Autonomous vehicles, perceived risk, and carsharing compatibility: assessing behavioral intention in Italy[1]

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Abstract

Frame of the research. *Developed to predict an individual inclination toward a certain type of technology, over the years, a Technology Acceptance Model (TAM) has been enriched with additional context-specific variables to adopt the model to new technologies, as well as integrating with Innovation Diffusion Theory (IDT). This paper relies on both of these to tackle the complex phenomenon of the mass diffusion of Autonomous Vehicles (AVs) and to analyze individual behavioral intention toward AVs.*

Purpose of the paper. *To our knowledge, few studies have focused on the perceived safety risk associated with AVs, despite the importance of this variable in potentially hindering or hampering the adoption of the technology. In addition, previous research shows that AV technologies could fit well into a carsharing business model, leading to what some authors call a fleet-oriented market. The paper analyzes these aspects as antecedents of the intention to adopt AVs in the future.*

Methodology. *Drawing from an integration of the Technology Acceptance Model with Innovation Diffusion Theory, the proposed research model analyses the effects of Perceived Usefulness, Perceived Ease of Use, Subjective Norm, and Perceived Safety Risk on the intention to use AVs, whilst considering carsharing compatibility as a moderator of the relationships between Perceived Usefulness, Perceived Ease of Use, and Perceived Safety Risk over behavioral intention. A survey on an Italian sample is conducted and data analyzed using SEM.*

Results. *Results, measured over a sample of 361 respondents, suggest that high carsharing compatibility decreases the importance of the Perceived Ease of Use variable for the intention to use AVs, while leading to a deeper consideration of the Perceived Usefulness variable over intention. Overall, carsharing compatibility does matter in fostering the behavioral intention to use AVs in the future.*

Research limitations. *The high technical complexity of Autonomous Vehicles and the fact that they are not fully available make it difficult for respondents to understand, for example, the different levels of automation involved and the implications these technologies could have on daily life. In addition, the study has some limitations that could be addressed in future research initiatives.*

Managerial implications. *This study analyses the intention to use AVs by considering carsharing compatibility within a TAM model: it sheds light on how integrating innovation in the mobility sector could foster the most radical innovations to be accepted. Ultimately, managerial implications deal with the sustainability of* *local transportation systems that can be redesigned in light of the synergies between different technological innovations.*

Originality of the paper. *Overall, the paper enriches the current debate on the intention to use AVs by offering an integration of TAM with IDT by focusing on the role of carsharing compatibility. In addition, it is based on an Italian sample that, to our knowledge, had not yet been investigated.*

Key words: *autonomous vehicle, technology acceptance model, carsharing, intention to use.*

1. Introduction

Among the issues which stand in the way of the mass diffusion of Autonomous Vehicles (AVs) and which limit them to experiments or protected labs, literature argues that user acceptance is more detrimental than technical barriers (Xiao and Goulias, 2022). An increasing number of empirical studies (e.g., Choi and Ji, 2015; Koul and Eydgahi, 2018; Nastjuk *et al.*, 2020; Xiao and Goulias, 2022) has focused on individual characteristics, personality traits, and subjective perception as factors influencing the intention to use AVs, thereby impacting their diffusion in local transportation systems. With regard to demographic characteristics, such as age, income, and education, results suggest that young people with a higher income are more likely to accept AVs (Bansal and Kockelman, 2017; Koul and Eydgahi, 2018). Similarly, Xiao and Goulias (2022) recognize young, well-educated males as the segment with the highest disposition to use AVs. Studies have also investigated how personality traits, such as a desire to exert control or the external locus of control, influence the intention to use AVs (Nastjuk *et al.*, 2020; Choi and Ji, 2015). Regarding the personal perception of AVs, literature refers to those theories and models developed to understand how technology use is diffused, finding contrasting results (Hamburger *et al.*, 2022). However, the antecedents of user intention related to a striking innovation such as AVs require further study.

In this paper, we rely on both Technology Acceptance Model (TAM) (Davis, 1989) and Innovation Diffusion Theory (IDT) (Rogers, 1995) to deal with the complexity related to user behavioral intention regarding AVs - in line with previous empirical studies in technological contexts (Zhang *et al.*, 2008; Giovanis *et al.*, 2012). TAM is one of the most widely used models to investigate the intention to adopt new technologies. Originally applied to information systems, it was lately extended to other technological fields to examine the individual technology acceptance behavior and enriched with specific context variables to investigate the phenomenon deeper. To assess variables of interest from TAM models, we deal with the current understanding of the phenomenon. As Fagnant and Kockelman (2018) point out, the task of driving is strictly related to a perception of safety, stating it as one of the crucial variables. While using AVs, people have to entrust safety to the automated system, raising the bar for automated driving safety above that of traditional driving (Fagnant and Kockelman, 2018; Xu *et al.*, 2018). In addition, some studies have consistently reported perceived risk as one of the most frequently mentioned reasons for not accepting AVs (Man *et al.*, 2020; Choi and Ji, 2015; Lee *et al.*, 2019). Only a few empirical studies, to date, have focused on the perceived safety risk related to AVs (Man *et al.*, 2020), analyzing perceived safety risk mainly as a predictor of trust rather than of the intention to use AVs (e.g., Man *et al.*, 2020; Zhang *et al.*, 2019).

As for IDT, we focus on compatibility as the extent to which innovation fits the needs, values, and experiences of the consumer (Rogers, 1995). Compatibility is related to an external condition in the adoption environment (Zhang *et al.*, 2008) and may indicate behavior toward other phenomena related to the technology under consideration and that has already experienced some degree of diffusion. In this case, compatibility towards existing technologies may play a crucial role in affecting the intention to use a new technology (Min *et al.*, 2019). However, it is difficult to determine compatibility for technologies that are either not widely used or not yet commercially accessible, such as a higher level of AVs. We then consider carsharing compatibility. Previous research has indeed found that AV technologies fit well into a carsharing business model, leading to what some authors call a "fleet-oriented market" (Wachenfeld *et al.*, 2016; Teece, 2018). Furthermore, a carsharing experience is a suitable means of innovation adoption in urban mobility (Han *et al.*, 2019; Schlüter and Weyer, 2019), so that interest in automotive innovation may result from a mobility-related receptiveness in people who have used or use carsharing. We then assume that people whose mobility style fits well with carsharing services may perceive fewer risks and a lower required effort associated with the use of AVs, and they could see in the characteristics of the technology a means to overcome some issues related to carsharing services.

An online survey was conducted on an Italian sample of 361 individuals. Results show the antecedents of the intention to use AVs, with perceived usefulness and perceived ease of use as the most influential, whilst the perceived safety risk has a negative impact. In addition, a high carsharing compatibility positively moderates the intention to use AVs. Overall, the contribution of the paper is threefold. Firstly, it enriches the current debate about the TAM with an analysis of the factors influencing the intention to use AVs. Secondly, the context-specific variable, perceived safety risk, is added to the model, as the extent to which a person believes the safety of AVs could meet expectations. Thirdly, a further attempt to improve the debate around acceptance models has been offered by the integration of TAM with IDT, by looking specifically at the role of carsharing compatibility.

The paper is structured as follows. The next paragraph presents the theoretical framework. The third paragraph presents the research model and the hypothesis. The fourth paragraph presents the methodology, and the fifth the results. The sixth paragraph discusses the findings, whilst the conclusions, limitations and future avenues of research end the paper.

2. Literature review

When people deal with new technologies, attitude is a crucial point in the acceptance process (Davis, 1989). Among the models that have been theorized to predict an individual inclination toward a certain type of technology, a Technology Acceptance Model (TAM) is one of the most used. Based on the Theory of Reasoned Action (TRA) (Fishbein and Ajzen, 1975), performance or non-performance of a given behavior is primarily determined by the strength of *a person's* intention to perform (or not perform) that behavior (Fishbein and Ajzen, 1975). In TAM, Davis (1989) recognizes Perceived Usefulness (PU) and Perceived Ease of Use (PEOU) as the drivers for the attitude toward a certain technology. The attitude predicts the intention to use that technology, or behavioral intention (BI), defined as *a person's* subjective probability of performing certain behavior. While PU tackles the performance enhanced by the prospect of using a new technology, PEOU refers to how easy and free from effort the use of a new technology is (Davis, 1989). Integrating new variables and resulting in TAM2, Venkatesh and Davis (2000) proposed Social Norms (SN) and add two more variables related to the social influence processes, namely Image, *meaning* the *aspiration* to maintain a favorable position among others, and Voluntariness, as the extent to which an individual decides freely to use a specific technology. More specifically, SN has been used to study technologies applied to contexts other than those adopted in the workplace. In parallel, TAM3 (Venkatesh and Bala, 2008) integrates additional determinants which positively influence PEOU: self-efficacy, perception of external control, computer anxiety, computer playfulness, perceived enjoyment and objective usability.

To assess which TAM variables are the most suitable in the context of AVs, we proceeded with a review of the empirical studies on the topic. Without the ambition of a systematic review, a total of 33 papers, starting from 2011, were selected, and the employed variables used were analyzed. Most research (e.g., Ghazizadeh *et al.*, 2012; Park *et al.*, 2015; Koul *et al.*, 2018) shows that a high level of PEOU and PU influences the intention to use AVs favorably (Koul and Eydgahi, 2018; Panagiotopoulos and Dimitrakopouluos, 2018; Rahman *et al.*, 2017), in line with what was found for previous technologies. However, the results are still not completely homogeneous. Some authors have found that PU does not have a favorable influence on BI, but just on attitude (Man *et al.*, 2020), whereas PEOU has no significant effect on attitude or BI (Man *et al.*, 2020; Lee *et al.*, 2019). In addition, SN, as the extent to which a person perceives that others (e.g., family, friends, colleagues) believe they should use AVs, is considered to have a positive impact on the intention to use them (Zhu *et al.*, 2020; Panagiotopoulos and Dimitrakopoulos, 2018; Rahman *et al.*, 2017). However, a lack of internal consistency within the SN construct has been noted, leading to a different consideration by respondents according to the source of social pressure, whether influencers (e.g., idols, celebrities) or people who are important to them (e.g., family members) (Rahaman *et al.*, 2017). Studies on AVs show a positive influence of self-efficacy on the intention to use (Buckley *et al.*, 2018; Choi and Ji, 2015; Lee *et al.*, 2019).

Specifically, Lee *et al.* (2019) found that only self-efficacy, and not PEOU, has a significant effect on the intention to use AVs, due to the fact that the ability to drive could be critical in AVs too (Lee *et al.*, 2019). Overall, one of the main advantages of the TAM is its flexibility to add variables according to the technological context (Ghazizadeh *et al.*, 2012). Hence, many researchers have used the TAM framework as the base model, to which adding new constructs and to offer a deeper explanation of technology acceptance.

As Fagnant and Kockelman (2018) point out, the driving task is strictly related to a safety perception and it is one of the crucial points in determining the individual behavioral intention to use AVs. While using AVs, people have to entrust their safety to the automated system, raising the bar for automated driving safety above that of traditional driving (Fagnant and Kockelman, 2018; Xu *et al.*, 2018). Previous studies also integrate the perceived risk with the TAM model (Zhang *et al.*, 2019; Lee *et al.*, 2019; Man *et al.*, 2020). Lee *et al.* (2019) enrich the TAM theory with the perceived risk variable, looking at its influence on the intention to use AVs and analyzing self-efficacy and PEOU as antecedents of perceived risk. Similarly, other studies also demonstrate that performance risk negatively influences the intention to use, while not being influenced by any variable, due to the fact that any accidental situations which might arise whilst driving an AV are perceived as related to external factors, since users are involved in few tasks (Lee *et al.*, 2019). Man *et al.* (2020) consider two types of risk when it comes to AVs: privacy risk and safety risk, both of which have some effect on PU. Concerning safety-critical activities, when using AVs people must entrust their safety to the automated system. In addition, a privacy risk emerges, which may result from the possibility that behavioral data or travel data might be obtained by third parties without the consent of users (Man *et al.*, 2020). The same types of risk are analyzed by Zhang *et al.* (2019) as antecedents of initial trust, pointing out that, while the safety risk has a significant negative effect on initial trust, no significant influence can be attributed to the perceived privacy risk. As for the TAM variables that ultimately appear as most suitable and adapted to an in-depth study within the context of AVs, perceived usefulness and perceived ease of use are considered as the strongest predictors of the intention to use, as well as the subjective norm, as the social influence acquires a relevant role for those technologies not yet fully widespread. In addition, the technological context that is still at a too embryonic stage would not allow the integration of other work-related variables, or any conceptual nuances between self-efficacy and perceived ease of use, and constructs such as playfulness and enjoyment would require a certain degree of experience to be evaluated more effectively. The perceived risk is, then, an important element characterizing the specific technological context.

Some authors (e.g., Yuen *et al.*, 2020, 2021) also integrate the TAM with variables related to Rogers's (1995) IDT while studying AVs. At the core of IDT there are five main constructs influencing adoption: relative advantage, compatibility, complexity, trialability, and observability. Relative advantage reflects the extent to which an innovation is perceived to be better than another for the same purpose (Rogers, 1995). Related to AVs, the construct reflects the advantages of compared to traditional vehicles (Lee *et al.*, 2019) and it has been analyzed both in relation to the other IDT variables (Yuen *et al.*, 2020, 2021) showing a positive influence on PU (Yuen *et al.*, 2020, 2021; Lee *et al.*, 2019). Compatibility is the extent to which the innovation is compatible with the needs, values, and experiences of the consumer (Rogers, 1995). Complexity shows the degree of difficulty in understanding and using the innovation (Rogers, 1995). Trialability defines the degree to which an innovation can be tested before actual adoption, while observability refers to the tangibility of the results obtained by using the new product (Rogers, 1995). In order to integrate the TAM and the IDT, Yuen et al (2020, 2021) analyze the IDT variables as antecedents of PU and PEOU, arguing that TAM and IDT are complementary models that can be integrated to explain the intention (BI) to use AVs. However, we believe that applying the IDT variables to technologies that are only present at an experimental level, can lead to biased findings. In fact, because full AVs are not yet available on the market, it is hard to consider IDT, based on the actual use of the new product, as a model by which to measure acceptance (Yuen *et al.*, 2021). Rather, in the case of emerging technologies that are not yet usable, like AVs, we argue that IDT variables could only be fruitfully used to capture user attitude towards technologies actually in use and to determine whether they might influence the future adoption of an emerging technology (Zhang *et al.*, 2008). For this reason, we focus on compatibility, and in particular on carsharing compatibility: previous studies have, in fact, shown that carsharing can positively influence the acceptance of more radical innovations such as electric and autonomous vehicles (Han *et al.*, 2019).

3. Research Model and Hypothesis Development

The following variables have been considered in the research model: Perceived Usefulness (PU) (TAM), Perceived Ease of Use (PEOU) (TAM), intention (BI) to use AVs (TAM), subjective norm (SD) (TAM 2), perceived safety risk (PR), and carsharing compatibility (IDT). Considering the still highly experimental nature of AVs and, consequently, the lack of consumer experience, the intention (BI) to use AVs has been selected as a dependent variable. BI is defined as a person's subjective probability of adopting certain behavior and is taken as the strongest predictor for guiding actual system use (Davis, 1989). We argue that a thorough analysis of the intention to use AVs could represent a robust antecedent of effective future adoption behavior. The main hypotheses are then presented.

3.1 Perceived Usefulness and Perceived Ease of Use

Within the TAM framework, PU and PEOU are considered the most important predictors of BI (Davis, 1989). In the context of AVs, PU defines the utility related to the AV use, while PEOU refers to the degree to which a person believes using an AV will be free from any significant effort. Within the literature regarding the intention to use AVs, both variables have been analyzed frequently (e.g., Rahman *et al.*, 2017; Koul and Eydgahi, 2018), and the intention to use AVs mainly depends on how easy and useful AVs are perceived (e.g., Zhang *et al.*, 2019; Nastjuk, *et al.* 2020; Panagiotopoulos and Dimitrakopoulos, 2018).

The intention to use AVs may be affected by the extent to which people believe AVs will help them in performing their task more efficiently (such as: reducing the time spent in the car, allowing them to perform other tasks while moving from one place to another). Since effort is considered as a limited resource that people could allocate to various activities (Radner and Rothschild, 1975), if an AV is perceived as easier to use, compared to a traditional vehicle, users are more likely to adopt it, as it reduces the mental and physical effort required for commuting, which can then be allocated to other activities. Likewise, if the vehicle is too difficult to use, the performance benefits of usage could be overshadowed by the effort of using it. We then expect that, also for AVs, PEOU will reinforce PU. The following hypotheses are posed:

H1. Perceived usefulness (PU) positively affects the intention (BI) to use AVs
H2. Perceived ease of use (PEOU) positively affects the intention (BI) to use AVs
H3. Perceived ease of use (PEOU) positively affects the perceived usefulness (PU) of AVs

3.2 Subjective Norm

Subjective norm (SN) reflects "perceptions that significant referents desire the individual to perform or not perform a behavior" (Taylor and Todd, 1975, p.149), meaning that the judgement of individuals toward a certain technology tends to follow what people who are important to them actually do or think. As a social factor, SN consists of the perceived opinions of other people or groups that are close or important to the individual, ultimately influencing individual decisions (Fishbein and Ajzen, 1975). Applied to AVs, SN is the extent to which individuals perceive that family, friends, or colleagues think they should use AVs. In the literature there is a consensus about the fact that the positive opinion of others about the usefulness of AVs can influence individual perception (e.g., Buckley *et al.*, 2018; Panagiotopoulos and Dimitrakopoulus, 2018). For instance, peer-to-peer pressure has been demonstrated to play an important role in the decision to adopt AVs (Zhu *et al.*, 2020). Bansal and Kockelman (2017) show that half the American population would be more likely to try AVs if they were adopted by family members, friends, or neighbors, showing that future AV adoption rates could depend on the adoption rates of a close set of intimate individuals. The following hypothesis is posed:

H4. Subjective norm (SN) positively affects the intention (BI) to use AVs.

3.3 Perceived Risk

Perceived risk (PR) refers to the perceived uncertainty in a given situation and the expectation to bear losses due to uncertainty (Bauer, 1967). To date, few studies have focused on the perceived safety risk associated with the intention (BI) to use AVs (Man *et al.*, 2020), while focusing on perceived safety risk as a predictor of trust (Zhang *et al.*, 2019) or PU (Man *et al.*, 2020). Associated with AVs, PR is the extent to which a person believes that the AV will not behave as expected, reducing their intention to use it. Although a large number of studies demonstrate a decrease in the number of incidents thanks to AVs and the subsequent enhancement in traffic safety levels (Liu *et al.*, 2019), the perceived safety risk associated with AVs among potential users has still been found to be high (Schoettle and Sivak, 2014). The following hypothesis is posed:

H5. Perceived safety risk (PR) negatively affects the intention (BI) to use AVs

3.4 Carsharing compatibility

Carsharing is described as an alternative to car ownership (e.g., Baptista *et al.,* 2014; Peterson and Travis, 2019), as people do not use their own car but use hourly rental services (Han *et al.*, 2019). The paradigm of private ownership related to vehicles is, then, switching toward a Transportation as a Service (TaaS) business model, and consumers rent the usage of the vehicle as needed rather than owning vehicles themselves (Teece, 2018). Some studies estimate that, just in the United States, the development of sharing economies related to the automotive sector could lead to a decline in annual sales in the order of several million units of car (Clements and Kockelman, 2017). Scholars expect a strong overlap of carsharing services with AVs (e.g., Motamedi *et al.*, 2020; Paddeu *et al.*, 2020), due to the expected high initial price of an AV and the fact that a vehicle able to go from one place to another without human intervention fits into a sharing business model well (Wachenfeld *et al.*, 2016). As carsharing services are growing in popularity and are seen as being in synergy with AVs (Krueger *et al.*, 2016; Teece, 2018), the question is being raised of whether using an AV as a private or shared means of mobility might influence the intent to use one.

Carsharing compatibility defines, then, the degree to which a carsharing model fits with a person's lifestyle and values (Han *et al.*, 2019). Some studies demonstrate that those people with an experience of carsharing have higher PU and intention to use shared AVs (Xiao and Goulias, 2022). Similarly, people with a high carsharing compatibility could see AVs as a potential solution to some problems related with carsharing services, such as spatial allocation and availability, leading to a stronger positive effect of PU on the intention to use AVs. Ultimately, a carsharing experience is a suitable means of innovation adoption in urban mobility (Schlüter and Weyer, 2019), becoming the vehicle through which emerging automotive technologies, such as electrification or autonomous driving, can make their way. Introducing AV technology in a carsharing business model would provide on-demand mobility at a low price and facilitate multi-modality by providing last-mile travel solutions, while lowering the barriers associated with traditional carsharing services, such as inconveniences caused by

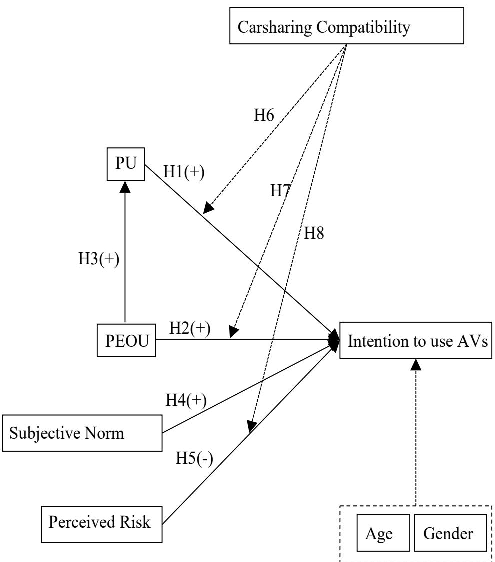
users travelling to access available vehicles and vehicle availability issues (Wachenfeld *et al.*, 2016; Paddeu *et al.*, 2020). The following hypothesis is posed:
H6. Carsharing compatibility increases the relationship between PU and the intention (BI) to use AVs

Rogers (1995) defines people with a high degree of innovation as those able to handle uncertainty and be more likely to take risks, assuming that they will have more enthusiastic intentions for using an innovation. In addition, they are more likely to be involved with the new technology and to handle the complexity of it easily (Rogers, 1995). At the same time, some studies define a positive relationship between innovativeness and carsharing services (Kim *et al.*, 2017; Han *et al.*, 2019), stating that individuals who have a high innovative propensity are more likely to have a positive opinion toward carsharing (Kim *et al.*, 2017). By analogy, people with a positive attitude toward carsharing services may see fewer risks associated with AVs and perceive them as less difficult to use. The following hypotheses are posed:

H7. Carsharing compatibility decreases the effect of PEOU on the intention (BI) to use AVs
H8. Carsharing compatibility decreases the relationship between Perceived Risk (PR) and the intention (BI) to use AVs

The research model is summarized in Figure 1.

Fig. 1: Research model



Source: authors' analysis

4. Methodology

4.1 Measurements

Measurements were taken from extant literature. Each construct was measured with multiple items and each item was borrowed from the literature to improve content validity. To measure PU, PEOU, and the intention to use, variable scale items from Davis (1989) were used. The scale items for SNs were adopted from Taylor and Todd (1995), while Featherman and Pavlou (2003) and Choi and Ji (2015) were used for the perceived risk (PR) scale. Finally, the carsharing compatibility items were adopted from Han *et al.* (2019). All items are based on a seven-point Likert scale ranging from 1 (strongly disagree) to 7 (strongly agree). Appendix A shows the items used and sources from which they have been adopted.

Confirmatory Factor Analysis (CFA) was applied to analyze the measurement model, using Lisrel, considered among the most comprehensive packages (Iacobucci, 2009). Construct validity is achieved when fitness indices of the model meet the required levels. The model thus specified showed a reasonably good fit with the data: $\chi 2$ (degrees of freedom) = 361 (174), goodness of fit index (GFI) = 0.91; root mean square error of approximation (RMSEA) = 0.05; Standardized Root Mean Square Residual (SRMSR) = 0.04. All items tended significantly toward the hypothesized latent variables, indicating convergent validity. All constructs showed acceptable values of composite reliability (CR ≥ 0.897), average variance extracted (AVE ≥ 0.744) and Cronbach's alpha (CA ≥ 0.831).

To test for discriminant validity, for each construct we compared the square root of its AVE with its highest correlation with other constructs (Fornell and Larcker, 1981). The square root of a construct's AVE was always greater than its highest correlation with other constructs, indicating discriminant validity. Table 1 shows the results from the CFA.

Tab. 1: CFA results, convergent validity and internal consistency

		CA	AVE	CR	1	2	3	4	5	6
1	Intention to use	0.972	0.922	0.979	0.960					
2	PU	0.866	0.789	0.918	0.7	0.888				
3	PEOU	0.844	0.763	0.906	0.614	0.63	0.873			
4	Perceived Risk	0.831	0.744	0.897	-0.335	-0.19	-0.081	0.862		
5	Subjective norms	0.953	0.877	0.966	0.601	0.538	0.47	-0.16	0.936	
6	Carsharing compatibility	0.937	0.887	0.959	0.306	0.26	0.25	0.096	0.33	0.941

Source: Authors' analysis

4.2 Data collection and sample description

Data were collected through a questionnaire and an online survey. The first part of the questionnaire was used to collect a participant's demographic information, while in the second part they were asked to respond to 30 items on the seven constructs included in the model.

Data from 373 respondents were collected through the online survey.

However, as these technologies will not be available in the near future, we believe it is reasonable to concentrate on the majority of respondents in the younger age group as potential future actual users of AVs. In addition, respondents who did not have a driving license could not complete the questionnaire. We also eliminated respondents who had missing data. As a result, a total of 361 respondents were selected and their profiles are shown in Table 2. The majority of them were younger than 33 years old (60%) and the prevalence is male respondents (57%).

Tab. 2: Sample characteristics

Variable	Category	No.	%
Gender	Female	155	42.9%
	Male	206	57.1%
Age	Younger than 33	219	60%
	33 and older	142	40%
Education	Middle school	4	1.1%
	High school	101	28.0%
	Bachelor's degree	115	31.9%
	Master's degree	112	31.0%
	PhD/second level master's degree	29	8.0%
Driving Experience	1-5 years	111	30.7%
	6-10 years	82	22.7%
	11-15 years	60	16.6%
	More than 15	108	29.9%
Family members	1 member	32	8.9%
	2 members	86	23.8%
	3 members	95	26.3%
	4 members	122	33.8%
	5 or more members	26	7.2%

Source: Authors' analysis

5. Results and discussion

The partial least squares structural equation modelling (PLS-SEM) results are acquired through the software of SmartPLS4.0. The structural model is tested based on bootstrapping with 5,000 subsamples. Age and gender were used as control variables in the model. With the path coefficient and its corresponding t value, we can assess statistical conclusion validity by testing the null hypothesis for each path coefficient (Table 3). All path coefficients are significant with the exceptions of H8. Of the seven supported hypotheses, five of them were found to be significant at $p<0.01$, and the others to be significant at $p<0.05$ (H7) and $p<0.10$ (H6). Only H8 is not supported. Specifically, PU has a positive effect on the intention to use ($\beta=0.32$, $p< 0.001$), while PEOU has a positive effect on both BI ($\beta=0.25$, $p<0.001$) and PU ($\beta=0.62$, $p<0.001$). Subjective norms (SN) also have a positive effect on the intention to use ($\beta=0.24$, $p<0.001$).

Conversely, perceived risk has a negative effect on the intention to use (β=-0.22, p<0.001). Finally, carsharing compatibility positively influences the relationship between PU and the intention to use (β=0.09, p<0.1), while negatively influences the relationship between PEOU and the intention to use (β=-0.09, p<0.05).

Tab. 3: Path coefficients

Hypothesis	Path	β	T value	P values	Supported or not
H1	PU → BI	0.323	6.147	0.000	Supported
H2	PEOU → BI	0.246	9.089	0.000	Supported
H3	PEOU → PU	0.624	15.412	0.000	Supported
H4	SN → BI	0.237	5.006	0.000	Supported
H5	Perceived Risk → BI	-0.223	6.176	0.000	Supported
H6	Carsh.Comp x PU → BI	0.092	1.932	0.053	Supported
H7	Carsh.Comp x PEOU → BI	-0.092	2.110	0.035	Supported
H8	Carsh.Comp x Perceived Risk → BI	0.042	1.136	0.256	Not Supported

Source: Authors' analysis

The results show that all the hypotheses predicted by the TAM are confirmed. In particular, the results show that PU and PEOU affect the intention to use AVs. On one hand, respondents believe using AVs would be useful for allowing them to do other tasks while driving, increasing productivity and relieving the stress of driving. On the other hand, the perception about the effort that is needed to use AVs would not hinder the intention to use them. In parallel, the belief that AVs are easier to use would enhance performance, positively affecting the PU. The subjective norm also has a significant impact on the intention to use, confirming that the social influence does affect AV adoption. As for other, not experienced technologies, opinion leaders assume a strong effect in the formation of acceptance (Venkatesh and Davis, 2000). As for the perceived safety risk, it has a significant and negative effect on the intention to use. Driving is inextricably linked to a safety perception (Fagnant and Kockelman, 2018). In line with previous studies (Zhang *et al.*, 2019), our results show that people who perceive AVs as having a higher risk are less likely to show an actual intention to use them.

Our model depicts a future in which AVs are integrated in a carsharing business model (Teece, 2018). This is, in part, verified by our results, from which it emerges that carsharing compatibility positively moderates the relationship between PU and the intention to use, indicating that those whose lifestyle and values fit well with carsharing services perceive the utility associated with AVs as a higher significant determinant towards their intention to use. This is likely related to the potential of AVs to overcome some of the limitations that are present in current transportation systems based on carsharing. Conversely, a negative moderation of carsharing compatibility affects the relationship between PEOU and the intention to use, showing that people who have more faith in carsharing services perceive that the ease of use of an AV has a lower impact on their intention to use. This is probably linked to the fact that people with a higher propensity to innovativeness, such as those people who have a positive attitude toward carsharing (Kim *et al.*, 2017), are willing to accept a higher level of complexity. However, contrary to our model, carsharing compatibility does not have any effect on perceived safety risk. Assuming a positive association between innovativeness and carsharing services (Kim *et al.*, 2017; Han *et al.*, 2019), we would have expected carsharing compatibility to reduce the perceived risk, i.e., those already accustomed to new service models in the automotive sector would be less wary of new technologies like AVs. However, in using AVs, users may consider themselves to be only involved in a few aspects of driving, as the positive relationship between PEOU and the intention to use partially confirms. The perceived risk associated with AVs may be primarily linked to external causes, such as system failures or accidental events (Lee *et al.*, 2019; Man *et al.*, 2020). Accordingly, whether AVs fit into a carsharing or individual driving pattern may not influence the perceived risk, as the potential users of AVs are likely to feel themselves hardly responsible for any accidental situations that might occur.

Overall, the study contributes to the stream of literature on consumer acceptance, by shedding light on key variables in the case of a technological change, defined as radical and strongly influencing consumer habits, as AVs have the potential to be. More specifically, it reinforces the applicability of the TAM in the context of emerging technologies such as AVs, showing that user perception of the utility and ease of use of AVs are essential drivers for their adoption. The results confirm that both perceived usefulness (PU) and perceived ease of use (PEOU) significantly influence the intention to use AVs. In addition, the study addresses the importance of the perceived safety risk as a key factor affecting the intention to use AVs, not only as a predictor of trust. While individuals who are more comfortable with carsharing are more inclined to adopt AVs, their concerns over safety remain significant. This suggests that further efforts are needed to mitigate safety concerns and enhance user behavioral intent in using AV technologies.

Furthermore, the study also contributes to the stream of literature on technology cycle and acceptance models, returning a nuanced picture of the complexity of variables and contextual factors that may intersect and influence the last phases. The novel inclusion of carsharing compatibility also contributes to the literature by extending the TAM framework with insights from IDT, shedding light on the social and behavioral contexts that influence technology adoption. The results highlight the moderating role of carsharing compatibility, indicating that individuals whose mobility styles align with carsharing services are more likely to perceive AVs as useful, thus increasing their intention to adopt that technology. This result also highlights the tendency of major technological trajectories of change to intersect and reinforce each other, not only in technological development, such as the development in connectivity in relation to the feasibility of AVs, but also in acceptance and diffusion, which, in the case of AVs, may be reinforced through a new mode of commuting.

6. Conclusion

This paper the factors that affect the intention to use AVs. We built a model drawing on the TAM and IDT. The TAM (Davis, 1989) is one of the most used theories for investigating the acceptance of new technologies. Although the TAM is a consolidated and effective model, it places emphasis, on the end user and individual characteristics, while little focus is given to the context of use even though is a crucial element for the adoption of new technologies. To tackle it, we then integrate - from IDT theory (Rogers, 1995) - compatibility as a moderating variable. Compatibility has been identified as the sole variable in Rogers's model to have a component of innovation that is still absent the TAM. Its connection to the context of use is precisely what makes it appropriate for investigating how users' prior experiences with related technologies influence their intention to use a particular technology (Min *et al.*, 2018). We specifically consider carsharing compatibility (Han *et al.*, 2019). Although it has been considered in earlier studies as a predictor of PEOU and PU, its moderating effect had not yet been directly investigated.

The contribution is threefold. Firstly, by applying the TAM model to the emerging context of AVs, it demonstrates a positive and significant effect on PEOU, PU, and SN. Secondly, the still under-explored relationship between the perceived safety risk and the intention to use is demonstrated. Thirdly, the main contribution lies in the integration of IDT and the TAM, by analyzing carsharing compatibility as a moderator of the model: results show the positive effects on the relationships between PU, PEOU, and the intention to use.

Results also offer practical and managerial implications to foster the acceptance of AVs and their diffusion in local transportation systems. On one hand, communications to end users should be addressed in order to highlight the benefits related to AVs, including in terms of improving the sustainability of the local transportation system. In addition, the fact that users associate the hazards of operating an AV with circumstances beyond their control highlights the need to provide adequate information regarding the checks performed on the vehicle prior to its release. Moreover, considering the positive role of opinion leaders (subjective norms - intention to use relationship), special attention should be paid to them as a means to foster the mass adoption of AVs. On the other hand, a human-friendly and sample design could make the user more confident in trying an AV, enhancing the probability of adopting it, especially if it fits in with carsharing services. Carsharing business models are likely to play a critical role in the diffusion of AVs. Collaborations with policymakers, manufacturing companies, and local carsharing service operators could help in the experimentation with higher levels of automation and the subsequent adaptation of local infrastructure, making them more familiar to the end user. Ultimately, policymakers should provide the necessary infrastructure to allow shared AVs to travel on public roads so that AVs can be integrated into the local transportation system to make it more efficient and sustainable.

This study has some limitations that could be addressed in future research. Firstly, AVs rely on technologies which are not yet fully available. Moreover, the high technical complexity makes it difficult for the respondents to understand, for instance, the different levels of automation involved and the implications these technologies could have on daily life. Secondly, the study is set as exploratory and cross-sectional, while complex phenomenon would need to be investigated further in time and space. Thirdly, the study focuses on an Italian sample and comprises only younger generations. Future research might, then, consider analyzing actual usage within experimentation fields such as living labs, which are emerging as a valuable means to test innovations and their impact within society. Fourthly, as AVs technologies are evolving, it could be interesting to apply a longitudinal lens of analysis, investigating how user acceptance changes over time. The road test would also allow the integration of other IDT variables that were not analyzed in this study, with new forms of integration between the TAM and IDT to be explored. In addition to this, the experimental context and the integration with the external environment could help in a deeper analysis of the perceived safety risk antecedents, as other kinds of risks could be associated with AVs. Finally, future research could extend the sample to other countries, analyzing how cultural and contextual differences might affect the adoption of AVs, to corroborate the results.

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Appendix A

Construct (no. of items)	Item	Conceptualization	Source
Intention to use (4)	INT1 I intend to use autonomous vehicles in the future.	The degree to which a person intends to use an AV in the future	Davis (1989)
	INT2 Assuming I had access to an autonomous vehicle, I would use it.		
	INT3 If I had access to an autonomous vehicle, I think that I would use it.		
	INT4 I will think about using an AV in the future.		
Perceived Usefulness (5)	PU1 Autonomous vehicles will let me do other tasks on my journey, such as eating, watching a movie, using a mobile telephone.	The degree to which a person believes that using an AV would improve their performance.	Davis (1989)
	PU2 Using AVs will decrease the risk of an accident.		
	PU3 Using AVs will relieve my stress of driving.		
	PU4 Using AVs would increase my productivity.		
	PU5 I think AVs will be useful when I'm impaired (e.g., drowsy, drunk, on drugs).		
Perceived ease of use (3)	PEOU1 I expect AVs will be easy to use.	The degree to which a person believes that using an AV will be free from effort	Davis (1989)
	PEOU2 I will find it easy to get AVs to do what I want them to do.		
	PEOU3 It will be easy for me to become skillful at using AVs.		
Subjective Norms(5)	SN1 In general, the people I like would encourage me to use the system.	The extent to which a person perceives that others (e.g., family, friends, colleagues) would say that they should use an AV	Taylor and Todd (1995)
	SN2 The people who influence me would say that I should use an AV.		
	SN3 The people who influence my behavior would say that I should use an AV.		
	SN4 The people who are important to me think that I should use an AV.		
	SN5 The people I admire would encourage me to use the system.		
Perceived safety risk (5)	PR1 Using AVs would be risky.	The extent to which a person believes that an AV will behave as expected	Pavlou (2003) Choi and Ji (2015)
	PR2 The safety of AVs may not meet my expectations		
	PR3 I worry about whether AVs will provide the level of benefits I expect		
	PR4 AVs may not be safe, i.e., they may be (or become) dangerous or harmful		
	PR5 Danger may arise due to a user's misuse of an AV.		
Carsharing Compatibility (3)	CS1 Carsharing is compatible with all aspects of my life.	The degree to which a person's lifestyle fits into carsharing	Han *et al.*, 2019
	CS2 Carsharing fits into my lifestyle		
	CS3 Carsharing fits well with my needs.		

Source: Authors' analysis

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