The goal of the Federal Motor Carrier Safety Administration (FMCSA) is to reduce the number and severity of large truck-involved crashes through more commercial motor vehicle and operator inspections and compliance reviews, stronger enforcement measures against violators, expedited completion of rulemaking proceedings, scientifically sound research, and effective CDL testing, recordkeeping, and sanctions. The Office of Research and Technology manages research and technology development and deployment programs for the FMCSA.

There are eight major research and technology focus areas: crash causation and profiling; regulatory evaluation and reform; compliance and enforcement; HAZMAT safety and cargo tank integrity; driver training and performance management; driver alertness and fatigue; driver physical qualifications; and car-truck proximity.

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Motor Carrier Technologies — Fleet Operational Impacts and Implications for ITS/CVO

Introduction

The Intelligent Transportation Systems/Commercial Vehicle Operations (ITS/CVO) Program is a cooperative effort between the Federal Motor Carrier Safety Administration (FMCSA), the Federal Highway Administration, States, motor carriers, and other transportation stakeholders to define, pilot test, and deploy technologies, information systems, and networks to enhance roadway safety, credentialing, and operations. The four major applications of ITS/CVO are:

Safety Information Exchange: Improve targeting of high-risk operators for inspection through roadside access to current safety data; automate safety inspection activities; and support deployment of in-vehicle safety technologies.

Electronic Credentialing: Automate regulatory functions and enhance data communications capabilities of state agencies to enable paperless transactions between motor carriers and agencies.

Electronic Screening (at fixed weigh stations, ports of entry, and mobile sites): Screen commercial vehicles for safety, size/weight, and credential compliance at mainline speeds.

Motor Carrier Operations: Enhance motor carrier safety and efficiencies through more timely and accurate information to fleet managers and accelerate development and adoption of emerging technologies.

ITS/CVO services focus on developing the technologies and information infrastructure and institutional relationships that enable seamless information exchange between motor carriers, regulators, and safety enforcement officials. This information exchange enables regulatory e-commerce, focuses enforcement resources on unsafe motor carriers, and provides motor carriers access to current fleet safety and operations enhancing information.

More businesses are becoming technologically integrated organizations, and require seamless information exchange between their business and their service providers, including trucking companies. To successfully compete for freight, trucking companies are increasingly in the business of information management and have made significant investments in information technology (IT) to meet the demands of their customers. Their use of IT in fleet operations is growing dramatically in number of users and intensity of use.

To guide the development of effective ITS/CVO services, FMCSA conducted research to examine information and technology use by motor carriers and explore the implications for ITS/CVO services. This tech brief summarizes the study final report, which is available from the National Technical Information Service.

Purpose

The study final report is intended as a benchmark by which FMCSA can refine its ITS/CVO program. Specifically, the document examines:

- Specific technologies that are most widely used by motor carriers to enhance operational efficiency;

- Estimated motor carrier benefit/cost ratios for fleet technologies; and

- Potential motor carrier participation in ITS/CVO services.

Figure 1.
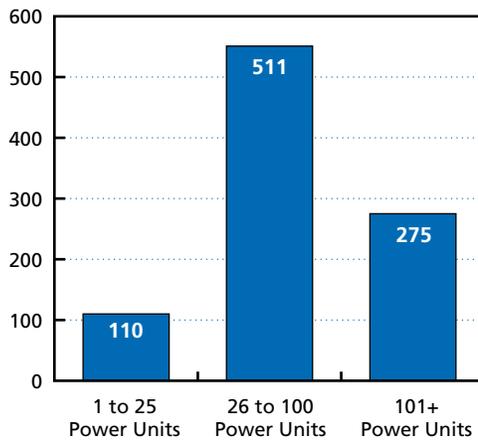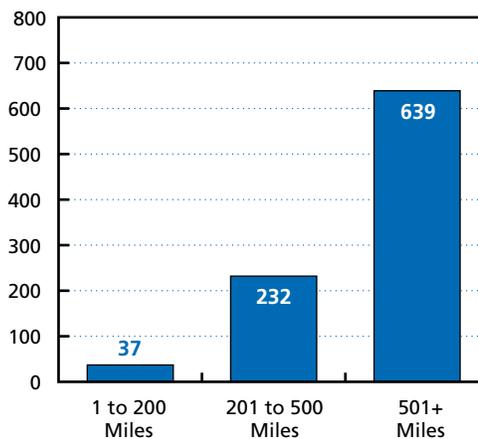**Number of Survey Respondents by Fleet Size.**

Methodology

In 1998, researchers conducted 2 surveys, one of 760 for-hire motor carriers and one of 172 private fleets. The purpose of the surveys was to examine how extensively various technologies were used in fleet operations of various sizes; examine the rates of technology adoption among the fleets; provide information to estimate the potential benefits of the technologies; and assess how motor carriers perceive the value of information and technology-based government services. **Figures 1** and **2** illustrate the number of survey respondents by fleet size and average length of haul.

The surveys collected information on the operational characteristics of the individual motor carriers, including fleet size, geographic range of operation, variability of routing, time sensitivity of pickups and deliveries, and special considerations due to cargo type. Both surveys queried what technologies the companies used in 1996 and 1998. The survey infor-mation and subsequent analysis were augmented by follow-up discussions with motor carriers and references to previous and ongoing research.

Use of Motor Carrier Technologies

Key Finding
The two motor carrier surveys revealed that the characteristics of individual motor carriers (size of fleet, type of haul, routing variability, etc.) and their primary operational objectives (on-time performance, safety assurance, cost avoidance, etc.), directly influence the firms' choice of technologies and their perceived value for ITS/CVO services.

Decision/Operation Support Technologies
Computer-aided routing and dispatching systems (CAD) are used extensively in the trucking industry — 53 percent of surveyed carriers — and the level of use increases for firms with on-time performance as their primary operational objective. Adoption of CAD has expanded between 1996 and 1998, an 8.5 percent increase. Maintenance Support Systems (MSS) are used by 30 percent of the surveyed carriers, increasing at 6 percent per year between 1996 and 1998.

Electronic Data Interchange (EDI) was used by 41 percent of surveyed carriers in 1998. Approximately 33 percent of small to mid-sized firms, and 60 percent of large fleets were EDI capable in 1998. **Table 1** shows the percent of motor carriers using EDI and the annual adoption rate of the technology by fleet size.

In 1998, 48 percent of surveyed firms reported using the Internet, up from 10 percent in 1996. Adoption

Figure 2.
Number of Survey Respondents by Average Length of Haul.

Table 1.
Percent of Surveyed Motor Carriers Using Electronic Data Interchange and Annual Adoption Rate by Fleet Size.

Electronic Data Interchange	1-25 Power Units	26-100 Power Units	100+ Power Units
1996	20%	22%	41%
1998	33%	32%	60%
Annual Adoption Rate	6.4%	5.1%	9.2%

Table 2.
Percent of Surveyed Motor Carriers Using Internet Technology and Annual Adoption Rate by Fleet Size.

Internet Access	1-25 Power Units	26-100 Power Units	100+ Power Units
1996	11%	9%	12%
1998	52%	42%	57%
Annual Adoption Rate	20.7%	16.4%	22.8%

Table 3.
Estimated Benefit/Cost Ratios Per Power Unit for Selected Technology.

Fleet Technology	Benefit/cost ratio range in fleet operations
Computer-Aided Routing and Dispatching Systems	3.3:1 to 9.4:1
Mobile Communications	4.4:1 to 6.3:1
On-Board Computers*	0.3:1 to 6.6:1
Maintenance Support Systems	0.7:1 to 2.4:1
Electronic Data Interchange/Internet Access	2.7:1 to 11.7:1

*FMCSA is currently in the process of evaluating on-board computers for electronic log books for hours-of-service reporting.

rates among firms using the Internet is very strong (19 percent per year) and generally consistent across haul types, fleet size, haul lengths, route variability, and time-sensitivity of hauls. The percent of motor carriers using Internet technology and the annual adoption rate, by fleet size, is shown in **Table 2**.

Mobile Communications Technologies

Mobile communications technologies are the most widely used technologies in the trucking industry. Of the surveyed motor carriers, 72 percent report using one or more of the following technologies: mobile radio, cellular phone, pager, or mobile satellite communications. Cellular phones and pagers are the most used mobile communications technologies, 62 and 55 percent, respectively. These technologies are complimentary and are often used together.

Cellular phones, pagers, and mobile radios are used primarily by motor carriers whose average haul length is less than 500 miles. Satellite communication is primarily used by larger truckload fleets with trips of greater than 500 miles. Satellite technology is very often used with automatic vehicle location tracking and on-board computers.

In-Vehicle Technologies

Ten percent of surveyed carriers reported using on-board computers (OBC) in 1998, up from 6 percent in 1996. OBCs are mostly used by larger truck fleets and firms with safety performance as their prime objective. Six percent of surveyed carriers used electronic logbooks in 1998, compared to 3 percent in 1996. Approximately 3 percent of for-hire carriers reported using an on-board computer for electronic logbooks, while 18 percent of the surveyed private carriers used the devices. (Since June 1998, the FMCSA has been conducting a Paperless Log System Pilot Project to assess how technology can be used to promote motor carrier safety through improved

compliance, reduce paperwork, and improve fleet management.)

Automatic Vehicle Location Tracking is primarily used by larger, time-sensitive, variable route fleets requiring increased asset coordination. Both Automatic Vehicle/Equipment Identification and Collision Warning Systems were used by only 3 percent of surveyed carriers in 1998.

Estimated Benefit/Cost Ratios

Motor carriers measure operational performance through many metrics. Researchers estimated per-power-unit cost savings and calculated benefit/cost ratios for CAD, mobile communications, on-board computers, MSS, and EDI/Internet technologies. The benefit/cost ratios developed in this analysis represent the estimated per power unit benefit divided by the likely cost of the technology per power unit. **Table 3** presents the estimated benefit/cost ratios for these technologies based on the surveys. The study final report contains further information about these estimates, and breaks down the cost savings by fleet size, haul type and haul length.

Some of the estimated benefits and reduction in costs included: improved coordination and utilization of personnel and assets; reduction in maintenance and insurance costs through enhanced preventative maintenance programs; and improved administrative efficiencies and reductions in overall clerical labor costs.

Value Perceptions and Potential Participation

How motor carriers perceive value for ITS/CVO services can provide a benchmark for estimating potential participation levels. To gauge value levels, surveyed motor carriers were asked to rate how they perceive the value of ITS/CVO services to their business. The results showed that the highest value was placed on services that involve the use of technologies currently widespread in use, reduce a perceived regulatory burden on the carriers, provide useful information to fleet/safety managers, and are initiated by the carriers.

Survey results also showed that perceived value of ITS/CVO services is sensitive to fleet operating characteristics such as fleet size, range of operations, time sensitivity of hauls, and route variability. Based on current and projected use of fleet technologies and the surveyed motor carriers' value perceptions by fleet characteristics, researchers estimated potential motor carrier participation in ITS/CVO services.

The ITS/CVO services estimated to have the highest initial and potential participation are safety information exchange and operations. These would provide electronic access to information about travel conditions, fleet safety performance, and motor carrier rules and regulations. It is expected that motor carriers would adopt these services rapidly, due to relatively low cost and expected adoption rates of enabling technologies, and potential benefits in terms of enhanced fleet operations and safety management.

Participation in the electronic credentialing service for fleet registration, fuel tax administration, and oversize/overweight permitting can be expected to be modest at first, then develop rapidly because carrier technology costs are relatively low, with low to medium benefits in reduced administration costs.

Participation in electronic screening is expected to be low at first, then slowly develop towards modest participation levels. Participation is expected to be constrained due to uncertain benefits, exposure levels, and institutional and technical issues.