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A method to investigate drivers' acceptance of Blind Spot Detection System®

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Abstract. Lately, with the goal of improving road safety, car makers developed and commercialised some Advanced Driver Assistance Systems (ADAS) which, through the detection of blind spot areas on the vehicle's sides, could help the drivers during the overtaking and the change lane task. Despite the possible benefits to reduce lateral crashes, the overall impact on road safety of such systems have not been deeply studied yet; notably, despite some researches have been carried out, there is a lack of studies regarding the long-term usage and drivers' acceptance of those systems. In order to fill the research gap, a methodology, based on the combination of focus groups interviews, questionnaires and a small-scale field operational test (FOT), has been designed in this study; such a methodology aims at evaluating drivers' acceptance of Blind Spot Information System® and at proposing some ideas to improve the usability and user-friendliness of this (or similar) device in their future development.

Keywords: ADAS, BLIS, acceptance, lane change, road safety

1. Introduction

Previous transportation studies performed in the United States estimated that lane change crashes account for 4%-10% of overall crashes [20]; in those situations, according to the literature review reported in Lee et al. [9], most drivers did not try an avoidance manoeuvre, suggesting that they were, probably, not aware of the presence of another vehicle or crash hazard when carrying out the lane change.

Those results indicate that lateral conflicts between vehicles might be caused by blind spot areas, transit zones on the left and right side of a vehicle, approximately 9.5 m long and 3 m width (Figure 1), which cannot be seen by the drivers through the wing mirrors. Aware of the issues caused by such areas, Original Equipment Manufacturer (OEM) and car makers have recently developed and commercialised some Advanced Driver Assistance Systems (ADAS) which can support the drivers in keeping the correct lateral control of the vehicle [16]. Among those systems, Blind Spot Information System® (BLIS®), introduced by Volvo, is a device that, using cameras installed on the side view mirrors, detects the presence of another car/motorcycle moving in the same direction of the equipped vehicle in the left and right 'blind spot' areas.

Unlike other ADAS, BLIS® does not directly intervene in the primary driving task but, simply, it indicates the presence of a vehicle in the blind spots by a warning light which blinks on the respective left/right A pillar of the equipped car. Blind Spot Information System® aims at assisting the driver but it does not eliminate the need, for the driver, to confirm the conditions around the vehicle to make sure that the change lane can be performed safely.

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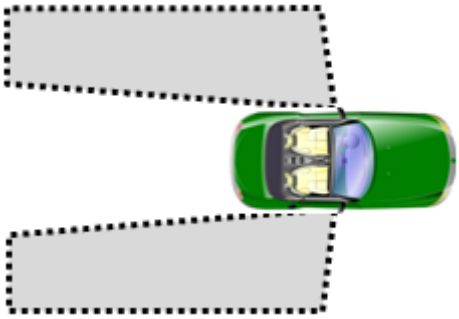

Fig. 1: blind spot areas on the left and right side of a vehicle

2. Problem

Despite the introduction in the market of Blind Spot Information System® and similar systems, up to now, few studies have been carried out on the drivers' usage of those devices (e.g., [7] and [15]). Furthermore, the existing studies focused their attention on the short-term effects that those systems might induce on the drivers. However, changes in drivers' attitudes toward the systems and toward road safety, such as 'behavioural adaptations' [10], might take long time before appearing/levelling off because their onset/development is the consequence of two temporal phases: the 'learning and appropriation phase' where the driver discovers the system, learns its operation principle and identify its limits and the 'integration phase' where the driver, through the experience with the system in different road situations, reorganizes the driving task based on the systems' functioning [1].

Like behavioural adaptations, also other variables related to the drivers' interaction with the system are supposed to evolve with the usage of the devices before reaching a stable level: this is the case, for example, of driver's acceptance of the system. In relation to technology, in Dillon and Morris [4], acceptance is defined as "the demonstrable willingness within a user group to employ information technology for the task it is designed to support".

The acceptance of a device is, with no doubts, relevant for the usage that drivers make of it and, therefore, it is worth to be studied both from a commercial and a road safety point of view. Concerning the first aspect, it is significant to evaluate if the system is perceived as useful and satisfactory by the drivers [17]. About the second feature, acceptance of an Advanced Driver Assistance System influences the decision of drivers about when, where and how to employ those devices during the driving task and, as a consequence, it affects road safety.

2.1. Acceptance

Concepts such as acceptability, acceptance and public support have been widely used, in the context of transports, to assess the implementation of new transport pricing strategies [12], to evaluate new in-vehicle systems [18] and, in related domains, to analyse user's acceptance of computer-based information systems [3].

Various questionnaires and methods have been developed to measure acceptance and acceptability but, somehow, those concepts are defined in different ways by different studies [19]. In a tentative to clarify on the topic, Schade and Schlag [11] distinguished between acceptability and acceptance: "acceptability refers to the attitude to an object" whereas "acceptance is related to some kind of behaviour as an (re-) action towards an object". Those definitions made clear that acceptability refers to people's attitude before the introduction of a measure/system whereas acceptance concerns the reaction after the experience of such measure/system.

In this study, it will be adopted the concept of acceptance, as expressed by Schade and Schlag [11], for investigating the drivers' acceptance of Blind Spot Information System® through responses given by drivers and detailed analysis of human behaviour during the usage of the device; especially, the objective of this paper is to introduce a method apt, not only to evaluate drivers' acceptance, but also to provide suggestions for future improvements in the design of such device.

3. Method

The research study, which is planned to be carried out, aims at answering to the research questions below reported.

1. When, where and how do the drivers use the BLIS® during the driving task?
2. What are the critical situations or problems encountered by the users when driving with BLIS® active?
3. How does the drivers' acceptance of BLIS® evolve over experience with the system?

4. How could the on-road usage of BLIS® be an indicator of drivers' acceptance of the system?
5. Which are the aspects of the device that could be improved in order to make the system more acceptable for drivers?

The inquiry strategy designed to answer to the research questions is based on the combination of focus groups interviews, a small scale Field Operational Test (FOT) and questionnaires.

The reason justifying the planning of different methods with various natures is related with the fact that neither of them could, as a stand-alone method, answers to the entire set of research questions. Then, the usage of multiple methods in scientific protocols can improve the effectiveness of the findings of a study because the weaknesses in one method can be balanced by the strengths in another [21]. For instance, in the case of the present study, despite the FOT being the core part in the research activity, this method cannot retrieve any subjective information from the drivers, requiring utilizing different techniques for that task (focus groups interviews and questionnaires). In the next sections, the methods will be explained with more detail.

3.1. Focus groups interviews

The focus groups interview is a well-established research technique "designed to obtain perceptions on a defined area of interest in a permissive, nonthreatening environment" [8]. During the focus groups, the sample of participants (usually, in a number between 4 and 12 individuals) are invited to gather in order to discuss about a specific topic under the supervision of a moderator and an assistant. Focus groups interviews have been used in market research since long time to derive information about commercialized products but they can also be used to bring together people in an effort to better understand how specific systems work or interact [5]; recently, focus groups have been also adopted by researchers to get users' opinions about different aspects (e.g. usage, trust, effectiveness, acceptance) of In-Vehicle Information Systems (IVIS) and ADAS (e.g., [6], [13] and [22]).

In this study, the focus groups will be used to dig for information about drivers' usage of BLIS® and to know which aspects of the system are considered acceptable and which would be better to improve; more in detail, focus groups interviews are adopted to answer to the research questions "When, where and how do the drivers use the BLIS® during the driving task?", "What are the critical situations or problems encountered by the users when driving with BLIS® active?" and "Which are the aspects of the device that could be improved in order to make the system more acceptable for drivers?". In order to answer to the first and second question, the performance of focus groups interviews won't be sufficient: indeed, even if they can provide a subjective assessment about usage and critical situations/problems encountered, it will be later necessary to collect objective data through the FOT.

With regard to the participants, it is forecast to recruit experienced users of BLIS® in order to get the highest amount of comments about the system and, above all, many ideas for the improvements of the device. Considering the limited number of drivers owning cars equipped with such system in Portugal, the plan is to have 3 sessions each of them composed by a number of participants between 5 and 7.

3.2. Field Operational Test (FOT)

As defined by Centro Ricerche Fiat [2], FOT can be seen as "A study undertaken to evaluate a function, or functions, under normal operating conditions in environments typically encountered by the participants using quasi-experimental methods". In general, Field Operational Test, compared to Naturalistic Methods, differs from the fact that drivers don't use their own vehicle and, furthermore, a kind of experimental control might be manipulated by the research team. FOT have been already used to investigate the effect of ADAS use on driver behaviour (e.g. TeleFOT, ACAS/FOT, ITS-Safety) and, within this research, the method will be adopted in order to gather data about the real usage of BLIS® by drivers. Notably, the FOT aims at answering to the research questions "When, where and how do the drivers use the BLIS® during the driving task?", "What are the critical situations or problems encountered by the users when driving with BLIS® active?", "How does the drivers' acceptance of BLIS® evolve over experience with the system?" and "How could the on-road usage of BLIS® be an indicator of drivers' acceptance of the system?".

As previously mentioned, the first two research questions will be answered by the combination of focus groups and FOT, with the former technique that aims at getting subjective information and the latter one directed to obtaining objective data.

On the other hand, in order to answer the third research question, the acceptance questionnaire developed by Van der Laan et al. [17] will be adopted dur-

ing the FOT in order to see the evolution of driver's acceptance of BLIS® over the experience with the system.

Finally, about the last research question, the purpose is to find, during the real driving with the system, some variables (e.g. activation of the system, glances at the warning light) that could be indicators of drivers' acceptance of BLIS® and relate them to the acceptance previously measured through the questionnaire.

The sample taking part in the FOT will be composed of a number between 8 and 12 individuals without any experience with the system; each of the participants will be driving an instrumented vehicle for a period of 1 month. The choice of recruiting drivers without any experience with BLIS® is driven by the fact that one aim of the study is the investigation of the evolution over time of the drivers' acceptance of the device.

3.3. Questionnaire

Questionnaires are widely used in different research fields because of their flexibility in collecting high amounts of data from large population samples. In Human Factors, questionnaires have been widely adopted to collect information regarding various issues such as usability, user satisfaction, user opinions and attitudes [14].

In this research, questionnaires will be used before carrying out the focus groups interviews and during the performance of the Field Operational Test in order to:

- collect information about the drivers (personal data, usage of the system, driving habits, etc.): those questionnaires will be presented to the participants in both focus groups and FOT;
- gather a global opinion about drivers' acceptance of the Blind Spot Information System® using the acceptance scale developed by Van der Laan et al [17]; the choice of this scale is driven by the fact that it is relatively simple, quick and already validated by many other studies and, also, it can assess the relevant aspects (usefulness and satisfaction) that account for the acceptance of BLIS®.

4. Expected results and next steps

The underpinning of this study is the idea that an in-vehicle system, which is not perceived by the drivers as useful and satisfying, won't be employed during the driving task or, even worse, might be used in improper ways with possible negative consequences on road safety. Based on this ground, it seems relevant to deeply evaluate the drivers' acceptance of an IVIS or ADAS once it is already introduced in the market. In order to achieve this objective, this research firstly aims at gathering drivers' opinions and comments about the usage of Blind Spot Information System® and, subsequently, at assessing the users' acceptance of such system and its evolution over time.

Once that the issues that reduce the drivers' acceptance of the system are stated, it is also in the scope of this research to propose some solutions in order to make BLIS® (or similar systems) more user-friendly.

Up to now, everything is ready for the performance of the focus groups which will be carried out during September and October 2011. Regarding the FOT, the plan is to start just after the focus groups execution (during October or November 2011) in order to allow enough time for the data collection and to complete it before June 2012.

5. Limitations of the study

The methodology outlined in this paper presents evident limitations.

As a first limitation, it is important to underline the small sample available for the focus groups, as a consequence of the difficulties in recruiting BLIS® users, and for the performance of the FOT, due to budget and time constraints. The limited amount of participants does not allow any statistical generalization but this is not, anyway, in the scope of the study.

A second limitation is linked to the usage of a Portuguese translated version of the questionnaire developed by Van der Laan [17], without an appropriate validation; this problem, already stated in [6], will be partly overcame through the usage of translation and back-translation.

Finally, the adoption of the Field Operational Test, compared with the Naturalistic Driving Study, does not assure the same degree of validity but, in any case, higher than a driving simulator study.

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