Extension of an adoption model to evaluate autonomous vehicles acceptance

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Abstract

Autonomous Vehicles (AVs) can provide safe, clean and efficient mobility by using advanced communication technologies to create an unprecedented revolution in transportation. Acceptance of AVs has a key role in their successful implementation. Most researchers have used Technology Acceptance Model (TAM), Theory of Planned Behavior (TPB) and Unified Theory of Acceptance and Use of Technology (UTAUT) to identify latent factors affecting, which focus only on individuals' internal schema of beliefs without considering the external factors of acceptance. The current study, uses Trialability (TR), Observability (OB) extracted from Diffusion of Innovations (DOI) theory, Performance Expectancy (PE), Effort Expectancy (EE), Social Influence (SI) extracted from UTAUT, as well as Perceived Risk (PR), Environmental Concerns (EC) and Consumer Innovativeness (CI)) to identify a wider set of latent factors. A stated preference survey conducted to this purpose in Tehran allowed collecting 641 responses. Considering the latent nature of research variables, Structural Equation Modeling is applied. Results show that PE, EE, PR, OB, SI, TR, CI and EC affect acceptance in decreasing order of regression weights, an explain 72.5% of the variance in the dependent variable.

Keywords: Acceptance of Autonomous Vehicles, Trialability, Observability, Performance Expectancy, Effort Expectancy, Social Influence, Perceived Risk, Environmental Concerns, Consumer Innovativeness, Structural Equation Modeling

1- Introduction

Recent technology developments have reduced the scope of human intervention in vehicle movement in the transportation network. They will finally lead to the emergence of fully-automated autonomous mobile robots. These robots move without any human interventions and can change the future of transportation [1].They are vehicles with integrated multi-sensor navigation and intelligent decision making systems [2] that improve the road safety (by reduce/eliminate human error) [3], increase network capacity, improve traffic flow efficiency, use the available capacity optimally [4], improve fossil fuel consumption [5], enrich travel time [6], improve land use patterns [7], reduce costs, increase social wealth [6], increase urban access [8] and, finally, achieve sustainable [9] and intelligent transportation goals [10].

Several studies, however, are concerned about the possibility of negative consequences from these vehicles, including an increase in reliance on private cars [11], a reduction in the share of public transportation [12], and the affordability of purchasing such vehicles based on their expected high price [9].

In the early stages of the introduction of any new product, policymakers should be aware of the needs and factors that affect people decision whether to accept and use it or not [13]. Knowing the potential users' perspective can help a further growth of the technology, facilitates its implementation and lead to a better evaluation and prediction of the users' responses and, hence, results in an optimal design and effective future development and planning and development [14]. Often, emerging technologies face unpopularity in their early market-introduction stages because consumers follow an "initial perception-resistance-gradual adaptation-final absorption" cycle, and technologies resisted hard at the beginning become essential to people's lives over time [15]; the same is quite likely to happen with AVs [16].

Among different AVs classifications proposed by different authorities, a very popular one is presented by Society of Automotive Engineers (SAE) and has six different automation levels: 1) no automation (level zero), 2) driver assistance, 3) partial automation, 4) conditional automation (autonomous in special traffic), 5) high automation (autonomous on specific infrastructure) and 6) full automation [17]. This study examines the last one.

There are many factors that contribute to acceptance of technology. These factors can be divided into internal and external categories. Internal factors (such as Performance Expectancy (PE), Effort Expectancy (EE), Social Influence (SI), Perceived Risk (PR), and Consumer Innovativeness (CI)) originate solely from people's attitudes towards technology. While external factors (such as Trialability (TR), Observability (OB), Environmental Concerns (EC) are influenced by a combination technology availability, the surrounding environment and individual's attitude. According to the literature review, the effect of each of these internal and external factors on technology acceptance can be decreasing or increasing.

Most of the previous studies have used the Technology Acceptance Model (TAM), Theory of Planned Behavior (TPB) and Unified Theory of Acceptance and Use of Technology (UTAUT) to identify the latent factors of the acceptance of the AV technology [16]. Considering that human behavior is complex, focusing on only one group of variables (internal or external categories) could lead to incomplete results. Motivated by addressing the aforementioned gaps, the main contributions of this paper are:

To the best of the authors' knowledge, a few studies considered the combination of internal or external factors [17,18]. We aim to integrate internal and external factors proposing a more comprehensive model that overcomes the limitations of previous studies in AV acceptance. We combine TR, OB, EC as external factors, with PE, EE, SI, PR and CI variables as internal factors (Fig . 1).

The majority of studies on acceptance of AVs have been conducted in developed countries [19-26]. Research indicates that common beliefs and values of a society influence the acceptance of technology. Moreover, the impacts of values on technology acceptance vary in different countries, which means that the results of research conducted in developed countries should not be generalized. The current study employs data collected in Tehran, Iran, which is a developing country. Our work, therefore, is a contribution because there is little literature about the issue in developing countries.

The literature review (theories, latent variables) is in Section 2, we explain the questionnaire and analyze the statistical data in Section 3, we present the modeling results in Section 4 and provide conclusions and suggestions for future studies in Section 5.

2- Literature review

The two general classes of previous studies on the latent factors affecting the acceptance of AVs are 1) those using the behavioral theories and 2) those using variables other than those used in class 1 [27]. Among different theories developed to describe the technology acceptance and its affecting factors, the Theory of Reasoned Action (TRA), Theory of Interpersonal Behavior (TIB), Social Cognitive Theory (SCT), TPB, DOI, TAM, Motivational Model (MM), Uses and Gratification Theory (UGT), Model of PC Utilization (MPCU) and UTAUT are worth mentioning [28]. This study uses the DOI and UTAUT as the underlying theories. In the following sections, related explanations are given to clarify and justify the reason behind this selection. Also, other related factors namely PR, EC, and CI are discussed.

2-1- Diffusion of Innovations (DOI)

The DOI theory identifies, by quantitative tools, the diffusion rate of an innovation and factors influencing its acceptance/non-acceptance to facilitate its implementation. In this theory, the process of deciding to accept/reject an innovation is mental and people is assumed to pass from the awareness to the acceptance/rejection and finally to the confirmation stage through five steps: 1) knowledge, 2) persuasion, 3) decision-making, 4) Implementation, and 5) confirmation.

In Step 1, people gain information on an innovation and learn how it works.

In Step 2, people develop a favorable/unfavorable attitude towards the innovation. Factors playing important roles in creating a positive attitude are:

a) Relative advantage - an individual's belief that the new innovation tops the previous ones (the main issue, as Rogers' theory states, is how people see an innovation and if it is really beneficial).

b) Compatibility-a person's belief if the new innovation is in harmony with the existing values and his/her past experiences and needs. If the answer is negative, the acceptance rate will decrease.

c) Complexity - difficulty in using the innovation perceived by the individual.

d) Trialability - addresses the innovation’s reviewability and testability; the pre-belief that an innovation can be tried and experienced will affect its acceptance/rejection.

e) Observability – individuals’ seeing/feeling the innovation results; if so, as Rogers believes, it is more likely to be accepted by users.

In Step 3, people decide to totally accept an innovation at the beginning, totally reject it at the beginning or accept it open-mindedly at first with the option to reject it after a while.

In Step 4, those who accepted the innovation try to use it. Here, people are still looking for information and may change their mind if they hear conflicting messages.

In Step 5, those who accepted the innovation seek to justify their decision by emphasizing its usefulness and benefits [29, 30].

The current research uses both the TR and OB variables in its conceptual model and suggests the following hypotheses based on the results of previous studies [31-35]:

H1: TR positively influences the acceptance of AVs.

H2: OB positively influences the acceptance of AVs.

2-2- Unified Theory of Acceptance and Use of Technology (UTAUT)

UTAUT was formulated by assessing similarities and differences across eight models (including TRA, TAM, MM, TPB, MPCU, DOI, SCT, TAM-TPB combination). The final significant constructs were PE, EE and SI, and Facilitating Conditions, among which the first three affect the behavioral intention, and the fourth affects the user behavior.

PE shows one's view to use technology to improve performance and EE relates to its easy use, application and social impacts based on how important people think about his/her use of that technology [36]. Previous studies have directly proven the effects of these latent factors on the AV acceptance [37-39]. Following hypotheses are proposed:

H3: PE positively influences acceptance of AV.

H4: EE positively influences acceptance of AV.

H5: SI positively influences acceptance of AV.

2-3- Non-Behavioral Factors

Perceived Risk (PR) is defined as the occurrence of a probable loss [40] and loss and uncertainty are its two main aspects. It plays an important role in a person's willingness to buy (use) a new product and is increased with an increase in the damage expectancy [41; 42]. [43] claim that the PR includes performance, financial, time, safety, social, and psychological risks, but [44] state that it involves social, financial, physical, performance, time and psychological risks. Some studies have proven that this variable has negative effects on the acceptance of AVs [45] and other have shown that although it does not directly affect the willingness to use such vehicles, it affects the people's trust level indirectly [32]. The present study defines this variable as the potential risk of the technology for users to achieve the desired results (safe journey) and proposes the following:

H6: PR negatively influences acceptance of AV.

People's EC include their considerations, interests/disinterest [46] and awareness of the environmental risks [34] and also, its related emotional involvements [47]. Regarding the AV impacts on the environment, while some believe they help protect the environment by affecting factors such as speed, economical driving, reduced congestion, vehicle weight, moving in a single lane, and reduced accidents [48]. This study proposes the following:

H7: EC positively influences acceptance of AV.

CI refers to people's different responses to new products and ideas. It leads the person to accept a new product regardless of its price and quality [49]. It is also defined as a person's degree of adaptation to a new product sooner than others and is studied as a force that leads to a novelty-seeking behavior which can also be defined as a person's speed of acceptance of a new product or his/her curious behavior to obtain information about it [50; 51]. Effects of this latent variable on the acceptance of an AV show that people with such attitudes are more inclined to accept it because it uses the latest technology [52; 17] .This study proposes the following hypothesis is:

H8: CI positively influences acceptance of AV.

This study uses data collected in Tehran. Fig. 2 shows the conceptual model of this study.

3- Data

To verify the proposed model, we conducted a face to face survey and collected data from Tehran (Iran's capital and largest city). According to some previous studies, AVs offer a variety of substantial benefits that are expected to revolutionize the transportation industry in the future such as increasing traffic flow efficiency [43, 44], allowing optimal use of transport infrastructures [45], so these technology can address some of the transportation problems in Tehran.

The pilot study was conducted in the spring of 2019 in the main parks of Tehran. In this study, 100 stated preference questionnaires were given to the interviewers and they were asked to write down the items that the respondents are unclear about. The interviewers were also asked to record the entire questioning process. The researchers reviewed all the recorded cases and made changes in the questionnaire based on them as well as the opinions of the interviewers. After these changes, the main study was conducted between July and September 2019 in cinemas, parks and main squares of Tehran under the full supervision of researchers (figure (3)). The revised questionnaire was randomly distributed among 22 Districts of Tehran.

- Individuals are first informed of the study objectives and the information confidentiality and then shown a short clip to get acquainted with AVs and how to use them to meet their transportation needs. In the clip, effort is made to provide enough information about the technology without directing their responses.
- Next, items related to the used latent variables are extracted from different references and individuals are asked, in the second part of the questionnaire, to respond the questions on a 5-point Likert scale (from strongly disagree (1) to strongly agree (5)). The literature suggests that five-point scale appears to be less confusing and to increase response rate.
- The last part is devoted to questions related to individuals' demographic characteristics (gender, marital status, age, education and family size).

3-1- Data analysis

Different opinions have been expressed in order to determine the sample size in structural equations modelling. Some believe that the ratio of the number of observations to the independent variables should not be less than 5 [53]. Others have suggested a more conservative 10 ratio [54]. Based on the ratio of 8 for the number of observations to independent variables, the desired number of samples is 560. For more assurance after refining and checking the outlier & missing data, 641 valid sample are used. Table 1 presents the individuals' demographic profile. The sample replicates Tehran's population distribution as of 54.4% men (collected data) vs. 52.3% (2016 census). The statistical analyses show that men, singles, aged 26-44, university graduate and 4-member family size have the highest frequency among respondents.

This questionnaire contains 12 acceptance-related items and people are asked to respond such questions as "I will buy if it is reasonably priced" to "I would recommend others to use/buy it" according to five-point Likert scale of agreement (from 1= strongly disagree to 5= strongly agree). They are also asked to respond such questions as "I will use it on optional trips (shopping, leisure)" to "I will send it to store to buy the daily necessities" according to five-level Likert scale of frequency (from 1= never to 5= always). Results show, in all questions except " I will buy when the first model is released", that the number of people who said "agree" and "strongly agree" (or "always" and "often") is more than those who said "disagree" and "strongly disagree" (or "rarely" and "never"). The highest and lowest percent oppositions are for questions of "I will buy when the first model is released" and "I will use it if it is reasonably priced", respectively. People agree most with "I will use it if it is reasonably priced", and least with "I will buy when the first model is released" (Fig. 4).

4- Modeling results and discussion

Fig. 5 and Table 2 show the SEM results achieved by the maximum likelihood method and AMOS (Analysis of moment structures) 25 software. Due to the assumed relationships between latent and observed variables (measurement models) as well as the assumed dependencies between the various latent variables (structural model), we use SEM. This model is obtained after several modeling runs, eliminating insignificant items or those with less standard regression weights than an acceptable value to satisfy the evaluation criteria. Results show:

TR has positive and significant effects on the AV acceptance and conveys the concept that technology can be reviewed and tested at a limited level to evaluate its benefits and usefulness. Providing this possibility can lead to the innovation's more and sooner acceptance, and will allow designers to detect and modify its weaknesses [30]. Some researchers emphasize the importance of TR in accepting an innovation, especially in developing countries, because facilities are inadequate and people are not sure if innovations adapt to the existing infrastructures [55]. Using this variable can evoke people's emotions to accept an innovation and it is suggested that the AVs' TR conditions be provided to turn as many potential users as possible to actual ones.

OB is defined as the "degree of apparentness/tangibility of the innovation results" and has shown to have significant and positive effects on the acceptance of autonomous cars because it eliminates people's uncertainty and skepticism in using the technology [56]. If the AV technology spread in the society and its benefits are made observable, its acceptance rate will increase too.

Since PE has positive effects on the AV acceptance, any improvement in its efficiency will strengthen the desire and, hence, the willingness to accept it. This result, conforming well to those of other previous studies [37-39], highlights the importance of improving the performance of these vehicles, especially in helping to achieve the transportation needs in an efficient and effective way.

Results show that if a person can easily understand how to use an autonomous car and finds the related skills, he will be more inclined to accept it. This means that the system should be so designed as to allow the user to learn to use it more easily without needing much time and mental effort because design is a very effective factor in accepting a new technology. Other researchers too have had results similar to those of this study acknowledging the direct effect of this variable on the AV acceptance [37-39].

The SI variable shows how much a person's feelings are affected by what his/her close and important individual(s) think or suggest about his/her using a new technology [36]. Since modeling results indicate that SI affects acceptance, the positive experience of one who has used this car can affect his/her peers, impressionable coequals and, in general, those for whom he/she is important; this conforms well to those of other studies on the AV acceptance [37-39].

An increase in the PR attitude reduces the AV acceptance which conforms well to the results of other previous studies [57; 58]. Researchers have defined the PR as the consumer's perception of the uncertainty and adverse consequences (if occur) of buying/using a product/service [59]. Since the PR can be reduced by increasing confidence and/or reducing consequences, it is suggested that the AV designers should not only improve the car performance and minimize its accident probability, but also make it so safe that the vehicle/passengers may experience the least damage in case of an accident. With proper advertising, we can try to create the right mentality about safety.

EC are the results of how one assesses the effects of one's behavior on the environment [60]. Similar to other studies [5; 60], this research finds that the effect of this variable on the AV acceptance is significant and positive, which means people with more EC accept autonomous cars more. Therefore, optimal routing, using clean fuels instead of the fossil type, reducing the weight and sharing the use, thus, reducing the fuel consumption can help these cars be accepted in the society more and more.

People with innovative attitude tend to use/buy new products faster than others because this variable is a behavioral stimulus that drives a person to start and implement new ideas, processes, and products [61]. Results of this study, consistent with those of other researches [57], indicate that people with more innovative behavior accept AVs more because they see them as a symbol of their desire due to the latest technologies used in such cars.

In the case, Likert scales are utilised for a study; Cronbach's alphas are considered the most appropriate measures of reliability [58]. As shown in Table 3, Cronbach's alphas range from 0.722 to 0.906; thus, the constructs are deemed to have adequate reliability. Table 2 presents standard regression weights for all items. Items loaded above 0.50 are considered for further analysis. Therefore, both reliability and discriminant validity met the baseline criteria.
There are several criteria to evaluate the modeling of structural equations among which Chi-squared/DOF< 5, goodness of fit index (GFI) >0.9 and adjusted goodness of fit (AGFI) > 0.8 are three indices [59]. The current research yielded CMIN/DOF = 3.245, GFI = 0.950 and AGFI = 0.839 for its proposed model which are acceptable, and RMSEA = 0.059 < 0.08. To evaluate the model relative position between the worst and best fits, relative fit indices (incremental fit index (IFI) and comparative fit index (CFI)) are recommended to be greater than 0.9 [60]; their values in this study are 0.910 and 0.909, respectively (Fig. 5). Reliability and convergent validity assessments using:1) significant standard regression weights> 0.5, 2) Construct Reliability (CR)

> Average Variance Extract (AVE), 3) AVE> 0.5 and CR> 0.7 [58] show that the measurement model fits well with the collected data (Table 3).

5- Conclusions

Autonomous vehicles (AVs) have the potential to fundamentally change the driver-vehicle interactions and provide opportunities to dramatically improve the transportation efficiency, stability and safety. This technology can reduce the fuel consumption by affecting such factors as reducing congestion, routing optimally, less maneuvering, platooning and reducing accidents. Further development of this technology to enable the best use of its features is tied to its acceptance by the people. Careful analysis/studying of people's main reasons for accepting/rejecting is of special importance to both decision makers and designers. Most previous studies have used Technology Acceptance Model (TAM), Theory of Planned Behavior (TPB) and Unified Theory of Acceptance and Use of Technology (UTAUT) theories to identify latent factors that affect the AV acceptance. These theories have limitations because they consider only the effects of individuals' internal schema of beliefs on acceptance. They neglect the facilitating/hindering role of the external factors such as Trialability (TR), Observability (OB) and Environmental Concerns (EC). As the aim of this paper, a more comprehensive model considering the internal and external factors proposed to overcomes the limitations of previous studies. Hence, this study used TR, OB (extracted from the Diffusion of Innovations (DOI)), Performance Expectancy (PE), Effort Expectancy (EE), Social Influence (SI) (from UTAUT) as well as Perceived Risk (PR), Environmental Concerns (EC) and Consumer Innovativeness (CI) to identify the latent factors affecting the AV acceptance. Most studies were conducted in the developed countries. To calibrate the proposed model, this research used the structural equation modeling and data of 641 questionnaires collected randomly in Tehran (capital of Iran as a developing country). Results of the statistical analyses of the responses to questions related to the AV acceptance indicated that the number of people who chose "agree" and "strongly agree" (or "always" and "often") in all items except " I will buy when the first model is released" was more than the number of those who chose "disagree" and "strongly disagree"(or "rarely" and "never"). The highest and lowest agreements were for items "I will use it if it is reasonably priced" and "I will buy when the first model is released", respectively.

Results of the structural equation modeling showed that all of the examined constructs had significant effects on the AV acceptance. Most of the adaption models explained the variance in acceptance of AVs less than 69% [62-72] although the proposed model explained 72.5% of the variance in acceptance. Among the examined variables, only PR had an expected negative sign (-0.161); PE and EC had the highest and lowest effects (0.215 & 0.044) on the AV acceptance, respectively. Regression weights of DOI-related variables showed that OB had a greater effect (0.094) than TR (0.067). Among variables related to the UTAUT theory, PE and SI (0.077) had the highest and lowest effects on the AV, respectively. Among considered variables, except those related to behavioral theories, PR had the highest and EC had the least impact on the acceptance of AVs.

5-1- Strategies and policy implications

This study provides policymakers with several recommendations for allocation of resources in promoting consumer acceptance of AVs. According to findings, it is suggested that necessary conditions should be provided and following measures be taken for as many potential AV customers to become actual users:

According to the significance of TR construct, it is recommended that designers and decision-makers allow individuals to test AVs before purchasing/ intending to use them. In relation to OB, it is suggested that stakeholders publish the performance reports of self-driving vehicles through the social media and make a side by side comparison between self-driving cars and conventional ones. In relation to EE, setting polices such as enabling their user-friendly designs so that people feel comfortable when using their various features and/ or reduce the number of AVs' components that need user-vehicle interaction are recommended. In case of PE, the policy of enabling the comparison of AVs' significant advantages (less/optimal travel time, reduced fuel consumption/costs, cost-effectiveness, comfort, etc.) over conventional cars could be considered. Regarding the significance of SI, sharing the positive experiences of individuals (particularly the celebrities) to their friends, colleagues and the social media could affect the acceptance of AVs. To remove the safety concerns as a barrier of AVs' acceptance, designers should consider subjects to promote vehicle's safety using preventing accidents and protecting their lives/property. Besides, it is suggested that AVs run on exclusive lanes to improve the safety perception of individuals. Reducing fuel consumption/ emissions through using compatible alternative fuels is suggested to increase the acceptance of AVs by individuals with higher environmental concerns. In relation to CI, Using attractive and up-to-date technologies can have a significant influence in acceptance of AVs.

5-2- Limitations and recommendations for further study

Despite some policy implications for decision makers and designers, the findings should be interpreted carefully. First: In this study, data was collected by questionnaires (as a conventional method) at one point in time, which is a limitation because the method is not free from the respondents' subjectivity. Future studies can use other objective qualitative data collection methods such as actual experience of AVs to better understand the factors affecting the AV acceptance.

Second: we used a stated preference questionnaire, since there was no implication of AV in Iran. The results can be affected by hypothetical biases (individuals may report unrealistic values to researchers). Further studies can compare results from the stated preference questionnaire to real world results when self-driving cars have been implemented in Iran.

Third: Due to using of data collected in Tehran, implies that the results are not necessarily applicable to other countries/cultures because of varying attitudes. However, the study raises discussion points useful for future comparative studies aimed at exploring differences among countries.

Many researchers believe that trust not only shapes inter-human relationships, but also affects human-computer system relations [62]. They said that trust has three dimensions; one refers to a person's belief that the system is able to understand and predict, the other states that technology performs its assigned tasks accurately and correctly and the third refers to the belief that the system provides enough and effective assistance to the individual [72]. It is suggested that future studies examine the effects of the mentioned dimensions on the AV acceptance and on the PR.

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Figure and table captions

Fig. (1): Pie chart to show the research variables (inner ring), classification based on internal and external (middle ring) and derived from behavioral or non-behavioral theories (outer ring)

Fig. (2): Proposed conceptual model (Based on the literature review, H+&H- are the hypotheses related to the positive & negative effects of the independent variable on the dependent variable, respectively)

ACC: Acceptance of autonomous vehicle; TR: Trialability; OB: Observability; PE: Performance expectancy; EE: Effort expectancy; SI: Social influence; PR: Perceived risk; CI: Consumer Innovativeness; EC: Environmental concern

Figure (3) Data flow chart for current research

Fig. (4): Statistical analyses results of items related to the acceptance of autonomous vehicles

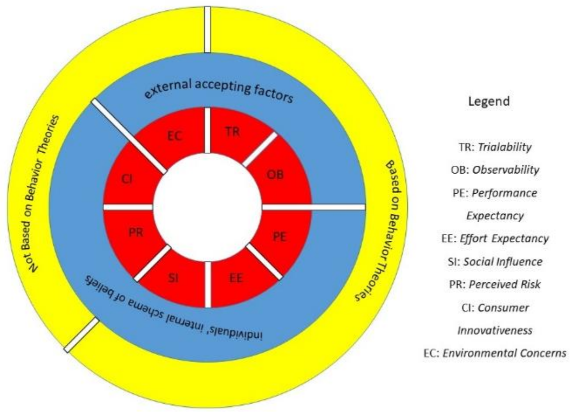
Fig. (5): Regression weights and evaluation criteria of the structural model (ACC: Acceptance of autonomous vehicle; TR: Trialability; OB: Observability; PE: Performance expectancy; EE: Effort expectancy; SI: Social influence; PR: Perceived risk; CI: Consumer Innovativeness; EC: Environmental concern)

Table (1): Participants' profile of survey

Table (2): Standard regression weights and evaluation criteria of measurement model

Table (3): Survey validation and model fit

Figures and tables



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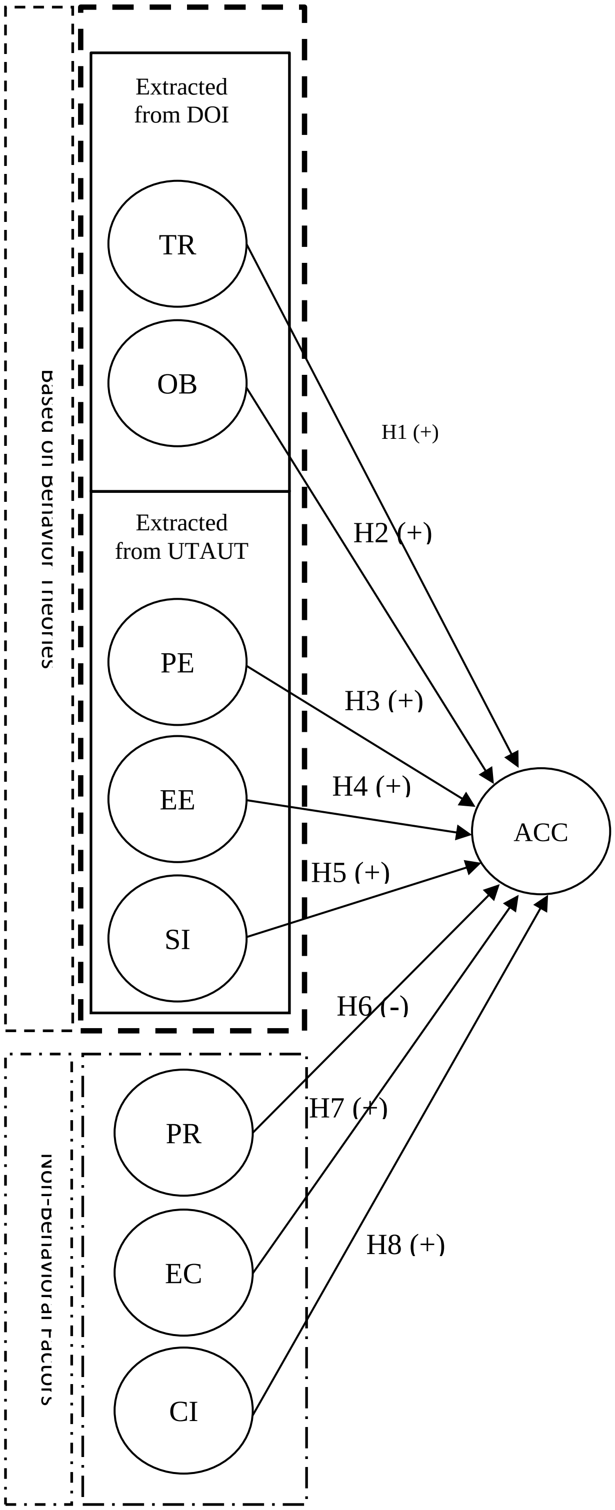

Extracted from DOI
TR
OB
Extracted from UTAUT
PE
EE
SI
PR
EC
CI
ACC
H1 (+)
H2 (+)
H3 (+)
H4 (+)
H5 (+)
H6 (-)
H7 (+)
H8 (+)

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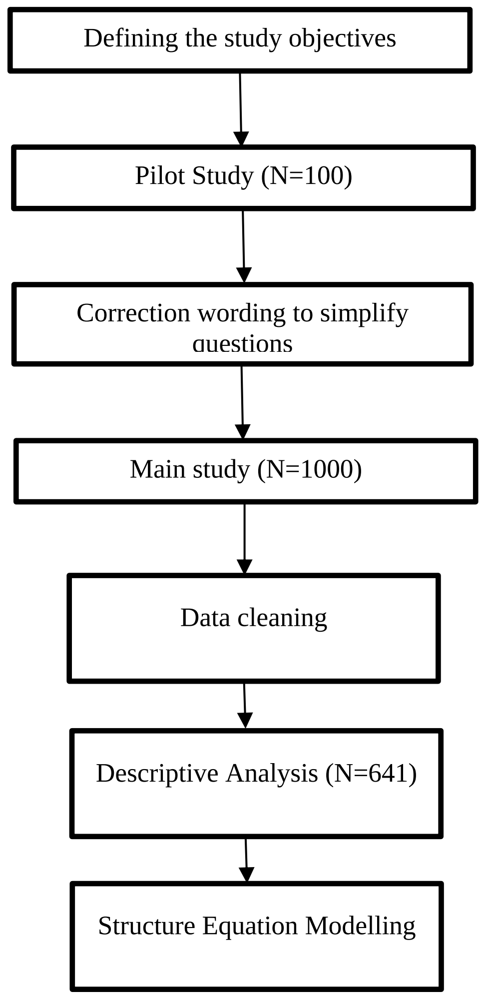

Figure (3) Data flow chart for current research

Table (1): Participants' profile of survey

Variable	Category	Frequency	Percent	Average	Standard Deviation

Gender	Male	292	45.6	0.54	0.498
	Female	349	54.4		
Marital Status	Single	281	43.8	0.56	0.497
	Married	360	56.2		
Age	<14	1	0.2	3.93	0.730
	15-24	181	28.2		
	25-44	330	51.4		
	45-64	119	18.6		
	+65	10	1.6		
Education	Lower than Diploma	65	10.1	2.70	0.808
	Diploma	141	22.0		
	Associate Degree and Bachelor of Science	359	56.0		
	Master of Science and Doctorate	76	11.9		
Household Size	1	14	2.2	3.82	1.241
	2	66	10.3		
	3	160	25.0		
	4	257	40.1		
	5+	144	22.4		

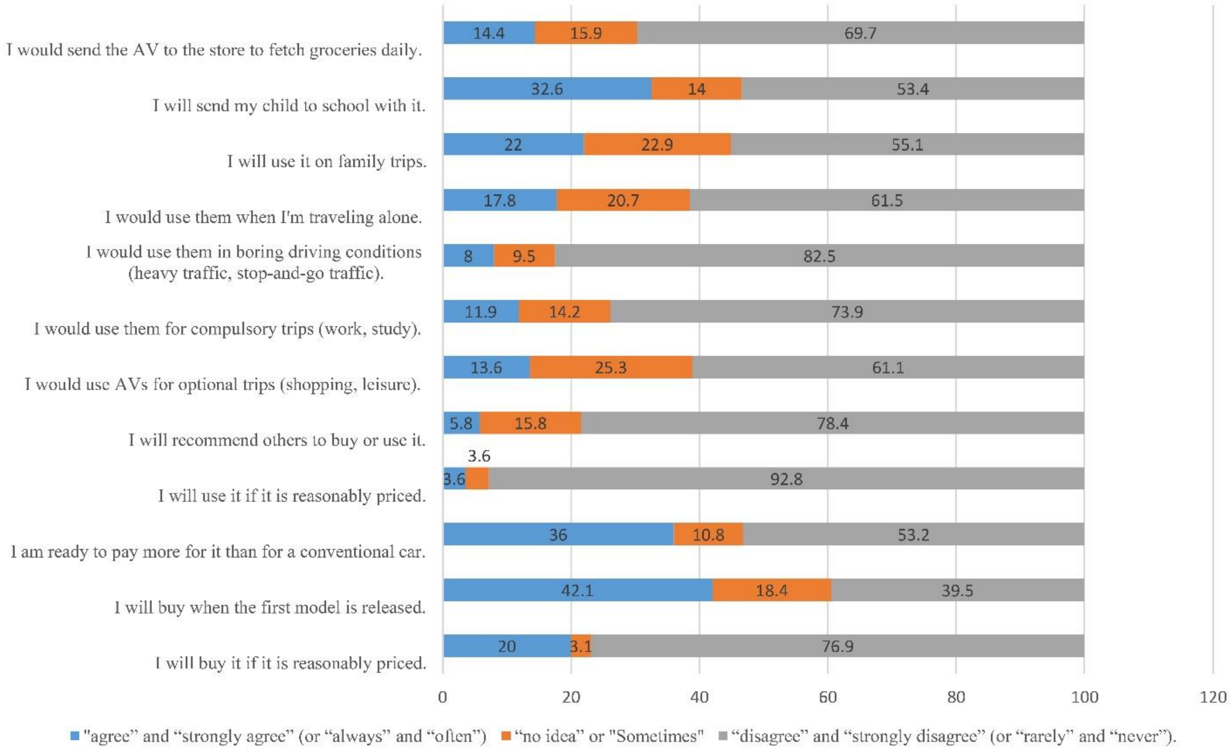

Fig. (4): Statistical analyses results of items related to the acceptance of autonomous vehicles

Table (2): Standard regression weights and evaluation criteria of measurement model

Latent Variable	Item	Standard Regression Weight	Source
Trialability	I prefer to try them long enough.	0.77	[62]
	The ability to try them would be useful in my decision to use them.	0.91	[63]
	The ability to try them would be useful in my decision to buy them.	0.88	
Observability	In the future, by watching others use them, I will be able to........		[64]
	a) Learn how they work.	0.82	
	b) Explain how they work to others.	0.78	
	c) I can say if they are useful to me.	0.89	
	d) Clearly understand how they work.	0.89	
Performance Expectancy	Due to the use of technology and effective communication with other vehicles, I can reach my	0.74	[65]

	destination faster.		
	AVs would enhance my performance while driving because I would be able to do other things (eating, sleeping, and using a computer).	0.67	
	They are easier to use and better than conventional cars.	0.79	[66]
	Overall, they are a good transportation alternative.	0.78	
	I would be able to easily adjust my daily schedule using my AV.	0.76	[67]
Effort Expectancy	It would be easy for me to use them to accomplish my goals.	0.83	[66]
	It would be easy for me to learn how to use AVs.	0.81	[67]
	I will not need much mental effort to interact with it.	0.71	[62]
Social Influence	Individuals who are important to me will think I should use them too.	0.80	[37]
	People will successfully accept it because its use looks good to others.	0.56	
	The people whose opinions I care about would encourage me to use AVs.	0.86	[39]
	People who influence my behavior will encourage me to use them.	0.95	
Perceived Risk	I am generally worried about using them.	0.85	[68]
	I am concerned about their safety.	0.78	
	I am concerned about the shared use of transport infrastructure by autonomous and conventional vehicles.	0.63	[10]
Environmental Concerns	We need more and better public transportation even if it means more taxes.	0.53	[69]
	We must decide and act on controlling greenhouse gas emissions.	0.56	
	I would like to pay more to buy products that are more environmentally friendly.	0.90	[57]

Consumer Innovative	I experience new technology products earlier than people around me.	0.91	[57]
	I am aware of the latest technologies more than others.	0.76	
	I often buy new technologies even if they are expensive.	0.65	
	Most technologies are great.	0.61	
Acceptance of AV	I will use it if it is reasonably priced.	0.60	[70]
	I would use AVs for optional trips (shopping, leisure).	0.56	Created for the present study
	I would use them in boring driving conditions (heavy traffic, stop-and-go traffic).	0.67	
	I will send my child to school with it.	0.56	
	I would send the AV to the store to fetch groceries daily.	0.58	

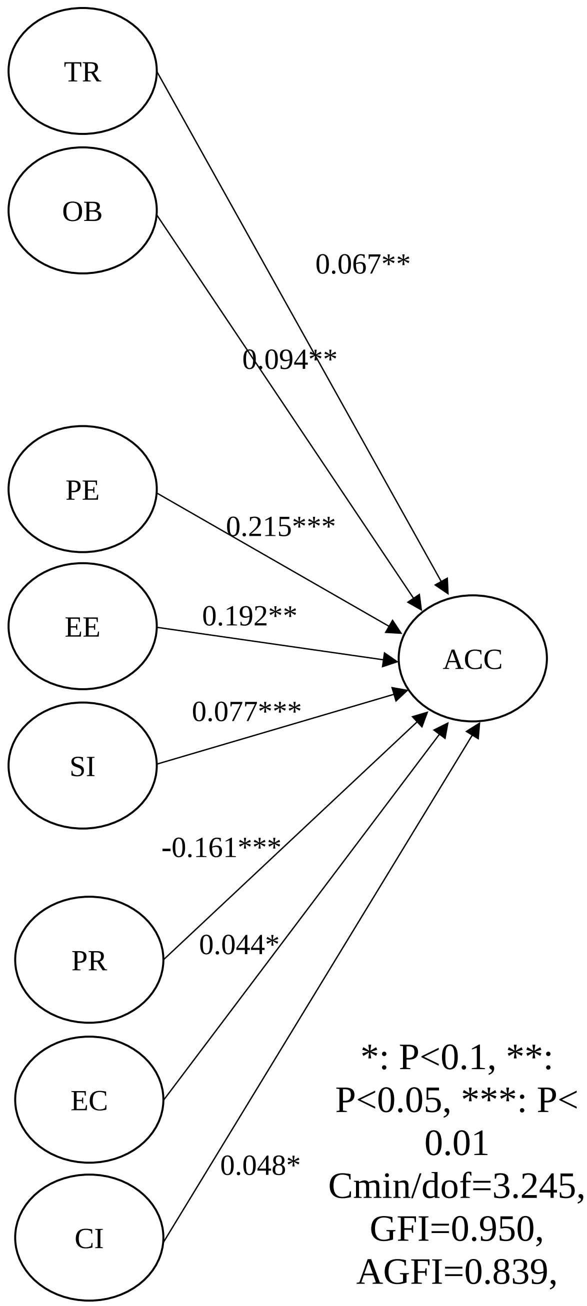

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Table (3): Survey validation and model fit

Latent Variable	**Cronbach's Alpha**	**Construct Reliability (CR)**	**Average Variance) Extract (AVE)**

Trialability	0.872	0.729	0.889
Observability	0.906	0.715	0.909
Performance Expectancy	0.846	0.560	0.864
Effort Expectancy	0.826	0.615	0.827
Social Influence	0.843	0.651	0.878
Perceived Risk	0.848	0.575	0.800
Environmental Concerns	0.778	0.526	0.762
Consumer Innovative	0.799	0.544	0.823
Acceptance of AV	0.722	0.505	0.835

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