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INTERACTIONS BETWEEN AUTONOMOUS VEHICLES, CYCLISTS, AND PEDESTRIANS FROM THE PERSPECTIVE OF POTENTIAL USERS AND NON-USERS OF AUTONOMOUS VEHICLES

Summary. In a few years, autonomous vehicles will slowly become part of traffic flow. This paper evaluated the level of perceived fear of interactions of autonomous vehicles (AVs) with other (vulnerable) road users of different actors in the Czech Republic. Data from the first exploratory project from 2017/2018 are used for the evaluation. A logistic regression model is utilised to evaluate the predictors that influence the fear resulting from interactions of AVs and cyclists or pedestrians. Kilometres driven last year was positively associated with fear of interactions with pedestrians or cyclists (OR = 1,251, p = 0.032). The level of concerns about the risk of AVs is also positively associated with fear of interactions (OR = 1.087, p = 0.000). Out of all socio-demographics and socio-economics, only gender was distinguished regarding the level of fear, with women having a higher chance than men of being fearful (OR = 1.871, p = 0.005). Then, the same model is utilised to evaluate the variables that influence the fear of interactions of Avs and other non-Avs. Only the general level of concerns about the risk of AVs is associated with the level of fear of interactions of AVs and non-AVs (OR = 1.149, p = 0.000). Since these results are only partly in accordance with those obtained in Western countries, our paper concludes that for central European countries, more research is needed to understand the local context and implications of autonomous mobility.

1. INTRODUCTION

The emergence of autonomous vehicles (AVs) represents a monumental change toward the organisation of traffic and transport, the urban scene, and the daily functions of people's lives [1,2]. Not only will driving and drivers' experiences change, but all other road users will also be affected by the dissemination of AVs [3]. Automated vehicles may impact walking and cycling through changes in infrastructure, the built environment, and land use [4]. AVs are expected to make traffic safer [5]. In the non-autonomous era, traffic safety is connected to gross domestic product (GDP) [6] – the higher the pace of economic growth, the higher the level of road safety in general. On the individual level, regarding non-autonomous traffic flow, both drivers and pedestrians or cyclists can be distracted by external factors, such as music or other noise, cell phones, or other road users [7,8]. When the role of a driver is considered, most of these distractors disappear in autonomous traffic flow with cars with level 5 automation. More specifically, distractors are still present but are no longer relevant because there is no human driver. On the other hand, a number of potential hazards still exist related to the

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communication and behaviour of other road users and the technical capabilities of the AVs to communicate with other AVs and safely react to manually driven cars and VRUs [4]. Moreover, formerly non-existing SOS accidents, which are partly related to autonomous systems, would never occur in cases of human control. Thus, traditional techniques contributing to functional safety need to be combined with SOS-related methods [9]. In short, AVs have the potential to diminish serious accidents caused by human factors; however, a number of potential risks still exist [10]. The safety of AVs in all dimensions (such as environmental consciousness) needs to be ensured during the homologation process (ZOLDY 2020) [11].

In the non-autonomous era, informal contact, such as eye contact, facial expressions, and hand gestures, are important features of communication. Such communication is seen between drivers and pedestrians or cyclists, especially in ambiguous situations, to enhance traffic flow and ensure safety [12-14]. In fully AVs (level 5), no driver will be present [15]. Even though an operator will be present in cars with lower automatisation levels (up to level 4) [15], other drivers, pedestrians, or cyclists cannot be sure whether the car is operating in an autonomous or manual mode [13]. Most of the time, the driver will not be part of the communication. Thus, informal traffic negotiations will not be a functional strategy for dealing with interactions among AVs and VRUs.

Thus, the introduction of AVs represents not only a true technological advancement but also a social revolution in traffic. Driving will be no longer be a social phenomenon with human-only interactions; instead, the interactions will also include AVs that have different ways of communicating with other (vulnerable) road users and predicting their reactions [16]. Several projects dealing with the interactions between VRUs and AVs are being tested to adapt to this new situation. One example is project @cityAF [17], which aimed to gain a common understanding of automated city driving; minimum operational requirements; system concepts; interfaces; and interactions among drivers, AVs, and other road users. Basically, the actual projects focused on AVs using two different approaches to communication: (1) communicating with pedestrians to let them know what to do and (2) understanding pedestrians' intentions to predict their behaviour and react adequately [16]. Thus, it is important to study the perception of interactions in every country where they will be implemented.

Autonomous mobility and its public acceptance are massive research and social topics. If perspectives of different road users, such as potential AVs' drivers, manual car drivers, cyclists, and pedestrians, are considered, the full picture of future passengers' transport becomes multidimensional because many new potential interactions emerge. Even though the lay public has limited technical knowledge [18], they have complex projections and sentiments about the problems associated with AVs and their safety in different situations [3].

The adoption and acceptance of AVs and various related factors at the individual and societal levels have been explained elsewhere [19,20]. However, we intend to explore differences in the acceptance of AVs among people who want to use AVs and those who do not. This paper evaluated the level of perceived fear of interactions of AVs with other (vulnerable) road users in different groups of road users in the Czech Republic. We seek to answer the following questions: Which factors predict people's acceptance and willingness to interact with AVs? How do the perspectives of people who intend to use AVs differ from those of people who do not intend to use AVs?

2. LITERATURE REVIEW

Tennant, Stares, and Howard (2019) [21] asked whether it makes any sense to research attitudes towards a technology that does not exist yet. Based on previous theories and research from different fields and perspectives, they state that people use their knowledge and experiences to frame expectations about emerging technology. General attitudes towards technology also need to be considered because people with positive attitudes towards technology tend to be more positive about AVs [18]. Bansal and Kockelman (2017) [19] predict the level of penetration of AVs, showing that during the first years (when the penetration is low), people will most likely experience AVs from the outside. Thus, people's opinions and attitudes regarding AVs will be shaped by their experiences with driver-AV, pedestrian-AV, or cyclist-AV interactions.

Hulse, Xie, and Galea (2018) [22] showed that AVs are associated with different levels of risk when considering the perspectives of different actors. Compared to manually driven vehicles, AVs were perceived as riskier from a passenger perspective but as less risky from a pedestrian perspective. Perceived risk ratings also appeared to differ by gender, with females tending to give higher ratings across populations and vehicle types. Correlations also highlighted differences in perceived risk ratings according to participants' age and their road user risk-taking propensities. Perceived risk was compared between pedestrians in an area with manually driven vehicles and those in an area with autonomous traffic. This situation was perceived as significantly less risky when the traffic consisted of AVs. More precisely, manually driven vehicles were considered riskier by younger people and people with a lower propensity to take road-user risks.

2.1. Acceptance as receptivity toward AVs

The technology acceptance model developed by Davis (1989) [25], which is a core of all later theories dealing with attitudes towards AVs, assumes that the technology is used by people. Thus, factors such as perceived ease of use, perceived usefulness, and user acceptance are considered. Smith (1988) [26] was the first to distinguish between the acceptance of the technology (which implies one's willingness to use it) and the receptivity towards the technology (which implies one's willingness to interact with it. In this paper, the second meaning of acceptance is used when considering people's willingness to interact with AVs. Further research shows that these dimensions are partly interconnected; however, receptivity is a broader concept that is applicable to groups exposed to AVs, such as cyclists, pedestrians, and even people who do not intend to own or use AVs [27] However, in general, acceptance is a complex, multi-layered construct that is not directly measurable [28]. AVs are seen not only as objects that are accepted or not by users [29]; the concept is broader, encompassing an attitudes dimension, an actions dimension, and a values dimension [28].

Deb et al. (2017) [27] developed a questionnaire to evaluate pedestrians' receptivity toward AVs. The questionnaire included 16 items based on attitudes, social norms, trust, compatibility, and system effectiveness. Three subdimensions were identified – namely, safety, interaction, and compatibility. Pedestrians' intentions to cross the road in front of fully autonomous vehicles (FAVs) was significantly predicted by both safety and interaction scores but not by the compatibility score. People who show positive behaviour expressed that the use of FAVs will improve overall traffic safety. Those who showed higher violation, lapse, and aggression scores, were more confident about crossing the road in front of FAVs.

The youngest age group (18-30) showed significantly higher receptivity toward AVs than the other two age groups. People who comply with traffic rules and show positive behaviour towards other road users indicated that the addition of FAVs will improve traffic safety by detecting pedestrians on the road. People who do not have enough knowledge about traffic rules, do not pay attention to traffic, or become aggressive when drivers behave unexpectedly, were found to feel more confident than people with less risky behaviours about crossing the road in front of an AV. However, around 5% of the participants without any interaction experience with AVs found it difficult to accept these vehicles in their area.

2.2. Feeling unsafe when interacting with AVs

Previous research shows that having separate lanes designated for AVs (thus making the interaction in traffic flow more predictable) enhances pedestrians' feelings of safety [30]. Tennant et al. (2019) [24] found that people feel the same when they are asked about travelling in or next to an AV. Many drivers expected to interact with AVs in a similar manner as they do with human-driven vehicles. Similarly, a complex research project conducted by Pew Research Centre [31] found that more than half of Americans would personally feel unsafe sharing the road with an AV. In addition, they expressed concerns about their safety if they were to share the road with AVs. These concerns were strong in the case of autonomous freight trucks. In total, 65% of Americans would feel unsafe sharing the road with an autonomous freight truck. A larger share of the public would be comfortable sharing the road with a driverless passenger vehicle. Nevertheless, 17% would feel not at all safe if they were in this situation.

In total, 83% of people agree that driverless vehicles should be required to travel in dedicated lanes. Americans who would like to ride in a driverless vehicle themselves express greater levels of enthusiasm and lower levels of worry about the ultimate impact of this technology, and they are more likely to say they would feel safe sharing the road with AVs and autonomous freight vehicles [31]. In line with these results, an AAA report [32] reported that only 10% of Americans would feel safer sharing the road with AV compared to a manually driven vehicle, while 54% would feel less safe. Similarly, Kennedy [33] reported that people are uncomfortable sharing the road with commercial AVs – only 20% of respondents did not have any problems with the idea of commercial AVs in a traffic flow. In comparison, 60% of people think that AVs would present a danger to other road users, especially pedestrians and animals; further, 57% are afraid that AVs would pose a threat to other drivers.

In order to let a pedestrian, know the information that would have been communicated informally with a driver in the non-autonomous era, companies test different ways for communicating whether a car is operating in autonomous mode or being driven by a person [4]. These include displaying short sentences on the car's surface (e.g. a frontal LED panel), signalling with lights or icons, or even through a music and speaker system. These signs also represent short instructions to pedestrians – for example, that it is safe to cross or pass – or information about the intentions of the AVs – for example, if the vehicle is going to change directions or stop. Even though these features are evaluated by the lay public as helpful and desirable, people still report feeling safer when interacting with manually driven cars than with AVs [34]. Similarly, Habibovic (2018) [35] showed that pedestrians feel safest when interacting with manually driven vehicles. When comparing AVs with and without an interface communicating instructions and intentions, the presence of an interface helps to enhance the feeling of safety.

In sum, previous research showed mixed results about the level of acceptance of AVs by other drivers and pedestrians or cyclists, as well as their willingness to share a lane with AVs. These results also vary across different countries, which shows the importance of taking different perspectives and actors into account and of distinguishing between different road users (i.e. those expecting to use AVs and those exposed to their existence in a traffic flow). In line with this research interest, this paper evaluated the level of AV acceptance and perceived AV risks among different actors – namely, pedestrians, cyclists, non-drivers, and drivers – in the Czech Republic.

3. DATA AND METHODS

Data collected between November 2017 and January 2018 is used in this study. The data comes from a one-year project conducted by the Transport Research Centre and funded by the Czech Ministry of Transport. This was the first study covering the topics of AV in a Czech context. It was conducted to support the first action plan on autonomous mobility that is in preparation. Since foreign research states that acceptance must be brought into the discourse surrounding autonomous driving at an early stage [28], the overall goal of the survey was to explore AV acceptance in the Czech context among the general public, potential users of AVs and other road users, and to understand perceptions and attitudes related to AVs.

Methods used in published research in this area were adapted to a Czech environment to facilitate comparability of the results [36-39]. The questionnaire covered issues associated with AVs and related topics such as attitudes towards new technology in general or respondents' travel behaviours. Also, control variables such as respondents' knowledge and experience with AVs were collected. The design of the study, sampling procedure, and questionnaire were piloted on 54 individuals in October 2017.

Overall, 59 professional interviewers used a standardised ad hoc questionnaire to personally interview 1 065 people older than 15 years via computer (CAPI). Respondents were selected using a multistage probabilistic sampling procedure based on the list of address points in the Czech Republic. The sampling procedure comprised three stages. First, 74 municipalities were randomly selected from throughout the Czech Republic. Second, the desired number of households was randomly selected from the list of households at the sampling point. Third, one person older than 15 years was randomly selected within each of the selected households to participate in the survey. Households were informed of their inclusion in the survey one week in advance. When the initial contact with the selected household failed, two more attempts were made. Finally, interviewers moved to one of the three randomly selected replacement households. A detailed description of the sampling procedure can be found in the work of Gabrhel, Ježek, and Havlíčková (2019, p. 44-45) [24].

Data analyses were performed using the IBM SPSS Statistics 21 statistical package. Procedures applied included frequency analysis, means and independent samples t-tests, correlation, and logistic regression. Because the purpose of this paper was to evaluate fear of interactions of AVs from the perspectives of VRUs and people willing to use AVs, there was a need to distinguish these two groups in the analysis. A dichotomy based on questionnaire items was made to distinguish between people who intend to use AVs once they become available and those who do not. Respondents were asked how likely they were to use AVs daily. Among the respondents, 27% (N = 283) rated this likelihood as highly improbable, while 36% (N = 387) rated it as improbable. On the other side of the continuum, 30 % (N = 316) of respondents stated their likelihood of using AVs daily was probable. Only 7% (N = 79) of respondents saw themselves as using AVs daily with a high level of probability. Due to this small proportion, the categories were merged into “not expecting to use AV” (originally “not expecting to use AV at all” and “unlikely to use AV”), which applies to 63% (N = 670) of respondents, and “expecting to use AVs” (originally “expecting to use AV” and “likely to use AV”), which applies to 37% (N = 395) of respondents. This dichotomy is used in further analyses.

The level of fear of interactions of AVs and other road users was conceptualised as a self-reported item (“I am worried about the interactions of AVs and other road users”), with responses given on a four-point scale (0 = not worried at all, 1 = minimum worries, 2 = some worries, 3 = maximum worries). Mean differences in the perceived level of fear of interactions between AVs and pedestrians or cyclists and other non-AVs were calculated separately for people intending to use AVs in the future and those with no such intention. Independent samples t-tests were used to analyse gender differences.

Next, regression was performed to evaluate the predictors of levels of fear of interactions. Independent variables included in the regression models were “knowledge about AVs (Have you ever heard about autonomous or self-driving cars before this survey?), with possible answers of yes or no”; “intention to use AVs daily (Would you use an AV on daily bases?), with possible answers yes or no”; “general attitude towards AVs (What is your attitude towards AVs?), with possible answers of very negative, slightly negative, neutral, slightly positive, or very positive)”; “kilometres driven last year (How many kilometres did you approximately travel last year?)”; “age (How old are you?)”; “gender (What is your gender? Male, female)”; “education (What is your level of education? No education, Elementary, Vocational school, Grammar school, High school, University)”; “driving licence holding (Do you have a driving licence? Yes, No”; “ADAS (Are there any automatic driving assistance systems in your car? yes, no)”; “gross domestic monthly income (What is the gross domestic monthly income of your household? Less than 9 200 CZK, 9 201 – 15 000 CZK, 15 001 – 22 000 CZK, 22 001 – 30 000 CZK, 30 001 – 50 000, 50 001 CZK and more)”; and “general level of concerns about the risk of AVs”.

The general level of concern about the risk of AVs is a cumulative index summarising 10 concerns about AVs. These include fear of technical failures and their consequences to traffic safety, data privacy, learning how to operate AVs, the reliability of AVs in bad weather, the inability to react to unexpected events or situations, general poor driving performance, poor performance compared to human drivers, and AVs’ inability to do what the driver needs. All these subdimensions were evaluated on a 4-point scale (0 = minimum, 4 = maximum). Thus, the final index score ranged from 0 (no concerns at all) to 32 (maximum concerns for all subdimensions).

Cronbach’s α was calculated to check for internal consistency (α= 0,72). Also, an item was added to the regression to identify positive attitudes towards modern technology (i.e. “I am interested in new technologies”, with possible answers of Absolutely disagree, Disagree, Neither agree nor disagree, Agree, Absolutely agree).

Based on the review of Parkin, Clark, Clayton, Ricci, and Pankhurst (2016) [36] and previous research, the following hypotheses were constructed:

H1: The (mean) level of fear of interactions of AVs with other road users will differ between those who intend to use AVs and those who do not. More specifically, we expect higher levels of fear in those who do not expect to use AVs.

H2: Level of knowledge about AV will be negatively associated with fear of interactions.

H3: Willingness to use AVs will be negatively associated with fear of interactions.

H4: General attitudes towards AVs will be associated with fear of interactions with AVs with other road users. More specifically, a positive attitude will be negatively associated with fear of interactions.

H5: Level of concern about the risk of AVs will be positively associated with fear of interactions of AVs with other road users.

H6: Kilometres driven last year will be negatively associated with fear of interactions.

H7: Socio-demographic and socio-economic characteristics will be associated with fear of interactions of AVs with other road users. More specifically, we expect that males will have less fear of interactions than females (H7.1), age will be positively associated with fear of interactions (H7.2), education will be negatively associated with fear of interactions (H7.3), and gross domestic monthly income will be negatively associated with fear of interactions of AVs and other vulnerable road users (H7.4).

4. RESULTS

First, a descriptive analysis was done. The socio-demographic characteristics of the sample are presented in Table 1.

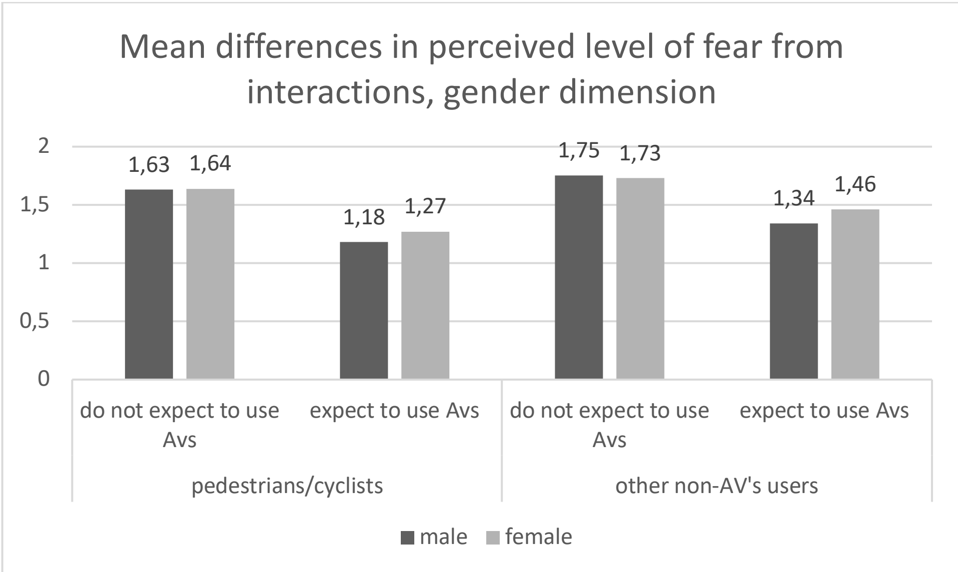
Table 1
Socio-demographic characteristics of the sample

Variables	Category	N = 1065 (%)
Gender	Men	542 (51%)
	Women	523 (49%)
Age (years)	Mean (CI)	50 (49-51)
	Median	51
	Range	16 – 92
Level of education	Primary	72 (7%)
	Vocational	377 (35%)
	High School	434 (41%)
	College	182 (17%)
Household monthly income	Less than 9 200 CZK	22 (2%)
	9 201 – 15 000 CZK	132 (12%)
	15 001 – 22 000 CZK	193 (18%)
	22 001 – 30 000 CZK	311 (29%)
	30 001 – 50 000 CZK	324 (31%)
	More than 50 001 CZK	83 (8%)

Respondents were asked about their level of fear of interactions of AVs with pedestrians or cyclists (0 = no fear at all, 1 = very little fear, 2 = some fear, 3 = a lot of fear) to explore the level of fear of interactions. Independent samples t-tests were used to explore the differences. Statistically significant differences were found between people not expecting to use AV – their mean level of fear was 1.36 (slightly worried) – and those expecting to use AV – their mean level of fear was 1.78 ($p = 0.00$) (worried). A similar trend was found when interactions of AVs and conventional vehicles were considered. People not expecting to use AVs expressed a mean level of fear of 1.26 (slightly worried).

In the group of people expecting to use AVs, the mean level of fear was 1.60 ($p = 0.00$) (worried). Both variables – fear of interactions with other non-AVs and fear of interactions with pedestrians or cyclists – are correlated ($r = 0.488$; $p < 0.01$).

Figure 1 below shows mean differences in perceived level of fear of interactions of AVs and pedestrians or cyclists and with other non-AVs. These levels were calculated separately for people intending to use AVs in the future and those who do not expect to use AVs. Independent samples t-tests were used to analyse gender differences. The results show no gender differences in perceived level of fear of interactions of AVs and pedestrians or cyclists and other non-AVs.



*Differences in the mean level of fear were not significant for any category

Fig. 1. Mean differences in perceived level of fear of interactions, gender dimension

Next, logistic regression was performed to evaluate the variables that influence the fear of interactions of AVs and cyclists or pedestrians. Independent variables to test were “knowledge about AVs”, “willingness to use AVs daily”, “general attitude towards AVs”, “kilometres driven last year”, “age”, “gender”, “education”, “driving licence holding”, “ADAS”, “gross domestic monthly income”, “general level of concerns about the risk of AVs[4]”. Three variables showed significant results. Kilometres driven last year was positively associated with fear of interactions with pedestrians or cyclists ($OR = 1{,}251$, $p = 0.032$). The level of concerns about the risk of AVs was also positively associated with fear of interactions ($OR = 1.087$, $p = 0.000$). Of all socio-demographics and socio-economics, only gender distinguished between levels of fear, with women having a higher chance of being fearful ($OR = 1.871$, $p = 0.005$). The entire model, including non-significant results, is presented in Table 3.

Next, the same model was applied to evaluate the variables that influence the fear of interactions of AVs and other non-AVs. Only a general level of concern about the risk of AVs was associated with the level of fear of interactions of AVs and non-AVs ($OR = 1.149$, $p = 0.000$). The entire model, including non-significant results, is presented in Table 3.

[4] Construction of the index explained in Methods section

Table 2
Logistic regression models: A) Fear of interactions with pedestrians or cyclists, B) fear of interactions with other non-AVs

A) pedestrians or cyclists			B other non-AVs	
predictors	Odds ratio	p	Odds ratio	p
knowledge about AVs	,947	.737	1,189	.221
willingness to use AVs no	Ref.		Ref	
yes	1,238	.570	1,242	.578
general attitude towards AVs	1,374	,151	1,270	.944
kilometres driven last year	1,251	,032*	1,058	.422
driving licence holders no	Ref.		Ref	.
yes	1,134	.735	1,804	.147
ADAS no	Ref.		Ref	.
yes	1,151	.454	0,661	.102
level of concerns about risk of AVs	1,087	.000**	1,149	.000**
positive attitude towards technology	0,852	.151	0,983	.944
age	1,006	.859	1,010	.142
Gender male	Ref.	.	Ref	.
female	1,871	.005**	1,209	0,454
education	0,907	.444	1,152	.077
gross domestic monthly income	0,914	.377	0,835	.091

* significant at 0.05
**significant at 0.01

5. DISCUSSION

The results of an exploratory study from 2017-2018 are used to explore the fear of interactions of AVs and other road users. Even though AVs are expected to make traffic safer, this paper revealed a fear of interactions with AVs and other road users, including VRUs. The results indicate that people perceive interactions either with pedestrians and cyclists or with non-AVs differently.

We explored the differences in acceptance of AVs in groups who do not choose to use AVs and who are road users exposed to AVs. H1 stated that the (mean) level of fear of interactions of AVs with other road users would differ between those who intend to use AVs and those who do not. More specifically, we expected a higher level of fear in those who do not expect to use AVs. According to our expectations, the mean level of fear in both situations (interactions with pedestrians or cyclists and with other non-AVs) was higher among people who do not intend to use AVs. No gender differences were found.

Contrary to the expectations stated in H6 (Kilometres driven last year will be negatively associated with fear of interactions.) Kilometres driven last year was positively associated with fear of interactions with pedestrians or cyclists (OR = 1,251, p = 0.032). In accordance with H5, the level of concern about the risk of AVs was positively associated with fear of interactions (OR = 1.087, p = 0.000). Of all socio-demographic and socio-economic categories, only gender presented a difference between the level of fear, with women having a higher chance of being fearful (OR = 1.871, p = 0.005). Thus, only hypothesis H7.1 is supported. Contrary to our expectation, no significant relationships were found between fear of interactions and level of knowledge about AVs (H2), willingness to use AVs (H3), and general attitude towards AVs. Similarly, demographics such as age (H7.2) or education (H7.3) did not influence fear of interactions, nor does gross domestic monthly income (H7.4).

According to the second logistic regression model, only the general level of concerns about the risk of AVs was associated with the level of fear of interactions of AVs and non-AVs. Thus, hypothesis H5 (Level of concerns about the risk of AVs will be positively associated with fear of interactions of AVs with other road users) is supported.

In Smith's study (1988) [26], only 37% of respondents expressed acceptance of technology. The sample differs significantly in levels of receptivity towards AVs. In line with Hulse et al.'s (2018) [22] findings, our study revealed that AVs are associated with different levels of risk by different actors. More specifically, people who expected to use AVs perceived them as less risky than people who did not expect to use them. Contrary to Hulse et al.'s (2018) [22] findings, demographics were not significant predictors of the level of fear of different kinds of interactions. Our regression model showed that the most important predictor of fear of interactions of AVs and other (vulnerable) road users is the general level of fear of AVs.

General attitude towards AVs, willingness to use them, and general level of fear of them form a complex mutually interacting relationship. This is in line with other research. For example, in Great Britain, more than 50% of the population does not agree with the implementation of AVs, they share a negative attitude towards them, and they are afraid of the potential risks associated with the technology [20, 23]. The same reasons prevent 73% of Americans from intending to use AVs [32]. Even though our model did not find basic demographics and socio-economic status as significant predictors, other researchers did [27, 22]. This discrepancy could be explained by nationally specific low socio-economic differences compared to Western countries.

The present study has some limitations. First, for future research, longitudinal panel data would be useful to track the shift in awareness, attitude acceptance and intention to use AVs once they are available on the market. Second, even though the data show differences in the levels of fear of interactions between AVs and other road users, they do not enable a comparison of the levels of fear of interaction with conventional human-driven cars. Since research suggests that people think of new technologies in comparison with technologies already known [24], comparing the data of the level of fear of interactions could aid the general understanding of this fear. Foreign research suggests that non-AVs are perceived to be safe; however, it is not clear whether this conclusion is applicable to the populations of the Czech Republic and other countries with similar cultural environments. Third, the present research did not distinguish between different types of AVs – for example, AVs for personal transport and trucks. These were identified in foreign research and have important implications for future traffic and transport. If dedicated lanes for AVs were a precondition of their broad acceptance, this would present significant demands on transportation and traffic.

6. CONCLUSION

This paper revealed that the level of fear of interactions between AVs and other road users differ between potential AV users and non-users. Potential AV users reported being slightly worried, on average, while non-users reported being worried.

Furthermore, we identified factors that predict perceived fear of interactions between AVs and other (vulnerable) road users such as pedestrians, cyclists, and other non-AVs. Our research extends the debate about interactions with AVs and other road users. Through our research, the debate has been enriched in a Central European context. The conclusions of our research align with other research regarding the following points:

1A. Level of fear of interactions with pedestrians or cyclists and with other non-AVs was higher in people who do not intend to use AVs than those who do intend to use AVs. Thus, specific attention needs to be given to communicating safety issues related to AVs not only with potential users but (more importantly) with vulnerable road users.

2A. The level of concern about the risk of AVs is positively associated with fear of interactions. This implies that strategies to lower concerns about the risk of AVs could also lower fear of interactions.

Meanwhile, contrary to foreign research, we conclude the following:

1B. Kilometres driven last year is positively associated with fear of interactions with pedestrians or cyclists. This increases the attention given to professional drivers, who drive more kilometres per year than the average person.

2B. Contrary to foreign research, no significant relationships were found between fear of interactions and level of knowledge about AVs. This finding implies that campaigns oriented towards raising knowledge about AVs might not be effective for lowering the fear of vulnerable road users of interactions with AVs. Since campaigns are the biggest tool of promotion, we believe that this mechanism needs further research in a national context.

3. Similarly, no relationship was found between willingness to use AVs and general attitudes towards AVs. This implies that even people with a high level of concern about interactions might have some willingness to use AVs; also, people with positive attitudes towards AVs might be fearful about interactions with AVs.

Since these results only partly corroborate findings from studies conducted in Western countries, we conclude that, for central European countries, more research is needed to understand local contexts and implications of autonomous mobility. Still, we think our results could be used for several practical reasons. For instance, they could inform promotional campaigns in the phase of AV implementation, they could be interesting for local politicians and municipalities dealing with transport planning, and they could be used to educate VRUs (thus lowering their fear of interactions with AVs). From another perspective, the fact that AVs are a controversial technology that evokes strong negative feelings could encourage further researchers to try to find alternative solutions to traffic problems.

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