Driver Citation/Carrier Data Relationship Project

Summary Report

September 1996

Prepared for:

US Department of Transportation
Federal Highway Administration

by

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The Driver/Carrier Relationship Project

The Driver/Carrier Relationship Project was commissioned to address three issues. The first was to determine if drivers of commercial motor vehicles get tickets at a different rate, depending on the carrier that they are working for. The results of the study were clear:

Driver violation rates differ substantially among carriers.

However, there could be any number of reasons for this difference. The second issue was to determine if the difference was related to safety performance. Based on the data analyzed,

Higher violation rates are associated with higher crash rates.

The third issue was whether this information could be useful in targeting carriers for further scrutiny. The statistical study was based on a manual name matching that could not be used in a production environment. However, the project team did identify a statistical approach that can be used for targeting potential problem carriers, Carrier's Drivers' Violation Rate (CDVR).

The derived statistic, Carrier's Drivers' Violation Rate, can be used to identify and target potentially problem carriers.

The remainder of this document will describe the project organization, the analysis that was performed, the results and the conclusions.

I. Background

This project was developed in two phases.

The goal of Phase I of the Driver/Carrier Relationship Project was to determine if there was a difference in the rates that drivers receive tickets (violations), based on the carrier that they are working for. Phase I included representatives and data from five States. Idaho, Indiana, Michigan and North Dakota provided data for all violations written by the State Police during the study period. (The actual period varied slightly from State to State, but was some or all of the year 1993.) California provided data for a limited number of carriers.

The data from these first four States represented the violation data used in the study. A number of analyses were performed and conclusions were drawn from this data. However, in order to perform a more complete analysis, it was necessary to calculate violation rates, i.e. violations per some measure of exposure. Two measures of exposure were offered;

- Idaho provided a hard-copy report of its ton-mileage tax records. Ton-mileage includes the carrier's reported mileage in the State for each calendar quarter.
- North Dakota and Indiana provided automated output of their IRP mileage for the year.

The data from Idaho was the most accurate, as it presented a report of actual carrier mileage. However, there was simply not enough data from either Idaho or North Dakota to develop valid statistical analyses, and only Indiana data was used for the Phase I statistical analysis.

In addition, the five participating States prepared reports of their individual State findings. These findings were included in the Phase I project reports, and are represented in this report. The two Phase I reports are titled "Driver/ Carrier Summary Analysis" and "Driver Carrier Statistical Analysis." These reports are available from Mr. Paul Alexander from the Office of Motor Carriers at FHWA.

The goals of Phase II were to validate the Phase I statistical results, to determine if the difference in carrier violation rates was due in part to safety performance and to identify appropriate measures for use in identifying potential problem carriers.

For Phase II, Indiana provided a second year's data, including both violations issued by the State Police and IRP mileage. Michigan also provided both violation and IRP mileage data. SAFETYNET data related to crash history, SCE scores and Safety Rating was also used. The resulting report, titled "Driver/Carrier Data Relationship Project, Phase II Report", is also available from Mr. Paul Alexander.

II. Driver Violation Rates Differ Substantially Among Carriers

A number of analyses were performed to understand the differences among carrier violation rates. This section describes the analysis and results.

A. Preparation

There were two major areas of preparation for the analysis. First was the preparation of the data. Second was the preparation of a statistical approach.

1. Data Preparation

Violation data was received in electronic format, with the carrier clearly identified. Indiana had 22,891 citations with carrier references for 1993, and 23,760 in 1994. Michigan offered 33,917 citation records. The data was summarized at the carrier level.

IRP data was also received electronically. However, a manual name matching was required to match the registrant name on the IRP to the carrier name on the violations. It is recognized that the registrant is not always the carrier; industry experts have estimated that 10% of all trucks on the road are leased. Nonetheless, this was the best data available. Further, some carriers have multiple registrations. Recognizing this from Phase I, registrant mileage records were merged in the Phase II analysis.

- In Phase II, Indiana reported 6,752 registrants. Of these, 189 were exact matches on both name and address. Of the 6,563 distinctly identifiable registrants, it was possible to identify violations on 936 carriers.
- Michigan reported 4865 registrants. Of these, 466 matched on name and address. From the remaining 4,399 registrants, it was possible to identify violations for 729 different carriers.

2. Statistical Approach

The non-technical reader may choose to skip this section. A more complete explanation of

the statistical approach is available in the project reports.

The basic statistical approach used is hypothesis testing. Typically, a Null Hypothesis is generated, and shown to be unlikely. For example, the hypothesis was suggested that violations are randomly distributed among carriers with greater than 750,000 IRP miles. This was shown not to be the case.

There was a special issue in that each carrier traveled a different number of miles, making comparison difficult. Two approaches were taken to address this issue.

- The first approach was to treat violations as random events, conforming to a bi-nomial probability distribution. In other words, for each mile driven, there is the same probability of getting a violation as in any other mile. For any population addressed (e.g. Indiana carriers with over 750,000 IRP miles) it was possible to calculate an average number of miles per violation. Then, the expected result for each carrier, including expected number of violations and the individual carrier's standard deviation (and the resulting Z-Score) was calculated.
- The second approach was to stratify carriers, and look at carriers in a mileage grouping. This allowed the use of the Poisson statistic, which addresses the actual outcome of low probability occurrences over a large number of events.

The other key statistical tools used in this phase of the project were:

- The Bell Curve - The expected distribution of randomly occurring events, and
- The Chi-Squared (X^2) statistic, which supports a determination as to whether an actual distribution matches an expected distribution.

B. Results

In testing the Null Hypothesis, we looked for evidence that the violations were randomly distributed. If violations were distributed randomly, the resulting distribution pattern (for carrier's Z-scores) would have approximated a bell curve. Several results of the analysis are presented below.

1. Indiana Carriers with Greater than 750,000 IRP Miles

Figure 1 shows a comparison of the distribution of Indiana carriers with greater than 750,000 miles, as compared to the expected distribution (a bell curve). This is from the Phase I study.

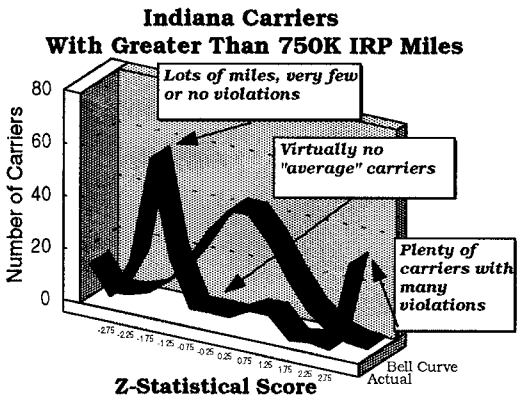

Figure 1

This group averaged about a ticket every 340,000 miles, so that with an overall expectation of over two violations per carrier for even the smallest carriers, this distribution would have been expected to approximate the bell curve if violations were randomly distributed among carriers.

Clearly, violations are not randomly distributed among carriers.

2. *Michigan Carriers with over 750,000 IRP Miles and Violations*

Figure 2 presents the distribution of Michigan carriers with over 750,000 miles and violations, and compares it to the expected distribution. This is from the Phase II validation.

Michigan Carriers with Greater than 750,000 IRP Miles and Violations

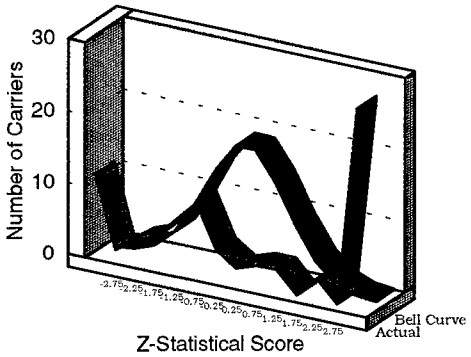

Figure 2

Within this group, there is a violation about every 250,000 miles, so there is strong reason to expect a bell curve, if violations are randomly distributed among carriers. There is reason to suspect that the large number of extremely low violation rates is due to the impact of leasing companies, which have high IRP mileage, but are not carriers. Nonetheless, the lack of average carriers, along with the presence of a large number of carriers with extremely high violation rates, clearly demonstrates that violations are not randomly distributed among carriers.

3. *Michigan Carriers with Between 60,000 and 80,000 Miles*

Table 1 presents the data relating to Michigan carriers with 60,000 to 80,000, summarized by number of violations for the carrier. The table also presents the expected number of carriers for each number of violations, based on 349 carriers randomly receiving 108 violations. (This is a Poisson distribution.)

Number of Violations	Number of Carriers	Expected Number of Carriers
0	305	256
1	18	79.25
2	11	12.25
3	6	1.25
4	3	.01
5	2	.006
6	1	.0003
7	2	.000001
8	1	...

Table 1

(This analysis ignores the one carrier with 31 violations.)

The results are apparent. There are more carriers than expected with no violations. There are far fewer than expected carriers with exactly one violation. The number of carriers with two violations was very close to the expected result. However, the number of carriers with more than two violations far exceeded the expectation.

This conforms to the previous view of many better than average and many worse than average carriers, but few "average" carriers.

The data was examined to see if there was any evidence that there were a large number of cases of drivers receiving more than one violation in one traffic incident, but this was not the case. Further, these results were consistent with other test cases.

Clearly, violations are not randomly distributed among Michigan carriers with 60,000 to 80,000 IRP miles.

4. Carriers with Over 100,00 Miles and Size and Weight Violations

Figure 3 shows the distribution for Michigan carriers with over 100,000 IRP miles and at least one size and weight violation.

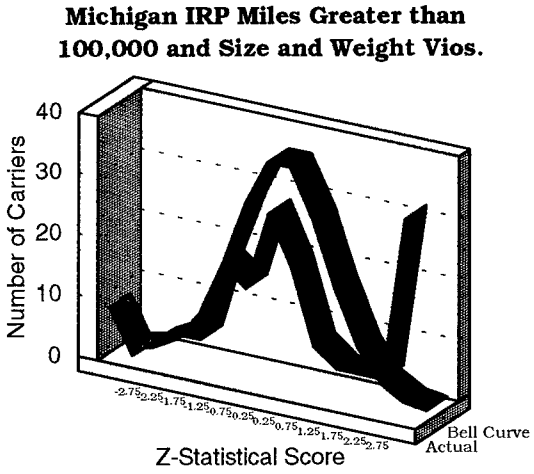

Figure 3

A review of the size and weight violations indicates that carriers fall into three groups;

- Carriers which receive no size and weight violations, or virtually no size and weight violations,
- Carriers which receive a few size and weight violations, based on the number of miles driven, and
- Carriers which receive a disproportionately large number of size and weight violations.

Even among carriers with size and weight violations, size and weight violations are not randomly distributed.

In addition to the analysis performed above, other tests were run. For thematic clarity the rests of these analysis have been left out of this summary. However, the conclusions included below draw from all the analysis, not just the results presented in this summary.

C. Conclusions

A wide variety of analyses were performed. Among the significant conclusions were;

- The types of violations received differ between for-hire and private carriers.
- The types of violations received are different for the carriers which receive the most violations.
- The number of violations per carrier mile, and number of violations per crash, differ among the States.
- The ratios of violations among the types of violations differed substantially among the States. (The representative from North Dakota also suggested that the ratio of types of violations differed within State, based on the season.)

The State reports placed a great deal of emphasis on the difficulty that they had encountered in developing accurate data, even though they had been collecting carrier identification on citations. There was a great deal of concern about assuring that the training component is in place should a larger, nationwide effort to identify carriers on citations be implemented.

Overall, the conclusion was that, despite the problems with the data, **there is clear evidence that violations are not randomly distributed among carriers.**

III. Higher Violation Rates Are Associated With Higher Crash Rates

Once it was determined that a difference in carrier's violation rates exists, the next issue was whether the difference could, in any

way, be attributed to a difference in safety performance.

Clearly, there are other explanations for the distribution of violation besides performance. For example, carriers with fleets based near police facilities may have higher than average violation rates.

It was not enough to show that there was a difference in carrier performance. One of the goals of the project was to determine if the difference was, in any way, related to safety.

A. Preparation

1. Data Preparation

In order to determine if there was a relationship between violation performance and safety fitness, three indicators of safety fitness were utilized;

- crash history,
- SCE score and
- Safety Rating.

SAFETYNET Data

SAFETYNET data was utilized. SAFETYNET data was manually matched to the Michigan and Indiana 1994 IRP files, and computer matched to the violation data base on USDOT number.

- An additional 943 Indiana carriers which had IRP miles, had no violations, and had either a crash, a SCE score, or a Safety Rating were identified and used in the subsequent analysis. Of these, 60 had crashes.
- An additional 1093 Michigan carriers which had IRP miles, had no violations, and had either a crash, a SCE score, or a Safety Rating were identified and used in the subsequent analysis. Of these, 184 had crashes.

Safety Ratings

It was recognized that Safety Rating may be a less accurate indicator of safety performance than crash rate for a number of reasons;

- Safety Rating is not entirely performance based. Much of the Safety Rating is based on management practices, which are expected to affect safety fitness.
- A portion of the Safety Rating is based on the carrier's violation history. Therefore, there should be a built in correlation between violation rates and the Safety Rating that is affected by the violation rate.
- Many Safety Ratings are based on Safety Reviews, which represent carrier self-evaluations There is no reason to believe that self-reporting was accurate.
- Many of the Safety Ratings are old. In fact, some may be close to 15 years old.

Nonetheless, it is expected that current Safety Rating should provide some insight as to the perceived safety fitness of the carrier, and immediate prior Safety Rating is accepted as providing additional input to the safety fitness of the carrier. A method of quantifying the results of the current and prior safety rating was developed, and is presented in Table 2, below.

Quantifying Safety Rating		
Safety Ratings Factor	Current Safety Rating	Prior Safety Rating
9	U	U
8	U	C
7	U	S or none
6	C	U
5	C	C

Quantifying Safety Rating		
Safety Ratings Factor	Current Safety Rating	Prior Safety Rating
4	C	S or none
3	S	U
2	S	C
1	S	S or none

Table 2

SCE

The SCE methodology is used to identify carriers for review. While it takes into account carriers that are likely to pose a greater safety threat, such as passenger and hazardous materials carriers, it is expected to present a listing which also addresses problem carriers.

Violation Data

Several measures of violation history were used by the project, including Z-Scores, Z-rankings, Violation Rates, and Violation Rate Rankings. This report focuses primarily on the results of correlations using Violation Rate, the most straightforward of these parameters.

2. *Statistical Approach*

The primary statistical approach used in this study was correlation analysis, as measured by the coefficient of correlation. The coefficient of correlation is an indicator of how well one parameter or statistic predicts another.

The coefficient of correlation does not suggest causality. For example, a high correlation between cigarette smoking and lung cancer does not suggest that lung cancer causes cigarette smoking. In fact, there may be no causality at all. A high correlation between heart disease and lung cancer may be the result of other factors, such as diet or cigarette smoking, which affect both. Further, some additional factor (such as obesity) might affect heart disease rates, but not lung cancer.

The goal of this analysis is not to suggest that there is *any* causality relationship between violation rates and crash rates. It is simply to demonstrate a statistical association.

B. Results

1. *Strong Relationship Between Violation Rates and Crash Rates*

The results of the correlation analysis of violation rates and crash rates was very simple, straightforward and strong. Some of the correlation coefficients between crash rate and violation rate for different portions of the study population are listed below, in Table 3.

Criteria	Coefficient of Correlation
Indiana carriers which had mileage, violations, and crashes	.904
Indiana carriers which had mileage and violations	.665
Indiana carriers which had mileage and a violation, a SCE score, a Safety Rating, or a crash (all carriers)	.847
Indiana carriers which had crashes	.808
Michigan carriers which had mileage, violations, and crashes	.580
All Michigan carriers (in the study)	.425
Michigan carriers with crashes	.520

Table 3

These are very strong findings.

There was one particularly significant observation of the crash data. It appeared that companies that could be clearly identified as leasing companies (or as having large leasing operations) tended to have far more accidents than would have been predicted from their (rather low) violation rates. This suggests that the officers assigning the violations (frequently MCSAP trained officers) were better at extracting the actual identity of the carrier than were the officers reporting the crashes.

2. *Poor Correlations with Safety Rating Factor and SCE.*

The Safety Rating factor and SCE score were considered the other measures of carrier safety performance or safety fitness. Despite a strong relationship between violation rates and crash rates, the relationships between violation rate and the Safety Rating factor, and between Violation Rate and SCE scores were quite weak. This would indicate that either;

- Violation rate is not a strong indicator of safety fitness, or
- Safety Rating and SCE score are not strong indicators of safety fitness.

In fact, the analysis suggested that neither Safety Rating nor SCE score is an effective indicator of crash rates. Table 4 presents comparative correlations between Violations Rate and Crash Rate as compared to SCE and the Safety Rating factor for several of the analyses performed.

	Correlation to	
Criteria	Vio. Rate	Crash Rate
Ratings factor of all Indiana carriers	.007	.023
SCE Score for all Indiana carriers	.003	.003
Safety Rating factor for Indiana carriers with crashes	-.038	-.037
SCE for Indiana carriers with crashes	-.105	-.284
Safety Rating factor of all Michigan	.09	-.003
SCE for all Michigan carriers	.001	.016
Safety Rating factor for Michigan carriers with crashes	-.057	-.036
SCE for Michigan carriers with crashes	-.068	-.077

Table 4

In short, it appears that neither Safety Rating nor SCE score are indicators of safety fitness. Therefore, the lack of correlation between violation rates and these factors does not weaken the findings.

C. Conclusion

Based on the data used for this project, it is clear that at least part of the difference in driver violation rates among carriers is associated with a difference in safety performance.

IV. A Useful Statistic - Carrier's Drivers' Violation Rate

A. Search for an Exposure Measure

Given that the States could provide violation data, it was still necessary to have some measure of exposure.

All of the statistical analysis for the Driver/ Carrier project (except the small piece of the

initial analysis that used Idaho ton-mileage data) used IRP mileage data. However, IRP mileage cannot be used in a production (real) environment, for a number of reasons.

1. First, manual name matching was used for the Driver/ Carrier project. While this was satisfactory for statistical purposes, it would be unacceptable in a large volume setting. (Further, commercial name matching software packages depend on address. However, IRP uses terminal address, suggesting that automated name matching is not likely to be a feasible alternative.)
2. Many companies have multiple IRP accounts for a single carrier.
3. IRP mileage can be estimated mileage. There was evidence in the study that some companies used estimated miles over several years. Estimated mileage is used in base State shopping situations.
4. Nationwide carriers had inappropriate mileage totals. Clearly, there were some nationwide carriers which had some IRP miles in the study States, but which had far more miles in the study States registered elsewhere. This resulted in an inappropriately low mileage total for these carriers, and the associated inappropriately high violation and crash rates.
5. Most importantly, IRP mileage is for registrants. Motor carriers have safety responsibility. Often, leases come between the registrant and the motor carrier. So long as leasing continues to be a factor, IRP mileage will not present an accurate representation of carrier mileage.

Clearly, IRP mileage cannot be used currently for an exposure measure. Another measure was needed.

- IFTA mileage was rejected; IFTA data is less connected to the carrier than IRP data.
- The number of power units, or the number of drivers could be used. However, this data is currently collected on the MCS-150, and only updated in the review process. This is clearly dated and inaccurate data.

Having not found an appropriate measure of exposure, the project team regrouped and met with the participant State representatives to identify a new approach. A particularly popular report throughout the project, Drivers with Three or More Violations for Two or More Carriers, was a triggering tool. The following concept was developed with F.Lt. Lisa Jacobs and Sgt. Sharon Van Campen of Michigan.

B. Concept

While it may be an obvious concept, Figure 4 demonstrates a simple way to reduce the size of the problem.

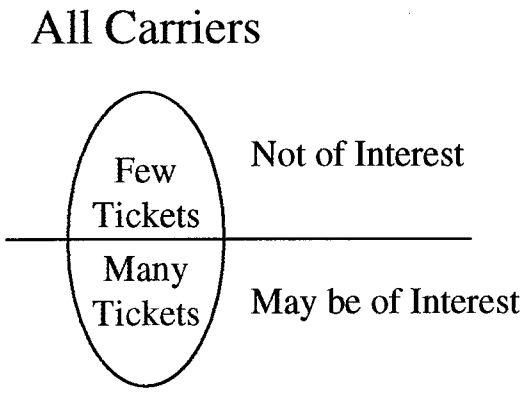

Figure 4

Carriers with few tickets are not of interest. If the carrier is not a good performer, the carrier is too small to tell.

As Figure 5 indicates, some of the carriers with many tickets are of interest.

Carriers with Many Tickets

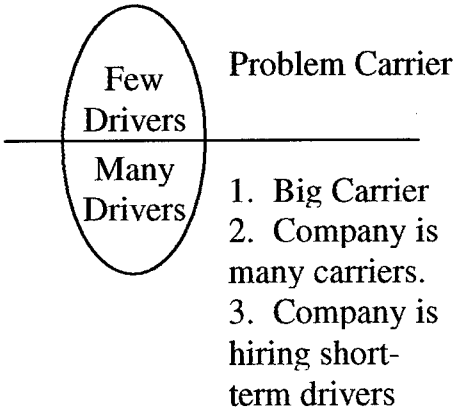

Figure 5

1. *Carriers with Many Tickets for Few Drivers*

If a carrier has many violations and only a few drivers, the carrier has a high rate of violations per driver. The point of this project is that high driver violation rates point to carriers of concern. A high violation rate per driver is sufficient reason for concern about the carrier's safety performance.

2. *Carriers with Many Tickets for Many Drivers*

Carriers with many tickets for many drivers (i.e. a low number of tickets per driver) were categorized as generally falling into one of the following three groups. The carrier could be,

- A large company,
- One company which functions as many carriers or
- A carrier which hires many short-term drivers.

Large Company

The project code named this situation "UPS". It is a situation where a large company has a many violations and many crashes, simply because of size. However, the company has a good safety record. One project objective was to avoid identifying such a carrier for further scrutiny. Notably, since these carrier's drivers tend to work for the same company all year, and have a fairly good overall record,

- The carrier's drivers have low violation rates while working for the carrier and
- the carrier's drivers have few or no violations for other carriers.

One Company is Many Carriers

There are many business reasons why one company may choose to do business as many carriers. There is no legal impediment to this type of activity.

However, it appears that one common reason that a company functions as several carriers could be to avoid enforcement for unsafe business practices. There is clear evidence in the data, and in the testimony of the State police officers relating that this is a common occurrence. The drivers for these companies are readily identified;

- The carrier's drivers have a few tickets, and a low violation rate, for the carrier.
- The carrier's drivers also have a number of violations while driving for other sibling carriers.

Company Hires Many Short Term Drivers

There is no particular reason to expect that a carrier that hires short-term drivers is a problem carrier. However, there are many situations where problem carriers do hire short-term drivers, and these carriers are

difficult to identify using current methods. Again, these carriers can be identified by their driver's records.

- The carrier's drivers have a low violation rate for that carrier, and
- The carrier's drivers have violations, perhaps many violations, for other carriers.

3. Summary

In order to distinguish between these three situations, it is necessary to look at the carrier's driver's record when the driver was working for other carriers.

C. Statistical Approach - Carrier's Drivers' Violation Rate

Taking this approach to a statistical structure, it is apparent that the unit of exposure is the driver-year; each driver drives a driver year per year. Further, each violation that a carrier's driver receives reflects on, and should be identified with that carrier, regardless of whether the driver was driving for the carrier at the time.

The Carrier's Drivers Violation Rate (CDVR) can be calculated as:

$$\frac{\text{Total Number of Carrier's Drivers' Violations}}{\text{Total Number of Drivers for The Carrier}}$$

CDVR, as a concept and as a statistic, offers several significant benefits.

1. Matches Methodology to Business Practice

While there are certainly examples of effective measures that are not related to the underlying business functions, it always appears better when a statistical measure is related to the item being measured.

CDVR directly addresses rating a carrier based on its drivers on-the-road performance.

2. Independent of Mileage

There is no current method of determining carrier mileage, and no method on the near-term horizon. CDVR self-generates an exposure measure, each driver is assumed to work a driver-year per year. (Each carrier assumes their driver's driver-year performance)

Consequently, CDVR provides a tool to measures driver and carrier performance without requiring a mileage or other external exposure metric.

3. CDVR can be Implemented Incrementally

The CDVR approach can be implemented incrementally. It does not depend on the development of nationwide systems. This offers substantial opportunity for expansion. These opportunities are discussed below.

D. CDVR Review

The CDVR analysis was applied to the data that the project team had received. Two separate reviews were performed. In the first review, the results were reviewed by experts, the State Police members of the project team. The second was a statistical review, in which the results of the CDVR ranking were compared to crash results.

1. Expert Review

A listing of carriers, based on CDVR was prepared, and reviewed by the State Police MCSAP experts.

Review of Carriers with a High CDVR

The review of the highest ranked carriers provided some interesting results. Many of the listed carriers were recognized immediately as problem carriers.

- One carrier was identified as possibly being influenced by organized crime.
- Another was identified as having been under extended State investigation.
- A third was the candidate of a relatively new investigation.
- Another was identified as being a member of a family of bad carriers. The CDVR approach had identified this carrier. The carrier had a number of drivers, each of whom had a low violation rate for the carrier, and each of whom had violations for the same group of other carriers.
- Several carriers garnered comments such as "this guy is a dirt bag", and "that guy is a double dirt bag."
- The mention of the name of one of the carriers simply upset one officer, and the session turned more somber.

It was recognized that the ultimate goal of the program is to save lives, and that this was a listing of carriers who could be a threat to lives, and who may not have been receiving the appropriate scrutiny.

Several other carriers on the list were unknown to the officers, but were soon to be targets of scrutiny.

None of these carriers had a Safety Rating of Unsatisfactory, and only one had a Conditional rating. Clearly, the CDVR rating had uncovered

- carriers that these State knew about, but which were unknown to FHWA, as well as
- carriers which were unknown to the States.

Review of Carriers With Low CDVR

A review of the low CDVR ratings found that, for the most part, these were recognized as good carriers, if they were recognized at all.

However, one carrier toward the bottom of the list was recognized as a national carrier of low repute. Apparently, this carrier's drivers drove through the study States, but did not spend a great deal of time in the States. Consequently, each of this carrier's identified drivers had a low rate of violations in the study States, (and few or no violations for other carriers.)

This demonstrates that CDVR is not the universal panacea. It is simply a tool that can be used in improving the identification of problem carriers.

2. *Statistical Review*

The second validation of CDVR was a statistical validation. The hypothesis is that CDVR is a predictor of crashes.

The first statistical approach was to correlate CDVR with crash rate. However, because of the low percentage variation in CDVR, the results were not satisfactory. To demonstrate the relationship, CDVR rank was correlated to crash rate rank.

The result was a solid statistical correlation. For example;

- For Indiana carriers with greater than 10 violations, the correlation between CDVR Rank and Crash Rate Rank was .29. When only carriers with crashes are considered, the correlation becomes .45.
- For Michigan carriers with 20 or more violations the correlation between CDVR Rank and Crash Rate Rank is .24. When only carriers with crashes are considered, the correlation becomes .37.
- For carriers with 25 or more violations in Indiana and Michigan, the correlation between CDVR Rank and Crash Rate Rank is .25. When only carriers with crashes are considered, the correlation is still .25.

This is a clear statistical result, and supports the use of CDVR as a tool for identifying potentially problem carriers.

E. Potential For Refinement/ Implications

The development and use of CDVR is, essentially, a three step process;

1. First, the driver is associated with the carrier.
2. Second, all of the driver's performance is associated with the carrier.
3. Third, carriers are ranked based on their drivers' performance.

Each of these portions of the approach could be expanded.

1. Associate the Driver with the Carrier

This study used only violations to associate drivers with carriers. In addition to expanding the association of drivers and carriers on tickets, other associations are possible.

Some drivers and experts have estimated that the average CMV driver has six encounters with the police each year. Most of these are paperwork checks, which are not written up as Level 3 inspections because to do so would impose a burden for the State to perform Level 1 inspections.

An effort to have these contacts written up and entered would increase the ability to match drivers to carriers. Additionally, a low probability (e.g. 1 in 500) random Level 3 inspection program could result in a very solid data base connecting drivers with carriers.

This would also make the program fairer, by associating driver's with no violations with their carrier, improving the ability to positively identify good carriers.

2. Associate the Driver's Performance with the Carrier

Once the driver is associated with a carrier, the driver's performance is associated to the carrier.

As was demonstrated, the first step in this process allows the ability to identify companies which are avoiding scrutiny by spreading violations among carriers.

However, this offers a second particular advantage. It has been noted that even State Police officers who are not MCSAP trained have a great deal of difficulty identifying the carrier from paperwork in a truck. It can be anticipated that it would be much more difficult for local police to make this identification.

By building a database associating carriers and drivers, it will be possible to (tentatively) match a drivers to the carrier after the fact.

(This data will only be used to identify potentially problem carriers, an actual assignment would be needed for enforcement action.)

Consequently, violations and crashes will be able to be written up by the local officers without requiring the officer to identify the carrier, and the action will still be used for identifying potentially unsafe carriers.

3. *Rank Carriers Based on Driver Performance*

This study gave equal weight to each violation. It has been suggested that a weighting methodology be developed. Such a methodology was beyond the scope of this study.

IV. Conclusion

The project met all of its major goals;

- It was demonstrated that violations are not randomly distributed among carriers.
- It was demonstrated that the difference in violation rates is associated, to some significant degree, with a difference in safety performance and
- A statistical tool, the Carrier's Drivers' Violation Rate, was presented as a method to identify potentially problem carriers.

It has been demonstrated that there is public policy benefit in collecting data about the carrier on driver citations. This data can be used to identify potentially unsafe carriers.

Further, there is benefit in collecting data about a driver's relationship to a carrier any time that the data is presented to law enforcement.

Finally, there is an implication that there are a wide variety of possible next steps which could be taken to improve the data collection, and which could be used to target potentially unsafe motor carriers for further scrutiny.