Special Study ADAS Evaluation
Analysis of ADAS Lane Departure Warning (LDW)

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Introduction

Generally, the goal of this analytics approach is to determine the effectiveness of specific Advanced Driver Assistance System (ADAS) features. This can only be accomplished by comparing the ADAS vs. non-ADAS over a relatively large number of test and control cases (large enough to obtain statistical significant results). In this example the "control" subset will be crash records for those vehicles with a given ADAS feature. The "test" subset will generally be a large subset of all vehicles that do not have the ADAS feature under consideration. If the ADAS feature is to reduce a given type of crash (e.g., lane departure crashes), the Primary Contributing Circumstances given in the crash records can be used to determine the effectiveness in reducing those crash types by a direct comparison of the test and the control subsets.

Consumer Reports has provided a list of ADAS features that indicate the Year, Make and Model in which each of the features covered were present. We assume that if an ADAS feature is present for a make and model in a given year, it will also be present for that model in subsequent years. A filter for the crash records was created that enabled vehicles known to have the Lane Departure Warning (LDW) to be compared with those that did not. The makes and models for the LDW vehicles were obtained from a large number of Toyota models, in the 2019 and 2020 model years. The comparison dataset was obtained from Dodge models that did not have LDW.

The major findings, which are described in the detailed IMPACT displays given below can be seen in the first display. This indicates a significant reduction in the percent of Improper Lane Changes from 10.03% without LCW to 7.17% with LCW, or a reduction (see Odds Ratio) of 1.398, or about 40%. The Max Gain column indicates that this accounted for a saving of at least 11 crashes. The Manner of Crash attribute, given in the second IMPACT display confirms this positive finding with similar results. Comments are given under each display.

Details of the Analysis

Note that we have reversed what is typically considered the Test and Control datasets. The reason for this is to adopt what has become standard in most IMPACT studies where the Subset (column heading) with some deficiency is considered in the first two numeric columns, and the "Other" subset is considered as the control. For example, if we were doing an analysis of DUI crashes, they would be considered in the Subset columns, and all non-DUI crashes would be considered in the Other columns. This is further reflected in the definitions below.

- What numbers are counting? In this case, CARE-IMPACT is being applied to the Driver-Vehicle dataset, so the numbers are literally counting vehicles. However, to become a part of this subset, these vehicles would have had to have been involved in a crash. To keep this definition in front of us, we will call the numbers produced and displayed in the IMPACT displays: Vehicle-Crashes, which we want to define literally as the number of vehicles that were involved in the crash types under consideration. For example, a two vehicle crash will result in there being two vehicle-crashes recorded in the dataset. This term will be used in the further definitions below.
- Subset columns: These record the experiences of 399 Dodge vehicles, none of which were of models that had LDW in 2019-2020, specifically, Challenger, Grand Caravan and Journey were included. Charger and Durango were excluded because they had LDW capabilities in these years. These will also be referenced as the non-LDW vehicle-crashes.
- Other columns: 3,042 Toyotas all models of which had LDW, which were most all models in the 2019 and 2020 model years. The only three models excluded were the 86 and the two Yaris models.
- Rationale. The non-LDW is used as the "Subset" so that it is easier to see any advantage of the LDW in the IMPACT displays. Generally, IMPACTS are used to determine how crashes of a given type (test subset, e.g., DUI) compared with crashes that are not (e.g., non-DUI). In this case we can envision the non-LDW vehicles to be those expected to cause more crashes involving, for example, Improper Lane Changes.

Summary of Findings

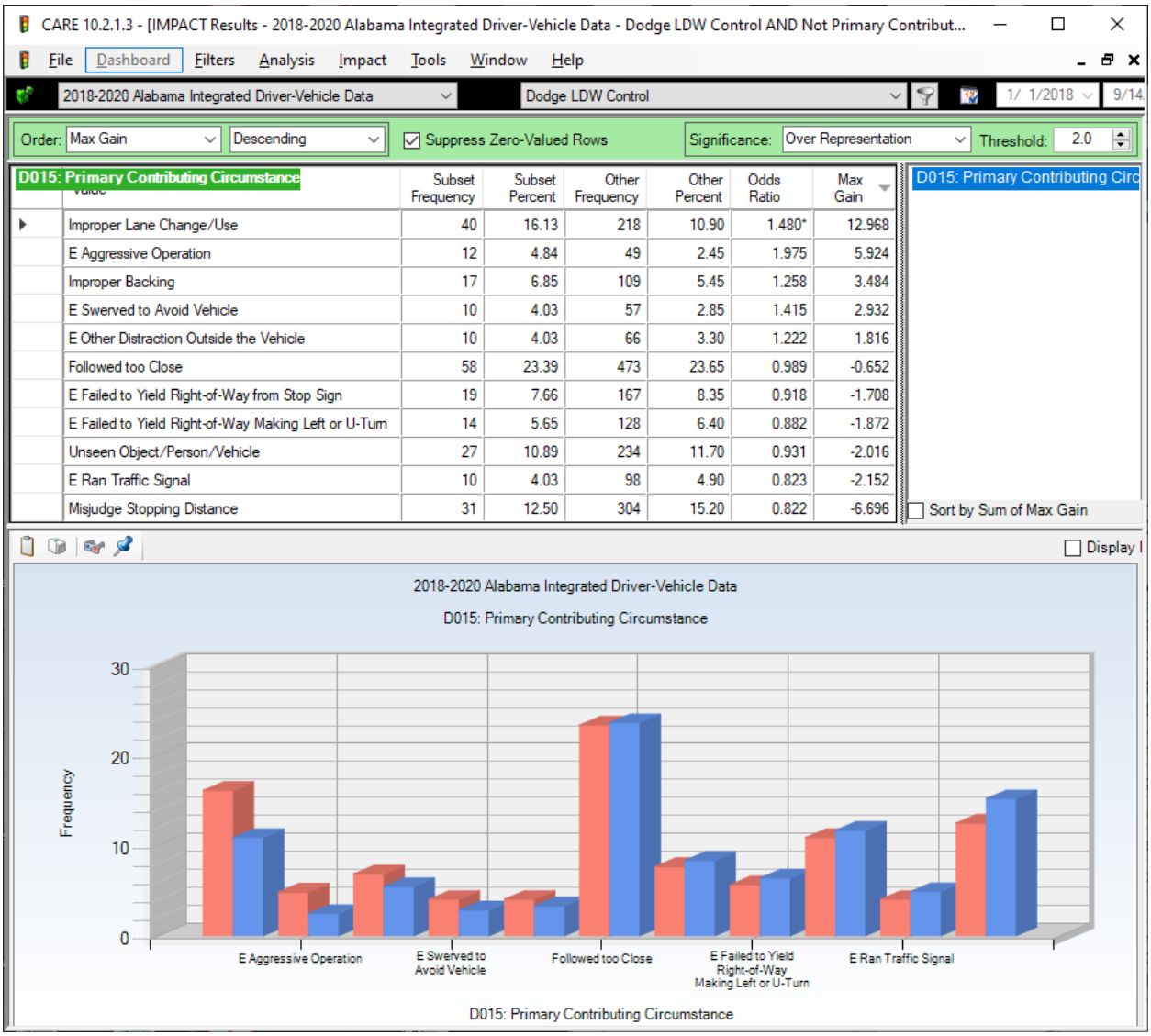
The following are the conclusions drawn from the findings in order of the IMPACT displays below:

- C015 Primary Contributing Circumstances. Improper Lane Change/Use, which we would expect to be the attribute most affected by LDW had a proportion that was reduced by 48%, as given by the Odds Ratio (1.480), which is calculated as the proportion of the Improper Lane Change/Use of the vehicles without LDW divided by the proportion of those with LDW. This was the only PCC value found to be statistically significant.

- C023 Manner of Crash. The manner of crash value that is most apt to be affected by LDW is the Sideswipe -- Same Direction. Other items might also be affected indirectly. The proportion of the Sideswipe – Same Direction was found to be 14.29 in the vehicles without LDW, and 11.34 in those with it, which produced an Odds Ratio of 1.259 and an estimated number of saved vehicle-crashes of 11.734, or close to 12 vehicle-crashes.
- C025 Crash Severity. The fatal category had too few cases to compare. All of the other injury categories had proportions that were reduced for the LDW vehicles. While none of these showed statistical significance, collectively this would seem to indicate that the severity with LDW certainly does not increase, and with larger sample sizes might well show reductions in injury severity.

The IMPACT displays supporting these major findings are given in the next section. Some additional explanations are given under each display.

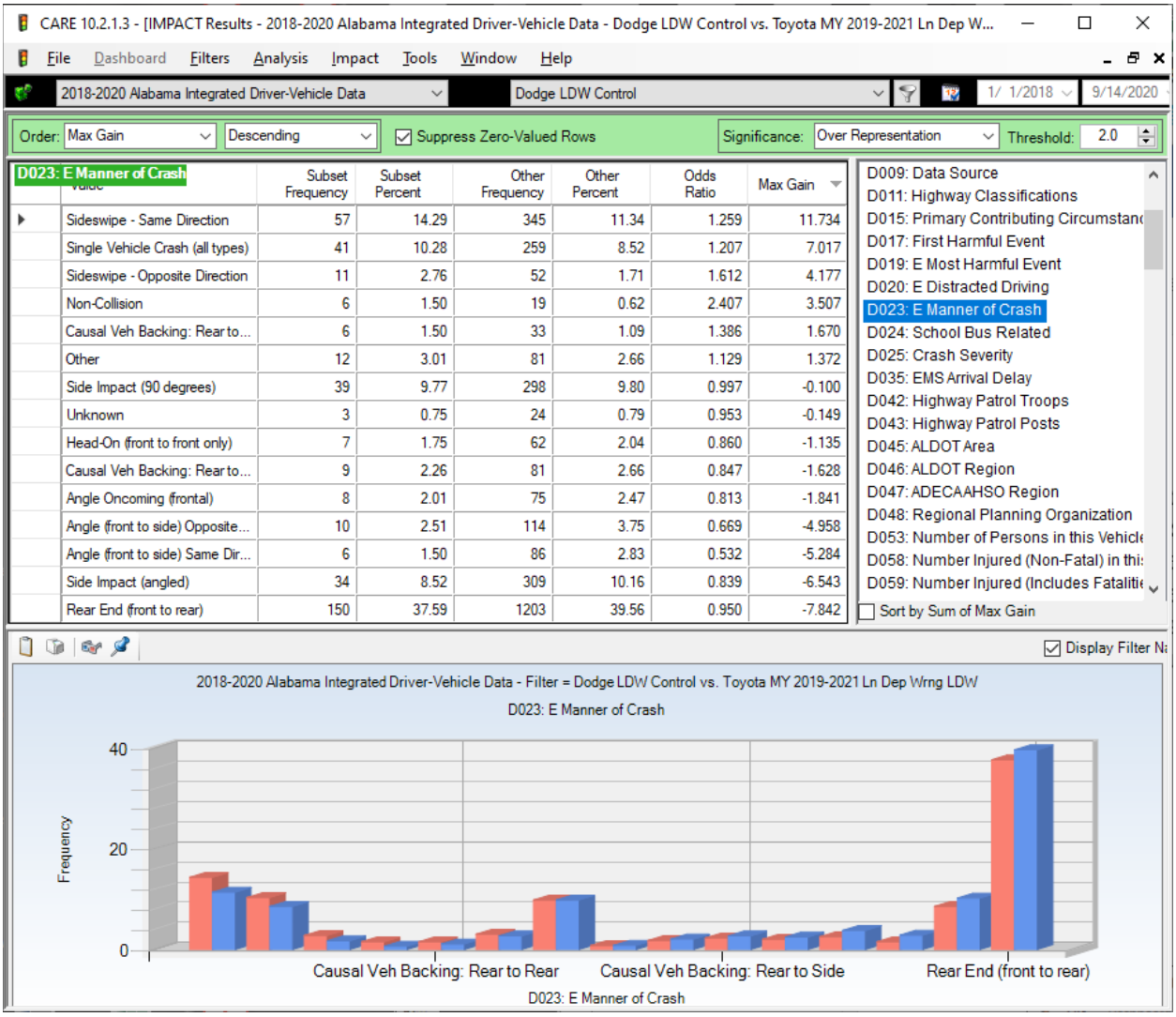
C015 Primary Contributing Circumstances (Non-LDW vs. LDW)



D015: Primary Contributing Circumstance	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
Improper Lane Change/Use	40	16.13	218	10.90	1.480*	12.968
E Aggressive Operation	12	4.84	49	2.45	1.975	5.924
Improper Backing	17	6.85	109	5.45	1.258	3.484
E Swerved to Avoid Vehicle	10	4.03	57	2.85	1.415	2.932
E Other Distraction Outside the Vehicle	10	4.03	66	3.30	1.222	1.816
Followed too Close	58	23.39	473	23.65	0.989	-0.652
E Failed to Yield Right-of-Way from Stop Sign	19	7.66	167	8.35	0.918	-1.708
E Failed to Yield Right-of-Way Making Left or U-Turn	14	5.65	128	6.40	0.882	-1.872
Unseen Object/Person/Vehicle	27	10.89	234	11.70	0.931	-2.016
E Ran Traffic Signal	10	4.03	98	4.90	0.823	-2.152
Misjudge Stopping Distance	31	12.50	304	15.20	0.822	-6.696

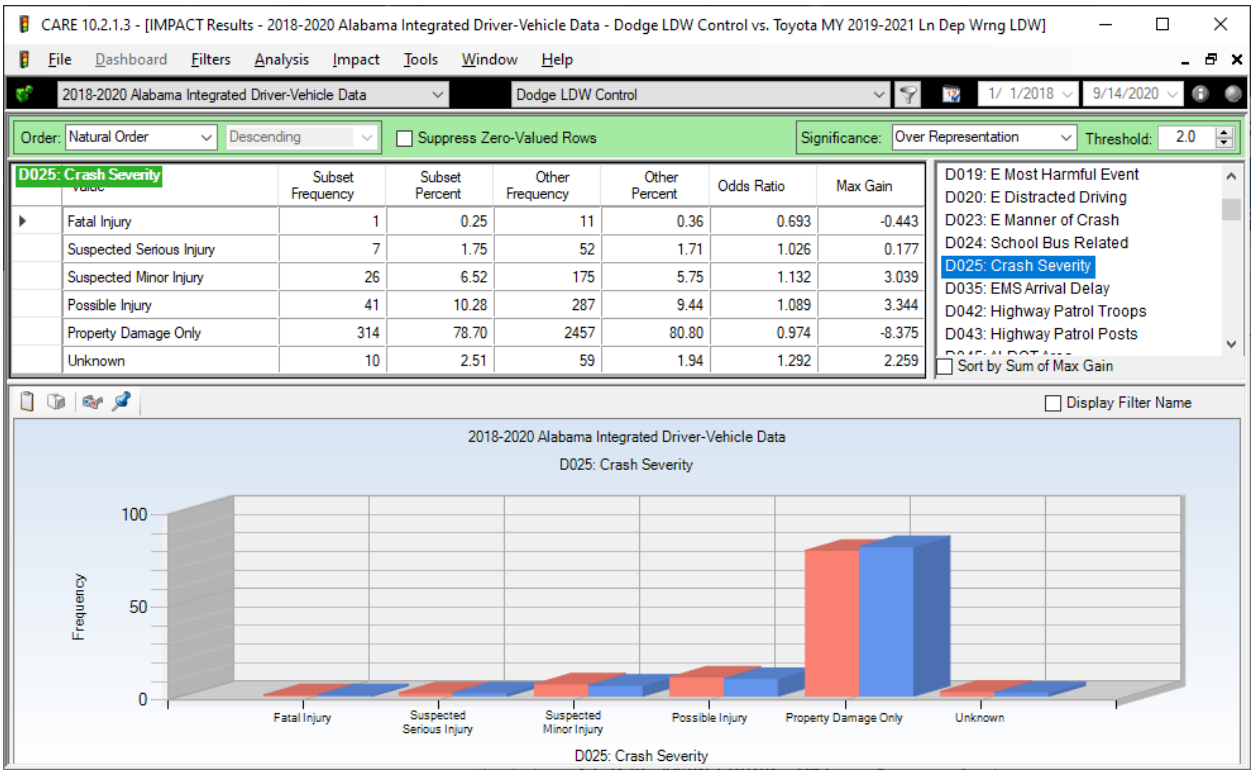
All PCC crash types with less than 10 crashes were excluded from the display so that both ends of the comparison could be seen. Improper Lane Change came to the top with the highest Max Gain, which indicated that LDW reduced about 13, crashes and the LDW crash proportions are significantly higher by about 48% (Odds Radio = 1.480) for the Dodge vehicles than for the Toyotas. The bottom of the display indicates that the largest cause of the Toyota crashes was Misjudged Stopping Distance.

C023 Manner of Crash



This is confirming information for the PCC IMPACT above. Sideswipe in the Same Direction would be the crash most expected to be prevented by the LDW. It is Interesting to see the Max Gains are almost the same in both of the IMPACT comparisons above. The over-representation of the Toyotas in Rear Ends (see the bottom line in the table) is a type of control that demonstrates that these results were not just the fact that Toyota vehicles had superior drivers or fewer crashes of all types. Rear End crashes are typical of novice drivers as is Misjudging Stopping Distance, which is shown at the bottom of the PCC analysis above (i.e., over-represented in the Toyotas).

C025 Crash Severity



Severity comparisons are favorable in all except fatal crashes, which were too few to compare effectively. The other three injury comparisons are favorable, although the proportion of crashes affected by LDW may be too small for this to be considered a significant finding.