Drivers’ acceptance and behavioural adaptation of Advanced Driver Assistance Systems

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1. Background

- A common cause of rear-end collisions is **driver inattention**; in a 100-car naturalistic study, driver distraction was present in 87% of rear-end crashes and 78% of all crashes (besides other factors) (Coelingh, Jakobsson, Lind, & Lindman, 2007; Klauer, Neale, Dingus, Ramsey, & Sudweeks, 2006; Lee, Llaneras, Klauer, & Sudweeks, 2007).

- Some advanced driver assistance systems (ADAS) were developed to prevent rear-end crashes or mitigate their impact by **monitoring the distance** from the vehicle in front and warning the driver of an imminent collision.
1. Background

- Jermakian (2011) estimates that **Forward Collision Warning** could **prevent up to 20% of all crashes** (on the basis of the US NASS General Estimates System and Fatality Analysis Reporting System 2004-2008 data).

- On the other hand, because of behavioural adaption, as is well known from previous studies (e.g. Smiley, 2000), these estimates might be quite overestimated.
1. Background

- Neither of the **systems relieves the driver completely from the need to pay attention** to the traffic ahead. The driver must always be prepared to resume control over the vehicle.

- The possible risk in terms of traffic safety is the **much longer reaction time** (when the driver resumes driving) than the “normal” reaction time when a driver is driving (Schleicher & Gelau, 2011).
1. Background

- Although the limitations are usually described in the user’s manual, this does not necessarily mean that drivers are aware of them. In a survey of 370 ACC owners, although 67% claimed they learned to use the system by reading the manual, 72% did not know about any limitations or manufacturer’s warnings about ACC (Jenness, Lerner, Mazor, Osberg, & Tefft, 2008).

- Research suggests that drivers’ awareness of potential problems with ACC or FCW increases over time, but it is crucial that they encounter them directly while driving, at least occasionally. Otherwise, drivers forget that these limitations exist and they might display unrealistic over-reliance on the systems (Beggiato & Krems, 2013; Beggiato, Pereira, Petzoldt, & Krems, 2015; Jenness et al., 2008; Larsson, 2012).

- As for user acceptance, drivers who were not informed beforehand about situations in which the system is not fully operational showed more negative affects after they encountered them in a field test, and their trust in the system decreased over time, without recovery (Beggiato & Krems, 2013).

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2. Method

The aim of the present research was to establish among a sample of Czech drivers:

- what **information** they have about the systems,
- **acceptance** of the systems,
- how ADAS owners **acquired** information about the systems and which methods they would prefer for **learning** about the systems’ **capabilities and limitations**.

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2. Method

ADAS under study:

− ACC – adaptive cruise control ("ACC monitors the distance from the vehicle ahead and maintains the set distance and/or speed.")
− FCW – forward collision warning ("FCW monitors the distance from the vehicle ahead and the speed of approach; in the event of imminent danger, it alerts the driver and/or activates the brakes.")
− LDW – lane departure warning ("LDW tracks the vehicle’s position within a lane; in the event of leaving the lane without a turn signal, it alerts the driver and/or corrects the movement.")
− Blind spot monitoring ("Alerts the driver if a vehicle in the adjacent lane is detected in the blind spot of the car.")
− Driver drowsiness detection system ("Monitors the driver’s behaviour and alerts the driver to take a break.")
− Traffic sign recognition system ("Recognizes traffic signs and displays them on the display or the navigation system’s monitor.")
− Automatic high beams ("High beams are automatically turned on/off, so that other drivers are not blinded.")

In this presentation I will focus on ACC and FCW only.

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2. Method

2.1. Interviews

In-depth semi-structured interviews were used in order to understand:

- how ADAS owners learned about the systems
- if they had encountered any problematic situations
- what instructional methods they would prefer for learning about the systems’ abilities and limitations.
- their satisfaction with the system
2. Method
2.1. Interviews

The interviews were analyzed using qualitative content analysis.

Participants were selected on the basis of the following criteria using quota sampling (Llaneras, 2006), so that:

1. they *had experience* of at least one of the ADAS under study;

2. approximately 1/3 of the sample were women;

3. 30% of the sample were drivers less than 30 years old, 60% were between 30 and 65 years old, and 1% were over 65 years old.

Altogether, **38 drivers were interviewed**. Period March-August, 2016.
2. Method

2.2 Online questionnaire

The questionnaire was distributed during November 2016-April 2017 in the form of:

- a) an **online survey using the snowball** method; altogether, 435 participants filled out the online survey;
- b) as a part of a larger testing at the Škoda Auto research centre and 54 completed questionnaires were collected;
- c) in **printed form**, the questionnaire was distributed at a trade fair for electronics and automation; 40 questionnaires were collected in this way

= general driving population

In total, 526 questionnaires were analyzed further.
3. Results

3.1. Interviews

Mostly, the respondents did not learn about the systems’ existence earlier than upon buying the car, when the dealer provided the initial information.

If drivers knew about the systems, they read about them previously on the internet or in magazines. These were often men who indicated a long-term interest in cars and automotive technologies.

In some cases drivers first experienced the system in a company car.

In 3 cases, for ACC, the respondents indicated they did not know about the system until they accidentally turned it on while driving; this happened only once with FCW.
3. Results
3.1. Interviews

Therefore, we asked about the drivers’ motivation to purchase the respective systems. The most frequent answers for FCW were the fact that the system was “already in the car” or came as part of a “bargain package”.

For ACC, the responses were similar, although a substantial number of respondents said that “they simply wanted the system”, without further explanation. Also, “safety” was given as a reason more often for ACC than FCW.

Fig. 1 Reasons for purchase (absolute frequencies; participants could mention more than one reason)
3. Results

3.1. Interviews

Considering the kind of information the drivers would have liked to receive prior to buying the system, the respondents emphasized the limitations of the system:

− “I would have liked to know about the system’s drawbacks, because if you claim something to be ‘intelligent’, you get the impression it can do anything.”
− “I would have liked to know that if the sensor is obstructed by, say, snow, it stops working.”
− “No one told me it only works within certain speed limits.”
− “I’d like to know if the FCW reacts to pedestrians as well.”

Most of the drivers stressed the importance of a “well-informed dealer” and recommended taking a demonstration drive:

− “Nowadays, you can find a ton of information, reviews on the internet, but to try to drive a car with the system is a completely different experience.”
− “The dealer can influence you a lot if he seems to know about the systems and he’s willing to show you. That’s the best thing he can do. Otherwise, he can put you off.”
3. Results
3.2 Online questionnaire

Information about ADAS and how to get it:

About half of the drivers indicated they either don’t know anything about the systems under study or they just know the systems exist; generally, the (perceived) amount of information was slightly higher for ACC than FCW.
3. Results
3. 2. Online questionnaire

Information about ADAS and how to get it:

When asked about ADAS in general, the drivers mostly did not believe using the systems relieves them from the need to pay attention or that the systems can take complete control over the vehicle.

The drivers suggested they would like to know more about ADAS.

More than half of the respondents agreed they would appreciate learning about the systems at a driving school, taking a test drive with an instructor, or attending a seminar at work.
3. Results
3. 2. Online questionnaire

As for the acceptance of ADAS:

For FCW, as compared to ACC, the ratings were higher on “I want other drivers to use the system”, but a diversity of opinions still existed on whether the system should be a part of mandatory vehicle equipment and, mostly, if the driver should be able to adjust the settings of the system.

On the other hand, for ACC, the respondents were almost unanimous that the driver should always have the option to turn the system on and off and they didn’t perceive the system as so necessary that it should become mandatory.

Overall, the drivers tended towards higher rankings, indicating that they don’t reject the systems in general, but they would like to retain the option to decide if they want to use the system and adjust its specific settings.
3. Results

3.2. Online questionnaire

A 6-point Likert scale (0 – “not at all true for me”; 5 – “completely true for me”) was used for the respondents to express their opinions on various aspects related to the systems FCW and ACC.
3. Results
3.2. Online questionnaire

As a second way to assess acceptance, we asked the drivers to indicate for each system whether they would want it in their car and how much money they would be willing to pay for it:

- Most drivers would want FCW in their cars, mainly for safety purposes, as compared to ACC, which is perceived slightly more as a comfort-enhancing than a safety system.
- Generally, the drivers are not willing to spend much extra money on either of the ADAS under study, but the maximum amounts increase if the system is perceived as safety-enhancing.
- On the basis of the responses, it can be concluded that the drivers show a relatively high degree of acceptance of the systems, but they hesitate to spend too much money on them and some would still not trust the systems completely.
3. Results
3.2. Online questionnaire

Yes, for safety purposes
Yes, for comfort
No, it wouldn’t be useful for me
No, I wouldn’t rely on it
Other response

100 CZK ≈ 4 EUR

more than 50,000 CZK
up to 50,000 CZK
up to 30,000 CZK
up to 15,000 CZK
up to 5,000 CZK
nothing
3. Results
3. 2. Online questionnaire

Associations between acceptance, amount of information, and experience of ADAS were also investigated using the Pearson’s Chi-squared test.

Generally, the more information or experience drivers had, the more likely they were to want the system.

A substantial number of drivers who don’t have any information or experience of the systems tend not to buy them because they would not rely on them. For ACC, they also tend to purchase the system for safety purposes, not just for comfort.

On the other hand, drivers with their own experience of the systems generally tend to buy them again, although for ACC, they claim to see a safety benefit, as well as comfort enhancement.

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4. Discussion

This finding addresses two issues previously discussed in the existing literature:

− First, if the drivers don’t know about the **limitations of FCW and ACC beforehand** and they don’t experience them on the road either, they might have **false, potentially dangerous expectations concerning the systems’ performance**.

− And second, encountering unexpected situations of reduced system performance might **lower acceptance of FCW and ACC in general**, or even discourage the driver from using the systems at all.
5. Implications and conclusions

1. As knowledge about ADAS among drivers is rather low, large-scale learning measures should be adopted. The main focus should be on **basic information about the system and its limitations.**

2. It is not possible (and partly a matter of passing the buck) to count on drivers reading the information in **the user’s manual.**

3. Suggested ways of informing drivers: lessons in driving schools, well-educated car dealers, short and interactive messages - e.g. videos available in the car.

4. Education should be **as practical as possible**; ideally, test drives where the limitations of the system can be experienced.

5. Education should stress the **safety benefits** of ADAS.
Tak

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