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THE HETEROGENEITY OF ACTOR INTERACTIONS IN THE DEPLOYMENT OF ADVANCED DRIVER ASSISTANCE SYSTEMS

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ABSTRACT

Advanced Driver Assistance Systems (ADAS) are promising means to reduce transport problems. However, ADAS have not yet been deployed on a large scale. Deployment of ADAS requires actions of actors, such as public authorities, the automotive industry and insurance companies. Since both the automotive industry and insurance companies are heterogeneous their strategies with respect to ADAS deployment are expected to be heterogeneous as well. This paper explores this heterogeneity by means of a cluster analysis performed on data collected by an actor survey. The results show that subgroups of respondents can be identified with different strategies in terms of preferred deployment actions and influence of other actors.

KEYWORDS

Actors, Advanced Driver Assistance Systems (ADAS), cluster analysis, deployment

INTRODUCTION

Advanced Driver Assistance Systems (ADAS), are expected to contribute to increase traffic safety and traffic flow performance, and decrease environmental pollution. ADAS are electronic in-car systems that support car drivers in their driving task. Examples of ADAS are Intelligent Speed Adaptation (ISA), a system that informs and/or assists the driver to comply with the legal speed limit, and Adaptive Cruise Control (ACC), a system that automatically keeps a preset speed and time headway to the preceding vehicle.

In order to be effective on a societal level, a vast amount of vehicles needs to be equipped with ADAS (i.e. a high deployment rate). While some ADAS are already on the market, they have not yet been deployed on a large scale (e.g. De Kievit et al., 2008). The present paper is part of a PhD study – performed by the first author – that aims to explore the potential deployment of ADAS by studying the expected actions of relevant actors. In this study, deployment is conceptualized by the actions of relevant actors that aim to increase the deployment rate, i.e. influence car buyers to adopt an ADAS. The actors studied are public authorities, the automotive industry, and insurance companies. It is assumed that they all have a certain interest in the deployment rate of ADAS, and that they all have certain means to influence this deployment rate. The actions of these actors are expected to be interactive: if one actor takes an action that will increase the deployment rate to a level that is satisfactory for another actor, that actor is expected to be less prone to take further action. The main subjects of study are the expected actions of public authorities, automotive industry, and insurance companies, and the influence of these actors' actions on each other.

The automotive industry and insurance companies consist of different companies that can potentially act or react differently. Heterogeneity is expected to exist particularly within these actor groups. Studying this heterogeneity is scientifically relevant since automotive industry is usually investigated as a single actor with respect to ADAS deployment (e.g. Macharis et al., 2004; Lathrop and Chen, 1997), while there are indications that certain companies are more likely to bring certain ADAS to the market than others. For instance, companies with a safety-related brand image may be relatively more progressive in introducing safety-enhancing ADAS. Knowledge on the (re)actions of automotive industry and insurance companies can enhance future ADAS policymaking. For instance, policymakers will be able to design policies more effectively to reach policy goals, when they have better knowledge of the different (re)actions they can expect from, for example, automotive industry.

This paper explores the heterogeneity of actor interactions by identifying different strategies among actors with respect to their own actions and their reactions to other actors' actions. Data has been collected on the actions and reactions of public authorities, automotive industry and insurance companies by means of a stated preference survey. A cluster analysis was performed on these data, in order to identify subgroups of respondents with different strategies.

CURRENT KNOWLEDGE ON ACTOR HETEROGENEITY

Literature review shows that heterogeneity within actor groups is rarely studied with respect to ADAS deployment. Most studies focus on the heterogeneity in opinions between actor groups, such as public authorities, automotive industry and users (e.g. Wiethoff et al., 2006; Walta et al., 2005; Macharis et al., 2004; Lathrop and Chen, 1997). However, a study by Levine and Underwood (1996) showed that the main differences in opinion on transport system goals between respondents from different actor groups could not be directly attributed to actor group membership. They applied a cluster analysis to establish groups of respondents with similar opinions regarding transport system goals. Differences within the actor groups are, therefore, also expected to exist.

METHODOLOGY

Data collection

The reactions of the actors to different types of ADAS and ADAS deployment actions of other actors were investigated by means of a survey. This survey featured three different types of ADAS, and three different potential actions for public authorities, automotive industry, and insurance companies. These actions were named deployment options, and included a *do nothing* option, a *stimulating* option by which users could be stimulated to purchase ADAS, and a *mandatory* option by which users are forced to have their cars equipped with an ADAS.

A number of possible deployment situations were presented to the respondents, consisting of an ADAS type and the deployment options applied by the other two actors. As a personal opinion, the respondents were asked to rate (the utility of) each of their predefined deployment options for each of the situations. The (utility) ratings were on a scale from 0 (very low) – 10 (very high). Furthermore, as an expectation for their actor group, the respondents were asked to give a probability distribution over their predefined deployment options (including the option 'other') for each of the situations.

Data were collected from 45 respondents from automotive industry, 20 from public authorities, and 7 from insurance companies. Respondents were invited from lists of participants to relevant ADAS conferences and the ADAS networks of colleagues.

Cluster analysis

Cluster analysis is a statistical technique to group cases with similar data or data patterns (Hair et al. 2006). This technique uses the multidimensional distances between cases to group cases that are most similar. Several different algorithms are available to group cases, based on different assumptions. Researchers should decide which algorithm best fit their case.

A cluster analysis was performed on both the individual respondent utility data, as on the probability data for the actor groups. The aim of the cluster analysis is to group respondents that react in a similar way to the ADAS and the deployment options applied by other actors. Or, in other words, to group respondents with a similar strategy.

For public authorities, two respondent subgroups were identified based on the rating data. For automotive industry, five respondent subgroups were identified based on the rating data, and three based on the probability data. For insurance companies two respondent subgroups were identified based on the rating data and the probability data. The number of groups indentified depended on the clarity of the differences between the groups and a minimum subgroup size of 2 respondents.

For each of the subgroups, regression models were estimated from the average data of the respondents in the subgroups. Separate models were estimated for each of the actors' deployment options, and for the individual utility ratings and actor group probabilities. They present the influence of the type of ADAS and the deployment options of other actors. The differences between the subgroups can be mainly characterized by the rank orders of the actors' deployment options, and their susceptibility to influence of other actors.

IDENTIFICATION OF ACTOR STRATEGIES

Figure 1 presents the results of the cluster analysis for the probabilities for automotive industry in terms of the average probability that a deployment option will be applied (horizontal dash) and the range of influence on this probability by the deployment options applied by other actors (vertical line). It was found that the type of ADAS generally did not have a significant influence on any of the utility ratings or probabilities. The deployment options considered for automotive industry were '*do nothing*', 'ADAS as *optional* equipment on each new car', 'ADAS as *standard* equipment on each new car', and '*other* deployment options'.

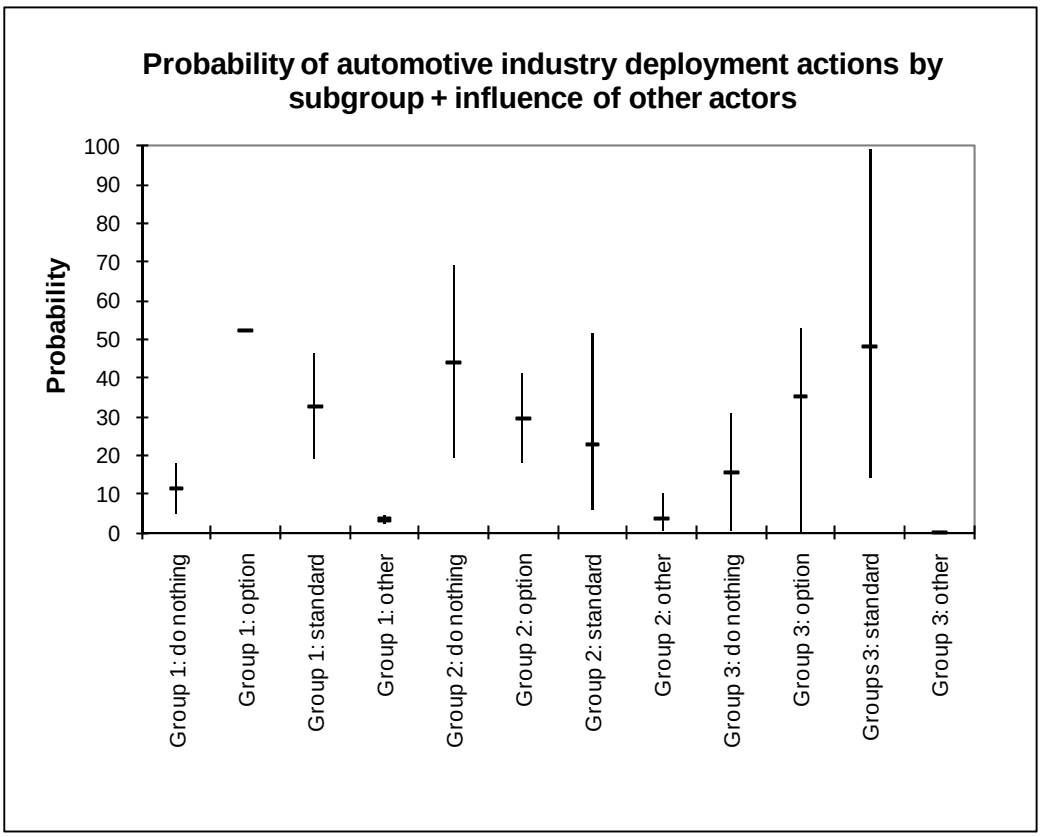

Figure 1: Automotive industry's probability subgroup characteristics

The first subgroup seems to expect that automotive industry will act as an *Active Deployer*, with higher average probabilities to take action as opposed to doing nothing, and limited influence of other actors (public authorities). The second subgroup seems to expect that automotive industry will act as a *Reluctant Deployer*, with a higher average probability to do nothing as opposed to taking action, and an important influence of other actors. The third subgroup seems to expect that automotive industry will act as an *Adaptive Deployer*, with higher average probabilities for taking action as opposed to doing nothing, and a high influence on the most preferred action to take by other actors.

The other subgroups that were identified were analyzed in a similar way. For automotive industry, it was found that there are clearly different strategies expected by the respondents, some favoring taking action, some favoring doing nothing. But, influence of public authorities increases the probability that they all take action. For public authorities, it was found that as individual respondents they prefer a passive or an active role in ADAS deployment. But their

expectation for public authorities in general is that they will be passive. For insurance companies, two different strategies were defined, one favoring action, and one favoring doing nothing. Their actions are not influenced by those of the other actors.

Explanation of observed differences

A possible explanation for the differences between the subgroups was found based on data collected in the survey regarding the stated familiarity of the actors with the ADAS, and their perceived impacts on safety, traffic flow, environment and user acceptance. The relation between these data and the subgroups was not significant because of the size of the subgroups. However, they indicate for public authorities and especially for insurance companies that the more familiar they are with the ADAS, the less positive they expect the impacts of ADAS will be, and the less willing they are to take action toward ADAS deployment. This is in contrast to what was found for automotive industry: the more familiar they are the more positive they expect the impacts to be and the more willing they are to take action.

CONCLUSIONS

Subgroups with different strategies regarding ADAS deployment exist among the respondents to an actor survey. These strategies can be mainly distinguished by different preferences for deployment options, and the different extent of influence of other actors. An explanation for the existence of different subgroups among automotive industry respondents is that different networks exist with a different attitude towards ADAS deployment. This may need to be taken into account in policymaking regarding ADAS deployment. An explanation for the existence of different subgroups for insurance companies is that they have different levels of experience with ADAS. Based on the finding that insurance company respondents in favor of taking action were considerably less familiar to ADAS, it is not expected that insurance companies will play a major role in ADAS deployment. The subgroups among public authorities' respondents did not show major differences in their expectations towards ADAS deployment. This may be due to the fact that the respondents were mainly from the Netherlands. Public authorities from different countries may be expected to have different strategies.

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