OLDER DRIVERS' PERCEPTION AND ACCEPTANCE OF IN-VEHICLE DEVICES FOR TRAFFIC SAFETY AND TRAFFIC EFFICIENCY

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ABSTRACT. A multitude of new technologies (ranging from guidance systems to speed-limit exceeding systems and to fatigue detection systems) are emerging, many of which are either explicitly targeted to older drivers or expected to benefit them the most. However, these same older drivers are more likely to find adapting to the use of such technologies challenging. Therefore, understanding older drivers' perception of such devices will allow experts to take the necessary steps to ensure their smoother acceptance and complete success of their deployment. Using Greek drivers' attitude data collected within the scope of an extensive recent survey in 23 European countries (the SARTRE-3 dataset), a statistical analysis of the perception of usefulness and acceptance of new technologies by older drivers is presented. The results of the developed ordered logit models provide insight into the human-factors' aspect of the introduction of advanced technologies with respect to these more sensitive segments of the driver population. For example, older respondents are in general more supportive of the considered in-vehicle technologies, while female respondents also show a higher willingness to adopt them.

CE Database subject headings: traffic engineering, traffic safety, age factors, intelligent transportation systems

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INTRODUCTION

The proportion of elderly people (65+) in the European Union (EU25) will increase from 16% in 2004 to 30% in 2050 (European Commission, 2008), while the proportion of very old people (80+) is expected to almost triple, from 4% in 2004 to 11% in 2050 (EUNESE, 2006). Furthermore, licensing rates among future cohorts of older drivers will be higher, especially for women, owing to the emergence of cohorts who have always had and will continue to expect access to a car (OECD, 2001). As that trend will continue, it is evident that older drivers will be one of the more critical driver population segments in the future. Road traffic injuries are predicted to rise to become the fifth leading cause of death by 2030 (WHO, 2009). A multitude of new technologies (ranging from guidance systems to speed-limit exceeding systems and to fatigue detection systems) are emerging, many of which are either explicitly targeted to older drivers or expected to benefit them the most. However, these same older drivers are more likely to find adapting to the use of such technologies challenging (Fox and Boehm-Davis, 1998; Donmez et al, 2006). Furthermore, the existence of such systems might result in the increased exposure of older drivers, as e.g. vision enhancement systems might increase the propensity of older drivers to drive at night. Overall, the potential net reduction in the number of elderly motorist casualties would depend on the size of the crash rate reduction, which must be larger than the possible increase in exposure as a result of the system usage (SWOV, 2006a). Therefore, understanding older drivers' perception of such devices will allow experts to take the necessary steps to ensure their smoother acceptance and complete success of their deployment.

The data used in this study was extracted from a questionnaire study that was conducted within the framework of the European Project SARTRE 3. SARTRE stands for ‘Social Attitudes to Road Traffic Risk in Europe’ and followed the European Projects SARTRE 1 and SARTRE 2. The first SARTRE survey was carried out from October 1991 to June 1992 in 15 European countries, which consisted at that time of 10 European Union member states and 5 non-European Union countries. In each country a representative sample of about 1,000 vehicle license holders, who actually drove, have been questioned, making a total of 17,430 car drivers. Based on the positive receipt of the conclusions and recommendations of the SARTRE survey (Barjonet et al., 1994), it was decided to perform a follow-up survey. The second step, SARTRE 2, was carried out from October 1996 to April 1997, using the same methods regarding the surveys. For most questions, the questionnaire was similar to the first one but the number of surveyed countries grew to 19 (all EU members at the time, except for Denmark and Luxemburg, plus Switzerland, Czech Republic, Slovakia, Hungary (already in SARTRE 1), and Slovenia and Poland (new in SARTRE 2). SARTRE 3 started in 2002 and finished in 2004, with the participation of 23 European Union countries. Surveyed countries include fourteen of the EU-15, seven of the accession countries, and Switzerland and Croatia, and a sample of around 1.000 responses from drivers was collected in each country. The results were analyzed within each nationality, but cross-national comparisons also took place to identify the similarities and differences between drivers of different nationalities as well as the main reasons behind these differences. The overall SARTRE 3 results reveal substantial differences in the perception of road risk and self-reported behaviors among European drivers from various age groups (SARTRE, 2004).

The main tool of this research was the questionnaire, which included a wide range of questions the aim behind which was to monitor driver behaviors towards different elements of the road environment. Hence, questions included general driver characteristics, driving behavior (speeding, wearing seat-belt, driving headways, alcohol consumption, etc.), respondents' assessment of driving behavior of other drivers (in relation to the respondents' driving behavior), driver accident involvement, as well as other questions on the drivers' views on general issues such as environmental pollution and legislation. Part of the questionnaire comprised questions on specific intelligent transport systems presented in two different ways: needs and acceptability.

Using data collected from Greek drivers within the scope of the SARTRE-3 dataset, a statistical analysis of the perception and acceptance of new technologies by older drivers is presented. The results of the developed ordered logit models provide insight into the human-factors aspect of the introduction of advanced technologies with respect to the more sensitive segments of the driver population. Specific recommendations about the further seamless acceptance of in-vehicle devices by older drivers conclude the paper.

LITERATURE REVIEW

The variability of road-safety trends among age groups is intuitive and well documented. The so-called "bath-tub" effect, resulting from the proportionally higher involvement of younger and older drivers in accidents, has been confirmed by various researchers using different data sets (e.g. Williams and Carsten, 1989, Deery, 1999, Langford and Kopell, 2006). Van den Bossche et al. (2007) also identified the same effect and used a time-series road safety analysis for different age and gender categories of road users. Using Belgian data it was also found that while risk is decreasing over time, the rate varies by age group (younger drivers were defined as up to 25 years old, while older drivers were defined as those over 65 years of age). Khattak et al. (2002) use ordered probit models to isolate factors that contribute to more severe injuries to older drivers (>65 years old) involved in car crashes, finding e.g. that older drivers who consumed alcohol were more likely to be seriously injured. Mueller et al. (2007) analyze the reasons that lead to higher crash rates of older drivers (above 65 years old) in left-turns at high-speed signalized intersections, finding that older drivers had higher crash rates for all types of phasing and that the highest crash rate was observed under protected/permitted and then permitted phasing (within each age group). The remainder of this section reviews related research that provides insight into the different behaviors and perceptions of older drivers towards new technologies.

Both younger and older drivers have been shown to be at higher crash risk when compared to middle- aged drivers. However, their greater risks are due to different reasons. Younger drivers tend to adopt to new technology fostering greater likelihood to be distracted while older drivers tend to be more cautious of new technology even if the technology can actually enhance driving abilities. For example, in a field study by Gish et al. (2002), younger drivers were able to observe pedestrians that were located further away using an infrared night enhancement systems. However, the system provided very little enhancement for older drivers and as the authors indicate, could be due to their seldom use the display.

Differences in risk perceptions and avoidance behavior are very likely due to decrements in abilities and these have been well examined in a simulated environment where eye movements can be observed in controlled scenarios. In this context, Pradhan et al (2003) observed that older drivers (60 to 75) were more likely to attend to risk relevant areas than younger drivers but are more cautious due to declining physical and cognitive abilities. DeRamus (2006) also used a simulator to observe how likely older drivers were able to scan potential risks. The findings from this study were actually mixed with some older drivers (60- 69, and 75- 79) able to scan risky areas more than others (40- 50, 70- 74).

With respect to signage, Golembiewski et al (2006) observed that older drivers could not legibly see significantly further than younger drivers regardless of the combinations of colors or elements used in traffic control devices. Alternatively, Porter et al (2006) showed that failure to check behind while backing up was an issue for many drivers, regardless of physical limitations. Although these studies demonstrate some of the issues related to older drivers, this same age group does appear to have a high likelihood for modifying their driving habits when provided advice on how to avoid risky situations.

Karlaftis et al. (2003) report that based on the data collected from SARTRE 2, older drivers tended to self-report that they drive slower than other drivers. This finding is also consistent with previous research according to which younger drivers have the tendency to drive faster compared to older and more experienced drivers (Webster and Wells, 2000, Badger, 1996). The findings of the analysis of the SARTRE 3 questionnaires provided additional insight (SARTRE, 2004), indicating that the likelihood to engage in unsafe driving behavior is influenced by several driver characteristics (gender, age, driving experience, etc).

A large number of Advanced Driver Assistance Systems (ADAS) are being developed and marketed to various segments of the population. Golias et al. (2002) provide a meta-analytic review and broad classifications of advanced driver assistance systems, using safety implications as one of the key dimensions of their analysis. Davidse (2006) aims to identify the driver tasks for which assistance is most desirable from a road safety perspective and identifies the relative weaknesses of the older driver. One of the conclusions is that currently available ADAS do not provide adequate support for the more critical weaknesses.

Lerner et al. (2008) investigated the decision process involved in a driver's willingness to engage in various technology-related and non-technology tasks, considering four age groups: teen (16-18), young (18-24), middle (25-59), and older (60+). Mean self-reported risk ratings for in-vehicle and driving tasks for the older group were frequently distinctly higher than those of the other age groups. Overall, older drivers reported greater reluctance to engage in in-vehicle activities.

Synthesis

Several studies have shed light into the reasons that increase the involvement of older drivers in traffic accidents. It becomes apparent that there is a lot of interest in the improvement of road safety for older drivers and ADAS can provide a viable tool to achieve this objective. One question that needs to be answered, however, is the attitude that older drivers have towards these systems. This information can help towards creating appropriate deployment and marketing campaigns that will maximize the effective acceptance and market penetration of these devices. Based on the review of the literature, it appears that while there are several definitions for “older” drivers, 60+ years of age is the most commonly used.

METHODOLOGY

The used data set

In this research, the emphasis is in the self-reported perception of in-vehicle devices for road safety, using the 1000 questionnaires that were completed by Greek drivers within the SARTRE 3 programme. The survey was conducted through interviews at home by 15 skilled interviewers using a structured questionnaire. No compensation was offered to the respondents. A number of restrictions were placed a priori on the sample, based on considerations of the SARTRE consortium. For example, only active drivers (people with driving license, who had driven in the last 12 months) were accepted in the sample. The respondents were selected randomly and covered all socio-economic classes. However, if the respondent did not satisfy one of the screening criteria, then the interview was concluded (and they were excluded from the sample). Furthermore, some restrictions were placed on the sample, so that it is representative of the driver population. For example, to ensure adequate geographic representation, it was requested that 420 subjects should reside in Athens, 120 in Thessaloniki, 110 in other large urban areas, 120 in urban areas, 120 in peri-urban areas and 110 in rural areas.

The distribution of age (aggregated in 5-year bins) and sex in the data set is shown in Figure 1. The overall mean age of the survey respondents used in this study was 40.2 years old (standard deviation was 14.5 years old), with 64.8% being male and 35.2% being female. The ages ranged from 18 to 84. Income level was collected in 8 groups, which have been further aggregated into five income groups (in order to ensure a rational balance between the groups): less than 734 Euro/month (18.3%), 735-1027 Euro/month (24.8%), 1028-1320 Euro/month (28.4%), 1321-1908 Euro/month (19.5%), more than 1909 Euro/month (9.0%). The income levels have been initially specified within the SARTRE-1 survey in 1992 by the experts from several European countries, and they have been used consistently in all three SARTRE surveys (1992, 1996, 2003) across the considered European countries.

Figure 1. Age and sex distribution in the data set (5-year bins)

Figure 2 presents the part of the questionnaire that asked the drivers about their attitude toward technological devices that could improve safety conditions. The selection of the specific considered in-vehicle systems has been performed within the SARTRE-3 survey in early 2003, was adopted for the surveys in all the involved countries and reflects the state of knowledge and ITS concerns of experts from several European countries of this period.

Figure 2. Relevant part of the SARTRE 3 questionnaire

Model formulation

Respondents in surveys are often asked to express their preferences in a rating scale. Such scales are often called Likert scales (Likert, 1932, Richardson, 2002). A multinomial logit model could be specified with each potential response coded as an alternative. However, the ordering of the alternatives violates the independence of the errors for each alternative, and therefore the Independence for Irrelevant Alternatives (IIA) assumption of the logit model. Nested or cross-nested models are one approach to overcoming this issue (Ben-Akiva and Lerman, 1985). Ordered logit models provide another approach that estimates parameter coefficients for the independent variables, as well as intercepts (or threshold values) between the choices.

Figure 3 shows the distribution of the choice probability P as a function of the utility U. Assuming a ranking scale with four levels (like the one used in Figure 2), there are three thresholds or critical values (k1, k2, and k3) that separate the four choices ("not at all useful" through "very useful"). For example, respondents choose the alternative "not at all useful" if the utility is below k_1, alternative "somewhat useful" if the utility is between k_1 and k_2, and so on.

Figure 3. Distribution of the respondents' preference (adapted from Train, 2002)

Ordered logit models, in which the ordered response is used directly as the dependent variable, are used in this research. In each model, the response variable takes numerical values between 1 and 4, with 1 indicating the lowest perceived usefulness of the considered system, and 4 indicating the highest perceived usefulness of that system.

MODEL ESTIMATION RESULTS

Several socio-economic characteristics have been considered and only the age, gender and income levels have been retained, as the others did not result in significant relationships. Gender has been modeled as a binary variable (male, female). Based on the literature, three age groups have been used, namely less than 25 years old, between 25 and 50 years old and more than 60 years old. Age and income level groups have been coded as factors. The lowest retained group was used as the basis for the factors. By using factors (instead of ordinal parameters), the model specification allows for capturing non-linear effects. The interaction terms among these variables have also been considered and –based on the statistical significance- the interaction between gender and income group has been retained. All models were estimated using the R Software for Statistical Computing, Version 2.9.0 (R Development Core Team, 2009) with the MASS package (Venables and Ripley, 2002).

Table 1 summarizes the estimation results for the models capturing the perceived usefulness of each system by the drivers. Variables that are not significant at the 95% confidence level have been removed from the model (e.g. the low-income level). Not statistically significant variables are indicated in Table 1 with "ns". The values of the thresholds (or intercepts) aid in defining the breadth of each of the responses. Naturally, their values should be consistent with their interpretational ordering. The interpretation of the age and gender coefficients is straightforward. In particular, larger coefficient values imply that the respondents in that group perceive the system in question as more useful. For example, from the first column of Table 1, it appears that older drivers perceive a guidance or navigation device to help them find their destination more useful that the other segments of the population, while female respondents report a significantly higher perceived usefulness of guidance devices. In order to understand the impact of income group, one needs to consider both the income group variables and the gender-income group variables.

Proportional odds-ratios are often more practical in understanding the differences between socioeconomic groups. Table 2 presents the odds-ratios for the estimated coefficients, along with their 95% confidence intervals. The odds-ratio in the case of logistic models is computed as the exponent of the coefficient value, while the confidence intervals as the exponent of the coefficient value minus (respectively plus) two times the standard error. Since the confidence interval does not include zero for any of the significant variables, the null hypothesis that a particular regression coefficient is zero given the other predictors are in the model can be rejected. Odds-ratios (and their confidence intervals) for the missing (not significant) variables are indicated as not applicable ("N/A") in Table 2.

As mentioned above, the four models indicate that the perceived system usefulness increases with age. For example, a guidance or navigation system is perceived as 1.4 times more useful by older respondents (60 years or older) than the other age-defined segments of the population (which do not show a significant difference in the odds between them). Similarly, alcohol meters are perceived as 1.8 times more useful by older respondents. A system that prevents exceeding the speed limit is perceived by respondents in the age group 25-50 as 2 times more useful than the younger population, while older respondents indicate a significantly higher perceived usefulness of 4.8 times (over those under 25 years old). Similarly, the fatigue detection system is perceived as 1.7 times more useful for people in the 25-50 age demographic (than younger respondents) while older respondents indicate a perceived usefulness that is 3.4 times higher than the young respondents (less than 25 years of age).

The model estimation results indicate that male respondents show almost half the perceived usefulness (than their female counterparts) for systems that prevent exceeding speed limit and meter alcohol (since the related proportional odds ratios are about 0.5). Similarly, respondents in the high income group show almost half the usefulness for the speed limiting system over other age groups (odds ratio about 0.5). A similar result is obtained for the alcohol meter, where the perceived usefulness decreases as the income group increases (respondents in the low-medium income group have 65% the perceived usefulness of the lower income group, while respondents in the medium-high and high income groups have about 55% the perceived usefulness of the lower income group).

Due to the gender-income level interaction term in the other two models, the assessment of the perceived usefulness requires some simple manipulations, combining the gender and income group terms with their interaction. For example, in order to assess the perceived usefulness of high income males over the reference case (low income females) one needs to combine the "male", "high income" and "male:high income" odds ratios. For the guidance or navigation system the combined odds ratio for high income males therefore becomes equal to 0.267*0.233*3.570=0.222, indicating that the perceived usefulness for this group is about 22% that of the low income females. Similarly, e.g. the perceived usefulness for medium-high income females (over low income females) would simply be given by the odds ratio for the medium-high income group. Table 5 presents the resulting computed odds ratios for all gender-income groups against low income females (which is the base) for the younger age segment (less than 25 years old). The computed odds ratios for the guidance or navigation system indicate that in general male respondents perceive a lower usefulness than female respondents in the same income group (with the exception of medium-high income respondents). On the other hand, the results for the fatigue detection system show that while lower income males perceive a much lower usefulness than their female counterparts, this difference reverses for higher incomes, with male respondents showing a slightly higher perceived usefulness.

The model estimation results for the ordered logit models relating to how much the respondents would favor the deployment of a series of systems are presented in Table 3 while Table 4 presents the odds-ratio and the respective 95% confidence intervals.

Again, in all cases older drivers are expected to be more in favor of such systems, including speed-limiting devices (more than 4 times more than those younger than 25 years old and 4.2/1.7=2.4 times more than those in the 25-50 years group), black boxes to identify accident cause (1.6 times more than younger respondents) and record driver behavior (1.7 times more than younger respondents), and electronic vehicle identification, both for services (1.8 times more) and enforcement (2.6 times more than those younger than 25 years and 2.59/1.84=1.4 times more than those in the 25-50 years of age demographic). The other parameters values also have similar coefficient estimates as those presented in Tables 1 and 2. The gender-income level odds ratios for the younger age group are presented in Table 5.

At this point an additional clarification needs to be made. While one can make inferences about how different segments of the population perceive each of these systems, it is not possible to attempt to compare how a given segment of the population perceives different systems relative to each other. Therefore, while estimated coefficient (or odds-ratios) can be interpreted within the same model, they cannot be compared across models.

DISCUSSION

In this research, ordered logit models have been used to analyze the perception of older drivers (compared to other age groups of the population) regarding the acceptance of in-vehicle devices for road safety. The results indicate that older drivers are much more open to such devices, while female respondents report a significantly higher perceived usefulness of such devices.

While the higher willingness of older drivers to accept the considered devices might at first seem as an unintuitive finding (considering e.g. that older segments of the population might not be as familiar with new technologies), it is actually consistent with other studies that show that older drivers tend to more accepting of technology (Fox and Boehm-Davis, 1998; Donmez et al, 2006). Such findings might be explained when one considers the more risk-averse behavior of older drivers. Furthermore, this willingness to accept new technologies could be a manifestation of the fact that older drivers actually comprehend and recognize their limitations due to aging, such as slower response time and impaired vision. It should be noted that it should not be assumed that the willingness to test and potentially adopt new in-vehicle devices offsets such age-related implications.

Older drivers' actual use of the technology (revealed preference) cannot always be expected to be consistent with their stated preference (especially when the survey questions deal with systems that they respondents have never used), and therefore other approaches (e.g. driving simulator experiments) may also be used to investigate potential discrepancies between stated and actual behavior. For example, Pohlmann and Traenkle (1994) found that when drivers are examined on the actual use of new systems, older drivers tend to perform worse.

Besides this point, the findings presented in this paper, should certainly be further validated using driver populations from other countries. If the transferability and generality of these findings is confirmed, however, then it means that older drivers are willing to accept these devices (to a larger degree than younger segments of the population). This might be a factor that can offset the difficulties that older drivers face when dealing with technology. However, the existence of such systems might result in the increased exposure of older drivers, e.g. vision enhancement systems might increase the propensity of older drivers to drive at night.

Other possible unintended side effects of in-vehicle, safety-oriented systems may also occur and should also be considered and factored in. One such example is behavioral adaptation, as the behavior of the drivers changes unpredictably in response to the changes in prevailing conditions. Examples of such negative side-effects may include (SWOV, 2006b): diminished attention level, information overload, incorrect interpretation of information, inappropriate reliance to the system (i.e. underestimating or overestimating its performance) and risk compensation.

One question that arises from this analysis is whether the respondents really comprehend the details related to the operation of each of the considered systems. Toward answering this question, further research could include a more detailed questionnaire, focusing on the verification of the respondents' perception of the functionality and the properties of each system. Furthermore, it would be particularly useful if the experimental setup was extended to include field experiments, e.g. using a driving simulator. Such a setup would allow the collection of richer, revealed-preference data about the situation, which are expected to be more reliable than the stated-preference data obtained from this survey. Testing of new technologies and in-vehicle systems should not only be made on the general population (in which older drivers may be under-represented), but efforts should be made to test them specifically on older drivers (SWOV, 2006a). Testing the devices on older drivers should be very carefully undertaken, considering the serious challenges and practical difficulties associated with field experiments with older subjects (Vardaki, 2008).

Other research directions that are necessary for the determination of the expected safety benefit of the introduction of in-vehicle safety systems for elderly drivers include the development and introduction of systems targeted specifically at this age group. From a statistical point of view, other interesting modeling approaches that are applicable for this kind of analysis may be pursued. Such analysis tools include generalized estimating equations (GEE, Liang and Zeger, 1986) and multivariate ordered logit models (Glonek and McCullagh, 1995).

ACKNOWLEDGEMENTS

The data collected in this research were collected within the EU co-funded project SARTRE 3.

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List of figure captions

Table 1. Model estimation results for perceived usefulness of each system

	Guidance or navigation system		Prevent exceeding speed limit		Alcohol meter		Fatigue detection	
Variable	Value	*t-value*	Value	*t-value*	Value	*t-value*	Value	*t-value*
Age in [25,50)	ns	*ns*	0.698	*3.085*	ns	*ns*	0.537	*2.395*
Age 60+	0.368	*1.926*	1.579	*5.705*	0.585	*3.131*	1.215	*4.477*
Male	-1.322	*-5.191*	-0.573	*-3.892*	-0.561	*-3.756*	-1.021	*-5.891*
Low-Medium Income	-0.926	*-3.207*	ns	*ns*	-0.425	*-2.509*	ns	*ns*
Medium-High Income	-1.386	*-4.251*	ns	*ns*	-0.608	*-3.116*	-0.967	*-3.445*
High Income	-1.457	*-2.743*	-0.735	*-3.003*	-0.619	*-2.466*	-1.008	*-2.118*
Male:Low-Medium Income	0.695	*1.922*	ns	*ns*	ns	*ns*	ns	*ns*
Male:Medium-High Income	1.680	*4.111*	ns	*ns*	ns	*ns*	1.156	*3.183*
Male:High Income	1.273	*2.084*	ns	*ns*	ns	*ns*	1.118	*2.016*
Intercept								
1|2	-3.274	*-12.779*	-1.872	*-7.585*	-2.653	*-13.560*	-2.321	*-8.891*
2|3	-2.367	*-9.825*	-0.645	*-2.745*	-1.585	*-9.098*	-0.965	*-3.907*
3|4	-0.516	*-2.276*	1.057	*4.460*	-0.122	*-0.748*	0.550	*2.258*
Number of observations	707		720		724		718	
Initial log-likelihood	-865.06	(3 d.o.f.)	-923.01	(3 d.o.f.)	-919.30	(3 d.o.f.)	-933.41	(3 d.o.f.)
Final log-likelihood	-841.29	(11 d.o.f.)	-890.99	(7 d.o.f.)	-898.58	(8 d.o.f.)	-902.35	(10 d.o.f.)

Legend: ns: not significant, d.o.f.: degrees of freedom

Table 2. Odds-ratios and 95% confidence intervals for perceived usefulness of each system

	Guidance or navigation system			Prevent exceeding speed limit			Alcohol meter			Fatigue detection		
Variable	odds-ratio	*CI 95%*		odds-ratio	*CI 95%*		odds-ratio	*CI 95%*		odds-ratio	*CI 95%*	
Age in [25,50)	N/A	N/A	N/A	2.009	*1.278*	*3.158*	N/A	N/A	N/A	1.710	*1.092*	*2.677*
Age 60+	1.445	*0.986*	*2.118*	4.850	*2.788*	*8.435*	1.794	*1.235*	*2.606*	3.370	*1.958*	*5.799*
Male	0.267	*0.160*	*0.444*	0.564	*0.420*	*0.757*	0.571	*0.423*	*0.769*	0.360	*0.255*	*0.509*
Low-Medium Income	0.396	*0.222*	*0.706*	N/A	N/A	N/A	0.654	*0.466*	*0.917*	N/A	N/A	N/A
Medium-High Income	0.250	*0.130*	*0.480*	N/A	N/A	N/A	0.544	*0.368*	*0.804*	0.380	*0.217*	*0.667*
High Income	0.233	*0.080*	*0.674*	0.480	*0.294*	*0.782*	0.538	*0.326*	*0.890*	0.365	*0.141*	*0.945*
Male:Low-Medium Income	2.004	*0.972*	*4.131*	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Male:Medium-High Income	5.365	*2.369*	*12.146*	N/A	N/A	N/A	N/A	N/A	N/A	3.177	*1.537*	*6.566*
Male:High Income	3.570	*1.053*	*12.109*	N/A	N/A	N/A	N/A	N/A	N/A	3.059	*1.009*	*9.275*

Legend: N/A: not applicable

Table 3. Model estimation results for the support for the deployment of each system

	In favor of speed limiter		In favor black box for accident cause		In favor of black box for speeding		In favor of electronic ID for services		In favor of electronic ID for police enforcement	
Variable	Value	*t-value*	Value	*t-value*	Value	*t-value*	Value	*t-value*	Value	*t-value*
Age in [25,50)	0.533	*2.277*	ns	*ns*	ns	*ns*	ns	*ns*	0.609	*2.585*
Age 60+	1.437	*5.153*	0.496	*2.575*	0.548	*2.981*	0.601	*3.200*	0.952	*3.421*
Male	-0.759	*-4.350*	-1.216	*-4.504*	-1.129	*-6.414*	-1.130	*-4.509*	-1.385	*-5.621*
Low-Medium Income	ns	*ns*	-0.770	*-2.497*	ns	*ns*	-0.786	*-2.781*	-0.776	*-2.782*
Medium-High Income	-1.283	*-4.544*	-1.965	*-5.824*	-1.213	*-4.409*	-1.270	*-4.187*	-1.465	*-4.816*
High Income	-1.661	*-3.192*	-1.551	*-2.833*	-1.517	*-3.025*	-1.270	*-4.187*	-1.465	*-4.816*
Male:Low-Medium Income	ns	*ns*	0.616	*1.635*	ns	*ns*	0.688	*1.946*	0.542 (ns)	*1.551*
Male:Medium-High Income	1.199	*3.278*	1.752	*4.240*	1.050	*3.000*	0.877	*2.409*	0.877	*2.411*
Male:High Income	1.220	*2.034*	1.365	*2.189*	1.254	*2.181*	0.877	*2.409*	0.877	*2.411*
Intercept										
1|2	-2.193	*-8.184*	-3.814	*-13.388*	-2.717	*-15.158*	-2.762	*-11.329*	-1.914	*-6.327*
2|3	-1.184	*-4.588*	-2.540	*-9.853*	-1.536	*-9.648*	-1.436	*-6.242*	-0.663	*-2.221*
3|4	0.810	*3.176*	-0.832	*-3.410*	-0.045 (ns)	*-0.306*	0.149 (ns)	*0.667*	0.748	*2.526*
Number of observations	719		718		716		695		693	
Initial log-likelihood	-897.29	(3 d.o.f.)	-841.45	(3 d.o.f.)	-949.07	(3 d.o.f.)	-934.08	(3 d.o.f.)	-957.02	(3 d.o.f.)
Final log-likelihood	-860.91	(10 d.o.f.)	-812.42	(11 d.o.f.)	-913.79	(9 d.o.f.)	-907.28	(9 d.o.f.)	-914.50	(10 d.o.f.)

Legend: ns: not significant, d.o.f.: degrees of freedom

Table 4. Odds-ratios and 95% confidence intervals for the support for the deployment of each system

	In favor of speed limiter			In favor black box for accident cause			In favor of black box for speeding			In favor of electronic ID for services			In favor of electronic ID for police enforcement		
Variable	odds-ratio	*CI 95%*		odds-ratio	*CI 95%*		odds-ratio	*CI 95%*		odds-ratio	*CI 95%*		odds-ratio	*CI 95%*	
Age in [25,50)	1.703	*1.067*	*2.719*	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1.838	*1.148*	*2.944*
Age 60+	4.207	*2.409*	*7.348*	1.642	*1.117*	*2.415*	1.729	*1.197*	*2.497*	1.823	*1.253*	*2.654*	2.590	*1.485*	*4.518*
Male	0.468	*0.330*	*0.664*	0.296	*0.173*	*0.509*	0.323	*0.227*	*0.460*	0.323	*0.196*	*0.533*	0.250	*0.153*	*0.410*
Low-Medium Income	N/A	N/A	N/A	0.463	*0.250*	*0.858*	N/A	N/A	N/A	0.456	*0.259*	*0.802*	0.460	*0.264*	*0.804*
Medium-High Income	0.277	*0.158*	*0.487*	0.140	*0.071*	*0.275*	0.297	*0.172*	*0.516*	0.281	*0.153*	*0.515*	0.231	*0.126*	*0.425*
High Income	0.190	*0.067*	*0.538*	0.212	*0.071*	*0.634*	0.219	*0.080*	*0.598*	0.281	*0.153*	*0.515*	0.231	*0.126*	*0.425*
Male:Low-Medium Income	N/A	N/A	N/A	1.851	*0.872*	*3.929*	N/A	N/A	N/A	1.989	*0.981*	*4.032*	1.720	*0.855*	*3.461*
Male:Medium-High Income	3.317	*1.596*	*6.893*	5.767	*2.523*	*13.180*	2.859	*1.419*	*5.760*	2.403	*1.161*	*4.977*	2.403	*1.161*	*4.975*
Male:High Income	3.389	*1.021*	*11.251*	3.914	*1.125*	*13.617*	3.505	*1.109*	*11.071*	2.403	*1.161*	*4.977*	2.403	*1.161*	*4.975*

Legend: N/A: not applicable

Table 5. Sample computed odds-ratios

Sample computed odds-ratios (<25 years old group)	**Guidance or navigation system**	**Fatigue detection**	**In favor of speed limiter**	**In favor black box for accident cause**	**In favor of black box for speeding**	**In favor of electronic ID for services**	**In favor of electronic ID for police enforcement**
Female low income	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Female low-medium income	0.396	1.000	1.000	0.463	1.000	0.456	0.460
Female medium-high income	0.250	0.380	0.277	0.140	0.297	0.281	0.231
Female high income	0.233	0.365	0.190	0.212	0.219	0.281	0.231
Male low income	0.267	0.360	0.468	0.296	0.323	0.323	0.250
Male low-medium income	0.212	0.360	0.468	0.254	0.323	0.293	0.198
Male medium-high income	0.358	0.435	0.430	0.240	0.275	0.218	0.139
Male high income	0.222	0.402	0.301	0.246	0.249	0.218	0.139