

Intelligent Vehicle Highway System Commercial Vehicle Operations: Perceptions, Needs, and Concerns of Indiana-Based Interstate Motor Carriers

JAMES G. KAVALARIS AND KUMARES C. SINHA

This paper highlights results of a comprehensive statewide survey examining Intelligent Vehicle Highway System (IVHS) perceptions, needs, and concerns from the perspective of Indiana-based interstate motor carriers. It was conducted as part of a study to examine institutional issues related to the application of IVHS technologies to commercial vehicle operations (CVO) in Indiana. Specific survey issues included how motor carriers perceive IVHS-CVO concepts would affect their current operations; what data items motor carriers are willing to have electronically stored within automatic vehicle identification (AVI) transponders; what type of weigh station preclearance information storage motor carriers prefer (i.e., centralized data base or data stored within a transponder); how willing motor carriers are to participate in a "Gold Card" precertification process for weigh station preclearance; what type of automatic toll collection system motor carriers prefer (i.e., debit system or credit system); how willing motor carriers are to pay additional tolls to help cover costs of building bypass lanes next to existing toll plazas for AVI-equipped vehicles to automatically pay tolls while operating at mainline speeds; and the degree to which motor carriers believe IVHS-CVO implementation will lead to a level playing field between motor carriers.

Trucking is a key component of Indiana's diverse economy. Whether hauling \$4.93 billion worth of commodities from the state's 65,000 family farms, or transporting 155 million tons of freight into and out of the state each year, truck-dependent industries encompass almost 68,000 Indiana businesses, employ approximately 1.37 million people (65 percent of Indiana's workers), and utilize over 25 280 km (15,700 mi) of state and federal roads that connect the state's economic centers (1).

In addition to these home-based operations, Indiana's location makes it a key component of the United States' trucking economy. Containing 1 835 km (1,140 mi) of both rural and urban Interstates, Indiana is a major through-travel state for operations along the north-south I-65 and I-69 corridors, and the east-west I-64, I-70, I-74, I-80, I-90, and I-94 corridors, including the 253-km (157-mi) Indiana Toll Road (I-80/90) that is often called the "Main Street of the Midwest" due to its connections with the Ohio Turnpike for points east and both the Chicago Skyway and Borman Expressway for points west (2).

With this operational magnitude, Indiana actions that benefit trucking efficiency, while still maintaining trucking safety, can potentially yield significant benefits to both the state and national

economies—especially to those areas with companies operating on the "just-in-time" (JIT) philosophy that has effectively turned many roads into moving warehouses for industry. Seeing this potential, the Joint Highway Research Project at Purdue University initiated a contract with the FHWA to identify government-based and industry-based institutional barriers affecting the implementation of Intelligent Vehicle Highway System (IVHS) technologies to interstate commercial vehicle operations (CVO) in Indiana. Specifically, research was focused on the potential for

- Automatic payment of tolls (while driving at mainline speeds) through the use of automatic vehicle identification (AVI) transponders;
- Preclearance of vehicles and drivers past weigh stations through the use of AVI transponders, weigh-in-motion (WIM) devices, and prequalifying safety inspections;
- "One-stop shopping" for licenses, registrations, and permits through increased cooperation and data sharing between state agencies; and
- Transparent state borders through increased cooperation and data-sharing between states.

Actions were coordinated with a similar study for the state of Illinois (conducted by the University of Illinois at Urbana-Champaign) as part of an FHWA initiative to designate I-80 as a "test bed for the next generation of highway safety improvements" due to its natural "link between existing IVHS operational tests in the east (Advantage I-75) and in the west (HELP/Crescent)" (3). Particular emphasis was given to achieving uniformity of Indiana laws with those of surrounding states so that the concept of transparent state borders could be realized.

This paper highlights methods and results from one portion of that study—a comprehensive statewide survey to examine IVHS-CVO perceptions, needs, and concerns from the perspective of Indiana-based interstate motor carriers. A detailed report of the full study, *Institutional Issues Related to the Application of Intelligent Vehicle Highway System Technologies to Commercial Vehicle Operations in Indiana*, is available (4). The full report includes a review of existing laws and policies applying to commercial vehicles operating in Indiana; an inventory of the agencies responsible, their existing procedures, their physical facilities, and their human resources used to implement these regulations; an itemization of present impediments preventing IVHS-CVO implementation under current Indiana State Laws; and recommendations for future phased-in modifications to the present systems for effective IVHS-CVO implementation. In addition, the full report contains details

about a day-long consensus-building workshop regarding future directions for Indiana/Illinois IVHS-CVO, which was held in Merrillville, Ind., on November 17, 1993. Organized by Purdue University in cooperation with the University of Illinois at Urbana-Champaign and the FHWA, it was attended by more than 100 representatives from a broad range of public and private sector interests. Participants included motor carriers, their industry associations, the above sponsors, and various state agencies from both Indiana and Illinois, including each state's Department of Transportation, Department of Revenue, Bureau of Motor Vehicles, and State Police.

BASIS FOR SURVEY

This study's Phase I efforts to determine trucking industry concerns and perceptions about IVHS-CVO development and implementation had been of a qualitative nature due to its basis on interviews and workshop-type meetings with motor carriers. However, quantitative data about these issues were still needed in order for unbiased inferences to be made about the entire population of Indiana-based interstate motor carriers. This was especially important because understanding these specific industry viewpoints is vital to the process of getting IVHS-CVO development and implementation to be acceptable to both government and industry—a critical element in fully realizing and utilizing the many potentials of IVHS-CVO technologies. As such, this study's Phase 2 included a comprehensive statewide survey to provide decision-makers with the quantitative data that they needed.

Intrastate carriers were not included in this survey due to its focus on interstate concerns such as transparent state borders and the reduction of multiple weigh station stops per trip. Currently, Indiana weigh stations are located such that it is highly unlikely that significant numbers of intrastate carriers would ever have to stop at more than one Indiana weigh station per trip. In addition, the "barrier" portion of the Indiana Toll Road, where electronic toll collection could be most beneficial due to the need to pay a toll every few miles, is primarily used by interstate carriers making trips to and from Illinois. Conversely, intrastate carrier trips on the Indiana Toll Road tend to be focused on the "gated" portion of the system where drivers obtain a ticket at their point of entry, and then pay an appropriate toll at their point of departure—a portion of the system thought to derive fewer benefits from implementing electronic toll collection.

SURVEY DEVELOPMENT

The questionnaire form used for this survey evolved from government and industry comments on two previous questionnaires developed for this survey, including critiques from pretesting a version to about 30 persons attending a government/industry IVHS-CVO seminar on June 17, 1993. This seminar was sponsored by the FHWA's Office of Motor Carriers in Indianapolis.

The survey mailing list was based on an International Registration Plan (IRP) registration list provided by the Indiana Bureau of Motor Vehicles. It was decided that this list would be used because of its comprehensive nature and because it provided necessary data for conducting a random, statistically significant, stratified sampling of the 7,136 Indiana-based interstate motor carriers who had vehicles registered with IRP on August 27, 1993. The list included each com-

pany's name, address, the number of power units registered in each of their fleets, and the name of their designated IRP contact person.

SAMPLING METHOD

To get responses from a cross section of motor carriers, both large and small, the IRP list was stratified into five groups based on the number of power units in a company's fleet—a surrogate measurement for company size and volume of their shipments. This was especially important for balanced opinions because trucking in Indiana tends to follow the motor carrier industry's general rule of thumb regarding large carrier dominance (i.e., approximately 80 percent of the companies have less than 20 trucks; however, the 20 percent of the companies that have more than 20 trucks transport approximately 80 percent of the goods). Thus, if responses were weighted only by the number of power units in a company's fleet (e.g., without stratification), instead of first grouping carrier responses by size, the many voices of smaller carriers whom Indiana's farmers are especially dependent on would be muffled by the relatively few number of larger carriers. However, it must be pointed out that, when the implementation policy is determined, the concerns of the smaller carriers will have to be balanced with those of the larger carriers that in fact control the majority of Indiana-based interstate vehicles. Indiana's version of this phenomenon along with a summary of the population of the Indiana-based interstate motor vehicles from which sampling was conducted appear in Table 1.

IMPLEMENTATION/RESPONSE RATES

First, an announcement postcard was sent to the 3,000 randomly selected companies who were in the survey sample. This was to let them know that they would be receiving a questionnaire and that they should expect it in 1 week. It was hoped that this would help to increase the response rate by familiarizing each recipient with the survey, by giving them time to plan/set aside a moment to complete and return it, and by helping to add legitimacy to the survey by distinguishing it from other unsolicited (and presumably unread) mail that companies get every day. One week later, on November 12, 1993, the actual questionnaire was mailed.

Responses, amounting to a 16.4 percent overall response rate, were received through January (Table 2). Response rates ranged from a low of 8.7 percent by carriers with only one truck, to a high of 32.6 percent by carriers with 20 or more trucks. It should be noted, however, that due to large carrier responses, the survey can describe IVHS concerns for a total of 19,657 trucks—32.4 percent coverage relative to the 60,730 Indiana-based IRP-registered power units.

STATISTICAL ANALYSIS METHODS

All survey data were entered into the SAS statistical software package for analysis (5). Preliminary examination of this data indicated that responses were not distributed normally. Also, many of the variables were discrete. Therefore, it was deemed appropriate to use nonparametric tests known for their robustness against departures from normality in order to determine the existence of statistically significant differences when data were stratified into various classes.

TABLE 1 Population of Indiana-Based Interstate Motor Vehicles from Which Sampling Was Conducted

Categories of Company Fleet Size	Based on all Indiana-based IRP registrants				Based only on surveys received			
	Companies in Category		Trucks in Category		Companies in Category		Trucks in Category	
	Number	Pct.	Number	Pct.	Number	Pct.	Number	Pct.
1 Unit	3379	47.4	3379	5.6	87	17.7	87	0.4
2-3 Units	1184	25.4	4230	7.0	95	19.3	226	1.1
4-7 Units	964	13.5	4880	8.0	88	17.9	475	2.4
5-19 Units	582	8.2	6746	11.1	90	18.3	1013	5.2
20+ Units	380	5.3	41495	68.3	124	25.2	17856	90.8
Other	17 ^a	0.2	0	0.0	8 ^b	1.6	0	0.0
Totals:	7136	100.0	60730	100.0	492	100.0	19657	100.0

^aThere were 17 companies that only had trailers registered with IRP (i.e. no power units).

^bThere were 8 surveys returned without any indication of company fleet size.

The χ^2 nonparametric test (6), able to discern differences in response frequencies between various classes of cross-tabulated data, was utilized to determine if stratifying companies into various classes produced any significant differences in the proportion of companies who indicated an awareness of IVHS before receiving this survey. The Kruskal-Wallis nonparametric test (7), able to discern differences in a variable's mean value when stratified into various classes, was utilized to determine if there were significant differences in each IVHS-CVO concept's mean rating when companies were stratified into various classes. Finally, when calculating confidence intervals around various sample means in order to bound the actual population proportion for that variable at a given level of significance (6), the large sample assumption was applied. Thus, the following was used as an estimator of the population variance: $\{[p \times (1 - p)]/(n - 1)\}$.

SURVEY RESULTS

Company Characteristics

Table 3 summarizes the types of trucking operations of the companies that responded to the survey. Private carriers were the most frequent type, representing 42 percent of the responses. For-hire less-than-truckload carriers were the least frequent type, representing only 5 percent of the responses. Table 3 also summarizes the driver payment methods used by responding companies. Both per-hour

wage and percentage of load revenue were the most frequent methods, each representing 32 percent of the responses. Per-trip flat fee was the least frequent method, representing only 4 percent of the responses. Finally, Table 3 summarizes the percentage categories of time-sensitive fleet trips that must be made within a 2-hour or less time frame by companies who responded to the survey. The 1 to 50 percent JIT trips is the most frequent category, representing 26 percent of the responses. The 85 to 99 percent JIT trips is the least frequent category, representing 11 percent of the responses.

IVHS Awareness

Only 33.9 percent of the companies who responded to the survey were aware of IVHS before receiving this survey. This aggregate statistic is stratified in the following paragraphs so that a targeted IVHS education program can be developed that would enable government and industry representatives to communicate with a

TABLE 2 Survey Response Rates Grouped by Fleet Size

Company Size	Total Number of Surveys		Response Rate
	Sent	Returned	
1 Truck	1,000	87	8.7%
2 - 3 Trucks	600	95	15.8%
4 - 7 Trucks	460	88	19.1%
8 - 19 Trucks	560	90	16.1%
20+ Trucks	380	124	32.6%
Total:	3,000	492 ^a	16.4%

^aThe total returned includes 8 surveys without any indication of company fleet size.

TABLE 3 Types of Trucking Operations of Responding Companies

Characteristic	Category / Method	Number of Companies in Group	Percent of the 492 Responses
Type of Carrier	For-Hire L.T.L.	27	5.5%
	Truckload	149	30.3%
	Contract	99	20.1%
	Private	205	41.7%
	Unknown	12	2.4%
Method of Driver Payment	Annual Salary	30	6.1%
	Per-Hour Wage	158	32.1%
	Per-Mile Wage	111	22.6%
	Per-Trip Flat Fee	22	4.5%
	Pct. of Load Revenue	156	31.7%
Percent Just-In-Time Trips	Unknown	15	3.0%
	0%	110	22.3%
	1% - 50%	128	26.0%
	51% - 84%	90	18.3%
	85% - 99%	53	10.8%
	100%	84	17.1%
	Unknown	27	5.5%

common terminology—thus increasing the potential for effective cooperation during IVHS development and implementation. This is especially important since what has long been known as IVHS is now being identified with the acronym ITS—Intelligent Transportation Systems. It should be noted, however, that even though current awareness of the term IVHS is low (and most likely lower for ITS), based on company comments and the general pattern of survey responses, there appears to be an industry understanding of concepts/user-services such as automatic payment of tolls, pre-clearance of vehicles and drivers past weigh stations, transparent borders, and one-stop shopping—even if they did not know of them collectively as IVHS.

Figure 1 summarizes prior IVHS awareness as stratified by the average number of vehicles in each company's daily operating fleet. The largest mean awareness is 44.3 percent by companies with 20 or more trucks. The smallest mean awareness is 27.7 percent by companies with two to three trucks. Using the χ^2 test, prior IVHS awareness between these strata is statistically different at a 90 percent level of significance. Figure 2 summarizes prior IVHS awareness as stratified by type of trucking operation. The largest mean awareness is 50.0 percent by for-hire less-than-truckload carriers. The smallest mean awareness is 24.6 percent by private carriers. Using the χ^2 test, prior IVHS awareness between these strata is statistically different at a 95 percent level of significance. Figure 3 summarizes prior IVHS awareness as stratified by method of driver payment. The largest mean awareness is 48.2 percent by companies that pay their drivers a per-mile wage. The smallest mean awareness is 16.7 percent by companies that pay their drivers an annual salary. Using the χ^2 test, prior IVHS awareness between these strata is statistically different at a 95 percent level of significance. Figure 4 summarizes prior IVHS awareness as stratified by the percentage of trips categorized as JIT with delivery scheduled within time frames of 2 or fewer hours. The largest mean awareness is 39.6 percent by companies with 85 to 99 percent time-sensitive trips. The smallest mean awareness is 24.1 percent by companies with zero percent time-sensitive trips. Using the χ^2 test, prior IVHS awareness between these strata is statistically different at an 85 percent level of significance.

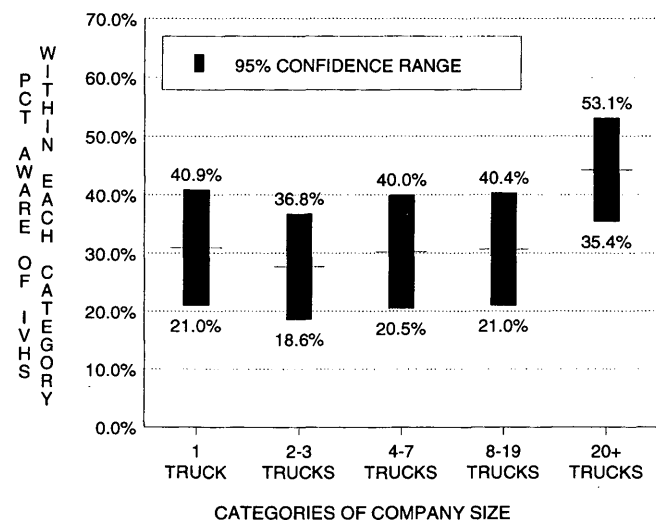


FIGURE 1 IVHS awareness of companies before receiving the survey, grouped by average number of vehicles in a company's daily operating fleet.

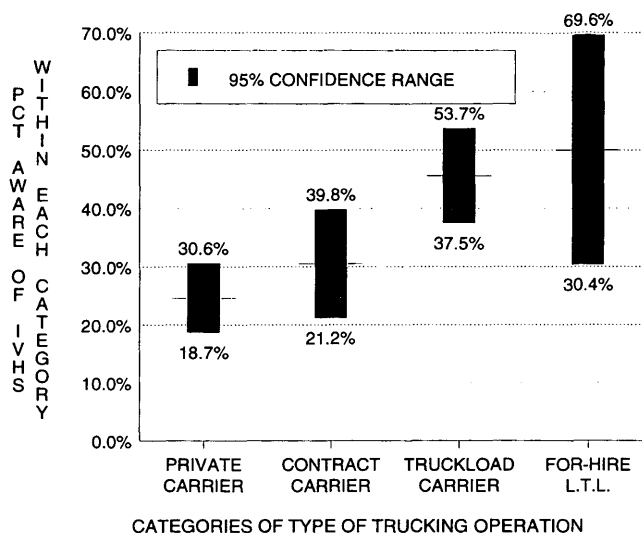


FIGURE 2 IVHS awareness of companies before receiving the survey, grouped by categories of trucking operations.

Overall Ratings of IVHS-CVO Concepts

Companies were presented with brief descriptions of the four main IVHS-CVO concept areas so that they could express expectations of how implementing each CVO innovation would possibly affect their current operations. Ratings were given on a scale of 1 (very harmful) to 7 (very beneficial).

Of these four concepts, "one-stop shopping" received the highest mean rating at 5.9, with 54.6 percent rating it very beneficial, and 3.5 percent rating it in one of the "harmful" categories (Table 4). "Preclearance of vehicles and drivers past weigh stations" received the second highest mean rating at 5.7, with 48.7 percent rating it very beneficial, and 6.7 percent rating it in one of the harmful categories (Table 4). "Transparent state borders" received the third highest mean rating at 5.5, with 40.1 percent rating it very beneficial, and 5.6 percent rating it in one of the harmful categories (Table 4). "Automatic payment of tolls while driving at mainline speeds" received the fourth highest mean rating at 5.0, with 27.3 percent rating it very beneficial, and 7.8 percent rating it in one of the harmful categories (Table 4). Table 5 summarizes the ratings as stratified by company size, carrier type, driver payment method, percent of time-sensitive deliveries, and prior IVHS awareness.

Automatic Toll Collection Details

Type of System Preferred

After a brief description of the two primary ways that automatic toll collection systems can be implemented, survey respondents were asked to indicate which type of automatic toll collection system that their company would favor. Most preferred, was a credit system with monthly billing—chosen by a mean of 55.3 percent of the companies. Least preferred was a debit system from a prepaid account—chosen by a mean of 3.5 percent of the companies. A mean of 21.4 percent of the companies had no preference for either system. Of the responding companies, 19.8 percent did not

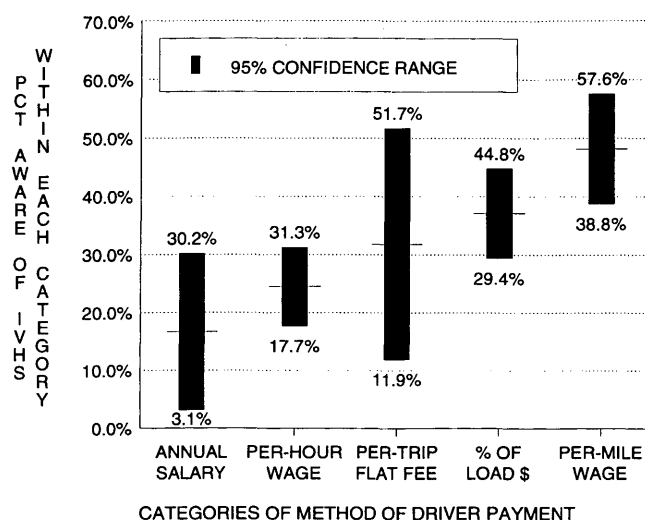


FIGURE 3 IVHS awareness of companies before receiving the survey, grouped by methods by which companies pay their drivers.

favor automatic toll collection. However, of these respondents, 79.6 percent were not aware of IVHS before receiving this survey—a level higher than the average of 66.1 percent of the companies who were not aware of IVHS before receiving this survey.

Willingness To Pay Extra Tolls

Of the companies answering this question, 24.5 percent were willing to pay additional tolls to help pay for constructing, equipping, and maintaining specially equipped bypass lanes next to existing toll plazas for use by AVI-equipped vehicles only. The largest mean willingness is 34.2 percent by companies who currently pay to either three, four, or five toll agencies. The smallest mean willingness is 3.4 percent by companies who currently do not pay any tolls. Of the companies currently paying to one toll agency, 15.9 percent were willing to pay these additional tolls, 24.0 percent of the companies currently paying to two toll agencies were willing to pay these additional tolls, and 28.4 percent of the companies currently paying to six or more toll agencies were willing to pay these additional tolls. Responding companies currently pay tolls to a median of two toll agencies and a mean of between four and five toll agencies.

Of the companies with this willingness, 27.7 percent were willing to pay less than \$0.05 per toll plaza, 26.7 percent were willing to pay \$0.06 to \$0.15 per toll plaza, 20.8 percent were willing to pay \$0.16 to \$0.25 per toll plaza, and 24.7 percent were willing to pay amounts in various categories of extra tolls that were greater than \$0.25 per toll plaza. However, the 90th percentile category of extra tolls is \$0.56 to \$0.70 per toll plaza.

Weigh Station Preclearance Details

Type of System Preferred

After a brief description of the two primary ways that systems for preclearing vehicles and drivers past weigh stations can be imple-

mented, companies were asked to indicate which type of weigh station preclearance their company would favor; 20.8 percent preferred data stored in a central database and 18.1 percent preferred data stored within an on-board AVI transponder. Most preferred was the category "no preference." It was chosen by a mean of 43.6 percent of the companies. Seventeen and a half percent of the companies did not prefer weigh station preclearance. However, of these respondents, 80.0 percent were not aware of IVHS before receiving this survey—a level higher than the average of 66.1 percent of the companies who were not aware of IVHS before receiving this survey.

Data Acceptable for AVI Transponder Storage

Respondents were asked to check off from a list all data items they would be willing to have stored within a transponder. Results, summarized below, include 95 percent confidence intervals appropriate to each group.

By a two-thirds majority (at a 95 percent level of significance), responding companies expressed their willingness to store the following data item within an on-board AVI transponder: proof of liability insurance (67 to 75 percent YES).

By a simple majority (at a 95 percent level of significance), responding companies expressed their willingness to store the following data items within an on-board AVI transponder: fuel-tax cab-card number (64 to 72 percent YES); U.S. Department of Transportation (USDOT) number (63 to 71 percent YES); vehicle identification number (VIN) (63 to 71 percent YES); commercial driver's license (CDL) number (61 to 70 percent YES); International Registration Plan (IRP) number (61 to 70 percent YES); International Fuel Tax Agreement (IFTA) number (61 to 69 percent YES); Interstate Commerce Commission (ICC) number (61 to 69 percent YES); vehicle registration cab-card number (60 to 69 percent YES); type of authority issued by ICC (58 to 67 percent YES); operating authority registration number (58 to 66 percent YES); type of carrier (i.e., for-hire, contract) (58 to 66 percent YES); registered gross vehicle weight (56 to 64 percent YES); and name of driver (55 to 64 percent YES).

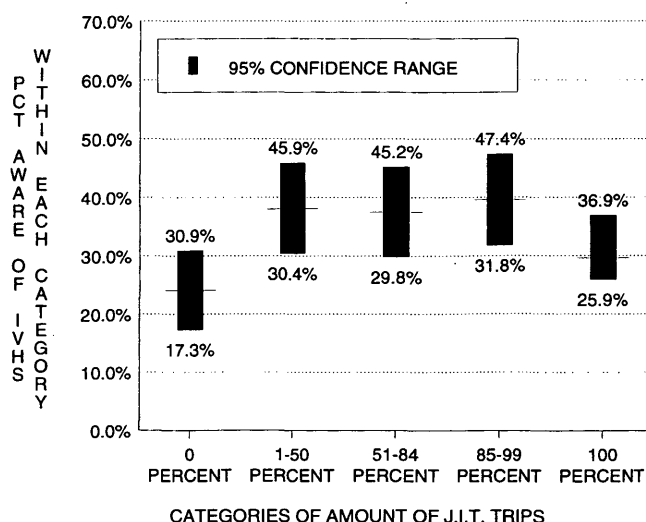


FIGURE 4 IVHS awareness of companies before receiving the survey, grouped by percentage of JIT trips in which delivery is scheduled for time frames of 2 or fewer hours.

TABLE 4 Ratings of IVHS-CVO Concepts

Rating Category	Automatic Toll Payments	Weigh- Station Pre- Clearance	Transparent State Borders	One-Stop- Shopping
7 = "Very Helpful"	27.3%	48.7%	40.1%	54.6%
6	11.5%	15.7%	12.9%	13.2%
5	16.0%	12.6%	13.2%	9.5%
4 = "No Effect"	37.4%	16.3%	28.2%	19.2%
3	2.3%	1.4%	1.5%	0.6%
2	1.6%	1.6%	0.8%	0.4%
1 = "Very Harmful"	3.9%	3.7%	3.3%	2.5%
Mean Rating:	5.04	5.74	5.46	5.91
Total Responding:	487	485	479	484

TABLE 5 IVHS-CVO Concept Ratings by Strata

Stratified By	Automatic Toll Payments		Weigh- Station Pre- Clearance		Transparent State Borders		One-Stop Shopping	
	Mean	Std	Mean	Std	Mean	Std	Mean	Std
Company Size	p = 0.0042 ^a		p = 0.0516		p = 0.6360		p = 0.0075	
1 Truck	5.15	1.66	5.76	1.76	5.61	1.64	6.11	1.50
2-3 Trucks	4.81	1.49	5.46	1.60	5.35	1.53	5.55	1.56
4-7 Trucks	5.23	1.52	5.76	1.63	5.52	1.58	6.01	1.33
8-19 Trucks	4.66	1.53	5.70	1.51	5.33	1.65	5.64	1.69
20+ Trucks	5.31	1.50	6.02	1.41	5.53	1.47	6.20	1.12
Type of Carrier	p = 0.0457		p = 0.0178		p = 0.0324		p = 0.0091	
For-Hire L.T.L.	5.74	1.29	6.22	1.01	6.12	0.99	6.30	1.03
Truckload	5.12	1.57	5.96	1.53	5.66	1.51	6.15	1.29
Contract	4.94	1.79	5.62	1.95	5.23	1.83	5.79	1.89
Private	4.95	1.44	5.60	1.45	5.36	1.50	5.74	1.35
Driver Payment	p = 0.0137		p = 0.0004		p = 0.0190		p = 0.1020	
Annual Salary	4.70	1.53	5.37	1.50	5.40	1.63	5.90	1.54
Per-Hour Wage	4.90	1.39	5.55	1.39	5.27	1.43	5.79	1.33
Per-Mile Wage	5.32	1.53	6.06	1.52	5.72	1.58	6.06	1.30
Per-Trip Flat Fee	4.52	1.66	5.57	1.99	5.05	1.81	5.48	1.89
Pct. of Load \$	5.23	1.62	5.90	1.67	5.60	1.61	6.01	1.54
Pct. J.I.T. Trips	p = 0.0014		p = 0.0003		p = 0.0008		p = 0.0018	
0%	4.66	1.55	5.23	1.79	4.97	1.67	5.38	1.74
1% - 50%	5.03	1.46	5.82	1.52	5.60	1.51	6.11	1.27
51% - 84%	5.47	1.51	6.29	1.15	5.87	1.43	6.16	1.32
85% - 99%	5.43	1.56	5.91	1.48	5.71	1.39	6.15	1.28
100%	4.89	1.65	5.67	1.72	5.42	1.59	5.99	1.43
Aware of IVHS?	p = 0.0219		p = 0.0952		p = 0.0004		p = 0.1080	
Yes	5.26	1.46	5.94	1.41	5.84	1.36	6.09	1.31
No	4.93	1.59	5.64	1.65	5.28	1.63	5.81	1.54

^ap-values < 0.05 indicate that when the concept being rated is stratified in the manner listed, mean ratings are statistically different at a 95% level of significance (based on the Kruskal-Wallis non-parametric one-way test).

TABLE 6 Ratings of How Various IVHS-CVO Scenarios Will Affect Safety, Competition, and Enforcement

Effect Category	Future amount of trucking safety as compared to today's level if "Gold-Card" pre-clearance is implemented	Amount of a "level-playing-field" between carriers with and without on-board AVI transponders	Amount of enforcement efforts AVI-equipped veh. would be subject to vs. non-equipped vehicles
Much More	13.7%	9.1%	13.3%
Somewhat More	33.0%	22.8%	26.9%
No Change	43.8%	39.6%	55.3%
Somewhat Less	7.9%	18.1%	3.4%
Much Less	1.6%	10.4%	1.1%
Total Responding:	482	468	409

By no clear statistical majority (at a 95 percent level of significance), responding companies may or may not be willing to store the following data items within an on-board AVI transponder: medical certificate validation (48 to 57 percent YES) and proof of financial responsibility (48 to 57 percent YES).

By a simple majority (at a 95 percent level of significance) responding companies are not willing to store the following data items within an on-board AVI transponder: bill of lading (60 to 69 percent NO); commodity shipped (60 to 69 percent NO); hazardous-material training certificate validation (61 to 70 percent NO); Commercial Vehicle Safety Alliance (CVSA) number and expiration (64 to 72 percent NO); fleet limitation certificate validation (64 to 72 percent NO); and axle spacings (65 to 73 percent NO).

By a two-thirds majority (at a 95 percent level of significance), responding companies are not willing to store the following data items within an on-board AVI transponder: oversize or overweight load permit number (67 to 75 percent NO); location of vehicle's port of entry into state (69 to 77 percent NO); date and time vehicle last entered a weigh station (72 to 79 percent NO); hazardous-material product identification number (72 to 79 percent NO); location of last weigh station vehicle entered (72 to 80 percent NO); and amount of driving and on-duty time remaining (74 to 82 percent NO).

"Gold Card" Preclearance Concept

Companies were given a short description of the concept of issuing a "Gold Card" to consistently safe motor carriers who are in compliance with all safety, registration, permitting, and tax requirements. The "Gold Card" carriers would be allowed to bypass all weigh stations until their next inspection or until a random inspection found violations that would cancel the card. When asked if they would be willing to have their fleet be subject to more frequently scheduled safety and compliance checks for "Gold Card" certification and weigh station preclearance based on weigh-in-motion weights only, 58.5 percent answered in the affirmative.

Effect of Preclearance on Trucking Safety

Companies were asked to indicate their beliefs about the future level of trucking safety compared with today's level if certain vehicles and drivers are precleared past weigh stations based on precertification and weigh-in-motion weights only; 46.7 percent of the

companies stated that trucking would be either "much safer" or "somewhat safer," and 9.5 percent of the companies stated that trucking would be either "somewhat more dangerous" or "much more dangerous" (Table 6).

Automatic Vehicle Identification Transponder Details

Current AVI Use by Indiana-Based Interstate Motor Carriers

Of the companies surveyed, only 6 out of 492 respondents reported having vehicles presently equipped with an AVI transponder. Of those companies, installation is on an average of 50.9 percent of their vehicles. The make of AVI transponders used in those installations are as follows: 90.9 percent from Lockheed IMS (750 power units in one company), 8.1 percent from Amtech (67 power units over four companies), and 1 percent from Qualcomm (8 power-units in one company). No other makes were reported in use.

Effects of AVI Transponders on Enforcement and Level Competition

Companies were also asked how having an AVI transponder or similar data transfer device on board company vehicles would affect (or presently affects) the concept of a "level playing field" and their exposure to regulatory enforcement. Regarding the degree to which there would be (is) a "level playing field" of competition between carriers with or without AVI transponders on board their vehicles, 31.9 percent of the companies stated that there would be either "much more" or "somewhat more" of a level playing field. Alternatively, 28.5 percent of the companies stated that there would be either "much less" or "somewhat less" of a level playing field (see Table 6). Regarding the perceived level of enforcement that vehicles in their company's fleet would be (are) subject to for registration, permitting, and tax requirements, 40.2 percent of the companies stated that there would be either "much more" or "somewhat more" enforcement. Alternatively, only 4.5 percent of the companies stated that there would be either "much less" or "somewhat less" enforcement (Table 6).

Amount of Mandatory IVHS-CVO Participation Preferred

The survey indicated that 70.3 percent of the companies expressed that IVHS should be a voluntary program if it included law enforcement's ability to electronically read a truck's AVI transponder

TABLE 7 How Much Money Companies Are Willing To Pay or Have Paid for AVI Transponders

Statistic Being Reported	Reported Value of Each Transponder Type Based on Those Willing to Spend Money for an A.V.I. Transponder		
	Type - I	Type - II	Type - III
Mean Value	\$177	\$266	\$537
Standard deviation	231	318	918
95th Percentile Value	\$750	\$1000	\$2000
Median Value	\$100	\$150	\$250
% Not Willing to Spend Any Money On Each Type of Transponder	52.7%	48.7%	54.3%

while it was moving down a roadway in order to check for motor carrier fuel tax payments and compliance with other requirements.

When asked what type of motor carriers should be required to purchase and maintain an on-board AVI transponder for each of the vehicles in their fleet if this above system scenario was mandatory, a mean of 61.1 percent of the companies stated that it should be mandatory for all motor carriers traveling in Indiana. Only 4.2 percent stated that it should be mandatory for Indiana-based interstate motor carriers only.

Value of AVI Transponders

After a brief description of the capabilities of each of the three primary "types"/models of AVI transponders (i.e., Type I is read only, Type II is limited read/write, and Type III is read/write with a communication interface to connect with an on-board fleet-management computer), companies were asked how much money per truck their company would be willing to pay (or have paid) for each type of transponder and its associated installation costs. These results are summarized in Table 7.

As a reference point, those companies that presently have AVI transponders on their vehicles indicated a mean value of \$166 for each Type I transponder (with a standard deviation of \$355), a mean value of \$255 for each Type II transponder (with a standard deviation of \$529), and a mean value of \$383 for each Type III transponder (with a standard deviation of \$793).

IMPLICATIONS OF RESULTS/CONCLUSIONS

Survey results have quantitatively confirmed many of the Indiana trucking industry's concerns and perceptions about IVHS-CVO that were previously only known in a qualitative manner through interviews or case studies of limited scope. In addition, a comprehensive database is now available for further investigations of significant data relationships regarding potential CVO users. This new knowledge, in conjunction with results from the full IVHS-CVO institu-

tional issues study that this survey was but one part of, is enabling decision-makers to be more confident that their actions are commensurate with CVO user/stakeholder needs and desires. In fact, the first in a series of high level meetings between leaders of the Indiana Department of Transportation, the Indiana Department of Revenue, the Indiana Bureau of Motor Vehicles, and the Indiana State Police took place during in the summer of 1994 to initiate processes to implement "one-stop shopping" in Indiana—this survey's highest rated concept/user-service. Furthermore, survey results and additional information in the full report are enabling them to minimize the risks of making costly errors that can sometimes appear when new programs are placed on a fast track, especially risks that have often forced promising new initiatives to the back burner without funding due to a lack of confidence that anticipated benefits of a desired magnitude will actually become reality. Most certainly, understandings gained from this survey are major benefits to have in today's world of fiscal constraints in government, and narrow profit margins in the trucking industry.

REFERENCES

1. Indiana Motor Truck Association. *Trucking in Indiana*. Indianapolis, Ind, 1992.
2. Indiana Department of Transportation. *Division of Program Development Mileage Report*. Indianapolis, Ind., 15 June 1992.
3. *The I-80 Corridor: A Progress Report*. FHWA, U.S. Department of Transportation, Spring 1993.
4. Kavaliris, J. G., and K. C. Sinha. *Institutional Issues Related to the Application of Intelligent Vehicle Highway Systems Technologies to Commercial Vehicle Operations in Indiana*. Report FHWA/IN/JHRP-94/5. National Technical Information Service, Springfield, Va., 1994.
5. SAS Institute, Inc. *SAS System Software Version 6.07.02*. Cary, N.C., 1989.
6. Neter, J., et al. *Applied Statistics*, 3rd ed. Allyn & Bacon, Boston, Mass., 1988.
7. Neter, J., et al. *Applied Linear Statistical Models*, 3rd ed. Irwin, Homewood, Ill., 1990.

Publication of this paper sponsored by Committee on Motor Vehicle Size and Weight.