91	52.24	128.15

5.4.2.3. Commercial Motor Carrier Benefits

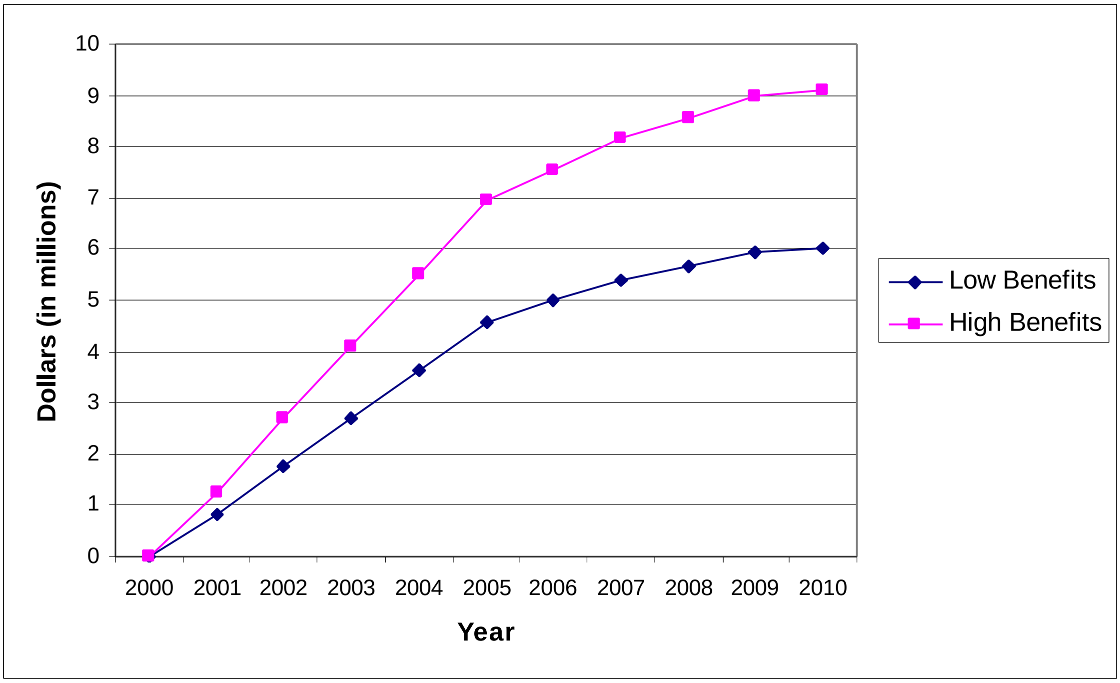
Table 5.4.2.3 (A) gives the *present value* for benefits accrued by commercial motor carriers for credential processing activities. These benefits are calculated for both the low and the high values of 33% and 50% savings in administrative costs accrued to commercial motor carriers respectively.

Table 5.4.2.3 (A). The Low and High Present Value for Credential Processing Activities Only for Maryland Commercial Motor Carriers at Different Discount Rates.

DISCOUNT RATE	6%	7%	8%
Best Case	$38,390,228	$35,524,121	$32,914,013
Worst Case	$25,337,550	$23,445,920	$21,723,249

Figure 5.4.2.3 (a) shows present values (in million dollars) for both the high and low benefits accrued by commercial motor carriers for credential processing activities for each of the years from Year 2000 to Year 2010. As shown, the present values of both the low and high benefits increase over time as the level of carrier participation in the program increases. For more motor carriers to participate, the motor carriers need to be educated and made aware of the significant benefits of this program.

Figure 5.4.2.3 (a). Present Values of Low and High Benefits of Credentials Processing Activities for Maryland Commercial Motor Carriers.



5.5. CVISN Safety Benefit Models

Safety is an integral and important feature of CVISN. Benefits due to the state's investment in the safety aspects of CVISN are modeled in this section. Such benefits include decreased accidents and decreased travel time by legal and safe carriers. Two factors that result in decreased accidents are modeled in this study: a) high-risk vehicle and/or driver identification and b) identification of illegally overweight vehicles. These factors are described next.

CVISN will help identify high-risk carriers that have had a history of out-of-service vehicles and/or drivers and/or higher accident rates. High-risk carriers and/or drivers are identified by means of tracking history of out-of-service violations for vehicles and drivers and/or higher accident rates. Such carriers and drivers have been known to cause a majority of accidents and pose a hazard to society. Vehicles and/or drivers that are in violation of federal and state regulations may be placed out-of-service until the violation is corrected. The accident rate due to commercial vehicles will decrease, assuming that carriers who have transponders can be identified for safety enforcement. This benefit, referred to as *Inspection Identification,* is described in Section 5.5.1. Carriers that do not have transponders will not profit from the state's investment in CVISN. Conversely, carriers who use a transponder benefit significantly, as shown below.

CVISN will also identify illegally overweight carriers. These carriers may be more likely to contribute to accidents. Weigh-in-motion scales (WIM), a sizable investment of CVISN, will allow more vehicles to be weighed. Therefore, more illegally overweight vehicles will be identified, resulting in a potential decrease in the accident rate. This benefit, referred to as *Overweight Identification,* is described in Section 5.5.2.

Vehicles with a read and write transponder meeting legal requirements may be allowed to travel at mainline speeds at weigh stations, as a result of the transponder exchanging data with the CVSIN system. This is referred to as pre-clearance of the vehicle and driver and in described in Section 5.5.3.

5.5.1. CVISN Inspection Identification Benefits

The safety benefits will be driven by the additional numbers of vehicles and drivers placed out-of-service by CVISN at roadside inspections. These additional out-of-service vehicles and drivers will result in decreasing the accident rate, which is quantitatively modeled in this analysis. For such an analysis, the benefits of placing vehicles and drivers out-of-service are first calculated in the existing inspection system. These figures are then used to estimate the benefits of CVISN to aid in identifying high-risk carriers. The implementation of CVISN will also have a deterrent benefit. This benefit has been added to the benefits resulting from CVISN.

The study team developed a methodology based on methodologies used in the Office of Motor Carrier study (Sienicki 1998) and that of Moses and Savage (1997). While those studies evaluated the benefits and costs of existing programs at a particular point in time, this study evaluates the future deployment of CVISN technology and resulting changes of benefits and costs. The safety benefits to society in the existing inspection system are calculated as follows:

(1) $X = V \times 3 \times 3625.83$ vmt

(2) $Y = D \times 3 \times 3625.83$ vmt

X is number of vehicle-miles of travel driven “safely” after vehicles are placed out-of-service and repaired, while Y is the number of vehicle-miles driven “safely” after drivers are placed out-of-service. V and D represent the number of vehicles and drivers placed out-of-service from the existing roadside inspection, respectively. The value 3625.83 is the average number of miles traveled monthly by a vehicle in Maryland and is based on the 1998 Commercial Vehicle Survey conducted by Morgan State University. The effect of placing a vehicle or a driver out-of-service lasts up to 3 months (Sienicki, 1998, Moses and Savage, 1997).

To estimate the number of motor carrier accidents avoided as a result of the existing inspection system, the number of motor carrier accidents that would have occurred without out-of-service placement must be calculated as follows:

(3) $CAx = 2.174X$

(4) $CAy = 2.174Y$

CA is the number of carrier accidents. Calculations for the number of carrier accidents per million vehicle-miles, 2.174, are explained in the remainder of the paragraph. The number is based on the 1995 accident value of 1.65 accidents per million miles for all heavy trucks in Maryland, as reported by the State Highway Administration (Maryland/Heavy Trucks/Statewide Accident Profile, 1996). Vehicles and/or drivers placed out of service would have a higher accident rate than this figure. Moses and Savage report that firms with poor safety records at roadside inspections have accident rates of 31.6% above average.

The number of accidents avoided (AA) is given by:

(5) $AAx = .06CAx$

(6) $AAy = .052CAy$

The analysis of Maryland Heavy Trucks/Statewide Accident Profile (SHA, 1996) revealed that approximately 6.0% and 5.2% of accidents are attributable to avoidable vehicle defects and driver problems, respectively. These numbers are consistent with the values of 4.6% and 5.7% reported by Sienicki (1998).

The direct annual safety benefit of putting drivers and vehicles out-of-service by the existing inspection system (Dben) is given as:

(7) $Dben = \$135{,}000(AAx + AAy)$

The figure $135,000 is the average weighted societal cost/ motor carrier of accidents avoided in 1996 dollars (Sienicki, 1998). Moses and Savage calculated a $118,211 cost in 1990-91 dollars. A higher amount in 1996 dollars seems appropriate, but given the low inflation since 1990, the 1996 figure does not warrant further inflating to 1998. Thus, the $135,000 is assumed to be in 1998 dollars as well. These costs do not include the cargo damage (approximately $5,000 per typical truck accident) which is not quantitatively modeled.

The next part of the model entails the calculation of direct annual benefits due to CVSIN. CVISN will aid in identifying high-risk carriers and drivers. The current inspection system is assumed to be efficient and leads to the identification of all high-risk vehicles and drivers who are then placed out-of-service. CVISN will lead to benefits only if the system is able to identify additional high-risk carriers to inspect, which should lead to a higher percentage of out-of-service vehicles and drivers. If vehicles in the population of all commercial vehicles traveling in Maryland have transponders that can communicate with CVISN, then the current pool of high-risk carriers can be expanded.

In the current system, vehicles and/or drivers are placed out-of-service from the pool of commercial vehicles that are visually inspected at the weigh facility. This pool is the number of commercial vehicles currently being weighed (W). This number is less than the population of commercial vehicles that an identification system can potentially target.

The maximum possible annual benefits ($Dben_{MAX}$) of an identification system that will identify all drivers and/or vehicles to be placed out-of-service will therefore be given by:

(8) $Dben_{MAX} = Dben * (P - W) / W$

P is the population of commercial vehicles traveling annually on Maryland highways with weigh facilities, during facility hours of operation, while W is the total number of commercial vehicles weighed annually at Maryland weigh stations. However, these maximum benefits can not be realized, since this entails a perfect identification system (a ideal system that can identify all high-risk carriers and/or drivers).

The discussion on the identification of high-risk drivers and/or vehicles by the CVISN system is given next. Lantz et al.'s (1996) analysis provides information on the percent of carriers having recurring out-of-service rates for drivers and vehicles. Our analysis assumes that in the worst case, the CVISN system will be able to identify all of the worst 5% of offenders, and in the best case, CVISN will be able to identify all of the worst 40% of offenders who have historically been placed out-of-service or are likely candidates to be placed out-of-service. The worst 5% identification level includes 33.3% of all vehicles and 66.6% of all drivers while the worst 40% identification level includes 71.1% of all vehicles and 93.3% of all drivers. The analysis assumes that identification of these vehicles and/or drivers can take place if the carriers have a transponder (benefits of an ASPEN-based identification system are not modeled). Therefore, the best case benefits of identifying all of the worst offenders is given by:

(9) $$Dben\_CVISN_{BEST} = 135{,}000\ (AAx\ \ 0.711 + AAy\ \ .933)\ \ T\ \ (P - W) / W$$

In the above equation, T is the fraction of carriers currently not being inspected that have transponders. The worst case benefits of identifying all of the worst 5% of offenders is similarly given by:

(10) $$Dben\_CVISN_{WORST} = 135{,}000\ (AAx\ \ 0.333 + AAy\ \ .666)\ \ T\ (P - W) / W$$

The OMC study and that of Moses and Savage calculate deterrence benefits of roadside inspections. The existence of the program deters motor carriers from unsafe vehicle or driver operations. Moses and Savage believe that the deterrence value ranges from 25% to 50% of the direct benefits, with the figure being closer to 25%. It is believed that CVISN's concentration on motor carriers with poor safety records will bring about an increase in deterrence benefits and a reduction in the number of vehicles/drivers placed out-of-service, therefore leading to a reduction in the direct benefits. It is also assumed that the deterrence benefit will increase proportionally from 25% to 50% over the 10-year life, but the direct benefit will decline by an equivalent amount. This assumption results in a total safety benefit that remains the same, despite changes in direct and deterrence effects. Note: revenues from fines will decline, as out-of-service placements decline.

(11) $$Totben_{CVISN} = (Dben\_CVISN + .25Dben\_CVISN)$$

$Totben_{CVISN}$ is the annual total safety benefit for each of the 10 years of the CVISN identification system.

The generation of safety benefits to society from roadside inspections incurs some costs to motor carriers. In addition to revenues from fines, there is the cost of being out-of-service. One may argue that the costs of being out-of-service are the obligation of the motor carrier whether placed out-of-service or not. This is correct; however, if the existing out-of-service system were not in place, those costs would be avoided, which would benefit motor carriers but add a cost to society in terms of increasing the number of accidents. The concepts are shown below:

(12) $MCC_{CVISN} = \$23(1.5V_{CVISN}+4D_{CVISN})$

MCC_{CVISN} is the additional annual motor carrier cost related to the safety benefit, while V_{CVISN} and D_{CVISN} are the additional numbers of vehicles and drivers placed out-of-service, respectively, due to the impact of CVISN. The $23 figure is a per person (driver) value per hour for tractor trailer trucks (Transportation Research Circular 477, 1998). It is commonly assumed that there is no additional value given to time for vehicles other than when in operation, although a truck sitting idle does incur costs. The coefficients of 1.5 and 4 are the average delay in hours for vehicles and drivers placed out-of-service, respectively.

The additional number of vehicles and drivers placed out-of-service is given by:

Best Case (13) $V_{CVISN} = 0.711\ V\ T(P - W)/W$, $D_{CVISN} = .933\ D\ T(P\text{-}W)/W$

Worst Case (14) $V_{CVISN} = 0.333\ V\ T(P - W)/W$, $D_{CVISN} = .666\ D\ T(P\text{-}W)/W$

However, there are other costs. A consequent lack of on-time delivery by out-of-service vehicles or drivers is a cost to motor carriers. Repair costs could also be incurred. To value such costs is beyond the scope and resource constraints of this study. In order to "compensate" for the inability to value such costs, the study team did not attempt to value the benefits of avoiding accidents as a result of being out-of-service and correcting defects as applied to motor carrier firms. Motor carrier accidents can result in significant driver delays and vehicle damage. For the sake of simplicity, the study team has assumed that these costs and benefits cancel out each other. Therefore, the annual net safety benefit of placing drivers and vehicles out-of-service ($Netben_{CVISN}$) by the CVISN identification system is given as:

(15) $Netben_{CVSIN} = Totben_{CVISN} - MCC_{CVISN}$

Based on conversations at IACG meeting on July 14,1998, as well as telephone conversations with Corporal Stanton on July 16,1998, the study team estimates P (the population of trucks) to be approximately 4 times the value of W. The benefit analysis assumes that for the best case scenario, P is 5 times the value of W, while for the worst case scenario, P is 3 times the value. Thus, for maximum benefits, the team assumes that $(P - W)/W = 4$. For minimum benefits, this ratio is assumed to be 2. A lower value of this ratio will decrease the benefits associated with inspection identification, while the benefits of pre-clearance will increase substantially, as described in Section 5.5.3.4.

The values of the current number of vehicles placed-out-of-service (V) and drivers placed out-of-service (D) are assumed to be 14.57% and 6.30%, respectively, of the total number of inspections and are based upon the 1996 MSP and 1996 MdTA annual reports. While the number of vehicles to be placed out-of-service is independent of Level III inspections, the percentages used above provide a consistent statistical value to be used for modeling the inspection identification benefits.

Table 5.5.1(A) lists the present value of the benefits for the three discount rates: 6%, 7% and 8%. This table does not list the costs incurred to avail the benefits.

Table 5.5.1(A). The Present Value of Inspection Identification Benefits

DISCOUNT RATE	6%	7%	8%
Best Case	$20,854,983	$19,294,219	$17,873,234
Worst Case	$20,129,171	$18,622,726	$17,251,196

These benefits are availed by significant investments by the state agencies and the carriers. The significant cost to the carrier is the transponder cost. Our estimates for the transponder costs are conservative as described in Section 5.3.

5.5.2. Overweight Identification Benefits of WIM

The safety benefits will also be driven by the decrease in the number of accidents resulting from identifying more overweight carriers. For this analysis, it is assumed that overweight vehicles that have the necessary OW permits are legally overweight and therefore are likely to comply with OW safety regulations. Those carriers that have not obtained OW permits are illegally overweight and less likely to comply with OW safety regulations.

The number of illegal overweight miles traveled annually (M_{OW}) is given by:

(1) $M_{OW} = M_{all} * F_{OW}$

where

M_{all} : Number of miles (in millions) traveled by all vehicles on Maryland highways

$F_{OW:}$ Fraction of vehicles on the road that are overweight illegally

In Maryland, the accident rate for all vehicles in 1995 was 1.65 accidents/million miles (Maryland Heavy Trucks/Statewide Accident Profile SHA, 1996). The number of miles (in millions) traveled by all vehicles on Maryland highways during the 10 years of the project is estimated. This estimate is based on the fact that 3,400 million vehicle miles were traveled during 1996 (Maryland Heavy Trucks/Statewide Accident Profile SHA, 1996) and that these miles will increase by 3% each year. The fraction of all vehicles on the road that are illegally overweight is estimated to be 1.3% (1997 Annual Report Governor's Motor Carrier Task Force for Safety and Uniformity). The accident rate for these illegally overweight vehicles may be higher when compared to the accident rate of all vehicles (TRB, 1998; Fancher and Campbell, 1995). For example, overweight vehicles may need a longer distance to come to a stop after braking. On some road conditions (e.g., wet roads, icy roads), this effect is magnified. Moses and Savage (1997) report that carriers who perform poorly in safety inspections have a 31.6% higher accident rate when compared with the average accident rate. These carriers have higher than average accident rates not only because they may be overweight, but also because they practice poor vehicle maintenance and driving habits. In lieu of the hard data, this analysis assumes that slightly more than half of the increase in the accident rate (18%) is attributable to illegally overweight carriers.

Therefore, the number of additional accidents caused by illegally overweight vehicles (A_{OW}) is given by:

(2) $A_{OW} = 1.65 * 18.0\% * M_{OW}$

Since the cost per accident is $135,000 (see Section 5.5.1), the cost of these accidents is given by:

$$(3) \qquad C_{OW} = 135{,}000 * A_{OW}$$

Currently, W vehicles are being weighed. The loss to society (L_{OW}) of not weighing these W vehicles would be:

$$(4) \qquad L_{OW} = 135{,}000 * A_{OW} * (W/P)$$

P is the population of heavy vehicles traveling on Maryland highways, and the value of the ratio W/P was described in Section 5.5.1.

Therefore, the benefits (B_{OW}) of identifying overweight vehicles by CVISN is given by:

$$(5) \qquad B_{OW} = C_{OW} - L_{OW}$$

Figure 4.3.2(a) in Section 4.3 shows the benefits (in 1998 dollars) due to the reduction in accidents caused by identifying illegally overweight carriers. The present value of these benefits (in 1998 dollars) is shown in Table 5.5.2(A) with three discount rate assumptions: 6%, 7%, and 8%. This table does not indicate the costs necessary to avail the benefits.

Table 5.5.2(A). The Present Value of Weighing Benefits

DISCOUNT RATE	6%	7%	8%
Best Case	$12,568,391	$11,744,026	$10,988,481
Worst Case	$10,473,659	$9,786,689	$9,157,067

Compared to other benefits resulting from safety investments (inspection identification benefit described in Section 5.5.1, and pre-clearance weighing benefits described in Section 5.5.3), the benefit of accident reduction due to identifying overweight vehicles is much smaller. This benefit is approximately half the benefit of identifying high-risk carriers, and one-sixth the pre-clearance benefits. Thus, the net impact of this benefit is negligible to the overall B/C ratios.

5.5.3. Pre-Clearance Weighing Benefits

Commercial vehicles need to be weighed primarily out of the necessity for public safety and to prevent damage to roads. Recognizing the direct relationship between the quality of enforcement and the degree of public safety enjoyed by Maryland citizens, several weigh and inspection facilities have been placed on major highways throughout the state to ensure that carriers are in compliance with the law (Maryland State Police, 1996). Additionally, roving crews patrol the “non-major” and surrounding highways in an effort to prevent carriers from bypassing and avoiding inspections. While weighing is beneficial to society, it is a time consuming activity for carriers who bear substantial costs associated with the weighing activity.

At the heart of CVISN is the feature of pre-clearing legal vehicles and drivers on highways. This is achieved by means of several technologies - the key technologies being WIM (Weigh-In-Motion scales) and transponder systems. Several benefits accrue due to the pre-clearance systems. These include benefits to carriers, regulatory agencies, and society. Carrier benefits include less travel time since a vehicle equipped with a transponder may continue to travel at mainline speeds without stopping at the weigh facility. Agency benefits accrue as a result of automating the weighing functions, which leads to resources being used more efficiently, thereby allowing the safety enforcement agencies to concentrate their efforts on poor–safety carriers and/or drivers. Targeting high-risk carriers and/or drivers will lead to lowering the accident rate and is therefore beneficial to society.

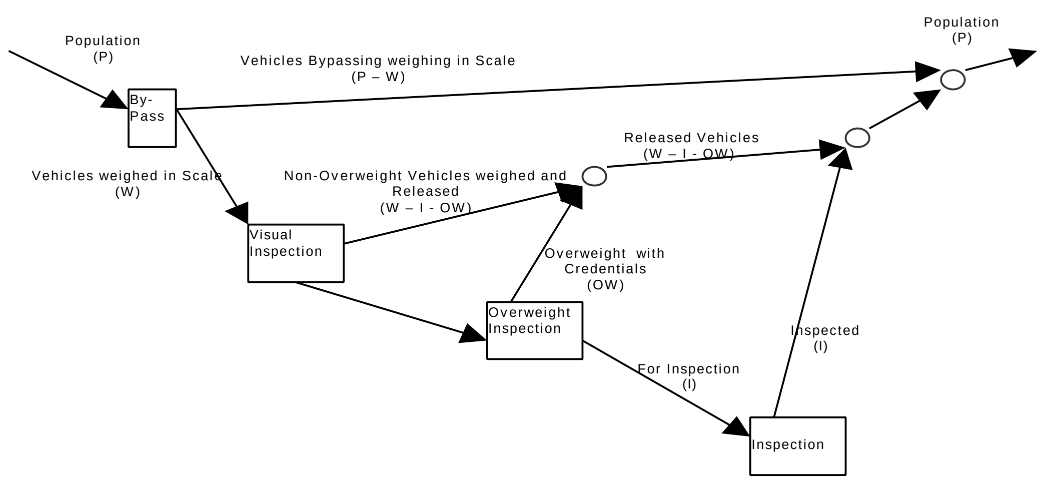
The model of the transponder benefits when combined with WIM is described next. To aid in understanding the models, please refer to Figures 5.5.3.1(a), 5.5.3.2(a), and 5.5.3.3(a). Figures 5.5.3.1(a), 5.5.3.2(a), and 5.5.3.3(a) describe the logical situations without WIM (conventional weigh scale), with WIM but without any transponders, and with WIM along with transponders (CVISN enhancement).

5.5.3.1. Conventional Weigh Scales

At the fixed weigh and inspection facilities, vehicles with a gross weight over 10,000 pounds must enter the weigh/inspection facility. Upon entrance, at some of the facilities there are two lanes in which a vehicle can travel. Lane one is for weighing vehicles, while lane two allows vehicles to bypass the scale. A signal is positioned on the entrance ramp to notify a vehicle of the to lane travel. If a vehicle is signaled to go through the bypass lane, it is not weighed and is allowed to continue on to its destination. For safety considerations, vehicles are allowed to bypass the scale at times of heavy traffic on the highway. When a vehicle is signaled to enter the scale lane, it is weighed and visually inspected. At that point, several factors are considered. These factors determine whether the vehicle is requested to pull into the inspection area to receive a Level I, II, III, or IV inspection, written warning, or citation for the violation. These variables fall into one of three categories: overweight violations, random selection, and/or visual violations.

A vehicle can fall into the overweight violations category if the gross vehicle weight, axle weight, or the bridge formula exceeds the allowable limit as specified in the Maryland Transportation Article (Maryland Vehicle Law). Visual violations are identified when a vehicle is on the weigh scale. The inspectors follow guidelines that pertain to the weighing and measurement of vehicles as established by both federal and state regulations. In most cases, the inspector relies on visual observation of the vehicle. Violations that are noted can vary in nature, e.g. missing IFTA decals, damaged/bald tires, cracked windshield, obvious equipment violations, improperly secured cargo, and other sundry violations. These visible violations are grounds for a vehicle to undergo closer inspection, which can be one of the following types: Level I, II, III, or IV.

Figure 5.5.3.1(a). Logical Model of Platform Scale



The model of a conventional weigh scale based on the above follows. Assume a population P travels on the road during hours of operation of the weigh facility. Of these, W vehicles are pulled in for weighing. The remaining vehicles (P-W) bypass the scales primarily due to resource constraints on the part of the regulatory agency. All of the W vehicles pulled in to the fixed facility undergo a visual inspection and a weight check. Of these W vehicles, I undergo inspection, and OW overweight vehicles undergo the weight and credential check. The remaining vehicles (W-I-OW) are weighed, visually checked, and allowed to continue on their journey. The total time (excluding inspection) spent by the carriers in the model is given by:

(1) $T_{CONV} = t_{OW}(OW) + t_{OK}(W\text{-}I\text{-}OW) + t_{BY}(P\text{-}W)$

where

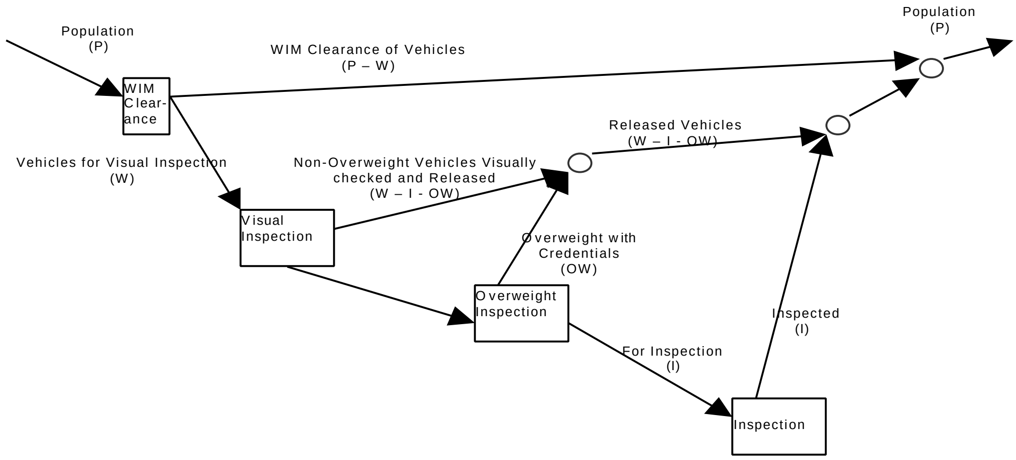
P:	Population of vehicles traveling during the hours of operation of the fixed weigh facility.
W:	Number of vehicles weighed at the fixed facility.
OW :	Number of overweight vehicles.
I:	Number of Level I, II, III, IV vehicle and/or driver inspections.
T_{CONV} :	Total time (minutes)excluding inspection, spent by vehicles at weigh facility.
$t_{OW:}$	Average time (minutes) taken by overweight vehicles at weigh facility.
t_{OK}:	Average time (minutes) taken by non-overweight vehicles who are only visually checked at weigh facility.
t_{BY}:	Average time (minutes) taken by vehicles at weigh facility who bypass the visual inspection.

The time components are described next. Vehicles spend approximately 1.25 minutes to travel the distance of the weigh station at mainline speeds; i.e., the vehicles do not come into the weigh facility (Center for Transportation Research, Iowa State University, 1997). This time will be referred to as γ_{MAIN}. The B/C ratios are insensitive to the assumptions behind the value of γ_{MAIN} as borne by a sensitivity analysis carried out by the research team. For vehicles that bypass the visual inspection, it is assumed that they take an additional 1 minute each for deceleration and acceleration i.e., $t_{BY} = 2 + \gamma_{MAIN}$. Based on the analysis of Titus (1995), commercial vehicles could save five minutes for each weigh enforcement stop bypassed, including three minutes for queuing and weighing, and two minutes for deceleration and acceleration. This is the time taken by vehicles that are visually inspected at the weigh station and released into the mainline. Thus, $t_{OK} = \gamma_{MAIN} + 5$. This analysis assumes that an additional 2 minutes are taken for overweight vehicles to verify their credentials. Thus, $t_{OW} = t_{OK} + 2$. Additional time for citations, if issued, would be incurred during the Inspection process (see Figure 5.5.3.1(a)).

5.5.3.2. Weigh-in-Motion (WIM)

WIM systems provide continuous weighing of all vehicles at mainline speeds. Figure 5.5.3.2(a) illustrates a typical WIM facility.

Figure 5.5.3.2(a). Logical Model of Weigh-In-Motion



The WIM model is similar to the conventional scale model. The average time component in several cases is smaller for WIM when compared to conventional weigh scales. The number of vehicles being visually inspected is also different. Assume a population P travels on the road during hours of operation of the weigh facility. The WIM system clears (P-W) vehicles that bypass the scales. The remaining W vehicles are pulled in for weighing. Of the W vehicles pulled in to the WIM facility, I vehicles undergo inspection, OW overweight vehicles undergo the credential check. The remaining vehicles (W-I-OW) are allowed to continue on their journey after a visual inspection. The total time (excluding inspection) spent by the vehicles in the WIM facility is given by:

(2) $T_{WIM} = \delta_{OW}(OW) + \delta_{OK}(W\text{-}I\text{-}OW) + \delta_{BY}(P\text{-}W)$

where

- P: Population of vehicles traveling during the hours of operation of the WIM weigh facility.
- W: Number of vehicles not allowed to by-pass by the WIM system.
- I: Number of Level I, II, III, IV vehicle and/or driver inspections.
- OW : Number of overweight vehicles.
- T_{WIM} : Total time (minutes)excluding inspection, spent by vehicles at WIM facility.
- $\delta_{OW:}$ Average time (minutes) taken by an overweight vehicle at WIM facility.
- δ_{OK}: Average time (minutes) taken by non-overweight vehicles that are only visually inspected and then released.
- δ_{BY}: Average time (minutes) taken by vehicles at WIM facility that bypass the visual inspection.

Time components for WIM are described next. Non-overweight vehicles that are only visually inspected and then released spend an additional 1 minute each for deceleration, acceleration, and stoppage over mainline times i.e., $\delta_{OK} = 3 + \gamma_{MAIN}$. This analysis assumes that an additional 2 minutes is taken for overweight vehicles to verify their credentials. Thus, $\delta_{OW} = \delta_{OK} + 2$. Vehicles that bypass the visual inspection take the same amount of time as they would take in a conventional scale i.e., $\delta_{BY} = t_{BY} = 2 + \gamma_{MAIN}$.

Compared to the conventional weigh scale, WIM offers substantial safety and travel time benefits. Safety benefits of identifying overweight carriers are realized since WIM allows more vehicles to be weighed. Such carriers pose greater accident risks. This has been discussed in Section 5.5.2. The travel time benefit of WIM allows carriers to pass through the weigh/inspection facility faster, thereby saving the carriers the unproductive weighing time. The travel time benefit is explained in details below.

The travel time benefits of WIM will be driven by the decrease in time carriers spend in the WIM weigh facility when compared with the conventional weigh scale.

$$TT\$_{WIM} = (T_{CONV} – T_{WIM}) * \text{Carrier Cost/minute}$$

where
$TT\$_{WIM}$: Travel time benefits in Dollars
$(T_{CONV} – T_{WIM}) = TT_{WIM}$ (minutes): Savings in travel time in minutes

The model of WIM is similar to the model of the conventional scale, and the bypass times are the same for both the models i.e., $t_{BY} = \delta_{BY}$. Therefore, the travel time reduction of using WIM is composed of two parts: a) the reduction in time (in minutes) for non-overweight loads that are only visually checked, and b) the reduction in the time (in minutes) for overweight loads. In the following equation, W is the number of commercial vehicles being weighed by conventional scales.

$$TT_{WIM} \text{ (minutes)} = (t_{OK} - \delta_{OK})(W – I – OW) + (t_{BY} - \delta_{BY})OW$$

$$TT_{WIM} \text{ (minutes)} = 2(W – I – OW) + 2\ OW$$

The results of the travel time benefits are described after the pre-clearance weighing benefits section.

5.5.3.3. Pre-Clearance at Weigh-in-Motion (WIM) Scales

Vehicles meeting legal requirements with a read and write transponder may be allowed to travel at mainline speeds as a result of the transponder exchanging data with the CVSIN system. This is referred to as pre-clearance of the vehicle and/or driver. Legal requirements for pre-clearance of a vehicle are as follows: 1) the vehicle is within the weight limits; and 2) the vehicle credentials have been checked to verify that the vehicle has IFTA permits, IRP registrations, and proof of payment of fuel taxes. Pre-clearance also requires that the vehicle and/or driver have been cleared by the automated inspection system. Electronic screening will be initially based on carrier-based data associated with credentials and safety. When data security issues are addressed and technology standards set (e.g., DSRC), comfort levels associated with the use of data on vehicles and drivers can be included in the roadside screening process.

Figure 5.5.3.3(a) illustrates a typical Pre-Clearance Model. Compared to the WIM model, vehicles with transponders may be allowed to travel at mainline speeds as described above.

Assume a population of vehicles (P) travels on the weigh facility roads during the facilities' hours of operation. Also assume that of these, T percent of the vehicles are equipped with a read/write transponder. I vehicles have been identified by the CVISN clearance system as requiring inspection. Therefore, only T(P-I) vehicles can be pre-cleared. Of these, assume that a fraction of the transponder equipped vehicles (f), even though they can be pre-cleared, are not allowed to pre-clear. This is done primarily to maintain the deterrent effect and will be implemented by randomly selecting vehicles for pulling into the weigh facility. Therefore, only (1-f)T(P-I) of the vehicles are pre-cleared. The remaining vehicles that are not pre-cleared ((P – (1-f)T(P-I)), are pulled in to the weigh station.

All of these vehicles may not be subjected to visual inspection. If the number of these vehicles is more than the capacity of the weigh station (W), only W vehicles will be subjected to visual inspection and the remaining (P – (1-f)T(P-I) – W) will bypass the visual inspection (Figure 5.5.3.3(a)). If the number of vehicles that are not pre-cleared is less than the capacity of the weigh station, then all of the W vehicles will be subjected to the visual inspection. In effect, no vehicles will bypass the visual inspection (Figure 5.5.3.3(b)). In either case, of these, (1-(1-f)T)OW overweight vehicles are allowed to go on to the highway after checking their permits. Those that are identified as needing inspection (I) are pulled over for inspection. The remaining vehicles that satisfy the visual inspection are allowed to return to the highway. This remaining number of vehicles (satisfying the visual inspection) depends upon the capacity of the weigh station as described earlier. When the number of vehicles not pre-cleared is greater than W, i.e., P-(1-f)T(P-I) > W, the number of vehicles being visually inspected is W. Of these, all overweight vehicles will have to undergo the overweight inspection. The number of vehicles subjected to overweight inspection and Level I, II, III or IV inspections will therefore be I + (1-(1-f)T)OW. Thus, W – (I + (1 - (1-f)T)OW) vehicles satisfy the visual inspection and are released after that inspection.

In the other case, when the number of vehicles not pre-cleared is less than W, i.e., P-(1-f)T(P-I) < W, all vehicles are subjected to visual inspection and the number of vehicles that satisfy the visual inspection is given by (1-(1-f)T)(P-I-OW). The number of vehicles not pre-cleared is determined by the adoption of transponders by the carriers. Initially, a large number of vehicles will enter the weigh facility. As transponders become more prevalent, the number of vehicles being pre-cleared will increase - eventually to the point that there are no constraints to visually inspect all vehicles that come into the weigh facility. At this stage, the inspection agencies can expect to expend less resources in visual inspection (this benefit cannot be modeled quantitatively).

The total time (excluding inspection) spent by the vehicles in the pre-clearance WIM facility when the number of vehicles coming into the weigh facility is greater than the capacity of weighing is given by:

$$(3) \qquad T_{PRE} = \gamma_{OW}(1-(1-f)T)(OW) + \gamma_{BY}(P - (1-f)T(P-I) - W) + \gamma_{OK}(W - (I + (1-(1-f)T)OW)) + \gamma_{MAIN}(1-f)T(P-I)$$

When the number of vehicles coming in to the weigh facility is less than the capacity of the weigh station, then the total time (excluding inspection) is given by:

$$(4) \qquad T_{PRE} = \gamma_{OW}(1-(1-f)T)(OW) + \gamma_{OK}((1-(1-f)T)(P-I-OW)) + \gamma_{MAIN}(1-f)T(P-I)$$

where

- P: Population of Vehicles traveling during the hours of operation of the WIM weigh facility.
- T: Fraction of vehicles equipped with a transponder.
- f: Fraction of vehicles equipped with a transponder who are not pre-cleared.
- W: Number of vehicles not allowed to bypass the WIM system.
- OW : Number of overweight vehicles.
- I: Number of Level I, II, III, IV vehicle and/or driver inspections.
- T_{PRE} : Total time (minutes)excluding inspection, spent by vehicles at WIM facility.
- γ_{OW}: Average time (minutes) taken by overweight vehicles a majority of which are not equipped with a transponder, at the WIM facility.
- γ_{OK}: Average time (minutes) taken by non-overweight vehicles that are visually inspected and then released to the mainline.

γ_{BY}: Average time (minutes) taken by non-overweight vehicles that have been pulled into the weigh facility, but released by the WIM scale to by-pass the visual inspection.

γ_{MAIN}: Average time (minutes) taken by transponder equipped vehicles that continue traveling at mainline speeds.

All time components for pre-clearance are assumed to be identical to WIM only (i.e., $\gamma_{OK} = \delta_{OK} = 2 + \gamma_{MAIN}$, $\gamma_{BY} = \delta_{BY}$, and $\gamma_{OW} = \delta_{OW}$).

Figure 5.5.3.3(a). Logical Model of Pre-clearance through WIM with no constraints on Weighing Capacity

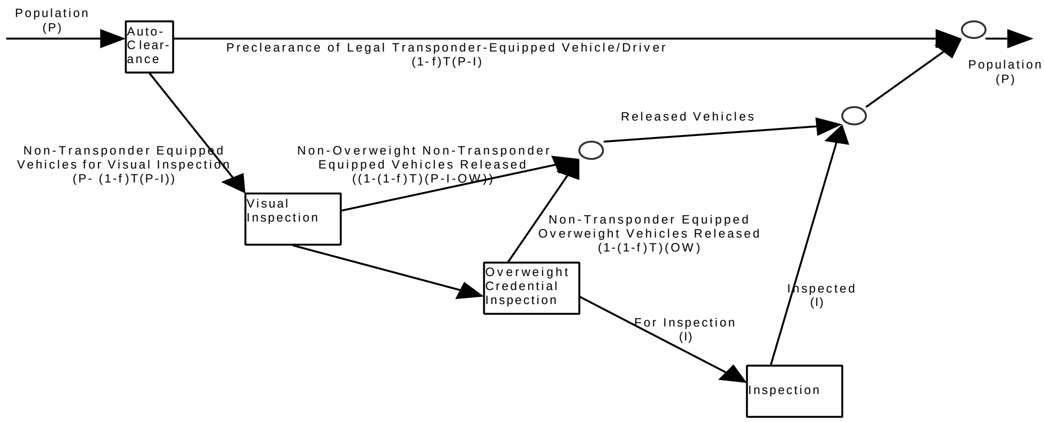
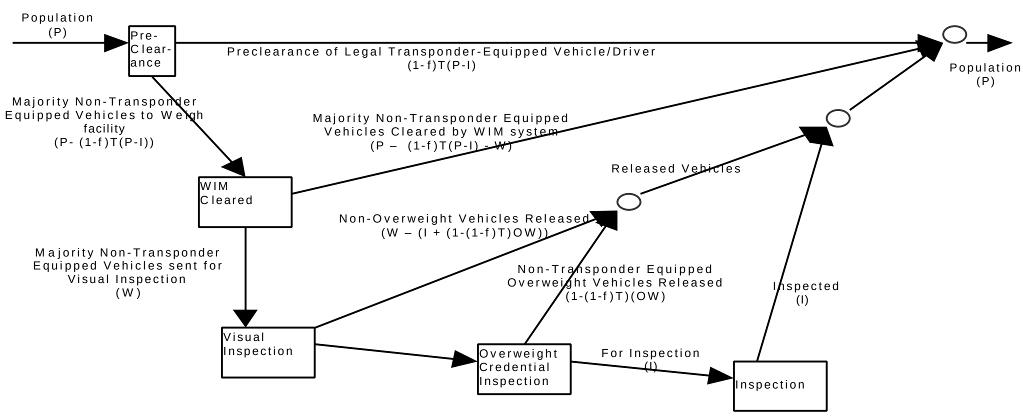


Figure 5.5.3.3(b). Logical Model of Pre-Clearance through WIM with Capacity Constraints for Weighing



5.5.3.3.1. Pre-Clearance Weighing Benefits

For weighing benefits, pre-clearance is only beneficial when used in conjunction with WIMs. This is due to the fact that WIMs can weigh the vehicles at mainline speeds, meaning that vehicles with a transponder need not slow down. Pre-clearance offers one tangible benefit: that of travel time benefit to carriers.

Travel-time benefit of pre-clearance is dependent on whether the existing facility is a WIM or a conventional weigh scale. The time savings in either case will be primarily driven by a decrease in the time carriers save by not going through the weigh facility.

For an existing WIM facility, this decrease in total time and associated costs is given by:

$TT_{WIM\text{-}PRE}\$ = (T_{WIM} - T_{PRE})$ * Carrier Cost/minute

where

$TT_{WIM\text{-}PRE}\$$: Travel time benefits in Dollars
$(T_{WIM} - T_{PRE}) = TT_{WIM\text{-}PRE}$ (minutes): Savings in travel time in minutes of pre-clearance over a WIM only weigh facility.

For an existing conventional platform scale, the decrease in total time and associated costs is given by:

$TT_{CONV\text{-}PRE}\$ = (T_{CONV} - T_{PRE})$ * Carrier Cost/minute

where

$TT_{CONV\text{-}PRE}\$$: Travel time benefits in Dollars
$(T_{CONV} - T_{PRE}) = TT_{CONV\text{-}PRE}$ (minutes): Savings in travel time in minutes of pre-clearance over a conventional scale weigh facility.

5.5.3.4. Travel-Time Benefits Data and Sources

The carrier cost/minute is based on the analysis of Titus (1995). Titus considers two methods of estimating the value of a carrier's time for truckload carriers. The first method is the average hourly income of drivers, while the second is the equivalent distance. The equivalent distance method requires determining the distance a vehicle could have traveled had enforcement stops not been made. A decrease in travel time would have enabled the vehicle to travel greater distances. Thus, the carrier cost per minute represents the cost to the carrier irrespective of whether the driver is paid by miles or by time. The study teams' analysis uses the average of the truckload ($13/hour) and non-truckload carriers ($24.60) where the truckload costs are based as described above (Titus, 1995). The wage rate is adjusted upwards for 1998 based on the wage rate change in Maryland during the period 1995 to 1998. Values of W and I are forecasted for the years 2000 to 2010 and are derived from the least squares linear regression model generated for the years 1993 –1997 (1997 Annual Report Governor's Motor Carrier Task Force for Safety and Uniformity). The value of OW based on the 1996 figures for the number of overweight permits issued is similarly revised upwards for each of the years.

For annual blanket hauling permits, it was assumed that a carrier annually travels on those permits 40 times on average. For monthly hauling permits, it was assumed that the carrier on average, travels 4 times monthly.

The best and the worst case estimates of P/W are described in Section 5.5.1. For conventional scales the ratio will be much lower. However, the low ratio merely increases the travel-time benefits of pre-clearance. As such, this travel-time benefit analysis is conservative. The fraction of commercial vehicles equipped with a transponder that are not pre-cleared (f) is assumed to be 5%. The market penetration of transponders for each of the years is assumed to be the same as the adoption of technology. The rationale for derivation of this adoption rate is described in Section 5.2.

In 1997, 1,623,511 vehicles were weighed with WIM while 337,290 were weighed on conventional scales (1997 Annual Report Governor's Motor Carrier Task Force for Safety and Uniformity). The sum of WIM and conventional scale weigh-ins gives the total number of weigh-ins (W). This ratio of WIM versus conventional scales, along with the growth rate of W, is used to derive the number of weighs for WIM and conventional scales, assuming that the existing ratio would have continued into the future in the absence of CVSIN. This allows the calculation of benefits of mainline pre-clearance. The benefits of ramp WIM are assumed to be half that of mainline WIM. Of the WIMs being constructed, only 2 sites will have ramp WIMs exclusively; 10 other sites will have at least a mainline WIM (as intimated by Fiscal Analyst, MVA). Therefore, the benefit realized by the previous analysis, which assumes that all WIMs are mainline, is multiplied by 0.8333 (10/12) to give the benefits that will be realized by CVISN. It should be noted that the maintenance of ramp WIMs will have less of an impact on the traveling public compared to mainline WIMs.

Figure 4.3.2(a) in Section 4.3 shows the ensuing travel-time benefits for pre-clearance for each of the 10 years. Table 5.5.3.4(A) lists the present value of the benefits accrued from safety investments in CVISN for three discount rates: 6%, 7%, and 8%. These present values are listed for existing conventional and WIM scales. Currently WIMs weigh 4.81 times more vehicles when compared to conventional scales. Since the total benefits of conventional scales and WIMs are approximately the same, the benefit values imply that the benefit of pre-clearance gained from conventional scales is more than 4 times the benefit gained from existing WIMs. The table does not include the investment necessary to accrue the benefits. The benefits availed from conventional scales will accrue only if the conventional scales are supplemented by WIMs.

In this analysis, it was assumed that OS/OW permit bearing vehicles would be automatically cleared. In the current design of CVISN, OS/OW permits will be checked manually. The net impact of manually checking the OS/OW permits is negligible to the overall B/C ratios since the value of the ratio OW/W is very small (3.1%).

Table 5.5.3.4(A) The Best and Worst Case Present Value of Benefits for Pre-clearance for Existing Conventional Scales and WIM Weigh Facilities

		NUMBER WEIGHED '96	6%	7%	8%
Worst	Conventional Scale	337,290	$29,682,736	$27,699,338	$25,879,759
Worst	WIM	1,623,511	$32,632,886	$30,476,583	$28,497,561
Best	Conventional Scale	337,290	$47,736,749	$44,534,496	$41,597,228
Best	WIM	1,623,511	$50,686,899	$47,311,741	$44,215,030

These benefits as well as benefits due to inspection identification are gained through significant investments by the enforcement agencies and carriers. Investment by agencies was described in Section 5.1. Costs that carriers incur were described in Section 5.5.2. and are briefly described again. The cost to carriers is the cost of transponders. The study team assumes that the benefits of CVISN can be realized if the carriers purchase and install a read and write transponder. The cost of each transponder is assumed to be $45.00 (Samuel, 1998). The annual total cost (CC_{TRANS}) borne by the carriers is given by the acceptance of transponders by the carriers i.e.,

$$CC_{TRANS} = 45\ T\ VP$$

where T is the penetration rate of transponders for that year and VP is the population of commercial vehicles. The population of commercial vehicles was calculated using published figures from the1992 Maryland TIUS survey conducted by the Census Bureau (TIUS, 1992) and inflating these figures by an assumed annual growth rate of 3%. Since transponders may need to be replaced due to failure and damage, it was assumed that transponders fail at the rate of 5% every year starting from the second year of the purchase. For example, if 100 transponders are purchased in Year 2001, then 5 of these will fail in Year 2002, another 5 of the 100 will fail in Year 2003, etc. By the tenth year, 50% of the transponders purchased 10 years ago will have been replaced. This failure rate, therefore, increases the total cost burden to the carriers.

CVISN pre-clearance benefits due to transponder penetration are accrued only for those vehicles that travel the routes which currently have weigh and inspection stations, as has been modeled in this analysis. This analysis does not include the entire population of commercial motor vehicles traveling on all highways in Maryland. Carriers that do not travel regularly on the weigh facility routes have no incentive to purchase transponders. In lieu of the hard data on the percentage of commercial vehicles traveling regularly on routes that have weigh and inspection stations, the worst case scenario is assumed. This scenario assumes that the entire population of vehicles in Maryland travels regularly on these routes and therefore will buy transponders at the transponder growth rate. This is conservative, since only those carriers that travel the routes with weigh and inspection stations need to buy transponders. Thus, the actual costs incurred to carriers for transponders will be much lower than those used in the benefit-cost model. Hence, the B/C ratios derived from this analysis are conservative when discussing carriers.

This analysis does not include agency benefits due to the reduction of operating costs or the benefit of reducing tax evasions. Operating costs may increase during the initial stages of CVISN due to the fact that the large number of high-risk vehicles and/or drivers who enter the inspection and weigh facilities will require more inspection time. During the later stages of CVISN, these operating costs will decline because a large number of vehicles will be pre-cleared due to the deterrent effect and the acceptance of transponders by the carriers. Tax dollars are paid by the carriers to the agencies. The cost to carriers is revenue to the agencies. The net impact of the decrease in tax evasion is a decrease in the B/C ratio of the carriers, while the B/C ratio of the state agencies will increase.

6.0. QUALITATIVE ANALYSIS

This qualitative analysis is a verbal accounting of "costs and benefits" for which dollar values cannot be assigned. Examples of intangible benefits are the environmental and social impacts of a project. These impacts and safety implications that can not be readily quantified are discussed. Qualitative benefits accrue due to investments in safety and credential processing activities and can be classified as follows: cost reduction benefit, societal benefit, increase in revenue benefit, and benefits to the economy of Maryland.

6.1. Cost Reduction Benefits of CVSIN

As already discussed, CVISN combined with WIM provides large roadside safety and carrier efficiency benefits. In theory, WIM will weigh all motor carriers, resulting in long-term cost savings to the State from extended physical lives of highways. Highways will need less reconstruction and maintenance for a given period of time, since all overweight motor carriers will be detected.

The benefit-cost analysis does not include potential benefits to agencies due to reduction of operating costs of the weigh facilities. Operating costs may increase during the initial stages of CVISN because a larger number of high-risk vehicles and/or drivers will enter the inspection and weigh facilities and tie up inspectors. During the latter stages of CVISN, these operating costs will decline when a large number of vehicles get pre-cleared. This will be due to the deterrent effect and acceptance of transponders by the carriers.

Electronic credential processing, in addition to increasing the productivity of agency personnel, will also likely result in a reduction of agencies' overhead costs. The integration of information systems from deployment of CVISN should then lessen the use of resources devoted to redundant systems.

6.2. Societal Benefits of CVISN

Significant benefits to society accrue due to investments in safety and credential processing. The weighing of all vehicles at mainline speeds results in environmental benefits. There will be less idling of diesel engines at weigh and inspection stations, as WIM will obviate the need for stopping and queuing for static weighing. This will result in fuel savings and fewer emissions. There will be additional fuel savings and reduced emissions and particulates from exhaust from reduction in the number of vehicles accelerating and decelerating at weigh stations. Moreover, this factor will also contribute to less wear and tear of brakes and other associated motor vehicle components. According to an Advantage I-75 task force, pre-clearance systems have demonstrated fuel savings between .05 and .18 gallons per avoided stop for commercial vehicles, not including fuel savings from reduced queues (McCall, 1997). The cumulative environmental benefit over all weigh and inspection stations may be substantial. Pre-clearance of vehicles at mainline speeds will also decrease noise pollution at weigh and inspection stations.

Since similar numbers of trucks will be inspected as before CVISN, there should not be any major environmental benefit resulting from CVISN-enhanced roadside inspection. Vehicle engines will suntil idle during some part of the inspection process. On the other hand, targeting high-risk carriers and allowing freer flow of safe carriers may have some environmental benefit. The deterrence effect of CVISN may cause high risk carriers to improve the maintenance of the entire vehicle, including engine operation.

There will be unquantifiable safety benefits from motor carriers maintaining mainline speeds on highways. Safety research has established that when certain vehicles vary from the prevailing speed of the vehicle flow on a highway, the potential for accidents increases. If significantly fewer trucks must decelerate to enter a queue at a weigh and inspection station or accelerate to enter a highway lane, then safety may be enhanced.

Automated identification of vehicles and drivers will decrease the crawling around and under commercial vehicles by the inspection and enforcement staff. This increase in safety for inspection and enforcement personnel will make the work area safer.

6.3. Revenue Benefits of CVISN

Additional revenues for IRP and IFTA taxes will be collected due to the increased monitoring of carrier activities. Tax dollars are paid by carriers to agencies whether or not the carriers are Maryland-based. The cost to carriers is a revenue to the agencies. The net impact of the decrease in tax evasion is a decrease in the b/c ratio of the carriers, but an increase of the ratio for state agencies. The state of Maryland will generate additional revenues due to the impact of the decrease in tax evasion. At the same time, the state of Maryland will have to pay additional revenues to neighboring states that implement CVISN or similar automated identification systems. Due to the strategic location of Maryland and traffic generated from the Port of Baltimore, CVISN may help in generating a net inflow of revenues from out-of-state commercial vehicles.

These vehicles are likely to comply with IRP and IFTA fuel tax regulations, thereby increasing the b/c ratio of the CVISN project.

6.4. Benefits to the Economy of Maryland

In addition to the above, CVISN will also enhance on-time delivery of goods by motor carriers. With Just-in-Time (JIT) inventory delivery systems becoming more prevalent, time saved during weighing and inspection may be of critical importance. JIT is an inventory system where smaller shipments occur more frequently as needed, thereby reducing the huge costs of large static inventories in warehouses. The transit time savings for carriers from participation in CVISN will have a “ripple effect” throughout the economy. More rapid delivery of goods resulting from fewer stops for weighing and inspection will mean lower transportation and inventory costs to wholesalers and retailers. This ripple effect can potentially lower prices for consumers. Improved service to shippers and receivers is also reflected in terms of less damage to goods from transport accidents. Moses and Savage (1997) estimate this savings to be $5,000 per truck accident avoided.

As market conditions and shipment demands occur, CVISN’s electronic credential processing will allow motor carrier firms to allocate vehicles in their fleets more quickly. The ability to quickly obtain permits for special shipments by an idle power unit will translate into lower costs for carriers, potentially lower rates for shippers, and an increase in loaded miles driven.

The construction of ramps and other facilities for WIM and roadside inspection should generate additional construction jobs, albeit temporarily. Highway construction generates an average of 7.9 jobs per $1,000,000 spent (FHWA, 1996). However, once the construction is over, those jobs can no longer be attributed to the project. There is also a difference in the “value” of jobs depending on whether or not the economy is at “full employment.” Because of the robust economy, those construction jobs would probably exist with or without the project. There is also an opportunity cost or the foregoing of an alternative use of the funds to any construction project.

This report ‘The Benefit-Cost Assessment of CVISN in Maryland’, has quantified only those benefits that can be modeled with reasonable assumptions. As discussed in this section, there are several other benefits of CVISN which increase the worth of the CVISN project.

7.0. CONCLUSION

The comprehensive benefit/cost analysis carried out in this study conclusively attests to the economic feasibility of the CVSIN project. For the project, the B/C ratios range from 3.28 to 4.68, respectively, for the worst and best case estimates for the benefits modeled. The net present values range from $76 million to $123 million. For the agencies and the carriers, the worst case B/C ratios are 1.45 and 6.67, respectively.

The study has examined benefits that can be modeled without making unreasonable assumptions. Therefore, the B/C ratios that are reported are conservative. Where data were unavailable, conservative estimates were used.

An important assumption relates to the technology adoption by the carriers. The study team feels that conservative estimates with respect to the adoption of transponders have been used. However, the adoption can be accelerated by means of educating the carriers about the high benefits of CVISN for them. In the absence of a concerted program to educate the carriers, the benefits realized to the carriers may be lower than projected.

The study team has assumed that carriers will be able to use the Internet to process credentials. While EDI may be embraced by large carriers, a majority of carriers in Maryland are small. Of the carriers processing IRP credentials, 91.29% have fewer than 5 vehicles (e-mail communication with MVA office, 1998). These carriers are less likely to adopt EDI for credential processing even though EDI offers secure processing capabilities. This group is more likely to adopt the Internet since processing through the Internet is less expensive. The 1998 Survey of Motor Carriers and Coaches conducted by Morgan State University also affirms the small carriers' preference of Internet over EDI. The per vehicle credential processing costs for this group of carriers is more than the costs incurred to large carriers (ATA, 1997). Therefore, this group will gain more benefits from CVISN.

Due to the competitive nature of the commercial vehicle industry, the benefits accrued to carriers will eventually be passed on to the receivers and shippers. Therefore, the benefits will eventually be passed on to consumers and the citizens of Maryland. The net and eventual impact of CVISN will be a benefit to Maryland citizens.

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APPENDIX A

(SUNK WEIGH-IN-MOTION COSTS)

The State of Maryland has already made investments in Weigh-in-Motion (WIM) scales, which allow vehicles to be weighed while in motion. Since the state would have pursued construction of WIM scales irrespective of CVISN, there is an interest in determining the benefit of CVISN alone. This is based on the assumption that all WIM costs and benefits are sunk. In view of the above, a benefit/cost analysis for CVISN without WIM investments is warranted.

CVISN in concert with WIM provides additional benefits that WIM alone cannot provide. The most significant of these benefits is the pre-clearance of legal and safe vehicles. With WIM only, all vehicles will be required to come into the weigh facility. The decision to let a vehicle bypass the visual inspection is made based upon WIM weight readings and the judgement of the inspector monitoring the WIM cameras. However, with CVISN, legal and safe vehicles and drivers with a transponder need not come into the weigh facility at all. Vehicle weighing is done by mainline WIMs while the inspection selection system of CVISN can pre-clear the vehicle and driver. Significant savings to the carriers can result by the synergy between the WIM and CVISN pre-clearance system.

For this analysis, it is assumed that carriers will be able to gain from the benefits of ramp WIMs already in operation. All benefits from future construction of WIMs cannot be accrued to CVSIN. The benefits of ramp WIMs are assumed to be half the benefits of mainline WIMs. It is also assumed that carriers will purchase transponders at the same rate, with or without WIMs. This assumption is based on the fact that WIMs are already operational and carriers can benefit from pre-clearance through existing WIMs.

The Benefit/Cost Ratio (B/C) and the Net Present Value (NPV) for low benefits in the CVISN project with and without WIM investments is shown in Table A1. The table includes benefits and costs to Maryland regulatory agencies and carriers. This analysis includes benefits and costs for credential processing and safety enforcement activities. For the discount rate of 7%, the low B/C ratio of CVISN, with and without WIM, is 3.28 and 2.43, respectively. Moreover, the difference in the corresponding net present values for the low benefits of CVISN with and without WIM is approximately $39 million (in favor of WIM-aided processes). The large net present value gain for CVISN with WIM investment clearly substantiates the synergy achieved by WIM and CVSIN.

Table A1. The Low Benefit/Cost Ratio (B/C) and the Net Present Value (NPV) for the Overall CVISN Project With and Without WIM at Different Discount Rates

DISCOUNT RATE		6%	7%	8%
CVISN with WIM	B/C	3.38	3.28	3.17
	NPV	$83,231,468	$76,040,108	$69,524,005
CVISN without WIM	B/C	2.50	2.43	2.36
	NPV	$40,396,498	$36,695,627	$33,350,417

WIM scales are part of the safety investment of CVISN. Table A2 shows the B/C ratios and NPV, with and without WIM, for safety investments of CVISN. As is evident from the table, WIM investment contributes to increasing B/C ratios for CVISN.

Table A2. Low Benefit/Cost Ratio (B/C) and the Net Present Value (NPV) for Safety and Enforcement Activities of CVISN With and Without WIM for Different Discount Rates

DISCOUNT RATE		6%	7%	8%
CVISN with WIM	B/C	4.31	4.15	4.01
	NPV	$68,638,267	$62,847,737	$57,595,630
CVISN without WIM	B/C	3.02	2.93	2.84
	NPV	$25,803,297	$23,503,256	$21,422,043

Carriers are the largest beneficiaries of CVISN with WIM. Table A3 shows the B/C ratios and NPV for carriers with and without the WIM investments. The B/C ratios for carriers decline by a large amount without WIM. Moreover, the NPV for carriers also declines by approximately $37 million without the state's WIM investment.

Table A3. Low Benefit/Cost Ratio (B/C) and the Net Present Value (NPV) for Carriers With and Without WIM Investments for Different Discount Rates

DISCOUNT RATE		6%	7%	8%
CVISN with WIM	B/C	6.86	6.67	6.49
	NPV	$71,868,326	$66,156,384	$60,970,516
CVISN without WIM	B/C	3.57	3.48	3.38
	NPV	$31,551,449	$28,876,037	$26,453,123

APPENDIX B

(TRANSPONDER GROWTH RATE SENSITIVITY ANALYSIS)

The total benefits accrued to motor carriers computed by this analysis is in direct proportion to their level of participation in the CVISN program. This BCA uses a Growth Model, as discussed in detail in Section 5.2, to determine the rate of adoption of technology. However, motor carriers may not purchase a transponder unit at this rate. This appendix shows the net payoff based on the assumption that the transponder adoption rate reaches a maximum of 50% and is linear over the economic life of this BCA. In other words, motor carriers would purchase transponders at the rate of 5% every year. It should be noted, as described in Section 5.3.3, the total costs are incurred by 50% of the motor carrier population, while the total benefits are accrued only by those carriers with transponders who travel on highways with weigh and inspection facilities. Hence, both the B/C ratios and the NPVs are conservative figures.

Table B1 shows both the low and high B/C ratios and the NPVs using the transponder adoption rate reported by this BCA. Table B2 shows the same values for the maximum 50% adoption rate of transponders by motor carriers.

Table B1. The Low and High Benefit/Cost Ratio (B/C) and the Net Present Value (NPV) for the Overall CVISN project, *Using Transponder Adoption Rate Reported in this BCA,* at Different Discount Rates.

DISCOUNT RATE		6%	7%	8%
Low	B/C	3.38	3.28	3.17
	NPV	$83,231,468	$76,040,108	$69,524,005
High	B/C	4.83	4.68	4.53
	NPV	$133,901,031	$122,900,418	$112,917,657

Table B2. The Low and High Benefit/Cost Ratio (B/C) and the Net Present Value (NPV) for the Overall CVISN project, *Using Maximum 50% Transponder Adoption Rate,* at Different Discount Rates.

DISCOUNT RATE		6%	7%	8%
Low	B/C	2.39	2.32	2.25
	NPV	$43,941,748	$39,728,942	$35,925,991
High	B/C	3.35	3.24	3.14
	NPV	$74,079,617	$67,560,500	$61,661,747

As shown in the Table B2, the B/C ratios and the NPVs, although decrease, are favorable for the 50% maximum transponder adoption rate by motor carriers. At 7% discount rate, the B/C ratio ranges from 2.32 to 3.24, and the NPV ranges from $40 million to $67.5 million.

APPENDIX C

(TRANSPONDER COSTS SENSITIVITY ANALYSIS)

This BCA presumes that motor carriers will purchase the transponder unit for efficient transportation of their cargo. Additionally, the motor carriers could also use information stored on the transponder to support their proprietary applications such as vehicle and cargo location, driver performance, and others. Based on a report by Samuel (1998), the cost of the transponder unit is assumed to be $45. However, motor carriers may suntil incur additional costs of installation and testing of the transponder unit. Further, the cost of the transponder unit may also increase if the unit is to be able to support more functions in the future. Hence, this appendix shows the sensitivity of the B/C ratios and the NPVs based on the price of the transponder unit. It should be noted that our BCA model uses a 5% failure rate for transponders. In other words, it implies that 50% of the transponders would have failed and hence been replaced over the economic life.

Table C1 shows both the low and the high B/C ratios and the NPVs reported by this BCA for the transponder cost of $45. Tables C2 and C3 show the same values for the transponder unit cost of $100 and $250.

Table C1. The Low and High Benefit/Cost Ratio (B/C) and the Net Present Value (NPV) for the Overall CVISN project, *for transponder cost of $45,* at different discount rates.

DISCOUNT RATE		6%	7%	8%
Low	B/C	3.38	3.28	3.17
	NPV	$83,231,468	$76,040,108	$69,524,005
High	B/C	4.83	4.68	4.53
	NPV	$133,901,031	$122,900,418	$112,917,657

Table C2. The Low and High Benefit/Cost Ratio (B/C) and the Net Present Value (NPV) for the Overall CVISN project, *for transponder cost of $100,* at different discount rates.

DISCOUNT RATE		6%	7%	8%
Low	B/C	2.73	2.65	2.57
	NPV	$74,878,281	$68,110,185	$61,987,737
High	B/C	3.90	3.78	3.67
	NPV	$125,547,844	$114,970,495	$105,381,390

Table C3. The Low and High Benefit/Cost Ratio (B/C) and the Net Present Value (NPV) for the Overall CVISN project, *for transponder cost of $250,* at different discount rates.

DISCOUNT RATE		6%	7%	8%
Low	B/C	1.79	1.74	1.69
	NPV	$52,096,863	$46,483,122	$41,434,281
High	B/C	2.56	2.48	2.41
	NPV	$102,766,426	$93,343,432	$84,827,933

As shown in the above tables, the B/C ratios and the NPVs are favorable for the transponder costs of $100 and $250, even though their values decrease. For the transponder unit cost of $100, at 7% discount rate, the B/C ratio ranges from 2.65 to 3.78 and the NPV ranges from $68 million to $115 million. Further, for the transponder unit cost of $250, at 7% discount rate the B/C ratio ranges from 1.74 to 2.48 and the NPV ranges from $46.5 million to $93.5 million.

ACRONYMS

A
AMASCOT- The Automated Mileage and Stateline Crossing Operation
ATA Foundation- American Trucking Associations Foundation

B
B/C- Benefit/Cost
BCA- Benefit Cost Analysis

C
CDL- Commercial Drivers License
CVISN- Commercial Vehicle Information Systems and Networks
CVO- Commercial Vehicle Operations

E
EDI- Electronic Data Interchange

F
FAX- Facsimile Machine

I
ID- Identification
IFTA- International Fuel Tax Agreement
IRP- International Registration Plan
ITS/CVO- Intelligent Transportation Systems/Commercial Vehicle Operations
ITS- Intelligent Transportation Systems
IACG- Inter-Agency Coordination Group

J
JIT- Just-in-Time

M
MC- Motor Carrier
MDE- Maryland Department of Environment
MdTA- Maryland Transportation Authority
MFTU- Motor Fuel Tax Unit
MPA- Maryland Port Administration
MSP- Maryland State Police
MVA- Motor Vehicle Administration

N
NGA- National Govenor's Association
NPV- Net Present Value

O
OMB- Office of Management and Budget
OMC- Office of Motor Carriers
OW- Over Weight

P
PSC- Public Service Commission

R
RAD- Revenue Administration Department
RPC-NY- Regional Processing Center- New York

S
SHA- State Highway Administration

T
TA- Technology Adoption
TSO- The Secretary's Office
TIUS- Truck Inventory and Use Survey

U
USDOT- United States Department of Transportation

V
VISTA- Vehicle Information Systems for Tax Apportionment

W
WIM- Weight-In-Motion