A Summary of the Economic Analysis Concerning the Application of Intelligent Transportation Systems/Commercial Vehicle Operations (ITS/CVO) to the Mid-Continent Corridor

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The existing operational procedures of motor carriers and state enforcement agencies have potentially substantial benefits to gain by integrating Intelligent Transportation System technology into their commercial vehicle operations (ITS/CVO). In particular, multi-state integration of these technologies throughout a transportation corridor will lead to more significant benefits then single state applications. This paper summarizes the results of an economic analysis on the application of three principal ITS/CVO technologies to the mid continent corridor: electronic credentialing, electronic screening and electronic border crossings. The mid-continent corridor is defined as Interstate Highway 35 (I-35) from Duluth, Minnesota to Laredo, Texas. The analysis corridor includes the international border crossing at the Laredo. Current baseline data for weigh station, permitting, credentialing, and international border crossing activities were collected for the corridor states. Additional data were collected on accidents and overweight citations in the vicinity of weigh stations for the Iowa segment of the corridor. A methodology was developed to identify and estimate the potential benefits and costs relating to the implementation of electronic credentialing, electronic screening and electronic border crossing technologies in the corridor states. Benefits and costs were estimated on a corridor wide basis for a ten year analysis period. Total benefits of electronic credentialing ranged from $25 to $50 million and total costs were estimated at $19 to $38 million. Benefits from the implementation of electronic screening were estimated at $49 to $59 million, while costs were estimated at $7 to $23 million. Benefits at the international border were significantly higher at $721 to $1,373 million while costs were estimated at $1.9 to 8.5 million. The analysis indicates that the corridor states and the motor carriers that operate in them may benefit from the implementation of the ITS/CVO technologies. Key words: Intelligent Transportation Systems, Commercial Vehicle Operations, benefit-cost analysis, corridor analysis.

INTRODUCTION

The existing operational procedures of commercial vehicles, mostly motor carriers, and state enforcement agencies have potentially substantial benefits to gain by integrating Commercial Vehicle Operation functions into Intelligent Transportation Systems deployments (ITS/CVO). In particular, multi-state deployment and coordination of ITS technologies throughout a transportation corridor will lead to greater benefits then single state applications. As a case study, the mid-continent corridor, defined as Interstate Highway 35 (I-35) from Duluth, Minnesota to Laredo, Texas (including the international border crossing at the Laredo), was analyzed to quantify the benefits and costs associated with deployment. The mid-continent corridor was designated a high priority corridor in the National Highway Highway System Designation Act of 1995 and is shown in Figure 1.

ANALYSIS APPROACH

The research first identified the anticipated benefits from the deployment of ITS/CVO in the mid-continent corridor. Three ITS/CVO functions were analyzed: electronic credentialing, electronic screening, and electronic border crossings. A methodology was developed to quantify the benefits for each of the ITS/CVO functions and the data to support the analysis were collected from various state agencies and the literature. To capture the uncertainty in future benefits streams, three estimates (named conservative, aggressive and expected) were developed for the market penetration

FIGURE 1 Mid-continent transportation corridor.

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TABLE 1 Summary of Electronic Credentialing

Benefits (million dollars)	Conservative	Expected	Aggressive
Motor Carriers	21.88	29.71	43.74
Jurisdictions	3.62	4.85	7.06
Total Benefits	25.50	34.56	50.79
Costs (million dollars)	Low		High
Motor Carriers	12.84		26.29
Jurisdictions	6.30		12.00
Total Costs	19.14		38.29
Motor Carriers			
B/C, Low Cost	1.70	2.31	3.41
B/C, High Cost	0.83	1.13	1.66
Jurisdictions			
B/C, Low Cost	0.58	0.77	1.12
B/C, High Cost	0.30	0.40	0.59
Total			
B/C, Low Cost	1.33	1.81	2.65
B/C, High Cost	0.67	0.90	1.33

of ITS/CVO technology, increase in truck volumes, increase in credentialing activities, and border crossing movements. Two cost estimates for each technology were also developed, a low and high costs estimate. A more complete description of data collection, methodology, and analysis can be found research report (*1*).

ELECTRONIC CREDENTIALING

Electronic credentialing functions for commercial vehicles will increase the efficiency of the existing process. Rather than the inefficient paper-based system currently in use, electronic credentialing will allow motor carriers or their representatives to request, pay for, and receive any necessary credentials or permits for all jurisdictions through a single, simplified electronic interface.

Benefits

The benefits of electronic credentialing were calculated as the labor savings made available to motor carriers and jurisdictions from the functions of electronic credentialing. As base data, the number of International Registration Plan (IRP) accounts, International Fuel Tax Agreement (IFTA) accounts, and Oversize/Overweight (OS/OW) permits were collected for all states in the corridor. The benefits were calculated for all motor carriers in the corridor states.

The labor savings for motor carriers were calculated as the difference between the current and future activity times. To account for the different cost structures of carriers, cost savings estimates were made for small, medium and large carriers. Activity times for current and future IFTA and IRP credential applications were derived from a recent Western Highway Institute (WHI) field operational test (*2*). The benefits for electronic requests of OS/OW permits were determined by estimating a cost savings per permit.

The labor savings to jurisdictions for IRP renewals and IFTA renewals were estimated using two sources. The current activity times for processing each type of application was taken from the WHI report. The future activity times were derived by reducing current times with factors estimated in a National Governor's Association (NGA) report on ITS/CVO benefits (*3*). The labor savings for oversize and overweight permits were calculated similarly.

A summary of the calculated benefits over the ten year analysis period is presented in Table 1. Clearly, the majority of benefits accrue to the motor carrier industry. The three estimates were base on the relative market penetration and growth in truck traffic in the corridor taken over a ten year period. The conservative estimate assumes 20 percent of the carriers will initially participate in electronic credentialling and penetration will grow by 3.5 percent per year until 50 percent participate, expected assumes a 5 percent per year growth to 60 percent of the carrier participate, and aggressive assume a seven percent per year growth rate to a maximum participation of 80 percent. The benefits to states were difficult to estimate accurately without a detailed knowledge of the agency structure. As a result, the benefits to state agencies might be underestimated. A more detailed approach would allow more accurate estimation of benefits.

Costs

The costs for deployment of electronic credentialing will be shared by state agencies and motor carriers, however, the majority of costs will be borne by the state agencies. The cost for motor carriers include the cost of personal computer based software system, annual communication cost, and maintenance of the system. The costs were also developed for all carriers in the state. The results of the cost estimates are summarized in Table 1.

The cost to state agencies included the modification costs of existing computer systems, interface systems for communication with carriers, annual communications cost, training of employees, annual maintenance costs, software development costs, and new hardware costs. The development of cost estimates for the implementation of electronic credentialing technologies was a difficult task. Current completed operational tests are limited in scope and the extrapolation of their costs to entire state agencies is difficult. The cost of deployment of electronic credentialing largely depends on the current status of credentialing and permitting in each individual state. The cost to state agencies was estimated very generally using the NGA report (*3*). The estimates are presented in Table 1.

Benefit to Cost Ratio

The analysis indicates that except for the most conservative growth and high cost estimate, benefits exceed costs for motor carriers. These ratios do not represent the B/C ratios that would be available to individual carriers, rather they represent the benefits and costs to motor carriers in the corridor states. A report by the American Trucking Association (*4*) found that B/C ratios for individual carriers from the implementation of electronic credentialing functions would range from 1.0 for small carriers to 19.1 for larger carriers.

TABLE 2 Summary of Electronic Screening

Benefits (million dollars)	Conservative	Expected	Aggressive
Motor Carriers	13.47	16.75	22.77
Jurisdictions	36.33	36.33	36.33
Total Benefits	49.80	53.08	59.10
Costs (million dollars)	Low		High
Motor Carriers	4.98		8.38
Jurisdictions	2.73		14.87
Total Costs	7.72		23.24
Motor Carriers			
B/C, Low Cost	2.70	3.36	4.57
B/C, High Cost	1.61	2.00	2.72
Jurisdictions			
B/C, Low Cost	13.29	13.29	13.29
B/C, High Cost	2.44	2.44	2.44
Total			
B/C, Low Cost	9.99	10.65	11.86
B/C, High Cost	5.95	6.34	7.06

For this research, benefits only exceeded costs for the most aggressive growth scenario and the lowest cost estimate. The NGA report (*3*), however, found B/C ratios ranging from 2.0 to 7.0 for state agencies. Benefits were also not included for such agency savings as paper costs, mailing savings, and reduced auditing costs. These benefits, however, are not likely to be significant enough to influence the B/C ratios.

ELECTRONIC SCREENING

Electronic screening will take place at static weigh/inspection facilities and possibly portable inspection sites. Vehicles known to be in compliance or having a low risk are allowed to bypass the weigh station, thereby providing travel time savings to the motor carrier and freeing agency personnel for other activities. Increased enforcement initiated by electronic screening will likely force a reduction in overweight trucks.

Benefits

As base data, each agency that operates the 19 static scales along I-35 was contacted to obtain the hours of operation, the number of trucks weighed, and the number of safety inspections performed (Level I, II, III). Except for Kansas, the corridor states have low levels of enforcement, weighing between 2 and 10 percent traffic (Minnesota does not presently operate fixed scales on I-35). In order to estimate reduced pavement damage and safety benefits, data were collected in Iowa to be used as an estimation for the rest the corridor. A sample of overweight citations not issued at fixed facilities was collected from the three Iowa counties with scales on I-35. In addition, accident data were collected within one mile of the weigh station location in the same counties. This data revealed no significant accidents related to weigh station activities.

Benefits to motor carriers included both time and fuel savings for bypassing the weigh station. Time savings was the difference between bypass time and through time, defined as the deceleration time off the mainline, time spent in queue, time at the scale, and time spent in acceleration onto the mainline. In addition, the time savings from bypassing safety inspections was also included. Fuel savings, 1/3 gallon per bypass per truck, were estimated using the results from a fuel consumption test from the Advantage I-75 project (*5*).

Benefits to jurisdictions included two parts: labor savings and reduced pavement damage caused by overweight trucks. The salary savings were calculated using existing operations as the base. It was assumed that ITS/CVO technologies would reduce the required personnel at each operating station. These benefits were minor. An estimate was made of the reduced amount of pavement damage for the corridor. To develop the estimate, overweight citation data were analyzed to determine a distribution of weight and axle configuration for overweight trucks. These base data were applied to the assumed amount of overweight trucks, estimated to be 5 percent of the total truck traffic, when the fixed scales were not operating. Because of the increased enforcement allowed through ITS deployment, the number of overweight trucks operating was expected to decline over the ten year period. The miles of overweight equivalent single axle loads (ESAL) saved were converted to a dollar amount.

A summary of the benefits of electronic screening is shown in Table 2. The benefits, as well as costs, are estimated over a ten year period. It is assume that the level of enforcement will grow at the same rate as truck traffic growth and participating carriers will bypass weigh stations. The conservative estimate is based on 1.5 percent per year growth in truck traffic, expected is based on 2.5 percent per year growth in truck traffic, and aggressive is based on a 3.5 percent per year growth in traffic. Under the conservative estimate, it is assumed that initially 20 percent of trucks will participate in the electronic screening program and participation will grow by 3.5 percent per year to a maximum of 50 percent, the expected estimate assume that participation will grow by 5 percent per year till 60 percent participation, and aggressive assumes a 7 percent per year growth in participation until 80 percent penetration is reached.

Compared to other analyses of electronic screening to motor carriers, these benefits are relatively low. This is related to the relatively low level of enforcement in the corridor states. Also the pavement damage savings were calculated using the overweight citation data from Iowa as representative of the entire corridor which may not accurately represent the entire corridor. Further, pavement and truck configurations could vary significantly along the corridor, which was not accounted for in this analysis. However, this simple analysis reveals that pavement damage savings could be very significant.

Costs

The costs for electronic screening will be shared by motor carriers and state agencies, but again the majority of costs will be borne by state agencies. The final estimates are shown in Table 2. The costs to motor carriers include the cost of transponders.

TABLE 3 Summary of Electronic Border Crossing

Benefits (million dollars)	Conservative	Expected	Aggressive
Motor Carriers	721.92	947.53	1373.05
Jurisdictions	na	na	na
Total Benefits	721.92	947.53	1373.05
Costs (million dollars)	Low		High
Motor Carriers	0.47		5.46
Jurisdictions	1.44		3.05
Total Costs	1.91		8.51
Motor Carriers			
B/C, Low Cost	1,532.39	2,011.28	2,914.49
B/C, High Cost	132.21	173.53	251.46
Total			
B/C, Low Cost	377.69	495.72	718.34
B/C, High Cost	84.80	111.31	161.29

The costs to state agencies include automatic vehicle identification (AVI) readers, weigh-in-motion (WIM) scales and equipment, computer workstations, communication costs, annual operation and maintenance costs. The costs for the necessary infrastructure were developed using estimates in the NGA report (*3*). Two cost scenarios were developed for deploying ITS at weigh stations.

Benefit to Cost Ratio

The ratios in Table 2 reflect that for electronic screening, analyzed for the entire corridor, has benefits that exceed cost for all scenarios. Unexpectedly, even with the low enforcement levels and truck volumes, electronic screening proves cost effective. The relatively low cost of implementation and the significant benefits yield these results.

ELECTRONIC BORDER SCREENING

Electronic processes at the international border will use some of the same functions as domestic electronic credentialing and screening, but will be more complex. All of the necessary paperwork and information to expedite transborder shipments will be transmitted in advance to the customs facility. When motor carriers arrive at the border, they will be screened by border crossing officials with minimal delay.

Benefits

Base data were collected from a variety of sources. The most recent data were available from the United States Customs Service. The Border Trade Institute at Texas A&M International University supplied northbound and southbound traffic from 1990-1995 for different bridge locations in Laredo.

Benefits to motor carriers were calculated as a function of time savings at the two border bridges accepting commercial vehicles, Laredo and Columbia, for northbound and southbound traffic. Benefits to shippers were calculated as reduction of in-transit inventory costs due to reduced transborder shipping time. Total benefits for the analysis period are presented in Table 3 (Shipper benefits included in motor carrier benefits). The conservative estimates assume 8 percent per year grow in transborder traffic, the expected estimate assumes a 10 percent per year growth rate, and the aggressive assumes a 12 percent growth rate. All three growth assumptions are based on market penetration rates for international electronic screen equivalent to the growth rates for domestic electronic screening.

The method used to calculate reduced inventory costs was extremely conservative. The addition of the inventory savings in this methodology is insignificant compared to the time savings to motor carriers. In practice, however, inventory savings could be very relevant. If total transborder time was reduced by one day, benefits could be a minimum of 1 million dollars annually for northbound traffic at the Laredo bridge alone. This methodology also did not attempt to analyze the reduction in warehouse inventory which would be possible with more reliable transborder shipping time. This benefit is likely to be very significant.

Because the traffic situation at the border is dynamic, the estimation of these benefits should be viewed carefully. The methodology assumes that the delays at bridges will remain constant over the analysis period. If no improvements were made, infrastructure or otherwise, delay at the bridges would most likely increase. While truck traffic is increased annually, the method does not account for the shifting of traffic from one bridge to another, rather, it assumes a constant growth. However, even the current situation, with no growth, produces annual benefits of 26 million dollars. Also, this analysis does not address the future plans for the fourth international bridge planned at Laredo.

Benefits to jurisdictions are likely to result from an increased efficiency in customs enforcement. Staff reductions at the border are unlikely, but the reduced delays will allow customs to better direct their efforts towards drug enforcement and other activities. In addition, Texas will be able to perform more effective weight and safety inspections, thereby decreasing the number of overweight and unsafe vehicles on Texas roadways. These benefits, however, were not calculated because of data constraints.

Costs

The costs to motor carriers for the installation of electronic border crossing include the cost of transponder and annual communication costs. Cost for motor carrier participation in electronic border crossing technology was much the same as the cost to participate in electronic screening. A summary of costs are shown in Table 3.

The costs to jurisdictions will include AVI readers, WIM scales and equipment, computer workstations, communication costs, and annual operation and maintenance costs. Total present worth of the implementation of the system is presented in Table 3. The costs for electronic border crossing have not included the development cost

of the software that allows shippers, carriers and drivers to file the necessary documents to participate in the technology.

Benefit to Cost Ratios

A summary of benefit to cost ratios is shown in Table 3. Because delays at the border are so significant and the cost to motor carriers of participating in the international electronic screening program is so small, large benefit to costs ratios result. Since jurisdictional benefits were not quantified, and although the jurisdictional benefits are significant, they were not included in the analysis. This simple analysis of the border shows that implementation of ITS/CVO functions at the border would have significant benefits. In fact the benefits are so significant that it would be improper not to implement these functions at the border. (Author's note: This technology has since been deployed at the Laredo border).

CONCLUSIONS

The analysis of electronic credentialing functions for the entire corridor was a complicated task. Many assumptions were made in performing the analysis. For example, the methodology assumes that time savings for electronic credentialing functions are identical in each state, which is likely not the case. A majority of the time savings approximations were based on WHI's operational test of electronic credentialing. This test had a limited sample size and the savings identified in the report may not necessarily apply to the motor carrier industry and state agencies in the mid-continent corridor. Perhaps the part of the methodology requiring the most refinement is the analysis of OS/OW permits. Because of data limitations, average values of time and dollar savings had to be used to estimate the benefits of electronic credentialing functions for OS/OW permit applications. The structure of motor carriers who apply for permits may make an average value of the savings inappropriate. Final conclusions about electronic credentialing functions can be drawn, however, that the implementation of electronic credentialing will be beneficial to both motor carriers and jurisdictions.

The analysis of electronic screening showed that the application of these functions had benefits greater than costs. The methodology used to calculate benefits for motor carriers could be improved by collecting more than one year of weigh station data. This would eliminate any concerns about the sample not being representative. The cost analysis for jurisdictions could be improved by collecting more specific information on each individual weigh stations and determining the exact nature of improvements necessary to allow electronic screening. A more detailed analysis of overweight data and pavement structures in other states would improve the accuracy of the pavement damage savings. Final conclusions about electronic screening functions can be drawn, however, that the implementation of electronic screening will be beneficial to both motor carriers and jurisdictions.

The analysis of electronic border crossing found that benefits to motor carriers far exceeded any costs. Analysis of the Laredo border was dominated by the existing delays for northbound traffic at the downtown bridges.

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