Spring 4-29-2020

TECHNOLOGICAL ENTHUSIASM AS A DISTINCTIVE ELEMENT FOR ADOPTING SEMI AND FULLY AUTONOMOUS VEHICLES

Klara Ljubi
University of Ljubljana, klara@ljubi.si

Anton Manfreda
University of Ljubljana, anton.manfreda@uni-lj.si

TECHNOLOGICAL ENTHUSIASM AS A DISTINCTIVE ELEMENT FOR ADOPTING SEMI AND FULLY AUTONOMOUS VEHICLES

Klara Ljubi, Anton Manfreda
University of Ljubljana, School of Economics and Business, Kardeljeva ploscad 17, 1000 Ljubljana, Slovenia
klara@ljubi.si, anton.manfreda@ef.uni-lj.si

Abstract

Smart cities rely on digital technologies that might be questionably acceptable among the population due to their newness. Millennials as a generation that was born into the setting featuring smart technologies seem to be an appropriate focus group for understanding the attitudes towards these technologies. Given that autonomous vehicles (AV) are the future mobility service in smart cities, an important question regarding their adoption arises. Previous research has shown that technological enthusiasm is an important factor for adopting new technologies. The purpose of this paper is therefore to examine the attitude of millennials towards semi- and fully AV. AV trust, AV concerns, AV benefits, AV safety and AV data sharing have been shown to be additional factors that are important in addressing AV adoption. Besides, statistically significant differences between the groups, namely technologically more enthusiastic and technologically less enthusiastic, were identified and further analysed.

Keywords: Autonomous vehicles, Fully autonomous vehicles, Semi-autonomous vehicles, Autonomous vehicles adoption, Digital transformation, Information technology, Millennials, Technological enthusiasm

1.0 Introduction

Just as the widespread use of smartphones a decade ago was unimaginable, vehicles that will drive autonomously are questionable today. Even though this new technology named autonomous vehicles (AV) is likely to remain unaffordable in the coming years (Fagnant & Kockelman, 2015), its dispersion is being researched from several perspectives, e.g. AV adoption factors (Manfreda, Ljubi, & Groznik, 2019), attitude towards AV (Kyriakidis, Happee, & de Winter, 2015), concerns regarding AV (Wang & Zhao, 2019), benefits and efficiencies of AV (Bansal, Kockelman, & Singh, 2016), the effect on the environment (Wadud, MacKenzie, & Leiby, 2016), facilitating mobility for the elderly (Yang & Coughlin, 2014), willingness to pay for AV (Daziano, Sarrias, & Leard, 2017), driving patterns (Haboucha, Ishaq, & Shiftan, 2017). AV are

expected to improve traffic flow (Papadoulis, Quddus, & Imprialou, 2019), safety and reduce congestion (Wadud, et al., 2016) and demand for parking (Millard-Ball, 2019).

Skeete (2018) has already emphasised a lack of non-technology-oriented studies in the field of AV; however, understanding the relationship with and attitude towards newly developed technologies that individuals possess is of equal importance before any widespread adoption of this new technology is achieved. Thus, the purpose of our research is to examine the attitude of millennials towards semi- and fully AV. The paper is divided into four parts. First, the literature review briefly presents the relevant concepts and research questions are set. This is followed by the description of the research methodology. Further, the results specify our main findings and finally the discussion and concluding remarks are outlined.

2.0 Literature review

2.1 Digital transformation

Digital transformation is changing the way of living and conducting our business (Manfreda, et al., 2019). Despite its inception in the 1980s, it has gained importance in recent times and is expected to become even more important in the coming decades (Gerth & Peppard, 2016). Being defined as "a process that is heavily influenced by external drivers, such as the use of new technologies by stakeholders of public administrations" and "a continuous process that needs frequent adjustments of its processes, services, and products to external needs" (Mergel, Edelmann, & Haug, 2019, p. 10), development from two perspectives is necessary for successful digital transformation; first, a change in technology and, second, a change in organisations and society. Nevertheless, there is often a discrepancy between the two. Importantly, the digital transformation is not only about new technology (Hinings, Gegenhuber, & Greenwood, 2018) but requires major changes in strategy, business models, processes, and organizational structures (Westerman, Calméjane, Bonnet, Ferraris, & McAfee, 2011) as well as a reassessment of company norms and values (Liu, Chen, & Chou, 2011). Companies, therefore, face major challenges in managing their digital transformation, and Venkatraman and Henderson (1998) argued decades ago that industrial-age business models are not suited to the challenges of the information age.

Digitalisation as the world's most important technology trend (Leviäkangas, 2016) with many potential opportunities affects individuals, organizations, communities and entire nations. Although the technology has developed greatly and several novelties have entered the market, e.g. mobile application service (Hur, Lee, & Choo, 2017), leasing smartphones (Rousseau, 2019), new technologies in tourism (Schiopu, Padurean, Tala, & Nica, 2016), new technologies in libraries (Soroya & Ameen, 2018), the decisive factor for the adoption of new technology is usually human-related. Therefore, we review the models for technology adoption below.

2.2 Technology adoption

In the absence of valid measures for technology acceptance/adoption, Fred D. Davis proposed a technology acceptance model (TAM) in 1989 with perceived usefulness and perceived ease of use as two fundamental factors for adopting or rejecting a particular technology. He referred to perceived usefulness as "the degree to which a person believes that using a particular system would enhance his or her job performance" while perceived ease of use represented "the degree to which a person believes that using a particular system would be free of effort" (Davis, 1989, p. 320). Since then, TAM has successfully explained several phenomena, also recently in relation to digital transformation. Scherer, Siddiq, and Tondeur (2019) used TAM in technology adoption by teachers, Vahdat, Alizadeh, Quach, and Hamelin (2020) validated TAM in the case of mobile app usage while Sepasgozar, Hawken, Sargolzaei, and Foroozanfa (2019) adapted TAM for the context of urban services.

Notwithstanding, already Davis (1989) emphasised the importance of extending TAM findings to examine the relationships between the original TAM variables and other variables that relate to these two. Accordingly, the models that have followed have been modified in a way to consider contextual characteristics of technologies. Venkatesh and Davis (2000) proposed TAM2 model, where social influence processes and cognitive instrumental processes significantly influence technology adoption. Further, Venkatesh, Morris, Davis and Davis (2003) developed unified theory of acceptance and use of technology model (UTAUT) in which four direct determinants and four moderators were studied as the factors of technology adoption. The determinants are performance expectancy, effort expectancy, social influence and facilitating conditions,

and the moderators are gender, age, experience a voluntariness to use. UTAUT was used by Zuiderwijk, Janssen, and Dwivedi (2015) to determine the predictors of open data source technologies and by Cimperman, Makovec Brenčič, and Trkman (2016) to predict the acceptance of home telehealth services, in both cases with some model modifications. Then, Dwivedi et al. (2017) developed the Unified Model of E-Government Adoption (UMEGA) which corresponds to the context of electronic government. Most of these modifications have empirically shown a significant improvement in the explanation of variability as well as an increase in fit indices. Therefore, we believe that we should support our research with these models.

2.3 Autonomous vehicles in smart cities

AV are technologically supported by the spread of information and communication technology (ICT), internet of things (IoT) and artificial intelligence (AI) resulting from digital transformation. These terms are phenomena that facilitate the life in smart cities (Eldrandaly, Abdel-Basset, & Abdel-Fatah, 2019) and would enable smarter infrastructure, e.g. mobility, in smart cities (Appio, Lima, & Paroutis, 2019). In our research, we refer to the definition of AV or self-driving vehicles as vehicles that operate without direct driver input for controlling the steering, acceleration, and braking and are designed in a way that the driver is not expected to constantly monitor the roadway when operating in self-driving mode (Fleetwood, 2017). Taking into account that smart city research could be divided into the following themes Smart Mobility, Smart Living, Smart Environment, Smart Citizens, Smart Government, Smart Economy and Smart Architecture and Technologies (Ismagilova, Hughes, Dwivedi, & Raman, 2019), AV fit into a theme of smart mobility and as such represent a building block of future smart cities.

Importantly, technology should be taken only as an enabler for smart cities' development, while full exploitation of envisaged benefits could only be obtained when the smart city is integrated with and into the local community (Peng, Nunes, & Zheng, 2017). Therefore, new business models should be designed with an understanding of the drivers of technology adoption (Daziano, et al., 2017) and user engagement to use such services (Peng, et al., 2017) rather than merely from a technological perspective.

2.4 Mobility-related trends and issues

Modern technologies that have flooded the market have not exempted the transport industry. The paradigm shift created by electric vehicles and AV is bringing new modes of conducting mobility that is becoming more intelligent, interconnected and efficient (Lee, Hancock, & Hu, 2014). To support transportation and the diversity of services in smart cities, various applications are being developed. For example, according to Lee, et al. (2014), the city of San Francisco has the highest number of services exactly in transportation. Moreover, are more and more intelligent analytical tools based on real-time and integrated services.

Referring to smart mobility as one component of smart cities, it could include, but is not limited to the following: traffic management, vehicle tracking, route stability, smart metros and internet of vehicles, where ICT aims to improvement of urban traffic and transport (Ismagilova, et al., 2019). Smart mobility has not yet been so extensively researched; however, it is becoming increasingly important in research, investment, and sustainable innovation around the world (Lopez-Carreiro & Monzon, 2018; Noy & Givoni, 2018). Zhou et al. (2020) see shared mobility as an opportunity for communities, e.g. parking needs' reduction. Even though AV are considered to primarily permeate private usage, they could also be incorporated into public transport as one of the means of modern transportation in smart cities. The introduction of shared autonomous public transport as a future alternative to current transportation could reduce vehicle ownership (Jadaan, Zeater, & Abukhalil, 2017; Pettigrew, Dana, & Norman, 2019).

In recent research, Manfreda, et al. (2019) linked smart mobility, or more precisely AV, and Slovenian millennials in order to highlight important factors in the adoption of AV adoption among them. As already mentioned, the identification of human-specific factors is crucial if we are to develop such strategies to maximise end-user AV adoption. They showed that technological mindedness, perceived safety, technological and legal concerns as well as perceived personal and societal benefits influence AV adoption. Thus, it is necessary to further explore how to bring AV technology closer to users where their concerns need to be addressed and dealt with. Even though the principles of technology adoption also apply in the case of AV, there are additional aspects, e.g. trust, giving up control, that should and could not be neglected (Hegner, Beldad, & Brunswick, 2019; Kaltenhäuser, Werdich, Dandl, & Bogenberger, 2020).

Hossain, Quaresma, and Rahman (2019) and Manfreda, et al. (2019) proved a positive relationship between technologically minded or personally innovative individuals, i.e. the high intention of the individual to adopt new technologies, and willingness to adopt new technology; in these two cases electronic health record in the healthcare system and AV, respectively. Another moderating factor influencing new technology adoption is age as found by Zhao, Ni, and Zhou (2018) for mobile health service adoption and Ruggeri et al. (2018) for AV adoption.

The generation aged between 20 and 30, the so-called millennials, interacts with technology in a way incomparable to any previous generation before them (Au-Yong-Oliveira, Gonçalves, Martins, & Branco, 2018). They were born into a setting featuring modern and smart technologies and are also prone to change. Since millennials are on the verge of assimilating deeper into the workforce with increasing purchasing power in the coming decades, they are expected to represent a significant market of digital technology and, more specifically, autonomous technology. Millennials have been engaged by many researchers to understand the relationships between them and new technologies, e.g. in the contexts of mobile application service (Hur, et al., 2017) and leasing smartphones (Rousseau, 2019). Besides, Ruggeri, et al. (2018) in their study confirmed that the age group between 18 and 25 years represents the highest proportion of early AV adopters, while the age group above 65 years was most likely among those who either avoid or late adopt. It is, therefore, justifiable to consider millennials also in our research in relation to AV and associated technologies.

2.5 Research questions

Findings on AV driving patterns and views on AV-associated technologies can make an important theoretical and practical contribution. As can be seen from the literature review, the transport industry and the mobility sector are experiencing a shift where human-related aspects have to be considered rather than just technology-related aspects. Based on the literature review, our previous research and observations, we wanted to further investigate the attitude of millennials towards AV. Specifically, in this research, we wanted to investigate the interaction of different factors important for AV adoption, focusing on the following research questions:

- Q1. How are assistant technologies in vehicles perceived by millennials?

- Q2. Are there differences between technologically more and technologically less enthusiastic millennials?
- Q3. How do groups of technologically more and technologically less enthusiastic millennials differ?

Important AV adoption factors have been identified from the literature review and are presented in Figure 1. We looked at how these factors are differently perceived among millennials. Our purpose was to look at the intersections of the circles in order to see whether there are differences in attitudes towards AV between millennials who are enthusiastic about technology and those who tend to adopt new technologies at later phases. Next, we planned to provide an insight into the attitude towards assistive technologies that are being installed into vehicles; for now, human and in the future autonomously driven. However, in the case of the latter research perspective, the sample was taken as a whole and not divided into groups.

This research would contribute to the body of knowledge regarding the understanding of millennials' attitude towards AV. Furthermore, it could provide policymakers and car manufacturers with more information on suitable approaches to the transformation to smart mobility.

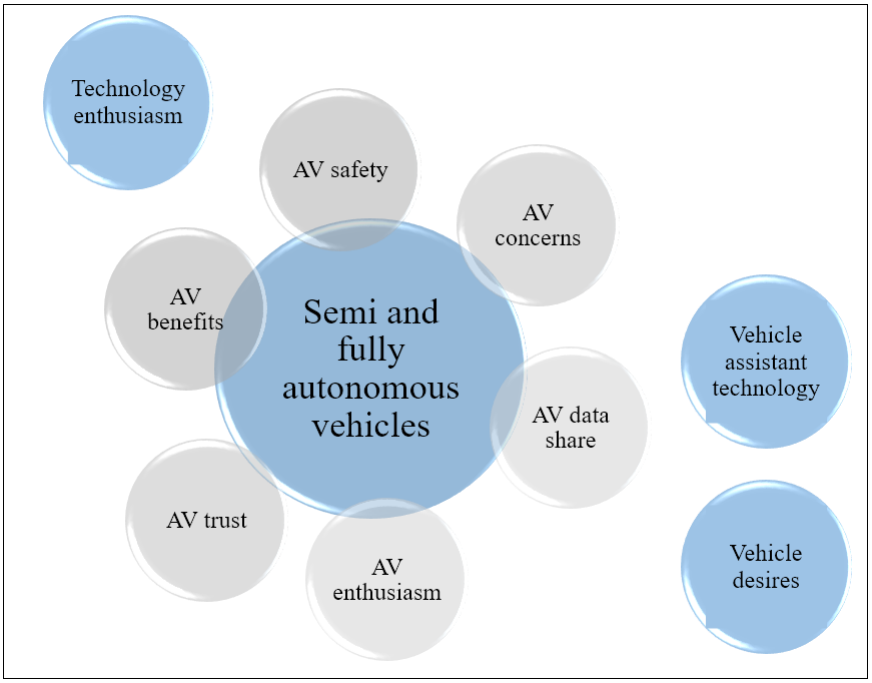

Figure 1. Interplay of factors important for AV adoption.

3.0 Research methodology

We prepared a web-based questionnaire in order to assist us with our research questions. The questionnaire contained several items measuring enthusiasm regarding new technologies, attitudes towards different technologies used in vehicles, and different perceptions regarding semi- and fully-AV including privacy issues, security, safety and efficiency. All variables were measured using a 5-point Likert scale ranging from "strongly disagree" (1) to "strongly agree" (5).

Different millennials in Slovenia aged from 20 to 30 were invited to participate in the research. For this purpose, an online questionnaire was thus randomly disseminated among individuals. Overall, 408 individuals finished the questionnaire; however, 305 individuals were included in the analysis, since they responded with all the data needed for the analysis. Data collection started in May and was completed in July 2019. The profile of the respondents is presented in Table 1. Slightly below the three-thirds of our sample were females and slightly above one-third were males. Most of them were, at the time of questionnaire distribution, obtaining a bachelor's degree and accordingly possessed secondary or lower education. Location of residence among them was diverse while the majority of them possessing driver's license with only 5.9 per cent that did not drive neither once per week.

		Share (%)
Gender	male	36.8
	female	63.2
Education	secondary or less	77.2
	tertiary	22.8
Type of settlement	urban settlement	43.0
	suburban areas	23.1
	small city	26.6
	village areas	7.3
Frequency of driving	don't drive	5.9
	less than one time per week	11.9
	1-2 times per week	20.6
	3-4 times per week	17.8
	5 times per week or more	43.7

Table 1. Profile of respondents.

We also looked at the daily habits of millennials and their preferred method of mobility. The results are evident from Table 2. Walking has proven to be the most commonly

used means of "transport" (transport in parentheses as walking might not be primarily considered as transport) used by more than half of respondents, followed by personal car and public transport.

	Daily	Weekly	Monthly	Occasionally	Never
Personal car	49%	34%	8%	7%	2%
Rent a car	0%	0%	0%	12%	88%
Taxi	0%	2%	11%	59%	28%
Car sharing	5%	14%	8%	20%	54%
Public transport	37%	18%	13%	26%	7%
Bicycle	9%	19%	13%	35%	25%
Walking	58%	23%	6%	13%	1%
Other	7%	6%	12%	15%	61%

Table 2. Preferred method of transport or mobility.

In order to examine the excitement at different levels of automation, we analysed the millennials' desire to own different vehicles if there were no financial restrictions. Millennials were asked to determine the likelihood of owning a vehicle with a certain level of automation ranging from no automation to full automation, i.e. a transfer of all safety-critical driving functions from driver to vehicle (Fleetwood, 2017).

As shown in Figure 2, millennials would be willing to own a vehicle with at least some automation. They would most likely own a vehicle with a first, second or third level of automation while they are not entirely sure about higher levels of automation. In case of unlimited financial budget, millennials would not be willing to own a vehicle without automation.

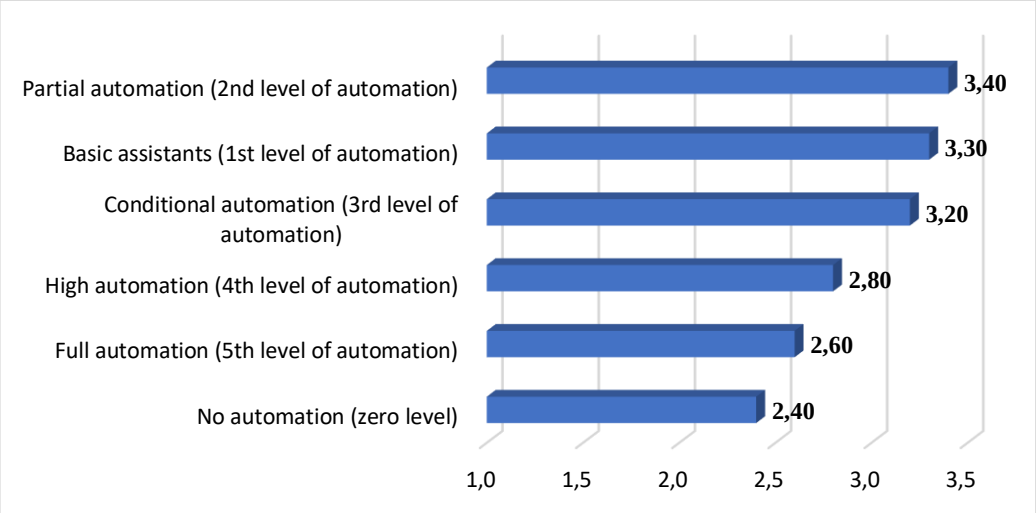

Figure 2. Desired millennials' vehicle.

4.0 Results

Besides the examination of the desire to own a particular vehicle, we were also interested in the attitude towards different assistant technologies used in the vehicles. There are some technologies with a solely assistive role, e.g. reverse driving camera, whereas the others have replaceable role meaning that they act instead of the user, e.g. automatic gearbox. As observable from Table 3, millennials turned out as inclined towards assistant technologies that are increasingly being installed in the vehicles. According to the means, enthusiasm towards assistive technologies is positive since they mostly exceed 4.00 on a Likert scale from 1 to 5.

	Mean	**Std. deviation**
Blindspot detection	4.47	0.755
Reverse driving camera	4.37	0.758
Parking assistant	4.29	0.852
Adaptive cruise control	4.19	0.848
Emergency assist	4.18	0.828
Pedestrian detection	4.17	0.879
Speed warning system	4.16	0.850
Automated braking system	4.12	0.891
Traffic jam assistant	4.11	0.883
Fatigue detection	4.02	0.944
Auto light assistance	4.00	0.950
Traffic sign detection	3.97	0.957
Automatic gearbox	3.84	1.122
Lane assist	3.83	1.072
Speed assessment	3.82	0.974
Trailer assistant	3.71	1.069
Left turn manoeuvre support system	3.58	1.064

Table 3. The attitude towards different assistant technologies perceived by millennials.

Further, we used four items to measure the attitude towards new technologies. Based on these items, we calculated the average value measuring the enthusiasm regarding new technologies. The distribution of these values is presented in Figure 3. The normality testing led us to the conclusion that millennials are normally distributed regarding their enthusiasm toward new technologies (Skewness 0.103 and Kurtosis -0.289).

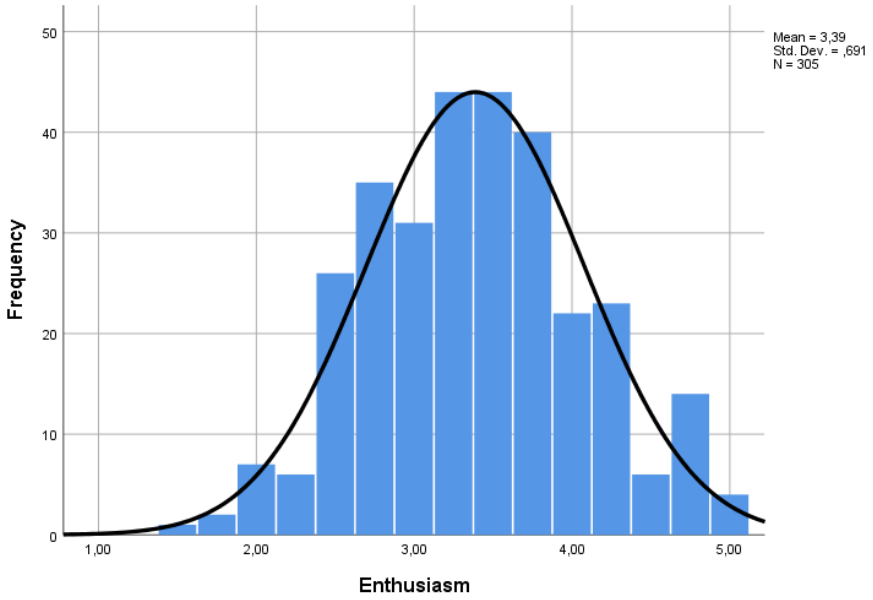

Figure 3. Distribution of technology attitude's average values.

In order to compare the differences in perception towards semi- and fully-AV, we divided millennials into three groups, i.e. technologically less enthusiastic (values from 1.00 to 2.50), neutral regarding the technology (values from 2.51 to 3.99) and technologically more enthusiastic (values from 4.00 to 5.00). The distribution within groups is evident from Table 4. Technologically neutral individuals represent the highest share of all three groups which is consistent with the literature stating that the shares of technologically more and technologically less enthusiastic individuals are lower Hossain, et al. (2019); (Ruggeri, et al., 2018).

Group	Frequency	Valid percent
1 – technologically less enthusiastic	42	13.8
2 – neutral regarding the technology	194	63.6
3 – technologically more enthusiastic	69	22.6
Total	305	100.0

Table 4. Distribution of millennials within three specified technology enthusiastic groups.

Related to the defined groups, we analysed factors that are important for AV adoption as perceived by technologically differently enthusiastic millennials. Results from Table 5 support the findings that higher enthusiasm regarding the technology leads to a more positive attitude. The first group scored the lowest on all factors but one; the opposite holds true for the first group as the least enthusiastic. The latter unsurprisingly turned out as the least concerned regarding AV themselves as well as safety and data sharing

were the most trustworthy towards AV and with the highest expectations of their positive benefits.

Factor	Group	N	Mean	Std. deviation
AV enthusiasm	1 – technologically less enthusiastic	37	2.85	0.145
	2 – neutral regarding the technology	178	3.29	0.059
	3 – technologically more enthusiastic	63	3.92	0.095
AV trust	1 – technologically less enthusiastic	37	2.99	0.133
	2 – neutral regarding the technology	178	3.23	0.054
	3 – technologically more enthusiastic	63	3.52	0.078
AV concerns	1 – technologically less enthusiastic	37	3.96	0.080
	2 – neutral regarding the technology	178	3.79	0.045
	3 – technologically more enthusiastic	63	3.57	0.081
AV benefits	1 – technologically less enthusiastic	37	3.08	0.162
	2 – neutral regarding the technology	178	3.55	0.057
	3 – technologically more enthusiastic	63	3.77	0.105
AV safety	1 – technologically less enthusiastic	37	3.02	0.132
	2 – neutral regarding the technology	178	3.43	0.055
	3 – technologically more enthusiastic	63	3.77	0.094
AV data sharing	1 – technologically less enthusiastic	37	2.66	0.161
	2 – neutral regarding the technology	178	3.12	0.067
	3 – technologically more enthusiastic	63	3.30	0.124

Table 5. Factors important for AV adoption perceived by technologically differently enthusiastic millennials.

Nevertheless, the differences for a factor AV concerns were among the lowest showing that the newness of the technology and its wide potential impact is questionable for all three groups. Oppositely, among the highest differences are observable from a factor AV safety which might be stemming from higher awareness of more technologically enthusiastic individuals regarding AV and their actual influence. The differences were the highest for a factor AV enthusiasm which was expected since it represents an overall-opinionated factor.

In further analysis, we focused on the first group, i.e. technologically less enthusiastic, and third group, i.e. technologically more enthusiastic, in order to outline the differences between these two groups. Table 6 shows statistically significant difference between the groups. Therefore, we can conclude that the millennials who are more technologically enthusiastic will have a higher willingness to adopt AV technology compared to those who are less technologically enthusiastic. This holds for all factors that are, according to the literature, important for AV adoption.

		Levene's Test for Equality of Variances		t-test for Equality of Means		
		F	Sig.	t	df	Sig. (2-tailed)
AV enthusiasm	Equal variances assumed	2.556	.113	-6.202	104	.000
	Equal variances not assumed			-6.006	78.211	.000
AV trust	Equal variances assumed	4.206	.043	-3.984	105	.000
	Equal variances not assumed			-3.784	72.800	.000
AV concerns	Equal variances assumed	2.091	.151	3.125	102	.002
	Equal variances not assumed			3.320	97.677	.001
AV benefits	Equal variances assumed	1.756	.188	-3.891	102	.000
	Equal variances not assumed			-3.725	71.398	.000
AV safety	Equal variances assumed	.059	.809	-5.024	101	.000
	Equal variances not assumed			-4.897	76.132	.000
AV data sharing	Equal variances assumed	.001	.974	-2.871	102	.005
	Equal variances not assumed			-2.868	82.738	.005

Table 6. Independent samples t-test for comparing the differences between technologically differently enthusiastic millennials.

5.0 Discussion

Literature suggestions go into the direction that individuals who are more open to new technologies will adopt technologies offered to them with higher likelihood (Hossain, et al., 2019) which could be concluded also based on our sample. Statistically significant differences were confirmed for all the factors, i.e. AV enthusiasm, AV trust, AV concerns, AV benefits, AV safety and AV data sharing, that are important to millennials in terms of AV adoption, most of which were recently referred to as vital factors for AV adoption (Manfreda, et al., 2019).

Importantly, our research focused on both, semi- as well as fully-AV, which is not that extensively represented in the current literature. However, since fully-AV are a long-term focus whereas in the meantime semi-AV are expected to spread across the market, research of semi-AV is of equal, if not higher, importance. Considering our findings, millennials would be willing to own a vehicle with at least some level of automation considering unlimited financial resources and have declared a positive attitude towards

the installation of any of the assistant technologies in their vehicle. The latter could be backed up with the fact that car manufacturers are already equipping their vehicles with those technologies and the millennials, or car drivers in general, already have some level of awareness regarding them and experience with them.

Relating to millennials as a technology generation being born with and opened to modern technologies (Au-Yong-Oliveira, et al., 2018), they seem to be the right choice for the research in relation to AV and associated technologies. However, the differences between more and less technologically enthusiastic individuals remain even in the population limited to millennials despite their familiarity with the technology. Thus, those differences would have to be further researched to provide some beneficial findings to car manufacturers and policymakers to firstly get an overview of the important factors and then further gain deeper insights in order to strategize regarding future development, especially overcoming AV concerns which still score high on a scale with regard to AV adoption factors besides AV safety. Taking into account the newness of the technology and its wide potential impact, AV adoption is questionable for all three groups that we divided our sample into.

Future research is required due to several reasons. First, our findings are constrained by the limitation of the sample to a single country. Moreover, since the technology is still in its infancy and requires further massive testing, the perceptions of millennials might be clarified with more intense testing and increased trust in AV. More research should be also dedicated to semi-AV as an intermediate solution in transportation.

6.0 Conclusion

The impact of digitalisation on society is enormous. Accessibility of information technology to the general public together with all the accompanying upsides and downsides that this technology brings, make the relevancy of the research in these areas increasingly important, particularly considering the generation that is going to be on the rise regarding their purchasing power in the upcoming decades. Not only it has been proven for AV but also other technologies arising from digital transformation that millennials are an important focus group as embracers and early adopters of smart technologies and new transport modes. After all, millennials are the generation that will

have to accept the changes, so knowing their scepticism, concerns and also positive expectations is crucial.

The progress in the development of smart cities heavily relies on accompanying technologies. The latter is expected to enhance the quality of living and reduce costs and resource consumption. To make AV future mobility in smart cities a reality, a rethinking of automotive industries' value chains and policymakers' strategies is required. Either semi- or fully-AV, understanding relationship with and attitude towards newly developed technologies is of vital importance before any widespread adoption is achieved.

References

Appio, F. P., Lima, M. and Paroutis, S. (2019) *Understanding Smart Cities: Innovation ecosystems, technological advancements, and societal challenges*, Technological Forecasting and Social Change, 142 1-14.

Au-Yong-Oliveira, M., Gonçalves, R., Martins, J. and Branco, F. (2018) *The social impact of technology on millennials and consequences for higher education and leadership*, Telematics and Informatics, 35 954-963.

Bansal, P., Kockelman, K. M. and Singh, A. (2016) *Assessing public opinions of and interest in new vehicle technologies: An Austin perspective*, Transportation Research Part C: Emerging Technologies, 67 1-14.

Cimperman, M., Makovec Brenčič, M. and Trkman, P. (2016) *Analyzing older users' home telehealth services acceptance behavior—applying an Extended UTAUT model*, International Journal of Medical Informatics, 90 22-31.

Davis, F. (1989) *Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology*, MIS Quarterly, 13 319-339.

Daziano, R. A., Sarrias, M. and Leard, B. (2017) *Are consumers willing to pay to let cars drive for them? Analyzing response to autonomous vehicles*, Transportation Research Part C: Emerging Technologies, 78 150-164.

Dwivedi, Y. K., Rana, N. P., Janssen, M., Lal, B., Williams, M. D. and Clement, M. (2017) *An empirical validation of a unified model of electronic government adoption (UMEGA)*, Government Information Quarterly, 34 211-230.

Eldrandaly, K. A., Abdel-Basset, M. and Abdel-Fatah, L. (2019) *PTZ-Surveillance coverage based on artificial intelligence for smart cities*, International Journal of Information Management, 49 520-532.

Fagnant, D. J. and Kockelman, K. (2015) *Preparing a nation for autonomous vehicles: opportunities, barriers and policy recommendations*, Transportation Research Part A: Policy and Practice, 77 167-181.

Fleetwood, J. (2017) *Public health, ethics, and autonomous vehicles*, American journal of public health, 107 532-537.

Gerth, A. B. and Peppard, J. (2016) *The dynamics of CIO derailment: How CIOs come undone and how to avoid it*, Business Horizons, 59 61-70.

Haboucha, C. J., Ishaq, R. and Shiftan, Y. (2017) *User preferences regarding autonomous vehicles*, Transportation Research Part C: Emerging Technologies, 78 37-49.

Hegner, S. M., Beldad, A. D. and Brunswick, G. J. (2019) *In Automatic We Trust: Investigating the Impact of Trust, Control, Personality Characteristics, and Extrinsic and Intrinsic Motivations on the Acceptance of Autonomous Vehicles*, International Journal of Human–Computer Interaction, 35 1769-1780.

Hinings, B., Gegenhuber, T. and Greenwood, R. (2018) *Digital innovation and transformation: An institutional perspective*, Information and Organization, 28 52-61.

Hossain, A., Quaresma, R. and Rahman, H. (2019) *Investigating factors influencing the physicians' adoption of electronic health record (EHR) in healthcare system of Bangladesh: An empirical study*, International Journal of Information Management, 44 76-87.

Hur, H. J., Lee, H. K. and Choo, H. J. (2017) *Understanding usage intention in innovative mobile app service: Comparison between millennial and mature consumers*, Computers in Human Behavior, 73 353-361.

Ismagilova, E., Hughes, L., Dwivedi, Y. K. and Raman, K. R. (2019) *Smart cities: Advances in research—An information systems perspective*, International Journal of Information Management, 47 88-100.

Jadaan, K., Zeater, S. and Abukhalil, Y. (2017) *Connected Vehicles: An Innovative Transport Technology*, Procedia Engineering, 187 641-648.

Kaltenhäuser, B., Werdich, K., Dandl, F. and Bogenberger, K. (2020) *Market development of autonomous driving in Germany*, Transportation Research Part A: Policy and Practice, 132 882-910.

Kyriakidis, M., Happee, R. and de Winter, J. C. F. (2015) *Public opinion on automated driving: Results of an international questionnaire among 5000 respondents*, Transportation Research Part F: Traffic Psychology and Behaviour, 32 127-140.

Lee, J. H., Hancock, M. G. and Hu, M.-C. (2014) *Towards an effective framework for building smart cities: Lessons from Seoul and San Francisco*, Technological Forecasting and Social Change, 89 80-99.

Leviäkangas, P. (2016) *Digitalisation of Finland's transport sector*, Technology in Society, 47 1-15.

Liu, D.-Y., Chen, S.-W. and Chou, T.-C. (2011) *Resource fit in digital transformation: Lessons learned from the CBC Bank global e-banking project*, Management Decision, 49 1728-1742.

Lopez-Carreiro, I. and Monzon, A. (2018) *Evaluating sustainability and innovation of mobility patterns in Spanish cities. Analysis by size and urban typology*, Sustainable Cities and Society, 38 684-696.

Manfreda, A., Ljubi, K. and Groznik, A. (2019) *Autonomous vehicles in the smart city era: An empirical study of adoption factors important for millennials*, International Journal of Information Management, In Press

Mergel, I., Edelmann, N. and Haug, N. (2019) *Defining digital transformation: Results from expert interviews*, Government Information Quarterly, 36 101385.

Millard-Ball, A. (2019) *The autonomous vehicle parking problem*, Transport Policy, 75 99-108.

Noy, K. and Givoni, M. (2018) *Is 'Smart Mobility' Sustainable? Examining the Views and Beliefs of Transport's Technological Entrepreneurs*, Sustainability, 10 19.

Papadoulis, A., Quddus, M. and Imprialou, M. (2019) *Evaluating the safety impact of connected and autonomous vehicles on motorways*, Accident Analysis & Prevention, 124 12-22.

Peng, G. C. A., Nunes, M. B. and Zheng, L. (2017) *Impacts of low citizen awareness and usage in smart city services: the case of London's smart parking system*, Information Systems and e-Business Management, 15 845-876.

Pettigrew, S., Dana, L. M. and Norman, R. (2019) *Clusters of potential autonomous vehicles users according to propensity to use individual versus shared vehicles*, Transport Policy, 76 13-20.

Rousseau, S. (2019) *Millennials' acceptance of product-service systems: Leasing smartphones in Flanders (Belgium)*, Journal of Cleaner Production, 118992.

Ruggeri, K., Kácha, O., Menezes, I. G., Kos, M., Franklin, M., Parma, L., . . . Miles, J. (2018) *In with the new? Generational differences shape population technology adoption patterns in the age of self-driving vehicles*, Journal of Engineering and Technology Management, 50 39-44.

Scherer, R., Siddiq, F. and Tondeur, J. (2019) *The technology acceptance model (TAM): A meta-analytic structural equation modeling approach to explaining teachers' adoption of digital technology in education*, Computers & Education, 128 13-35.

Schiopu, A. F., Padurean, A. M., Tala, M. L. and Nica, A. M. (2016) *The influence of new technologies on tourism consumption behavior of the millennials*, Amfiteatru Economic, 18 829-846.

Sepasgozar, S. M. E., Hawken, S., Sargolzaei, S. and Foroozanfa, M. (2019) *Implementing citizen centric technology in developing smart cities: A model for predicting the acceptance of urban technologies*, Technological Forecasting and Social Change, 142 105-116.

Skeete, J.-P. (2018) *Level 5 autonomy: The new face of disruption in road transport*, Technological Forecasting and Social Change, 134 22-34.

Soroya, S. H. and Ameen, K. (2018) *What do they want? Millennials and role of libraries in Pakistan*, The Journal of Academic Librarianship, 44 248-255.

Vahdat, A., Alizadeh, A., Quach, S. and Hamelin, N. (2020) *Would you like to shop via mobile app technology? The technology acceptance model, social factors and purchase intention*, Australasian Marketing Journal (AMJ),

Venkatesh, V. and Davis, F. (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. and Davis, F. (2003) *User Acceptance of Information Technology: Toward a Unified View*, MIS Quarterly, 27 425-478.

Venkatraman, N. and Henderson, J. C. (1998) *Real strategies for virtual organizing*, MIT Sloan Management Review, 40 33.

Wadud, Z., MacKenzie, D. and Leiby, P. (2016) *Help or hindrance? The travel, energy and carbon impacts of highly automated vehicles*, Transportation Research Part A: Policy and Practice, 86 1-18.

Wang, S. and Zhao, J. (2019) *Risk preference and adoption of autonomous vehicles*, Transportation Research Part A: Policy and Practice, 126 215-229.

Westerman, G., Calméjane, C., Bonnet, D., Ferraris, P. and McAfee, A. (2011) *Digital Transformation: A roadmap for billion-dollar organizations*, MIT Center for Digital Business and Capgemini Consulting, 1 1-68.

Yang, J. and Coughlin, J. F. (2014) *In-vehicle technology for self-driving cars: Advantages and challenges for aging drivers*, International Journal of Automotive Technology, 15 333-340.

Zhao, Y., Ni, Q. and Zhou, R. (2018) *What factors influence the mobile health service adoption? A meta-analysis and the moderating role of age*, International Journal of Information Management, 43 342-350.

Zhou, F., Zheng, Z., Whitehead, J., Washington, S., Perrons, R. K. and Page, L. (2020) *Preference heterogeneity in mode choice for car-sharing and shared automated vehicles*, Transportation Research Part A: Policy and Practice, 132 633-650.

Zuiderwijk, A., Janssen, M. and Dwivedi, Y. K. (2015) *Acceptance and use predictors of open data technologies: Drawing upon the unified theory of acceptance and use of technology*, Government Information Quarterly, 32 429-440.