
Principal Investigator/Corresponding Author:

Racquel L. Pickett
Research Associate
American Transportation Research Institute
Roseville, MN
rpickett@trucking.org

Co-Principal Investigators:

Daniel Murray
Vice President, Research
American Transportation Research Institute
Roseville, MN
dmurray@trucking.org

Chris Flanigan
Technology Engineer
Federal Motor Carrier Safety Administration
Washington, DC
chris.flanigan@dot.gov

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American Transportation Research Institute
950 N. Glebe Road
Arlington, VA 22203

Phone: (651) 641-6162
Fax: (651) 631-9500
ABSTRACT

This report consolidates and synthesizes the findings from six onboard safety systems (OSS) reports that were sponsored and managed by the Federal Motor Carrier Safety Administration (FMCSA) and conducted by the American Transportation Research Institute (ATRI) and/or the University of Michigan Transportation Research Institute (UMTRI). The research studies primarily focused on three types of OSS, including: forward collision warning systems; lane departure warning systems and roll stability control systems. The OSS studies covered the continuum of testing and evaluation through adoption and utilization, with an emphasis on empirical benefit-cost assessments and qualitative user issues and requirements. Finally, naturalistic field-testing research designs were developed in response to system and efficacy data gaps.

Report findings suggest that, although there have been documented crash reduction benefits and cost-savings related to the investment in OSS, small carriers are lagging in the deployment process and all motor carriers in general desire more robust operational and impact data for investment consideration. Various factors were identified that influence a carrier’s decision to invest in the technologies; these primarily consisted of more replicable safety statistics, short-term returns-on-investment and insurance discounts or tax credits for OSS investment. Lastly, the research documented discrete differences in adoption rates and user requirements based on operating sectors and fleet sizes.
INTRODUCTION

This report synthesizes and examines the key findings from six Onboard Safety System (OSS) studies that assessed the adoption utility and challenges associated with onboard safety systems in the trucking industry. Based on the assessment, it further promulgates several research design approaches for expanded field testing of onboard safety systems. FMCSA sponsored and co-authored the six studies; five of the studies were conducted by the American Transportation Research Institute (ATRI) with the sixth completed by the University of Michigan’s Transportation Research Institute (UMTRI).

Over the past decade, the use of onboard safety systems (OSS) in the trucking industry has been on the rise. However, OSS investment has reached a plateau and additional data is needed on the OSS efficacy and user requirements if accelerated adoption is to be realized – a key objective of both FMCSA and the National Highway Traffic Safety Administration. Public promulgation of OSS “real world” safety benefits has the potential to encourage widespread deployment of OSS across the industry. All six studies included in this synthesis identified a dearth of OSS data and related analyses by carriers, drivers and insurers. The six FMCSA-sponsored studies are:

- Analysis of Benefits and Costs of Lane Departure Warning Systems for the Trucking Industry (ATRI) (1);
- Analysis of Benefits and Costs of Forward Collision Warning Systems for the Trucking Industry (ATRI) (2);
- Analysis of Benefits and Costs of Roll Stability Control Systems for the Trucking Industry (ATRI) (3);
- Large Truck Onboard Safety System Field Test (ATRI) (4);
- Onboard Safety Systems and Industry Demographics (ATRI) (5); and
- Tracking the Use of Onboard Safety Technologies across the Truck Fleet (UMTRI) (6).

Between 1985 and 2005, the number of fatal crashes involving large trucks has decreased from 3.92 per 100 million vehicle miles traveled to 2.03 per 100 million vehicle miles traveled (7). The trucking industry and federal government continue to seek ways to improve truck safety and further reduce the injuries and fatalities resulting from large truck-involved crashes. In 2006 there were 368,000 crashes involving large trucks; 22 percent of these involved fatalities or injuries (8).

At a high-level, safety can be defined as avoidance of undesirable events, whereby barriers are incorporated to prevent such events in the future (9). Safe driving practices are imperative for both commercial and non-commercial drivers (9) since data has suggested that two-thirds of large truck-car crashes are a result of driver error on part of the passenger vehicle driver (10).

To assess the effects of a safety initiative, the identification of variables that influence safety is imperative. For instance, a recent study found that truck drivers who were either cited or convicted of various behaviors were statistically more likely than other drivers to be involved in a crash within the next year (11). Improper turning, erratic lane changes, failure to keep in proper lane and following too closely are several driver behaviors identified as significant contributors to future crash likelihood (7). In addition, 60.1 percent of truck crashes result from the following four types of crashes: rear-end (23.1), lane departure (17.8%), side swipe (10.3) and rollover (8.9%) (12). Since the three major OSS technologies focus on these four crash
types, it logically follows that a priori crash risk can be mitigated through the use of these systems. (13).

Continuing advancements in vehicle technologies have increased their efficacy in reducing large truck-involved safety events. OSS technologies are designed to reduce collisions by intervening to prevent the consequences of truck operator error (14); car driver errors that occur around large trucks can often generate an OSS response and mitigate the potential crash. OSS technologies detect thresholds for conditions that exist prior to certain types of crashes, and they either alert the driver of the condition or automatically attempt to resolve the condition by temporarily taking control of the vehicle operation.

In addition, several OSS technologies can record multiple vehicular parameters on operations and/or driver performance. Feedback on safety-related behaviors, recorded by OSS, can provide an indirect level of expected future driver performance. This information can be used to increase safety-related behaviors of drivers by serving as a self-assessment for driver behavioral violations (15). Feedback related to this data can be relayed in a variety of ways to match driver and company needs.

The following three OSS technologies were assessed throughout the six studies and have been shown to be effective in reducing certain crash types, including side-swipes, jack-knives, rollovers and rear-end crashes.

- Lane Departure Warning Systems (LDWS);
- Collision Warning Systems (CWS);
- Stability Control Systems (RSS).

### Lane Departure Warning Systems

Lane Departure Warning Systems (LDWS) are electronic systems that monitor the position of a vehicle with respect to lane markings (16). Currently available LDWS are forward-looking, vision-based systems, consisting of a small video camera mounted on the vehicle’s windshield. This camera records data on the upcoming roadway. Algorithms within the lane departure warning systems interpret video images of the lane to estimate the vehicle state (lateral position, speed, heading, etc.) and the road alignment (lane width, road curvature, etc.). LDWS warn the driver of a lane departure when the vehicle is traveling above a certain speed threshold and the vehicle’s turn signal is not in use. In addition, LDWS notify the driver when lane markings are inadequate for detection, or if the system malfunctions. LDWS do not take any active control to avoid a lane departure or to control the vehicle; the systems only alert the driver if a potentially unsafe situation is detected. Crash types prevented through the use of this technology would include:

- Single-vehicle roadway departures (SVRD);
- Same-direction lane departure (SDLD); and
- Opposite-direction lane departure (ODLD).

### Stability Control Systems

A roll stability control (RSC) system includes wheel speed sensors and a lateral accelerometer to determine critical rollover thresholds. If these thresholds are exceeded, the RSC system can provide anti-lock braking, traction control, and roll control to prevent rollovers due to lateral forces. An electronic stability control (ESC) system includes wheel speed, yaw, steering angle,
and control pressure sensors, and longitudinal and lateral accelerometers to detect lateral
instability. To improve vehicular stability, this system provides anti-lock braking along with
roll, yaw, and traction control. When an ESC system detects yaw instability or a low roadway
coefficient of friction, the system engages to prevent rollovers, jackknifing, over-steering, and
under-steering.

Collision Warning Systems

Forward and side collision warning systems (CWS), in use by the trucking industry since 1994,
can reduce rear-end and side-impact crashes (17). CWS use radar sensors to provide visual and
auditory alarms to a driver of unsafe closing intervals between the truck and a vehicle in front of
or beside it. Currently available systems use Doppler-based radar that transmits and receives
signals to determine the distance, difference in relative speed, and azimuth between the truck and
the vehicle or object in front of it. When a truck equipped with the system approaches a slower
moving vehicle or stationary object and exceeds preset thresholds, progressive warnings alert the
driver of a potentially dangerous situation. Forward Collision Warning Systems (FCWS) have
been found to be most useful for avoiding rear-end crashes when vehicles are traveling at
highway speeds (18).

RESEARCH DESCRIPTIONS

A brief description of each study has been included in the following section to preface the OSS
synthesis activities.

Benefit-Cost Analyses of Onboard Safety Systems (BCA)

Findings from the three benefit-cost studies (LDWS, RSC and FCWS) focused on assessing and
weighing safety and economic benefits against financial and opportunity costs for the OSS
technologies. The analyses also provided detailed calculations for return on investment
information and payback periods to assist in the investment decision-making process. Crash cost
avoidance was assessed alongside purchase, installation and operational costs of the systems.
Multiple data sources were used including carrier and insurance industry data, and the General
Estimates System (GES) which was used to estimate prevented crashes across a five year span
(2001-2005) and assist in determining the costs associated with property damage only (PDO),
injury and or fatality crashes. Finally per-unit and aggregated truck mileage was collect and
incorporated into a crash exposure calculation.

Large Truck Onboard Safety System Field Test (LOFT)

While industry return on investment (ROI) and benefit-cost analyses for OSS have been
developed and published, industry stakeholders indicated that tangential issues and user
requirement information were still unresolved, particularly in the areas of: driver perspectives
and training; installation and maintenance requirements; operational constraints, and product life
cycle issues. As a result, ATRI and FMCSA proceeded to develop and evaluate different
naturalistic field-testing designs that would address the data gaps identified by the industry OSS
advisory group. This study was also viewed as an evaluation and validation activity for the benefit-cost assessments and other OSS studies, and was partially motivated by recent indications that OSS adoption was stagnating beyond the early adopters. The following goals were developed for the research to better understand these factors and accelerate OSS adoption:

- Identify challenges and opportunities not previously documented in currently available test results;
- Address hypotheses through a before-and-after OSS test design that generated outputs useful for government and industry stakeholders; and
- Expand industry awareness of OSS and potential benefits.

Onboard Safety System Industry Demographics (OSS ID)

The focus of this study was to better understand and address the challenges of deploying and using onboard safety systems across all sectors of the trucking industry. Previous findings have indicated that small carriers tend to invest in new technologies only after the technologies are widely adopted by large- and medium-sized carriers. As a result, this research highlighted the specific issues and strategies to accelerate OSS deployment within the trucking industry, particularly among smaller carriers. While considerable attention was paid to small carrier issues, the research compared and contrasted investment issues for all fleet sectors and sizes relating to training requirements, maintenance issues, driver perspectives and other factors. By understanding these operational differences and related OSS investment issues across fleet sizes and sectors, strategies were developed that address unique ways for accelerating OSS deployment.

Tracking the Use of Onboard Safety Technologies across the Truck Fleet

This market research study was an outcome of previous research findings that indicated a need to understand the magnitude of deployment across industry sectors and the issues encountered during investment decision-making. The objectives for this study were to assess OSS deployment levels, and document carrier experiences and knowledge bases for the various technologies, which included the following:

- Level of familiarity with the technologies;
- Proportion of current and future fleet use;
- Rationale for implementing OSS and challenges faced; and
- Direct and indirect benefits measured.

In addition to the carrier information received, vendor insights were collected relating to the direction of OSS engineering and product development.

METHODOLOGY COMPARISONS

To understand research synergies and contrasts, the research methodologies in each of the six studies were compared and contrasted. To minimize duplication, the benefit-cost studies are included as one study throughout. Initially, all OSS initiatives utilized secondary research to
determine what level of research has been conducted thus far and further expand previous
findings (see Table 1). The secondary research also provided necessary guidance in the
development of primary data collection activities. As can be seen, a variety of data was utilized
through the processes. The BCA studies were different from the others in that, the researchers
gathered direct “out-of-pocket” empirical data from the motor carriers, insurers and suppliers
rather than using modeled, averaged and/or societal data. However, LOFT, OSS ID and the
UMTRI study used more qualitative information (e.g. surveys, interviews and expert
panels/focus groups); still appropriate since the objectives of the research were to measure
carrier perceptions and experiences of OSS adoption.

TABLE 1 Data Collected

<table>
<thead>
<tr>
<th>Utilized Data</th>
<th>BCA</th>
<th>LOFT</th>
<th>OSS ID</th>
<th>UMTRI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Secondary Research</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Survey</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Interview</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Expert Panel</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Direct Empirical Data</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The commonalities in respect to fleet sectors and sizes were relatively consistent across
all studies. As can be seen in Table 2, the benefit-cost studies did not directly measure smaller
fleet sizes but took into consideration how the results might affect a smaller carrier differently.
Carriers were included as participants in all of the studies, but drivers, maintenance and other
personnel varied slightly across the initiatives.

TABLE 2 Study Samples Used

<table>
<thead>
<tr>
<th>Study Samples</th>
<th>BCA</th>
<th>LOFT</th>
<th>OSS ID</th>
<th>UMTRI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fleet Size</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Small</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Medium</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Large</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Very Large</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Sample</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carriers</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Drivers</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Maintenance</td>
<td></td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Other</td>
<td>X</td>
<td></td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>

KEY FINDINGS

The key findings differed across the studies since each had a slightly different focus. However,
the principal results of the assessments have been highlighted in the following sections.
Benefit-Cost Analyses of Onboard Safety Systems

Crash prevention is imperative for increased safety. The benefit-cost analyses measured this relationship and the results of the assessment can be seen in Table 3. The efficacy rates (crash prevention estimates) for each OSS technology and the estimated number of crashes that could be prevented by utilizing the systems have been displayed. For instance, FCWS are estimated to prevent 8,597 rear-end crashes at an efficacy rate of 21 percent and 18,013 at 44 percent.

<table>
<thead>
<tr>
<th>Type of Crash</th>
<th>Efficacy Rates</th>
<th>Prevented Crashes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Forward Collision Warning System (FCWS)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rear-end</td>
<td>21-44%</td>
<td>8,597 – 18,013</td>
</tr>
<tr>
<td><strong>Lane Departure Warning Systems (LDWS)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SVRD Collisions</td>
<td>23-53%</td>
<td>1,069-2,463</td>
</tr>
<tr>
<td>SVRD Rollovers</td>
<td>24-50%</td>
<td>627-1,307</td>
</tr>
<tr>
<td>SDLD Sideswipes</td>
<td>23-46%</td>
<td>1,111-2,223</td>
</tr>
<tr>
<td>ODLD Sideswipes</td>
<td>23-46%</td>
<td>997-1,992</td>
</tr>
<tr>
<td>ODLD Head-ons</td>
<td>23-46%</td>
<td>59-118</td>
</tr>
<tr>
<td><strong>Roll Stability Control Systems (RSC)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Combination Vehicle Rollovers</td>
<td>37-53%</td>
<td>1,422-2,037</td>
</tr>
</tbody>
</table>

Crash-related data exist in multiple formats and therefore addresses several safety components. For the purposes of this report, property damage only (PDO), injury and fatality crashes were examined. PDO crashes represent the largest type/group of crashes that occur in trucking and are a critical metric since many PDO crashes fall below insurance and/or government reporting requirements. Therefore, PDO crash data differs from higher consequence crashes, reflecting large but frequently unreported safety events.

Benefit-cost assessments also revealed the anticipated avoided costs for PDO, injury and fatality crashes for each of the OSS technologies tested. Table 4 displays the crash cost information by OSS type.

<table>
<thead>
<tr>
<th>OSS</th>
<th>PDO</th>
<th>Injury</th>
<th>Fatality</th>
</tr>
</thead>
<tbody>
<tr>
<td>FCWS (Rear-end)</td>
<td>$122,650</td>
<td>$239,063</td>
<td>$1,056,221</td>
</tr>
</tbody>
</table>

TABLE 3 Preventable Crashes by Type and Efficacy Rates

TABLE 4 Crash Costs by OSS Type
Estimates for deploying each of the OSS were also calculated and factored into purchase prices, maintenance costs, driver training, technology usage (monthly fees, etc.), financing options and tax savings. FCWS generally ranged in cost from $1,415 to $1,843 per vehicle followed by LDWS at $765.00 to $866.40 and RSC at $440.00 to $866.00.

These system costs were used to determine what the future benefits of utilizing OSS would be over a span of five years. The ranges identified for each OSS technology depended on the vehicle miles traveled (VMT), system efficacies and purchase prices. Therefore, the values displayed in Table 5 reflect average ROI estimates and payback periods for carriers.

### TABLE 5 Return on Investment and Payback Period for OSS

<table>
<thead>
<tr>
<th>OSS</th>
<th>BCA ROIs</th>
<th>Payback Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>FCWS</td>
<td>For each $1 Spent, ROI is $1.33 to $7.22</td>
<td>8 to 37 months</td>
</tr>
<tr>
<td>LDWS</td>
<td>For each $1 Spent, return is $1.37 to $6.55</td>
<td>9 to 37 months</td>
</tr>
<tr>
<td>RSC</td>
<td>For each $1 Spent, return is $1.66 to $9.36</td>
<td>6 to 30 months</td>
</tr>
</tbody>
</table>

Even though the benefit-cost analyses demonstrated average savings across carriers, it is important to note that the results expected may vary from the reported values due to differences in operating practices. Specifically, small carriers that have lower deductibles may not see an ROI within the first five years of investment since they often carry lower insurance deductibles and do not pay “dollar one” for the first several crashes. However, using insurance deductibles as an alternative to OSS investment provides cost protection only for one to two severe crashes at which point premiums will increase dramatically or the carrier will be dropped outright.

### Large Truck Onboard Safety System Field Test

Although some industry stakeholders utilize OSS, research conducted by ATRI and FMCSA indicates that many motor carriers still require stronger supporting data and additional findings and guidance prior to investing in such technologies. The factors affecting OSS investment decisions often include financial considerations, the probability of increased safety, mitigating negative driver perceptions and/or reactions, secondary resources and information credibility.

Critical outcomes that were identified during the different LOFT tasks contributed significantly to the development of OSS-oriented research designs. The purpose of identifying field test requirements and designs was to ensure that any future OSS field testing was based on meaningful metrics, issues and outputs; thus meeting the mutual objectives of FMCSA and industry.

The data elements necessary for a naturalistic data collection effort are displayed in Table 6. While additional variables have been suggested for inclusion, the following measures selected
were considered to be most critical and have been deemed to be available in some capacity for field testing.

### TABLE 6 OSS Research Design Variables

<table>
<thead>
<tr>
<th>Targeted Populations</th>
<th>Safety Measures</th>
<th>Fleet/ Operational Characteristics</th>
<th>Cost Considerations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drivers</td>
<td>Crash Data</td>
<td>Route/Geography</td>
<td>Installation Cost</td>
</tr>
<tr>
<td>Maintenance Managers</td>
<td>Driver Training (safe driving practices)</td>
<td>Industry Sectors</td>
<td>Maintenance</td>
</tr>
<tr>
<td>Safety Directors</td>
<td>Maintenance (road hazard prevention)</td>
<td>Carrier Size</td>
<td>Additional Costs</td>
</tr>
<tr>
<td>Corporate Management</td>
<td></td>
<td>Fuel Efficiency</td>
<td></td>
</tr>
</tbody>
</table>

Throughout the OSS field test design process, it was apparent that carriers have utilized a wide variety of OSS testing and assessment procedures over the years. One consequence is that comparing different carrier-generated OSS test data sets is challenging at best. Consequently, standardized field test designs and data collection strategies should be identified, reviewed and approved by a variety of industry stakeholders prior to carrier recruitment and testing. This will ensure that coordinated and common data collection ensues.

After completing the industry assessment and comparing analysis results with standard academic-oriented research designs, a pretest-posttest nonequivalent groups design appeared to be the most acceptable option across carriers involved for an OSS field test. The research design would ensure that proper inferences are made between pretest and posttest data. In addition, the development of a baseline measure to compare with testing outcomes would ensure that measures were standardized across carrier participants.

### Onboard Safety System Industry Demographics

Carriers of all fleet sizes may be affected by several OSS investment decisions including: pricing for OSS units; support staff comfort levels with new technology; stability of revenue streams; and in-house maintenance facilities for OSS unit repair and recalibration. However, the magnitude of influence each variable has on a carrier’s investment decision may depend on their size. For instance, recent findings suggest that smaller carriers may have delayed OSS deployment patterns when compared to their larger counterparts (6). ATRI and FMCSA commenced this study to fully understand the underlying variables associated with small carrier investment and how those deployment issues could be addressed.

Carriers range dramatically by fleet size and can be categorized either by annual revenue or number of power units operated in a fleet. Although there is no clear definition for the parameters that would represent a small, medium or large carrier, there is a general understanding of the role and magnitude that each carrier-size encompasses. The following bullets describe the basic attributes that are typical of each carrier category.

- **Small Carriers & Owner-Operators** - These two groups of carriers comprise the vast majority of trucking companies in the U.S. These carriers are almost exclusively privately-
held. Small carriers and owner-operators are characterized by informal decision-making processes; access to limited capital funding sources; less use of current technologies and software systems, and use of third-party maintenance providers. Many independent drivers are contracted to larger carriers -- thus subject to company policies such as the use of in-cab communication technologies.

- **Medium Carriers** - Similar to large carriers, the total number of medium-sized carriers is a relatively small percentage of the industry. Medium-sized carriers typically have somewhat structured decision-making processes, centralized decision-making and access to moderate capital funding resources. Carriers of this size employ at least some current technologies and software systems, though typically not across all operational areas. Equipment maintenance may be performed in-house or by third-party maintenance providers.

- **Large Carriers** - Large carriers comprise a very small percentage of total trucking companies in the U.S. but control a large percentage of employees, assets and cargo. These companies oftentimes have formalized decision-making processes as well as access to substantial capital funding resources. To manage large operations, these carriers utilize sophisticated technologies, software systems and reporting across all operational areas and must adhere strictly to generally-accepted accounting practices. Additionally, large carriers may have elaborate in-house safety and maintenance resources.

Several data collection activities were conducted during the OSS ID study to examine the factors hindering small carrier deployment of OSS. Findings suggested that small carriers would be most motivated to purchase an OSS technology when safety statistics documenting the effectiveness of the systems (e.g., safety benefits) were available or when the purchase price was low (see Table 7). The top five motivators for purchasing the systems represent more than 50 percent of the responses. Similarly, other studies have found safety benefits and ROI to be motivators for carrier investment of the systems (6)(19).

<table>
<thead>
<tr>
<th>TABLE 7 Top Five Motivators for Small Carrier Investment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Top Five Motivators</td>
</tr>
<tr>
<td>Safety Statistics</td>
</tr>
<tr>
<td>Purchase Price</td>
</tr>
<tr>
<td>Overall Cost</td>
</tr>
<tr>
<td>Insurance Cost/Savings</td>
</tr>
<tr>
<td>Product Features</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>

Although the motivators alone would not secure a small carrier’s decision to purchase an OSS, several incentives to increase the likelihood of investment were provided by interview participants (see Table 8). The research team recognizes that motivators and incentives are synonymous; in this study the two represent different degrees of investment on the continuum of a carrier’s decision-making process. Therefore, motivators would move a carrier toward investment whereas incentives would secure the decision to purchase. Not surprisingly, three of...
the top five factors were directly related to cost savings. Likewise, a previous study also demonstrated various types of tax credits, insurance savings and grants to be incentives for investment (20).

TABLE 8 Top Five Incentives for OSS Investment

<table>
<thead>
<tr>
<th>Top Five Incentives</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tax Credit/Break</td>
<td>24</td>
</tr>
<tr>
<td>Good Warranty</td>
<td>21</td>
</tr>
<tr>
<td>Carrier/Peer Feedback</td>
<td>21</td>
</tr>
<tr>
<td>Reduced Insurance</td>
<td>20</td>
</tr>
<tr>
<td>ROI</td>
<td>14</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

Tracking the Use of Onboard Safety Technologies across the Truck Fleet

UMTRI’s research further supported the contention that companies may not be as familiar with the OSS technologies as originally anticipated and that the proportion of those investing in the systems (LDWS, CWS and SCS) were relatively low in comparison to the trucking industry population. Although carriers indicated that challenges did occur from implementing the OSS, significant safety improvements were identified as a result of the systems. Implications for each of the findings were identified throughout the study and have been provided in the following bullets.

**Product Familiarity**
- In order to expand adoption, an active role needs to be taken to introduce and promote the benefits of these safety systems to carriers; and
- Regulation of these systems can prove daunting, especially when carriers are generally unfamiliar with the products. Therefore, government should put considerable effort into increasing the level of OSS familiarity across carriers.

**OSS Penetration**
- Due to the low investment rate, there are opportunities to increase adoption of the technologies;
  - OSS usage is expected to increase over the next five years; and
  - The use of multiple technologies is relatively low, however, integration of the various systems may increase deployment rates.

**Safety Improvements**
Safety improvements appeared to be moderated by the level of systems installed on the fleet. For instance, those with higher proportions of the systems installed tended to see more significant positive driver and cost saving benefits. A carrier’s overall safety culture appeared to be dependent on the level of commitment each had relating to the technology investment. For instance, those that were more involved and supportive of OSS were inclined to have a more trusting relationship with drivers.

Implementation Challenges

Although there is an opportunity to expand adoption of OSS, carriers need evidence that ROI would be positive and occur within a reasonable timeframe after deployment especially since large truck crashes are relatively rare on a VMT basis.

Reaching smaller carriers can be a challenge for vendors since there is such a large number of these fleets (>75%) and the safety culture is typically developed and maintained without the use of OSS.

Carriers need research documenting the practicality of using an OSS when internal safety practices (training and hiring) appear to be meeting the same safety objectives.

Tampering and driver resistance are among the challenges carriers face when installing the systems. Therefore, the availability of tamper-proof products may increase the likelihood of deployment.

Future Developments

System integration of the technologies would likely accelerate the deployment rate if system suppliers were willing to consider such an option.

OSS CHALLENGES

Many challenges must be addressed to encourage widespread deployment of OSS. These challenges include issues associated with: system integration; system reliability; sensor prioritization; driver distraction; driver resistance, data storage/privacy/discovery; and post-deployment impacts on motor carrier operations and system costs.

Despite encouraging field operational test results and anecdotal evidence of OSS improving safety, some trucking industry personnel remain unconvinced by the effectiveness of OSS -- hindering widespread deployment (21). Specifically, study findings indicate that average crash count and cost reductions of 20 percent have been measured across carriers utilizing the technologies (6). Another school of thought suggests that the majority of safety benefits associated with on-board systems accrue to passenger vehicle drivers rather than large truck operators, reducing the likelihood of motor carrier investment in the technology (21).

Motor carriers are also faced with challenges related to the use of OSS. To effectively use OSS, motor carriers must incorporate OSS technologies and data outputs into many safety and operational areas. Management is responsible for planning the additional costs and resources needed to maintain and integrate these systems into ongoing operations; safety personnel have to develop performance metrics based on OSS data; maintenance personnel need to understand the priority of maximizing OSS unit up-time; and dispatch departments may have to develop procedures for routing trucks with OSS unit problems to maintenance facilities.

Carriers will ultimately need to conduct periodic reviews of the impact of OSS on all operational
areas to ensure additional issues and costs are detected. Carriers may incur other unforeseen technical impacts and costs when using OSS. These may include:

- Ongoing computer programming charges to integrate OSS with existing software systems or planned system upgrades;
- OSS equipment damage occurring outside warranty reimbursement provisions;
- Damage to tractor electrical systems due to electrical system overload;
- Maintenance labor costs to replace defective units, upgrade OSS unit software, or recalibrate OSS units;
- Out of route miles or driver delay to 3rd party maintenance providers for unit repair or recalibration;
- Ongoing training costs for new drivers, non-compliant drivers, new maintenance personnel, and 3rd party maintenance providers; and,
- Additional costs of installing or removing the devices when retiring or adding new tractors to the carrier’s fleet.

Low system efficacy and accuracy were presented as limitations for increased investment across new technologies. Several LOFT panelists explained the various failures and incorrect functioning and the need for thorough testing of any unit before they are released or purchased. If many smaller carriers are relying on OSS user input to move forward with purchasing decisions, there would need to be more increased system testing that is reliable and results in minimal failure rates to increase satisfaction across users.

Typically, carriers need to observe a demonstrated payback period of 18 months or less in order to cost-justify the investment. Current ROI estimates are often provided by vendors of the OSS product and carriers report being unable to replicate the ROI estimates in actual test environments. Carriers would like to be able to verify the cost/benefit value for the investment before the purchase decision is made.

Lastly, there are significant concerns relating to the data produced by OSS. Motor carrier concerns related to the accuracy of the data, the impact of the data from newly-hired or improperly trained drivers, system efficacy questions, and the prevalence of “false warnings,” may play a role in impeding OSS deployment. Carrier concerns regarding the use of this data in civil and or criminal litigation may also impact OSS deployment decisions.

CONCLUSION

While carriers are interested in making business decisions based on reliable and verifiable research findings, these same carriers recognize the difficulties of controlling many of the intervening variables that can impact the outcome of the research. Variations in driver experience and skill as well as driver turnover make it difficult to completely isolate and control for the differences in OSS effectiveness created by driver acceptance and use of any OSS.

The reality of trucking industry operations is that truck assignments and routes will vary based on the needs of the business and client. Such realities can hamper the ability to control for the impact of operational differences at the carrier level. It is therefore imperative that OSS research include carrier participation, address carrier operational issues, and generate carrier-oriented safety and non-safety data and findings. Research findings should illustrate relationships that are specific to each segment or operation included so that carriers may utilize results that correspond to their fleet demographics. In order to reach carriers at a broader level,
industry awareness opportunities to overcome deployment barriers and create an industry-wide safety culture are necessary components for increased investment.
REFERENCES


