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Published in:
Proceedings of TRA2020, the 8th Transport Research Arena

Published: 27/04/2020

Document Version
Publisher's final version

[Link to publication](#)

Please cite the original version:
Penttinen, M., & Luoma, J. (2020). Acceptance and use of ADAS. In Proceedings of TRA2020, the 8th Transport Research Arena: Rethinking transport – towards clean and inclusive mobility (pp. 67). Liikenne- ja viestintävirasto Traficom. Traficom Research Reports No. 7/2020



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Proceedings of 8th Transport Research Arena TRA 2020, April 27-30, 2020, Helsinki, Finland

Acceptance and use of ADAS

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Abstract

This study was designed to investigate how many Finnish drivers with new cars have ADAS in their vehicles, and how frequently and in which context they use those systems, ACC and Lane Keeping (LKA) in particular. In addition, the impacts of these systems were to be assessed. Moreover, limitations of the current systems, willingness to have the systems in the future, and willingness to pay for such systems or higher automation levels were of interest.

The data was collected with an online survey of 1,005 drivers who drive regularly and have purchased their vehicle in 2016 or later. The selection of driver sample seemed to be successful and allowed collecting versatile quantitative data of the usage of the systems in various contexts and self-reported benefits of the systems. This paper concentrates into the results concerning longitudinal support systems, cruise control and adaptive cruise control.

Keywords: ADAS; user acceptance; impacts; context of use; user survey; focus groups

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1. Objective

The main objective of this study was to investigate how much drivers with new cars have advanced driver assistance systems (ADAS) in their cars, and how much and in which context and environmental conditions they decide to use ADAS, specifically ACC and lane keeping. In addition, the estimated impacts, both positive and negative, of these systems were of interest. Moreover, limitations of the current systems, and willingness to have the system in the next car were investigated.

2. Method

The data was collected by an online survey of representative sample of 1,005 respondents, who have up to 3-year old vehicle, and who drive at least 1,500 km annually. Data collection lasted 3 weeks in June 2019. The questions in the survey were selected to be comparable with the earlier studies of the same subject (e.g. Nordtomme et. al, 2014 & Gorter, 2015).

Potential effects on main results of gender, age and driving experience were analyzed. Only statistically significant differences ($p < .005$) between the driver groups are presented in this paper.

3. Results

3.1 Respondents

In total, 1,005 Finnish car drivers having a car year model 2016 or newer participated in the study. Most of them owned the car they drive, but someone also had a leased car, or car belonging to their employer. The driver sample was not aimed to be a representative to all Finnish car drivers, but rather representing the group of drivers driving with new vehicles, and hence being potential users of advanced driver assistance systems.

Based on the gender and the driving experience distributions in the sample, the group of respondents was in fact representing the Finnish drivers very well. On contrary, the respondents' group was somewhat older than the Finnish car drivers on average. However, this is also true among the drivers who currently buy new cars in Finland. Hence, the respondents can be considered as a representative sample of those drivers in Finland who tend to drive with newest cars. In all, the selection of the sample to include only drivers with new vehicles seemed to be successful for the purpose of this study.

3.2 ADAS in the current vehicle

More than 90% of the drivers had at least some kind of cruise control in their current car (Figure 1). Almost half of the drivers also had adaptive headlights. Lane support is increasing its penetration in cars driven in Finland, too. In addition, more than 40% of the drivers reported having some type of lateral support in their current car. Almost similar share of drivers reported to have automated emergency braking (AEB).

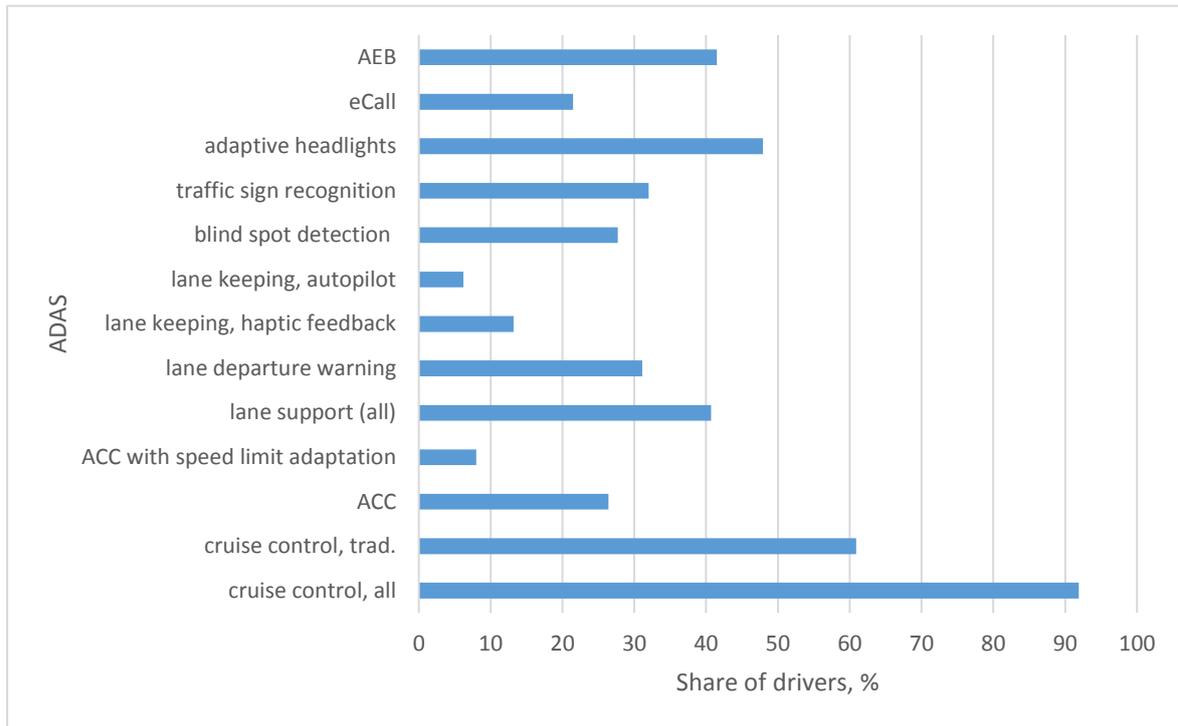


Figure 1. ADAS in the current vehicle.

Overall, 60% of the drivers indicated that they made the decision of the car and its optional equipment by themselves. In addition, over third of the drivers reported that they selected the car and its equipment together with someone, and only a few in the sample indicated that they did not participate the selection process at all. Males indicated more often that the decision was made by them only, whereas female respondents replied more often that the decision was made together with someone ($p < 0.001$).

As expected, the drivers had longer experience with cruise control than with adaptive cruise control (Figure 2). The largest group of cruise control users had more than four years of experience with it. On contrary, the largest share of adaptive cruise control users had only 1-2 years of experience. No significant effects of driver characteristics were found.

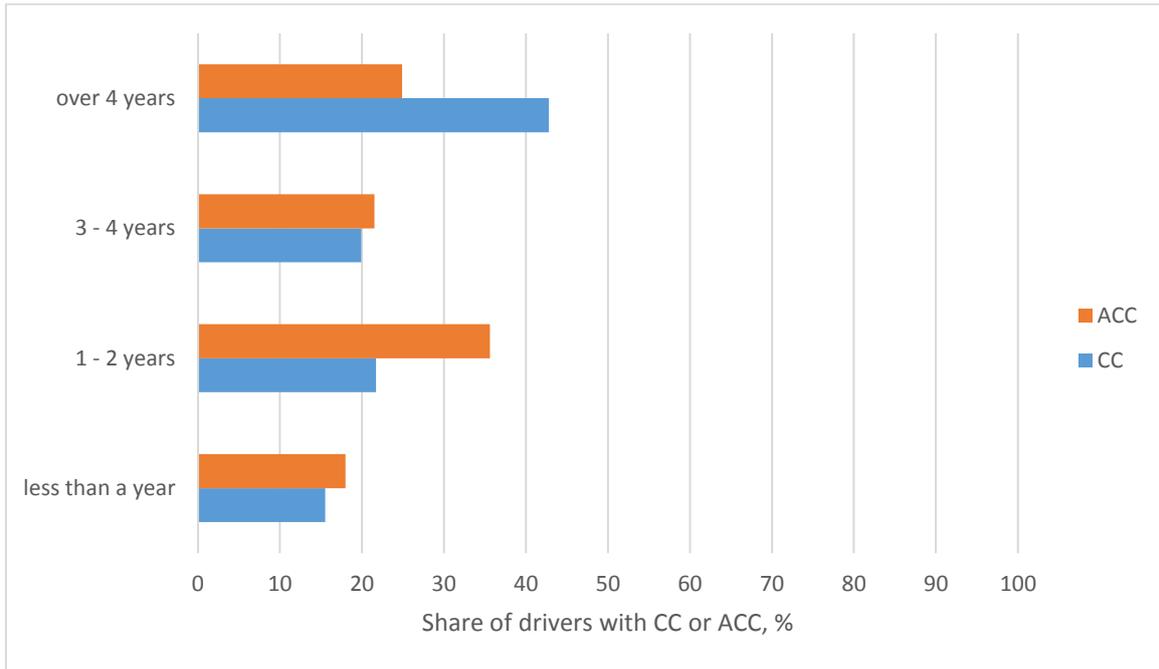


Figure 2. Experience with cruise control or adaptive cruise control respectively.

The main argument to purchase cruise control or adaptive cruise control was also requested (Figure 3). No remarkable differences between the listed arguments were found. However, the most typical argument seemed to be otherwise suitable car, which already had the system included. None of the background variables affected the arguments to purchase longitudinal support system, CC or ACC.

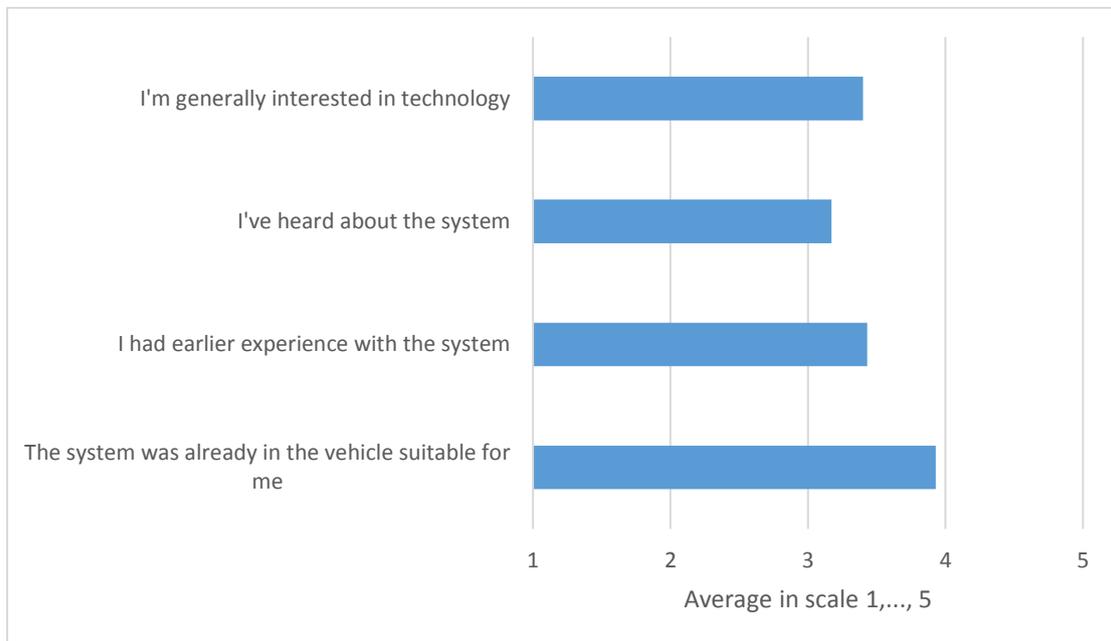


Figure 3. Main argument to purchase cruise control or adaptive cruise control.

3.3. Benefits of longitudinal control

Figure 4 shows what kind of benefits the respondents had experienced with longitudinal support. Better driving comfort scored highest, followed by safety improvements. Reduced fuel consumption and improved ability to drive long distances scored almost equally high. On contrary, drivers assessed that the current longitudinal support did not allow them to concentrate into other tasks than driving that much. No significant differences between the driver groups were found in reported benefits of longitudinal support.

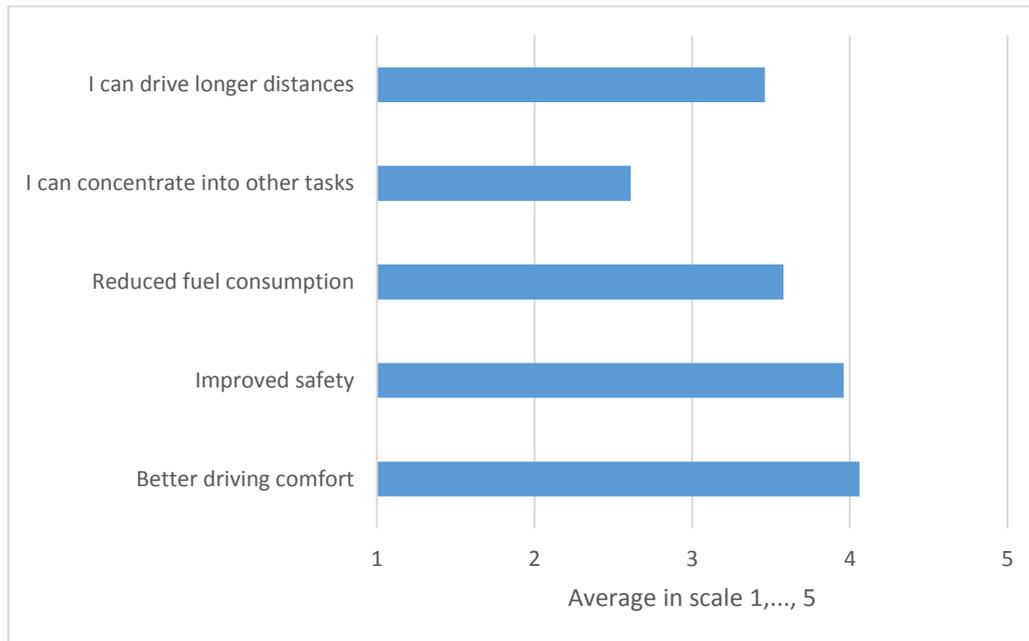


Figure 4. Reported benefits of longitudinal support.

3.4. Using longitudinal support in various roads and conditions

One main goal of the study was to find out where and in which conditions drivers select to use the support systems. Overall, the use of both cruise control and adaptive cruise control was most common on motorways, where 70-80% of drivers reported using the systems regularly. On other main roads, which in Finland are mainly one-carriageway, two-lane rural roads, the share of regular users was somewhat lower, 60-70%. The difference in regular use of cruise control versus adaptive cruise control in these environments was less than 10%. The use of the systems in urban arterials or streets was remarkably lower than on high-speed roads. Moreover, adaptive cruise control was used more often than cruise control in these environments, and the difference between these two systems was somewhat larger than for the high-speed roads.

In addition to the road type, the conditions, in which the drivers select to use the longitudinal support systems, were of interest (Figure 5). In general, the usage of adaptive cruise control seems to be overall more regular than the usage of traditional cruise control. This holds true especially in heavy traffic, where the use of cruise control is very low. Overall, the use decreases when either the road, or weather or the traffic situation gets more difficult.

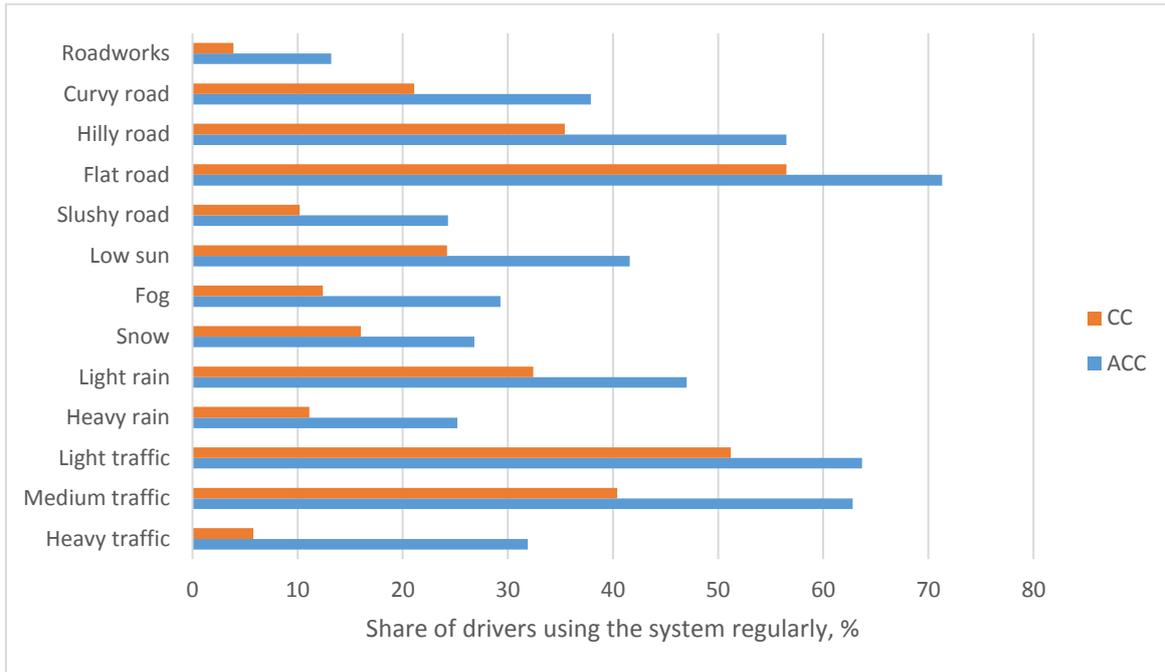


Figure 5. Use of longitudinal support on various conditions.

3.5. Unexpected situations and safety effects while using longitudinal support

Another research question concerned unexpected situations while using adaptive cruise control. Overall, quite many drivers had experienced a few unexpected situations. Unexpected deceleration due to vehicle cutting in was the most often experienced situation with almost half of the drivers reporting that they experienced this at least a few times (Figure 6). The second most common situation was the unexpected deceleration, because the vehicle was reacting to a vehicle on other lanes.

Only a few differences were found between the various driver groups. Female drivers indicated more often than male that they were unclear of the system status ($p < 0.001$). With the driving experience, the group driving between 10,000 and 20,000 km annually had faced this situation a bit more often than drivers driving either less than 10,000 km or more than 20,000 km ($p < 0.05$). The unexpected deceleration due to curve or vehicle on another lane (opposite direction) has been experienced more often by them who drove most ($p < 0.001$).

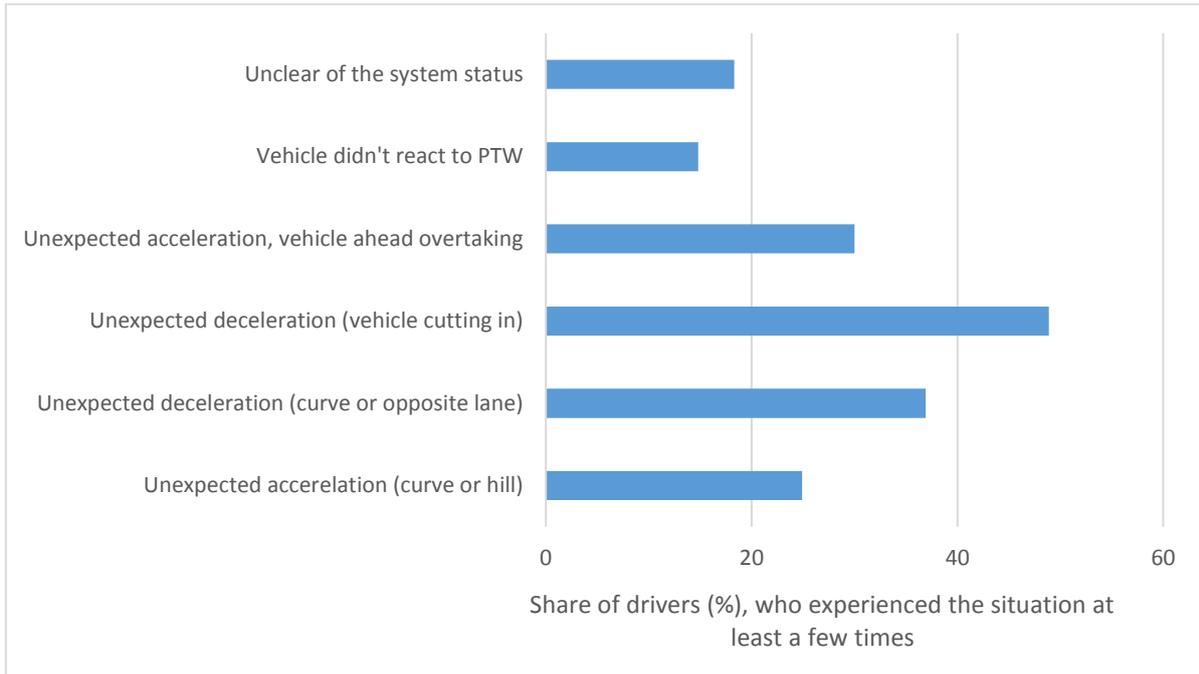


Figure 6. Unexpected situations while using adaptive cruise control.

In addition to the unexpected situations, safety effects were also under interest. Overall, both systems, cruise control and adaptive cruise control seemed to have helped the drivers to avoid near accidents or accidents more often than increased the risk to face such an incident (Figure 7).

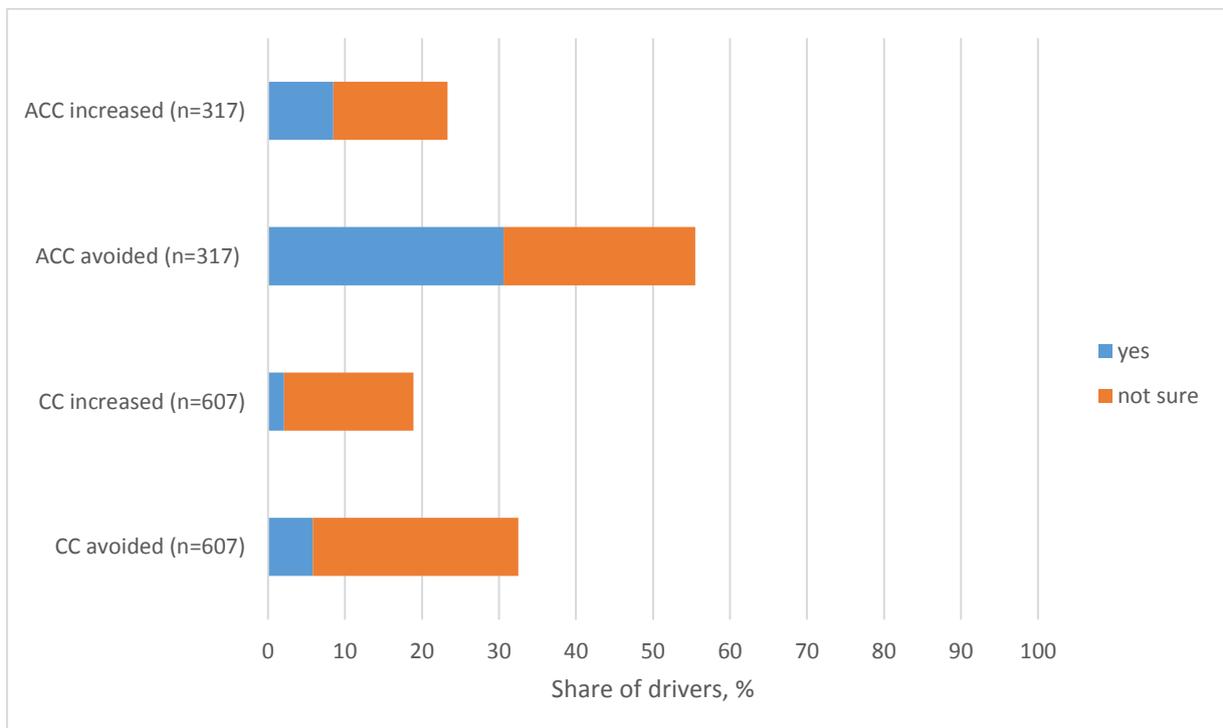


Figure 7. Safety impacts of longitudinal support.

3.6. Other impacts of longitudinal control

In addition to the direct safety impacts, the other impacts and willingness to have the system in the next vehicle were requested. Overall, drivers agreed at least to some extent with almost all the posted statements (Figure 8). They seemed to be quite confident of being able to utilize the system well, and agreed with the statements of increased usage and trust with the longer experience. The only statement they mainly disagreed with was the one concerning the focus on traffic while using the system. Moreover, the willingness to have the system also in the next vehicle was very high. Different driver groups responded the statements quite similarly.

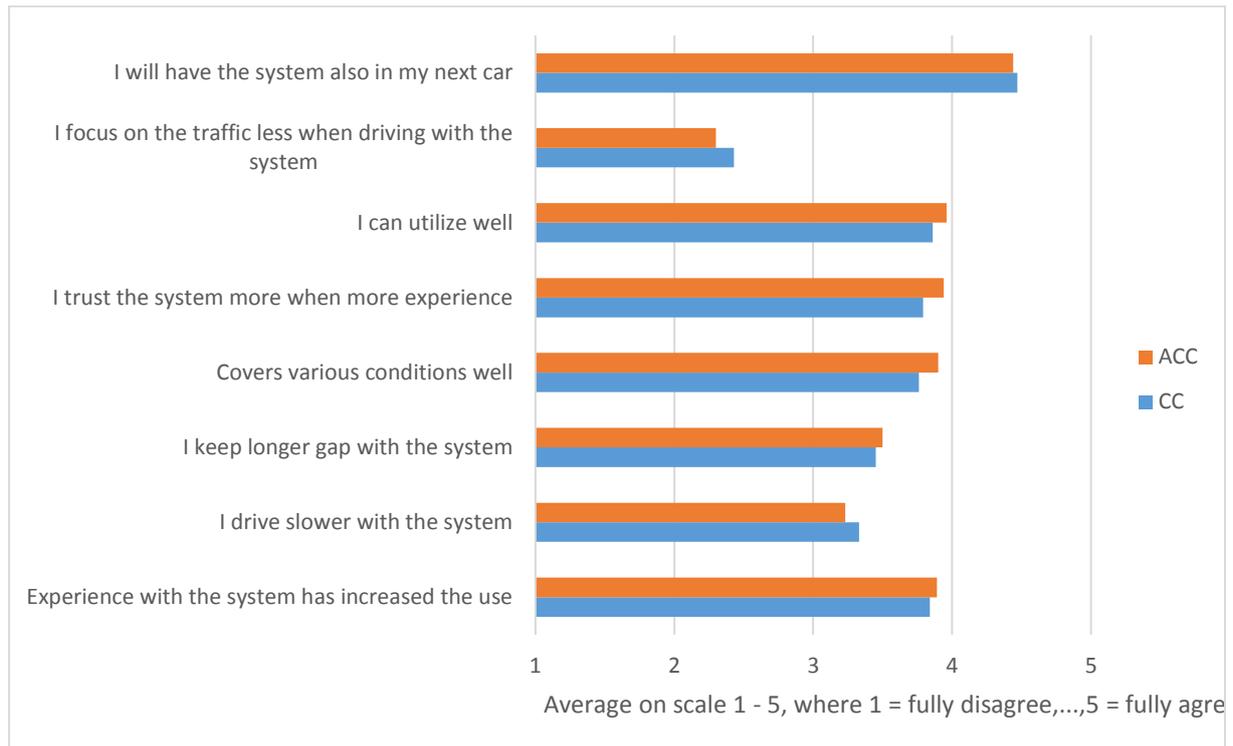


Figure 8. Other impacts of longitudinal support.

4. Discussion

The main objective of this study was to investigate how much Finnish drivers with new cars have ADAS in their vehicles, and how much and in which context and environmental conditions they use ADAS, specifically ACC and lane keeping. This paper concentrates into the use and self-reported impacts of longitudinal support, cruise control and adaptive cruise control.

The data was collected by an online survey, and the sample of drivers were selected to represent Finnish drivers with a new, at most 3-year-old car. Overall, the sample seems to be quite well representative to the Finnish drivers with new vehicles. One can also conclude that the selection of the sample to include only drivers with new vehicles seemed to be successful for the purpose of this study. The data gives a good overview of how and where longitudinal support is used. It also gives overview of self-reported impacts of such systems.

As expected, adaptive cruise control appeared to be used much more in versatile roads and conditions than traditional cruise control. Adaptive cruise control can still be used in heavy traffic, when traditional cruise control is useless. Both adaptive and traditional cruise controls were reported to have more positive than negative safety impacts. Almost one third of the drivers reported that adaptive cruise control has helped them to avoid and accident or near-accident.

It seems that drivers have experienced quite a few unexpected situations when using adaptive cruise control.

Despite of this, they report increased trust and use of ACC with longer experience. In addition, the willingness to have the system in their next car is high.

Of course, due to nature of this kind of quantitative surveys, no details of the impacts were collected. The survey form was designed to collect quantitative data to allow comparison between the driver groups, and to allow highlighting the most common usage situations and self-reported impacts.

When comparing the results with earlier studies of similar goal (e.g. Gorter, 2015; Nordtomme et. al, 2014) and Finnish studies where the penetration of driver assistance systems were of interest (Lähderanta, 2018; Liikenneturva, 2017 and Penttinen et. al., 2019) the selection of driver sample seemed to be successful and allowed collecting versatile quantitative data. The presented quantitative results will be later complemented with qualitative data to be collected in focus groups.

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