DRIVER'S ACCEPTANCE
OF FULLY AUTOMATED VEHICLES

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Rezumat. *Conform Buletinului Siguranței Rutiere din anul 2021, categoria de risc în accidentele rutiere soldate cu victime este reprezentată de persoanele de 20 de ani. Pe măsură ce înaintează în vârstă și implicit dobândesc experiența necesară, tinerii conducători auto produc mai puține accidente rutiere grave. Datele statistice ne indică tototdată, faptul că, aproape 1 milion de deținători de permis de conducere au vârsta de peste 71 de ani. În contextul în care 98% din accidentele rutiere sunt asociate erorii umane, apariția mașinilor autonome de tehnologie de nivel 5 este de așteptat să vină ca o soluție pentru targetul asumat al Uniunii Europene, și anume apropierea de 0 decese până în anul 2050. Cercetarea de față analizează trei aspecte ce pot determina creșterea nivelului de acceptare a mașinilor complet automatizate, și anume vârsta, imposibilitatea de a conduce un autovehicul și timpul petrecut în trafic.*

Abstract. *According to the 2021 Road Safety Bulletin, the risk category for road traffic fatalities is defined by drivers in their 20s. As they get older and gain experience, young drivers cause fewer serious road accidents. Statistics also show that almost 1 million licensed drivers are over the age of 71. With 98% of road accidents linked to human error, the widespread use of autonomous cars with level 5 technology is expected to help meet the EU's target of approaching 0 deaths by 2050. This research examines three aspects that can increase the acceptance of fully automated cars, namely age, inability to drive a car and time spent in traffic.*

1. Introduction

History has proven over time the importance of transport infrastructure in the context of global economic development. Material goods, production and people have benefited from transport services that have progressively evolved in line with market needs. Since the first industrial revolution, the development of means of transport has accelerated economic exchange, both in terms of material and human resources. Starting with the invention of the steam engine and continuing through the stages of the appearance of electricity and nuclear energy, the

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transport sector has experienced a new challenge, namely the combination of transport networks with a new component that was made possible by the development of the Internet. In a reality in which we are already discussing artificial intelligence at levels where human intervention is becoming optional, the European Union is facing prospects and challenges relating to every level of autonomy, from partial to total autonomy.

As the number of vehicles increases, the protection of road users has become a priority issue for both government representatives and car manufacturers. Vision 0, the approach that Romania has committed to through its National Road Safety Strategy for 2022-2030, aims to reduce road fatalities to the target of 0 road deaths by 2050. According to the Road Safety Bulletin [11] 43% of the country's population held a driving license at the end of 2021 and of young people under 21, more than a third are drivers. Compared to the statistics of the same year, young people aged between 18 and 29 were the main culprits in 22.9% of all serious road accidents, with an average of 3 serious road accidents caused by young people occurring every day of 2021, in which one person lost their life and about 3 people were seriously injured.

The present study aims to analyze a number of factors that may influence the acceptance of fully automated cars, according to SAE International (Fig.1), where at level 5 the operating system can drive the car by itself under all possible conditions.
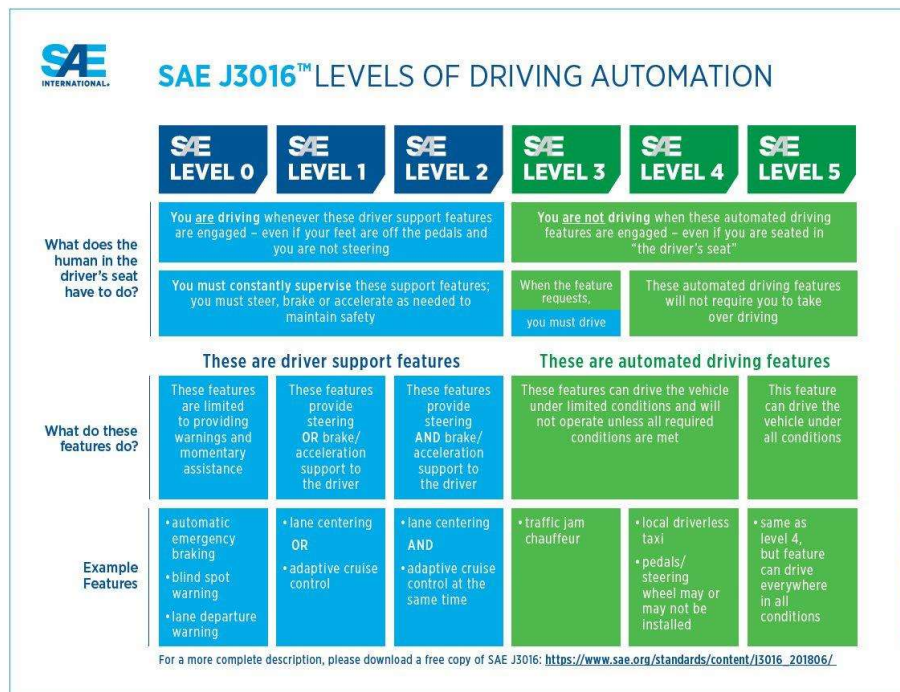

Fig. 1 SAE Levels of Automated Driving graphic

2. Literature review and hypothesis development

Considering the increasing number of vehicles in traffic and the significant proportion of accidents reported among young drivers, it is important to observe the attitude of the young population towards other means of transport. Individual cars have been preferred among young people as opposed to bicycles, on practical rather than social grounds [6]. The strengths behind this choice were the degree of comfort and more rapid travel time. Acceptance of the concept of full autonomous travel is important in terms of reducing casualties due to road accidents through the car-free vision, in which case ride-sharing and car-sharing are likely to be the main methods of travel in the future. Based on the idea that 96% of daily car use is idle, the CityMobil2 project [3,12] has identified a significant difference in the acceptance of vehicle ARTS, with younger people showing more interest in the concept compared to older people. At the same time, statistics on the age of drivers in Romania show that a predominant segment of them is defined by the population over the age of 50. As driving instincts decline with age, people who no longer meet the requirements for driving a car can benefit from the facilities offered by transport technology. Last but not least, in an increasingly congested traffic environment due to the large number of vehicles on the move, the travelling time between two locations is getting longer and longer and the individuals' quality time is getting shorter. Thus, for people who spend a lot of time in traffic over the course of a year, fully automated cars can provide an opportunity to use up travel time efficiently by doing other types of activities, independent of driving.

2.1 Acceptance of fully automated vehicles and the age factor

Young drivers' perspectives on the potential of autonomous cars are also noteworthy in the context that fully autonomous cars preclude the need for a driving license. According to statistics [11] almost 50% of serious road accidents caused without a driving license were young drivers.

Another important aspect in differentiating the degree of acceptance of autonomous cars is rendered by how quickly individuals relate to the new technology. The literature [15] points out that older people take longer to learn and adapt, but this does not make them technology sceptics. Research [4] shows a difference between how young and adult people assimilate information related to technological developments. Thus, people with more driving experience were distracted from driving when the warning system provided an alert that was not consistent with their own judgement. Younger people have shown confidence in warning systems by choosing to rely entirely on technology rather than just its assistance.

In 2021 [11], 35,387 fines were imposed for using a mobile phone while driving. Autonomous car technology, as early as Level 3, provides assistance while driving through the eyes-off function. Research [7] shows that, in the presence of a distractor such as a mobile phone, the driver's reaction time is slower as the driver gets older. Thus, when performing complex maneuvers, the brake response time was much faster for younger people. Hence, based on the previous literature, the Hypothesis was developed is as follows:

H$_0$ There is no significant relationship between age and acceptance of fully automated vehicles
H$_1$ There is a significant relationship between age and acceptance of fully automated vehicles

2.2 Acceptance of fully automated vehicles and inability to drive a vehicle

According to the 2021 Road Safety Bulletin [11], "most licensed drivers are between the ages of 31 and 50 years old, followed by those in the 51-70 age category." In addition, 819,031 people of the Romanian population have a driving license and are over 71 years old.
Fully automated technology offers solutions both in situations where the individual does not have a driving license as well as in situations where the individual can no longer drive a vehicle (age, health, loss of driving privileges, etc.). However, studies [8,2] show that while individuals may be benefiting from these advantages offered by technology, they are expressing many concerns and have considerably lower levels of acceptance in a self-driving vehicle. Relevant research [10] highlights the fact that for people unable to drive a car and for the elderly, public transport is the most efficient method of travel. According to the findings of this study, these people have a high degree of acceptance of full car automation [13]. A variety of different types of automated vehicles and the coverage of all types of transport under the potential of full automation provides the scenario for reducing serious accidents and at the same time the solution for increasing mobility. In the context of an ageing global population, improving the parameters for developing acceptance towards fully automated technology is imperative [1]. Thus, from existing research, we formulate the following hypothesis:

Hypotesis 2 There is a significant relationship between the acceptance of fully autonomous cars and the inability to drive

2.3. Acceptance of fully automated vehicles and time spent in traffic

People who spend long periods of time in traffic or people travelling in their own cars can benefit from the fully automated level of technology in cars, given their potential to provide recreational activities during the journey, the possibility to rest, the possibility to relax with other passengers and much more. The research literature has attempted to analyze the impact of fully automated cars on the time spent in traffic by an individual. A number of studies [5,16] have found that fully automated cars would influence the real estate sector, given the potential for individuals to purchase a home further away from work, as time spent commuting is no longer unproductive time.

Research results [9,14] indicate that the acceptance of autonomous cars will increase mobility, but that this may have some consequences due to two considerations. One, for the urban structure, because of the need to introduce longer commutes, and for increased urban and suburban traffic congestion due to increased travel and longer trips. Therefore, based on previous studies, the Hypothesis was developed is as follows:

H_0 There is no significant relationship between time spent in traffic and acceptance of fully automated vehicles
H_1 There is a significant relationship between time spent in traffic and acceptance of fully automated vehicles

2. Methodology

This research, which is both descriptive and quantitative, aims to study the variable relationships by applying descriptive statistics, bivariate corelations and nonparametric tests. The data was collected from questionnaires sent from Google Form. 381 questionnaires were distributed and 378 of them were usable for data analysis. Statistical Package for Social Science (SPSS) was used for data analysis and hypothesis testing. Participants in the survey varied in age from 16 to 50+, as shown in Table 1 below. When applying a descriptive analysis we observe that 25.9% of them are aged between 16 and 18 years, 5% are in the age segment 19-25 years, 13.5% are aged between 26 and 35 years, 38.1% belong to the age range 35-50 years and 17.5% are aged 50+.

Table 1. Age distribution of questionnaire respondents

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	16 - 18 years old	98	25.9	25.9	25.9
	19 - 25 years old	19	5.0	5.0	31.0
	26 - 35 years old	51	13.5	13.5	44.4
	35 - 50 years old	144	38.1	38.1	82.5
	50+ years old	66	17.5	17.5	100.0
	Total	378	100.0	100.0	

3. Results

In order to determine whether there is a statistically significant correlation between age and acceptance in the case of fully automated vehicles, we performed a nonparametric Kruskal-Wallis test, as shown in the figures below.

Figure 2, representing the test summary, shows that there are no significant correlations between the two variables and decides to retain the null hypothesis.

The distribution of the acceptance rate across the age (Fig. 3), the distribution of acceptance among the respondents (Fig. 4) and the distribution of age among the respondents (Fig. 5) are the graphical information underlying the nonparametric test.

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of ACCEPTANCE is the same across categories of AGE.	Independent-Samples Kruskal-Wallis Test	.074	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .050.

Independent-Samples Kruskal-Wallis Test

ACCEPTANCE across AGE

Independent-Samples Kruskal-Wallis Test Summary	
Total N	378
Test Statistic	8.531[a,b]
Degree Of Freedom	4
Asymptotic Sig.(2-sided test)	.074

a. The test statistic is adjusted for ties.

b. Multiple comparisons are not performed because the overall test does not show significant differences across samples.

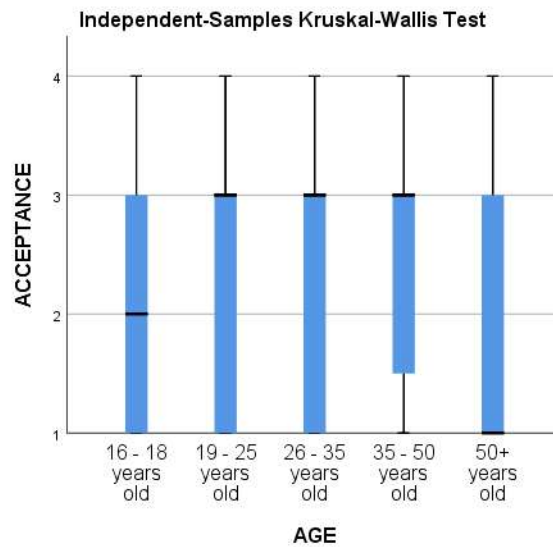**Fig.2** Independent sample Kruskal-Wallis Test

Independent-Samples Kruskal-Wallis Test

Fig 3. The distribution of acceptance across the age

Categorical Field Information ACCEPTANCE
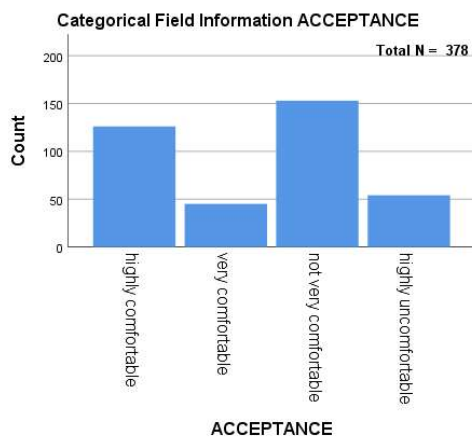
Categorical Field Information AGE

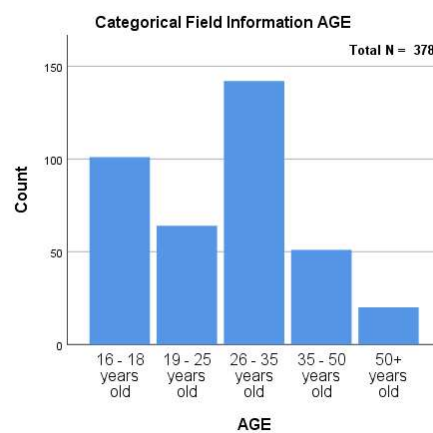**Fig 4.** The distribution of acceptance on the sample of respondents

Fig 5. The distribution of age on the sample of respondents

Analyzing the results from the above test, we see that the p-value is 0.074 and thus greater than 0.05. Therefore, the null hypothesis is retained, and it is assumed that there is no difference in the acceptance of autonomous cars depending on age.

The second hypothesis was tested using a Spearman correlation test.

Table 2 Correlation between the level of acceptance of fully automated vehicles and the inability to drive a car.

Correlations

			ACCEPTANCE	INABILITY
Spearman's rho	ACCEPTANCE	Correlation Coefficient	1.000	-.225**
		Sig. (2-tailed)	.	.000
		N	378	378
	INABILITY	Correlation Coefficient	-.225**	1.000
		Sig. (2-tailed)	.000	.
		N	378	378

**. Correlation is significant at the 0.01 level (2-tailed).

Analyzing Table 2, we see that there is a statistically significant correlation between the level of acceptance of fully automated cars and the inability to drive. At the same time, we have a significant negative correlation between the two variables, which means that if the respondent identifies himself with the impossibility to drive a car the acceptance of fully automated technology increases.

For the third hypothesis we conducted a descriptive analysis (Table 3). Of the total 378 respondents, 19.6% have travelled more than 25,000 km, 34.7% have travelled between 10001 and 25000 km and 45.8% have less than 10,000 km travelled.

Table 3. Time spent in traffic by the respondents.

km driven/year

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	over 25.000 km	74	19.6	19.6	19.6
	between 10.001 - 25.000 km	131	34.7	34.7	54.2
	between 0 - 10.000 km	173	45.8	45.8	100.0
	Total	378	100.0	100.0	

In order to determine whether there is a statistically significant correlation between time spent in traffic and acceptance in the case of fully automated vehicles, we performed a nonparametric Kruskal-Wallis test, as shown in the figures below.

Figure 6, representing the test summary, shows that there are no significant correlations between the two variables and decides to retain the null hypothesis.

The distribution of the acceptance rate across time spent in traffic (Fig. 7), the distribution of acceptance among the respondents (Fig. 8) and the distribution of age among the respondents (Fig. 9) are the graphical information underlying the nonparametric test.

Nonparametric Tests

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of acceptance is the same across categories of km driven/year.	Independent-Samples Kruskal-Wallis Test	.170	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .050.

➡ **Independent-Samples Kruskal-Wallis Test**

acceptance across km driven/year

Independent-Samples Kruskal-Wallis Test Summary

Total N	378
Test Statistic	3.545[a,b]
Degree Of Freedom	2
Asymptotic Sig.(2-sided test)	.170

a. The test statistic is adjusted for ties.

b. Multiple comparisons are not performed because the overall test does not show significant differences across samples.

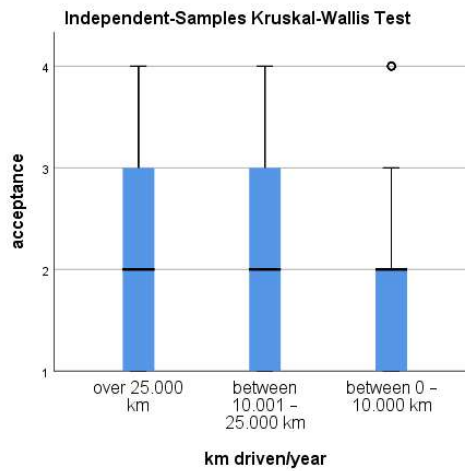**Fig.6** Independent sample Kruskal-Wallis Test

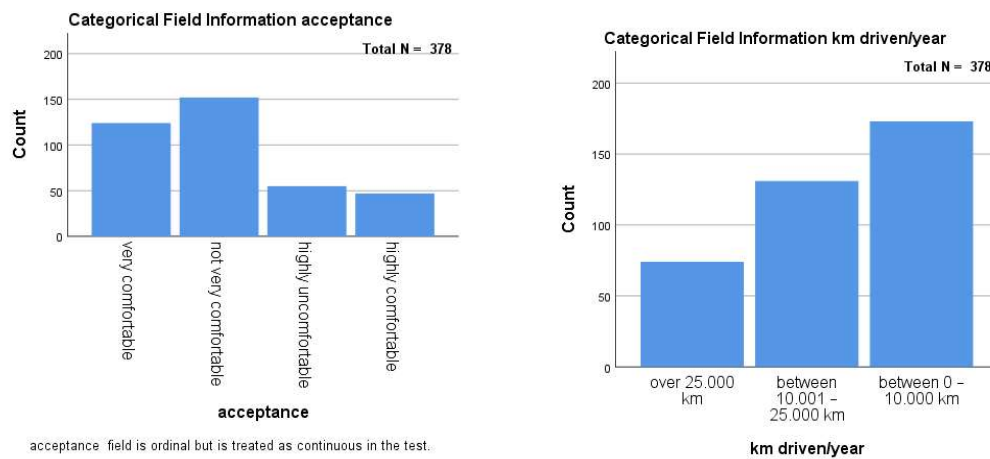**Fig .7** The distribution of acceptance across time spent in traffic

Fig. 8 The distribution of acceptance on the sample of respondents

Fig. 9 The distribution of time spent in traffic on the sample of respondents.

Analyzing the results from the above test, we see that the p-value is 0.170 and thus greater than 0.05. Therefore, the null hypothesis is retained, and it is assumed that there is no difference in the acceptance of autonomous cars depending on the time spent in traffic.

4.   Conclusions

Fully automated vehicles have the potential to radically change the dynamics of transport. Both in terms of commuting and tourism. With a focus on reducing road fatalities, the fully automated vehicle provides at least one certainty: the elimination of the human factor. Given that 98% of accidents resulting in death or injury are caused by human error, the potential of transport technology is not to be underestimated.

Considering that fully automated cars will be an affordable product in at least 10 years, Romania's adult licensed population will be the age segment that should be directly interested in using them, given the degradation of instincts caused by ageing.

At the same time, today's young drivers will become the adult user segment when the product becomes possible, so gaining their acceptance of autonomous cars early in the technology development process is an important consideration. Last but not least, transport dynamics will change when fully self-driving cars appear on the market. The way we look at traveling to work, the way we organize our daily schedule and the way we travel will change radically.

Age, time spent in traffic, inability to drive, are just some of the factors that can determine the acceptance of transport technologies. The degree of acceptance of fully autonomous car technology will depend on a combination of marketing strategies, effective public policy, and the personal benefits of each individual user.

Limitations and future research

First, it is important to consider the effect of time on the results.

Conducting a study over a longer period may change the correlation between variables. Secondly, a number of other factors need to be analyzed in correlation with the acceptance of autonomous cars, as well as existing mediation relationships.

Last but not least, as developments in transport technology continue, skeptical perspectives and mistrust may be diminished.

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