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Evaluating the Market for Electric Vehicles (EV) Using the Technology Acceptance Model (TAM)

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Abstract

An electric vehicle (EV) is a vehicle which uses one or more electric motors for propulsion. This type of vehicle has the potential of significantly reducing city pollution by having zero tail pipe emissions. As a consequence of the differences between EV and fossil fuel vehicles, this market has been increasing, causing the appearance of new products and consumer attitudes. The main goal of this project dissertation is to evaluate how the EV Market is being sustained by the consumers behaviors, according to the technology acceptance model (TAM). A questionnaire with 695 valid answers was created and it will be better explained in this dissertation. The main conclusions extracted allowed to confirm that attitude and perceived usefulness had a major influence role among the users of EV. At the same time, it was possible to evaluate the current condition of the technology, and also to make judgments and suggestions regarding the future of this topic.

Keywords: **electric vehicle (EV), autonomous vehicles, consumer attitudes, consumer behavior, technology acceptance model (TAM), perceived usefulness**

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1. Introduction

The goal of this paper is to present a framework for investigating the determinants of the electric vehicles (EV) implementation in the automotive market, by expanding technology acceptance model (TAM).

An electric vehicle (EV) is a vehicle that uses one or more electric or traction motors for propulsion, instead of a internal combustion engine.

Nowadays, this type of vehicles are becoming a trend topic, due to environmental problems of the planet and also as consequence of the new technological challenges addressed to the main automotive constructors.

According to Aizstrauta and Ginters (2017), technology is a powerful component of the world and therefore the understanding of development, adoption and usage of technology is one of central concerns for researchers and practitioners across multiple disciplines. They also affirm that sustainability is also a matter of the quality of the decision making process in policy planning.

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The original TAM is based on the theory of reasoned action (TRA), that aims to explain the relationship between attitudes and behaviors as a consequence of human action. TRA is used to predict how individuals will behave based on their pre-existing attitudes and behavioral intentions (Azjen & Fishbein, 1980). The TAM explores the relationship between perceived usefulness, perceived ease of implementation, intentions to implement and actual system implementation (Bach et al. 2016).

In the specific case of the EV Market, it is important to understand the social and technologic influences that will occur, because it is a sociotechnical system. According to Aizstrauta & Ginters (2017), sociotechnical systems are systems that contain technology subsystems and components central to its performance and having social and economic relevance and impact.

The following sections of this article are organized as follows: research context; theoretical models; Research Methodology: Survey; Variables; Results; Discussion and Conclusion.

2. Research Context

2.1. Electric Vehicle (EV)

An electric vehicle (EV) uses one or more electric or traction motors for propulsion, instead of a internal combustion engine. An electric vehicle may be powered through a collector system by electricity from off-vehicle sources, or may be self-contained with a battery, solar panels or a generator to convert fuel to electricity. EVs include road and rail vehicles, surface and underwater vessels, electric aircraft and electric spacecraft (Faiz et al. ,1996).

They are different from fossil fuel-powered vehicles, because they can receive their power from a wide range of sources, including fossil fuels, nuclear power, and renewable sources such as tidal power, solar power, and wind power or any combination of those. This energy is then transmitted to the vehicle through use of overhead lines, wireless energy transfer such as inductive charging, or a direct connection through an electrical cable. The electricity may then be stored onboard the vehicle using a battery or fuel cell. Vehicles making use of engines working on the principle of combustion can usually only derive their energy from a single or a few sources, usually non-renewable fossil fuels. A key advantage of electric or hybrid electric vehicles is their ability to recover braking energy as electricity to be restored to the on-board battery (regenerative braking) or sent back to the grid (V2G), giving to this type of engine an efficiency of 80%, when the thermodynamic engines only have 25% of efficiency (Shah, 2009; Baglione, 2007).

As a consequence of the technologic evolution of the automotive industry, with the production of new batteries, higher range and also of the environmental problems (Liasi & Golkar, 2017), EV became a new trend in the market, that is increasing yearly sales and creates new behaviors towards this technology.

2.1.1. EV: The Norwegian Example

In 2016, in Norway, nine of the top ten best-selling models were electric-drive models. In the same year, it also became the first country where 5% of all registered passenger cars was a plug-in electric.

This situation helped to reach in January 2017, the milestone of 51.4% of new car sales in the electrified passenger car segment, consisting of plug-in hybrids, all-electric cars and conventional hybrids for the first time ever surpassed combined sales of cars with a conventional diesel or gasoline engine.

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These milestones are an example to the whole world and they only could be reached with the adoption of 5 phases of development, promoted by the local government, since 1970 (Figenbaum & Kolbenstvedt, 2013).

The first phase - **Concept Development** - happened between 1970 and 1990. In those years, Electric vehicle prototypes and propulsion systems were developed. The government sponsored those prototypes and propulsion systems by funding research.

The second phase - **Test -** happened between 1990 and 1999. In those years, test programs and electric car fleets were promoted, with some measures such as: reduced annual licence fee (1996); road toll exemption (1997); free parking (1993-1998) and reduced imposed taxable benefit on company cars (1998).

The third phase can be described as the **Early Market** phase, and it lasted 10 years (1999-2009). In this phase, the first attempt on commercialization was done and the supply of vehicles became a challenge to the automotive industry. The Norwegian government increased incentives to the owners of electric vehicles, promoting measures such as: VAT (25%) exemption (2001);experiment with bus lane access (2005) and ferry ticket exemption (2009).

The fourth phase is the **Market Introduction.** In this phase, established vehicle importers start selling EV in larger volumes. As a consequence of the better vehicle supplying and of measures such as a 10% weight reduction before calculation of the weight tax (2011), prices decreased.

The fifth phase started in 2013 and lasts until today, and consists in the EV **Market Expansion.** More imports are coming to Norway to sell their vehicles and it means an increased competition with more dealers According to Figenbaum & Kolbenstvedt (2013), in this phase, the bus lane access will be a challenge to public transport, and this will eventually be removed, first locally, then nationally. As a consequence of this program, for many years, Norwegian electric vehicles have been subsidized by approximately 50%, and because of the great adhesion by the Norwegian drivers, many of these perks have been extended to 2020.

2.2. Autonomous Vehicles (AV)

Autonomous vehicles (AVs, often referred to as "self-driving cars" or "fully automated vehicles") are a trend topic, in what concerns new types of sustainable mobility. According to Berrada & Leurent (2017), these cars promise many benefits for future mobility. Several modeling studies investigated their potential impacts with special focus on spatial and/or socio-economic features.

For example, it is predicted that autonomous systems can result in far safer operation and improved efficiency of traffic flow. Furthermore, people who use these vehicles could use their commuting time much more productively and pleasantly. Also, those previously unable to drive, due to age or infirmity, could gain access to the same level of mobility as today's car drivers (Gruel et al. , 2016).

In this paper some examples of applications and address their respective outreach and limitations will be provided.

Firstly, it is necessary to understand the historic evolution, in what concerns the importance to the automotive industry. The first autonomous car in the world, Mercedes-Benz and Bundeswehr University Munich, in 1980, enabling to start thinking about legislation adaptation (Berrada et al., 2017). Since then, many companies launched themselves in the quest start thinking about legislation adaptation and launched themselves in

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the quest for the perfect car or autonomous system, including Mercedes-Benz, General Motors, Google, Continental Automotive Systems, Inc. Autoliv, Bosch and Nissan (Berrada et al., 2017).

Today there are self-driving features in cars out on the market such as Tesla and Volvo Cars is testing autonomous driving among 100 users in West Sweden (F.Sprei, 2018).

Those features are happening in order to test the driving technology and possibly also to test the attitudes, use gestures and behaviors of potential users.

It is still being debated when the fully automated vehicle that does not need any driver actually will be on the market. The difference in opinions of the timing of the market introduction and penetration of AV depends on different views on technological development and diffusion rates, public acceptance and regulations (F.Sprei, 2018).

2.3. Shared Autonomous Electric Vehicles (SAEV)

While autonomous vehicles have the potential to lead to increased travel, vehicle usage and energy consumption they are also put forward as the opposite, i.e., as a technology that has the potential to drastically reduce the number of vehicles on the roads and create a completely new

transportation system. The key to achieving this are shared autonomous electric vehicles, SAEV (F.Sprei, 2018). Fagnant and Kockelman (2013) do not presume electrification only that the autonomous vehicles are shared and find that they can reduce greenhouse gas emissions (GHG) since one SAEV can replace 11 conventional vehicles.

Fulton et al. (2017) find that combining electrification and automation of the vehicles has the potential to reduce carbon emission after 2030 despite an increase in vehicle travel due to a decarbonization of electricity production. The greatest savings in their scenarios is the combination of what they define as the 'three revolutions' with CO2 emissions at one third of the business-as-usual scenario. In this scenario, proposed by Fulton et al. (2017), not only are there SAEV but public transport and active modes of travel such as walking and biking increase as well. In this scenario congestion and parking needs are dramatically reduced allowing for more space for the active modes (F.Sprei, 2018).

Still compared to shared mobility today, SAEV enhances many of the advantages and especially accessibility, making them more attractive. One possibility is that the shared mobility of today paves the way for a future with SAEV, especially if combined with regulations that limit the use of vehicles in the city center.

As a consequence of the evolution of SAEV, It is also possible that person driven vehicles won't completely disappear but will just not be used as the main mode of transport in denser urban areas. (F.Sprei, 2018).

3. Theoretical Models

3.1. Technology Acceptance Model (TAM)

The technology acceptance model (TAM) is an information systems theory that models how users come to accept and use a technology. It was created by Davis, Bagozzi & Warshaw (1989) and it is one of the most influential extensions of Ajzen and Fishbein's theory of reasoned action (TRA) in the literature. The model suggests that when users are presented with a new technology, a number of factors influence their decision about how and when they will use it.

A key purpose of TAM is to provide a basis for tracing the impact of external variables on internal

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beliefs, attitudes, and intentions (Legris et al. , 2003).

According to Bach et al. (2016) and Davis (1989), TAM has three major factors that are proposed as a motivation for adopter to use a system: perceived ease of use (PEOU), perceived usefulness (PU) and attention to use. Davis had a first refined version of TAM where they found that both PEU and PU have direct influence on intention to use (ITU) which eliminated the previous attention to use factor (Bach et al. , 2016). Overall the two (PEOU and PU) explain about 40% of system's use.

Perceived Usefulness (PU) was defined by Fred Davis 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 (PEOU) was defined as " *the degree an individual believes that using a particular system would be free of effort*".

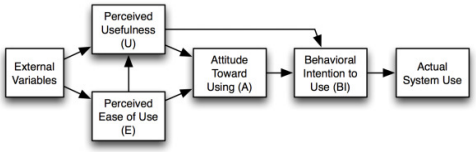

Figure 1: The Technology Acceptance Model, version 1. (Davis, Bagozzi & Warshaw, 1989)

Behavioral intention (BI) is defined as a person's perceived likelihood or "subjective probability that he or she will engage in a given behavior" (Committee on Communication for Behavior Change in the 21st Century, 2002, p. 31).

According to Hashim et al. (2015), it is stated that the concept of behavioral intention was operationalized with four items. It is affecting to the customers loyalty, commitment, repurchase intentions and recommendations as well.

3.1.1. Criticisms and Problems of TAM

TAM has been criticized despite its frequent use, leading the original proposers to attempt to redefine it several times. Criticisms of TAM as a theory include its questionable heuristic value, limited explanatory and predictive power, triviality, and lack of any practical value (Chuttur, 2009).

In general, TAM focuses on the individual user of a computer, with the concept of perceived usefulness, with extension to bring in more and more factors to explain how a user perceives usefulness, and ignores the essentially social processes of Information Systems (IS) development and implementation, without question where more technology is actually better, and the social consequences of IS use. Lunceford (2009) argues that the framework of perceived usefulness and ease of use overlooks other issues, such as cost and structural imperatives that force users into adopting the technology.

According to Bagozzi (2007), parsimony has been an Achilles' heel for TAM. It is unreasonable to expect that one model, and one so simple, would explain decisions and behavior fully across a wide range of technologies, adoption situations, and differences in decision making and decision makers. TAM has seduced researchers into overlooking the fallacy of simplicity. Researchers have overlooked essential determinants of decisions and action, in favor of a simple model and turned a blind eye to inherent limitations in TAM.

The second critical gap in TAM occurs for the linkage between individual reactions to using information and intentions. Two issues deserve scrutiny. One concerns the possible, and in practice frequently occurring, absence of compelling motivations for acting on putative reasons for acting (Bagozzi, 2007).

In other words, perceived usefulness and attitudes don't need to contain or constitute motives to act for

any particular decision maker or for any specific situation (Bagozzi, 2007).

4. Research Methodology: Survey

4.1. Survey: pre-testing

The survey was the main tool that was used in this dissertation thesis, in order to obtain results that could assess TAM in the EV Market.

After concluding the questionnaire, a pre-test was applied. According to Gomes et al. (2016), pretesting tools can be used to improve the quality of survey data.

At the end of the pre-test, each respondent gave a personal opinion about interpretability issues, size and time spent in filling out. We applied the initial version of the survey on a small sample (n = 11), which had a similar profile to that of the final sample.

The pre-test had a very specific condition: it failed in one of the criteria, that was the age of the respondents. All of them were aged above 35 years old. As suggested in literature, respondents were asked to make comments when responding to the questionnaire about how they perceived certain questions or items, whether anything was missing, and how they perceived the questionnaire's relevance, comprehensibility and ease of response (Jungner et al. , 2018).

All the respondents spent approximately the same time filling out the questionnaire: 6 minutes. It was unanimous that the items were of easy reading, easy response and of easy comprehension. It was also considered that the questionnaire was very complete, because it asked about topics of the daily life, like using a EV Vehicle.

4.2. Survey: approaches, design and application

The main core of the survey questionnaire is to obtain information, in what concerns the behavior of a total of 960 people, towards the topics of Electric Vehicles (EV) and Autonomous Vehicles (AV).

As suggested in literature, it was decided to discard the incomplete questionnaires and the ones in which participants responded incorrectly (De Angelis et al. , 2016). After cleaning the data, the remaining respondents were 936 (97,3%). The analysis will be more specific, selecting only 695 respondents (74,3%) with ages from 19 to 35 years old. The duration of this questionnaire was reduced from the initially planned - two months- to two weeks, in October and November 2018, due to the great acceptance that it had among the respondents.

The questionnaire was administered on-line, in the social network Facebook, and also in the database of Master Students of Instituto Superior Técnico (IST), by sending an email explaining the theme and the purpose of it. Participants were also asked to provide information including sex and age.

The behaviors were assessed according to the given answers, sustained on the theories defended, such as the Technology Acceptance Model (TAM) and the Diffusion of Innovation (DOI).

In the specific case of this survey, considering the fact that the TAM prefer to assess with Likert-type 7 point scales, the question type chosen to the majority of its length, are the **Closed Questions**. In this type, the respondent must choose only one of the alternatives exposed, as an answer (Hill et al. , 2008).

The main advantages of **Closed Questions**, comparing to **Open Questions** are: it is easier to apply statistical analysis to the given answers and the data analysis can be done in a more sophisticated way. But, there is a disadvantage that won't influence the choice, because it is stated that

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the obtained answers guide to simpler conclusions than in **Open Questions** (Hill et al. , 2008).

5. Variables

5.1. Conceptual Model and Research Hypothesis

The instrument was developed by the researcher based on the objectives of the study and previous literature review. First, according to most basic models of human behavior, TAM proposes that behavioral intentions depend basically on attitudes and Perceived Uselfulness (PU). Second, TAM is linked to the cost-benefit paradigm in which the decision-making is based on subjective perceptions of the individual about performance and effort. Consequently, TAM also proposes that PU and ease of use affect attitude (Belanche et al. , 2012).

Variables used in this study are variables that not be obtained measured directly (latent variable) that is (Siregar et al. , 2017):

- Exogenous variables, as a variable (X) consisting of perceived ease of use (PEOU) and Perceived Enjoyment (PE)
- Endogen Variable, as dependent variable (Y) that are: perceived usefulness (PU) and Attitude.

As a result of the data analysis, Figure 3 represents the final model, with 5 hypothesis, according to the Money and Turner (2004) revised TAM and to Dulcic et al. (2012).

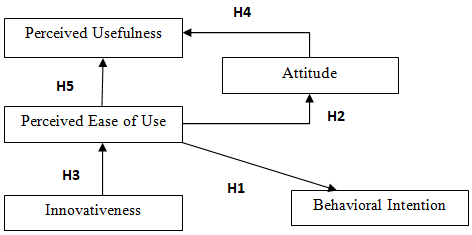

Figure 3: Final research model and hypothesis for EV and AV

Based on the Figure 4 above and taking all this information about TAM and IASAM in account, the hypothesis are:

- **Hypothesis 1 (H1). Perceived ease of use positively affects behavioral intention on the use of EV and AV.**
  Extensive research has provided evidence that perceived ease of use has a significant effect on behavioral intention to use, either directly or indirectly, through its effects on perceived usefulness (Davis et al. , 1989). Research has proved that there is a significant effect of users‟ perceived usefulness of an information system on the intention to use the system (Venkatesh et al, 2000). Perceived ease of use was found to be the second most important determinant of a users‟ behavioral intention towards the system.

- **Hypothesis 2 (H2). Perceived ease of use positively affects attitude on the use of EV and AV.**
  According to literature, perceived ease of use has a positive and significant influence on attitude. According to Rahmiati (2017), this relation is verified in online shopping. So, if users feel the ease in conducting transactions online it will cause a positive attitude towards online shopping.

- **Hypothesis 3 (H3). Innovativeness positively affects perceived ease of use on the use of EV and AV.**
  Innovativeness can be defined as the level of a person's desire to adopt new ideas compared to other users. Innovativeness is a personality factor that can be used to predict the user's innovative tendency to adopt

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various technological innovations (Septiani et al. , 2017). The higher the level of innovativeness a user has, the higher the likelihood of the user to adopt the latest technology.

- **Hypothesis 4 (H4). Attitude positively affects Perceived Usefulness on the use of EV and AV.**

  The more people perceive technology is easy to use, the positive their attitude to the technology will be. It is the same with online shopping; as people perceive that online shopping is easy like to access the online sites, to learn the procedure, to compare products and prices, to find desired product, their attitude to online shopping will be more positive (Juniwati, 2014).

  It is posited that attitude towards using a new information system is determined by the users' perception of usefulness and that attitude is in turn a key determinant of actual usage of the new information system (Buguembe, 2010).

- **Hypothesis 5 (H5). Perceived ease of use positively affects perceived usefulness on the use of EV and AV.**

  Perceived usefulness is an internal belief that is critical to the use of technology. Research conducted by Zhang et al. (2012), and referred by Septiani et al. (2017), states that perceived usefulness is influenced by how high perceive ease of use the user has. The more users believe that to use innovation the only requires minimum effort, the higher their level of trust that their performance can be improved by using the technology. In addition, it also affects the level of user trust that the technology offered can improve their performance (Septiani et al. , 2017).

5.2. Questionnaire Analysis

The TAM and the IASAM theories were assessed by applying an on-line questionnaire to a minimum of 50 valid answers, in a timeline of two months (October and November 2018).

This tool was directed mainly to college students, with ages varying from 19 to 35 years old, because they will be the main users of the EV and AV vehicles in the future. As early referred, age was important, because it is a filter in what concerns the analysis of the data obtained with the answers.

The data were analyzed with the help of the SPSS software, applying the concept of multivariate analysis, after using snowball sampling of the data obtained.

Snowball sampling is a non-probability sampling and research technique through survey and data registration which is usually used in sociology, psychology, or management studies, and are recommended when the population cannot be strictly delimited or detailed (e.g. homeless people); the characteristics of the sample are rare (drug-addicts, people with rare diseases, unemployed youth, club members, elites, etc.). It is a good research method when the study is on behaviors, perceptions, customs, for the description of "typical" cases which cannot be generalized for an entire population (Dragan et al. , 2013). The main advantages of this sampling process are: it allows the researcher to reach populations that are difficult to sample when using other sampling methods; the process is cheap, simple and cost-efficient and this sampling technique needs little planning and fewer workforce compared to other sampling techniques.

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The main disadvantages are: the researcher has little control over the sampling method. As a consequence, the subjects that the researcher can obtain rely mainly on the previous subjects that were observed.

5.3. Hypothesis Testing

In order to better understand the data that is going to be provided with the answers of the questionnaire, it is necessary to recur to hypothesis testing.

According to Wang et al. (2012), in classical statistics, hypothesis testing is the process of inferring from a sample whether or not to accept a certain statement about the problem. The statement itself is called hypothesis. In each case, the hypothesis can be tested on the basis of the evidence contained in the sample. The hypothesis is either rejected, meaning that the evidence from the sample casts sufficient doubt on the hypothesis for us to say with some degree of confidence that the hypothesis is false, or accepted, meaning that it cannot be rejected.

In the real world, for one uncertain variable, two experts may give their respective views. We need to measure if their views are different or not.

There are a range of options available, depending on the context and the researchers' comfort level with statistical modeling. For example, p-value bound is simple and doable in essentially every context, as it avoids the need to specify $\pi(\theta)$ altogether (Bayarri et al. , 2016).

6. Results

6.1. Measurement Model

The measurement model was assessed by using confirmatory factor analysis (CFA) and generalized least squares (GLS). According to Septiani et al. (2017), the first step is examining measurement model by testing the construct reliability and validity to assess the internal consistency of the construct measurement. The construct reliability and validity were measured using loading factors and Cronbach's Alpha (CA). Stevens (1992) suggests using a cut-off of 0.4, irrespective of sample size, for interpretative purposes. To measure the reliability of the scales, the Cronbach's alpha indicator was used, considering the reference value 0.6 (Malhotra, 1997).

The table below provides a list of all measurement items and the results of validity and reliability analysis.

Items	Loading Factors	Cronbach's Alpha
A1	0,276	0,652
A2	0,752	
A3	0,205	
A4	0,384	
A6	0,791	
B1	0,918	0,664
B2	0,615	
C1	0,927	0,61
C2	0,447	
C3	0,263	
C4	0,229	
D1	0,555	0,643
D2	0,643	
D3	0,456	
F1	0,822	0,707
F3	0,748	

Table 1: Validity and Reliability value of EV and AV environment constructs.

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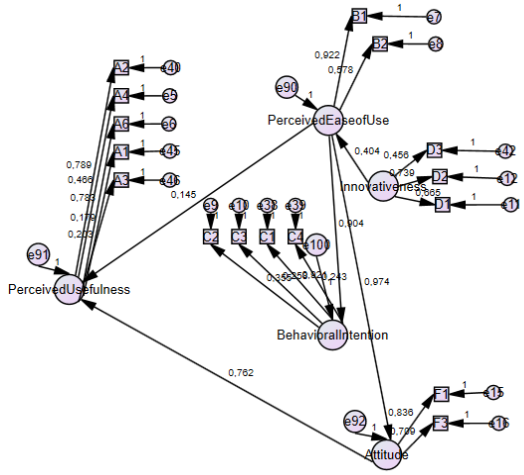

Figure 4: The Hypothesized model of EV and AV Market

6.2. Structural Model

According to Siregar et al. (2017), the measurement model test, between the indicator with the construct will get relationship. If the measurement model, the test is continued on the structural model to obtain a number of correlations that show the relationship between constructs. The process of validating the measurement model requires testing each cluster of observed variables separately to fit the hypothesized GLS and also to the CFA model.

The Goodness of Fit (GOF) can be assessed with the indicators shown in the table below.

In the specific GLS model, the indicators assessed were: Chi-Square; Root Mean Square Error of Approximation (RMSEA); Goodness of Fit Index (GFI), CMIN/DF and Normed Fit Index (NFI).

Fit Index	Chi Square	RMSEA	GFI	NFI	CMIN/DF
Recommended Values (GOF)	>0,05	< 0.08	> 0,8	0-1	< 6
Model Value	600,7	0,078	0,892	0,369	5,223

Table 2: Fit indices for measurement model with GLS

As it was verified, even though the Normed Fit Index (NFI) is low, the GLS model fits marginally better to the proposed model, with an acceptable RMSEA, an acceptable CMIN/DF, a high Chi Square and a high GFI. So, it can be concluded that the final model fits better to a GLS model, with low normality.

R^2 value was examined to see the strength of structural prediction model (Septiani et al., 2017). Table 3 shows R^2 value for all endogen variables. PU has R^2 value of 0.866 that shows that PU variable can be explained by its exogenous factors up 86,6% and the rest of it explained by other factors outside model. Therefore, one can conclude that BI, Attitude and PU variables have strong correlation with its exogenous variables, in the proposed model.

Endogen Variable	R^2
Perceived Usefulness	**0,866**
Perceived Ease of Use	**0,116**
Attitude	**0,969**
Behavioral Intention	**0,725**

Table 3: R^2 for endogen variables

AMOS 25.0 is utilized to perform one-tailed hypothesis testing. The significant path coefficients ($p \leq 0.05$) appear to support the proposed model. The table below shows the result of hypothesis testing. All the 5 initial proposed hypothesis were accepted.

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Hypothesis	Attributes	Estimate	p-value	p/2	Results
H1	PEOU - BI	0,904	<0,001	< 0,0005	Accepted
H2	PEOU - AT	0,974	< 0,001	< 0,0005	Accepted
H3	IN - PEOU	0,404	< 0,001	< 0,0005	Accepted
H4	AT - PU	0,762	0,092	0,046	Accepted
H5	PEOU-PU	0,145	<0,001	< 0,0005	Accepted

Table 4: Hypothesis Testing Results

7. Discussion

The analysis has initially yielded 10 variables to be assessed with TAM. From those 10 variables, it was necessary to reduce the analysis only to 5 variables in the final model, due to problems with Cronbach Alphas and with the model fit. Goodness of fit with GLS indicates a good fit of the collected data. This indicates that the EV and AV market questionnaire is acceptable in measuring all the five constructs. Although it has been tested in other studies with CFA (Hewitt et al. , 2019), conducting GLS ensured the validity of the instrument. The use of GLS is also to assess the questionnaire in different research settings, just like is suggested by Maat et al. (2015), so that the empirical evidence can be enhanced. Having relevant dimensions of EV and AV Market questionnaire, provides a comprehensive measurement of the chosen constructs.

In our specific model, we could reach identical results to Böhm et al. (2017), in which attitude may be a predictor for AV and EV acceptance. Acceptance refers exclusively to positive attitude towards using as opposed to "happy to drive alongside" AVs and EVs.

The results of this study confirm previous observations that the public is yet to be fully convinced about autonomy in cars. Participants reported lower expected perceived ease-of-use (Hewitt et al. , 2019). On the other hand, we find that the respondents tend to find easy to use AVs and EVs, even if in Portugal this market is still, according to the Rogers' DOI theory (2003), in an Early Adopter phase.

This study had limitations. This study did not consider other important aspects of user behavior such as prior driving experience, social impact, risk and enjoyment factors.

However after the work is done we can conclude that the benefits of this methodology far outweigh the disadvantages.

8. Conclusion

The main core of this project is to establish the main conclusions about the application of the Technology Acceptance Model (TAM) in EV Market.

TAM was tested in the thesis, with the creation of an on-line questionnaire, with 37 items, available between October and November 2018, with 695 valid answers. It was mainly directed to college students, with ages varying from 19 to 35 years old, the main users of the EV and AV vehicles in the future.

When tested with an online questionnaire, the proposed model showed good internal consistency and presented results consistent with prior research in the domain.

The questionnaire is applicable to measure EV and AV vehicles, among the users, that has been supported widely by many studies. It is hoped that by the development and evolution of the EV market in Portugal, more upcoming related issues will be conducted in the future in order to facilitate the use of the vehicles.

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