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CONSUMER SURVEY ON SELF-DRIVING TECHNOLOGY, BROKEN DOWN BY GENDER

ÖNVEZETŐ TECHNOLÓGIA FOGYASZTÓI VIZSGÁLATA NEMEK SZERINTI BONTÁSBAN

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Abstract

Self-driving vehicle technology is receiving increasing attention in the development of modern transport systems, particularly as a result of growing demand for sustainable mobility solutions and technological innovations. However, understanding consumer acceptance is essential for the successful social integration of this technology, with particular regard to gender differences in attitudes, trust and safety expectations. This study presents the results of a comprehensive consumer survey, in which we used the Mann-Whitney U test to analyse how men and women's opinions differ on the use of self-driving technology. The results show that although there are no significant differences between the sexes on many issues, significant differences can be observed in certain areas, such as passenger safety. Based on the results of the research, specific recommendations can be made to decision-makers and technology developers to promote the acceptance of self-driving technologies, improve safety perceptions and ensure the successful integration of the technology into transport systems.

Keywords

Self-driving vehicles, Mann-Whitney U-test, generations

Absztrakt

Az önvezető járművek technológiája egyre nagyobb figyelmet kap a modern közlekedési rendszerek fejlesztésében, különösen a fenntartható mobilitási megoldások iránti növekvő igény és a technológiai innovációk eredményeként. E technológia sikeres társadalmi integrációjához azonban elengedhetetlen a fogyasztói elfogadás megértése, különös tekintettel a nemek közötti különbségekre az attitűdökben, bizalomban és biztonsági elvárásokban. Jelen tanulmány egy átfogó fogyasztói vizsgálat eredményeit ismerteti, amely során Mann-Whitney U próba segítségével elemeztük, hogyan térnek el a férfiak és a nők vélemények az önvezető technológia alkalmazásáról. Az eredmények rávilágítanak arra, hogy bár számos kérdésben nincs jelentős különbség a nemek között, bizonyos területeken, mint például az utasbiztonság, szignifikáns eltérések figyelhetők meg. A kutatás eredményei alapján konkrét ajánlások fogalmazhatók meg a döntéshozók és a technológiafejlesztők számára, amelyek elősegíthetik az önvezető technológiák elfogadottságát, a biztonsági percepció javítását és a technológia sikeres integrációját a közlekedési rendszerekbe.

Keywords

Önvezető járművek, generációk, Mann-Whitney u-próba

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INTRODUCTION

Self-driving technologies have developed at an almost unprecedented pace over the past decades, and are now a major focus not only for technological innovation but also for sustainable transport. The worldwide demand for intelligent transport systems has led to new developments that have made autonomous vehicles (AVs) a key driver of mobility innovation. These vehicles are enabled by a combination of sophisticated sensor systems, artificial intelligence and machine learning algorithms, which ensure that they are able to react accurately and reliably to changes in their environment, even in complex traffic situations. One of the most critical aspects of the development of such systems is reliability - a factor that fundamentally determines not only their acceptance, but also road safety as a whole.

However, technological progress alone is not enough - it is just as important to understand how users relate to this new form of transport. Social acceptance does not always keep pace with the rapid spread of technological innovation. Research has consistently shown that people's perception of safety and their trust in technology are key determinants of the social embeddedness of autonomous systems. The issue of safety is particularly pronounced, as many people still fear that these vehicles will not be able to operate reliably and safely in traffic - especially when it comes to their ability to avoid accidents.

In addition, the proliferation of self-driving vehicles raises serious legal, ethical and societal challenges. It's not simply a question of who is liable in the event of an accident - there are also questions about the protection of personal data and protection against cyber-attacks. And we haven't even touched on classic ethical dilemmas such as the famous "trolley problem", where autonomous decisions can be interpreted in moral terms.

The issue of social acceptance is linked not only to overall trust but also to certain demographic differences. A prominent example is the gender gap, which is also reflected in attitudes towards technology. Previous research has shown that women tend to be more cautious, often expressing stronger concerns about safety, while men tend to be more open to new technologies and more likely to try or purchase such vehicles.[1] This gender difference can provide valuable guidance for those working to promote and market technology.

Against this background, the aim of the present study is to examine in depth the consumer acceptance of self-driving vehicles, with a particular focus on gender differences in the dimensions of safety and technological attitudes. The Mann-Whitney U test was used in the research, as this non-parametric statistical method is an excellent way to compare ranked values of independent samples - especially when the distribution of the data does not meet the requirements of normality, which is often the case in social science studies.

Our results provide useful guidance for decision-makers, developers and transport policy makers. The detailed data analysis revealed that although there were no significant differences between male and female respondents on a number of aspects, there were some areas where gender differences were noticeable, such as passenger safety. The conclusions of the study provide some suggestions that could help to promote the social acceptance of autonomous vehicles, contribute to safer transport and increase confidence in the technology.

To sum up, the take-up of self-driving technology is a complex process whose success goes beyond the world of technical innovation. Social support, a sense of security and

the continued building of consumer confidence, taking into account gender differences in opinions, are essential.

LITERARY PROCESSING

Self-driving vehicles (AVs) are increasingly becoming an integral part of the modern transport system, with technological advances and a growing demand for sustainable mobility solutions. The autonomous vehicle group can be grouped under the following key points: technological development, consumer acceptance, and social, legal and ethical issues.

First of all, technological advances in self-driving vehicles are playing a prominent role in their uptake. AVs are composed of a variety of sensor and control systems that enable accurate perception of their environment and safe navigation [2][3][4]. Reliability is a key factor in the development of such systems, which is achieved by using various algorithms and machine learning techniques [3]. The integration of urban infrastructures with self-driving technologies is essential as it helps to reduce traffic congestion and CO2 emissions [5].

Secondly, consumer acceptance is a key factor in the uptake of self-driving vehicles. Several research studies show that user comfort and safety are essential for the success of the technology [6][7][8]. For example, safety is cited as the most important aspect of self-driving cars, alongside functional and subjective factors [6]. In this regard, it is highlighted that social pressure and the development of trust in the technology will influence consumer behaviour. The current pace of technological innovation is outpacing consumer adoption, which may be a barrier to future uptake [9].

Third, the introduction of self-driving cars raises a number of legal, ethical and social issues. Issues such as liability in the event of accidents, as well as personal data protection and cybersecurity, play a key role in the social discourse [10][11]. Discussing ethical dilemmas, such as the "trolley problem", is essential for the social acceptance of the technology, and the decision-making of vehicles in potentially dangerous situations may be ethically questionable [11].

The future of self-driving vehicles will therefore be shaped by technological innovation, increasing social acceptance and strengthening the legal framework to respond effectively to the challenges of modern mobility.

Safety of self-driving vehicles

The safety of self-driving vehicles is a major issue in modern mobility, as the introduction of autonomous technologies creates many new challenges and opportunities. The discourse around the development, social acceptance and safety issues of self-driving vehicles has intensified in recent years, as both the benefits and challenges of the technology need to be considered.

The safety of autonomous vehicles is based on technological developments to reduce road accidents and increase transport efficiency. The expectation is that self-driving technology such as sensors and artificial intelligence will enable vehicles to collect and analyse real-time data on traffic conditions, which will improve the decision-making process [12][13]. In this way, autonomous vehicles will be able to anticipate and possibly avoid accident-prone situations, thus reducing the occurrence of road accidents [14].

In addition to technological progress, social acceptance is also a key factor influencing the perception of the safety of self-driving vehicles. Consumers' attitudes and fears about safety play an important role in the extent to which they trust autonomous technologies [15][16]. Some research shows that increasing consumer acceptance requires improving technology and social communication to ensure that users understand and accept new solutions in transport [17][18].

To address security risks, manufacturers and research institutes are working to ensure that cybersecurity concerns are adequately addressed, as autonomous vehicles are interconnected systems whose vulnerability can pose risks to vehicle integrity and user safety [13][19][20]. Cybersecurity is crucial to protect vehicles, as hackers have the potential to manipulate control systems, potentially leading to accidents [15][21]. Implementing robust cybersecurity solutions is essential to strengthen user trust and to successfully integrate autonomous vehicles into the transport ecosystem [22].

In summary, the safety of self-driving vehicles is a complex issue that relies on a combination of technological advances, social acceptance and cybersecurity challenges. For autonomous vehicles to become truly safe, it is essential to continuously develop technological innovations and strengthen the social dialogue.

Confidence in self-driving cars

Confidence in self-driving vehicles is a key factor for the successful introduction and uptake of the technology. In order to develop trust, it is important to understand the feelings and attitudes of users, shape the general acceptance of vehicles and their willingness to use the technology.

Building trust depends in part on how people perceive the safety and reliability of self-driving vehicles. Research has shown that the safety and promise of reduced traffic accidents provided by vehicles is closely related to the level of trust [23]. The increased sense of safety promised by self-driving vehicles contributes to users' positive attitudes towards them [24][25][26]. The confident and cautious driving style of vehicles can increase trust among users [27][28].

Further analysis shows that user experience has a significant impact on trust. People who have already tried autonomous vehicles tend to be more positive about the technology, while those who have not and are more sceptical about the reliability of the vehicles [29][30]. During interactions, users may be potentially disappointed if self-driving vehicles do not meet their expectations, which may lead to a decrease in trust [31][32]. Several researches suggest that if vehicles do not perform flawlessly, users tend to lose trust in them in the long run, which may be a barrier to technology adoption [31][32].

Factor	**Characteristics, effects**	**Examples from the literature**
Technological reliability	Sensor sophistication, use of artificial intelligence, machine vision capability, reliability of real-time data analysis	[2],[3],[14]
Cybersecurity	Protection against external attacks, integrity of control systems, protection of personal data	[10],[13],[15]

Factor	Characteristics, effects	Examples from the literature
User experiences	The impact of personal testing and experience, handling system errors, meeting user expectations	[8],[29],[30]
Social context	Gender and age differences in attitudes, the role of social norms and cultural factors	[26],[34],[37]
Communication, information	Impact of quality of information on technology adoption, importance of marketing communication, effectiveness of education campaigns	[7],[17],[35]

Table 1: Factors affecting confidence in self-driving vehicles. Source: own ed.

The social and cultural context of trust also plays a role. For example, taking into account differences between women and men and age-related differences, studies have shown that women are more prone to mistrust self-driving vehicles, while men tend to have a more positive view of autonomous technologies [34][35]. The attitudes of different groups towards trust provide important social support for vehicle design and transport policy making.

Overall, trust in self-driving vehicles is a complex issue that depends on a number of factors, including technological performance, user experience and social context. Increasing confidence to continuously improve the safety and reliability of vehicles and taking into account user interactions and experiences is a key priority in the deployment of this new transport technology.

Perception of self-driving cars by women and men

The gender gap in the perception of self-driving cars is of particular interest, as there are significant differences between men and women in attitudes and risk perception towards self-driving cars. Research shows that women tend to be more cautious, while men are more willing to use self-driving cars [36].

Men have a higher perception of the risks associated with self-driving vehicles and are more likely to perceive these vehicles as less risky. Conversely, women show more concern when it comes to autonomous vehicles, due to their concerns about safety and reliability [36]. Research often cites the social construction of gender roles and the stronger positive correlation between men's technological knowledge and experience [36].

Female respondents often emphasise the importance of professional and personal safety, while for men, technological advances and vehicle reliability predominate [36]. These differences are also reflected in driving habits: female car users often take a more conservative approach and avoid potentially dangerous situations, while men are more likely to take risks [36].

Gender differences are therefore not only reflected in the statistics, but also in the user experience. The different patterns of attitudes of men and women towards vehicles, especially self-driving technologies, can reshape transport policy and vehicle manufacturers' developments. Increasingly, developments should take into account the need to increase the confidence of different groups in autonomous vehicles [36].

Overall, examining the differences in attitudes between men and women is essential in the design and application of future autonomous vehicle technologies to ensure that they are acceptably safe for all user groups.

Distribution of self-driving car use by gender

The gender distribution in the use of self-driving vehicles is an important issue that will influence the adoption of the technology and the development of transport policies. There are different perspectives and attitudes between men and women, which influence brand preferences and their feelings about safety.

Several studies have shown that women are generally more cautious about self-driving vehicles than men. Part of the explanation for this effect lies in the fact that women tend to be more risk-averse and concerned about the reliability of the technology [37][38]. While men are more confident, female respondents tend to approach technological innovations with a more cautious attitude, paying particular attention to safety concerns about the vehicles [39].

It is also interesting to note that women often consider social and environmental impacts, while men focus more on technological benefits and vehicle performance [40]. Men dominate interest in vehicles because of the social norms associated with motor vehicles and the influence of driving as a masculine activity [41].

The make and type of vehicle also affect the gender distribution. In addition to sports cars and SUVs, which are traditionally preferred by men, women are more interested in more practical, safer vehicles, the use of which is more suited to their lifestyle and family situation [42]. These views also influence manufacturers' marketing strategies, which try to take into account the needs of different target groups [43].

The process of trust and acceptance is closely linked to the risk assessment of different genders. Men tend to be quicker to adopt new technologies and innovations, while for women, experience and reliability are more important, which can lead to a delay in adoption [44][45]. By taking into account the differences between men and women, it is possible to optimise vehicle design, safety features and marketing campaigns [39][45].

Overall, men's and women's perceptions of self-driving vehicles are not only based on technological utility, but also take into account social norms, risk-assessing attitudes and subjective trust. In this way, it is possible to promote the success not only of the technology, but also of related business policies and strategies.

Safety of self-driving technology

The safety of self-driving technology is a key issue in modern transport systems, as it affects not only the efficiency of vehicles on the road, but also the protection of road users. The advancement of self-driving vehicles is constantly creating new challenges that need to be addressed in order to ensure social acceptance and widespread uptake of the technology.

Reliability of the technology and safe operation are the main criteria. The development of self-driving vehicles has seen significant advances in the use of sensors, machine vision and artificial intelligence [46][47]. Vehicles are able to sense their surroundings in real time, assess traffic situations and make optimal decisions to avoid accidents [48].

From a safety perspective, it is essential that self-driving vehicles not only reduce the risk of accidents, but are also able to dynamically manage different environmental and

traffic situations. Driver and pedestrian interactions must be taken into account in the development process, as they have a significant impact on vehicle safety [49][50]. When testing self-driving vehicles, it is important to simulate different environmental conditions and traffic situations to ensure that the technology is truly reliable in real-life situations.

Another key issue is the relationship between transport security and cyber security. The vulnerability of connected self-driving vehicles can be affected by external attacks, such as hacking, if the vehicles are not properly protected [51][52]. Developers must therefore pay attention not only to the mechanical reliability of vehicles, but also to the continuous improvement of cybersecurity systems.

It is important to note that security raises not only technical but also social aspects. The success of the deployment of self-driving technologies is largely influenced by consumer confidence. Recent research has shown that trust and attitudes towards the technology contribute significantly to user acceptance, so social discourse and information is essential [52][53]. It is important for vehicle manufacturers and research institutions to address societal expectations and concerns, otherwise the uptake of the technology may be stalled.

In summary, the security of self-driving technology is a multidimensional issue, including technological reliability, cyber security and social acceptance. A holistic approach that integrates these aspects is therefore essential for future developments.

MATERIAL AND METHODOLOGY

The Mann-Whitney U test, also known as the Mann-Whitney U test or Mann-Whitney-Wilcoxon test, is a non-parametric statistical test used to test the difference between two independent samples. Nonparametric tests are statistical methods that do not assume a normal distribution of populations.

The Mann-Whitney U test examines whether there is a significant difference between two samples based on the ranked values. The method involves comparing the ranking of all the items in the two samples and calculating which sample has a higher average rank. On this basis, it determines whether there is a statistically significant difference between the two samples.

The basis of the Mann-Whitney U test is that if there is no difference between the two samples, the sum of the ranks of the items in one sample will be similar to the ranks of the items in the other sample. However, if there is a difference between the samples, the sum of the ranks of the items in one sample will tend to be higher than the other.

This test can be used when the variables are not normally distributed or when the measurement scales provide only ranked data. It is often used, for example, in medicine or the social sciences when examining differences between two groups.

The Mann-Whitney U test is usually used to test the following hypotheses:

- Null hypothesis (H0): No significant difference between the two samples.
- Alternative hypothesis (H1): There is a significant difference between the two samples.

The result of the test is a U statistic, which allows us to decide whether to reject the null hypothesis or not. We usually use the critical values or p-values to evaluate the results. The Mann-Whitney U test examines whether there is a significant difference between the results, but does not tell us anything about the causes or correlations.

The Mann-Whitney U test for comparing genders

While human behaviour plays a key role in road accidents, it is important to look at gender differences in driving habits and accident statistics. Several studies have highlighted differences in driving styles and behaviour between men and women. In general, men tend to have more aggressive driving styles, while women tend to prefer safer and more cautious driving habits.

In addition, accident statistics also reveal some non-specific trends. Although men tend to drive more and are more likely to be involved in accidents, certain types of crashes, such as slow-speed collisions or parking incidents, may be more common for female drivers. Understanding such differences can help to develop more targeted measures to improve road safety [54][55]. Of course, the parametric or non-parametric nature of the data is a key consideration in the choice of the method of analysis. The non-parametric nature of the gender distribution justifies the use of the Mann-Whitney U test.

In general, non-parametric data analysis offers a more flexible approach to data sets that do not meet the conditions imposed by parametric statistical tests. Non-parametric tests, such as the Mann-Whitney U test, do not require knowledge of the exact distribution of the data and are less sensitive to possible outliers in the data or small sample sizes.

Gender analysis is often important in areas where data do not have a normal distribution and/or where variables can be ranked but not measured in intervals or proportions. When working with this type of data, the Mann-Whitney U test can be a powerful tool for examining gender differences and making them statistically meaningful.

Since the data are non-parametric for the distribution of gender, the Mann-Whitney U test is an appropriate tool for statistically assessing and detecting potential differences. The test allows us to draw reliable conclusions about potential differences between genders without distorting the data or ignoring their characteristics.

Differences in the nature of self-driving and their significance are of paramount importance for the development of technology and the uptake of self-driving vehicles. Studies that address the nature of self-driving will contribute to technological developments and to making self-driving vehicles safer. In terms of safety, research on self-driving vehicles is key to shaping the future of road transport. In areas where there is no significant difference between self-driving and conventional driving, the focus should be on safety measures and design elements that improve the safety of self-driving vehicles and user confidence in these technologies. Detailed studies, covering only those areas where there is a difference in the nature of self-driving, will provide relevant and valuable information for designers, engineers and decision-makers. These results will allow them to fine-tune self-driving systems, optimise the user experience and further improve the safety and efficiency of self-driving vehicles. Thus, the differences in the nature of self-driving and their significant relevance are of paramount importance for both technology development and road safety. The results of such studies can help to advance the design and development of self-driving vehicles to make future transport safer and more efficient (Table 2).

	Male		Female		
	Ave-rage	Source	Ave-rage	So-urce	p
Would you use a self-driving car?	2,65	1,202	2,50	1,165	**0,000**
Would you like to buy self-driving features for your vehicle?	1,71	0,785	1,63	0,712	**0,000**
How much would you spend on a self-driving feature?	1,59	1,602	1,40	1,461	**0,000**
Self-driving system should be cheap	2,57	1,087	2,50	1,070	**0,007**
Self-driving system to simplify driving	3,11	0,870	3,16	0,855	**0,003**
A self-driving system to make transport faster	2,85	0,996	2,86	0,982	0,793
Self-driving system to increase road safety	3,44	0,791	3,41	0,845	0,662
Self-driving system to increase the value of your car	2,45	1,096	2,46	1,095	0,601
Self-driving system to increase passenger safety	3,43	0,815	3,46	0,816	**0,007**
Self-driving system to reduce the number of accidents	3,52	0,802	3,51	0,831	0,918
How much would you trust a self-driving system?	2,86	1,361	2,83	1,362	0,284
How much self-driving technology is changing driving safety	2,97	1,338	2,93	1,346	0,092
How safe would you feel in a self-driving car?	2,86	1,373	2,80	1,356	0,050

Table 2 Mean and standard deviation of responses for men and women and Mann-Whitney U test results. Source: own survey N=8663.

Hypothesis I assumed that there are no differences between men and women in the safety issues expected from self-driving technology.

After conducting the data analysis, the results of which are presented in Table 2, it was found that there were significant differences between men's and women's expectations of self-driving technology in some of the questions asked.

Men would prefer to buy and use a self-driving car, and spend more on it. Women would rather expect self-driving technology to simplify transport. On the question of safety, there is typically no difference between men and women, who are equally likely to expect an increase in road safety, a reduction in accidents from self-driving technology and the same level of safety in a vehicle with this feature. There is one safety issue where there is a significant difference, with women having higher expectations for passenger safety, presumably related to increased protection of children, as no gender difference was found for the question on their own safety [56]

Based on the results of the Mann-Whitney U test, my hypothesis I is confirmed, there are no differences between men and women on the safety issues expected from self-driving technology, except for the issue related to passengers, which is associated with the transport of children.

SUMMARY

In recent years, the technology of self-driving vehicles has increasingly become the focus of attention in the modernisation of transport. This is not only due to increasingly pressing sustainability needs, but also to technological breakthroughs. This innovation has the potential to become a cornerstone of the future of transport, as it has great potential to reduce accidents, improve road safety and reduce environmental pollution. At the same time, social acceptance is key, especially if we want to talk about a successful introduction in the long term. Therefore, the attitude of different social groups, especially men and women, to this new approach to transport is not an insignificant question. This study presents the results of a large-scale consumer survey in which the researchers used the Mann-Whitney U test. This non-parametric statistical method was ideally suited to this case, as it does not assume a normal distribution of the data - something that is often lacking in the social sciences.

The survey found that while there were significant differences between male and female respondents on a number of points, most of these did not suggest that radically different approaches to promoting or developing technology were needed. Of particular interest was the issue of openness to technology, with men showing stronger acceptance, being more inclined to try or buy self-driving vehicles and not shying away from digging deeper into their pockets to do so. In contrast, female respondents were somewhat more down-to-earth in their approach. They were particularly attracted by the potential of self-driving technology to simplify the everyday challenges of transport, offering convenience and ease. This difference illustrates the societal picture that men are more attracted by the allure and prestige of technological novelty, while women tend to value practicality, comfort and safety more. The issue of safety was also given special emphasis in the analysis, as one of the most important factors in the social acceptance of self-driving systems is the degree to which we feel they are reliable. The data shows a surprisingly even balance: both women and men consider it important that these vehicles actually increase overall road safety, reduce the risk of accidents and make passengers feel safe. This finding is particularly important as it suggests that safety expectations do not really differ by gender - at least in broad terms. The only area where there was some difference was in passenger safety, where women had slightly higher expectations. The study explained this by the fact that women may be more sensitive to passenger protection, especially when it comes to family members or children - an attitude that is understandable and could be an important feedback for developers.

One of the key lessons of the research is that while there are indeed differences in the way men and women approach technology, these are not insurmountable barriers to its social embedding. Rather, they can provide guidance for those responsible for development, deployment or communication. By keeping these differences in mind, they can address users more effectively and facilitate the social integration of self-driving systems. The results of this research will not only provide a basis for technological development, but also for improving the user experience, refining the perception of safety and ultimately making these vehicles an integral part of the transport of the future. In conclusion, the study provides important information for technology developers, manufacturers and transport policy makers. These findings can help to shape policies that take into account the needs of both genders and thus support the successful and widespread uptake of self-driving vehicles.

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