Electric vehicle safety norway

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The rest of the paper is organized as follows. Section 2 is the literature review. Section 3 introduces the materials used in this study. Section 4 conducts a statistical analysis to identify the factors significantly influencing the severity of EV crashes. Section 5 concludes the main findings and discusses the limitations of this study.

As a summary, there is lack of studies of exploring the characteristics and features of EV crashes with the real EV crash data. An extensive investigation to EV crashes with the large, updated, and complete crash data is urgently required.

A Pearson''s chi-squared test [34, 35] is used to check whether the severity distributions of EV and ICEV crashes significantly differ from each other. The p-value of the test statistic is 0.289, and the 95% confidence interval of the difference of the two proportions is (- 0.004, 0.001). Therefore, at the 95% confidence interval, the crash severity distributions of EVs and ICEVs do not show statistically significant differences.

Travel patterns of people vary by day of week. Here, an EV crash means at least a PHEV or BEV is involved in the crash. Besides, compared to ICEV crashes, the proportion of EV crashes on weekends is obviously smaller: 17.6% for EVs versus 24.1% for ICEVs. Since travels are dominated by commuting trips on weekdays and discretionary trips on weekends, it implies that EVs might be used more for commuting trips comparing to ICEVs (Fig. 3).

As shown in Fig. 4, both ICEV and EV crashes present the clear morning peak (7:00-9:00 a.m.) and afternoon peak (3:00-6:00 p.m.). Besides, compared to ICEV crashes, EV crashes occur more often at the two peaks: 15.5% in the morning peak and 32.5% in the afternoon peak for EV crashes, compared to 10.4% in the morning peak and 26.2% in the afternoon peak for ICEV crashes. Meanwhile, there are very few EV crashes at nighttime (7:00 p.m. to 6:00 a.m.). It confirms that EVs might be mainly used for commuting.

Table 3 shows the distribution of crashes by speed limit: 66.5% of ICEV crashes and 80.7% of EV crashes occurred on low and middle-speed (< 80 km/h) roadways, whereas 32.5% of ICEV crashes and 19.3% of EV crashes occurred on high-speed (>= 80 km/h) roadways. That is, compared to ICEV crashes, EV crashes are less likely to occur on high-speed roadways. It is also understandable as high-speed roadways in Norway are the main roads for long-distance travels, which is a big hurdle for the EV adoption [36].

Regarding roadway locations, crashes are divided into two categories: junctions, including cross intersections, roundabouts, exits, bridges, level crossings, tollbooths, etc., and segments, including routes beyond crossings/exits, tunnels, underpasses, etc. As shown in Table 4, 62.9% of ICEV crashes occurred at segments, while this proportion is only 47.1% for EV crashes. That is, EV crashes are more likely to occur at junctions.

Different from other factors, distributions of ICEV and EV crashes by visibility are very similar (Table 5). In the dataset, visibility is mainly influenced by weather conditions. Three fourths of crashes occurred in good visibility, whereas only 5.6% of crashes occurred in poor visibility.

As a Nordic country, Norway has very long and dark winters with severe snows. Table 6 shows distributions of crashes by roadway surface conditions. It can be found that 14.8% of ICEV crashes occurred on snowy/icy roads, whereas this proportion is only 7.6% for EVs. That is, the probability of EV crashes occurring in icy roads is only about half of that of ICEV ones. It implies that EVs might be less used in inclement weather, probably due to their battery issues.

Crashes are divided into four types by accident category in Norway: car, motorcycle, bike, and pedestrian. Table 7 indicates that 31.5% of EV crashes involve bikes/pedestrians, but this proportion is only 20.3% for ICEV ones. It confirms the threat of EVs to pedestrians and cyclists. Meanwhile, 10.5% of EV crashes involve motorcycles, while this proportion is 16.0% for ICEV ones. That is, EVs were less likely to collide with motorcycles.

Identification of important factors that affect crash severity is essential to formulate appropriate countermeasures. In this section, two logistic regression models are established to determine the statistically significant factors that affect crash severity (i.e., light vs severe) for ICEVs and EVs, respectively.

Table 8 lists a summary of variables used in regression analysis to crash severity. Some variables are recategorized to balance sample sizes in each category without losing the representativeness. Only crashes with definite values for these variables are adopted here. Out of the total 35,441 ICEV and 342 EV crashes, 28,442 and 278 of them are kept in the following regression analysis, occupying 80.2% and 81.3% of the raw data, respectively.