Transportation Research Part F 74 (2020) 280–297

Contents lists available at ScienceDirect

Transportation Research Part F

journal homepage: www.elsevier.com/locate/trf

Using the UTAUT2 model to explain public acceptance of conditionally automated (L3) cars: A questionnaire study among 9,118 car drivers from eight European countries

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ARTICLE INFO

Article history:
Received 17 December 2019
Received in revised form 29 July 2020
Accepted 29 July 2020
Available online 15 September 2020

Keywords:
Automated vehicle acceptance
UTAUT2
Conditionally automated driving
Structural equation modeling
L3Pilot

ABSTRACT

We investigated public acceptance of conditionally automated (SAE Level 3) passenger cars using a questionnaire study among 9,118 car-drivers in eight European countries, as part of the European L3Pilot project. 71.06% of respondents considered conditionally automated cars easy to use while 28.03% of respondents planned to buy a conditionally automated car once it is available. 41.85% of respondents would like to use the time in the conditionally automated car for secondary activities. Among these 41.85%, respondents plan to talk to fellow travellers (44.76%), surf the internet, watch videos or TV shows (44%), observe the landscape (41.70%), and work (17.06%). The UTAUT2 (Unified Theory of Acceptance and Use of Technology) was applied to investigate the effects of performance and effort expectancy, social influence, facilitating conditions, and hedonic motivation on the behavioural intention to use conditionally automated cars. Structural equation analysis revealed that the UTAUT2 can be applied to conditional automation, with hedonic motivation, social influence, and performance expectancy influencing the behavioural intention to buy and use a conditionally automated car. The present study also found positive effects of facilitating conditions on effort expectancy and hedonic motivation. Social influence was a positive predictor of hedonic motivation, facilitating conditions, and performance expectancy. Age, gender and experience with advanced driver assistance systems had significant, yet small (<0.10), effects on behavioural intention. The implications of these results on the policy and best practices to enable large-scale implementation of conditionally automated cars on public roads are discussed.

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https://doi.org/10.1016/j.trf.2020.07.015
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1. Introduction

In 1935, Keller (1935, p. 1470) presented the first versions of a driverless car concept: "*Old people began to cross the continent in their own cars. Young people found the driverless car admirable for petting. The blind for the first time were safe. Parents found they could more safely send their children to school in the new car than in the old cars with a chauffeur*". Almost nine decades later, we see significant steps towards this driverless future.

The EU co-funded L3Pilot project, under the Horizon2020 Framework programme, sets the stage for the safe and acceptable introduction of conditionally automated cars on public roads in daily traffic, investigating technology and human interaction through large-scale on-road pilots in mixed-environments and different road networks. L3Pilot focusses on SAE Level 3 "conditional automation" (SAE International, 2018) that allows its users to take their eyes off the road and engage in non-driving related activities, such as reading a book, or using a smartphone (Berghöfer et al., 2019; Gold et al., 2018; Naujoks et al., 2017, 2018). At the same time, human drivers have to remain receptive for a request to take over control from the conditionally automated car in "*situations that exceed the operational limits of the automated driving system*" (e.g., missing lane markings, emergency secondary lanes, construction site with offset of lane marking, sensor malfunctions) (Forster et al., 2017; Gold et al., 2018; Louw et al., 2019; SAE International, 2018). This implies that human drivers need to redirect attention from their previous activities they were engaged in, to the driving scene, free their hands and place them back on the steering wheel, and place their feet on the pedals again (Berghöfer et al., 2019). Hence, conditional automation represents a paradigm shift for drivers in terms of their relationship with the driving task. In contrast to SAE Level 1 or 2 systems, drivers are no longer permanent system supervisors but can engage in secondary activities while still being able to take over control from the conditionally automated car (Hecht et al., 2018; Reilhac, Millett, & Hottelart, 2016).

Several Human Factors specialists have pointed to the challenges associated with conditional automation, which "*is to verify that the human drivers are aware of the AV's limitations, in order to resume control when required, whilst also remaining free to engage in other activities, beyond driving*", expressing "*serious doubt as for the handing over of the driving task associated with SAE Level 3*" as "*it is human nature that a driver, who is relieved even briefly from their driving task, will engage to other distracting tasks*"(Kyriakidis et al., 2019, p. 14 & 16). Various studies have also highlighted the public's scepticism towards, and fear of, automated vehicles (Medina & Jenkins, 2017). This is a concern, because automated vehicle acceptance is a catalyst for realising their potential to improve traffic safety and efficiency (Litman, 2019). In simple terms, acceptance of new technology can be viewed as the extent to which an individual has the intention to use that technology (Venkatesh et al., 2003). Therefore, in order to improve the likelihood that a particular technology is accepted, modelling technology acceptance is necessary to understand the factors influencing acceptance and its development over time (Rahman et al., 2017).

The Unified Theory of Acceptance and Use of Technology (UTAUT) is one of the most comprehensive technology acceptance models, integrating eight influential acceptance models, including the Theory of Planned Behaviour (TPB) (Ajzen, 1985) and the Technology Acceptance Model (TAM) (Venkatesh & Davis, 2000). UTAUT assumes that an individual's behavioural intention to use a technology is influenced by performance expectancy (*i.e.*, degree to which the technology is perceived to be useful), effort expectancy (*i.e.*, degree to which using the technology is perceived to be easy to use), social influence (*i.e.*, degree to which using the technology is appreciated in the social network important to the individual), and facilitating conditions (*i.e.*, degree to which the individual believes to be in possession of the resources to use the technology) (Venkatesh et al., 2003). UTAUT2 posits that, in addition to the UTAUT constructs, the intention to use the technology is influenced by hedonic motivation (*i.e.*, degree to which the technology is perceived to be enjoyable), price value (*i.e.*, cognitive trade-off between perceived benefits and monetary costs of technology usage) and habit (*i.e.*, defined as the passage of time from the initial technology usage) (Venkatesh, Thong & Xu, 2012). Conditionally automated cars are not yet commercially available and there are no respondents who would have habitual use of them. Therefore, the present study did not examine the influence of price value or habit on behavioural intention. Future studies should investigate willingness to pay and price value (see Venkatesh et al., 2012) and the influence of habit after prolonged on-road usage of automation.

A wide range of studies have addressed the acceptance of private conventional and public pod-like automated vehicles, applying constructs from common technology acceptance models, such as the TAM, TPB, and UTAUT (Kaur & Rampersad, 2018; Kaye et al., 2019; Madigan et al., 2016, 2017; Rahman et al., 2017; Xu et al., 2018; Zhang et al., 2019, 2020). These studies have advanced our understanding of automated vehicle acceptance. However, they have two main limitations. First, they have not examined attitudes towards nor modelled acceptance of conditionally automated cars using UTAUT2. In fact, the examination of the acceptance of conditional automation has been underrepresented by literature on automated vehicle acceptance, with only 3 out of 124 studies (Buckley et al., 2018; Xu et al., 2018; Zhang et al., 2019) being devoted to the study of conditional automation (Nordhoff et al., 2019). UTAUT2 has been tailored to the consumer context and explained a larger portion of the variance in behavioural intention to use automated vehicles (Madigan et al., 2017) than the TAM, TPB and UTAUT (Buckley et al., 2018; Madigan et al., 2016; Xu et al., 2018). Second, these studies have not recruited large European samples with a good representation of gender, age and different regions, but were conducted among smaller samples ($\leq$300) from China and the U.S.. Large sample sizes are needed to achieve statistical power and detect significant correlations (Hair et al., 2014).

1.1. Study objectives

The examination of the acceptance of conditional automation at an early stage is necessary in order to successfully implement these cars into the transportation system. The L3Pilot project pursues a multifaceted assessment approach for user and acceptance evaluation, collecting data from individuals who physically experience conditional automation in on-road pilots, simulator and Wizard-of-Oz studies, and individuals who are asked to imagine the use of conditional automation using a large questionnaire study (Louw et al., 2020).

The present study reports the results of the questionnaire study, whose main objective was to assess and model the acceptance of conditionally automated cars using constructs from the UTAUT2 model. The two sub-research objectives that the present study addressed were:

i. To examine the effect of the UTAUT2 constructs performance and effort expectancy, social influence, facilitating conditions, and hedonic motivation on individuals' behavioural intentions to use conditionally automated cars
ii. To examine the interrelationships between these constructs

1.2. Hypothesis development

1.2.1. Main effects of the UTAUT2 constructs on behavioural intention

In order to predict the acceptance of conditional automation, the TAM and TPB were applied (Buckley et al., 2018; Kaye et al., 2019; Xu et al., 2018; Zhang et al., 2019). Xu et al. (2018) applied an adapted version of the TAM and found that the behavioural intention to use a conditionally automated car was most strongly determined by perceived usefulness (equivalent to performance expectancy), and perceived ease of use (equivalent to effort expectancy). Perceived usefulness was also the strongest predictor of the willingness to re-ride. Buckley et al. (2018) used the TPB and TAM and found that perceived usefulness, perceived behavioural control (equivalent to facilitating conditions) and subjective norm (equivalent to social influence) were significant predictors of behavioural intention. Kaye et al. (2019) applied the TPB and the TAM to examine the acceptance of conditionally and fully automated cars, and found that the attitude towards using conditionally automated cars was the strongest predictor of intentions to use conditionally automated cars, followed by perceived usefulness, subjective norms, and perceived ease of use. Zhang et al. (2019, 2020) applied an adapted version of the TAM and found a direct effect of perceived usefulness and ease of use on behavioural intention to use conditionally automated cars. Other studies have shown that the UTAUT2 constructs performance and effort expectancy, social influence, facilitating conditions, and hedonic motivation are correlated with the behavioural intention to use SAE Level 4+ automated vehicles (Kaur & Rampersad, 2018; Madigan et al., 2016, 2017). Based on the above findings, we hypothesised:

H1: *Performance expectancy is a significant positive predictor of behavioural intention, implying that individuals who value the perceived benefits of conditionally automated cars (i.e., performance expectancy) are more likely to intend to use them (i.e., behavioural intention) than individuals who are less likely to value the perceived benefits of conditionally automated cars.*
H2: *Effort expectancy is a significant positive predictor of behavioural intention, implying that individuals who perceive conditionally automated cars as easy to use (i.e., effort expectancy) are more likely to intend to use them (i.e., behavioural intention) than individuals who are less likely to perceive conditionally automated cars as easy to use.*
H3: *Social influence is a significant positive predictor of behavioural intention, implying that individuals who believe that important people in their social networks support their use of conditionally automated cars (i.e., social influence) are more likely to intend to use them (i.e., behavioural intention) than individuals who are less likely to believe that their use of these cars is supported in their social networks.*
H4: *Facilitating conditions is a significant positive predictor of behavioural intention, implying that individuals who believe that conditions facilitating their use of conditionally automated cars are available (i.e., facilitating conditions) are more likely to intend to use them (i.e., behavioural intention) than individuals who are less likely to believe that facilitating conditions are available.*
H5: *Hedonic motivation is a significant positive predictor of behavioural intention, implying that individuals who perceive conditionally automated cars as enjoyable (i.e., hedonic motivation) are more likely to intend to use them (i.e., behavioural intention) than individuals who are less likely to perceive conditionally automated cars as enjoyable.*

In line with Venkatesh et al. (2003, 2012), we expect that the relationships between performance and effort expectancy, hedonic motivation, facilitating conditions, social influence, and behavioural intention are moderated by age, gender, and experience with advanced driver assistance systems. We hypothesised:

H6: *Age, gender and experience with advanced driver assistance systems moderate the relationships between performance and effort expectancy, hedonic motivation, facilitating conditions, social influence, and behavioural intention to use conditionally automated cars.*

1.3. Interrelations between the UTAUT2 constructs

1.3.1. Effect of effort expectancy on performance expectancy

In order to develop effective strategies to foster acceptance of conditionally automated cars, it is important to understand and identify the underlying beliefs or assumptions behind the UTAUT2 constructs performance and effort expectancy, hedonic motivation, facilitating conditions, and social influence. The examination of the interrelationships between the UTAUT2 constructs in the field of automated driving has received renewed interest in the literature. However, little is known about the interrelationships among the UTAUT2 constructs in the context of conditional automation. A positive effect of perceived ease of use on perceived usefulness has been supported by the literature on automated vehicle acceptance (Herrenkind, Nastjuk, Brendel, Trang, & Kolbe, 2019; Nordhoff, Madigan, Van Arem, Merat, & Happee, 2020; Zhang et al., 2019), which is in line with the broader body of research on technology acceptance (Adams, Nelson, & Todd, 1992; Karahanna, Agarwal, & Angst, 2006; Venkatesh & Davis, 2000). The positive effect of effort expectancy on performance expectancy implies that individuals who consider automated cars to be easy to use (*i.e.*, effort expectancy) are more likely to consider automated cars useful (*i.e.*, performance expectancy). For this study, we hypothesised that:

> ***H7:*** *Effort expectancy is a significant positive predictor of performance expectancy, implying that individuals who perceive conditionally automated cars as easy to use (i.e., effort expectancy) are more likely to value their usefulness (i.e., performance expectancy) than individuals who perceive conditionally automated cars as less easy to use.*

1.3.2. Effects of social influence on the other UTAUT2 constructs

Acheampong and Cugurullo (2019) revealed positive relationships between subjective norm (*i.e.*, equivalent to social influence) and the perceived benefits of automated vehicles, and the ease of use of automated driving technology, and a positive relationship between subjective norm and perceived behavioural control. A positive effect of social influence on performance expectancy, facilitating conditions and hedonic motivation was found by Nordhoff et al. (2020). We thus expect a positive relationship between social influence and performance and effort expectancy, facilitating conditions, and hedonic motivation. The underlying assumption is that individuals who believe that people important to them in their social network will support their use of conditionally automated cars (*i.e.*, social influence), are more likely to consider conditionally automated cars useful (*i.e.*, performance expectancy), easy to use (*i.e.*, effort expectancy), enjoyable (*i.e.*, hedonic motivation), and are more likely to believe they have the necessary resources to use these cars (*i.e.*, facilitating conditions). Therefore, in this study, we hypothesised that:

> ***H8:*** *Social influence is a significant positive predictor of performance expectancy, implying that individuals who believe that important people in their social networks support their use of conditionally automated cars (i.e., social influence) are more likely to perceive them as useful (i.e., performance expectancy) than individuals who are less likely to believe that their use of these cars is supported in their social networks.*
> ***H9:*** *Social influence is a significant positive predictor of effort expectancy, implying that individuals who believe that important people in their social networks support their use of conditionally automated cars (i.e., social influence) are more likely to perceive them as easy to use (i.e., effort expectancy) than individuals who are less likely to believe that their use of these cars is supported in their social networks.*
> ***H10:*** *Social influence is a significant positive predictor of facilitating conditions, implying that individuals who believe that important people in their social networks support their use of conditionally automated cars (i.e., social influence) are more likely to believe that conditions facilitating their use of conditionally automated cars are available (i.e., facilitating conditions) than individuals who are less likely to believe that their use of these cars is supported in their social networks.*
> ***H11:*** *Social influence is a significant positive predictor of hedonic motivation, implying that individuals who believe that important people in their social networks support their use of conditionally automated cars (i.e., social influence) are more likely to perceive them as enjoyable (i.e., hedonic motivation) than individuals who are less likely to believe that their use of these cars is supported in their social networks.*

1.3.3. Effects of facilitating conditions on the other UTAUT2 constructs

In Nordhoff et al. (2020), it was reported that there is a paucity of knowledge on the relationship between facilitating conditions, performance and effort expectancy and hedonic motivation. The study found positive effects of facilitating conditions on effort expectancy and hedonic motivation, but facilitating conditions was not related to performance expectancy. The present study builds on these results and expects that individuals who believe to have the necessary resources to use conditionally automated cars are more likely to consider conditionally automated cars useful, easy to use, and enjoyable. Therefore, in this study, we hypothesised that:

> ***H12:*** *Facilitating conditions is a significant positive predictor of performance expectancy, implying that individuals who believe that the conditions facilitating their use of conditionally automated cars are available (i.e., facilitating conditions) are more likely to value the perceived benefits of conditionally automated cars (i.e., performance expectancy) than individuals who are less likely to believe that facilitating conditions are available.*

H13: *Facilitating conditions is a significant positive predictor of effort expectancy, implying that individuals who believe that the conditions facilitating their use of conditionally automated cars are available (i.e., facilitating conditions) are more likely to perceive them as easy to use (i.e., effort expectancy) than individuals who are less likely to believe that facilitating conditions are available.*
H14: *Facilitating conditions is a significant positive predictor of hedonic motivation, implying that individuals who believe that the conditions facilitating their use of conditionally automated cars are available (i.e., facilitating conditions) are more likely to perceive them as enjoyable (i.e., hedonic motivation) than individuals who are less likely to believe that facilitating conditions are available.*

1.3.4. Effects of hedonic motivation on the other UTAUT2 constructs

Literature in the field of technology acceptance has revealed positive effects of perceived enjoyment on usefulness and ease of use in the field of technology acceptance (Koenig-Lewis et al., 2015; Teo & Noyes, 2011). In the study of Nordhoff et al. (2020), however, a positive effect of hedonic motivation on effort expectancy was reported, while the effect of hedonic motivation on performance expectancy was not significant. This corresponds with the results obtained in the study of Herrenkind et al. (2019). While the evidence on the relationship between hedonic motivation and effort expectancy is ambiguous, in this study, we expect a positive effect of hedonic motivation on both performance and effort expectancy. The assumption is that individuals who consider conditionally automated cars enjoyable are more likely to give higher ratings to performance and effort expectancy. Therefore, we hypothesised that:

H15: *Hedonic motivation is a significant positive predictor of performance expectancy, implying that individuals who perceive conditionally automated cars as enjoyable (i.e., hedonic motivation) are more likely to value the perceived benefits of conditionally automated cars (i.e., performance expectancy) than individuals who are less likely to believe that conditionally automated cars are enjoyable.*
H16: *Hedonic motivation is a significant positive predictor of effort expectancy, implying that individuals who perceive conditionally automated cars as enjoyable (i.e., hedonic motivation) are more likely to perceive them as easy to use (i.e., effort expectancy) than individuals who are less likely to believe that conditionally automated cars are enjoyable.*

The proposed relationships are shown in Fig. 1.

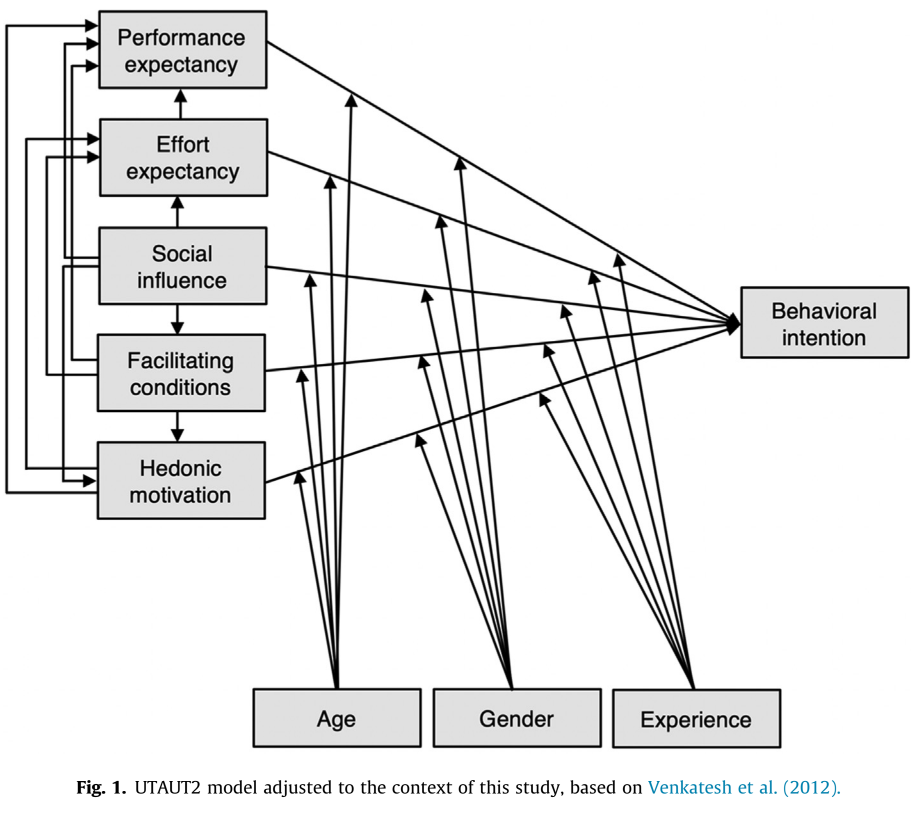

Fig. 1. UTAUT2 model adjusted to the context of this study, based on Venkatesh et al. (2012).

2. Methodology

2.1. Procedure and recruitment

An online questionnaire was administered to 9,118 respondents from eight European countries, including Finland, France, Germany, Italy, Spain, Sweden, Hungary, and the United Kingdom. These countries were selected based on the size of their car market and geographical representation within Europe. The questionnaire was conducted by the German market research institute INNOFACT AG (www.innofact.com) using the questionnaire tool EXAVO (https://www.exavo.de/surveytainment/), except for Finland where the data collection was conducted by Taloustutkimus Oy (taloustutkimus.fi/in-english) among their nationally representative Internet panel using their proprietary questionnaire tool. The questionnaire was translated into the national languages of the countries surveyed to be administered in the respective countries. For all countries except for Spain, data was collected between April and June 2019. For Spain, the data collection process took place in March 2020. In each country, a sample that was representative of age, gender, and income of its country population was selected. In order to recruit car drivers, respondents were excluded if they indicated that they never make use of private, carsharing and rental cars as driver. The invitation to participate in the questionnaire study was sent by online panels having access to large number of respondents via email. Once a representative sample per country was obtained, the questionnaire was closed, and participation in the questionnaire was no longer possible. The market research institute used a number of technologies to enhance data quality, ensuring that human (*i.e.*, no bot) respondents without suspect proxies or email addresses and that did not take the same questionnaire more than once – e.g., via multiple email or panel accounts from the same computer – were included into the sample. Respondents were financially compensated for their participation in the questionnaire. In Germany, respondents received 1.00 Euro for completing the questionnaire. The other respondents received points that were worth between 0.80 and 1.00 Euro per respondent, which could be redeemed as vouchers. The Finnish respondents had a chance to win prizes by being a member in the panel and participating in questionnaires.

2.2. Questionnaire

The questionnaire was divided into five main parts.

In the first part of the questionnaire, respondents were asked to provide information on their socio-demographic profile and mobility behaviour in order to select a representative sample of the country population as described in Section 2.1. Thus, respondents were asked to provide their age (Q1), gender (Q2), and income (Q3). For these questions, specific quoting criteria were used (see supplementary material Table S1). Note that age and income were adjusted to account for country-specific differences. In order to select frequent car drivers as potential first users of conditionally automated driving systems, respondents were asked to indicate their frequency of travel mode use (Q4), and the mode of transport they use per trip (Q5).

After respondents were presented with the first part, they received the following description about the functionality of conditionally automated cars, to ensure that they had a sufficient understanding of conditionally automated cars:

> "*There are different terms to define the capabilities of automated cars, such as self-driving, autonomous, automated, pilotless, driverless, and conditionally automated. With this questionnaire, we would like to get your opinion* ***on conditionally automated cars.***
> *Conditionally automated cars can drive under limited conditions, such as* ***driving on motorways, on congested motorways, in urban traffic, and in parking situations.*** *They will not operate beyond these conditions.*
> *Conditionally automated cars do the steering, acceleration and braking. They will stay in the lane and maintain a safe distance to the vehicle in front. They will also overtake slower moving vehicles or change the lane. These cars still have gas and brake pedals and a steering wheel.*
> *You are <u>not</u> driving when the car is in conditionally automated mode – even if you are seated in the driver's seat. This will allow you to engage in other activities, such as emailing or watching videos. However, the car might ask you to resume vehicle control anytime, e.g., when approaching a construction site, which means you might have to stop what you are doing and resume control of the car.*"

The second part of the questionnaire concerned respondents' degree of understanding of the concept of conditionally automated cars, based on the introduction to these cars they received at the beginning of the questionnaire. They were also asked of their level of familiarity with automated cars, and their self-rated technology readiness.

The third part consisted of questions measuring respondents' willingness to allow the car collecting data, and their general attitudes towards conditionally automated cars using the UTAUT2 constructs.

The fourth part asked respondents to assess their usage of conditionally automated cars in specific conditions. These included driving a conditionally automated car on urban roads, congested motorways, motorways, and in parking situations.

The fifth part asked respondents to provide further information about their socio-demographic profile and mobility behaviour that had not been addressed in the first part.

Respondents were informed that it would take around 20 minutes to complete the questionnaire and that the data would be treated anonymously. Respondents were further informed that the survey is executed as part of the EU-financed project L3Pilot.

Before the questionnaire was programmed and launched by INNOFACT AG, it was pre-tested in several iteration rounds to ensure clarity in terms of a common understanding of the logic of the questionnaire (*e.g.,* order of items) and the questionnaire items (*i.e.*, meaning of items). This also encompassed ensuring that the questionnaire was correctly translated in the different languages. In addition, INNOFACT AG performed a soft launch of the questionnaire, with approximately thirty respondents, to resolve any implementation or wording errors. To ensure that responses were not influenced by the order in which questionnaire items were presented, those that did not follow a specific logic were presented in a random order across respondents.

The present study will only report the results to the questions addressing the UTAUT2 hypotheses presented above (*i.e.*, Q17, and Q22–Q44). The specific wording of these questions and their underlying constructs are shown in Tables 2 and 3. The results to the remaining questions will be addressed in consecutive scientific studies.

2.3. Data analysis

A two-step approach (Anderson & Gerbing, 1988) to analyse the data was adopted. In the first step, a confirmatory factor analysis was performed to evaluate the measurement relationships between the latent and observed variables (*i.e.*, questionnaire items). The psychometric properties of the measurement model were assessed by its indicator reliability, internal consistency reliability, convergent validity and discriminant validity. Convergent validity was assessed by four criteria: 1) All scale items should be significant and have loadings exceeding 0.50 on their respective scales, 2) the average variance extracted (AVE) should be higher than 0.50, 3) construct reliability (CR), and 4) Cronbach's alpha values should exceed 0.70 (Anderson & Gerbing, 1988; Fornell & Larcker, 1981; Hair et al., 2014). Discriminant validity of our data was examined with the test of squared correlations by Anderson and Gerbing (1988). The correlation coefficient between two latent variables should be smaller than the square root of the average variance extracted (AVE) of each latent variable.

The second step of the analysis involved estimating the structural model consisting of the path relationsships between the latent variables. The assessment of the structural equation modelling involved reporting the standardised regression weights, their level of significance, and the amount of variance accounted for by these latent variables. Maximum likelihood estimation (MLE) was used for this calculation.

To assess whether the model fits the data, the fit indices were as follows: *Comparative Fit Index* (CFI) $\geq$ 0.90, *Root Mean Square Error of Approximation* (RMSEA) $\leq$ 0.08, and the *Standardised Root Mean Square Residual* (SRMR) $\leq$ 0.06 (Hair et al., 2014; Hooper, Coughlan, & Mullen, 2008; Hu & Bentler, 2009; Schreiber et al., 2006).

To assess the moderating effects of age, gender and experience with advanced driver assistance systems on the relationships between the UTAUT2 constructs performance and effort expectancy, social influence, facilitating conditions, hedonic motivation, willingness to pay and behavioural intention, we created mean-centered product-terms of age, gender, and experience with advanced driver assistance systems and the UTAUT2 predictor constructs, respectively, in line with the literature (Du et al., 2018). For experience with advanced driver assistance systems, a dummy variable was created with 1 representing the response categories *"I have it and I use it"*, and 0 representing the response categories *"I have it and I don't use it"*, *"Don't know if I have it"*, *"I don't have it but I would use it"*, *"I don't have it and I would not use it"*.

2.4. Data filtering

Data was filtered in two stages. First, the German market institute INNOFACT AG who conducted all the questionnaires, except for the Finnish questionnaire, omitted individuals who indicated that they frequently used all transport modes (Q4), who responded *"I don't know"* to all knowledge questions (Q6–Q10) in order to screen out individuals who had an insufficient understanding of conditionally automated driving, and who gave inconsistent socio-demographic responses (*i.e.*, being at the age of 20 years old while being retired). To identify frequent car users, individuals were omitted from the sample if they indicated that they rarely used the private car (without carsharing and rental cars), and carsharing and rental cars as driver (*i.e.*, responded with *"almost never"* to these questions), or if they did not provide any response to these questions. Second, *"I prefer not to respond"* - responses to the questions Q17 and Q22–Q44 were defined as missing values and excluded from the analysis. In total, there were responses from 9,118 individuals for the analysis.

3. Results

3.1. Respondents

An overview of respondents' age, gender and experience with advanced driver assistance systems is given in Table 1.

3.2. Ratings of attitudinal questions

The means, standard deviations and frequency distributions of the attitudinal questions that are the focus of the present study are given in Table 2. The highest ratings were obtained for items pertaining to the ease of use of conditionally automated cars. The highest mean rating was obtained for respondents' belief that a conditionally automated car would be easy

Table 1
Descriptive statistics of age, gender and experience with advanced driver assistance systems (*i.e.*, means (***M***), standard deviations (SD), *n* = number of respondents, relative frequencies).

Question	*M*	SD	*n*	Response categories				
Age (Q1)				**18–29**	**30–39**	**40–49**	**50–59**	**60–69**
	4.96	8.08	9118	9.05%	25.03%	41.37%	22.47%	2.08%
Gender (Q2)				**Male**	**Female**			
	1.49	0.50	9105	50.74%	49.26%			
Experience with advanced driver assistance systems (Q25_1–Q25_9)				**I have it and I use it**	**I have it but I don't use it**	**Don't know if I have it**	**I don't have it but I would use it**	**I don't have it and I would not use it**
Automated Emergency Braking (AEB): System that automatically brakes the vehicle when an impending collision is detected.	3.33	1.26	8656	17.42%	6.27%	11.54%	55.44%	9.32%
Forward Collision Warning (FCW): System that provides warnings for potential collisions with the vehicle in front.	3.45	1.19	8660	14.27%	5.51%	10.95%	59.34%	9.93%
Blind Spot Monitoring (BSM): System that monitors the driver's left and right blind spots for other vehicles. Often, drivers receive a visual or audio alert whenever a vehicle is present.	3.50	1.14	8383	12.40%	5.62%	9.93%	63.13%	8.93%
Drowsy Driver Detection (DDD): System that detects driver drowsiness.	3.68	1.04	8368	8.52%	4.69%	9.59%	64.093%	13.11%
Lane Departure Warning (LDW): System that provides assistance with lane-keeping by sounding warnings when the vehicle travels outside the current lane's markings/boundaries of the current lane.	3.52	1.19	8372	12.81%	6.48%	9.41%	57.96%	13.33%
Lane Keeping Assistance (LKA): System that helps the driver to avoid inadvertently moving out of a lane.	3.61	1.13	8364	10.21%	6.15%	10.82%	57.35%	15.47%
Adaptive Cruise Control (ACC): System that maintains vehicle speed while in cruise control mode, but automatically slows down or speeds up to keep a driver-selected distance from a vehicle ahead.	3.21	1.35	8383	20.12%	10.27%	9.13%	49.22%	11.25%
Parking Assist (PA): Radar – beeps - or camera view. The driver is in the car during the parking maneuver.	2.94	1.47	8363	31.85%	5.98%	6.68%	46.53%	8.96%
Self-Parking Assist (SPA): System that controls the vehicle for parallel or reverse parking. The system may control both steering and the throttle, or only control the steering (the driver presses the brake and throttle) during the parking maneuver.) The driver is in the car during the parking maneuver.	3.64	1.13	8390	9.82%	7.13%	7.68%	60.18%	15.18%

to use (Q25, ***M*** = 3.80, SD = 0.97, on a scale from strongly disagree (1) to strongly agree (5)), and that they could acquire the necessary knowledge to use a conditionally automated car (Q34, ***M*** = 3.79, SD = 1.00). The third-highest mean rating was obtained for respondents' belief that learning how to use a conditionally automated car would be easy for them (Q24, ***M*** = 3.74, SD = 0.98).

The lowest ratings were obtained for items pertaining to the social influence and willingness to buy a conditionally automated car. The lowest rating (Q44, ***M*** = 2.77, SD = 1.20) was obtained for respondents' willingness to buy a conditionally automated car. As shown by the frequency distribution underlying Q44, 28.03% of respondents agreed with the statement capturing their intention to buy a conditionally automated car. The second-lowest rating was obtained for respondents' belief that people who are important to them think that they should use a conditionally automated car (Q41, ***M*** = 3.02, SD = 1.12). The third-lowest rating was obtained for respondents' belief that people who influence their behaviour think that they should use a conditionally automated car (Q39, ***M*** = 3.06, SD = 1.12).

A moderate rating was obtained for using the time the conditionally automated car is driving for other activities (Q21, ***M*** = 3.09, SD = 1.15), with 41.85% of respondents indicating that they would like to spend the time in a conditionally automated car for secondary eyes-off road activities. As shown by Table 3, the three most preferred activities included talking to fellow travelers; surfing the internet, watching videos or TV shows; and observing the landscape, with 44.76%, 44%, and 41.70% of respondents favouring these types of activities, respectively.

3.3. Results of confirmatory factor analysis

The results of the confirmatory factor analysis are shown in Table 4. Model fit parameters were acceptable for all latent variables with the exception of the chi-square statistic, which has exceeded the recommended threshold of 3. However, the chi-square statistic is sensitive to sample size, implying that a value larger than 3 is usually expected with larger sample sizes (Hair et al., 2014). The items PE3–PE4, EE1–EE2, HM1 and HM3, SI1–SI2, FC1 and FC3, BI1 and BI5 were maintained in the analysis as their loadings exceeded the threshold of 0.70. The remaining items were omitted from the analysis due to factor loadings that were lower than 0.70, and high inter-construct correlations. The constructs demonstrated sufficient

Table 2
Descriptive statistics (*i.e.*, means (***M***), standard deviations (SD), relative frequencies). Questions are presented in descending order according to their means in order to identify high, moderate, and low mean ratings.

Question	*M*	SD	*n*	Relative frequencies				
				Strongly disagree (1)	Disagree (2)	Neutral (3)	Agree (4)	Strongly agree (5)
Q25: I expect that a conditionally automated car would be easy to use.	3.80	0.97	9044	3.77%	5.46%	19.70%	48.86%	22.21%
Q34: I could acquire the necessary knowledge to use a conditionally automated car.	3.79	1.00	9029	4.64%	5.09%	19.84%	47.25%	23.18%
Q24: Learning how to use a conditionally automated car would be easy for me.	3.74	0.98	9038	3.76%	5.82%	24.13%	45.46%	20.83%
Q38: I would expect to have the necessary knowledge to use a conditionally automated car.	3.65	1.05	9019	5.53%	7.30%	23.28%	44.19%	19.70%
Q27: It would be easy for me to become skillful at using a conditionally automated car.	3.60	1.03	9027	5.33%	7.28%	27.04%	42.76%	17.59%
Q36: I would expect the use of a conditionally automated car to be compatible with other digital devices I use.	3.54	1.08	9006	6.75%	7.84%	26.95%	41.10%	17.36%
Q26: Using a conditionally automated car would help me reach my destination more comfortably.	3.52	1.10	9044	7.32%	8.69%	25.70%	40.91%	17.38%
Q28: Using a conditionally automated car would be fun.	3.42	1.14	9034	9.05%	9.70%	28.04%	36.99%	16.22%
Q43: I assume that a conditionally automated car would be useful in my daily life.	3.39	1.15	8996	9.31%	10.83%	26.56%	37.98%	15.32%
Q32: Using a conditionally automated car would be enjoyable.	3.38	1.16	9018	9.87%	10.37%	27.22%	37.05%	15.49%
Q40: I would be able to get help from others when I have difficulties using a conditionally automated car.	3.37	1.05	8961	7.13%	10.70%	31.56%	38.91%	11.70%
Q37: I would use a conditionally automated car during my everyday trips.	3.37	1.18	9029	9.92%	12.13%	24.50%	37.51%	15.94%
Q33: Assuming that I had access to a conditionally automated car, I predict that I would use it.	3.36	1.18	9038	8.58%	8.73%	22.34%	41.04%	19.31%
Q22: I expect that a conditionally automated car would be useful in meeting my daily mobility needs.	3.36	1.18	9038	10.13%	11.98%	24.62%	38.08%	15.19%
Q30: Using a conditionally automated car would be entertaining.	3.36	1.14	8996	9.29%	10.95%	28.72%	36.88%	14.16%
Q23: Using a conditionally automated car would help me reach my destination more safely.	3.35	1.11	9033	8.39%	10.90%	32.04%	34.82%	13.85%
Q31: I intend to use a conditionally automated car in the future.	3.22	1.17	8995	11.88%	11.42%	32.49%	31.45%	12.76%
Q42: I would recommend a conditionally automated car to others.	3.20	1.14	8955	11.33%	11.36%	35.48%	29.74%	12.09%
Q35: I plan to use a conditionally automated car in adverse weather conditions such as during heavy rain or fog, and in darkness.	3.16	1.21	9022	12.45%	15.65%	28.22%	30.66%	13.02%
Q17: I would use the time during which a conditionally automated car is driving for other activities.	3.09	1.15	9010	11.20%	19.90%	27.05%	32.72%	9.13%
Q29: I assume that people whose opinions I value would prefer that I use a conditionally automated car.	3.08	1.10	8987	11.15%	14.45%	39.07%	26.38%	8.95%
Q39: I expect that people who influence my behaviour think that I should use a conditionally automated car.	3.06	1.12	8985	11.42%	16.25%	37.03%	25.95%	9.35%
Q41: I expect that people who are important to me think that I should use a conditionally automated car.	3.02	1.12	8974	12.38%	16.08%	37.23%	26.03%	8.28%
Q44: I plan to buy a conditionally automated car once it is available.	2.77	1.20	8980	19.67%	18.83%	33.47%	20.55%	7.48%

Table 3
Preference for engagement in eyes-off-road activities (Q17b_1–Q17b_10) sorted in descending order.

Activities	Relative frequencies
Q17b_2: Talking to my fellow travellers	44.76%
Q17b_3: Surfing the internet, watching videos or TV shows	44%
Q17b_7: Observing the landscape	41.70%
Q17b_8: Relaxing and resting	34.42%
Q17b_6: Eating and drinking	28.90%
Q17b_5: Socialising with friends or family (e.g., write messages, make phone calls, use social media)	26.37%
Q17b_10: Working	17.06%
Q17b_9: Reading a book	14.68%
Q17b_1: Taking care of children	13.37%
Q17b_4: Playing games (e.g., video or board games)	10.11%

Note: Only respondents who provided their agreement (*i.e.*, selected "Agree" and "Strongly agree") in Q17 to use the time the conditionally automated car is driving for other activities were allowed to respond to questions pertaining to the types of eyes-off-road activities they preferred to engage in (Q17b_1–Q17b_10). Respondents could select a maximum number of three activities. In total, 10,976 responses were collected from 3,771 respondents.

Table 4
Results of confirmatory factor analysis.

Latent variable	Observed variable	λ	α	CR	AVE
Performance expectancy (PE)			0.82	0.82	0.70
	PE1: I would use the time during which a conditionally automated car is driving for other activities (Q17).	Omitted from analysis due to factor loadings < 0.70 and high inter-construct correlations			
	PE2: I expect that a conditionally automated car would be useful in meeting my daily mobility needs (Q22).	Omitted from analysis due to factor loadings < 0.70 and high inter-construct correlations			
	PE3: Using a conditionally automated car would help me reach my destination more safely (Q23).	0.83			
	PE4: Using a conditionally automated car would help me reach my destination more comfortably (Q26).	0.85			
	PE5: I assume that a conditionally automated car would be useful in my daily life (Q43).	Omitted from analysis due to factor loadings < 0.70 and high inter-construct correlations			
Effort expectancy (EE)			0.76	0.77	0.62
	EE1: Learning how to use a conditionally automated car would be easy for me (Q24).	0.75			
	EE2: I expect that a conditionally automated car would be easy to use (Q25).	0.83			
	EE3: It would be easy for me to become skillful at using a conditionally automated car. (Q27).	Omitted from analysis due to factor loadings < 0.70 and high inter-construct correlations			
Social influence (SI)			0.79	0.79	0.66
	SI1: I assume that people whose opinions I value would prefer that I use a conditionally automated car (Q29).	0.86			
	SI2: I expect that people who influence my behaviour think that I should use a conditionally automated car (Q39).	0.76			
	SI3: I expect that people who are important to me think that I should use a conditionally automated car (Q41).	Omitted from analysis due to factor loadings < 0.70 and high inter-construct correlations			
	SI4: I would recommend a conditionally automated car to others (Q42).	Omitted from analysis due to factor loadings < 0.70 and high inter-construct correlations			
Facilitating conditions (FC)			0.77	0.79	0.66
	FC1: I could acquire the necessary knowledge to use a conditionally automated car (Q34).	0.82			
	FC2: I would expect the use of a conditionally automated car to be compatible with other digital devices I use (Q36).	Omitted from analysis due to factor loadings < 0.70 and high inter-construct correlations			
	FC3: I would expect to have the necessary knowledge to use a conditionally automated car (Q38).	0.77			
	FC4: I would be able to get help from others when I have difficulties using a conditionally automated car (Q40).	Omitted from analysis due to factor loadings < 0.70 and high inter-construct correlations			
Hedonicmotivation (HM)			0.80	0.80	0.67
	HM1: Using a conditionally automated car would be fun (Q28).	0.78			
	HM2: Using a conditionally automated car would be entertaining (Q30).	Omitted from analysis due to factor loadings < 0.70 and high inter-construct correlations			
	HM3: Using a conditionally automated car would be enjoyable (Q32).	0.86			

(continued on next page)

Table 4 (*continued*)

Latent variable	Observed variable	λ	α	CR	AVE
Behavioural intention (BI)			0.82	0.82	0.70
	BI1: I intend to use a conditionally automated car in the future (Q31).	0.88			
	BI2: Assuming that I had access to a conditionally automated car, I predict that I would use it (Q33).	Omitted from analysis due to factor loadings < 0.70 and high inter-construct correlations			
	BI3: I plan to use a conditionally automated car in adverse weather conditions such as during heavy rain or fog, and in darkness (Q35).	Omitted from analysis due to factor loadings < 0.70 and high inter-construct correlations			
	BI4: I would use a conditionally automated car during my everyday trips (Q37).	Omitted from analysis due to factor loadings < 0.70 and high inter-construct correlations			
	BI5: I plan to buy a conditionally automated car once it is available (Q44).	0.80			
CFI	0.98				
RMSEA	0.06				
SRMR	0.02				
x^2	30.04				

Note: Measurement of the UTAUT2 constructs were used from Xu et al. (2018) and Venkatesh et al. (2012) and adjusted to the context of this study. λ = Lambda, factor loading; α **= Cronbach's alpha, internal consistency measure; CR = Construct reliability, internal consistency measure; AVE = average variance extracted, summary measure of convergence among observed variables representing a latent variable** (Hair et al., 2014)**.**

Table 5
Inter-construct correlation matrix.

Construct	PE	EE	SI	FC	HM	BI
Performance expectancy (PE)	**0.84**					
Effort expectancy (EE)	0.59	**0.79**				
Social influence (SI)	0.65	0.47	**0.82**			
Facilitating conditions (FC)	0.57	0.73	0.43	**0.81**		
Hedonic motivation (HM)	0.75	0.59	0.64	0.56	**0.82**	
Behavioural intention (BI)	0.72	0.54	0.71	0.51	0.73	**0.84**

Note: The diagonal values represent the square root of the average variance extracted (AVE) of the constructs. The below diagonal values represent the coefficients of the Pearson correlation between two constructs. Sufficient discriminant validity is provided if the square root of the AVE exceeds the correlation coefficients.

internal consistency reliability as shown by the Cronbach's alpha and composite reliability values, which were both higher than 0.70. Average variance extracted values (AVE) were higher than 0.50 for all latent variables except for willingness to pay. As shown by Table 5, discriminant validity was acceptable for all latent variables: The Pearson correlation coefficients between two constructs do not exceed the square root of the AVE, are smaller than 0.80, and the variance inflation factors (VIF) for all constructs are below the recommended cut-off value of 3, suggesting the absence of substantial multicollinearity (Garson, 2012; Hair et al., 2014).

3.4. Results of structural equation modeling

The results of the structural equation modelling are shown in Table 6. The model fit was acceptable except for the chi-square statistic (see Section 3.3.). The majority of our hypotheses was supported. Age, gender, and experience with advanced driver assistance systems did not moderate the relationships between performance and effort expectancy, social influence, facilitating conditions, hedonic motivation, and behavioural intention.

Experience with advanced driver assistance systems did not moderate any of our relationships in the model. Due to the relatively large number of interaction effects, the moderating effects of experience with advanced driver assistance systems on the UTAUT2 constructs are not reported.

4. Discussion

As part of the L3Pilot project, the present study investigated the acceptance of conditionally automated cars among 9,118 car drivers from eight European countries using an online questionnaire. This study was motivated by the paucity of

Table 6
Results of structural equation modelling; significant structural path relations between latent variables, socio-demographics and experience with advanced driver assistance systems (β), variance explained (R^2), and model fit parameters.

Hypothetical path			Model 1	Model 2
Hypothesis	**Independent variable**	**Dependent variable**	**Effect β & significance level**	**Effect β & significance level**
H1	Performance expectancy	Behavioural intention	0.107*	0.135**
H2	Effort expectancy		0.082, *n.s.*	0.051, *n.s.*
H3	Social influence		0.393***	0.404***
H4	Facilitating conditions		-0.095, *n.s.*	-0.062, *n.s.*
H5	Hedonic motivation		0.496***	0.462***
H6	Age		–	-0.082***
	Gender		–	0.026***
	Experience with Automated Emergency Braking (AEB)		–	0.003, *n.s.*
	Experience with Forward Collision Warning (FCW)		–	-0.007, *n.s.*
	Experience with Blind Spot Monitoring (BSM)		–	-0.004, *n.s.*
	Experience with Drowsy Driver Detection (DDD)		–	0.003, *n.s.*
	Experience with Lane Departure Warning (LDW)		–	0.002, *n.s.*
	Experience with Lane Keeping Assistance (LKA)		–	0.012, *n.s.*
	Experience with Adaptive Cruise Control (ACC)		–	0.035**
	Experience with Parking Assist (PA)		–	-0.029**
	Experience with Self-parking Assist System (SPA)		–	0.051***
H7	Effort expectancy	Performance expectancy	-0.009, *n.s.*	-0.009, *n.s.*
H8	Social influence	Performance expectancy	0.209***	0.207***
H9	Social influence	Effort expectancy	0.059**	0.057**
H10	Social influence	Facilitating conditions	0.560***	0.562***
H11	Social influence	Hedonic motivation	0.561***	0.566***
H12	Facilitating conditions	Performance expectancy	0.125, *n.s.*	0.125, *n.s.*
H13	Facilitating conditions	Effort expectancy	0.845 ***	0.845***
H14	Facilitating conditions	Hedonic motivation	0.406***	0.402***
H15	Hedonic motivation	Performance expectancy	0.677***	0.679***
H16	Hedonic motivation	Effort expectancy	0.103***	0.105***
Assessment of model fit				
CFI			0.982	0.85
RMSEA			0.059	0.048
SRMR			0.021	0.045
χ^2/df			28.37	20.68
R^2 of BI			0.877	0.883
R^2 of PE			0.879	0.879
R^2 of EE			0.919	0.919
R^2 of HM			0.734	0.738
R^2 of FC			0.314	0.316

Note: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$, *n.s.* = not significant.

knowledge on the examination of acceptance of conditional automation among a large European age- and gender-balanced sample applying the UTAUT2 constructs performance and effort expectancy, social influence, facilitating conditions, and hedonic motivation as direct predictors of behavioural intention, and the moderating influences of age, gender and experience with advanced driver assistance systems on these relationships. The study has advanced our knowledge on the applicability of UTAUT2 to conditional automation – e.g., which constructs of the UTAUT2 model are the most important predictors of the acceptance of conditional automation – and the acceptance of conditional automation itself – e.g., by measuring the acceptance of conditional automation.

4.1. Ratings of questionnaire items

The study revealed that the highest mean rating was obtained for the questionnaire item pertaining to the perceived ease of use of conditionally automated cars, with 71.06% of respondents considering conditionally automated cars easy to use. Conditionally automated driving may pose excessive demands on the abilities of human drivers to safely, comfortably and efficiently take back control from a conditionally automated car. Zeeb, Buchner, and Schrauf (2016) found that the quality of taking over control from a conditionally automated car deteriorated for distracted drivers (*i.e.*, reading a news text and watching a video). Gold et al. (2018), who modelled the take-over performance in conditionally automated cars on the basis of 729 take-over situations, found significant effects of the time budget, traffic density, and experience with take-over situations on drivers' take-over performance, while the engagement in non-driving related activities only accounted for a small amount of variance in the take-over performance. The positivity of our respondents towards the perceived ease of use of conditionally automated cars may be explained by their lack of physical exposure to conditionally automated cars, which may make it difficult for them to accurately envision their interaction with these cars. Furthermore, the items measuring perceived ease of use (*i.e.*, effort expectancy) did not measure the specific take-over situation and interaction with a conditionally automated car but were phrased generically. This means that it is not very clear which associations respondents had with the construct effort expectancy. Davis (1993) posit that perceived ease of use (*i.e.*, effort expectancy) reflects part of the cost of using the system. In line with Davis (1993), we posit that future research should adjust the operationalisation of effort expectancy to the context of conditionally automated driving.

The lowest mean rating was obtained for the questionnaire item pertaining to respondents' willingness to buy a conditionally automated car, with 28.03% of respondents planning to buy a conditionally automated car once it is available. This finding corresponds to some extent with Power (2012) who surveyed 17,400 vehicle owners and found that only 37% of respondents would definitely or probably be interested in purchasing automated driving technology, and with Pfleging, Rang, and Broy (2016) who revealed that 44% of their respondents could imagine buying a highly automated car. In contrast, in our study, a higher mean rating was obtained for the behavioural intention to use conditionally automated cars, implying that the intention to use a conditionally automated car is higher than the intention to buy a conditionally automated car.

One of the main benefits of automated cars advertised in the media and by car manufacturers is the engagement in secondary, eyes-off road activities. However, in this study only 41.85% of respondents reported a willingness to use the time the conditionally automated car is driving for other activities (27.05% were neutral). Within these 41.85%, the most preferred activities were talking to fellow travellers (44.76%), surfing the internet, watching TV shows or videos (44%), and observing the landscape (41.70%). Working was preferred by 17.06%. The preference to engage in activities that require less attentional resources, and that can be performed in traditional transport modes mirrors the literature (Cunningham, Regan, Horberry, Weeratunga, & Dixit, 2019; Cunningham, Regan, Ledger, & Bennett, 2019; Cyganski et al., 2015; Pfleging et al., 2016). This could imply that the possibility to relax and perform lighter activities is preferred in conditionally automated driving, and that the car interior has to be adjusted to accommodate these activities (Pfleging et al., 2016). An alternative explanation for the low preference to engage in secondary activities may be concerns about discomfort, due to the emergence of motion sickness, by having the eyes off the road. Such concerns may be remedied only if automation driving styles and interiors are demonstrated to result in high comfort levels even when taking the eyes off the road, and when such benefits are effectively communicated to potential users. Finally, the limited intention to take the eyes off the road could be explained by the particular nature of conditional automation, which places considerable demands on the sensory, motoric and cognitive state of the human driver (Naujoks et al., 2018). Gold et al. (2018) provide a short review of the driver behaviour in take-over situations that ranges from mode confusion and errors, delayed responses to critical rear-end collision events, and impaired driving performance after automated driving. We posit that the human driver has to direct his/her attentional resources to *both* the driving environment, the performance of the automated system, *and* the activity s/he is engaged in. Conditionally automated cars that will be commercialised will have to enable a safe, comfortable and efficient take-over situation, without jeopardising the added benefits that this level of automation entails. If this is achieved, human drivers will not have to divide their attentional resources between the driving environment, while also supervising the performance of the automated system, and managing their own activity all at the same time. To be safe, useable and acceptable, the systems that will enter the market will have to enable the driver to comfortably engage in the non-driving related activity, and provide sufficient time for a request to intervene and take over control of the automated system. We recommend future research to investigate the types of activities that drivers of conditionally automated cars can pursue to prevent mental overload and underload, and ensure that a drivers' situation awareness matches the requests of the automated car.

4.2. Structural equation modelling analysis: UTAUT2 model without moderator effects

Structural equation modelling was performed to examine the effects of the UTAUT2 constructs performance and effort expectancy, social influence, hedonic motivation, and facilitating conditions on individuals' behavioural intentions to use conditionally automated cars as well as their interrelationships.

Hedonic motivation was the strongest predictor of individuals' behavioural intention, implying that individuals who consider conditionally automated cars enjoyable are more likely to intend to use them. This finding corresponds with the study of Madigan et al. (2017), which has also identified hedonic motivation as the strongest predictor for the acceptance of driverless public transport. In the study of Madigan et al. (2017), most of the respondents were physically exposed to the automated vehicle they were asked to rate using a questionnaire after their ride with the vehicle. We encourage further research into the hypothesis that the ratings of perceived enjoyment (*i.e.*, hedonic motivation) may not differ before and after the exposure to conditionally automated cars.

The second-strongest predictor of behavioural intention was social influence, implying that individuals who believe that people important to them in their social network appreciate their use of conditionally automated cars are more likely to intend to use them. Performance expectancy was predicted by the factors perceived safety and expected comfort. This means that individuals who consider conditionally automated cars safe and comfortable are more likely to form positive intentions to use these cars. In our study, performance expectancy was the third-strongest predictor of the behavioural intention to use conditionally automated cars, while in previous research performance expectancy was the strongest predictor (Madigan et al., 2016; Panagiotopoulos & Dimitrakopoulos, 2018). As shown by the relatively strong correlation between performance expectancy and hedonic motivation, hedonic motivation may represent some of the effects of performance expectancy on behavioural intention, probably also since the factor comfort included in performance expectancy is conceptually related to hedonic motivation. The conceptual similarity between performance expectancy and hedonic motivation may make it difficult for respondents to clearly discriminate between these constructs. Furthermore, the UTAUT2 constructs are expressed in very generic terms, which leaves ample room for respondents to attach different meaning to them. Future research should assess whether it is reasonable to develop more specific items as indicators of the UTAUT2 constructs. It should also be assessed whether the questions pertaining to the UTAUT2 constructs have the same meaning across countries. It was beyond the scope of this study to examine how the acceptance of conditionally automated cars differs across countries. This will be executed by the authors of the present study in a subsequent study.

Investigating the interrelationships between predictors, this study advances our knowledge of the mechanisms to promote the individual beliefs underlying the UTAUT2 predictor constructs. Social influence was the strongest predictor of hedonic motivation, implying that promoting the use of conditionally automated cars in individual's networks can enhance their perceived enjoyment. Facilitating conditions was the second-strongest predictor of hedonic motivation, implying that the belief of individuals to have the necessary resources to use conditionally automated cars has a positive influence on hedonic motivation. This finding corresponds with Madigan et al. (2017) who investigated the acceptance of driverless public transport.

Facilitating conditions was the strongest predictor of effort expectancy, followed by hedonic motivation and social influence. This implies that individuals who think they have the necessary resources, who believe that conditionally automated cars are enjoyable and that their use of conditionally automated cars is supported in their social networks are more likely to consider conditionally automated cars easy to use. Facilitating conditions, in turn, was influenced by social influence, meaning that the perceived capabilities to use conditionally automated cars can be promoted by increasing the reliance on the individual's social networks. Effort expectancy was determined by hedonic motivation, implying that the perceived ease of use of conditionally automated cars has a positive influence on the perceived enjoyment.

Hedonic motivation was the strongest predictor of performance expectancy, followed by social influence. This means that individuals who consider conditionally automated cars to be enjoyable and who believe that important people in their social network appreciate the use of conditionally automated cars are more likely to consider them useful.

4.3. Structural equation modelling analysis: UTAUT2 model with moderater effects

In the second structural model, the moderating effects of age, gender and experience with advanced driver assistance systems on the relationships between the UTAUT2 constructs performance and effort expectancy, social influence, hedonic motivation, facilitating conditions, and behavioural intention were investigated. The effects of the moderators on the proposed relationships were not significant. Small negative effects of age were found on behavioural intention (<0.10). This suggests that elderly people are less likely than younger people to intend to use conditionally automated cars. Small effects of gender were found on behavioural intention (<0.05), with males being more likely than females to intend to use conditionally automated cars (*i.e.*, behavioural intention). These findings mirror the literature on automated vehicle acceptance in two substantial ways. First, they correspond with the studies which have shown significant, yet small, effects of age and gender on the factors predicting automated vehicle acceptance, as well as the acceptance construct itself (Kettles & Van Belle, 2019; Kyriakidis, Happee, & De Winter, 2015; Nordhoff et al., 2018). Second, the findings corroborate the more positive attitudes, higher ratings of the perceived usefulness, social norms, and trust of automated vehicles of males than females, which reflect a relatively consistent pattern across studies on automated vehicle acceptance (Rahman et al., 2019; Rice & Winter, 2019).

Small positive effects of experience with advanced driver assistance systems were found on behavioural intention (<0.10). Individuals who currently have Adaptive Cruise Control in their cars are less likely to intend to use conditionally automated cars. This corresponds with Kyriakidis et al. (2015) who reported that people who currently use Adaptive Cruise Control would be willing to pay more for automated vehicles, and are more comfortable about driving without a steering wheel. Furthermore, it was found that individuals whose cars are equipped with Parking Assist systems are less likely to use conditionally automated cars. This could be explained with regards to driver difficulties with using Parking Assist systems (Trösterer et al., 2014). The positive relationship between the experience with Self-Parking Assist systems and the intention to use conditionally automated cars can possibly be explained with regards to the perceived difficulty of parking, especially among elderly drivers (Baldock et al., 2006), and the added value of Self-Parking Assist systems in decreasing the difficulties associated with parking. Future research should examine more closely the effect of experience with advanced driver assistance systems that differ in their functionality.

4.4. Practical implications

The findings of the present study yield important practical implications. First, the positive effects of hedonic motivation, social influence, and performance expectancy on the behavioural intention to use conditionally automated cars suggest that the benefits of conditionally automated cars must be clearly demonstrated and promoted by public (e.g., media, policymakers) and private decision-makers (e.g., manufacturers) via established communication channels and in social networks. McDonald, Site, Stam, & Salucci (2018) study has shown that the proportion of respondents recalling someone at the dealership offering training related to the systems Adaptive Cruise Control, Automated Emergency Braking, Forward Collision Warning, Lane Departure Warning, and Lane Keeping Assist ranged between 42% and 56%. This suggests that automated cars could be more effectively promoted via car dealers in order to increase the level of awareness of and knowledge about automated cars. Car dealers could be trained as real experts for automated driving functionalities to explain system strengths and limitations and show the systems to customers, e.g., by offering test rides. Social networks (both online and offline) could play a more important role in promoting the benefits of conditionally automated cars as friends, family, and colleagues represent an important and trusted source of information. Marketing could establish a "bring a friend/relative campaign" or focus on recommendations by friends/relatives in order to leverage the potential of trustful social relationships (see also Bughin, Doogan, & Vetvik, 2010; Bulbul et al., 2014). Second, governmental agencies could form alliances with private organisations (e.g., automobile clubs, roadway organisations) in order to launch joint education campaigns about the benefits of automated cars, and implement test rides in order to expose the general public to automated cars.

4.5. Limitations

The results of the present study have to be interpreted with regards to a number of limitations.

First, as conditionally automated cars do not yet exist in the market, our respondents have not physically experienced them but were asked to *imagine* the use of such cars. To increase the internal validity of our study findings, respondents who replied to all knowledge questions on conditionally automated cars with 'I don't know' were omitted from the analysis, ensuring that all respondents had sufficient understanding of the functionalities of conditionally automated cars. Nevertheless, respondents may overestimate their capabilities and general positivism to use these cars. The social desirability and acquiescence biases in survey research, the novelty factor that surrounds automated cars, and the influence and power of the media in marketing automated cars (Lee et al., 2019; Nordhoff, De Winter et al., 2019) may have further contributed to their positivity towards conditionally automated cars. The limitation of this study that pertains to asking respondents to imagine rather than directly exposing respondents to conditionally automated cars will be addressed by work that will be conducted in the context of the L3Pilot itself, exposing 1,000 individuals to conditionally automated cars. A comparison of the attitudes of experienced versus less experienced individuals will be made. Second, the present study did not examine the effects of individuals' socio-demographics except for age and gender. Therefore, we will examine the added contributions of individuals' socio-demographic characteristics, travel behaviour, and personality on the behavioural intention to use conditionally automated cars in subsequent studies within the L3Pilot project.

Third, behavioural intention was operationalised by two items, measuring the intention to use and intention to buy conditionally automated cars, respectively. The operationalisation of automated vehicle acceptance by the intention to use and buy has been supported by the literature (McDonald, Site, Stam, & Salucci, 2018; Wu, Liao, & Wang, 2020). The wording of the questionnaire item measuring the purchase intention may have produced biased responses by encouraging respondents to disagree with this item, possibly because they just bought a new car, or because they can't afford buying a conditionally automated car. In other words, a disagreement with this item does not necessarily imply that people are generally unwilling to consider the purchase of a conditionally automated car, or that respondents who intend to use conditionally automated cars will immediately consider purchasing one. We recommend future research to revisit the operationalisation of this item. It could also be assessed whether the rewording of this item to *"When I buy my next car, I plan to buy a conditionally automated car once it is available*" produces similar results than the item used in this study, representing an equally valid and reliable measure of behavioural intention. Furthermore, research on the examination of the willingness to pay for automated driving technology and its determinants has grown in the past few years (Asgari & Jin, 2019; Liu et al., 2019; Tsouros & Polydoropoulou, 2020).

Finally, as cross-country effects were not examined in this study, the dataset is not representative for the general European population nor for the sum of the national populations of the eight countries on which data were obtained. In order to leverage the full potential of a representative dataset, we will conduct a cross-country analysis in a subsequent study.

4.6. Final conclusions

We investigated public acceptance of conditionally automated (SAE Level 3) passenger cars using a questionnaire study conducted among 9,118 car-drivers in eight European countries. Respondents considered conditionally automated cars easy to use, but were less inclined to consider a purchase of conditionally automated cars. Slightly less than the majority imagined the engagement in eyes-off road activities such as talking to fellow travellers, surfing the internet, watching videos or TV shows, observing the landscape, and working. The present study also applied UTAUT2 to investigate the effects of performance and effort expectancy, social influence, facilitating conditions, and hedonic motivation on the behavioural intention to use conditionally automated cars. Structural equation modeling revealed that hedonic motivation was the strongest predictor of the behavioural intention to use conditionally automated cars, followed by social influence and performance expectancy. Age, gender and experience with advanced driver assistance systems had significant, yet small (<0.10), effects on the behavioural intention to use conditionally automated cars. We recommend future research to expose individuals to conditionally automated cars in realistic and complex traffic situations.

CRediT authorship contribution statement

Sina Nordhoff: Conceptualization, Methodology, Software, Validation, Formal analysis, Investigation, Resources, Data curation, Writing - original draft, Writing - review & editing, Visualization, Supervision, Project administration. **Tyron Louw:** Conceptualization, Methodology, Writing - review & editing. **Satu Innamaa:** Conceptualization, Methodology, Writing - review & editing, Supervision, Funding acquisition. **Esko Lehtonen:** Conceptualization, Methodology, Writing - review & editing. **Anja Beuster:** Conceptualization, Methodology, Writing - review & editing. **Guilhermina Torrao:** Conceptualization, Methodology, Writing - review & editing. **Afsaneh Bjorvatn:** Conceptualization, Methodology, Writing - review & editing. **Tanja Kessel:** Conceptualization, Methodology, Writing - review & editing, Supervision, Funding acquisition. **Fanny Malin:** Conceptualization, Methodology, Writing - review & editing. **Riender Happee:** Writing - review & editing. **Natasha Merat:** Conceptualization, Methodology, Writing - review & editing, Supervision, Project administration, Funding acquisition.

Acknowledgements

The research leading to these results has received funding from the European Commission Horizon 2020 program under the project L3Pilot, grant agreement number 723051. Responsibility for the information and views set out in this publication lies entirely with the authors. The authors would like to thank partners within L3Pilot for their cooperation and valuable contribution.

Appendix A. Supplementary material

Supplementary data to this article can be found online at https://doi.org/10.1016/j.trf.2020.07.015.

References

Acheampong, R. A., & Cugurullo, F. (2019). Capturing the behavioural determinants behind the adoption of autonomous vehicles: Conceptual frameworks and measurement models to predict public transport, sharing and ownership trends of self-driving cars. Transportation Research Part F: Traffic Psychology and Behaviour, 62, 349– 375.

Adams, D. A., Nelson, R. R., & Todd, P. A. (1992). Perceived usefulness, ease of use, and usage of information technology: A replication. *MIS Quarterly, 16*, 227–247.

Anderson, J. C., & Gerbing, D. W. (1988). Structural equation modeling in practice: A review and recommended two-step approach. *Psychological Bulletin, 103*, 411–423.

Ajzen, I. (1985). From intentions to actions: A theory of planned behavior. In J. Kuhl & Beckmann, (Eds), Action-control: From cognition to behavior. Heidelberg: Springer, 11–39.

Asgari, H., & Jin, X. (2019). Incorporating attitudinal factors to examine adoption and willingness to pay for automated vehicles. *Transportation Research Record, 2673*, 418–429.

Baldock, M. R. J., Mathias, J. L., McLean, A. J., & Berndt, A. (2006). Self-regulation of driving and its relationship to driving ability among older adults. *Accident Analysis & Prevention, 38*, 1038–1045.

Berghöfer, F. L., Purucker, C., Naujoks, F., Wiedemann, K., & Marberger, C. Prediction of take-over time demand in conditionally automated driving – results of a real world driving study. In: D. de Waard, K. Brookhuis, D. Coelho, S. Fairclough, D. Manzey, A. Neumann, L. Onnasch, S. Röttger, A. Toffetti, and R. Wiczorek (Eds.) (2019). In Proceedings of the Human Factors and Ergonomics Society Europe Chapter 2018 Annual Conference. ISSN 2333–4959 (online). Available from http://hfes-europe.org.

Buckley, L., Kaye, S. A., & Pradhan, A. K. (2018). Psychological factors associated with intended use of automated vehicles: A simulated driving study. *Accident Analysis & Prevention, 115*, 202–208.

Bughin, J., Doogan, J., & Vetvik, O. J. (2010). A new way to measure word-of-mouth marketing. [online]. Available at: https://www.mckinsey.com/business-functions/marketing-and-sales/our-insights/a-new-way-to-measure-word-of-mouth-marketing Accessed 07 May 2020.

Bulbul, C., Gross, N., Shin, S., & Katz, J. (2014). When the path to purchase becomes the path to purpose: Three new opportunities for brand advertisiers. [online]. Available at: http://think.storage.googleapis.com/docs/the-path-to-purpose_articles.pdf Accessed 07 May 2020.

Cunningham, M. L., Regan, M. A., Horberry, T., Weeratunga, K., & Dixit, V. (2019). Public opinion about automated vehicles in Australia: Results from a large-scale national survey. *Transportation Research Part F: Traffic Psychology and Behavior, 129*, 1–18.

Cunningham, M. L., Regan, M. A., Ledger, S. A., & Bennett, J. M. (2019). To buy or not to buy? Predicting willingness to pay for automated vehicles based on public opinion. *Transportation Research Part F: Traffic Psychology and Behavior, 65*, 418–438.

Cyganski, R., Fraedrich, E., & Lenz, B. (2015). Travel time valuation for automated driving: a use-case-driven study. In 94th Annual meeting of the Transportation Research Board. Washington, DC: Transportation Research Board.

Davis, F. D. (1993). User acceptance of information technology: System characteristics, user perceptions and behavioural impacts. *International Journal of Man-Machine Studies, 38*, 475–487.

Du, H., Liu, D., Sovacool, B. K., Wang, Y., Ma, S., & Man Li, R. Y. (2018). Who buys new energy vehicles in China? Assessing socio-psychological predictors of purchasing awareness, intention, and policy. *Transportation Research Part F: Traffic Psychology & Behavior, 58*, 56–69.

Fornell, C., & Larcker, D. F. (1981). Evaluating structural equation models with unobservable variables and measurement error. *Journal of Marketing Research, 18*, 39–50.

Forster, Y., Naujoks, F., Neukum, A., & Huestegge, L. (2017). Driver compliance to take-over requests with different auditory outputs in conditional automation. *Accident Analysis & Prevention, 109*, 18–28.

Garson, G. D. (2012). *Testing statistical assumptions*. Asheboro, NC: Statistical Associates Publishing.

Gold, C., Happee, R., & Bengler, K. (2018). Modeling take-over performance in level 3 conditionally automated vehicles. *Accident Analysis & Prevention, 116*, 3–13.

Hair, J., Black, W. C., Babin, B. J., & Anderson, R. E. (2014). *Multivariate analysis*. Harlow, Essex: Pearson New International Edition.

Hecht, T., Feldhütter, A., Radlmayr, J., Nakano, Y., Miki, Y., Henle, C., & Bengler, K. (2018). A review of driver state monitoring systems in the context of automated driving. In Proceedings of the 20th Congress of the International Ergonomics Association (IEA 2018). Advances in Intelligent Systems and Computing, Vol 823. Springer, Cham.

Herrenkind, B., Nastjuk, I., Brendel, A. B., Trang, S., & Kolbe, L. M. (2019). Young people's travel behavior – using the life-oriented approach to understand the acceptance of autonomous driving. *Transportation Research Part D: Transport & Environment, 74*, 214–233.

Hooper, D., Coughlan, J., & Mullen, M. (2008). Structural equation modelling: Guidelines for determining model fit. *Electronic Journal of Business Research Methods, 6*, 53–60.
Hu, L., & Bentler, P. M. (2009). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling: A Multidisciplinary Journal, 6*, 1–55.
Kaur, K., & Rampersad, G. (2018). Trust in driverless cars: Investigating key factors influencing the adoption of driverless cars. *Journal of Engineering and Technology Management, 48*, 87–96.
Karahanna, E., Agarwal, R., & Angst, C. M. (2006). Reconceptualizing compatibility beliefs in technology acceptance research. MIS Quarterly, 30, 781–804.
Kaye, S. A., Lewis, I., Buckley, L., & Rakotonirainy, A. (2019). Examining Queensland drivers' a priori acceptance of conditional and full automated vehicles. In Proceedings of the 2019 Australasian Road Safety Conference, 25–27 September 2019, Adelaide, Australia.
Keller, D. H. The Living Machine. Wonder Stories, May 1935, 1465–1511.
Kettles, N., & Van Belle, J. P. (2019). Investigation into the antecedents of autonomous car acceptance using an enhanced UTAUT model. *2019 International Conference on Advances in Big Data, Computing and Data Communication Systems (icABCD), August 5-6*. South Africa: Winterton.
Koenig-Lewis, N., Morgan, M., Palmer, A., & Zhao, A. (2015). Enjoyment and social influence: Predicting mobile payment adoption. *The Service Industries Journal, 35*, 537–554.
Kyriakidis, M., Happee, R., & De Winter, J. C. F. (2015). Public opinion on automated driving: Results of an international questionnaire among 5,000 respondents. *Transportation Research Part F: Traffic Psychology and Behavior, 32*, 127–140.
Kyriakidis, M., De Winter, J. C. F., Stanton, N., Bellet, T., Van Arem, B., Brookhuis, K., ... Happee, R. (2019). A human factors perspective on automated driving. *Theoretical Issues in Ergonomics Science*, 1–11.
Lee, C., Seppelt, B., Abraham, H., Reimer, B., Mehler, B., & Coughlin, J. F. (2019). Consumer comfort with vehicle automation: Changes over time. In Proceedings of the Tenth International Driving Symposium on Human Factors in Driver Assessment, Training, and Vehicle Design, pp. 412–418.
Litman, T. (2019). Autonomous vehicle implementation predictions: Implications for transport planning. Available at: https://www.vtpi.org/avip.pdf Accessed 31 May 2019.
Liu, P., Guo, Q., Ren, F., Wang, L., & Xu, Z. (2019). Willingness to pay for self-driving vehicles: Influences of demographic and psychological factors. *Transportation Research Part F: Traffic Psychology and Behavior, 100*, 306–317.
Louw, T., Kuo, J., Romano, R., Radhakrishnan, V., Lenné, M. G., & Merat, N. (2019). Engaging in NDRTs affects drivers' responses and glance patterns after silent automation failures. *Transportation Research Part F: Traffic Psychology and Behaviour, 62*, 870–882.
Louw, T., Merat, N., Metz, B., Wörle, J., Torrao, G., & Innamaa, S. (2020). Assessing user behaviour and acceptance in real-world automated driving: the L3Pilot project approach. In Proceedings of 8th Transport Research Arena TRA 2020, April 27-30, 2020, Helsinki, Finland.
Madigan, R., Louw, T., Dziennus, M., Graindorge, T., Ortega, E., Graindorge, M., & Merat, N. (2016). Acceptance of Automated Road Transport Systems (ARTS): An adaptation of the UTAUT model. In Proceedings of the 6th Transport Research Arena, April 18–21, Warsaw, Poland.
Madigan, R., Louw, T., Wilbrink, M., Schieben, A., & Merat, N. (2017). What influences the decision to use automated public transport? Using UTAUT to understand public acceptance of automated road transport systems. *Transportation Research Part F: Traffic Psychology and Behaviour, 50*, 55–64.
McDonald, A., Carney, C. & Mc Gehee, D. V. (2018). Vehicle owners' experiences with and reactions to Advanced Driver Assistance Systems. Available at: http://aaafoundation.org/wp-content/uploads/2018/09/VehicleOwnersExperiencesWithADAS_TechnicalReport.pdf Accessed 30 April 2020.
McDonald, M., Site, P. D., Stam, D., & Salucci, M. V. (2018). Evaluation of automated road transport systems in cities. *Implementing Automated Road Transport Systems in Urban Settings*, 81–207.
Medina, K. F., & Jenkins, R. (2017). GATEway: Public perceptions of a last-mile driverless shuttle. [online] Available at: https://gateway-project.org.uk/wp-content/uploads/2018/06/D3.7_TRL-Workshop-Findings-Report.pdf Accessed 30 May 2019.
Naujoks, F., Befelein, D., Wiedemann, K., & Neukum, A. (2018). A review of non-driving related tasks used in studies on automated driving. In: Stanton N. (eds.). Advances in Human Aspects of Transportation. AHFE 2017. Advances in Intelligent Systems and Computing, Vol. 597. Springer, Cham.
Naujoks, F., Forster, Y., Wiedemann, K., & Neukum, A. (2017). Improving usefulness of automated driving by lowering primary task interference through HMI design. *Journal of Advanced Transportation, Article ID 6105087*, 12.
Nordhoff, S., De Winter, J., Kyriakidis, M., Van Arem, B., & Happee, R. (2018). Acceptance of driverless vehicles: Results from a large cross-national questionnaire study. *Journal of Advanced Transportation, Article ID 5382192*, 22.
Nordhoff, S., De Winter, J., Payre, W., Van Arem, B., & Happee, R. (2019). What impressions do users have after a ride in an automated shuttle? An interview study. *Transportation Research Part F: Traffic Psychology and Behavior, 63*, 252–269.
Nordhoff, S., Kyriakidis, M., Van Arem, B., & Happee, R. (2019). A multi-level model on automated vehicle acceptance (MAVA): A review-based study. *Theoretical Issues in Ergonomics Science, 20*, 682–710.
Nordhoff, S., Madigan, R., Van Arem, B., Merat, N., & Happee, R. (2020). Structural equation modeling discloses interrelations between predictors of automated vehicle acceptance. *Theoretical Issues in Ergonomics Science*.
Panagiotopoulos, I., & Dimitrakopoulos, G. (2018). An empirical investigation on consumers' intentions towards autonomous driving. *Transportation Research Part C: Emerging Technologies, 95*, 773–784.
Pfleging, B., Rang, M., & Broy, N. (2016). Investigating user needs for non-driving related activities during automated driving. In Proceedings of the 15th International Conference on Mobile and Ubiquitous Multimedia (MUM '16). ACM, New York, NY, USA, 91–99.
Power, J. D. (2012). 2012 U.S. Automotive emerging technologies study results. [online] Available at: https://www.jdpower.com/business/press-releases/2012-us-automotive-emerging-technologies-study Accessed 18 October 2019.
Rahman, M. M., Lesch, M. F., Horrey, W. J., & Strawderman, L. (2017). Assessing the utility of TAM, TPB, and UTAUT for advanced driver assistance systems. *Accident Analysis & Prevention, 108*, 361–373.
Rahman, M. M., Deb, S., Strawderman, L., Burch, R., & Smith, B. (2019). How the older population perceives self-driving vehicles. *Transportation Research Part F: Traffic Psychology and Behavior, 65*, 242–257.
Reilhac, P., Millett, N., & Hottelart, K. (2016). Shifting paradigms and conceptual frameworks for automated driving. In G. Meyer & S. Beiker (Eds.), *Road Vehicle Automation 3*. Springer, Cham: Lecture Notes in Mobility.
Rice, S., & Winter, S. R. (2019). Do gender and age affect willingness to ride driverless vehicles: If so, then why? *Technology in Society, 58*, 101–145.
SAE International (2018). Surface vehicle recommended practice. (R) Taxonomy and definitions for terms related to driving automation systems for on-road motor vehicles. [online] Available at: https://saemobilus.sae.org/content/j3016_201806 Accessed 30 May 2019.
Schreiber, J. B., Nora, A., Stage, F. K., Barlow, E. A., & King, J. (2006). Reporting structural equation modeling and Confirmatory Factor Analysis Results: A Review. *The Journal of Educational Research, 99*, 323–338.
Teo, T., & Noyes, J. (2011). An assessment of the influence of perceived enjoyment and attitude on the intention to use technology among pre-service teachers: A structural equation modeling approach. *Computers & Education, 57*, 1645–1653.
Trösterer, S., Wurhofer, D., Rödel, C., & Tscheligi, M. (2014). Using a parking assist system over time: Insights on acceptance and experiences. In *In Proceedings of the 6th International Conference on Automotive User Interfaces and Interactive Vehicular Applications* (pp. 1–8).
Tsouros, I., & Polydoropoulou, A. (2020). Who will buy alternative fueled or automated vehicles: A modular, behavioral modeling approach. *Transportation Research Part A: Policy and Practice, 132*, 214–225.
Venkatesh, V., & Davis, F. D. (2000). A theoretical extension of the technology acceptance model: Four longitudinal field studies. *Management Science, 46*, 186–204.
Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. (2003). User acceptance of information technology: Toward a unified view. *MIS Quarterly, 27*, 425–478.
Venkatesh, V., Thong, J. Y. L., & Xu, X. (2012). Consumer acceptance and use of information technology: Extending the Unified Theory of Acceptance and Use of Technology. *MIS Quarterly, 36*, 157–178.

Wu, J., Liao, H., & Wang, J. W. (2020). Analysis of consumer attitudes towards autonomous, connected, and electric vehicles: A survey in China. *Transportation Economics, 100828*.
Xu, Z., Zhang, K., Min, H., Wang, Z., Zhao, X., & Liu, P. (2018). What drives people to accept automated vehicles? Findings from a field experiment. *Transportation Research Part F: Traffic Psychology and Behaviour, 95*, 320–334.
Zeeb, K., Buchner, A., & Schrauf, M. (2016). Is take-over time all that matters? The impact of visual-cognitive load on driver take-over quality after conditionally automated driving. *Accident Analysis & Prevention, 92*, 230–239.
Zhang, T., Tao, D., Qu, X., Zhang, X., Lin, R., & Zhang, W. (2019). The roles of initial trust and perceived risk in public's acceptance of automated vehicles. *Transportation Research Part C: Emerging Technologies, 98*, 207–220.
Zhang, T., Tao, D., Qu, X., Zhang, X., Zeng, J., Zhu, H., & Zhu, H. (2020). Automated vehicle acceptance in China: Social influence and initial trust are key determinants. *Transportation Research Part C: Emerging Technologies, 112*, 220–233.