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THE ROLE OF DEMOGRAPHIC AND ECONOMIC VARIABLES IN PERCEPTIONS TOWARDS AUTONOMOUS CARS

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Abstract: This study examines the socio-demographic and economic factors that affect consumers' perceptions and usage intentions toward autonomous vehicles. The effects of variables such as age, gender, marital status, education level, and vehicle ownership on consumer attitudes were analysed. The results show that younger individuals, 34 years and under, have a more positive and innovative attitude towards autonomous vehicles. In contrast, men have a higher intention to use autonomous vehicles in the future than women. Regarding marital status, it was found that single individuals have higher perceptions of innovativeness and anthropomorphism than married individuals. While vehicle ownership creates a difference in the perception of innovativeness, income level did not significantly affect perceptions. In terms of education level, individuals with lower education levels have higher perceptions of anthropomorphism and positive attitudes. The study emphasizes that demographic factors such as age and education should be focused on to increase the adoption of autonomous vehicles.

Keywords: Autonomous Vehicle, Consumer Perception, Socio-Demographic Factors, Anthropomorphism, Innovativeness.

Otonom Araçlara Yönelik Algilarda Demografik Ve Ekonomik Değişkenlerin Rolü

Öz: Bu çalışma, tüketicilerin otonom araçlara yönelik algılarını ve kullanım niyetlerini etkileyen sosyo-demografik ve ekonomik faktörleri incelemektedir. Yaş, cinsiyet, medeni durum, eğitim düzeyi ve araç sahipliği gibi değişkenlerin tüketici tutumları üzerindeki etkileri analiz edilmiştir. Sonuçlar, 34 yaş ve altındaki daha genç bireylerin otonom araçlara yönelik daha olumlu ve yenilikçi bir tutuma sahip olduklarını göstermektedir. Buna karşılık, erkeklerin gelecekte otonom araç kullanma niyetleri kadınlara göre daha yüksektir. Medeni durum açısından, bekâr bireylerin evli bireylere kıyasla daha yüksek yenilikçilik ve antropomorfizm algılarına sahip oldukları bulunmuştur. Araç sahipliği yenilikçilik algısında bir farklılık yaratırken, gelir düzeyinin algılar üzerinde anlamlı bir etkisi olmadığı belirlenmiştir. Eğitim düzeyi açısından ise, daha düşük eğitim düzeyine sahip bireylerin daha yüksek antropomorfizm algılarına ve daha olumlu tutumlara sahip oldukları tespit edilmiştir. Çalışma, otonom araçların benimsenmesini artırmak için yaş ve eğitim gibi demografik faktörlere odaklanılması gerektiğini vurgulamaktadır.

Anahtar Kelimeler: Otonom Araçlar, Tüketici Algısı, Sosyo-Demografik Faktörler, İnsanbiçimcilik, Yenilikçilik.

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1. INTRODUCTION

Autonomous vehicle technology refers to systems that enable vehicles to move and operate without human intervention using a combination of sensors, artificial intelligence (AI), and advanced algorithms. The history of autonomous vehicles dates back to the 1920s, with significant advances starting in the 1980s with pioneering projects such as the PROMETHEUS project led by Ernst Dickmanns of Carnegie Mellon University. This project forms the basis of modern autonomous systems (Paden et al., 2016; Zortul et al., 2020). The evolution of this technology has progressed with the development of radar, 2D and 3D lidar, cameras, and various sensor technologies that make it easier for the vehicle to perceive its surroundings (Zortul et al., 2020; Lazaro et al., 2018). The current state of autonomous vehicles ranges in size from advanced driver assistance systems (ADAS) to fully autonomous vehicles (AVs) across various applications.

The automotive industry is integrating these technologies with existing technologies to increase safety, reduce traffic accidents, and improve mobility efficiency (Dixit et al., 2021). Studies show that autonomous vehicles can significantly reduce accident rates due to their faster reaction times compared to human drivers (Dixit et al., 2021). The introduction of connected and autonomous vehicles (CAVs) also promises to optimize traffic flow and reduce congestion through collaborative driving strategies (Zheng et al., 2020; Huch et al., 2021).

The potential benefits of autonomous vehicles for traffic systems have been increasingly substantiated through both empirical studies and simulation-based analyses (Faisal et al. 2019; Wang et al. 2020). First and foremost, a significant reduction in traffic accidents is anticipated due to the elimination of human-related errors, particularly those associated with distraction, fatigue, and aggressive driving behaviors. In addition, autonomous vehicles, operating within connected and intelligent transportation systems, enable more efficient and coordinated traffic management through vehicle-to-vehicle and vehicle-to-infrastructure communication. This capability helps to minimize abrupt braking, unnecessary acceleration–deceleration cycles, and lane violations, thereby improving the effective utilization of road capacity and alleviating traffic congestion. Furthermore, smoother traffic flow contributes to reduced fuel consumption and lower emissions, while enhancing the predictability of travel times and overall transportation efficiency. Taken together, these factors suggest that autonomous vehicles have the potential not only to improve individual driving experiences but also to significantly enhance traffic safety, environmental sustainability, and the overall performance of transportation systems at a systemic level.

In addition, it should be emphasized that autonomous vehicle technologies are increasingly being developed in conjunction with electric powertrains, positioning them as a critical component of the transition toward low-carbon mobility systems. At the global scale, particularly in developed countries, significant progress has been achieved in terms of autonomy levels, with advanced driver assistance systems (ADAS) and conditionally automated driving (SAE Level 2 and Level 3) already commercialized, and higher levels of automation (Levels 4 and 5) being actively tested in controlled environments. Nevertheless, the widespread adoption of fully autonomous vehicles is widely regarded as a long-term transformation, potentially spanning a transition period of up to 50 years. During this phase, traffic systems are expected to consist of a heterogeneous mix of autonomous and conventional vehicles, creating complex interaction dynamics that must be carefully managed.

Within this context, user culture, acceptance, and satisfaction emerge as critical determinants of successful integration. Public trust in automation, perceived safety, and adaptability to new mobility paradigms will significantly influence adoption rates and usage patterns. From a sustainability perspective, the convergence of automation and electrification offers substantial environmental benefits, including reductions in greenhouse gas emissions, improved energy efficiency, and optimized resource utilization. Moreover, autonomous systems

have the potential to contribute to social sustainability by enhancing accessibility for elderly and disabled populations, reducing driver-related stress, and promoting more inclusive mobility solutions. However, these benefits are closely linked to user behavior and mobility habits; for instance, increased convenience may induce higher travel demand, potentially offsetting some environmental gains. Therefore, understanding and shaping user perceptions and behavioral responses remain essential for maximizing the socio-environmental sustainability contributions of autonomous vehicles.

The potential changes that autonomous vehicle technology will bring to transportation are a significant issue. For example, the implementation of autonomous vehicles could lead to a reduction in traffic congestion, improved road safety, and improved environmental sustainability through optimized driving patterns and reduced emissions (Zheng et al., 2020; Huch et al., 2021).

The concept of user intent is becoming increasingly important, as AVs must interpret and respond to the behavior of pedestrians and other vehicles to ensure safety (Schöller et al., 2020). For example, an autonomous vehicle must predict the movement of a pedestrian to avoid potential collisions, demonstrating the need to understand user intent in real-time scenarios (Li et al., 2022).

Autonomous vehicle technology represents a significant advancement in transportation, with roots dating back several decades. The current state of this technology reflects a shift toward more sophisticated systems that can perform accurately in complex environments. As this technology continues to evolve, understanding user intent and the impact of AVs on transportation systems has the potential to be critical to maximizing their benefits and ensuring safety.

The technological development of autonomous vehicles has the potential to reshape the future of transportation. However, among the important factors that determine the adoption process of this innovative technology, the socio-demographic and economic characteristics of consumers play an important role. Understanding the factors such as age, gender, education level, income status, and vehicle ownership of individuals that affect the intention to use autonomous vehicles is important in developing strategies that will accelerate the spread of this technology. In addition, the evaluation of the dimensions of the research such as optimism, innovation, discomfort, insecurity, anthropomorphism, attitude, and intention to use, together with the elements that may be effective in the adoption process of autonomous vehicles, will reveal meaningful results that will contribute to the literature.

This research aims to reveal the factors that can accelerate the adoption and acceptance process of this technology by examining in depth the socio-demographic and economic factors that affect the intention to use autonomous vehicles. In particular, the analysis of the differences between the tendencies of different age groups and socio-economic profiles to accept autonomous vehicles will provide important results in terms of developing marketing strategies and public policies.

The research question can be expressed as "To what extent do the socio-demographic and economic characteristics of consumers affect the intention to use autonomous vehicles and how do these factors affect the adoption process of this technology?"

The main purpose of this study is to deeply examine the socio-demographic and economic factors that affect the intention to use autonomous vehicles. In particular, the effects of variables such as age, gender, education level, income status, marital status, and car ownership on the intention of individuals to use autonomous vehicles will be investigated. The potential effects of each of these variables on attitudes and behaviors toward autonomous vehicles will contribute to the understanding of the dynamics that shape the acceptance and adoption processes toward technology.

In the literature, studies on the adoption of autonomous vehicles evaluate the effects of this new technology on the societal and individual levels. While autonomous vehicles have the

potential to make the transportation system safer and more efficient, the acceptance of this technology can be directly related to the socio-demographic profiles and economic situations of individuals. For example, the attitudes of different age groups towards technology, gender differences, and the impact of income levels can determine how autonomous vehicles are perceived in society and to what extent they can be adopted.

The results of this study will contribute to academic literature by providing implications for developing strategies for the adoption of autonomous vehicle technology and will provide practical recommendations for practitioners. In addition, understanding the relationship between consumer behavior and technological innovations will support the shaping of future transportation policies and marketing strategies. In this context, determining the socio-demographic and economic factors that affect the social acceptance of autonomous vehicles is a guiding feature for research in this field.

Although previous studies on autonomous vehicles have mainly focused on technology acceptance, trust, safety, and behavioral intention, fewer studies have examined whether AV-related perception dimensions systematically differ across socio-demographic and economic groups within a single analytical framework. In particular, evidence remains limited regarding how optimism, innovativeness, discomfort, insecurity, anthropomorphism, attitude, and future use intention vary by age, gender, income, marital status, car ownership, and education level, especially in the Turkish context. Therefore, this study addresses this gap by comparing these dimensions across key demographic and economic segments. In this respect, the study contributes to the literature by offering segment-based evidence that may support both marketing strategies and public policy decisions related to autonomous vehicle adoption.

2. LITERATURE REVIEW

Studies in the literature have investigated the factors that influence users' acceptance of autonomous vehicles, focusing on psychological, socio-demographic, and cultural aspects. Understanding these factors is important for manufacturers and policymakers who aim to encourage the adoption of AV technology. One of the methods used to analyze user intention is the Theory of Planned Behavior (TPB), which assumes that individual behavior is guided by attitudes, subjective norms, and Perceived Behavioral Control (PBC) (Gardner and Abraham, 2010). Research shows that positive attitudes toward AVs significantly increase the intention to use them. For example, consumers' attitudes toward environmentally friendly automotive technologies are significant in shaping their intention to adopt (Ssekakubo and Namukasa, 2023). This result is in line with studies suggesting a strong correlation between consumer attitudes and behavioral intentions toward various products, including automobiles (Weng, 2023). In addition, in another study conducted by Bilici and Türkoğlu (2024) using the theory of planned behavior, the dimensions of optimism, innovativeness, discomfort, insecurity, anthropomorphism, attitude and intention to use were investigated. In this study, the effect of age and gender on the research model was also examined with the structural equation model. According to the results of this study, it was determined that the dimensions of discomfort and insecurity significantly and negatively affected consumers' attitudes towards use. However, it was determined that the dimensions of optimism, innovativeness and anthropomorphism significantly and positively affected consumers' attitudes towards use. In the discomfort dimension, it was found that men felt more uncomfortable than women. Psychological factors such as self-efficacy and motivation were identified as important predictors of AV usage intention, and the importance of addressing these psychological structures in encouraging AV adoption was suggested (Huang, 2023).

Age and socio-demographic factors also play a significant role in shaping user intentions. Younger individuals tend to have a more positive attitude toward AVs compared to older adults, who may have concerns about safety and technology reliability (Othman, 2021). This

generational divide suggests the need for targeted marketing strategies that address the specific concerns and preferences of different age groups. Socioeconomic status affects perceptions of AVs, as individuals from higher-income groups may be more willing to adopt new technologies due to greater financial flexibility (Ruslim vd., 2023). This suggests that manufacturers need to consider these demographic variables when designing and marketing AVs to ensure wider acceptance.

Cultural factors further complicate the situation of AV acceptance. Different cultures show different levels of trust in technology. This can significantly affect the intention to use AVs. For example, a study conducted in China found that cultural orientation significantly moderated the relationship between attitudes and intention to adopt AVs (Jing et al., 2019). This research suggests that cultural sensitivity is an important consideration for manufacturers aiming to enter various markets.

The integration of anthropomorphism (attributing human-like characteristics to AVs or AI-supported technologies) with vehicles is said to increase user acceptance by establishing emotional bonds with users' vehicles (Bilici and Türkoğlu, 2024; Tian and Wang, 2022). This psychological aspect shows the importance of design elements that promote familiarity and trust in AV technology and the importance of emotionality.

Discomfort and insecurity with AVs are common concerns that can inhibit adoption. Many potential users express anxiety about relinquishing control to a machine, and this is often exacerbated by media hype and amplification of AV failures (Baccarella et al., 2020). Addressing these concerns through educational campaigns that emphasize the safety and reliability of AV technology is important for the development of the industry. Research shows that increasing public understanding of AV functions can alleviate fears and increase acceptance rates (Othman, 2021). Developing user-friendly interfaces that facilitate human-machine interaction can help reduce discomfort by providing users with a sense of control and understanding of the vehicle's operations (Burns et al., 2019).

Optimism about technological developments also influences user intention. Studies have shown that individuals with a positive outlook towards technology are more likely to adopt autonomous vehicles (Bilici and Türkoğlu, 2024; Huszár and Majó-Petri, 2020). This optimism can be furthered through public engagement initiatives that showcase the benefits of autonomous vehicles, such as reduced traffic congestion and environmental sustainability. For example, highlighting the ecological advantages of autonomous vehicles can resonate with environmentally conscious and green consumers, thereby increasing their intention to adopt such technologies (Tanwir and Hamzah, 2020).

The intersection of innovation and user intention is another important issue. The acceptance of autonomous vehicles is often linked to broader trends in technological innovation. Here, users' willingness to adopt new technologies may be influenced by their previous experiences with similar innovations (Baccarella et al., 2020). This result suggests that manufacturers should focus not only on the technical aspects of AVs, but also on creating value that positions them as part of a larger movement towards sustainable and innovative transportation solutions.

Research shows that perceived risk and safety are the most important factors in shaping consumer attitudes. For example, Meidutė-Kavaliauskienė et al. (2021) emphasize that users' risk perception negatively affects their intention to use OA, especially when they perceive autonomous systems as unreliable. This result is in line with the results of the study by Asadi-Shekari et al., who highlighted that vulnerable road users such as pedestrians and cyclists show greater safety concerns, which subsequently affects their willingness to share the road with OVs (Asadi-Shekari et al., 2022).

Acceptance of autonomous vehicles is influenced by various psychological factors, including perceived trust and perceived value. Huang's (2023) study integrates these psychological dimensions into the technology acceptance model, showing that these factors

significantly influence users' intention to adopt autonomous vehicles (Huang, 2023). Similarly, Bilici and Türkoğlu (2024) discuss how technological readiness and attitudes toward autonomous vehicles are important for understanding consumer acceptance, suggesting that individuals who own their own vehicles may have different levels of readiness compared to those who do not own vehicles. Although the environmental benefits of autonomous vehicles are recognized, they do not significantly influence user intentions. Garidis et al. found that although participants acknowledged the positive environmental impact of autonomous vehicles, this perception did not translate into a strong intention to use them (Garidis et al., 2020). This finding is also supported by Baccarella et al., who argued that perceived ease of use was a more important predictor of adoption intention than environmental considerations (Baccarella et al., 2020). Furthermore, the role of social influence and familiarity with technology cannot be ignored. Mesch and Dodel's (2023) research suggests that long-term exposure to technology fosters positive attitudes toward AVs, suggesting that individuals who are more accustomed to technological innovations may exhibit different intentions compared to those who are less familiar (Mesch and Dodel, 2023). This result will be considered important for vehicle owners who may have established preferences and biases toward traditional driving experiences.

In addition to structural models of AV acceptance, prior research has examined whether perceptions and usage intentions differ across demographic groups using mean-comparison techniques. For example, survey-based studies have investigated the role of gender and other socio-demographic variables in AV intention and acceptance by using group-based comparisons and analysis of variance. Similarly, research on self-driving bus acceptance has used one-way ANOVA to test whether acceptance differs by age, education, income, marital status, and related individual characteristics. These studies indicate that mean comparison techniques are appropriate for identifying segment-based differences in AV-related perceptions and support the methodological approach adopted in the present research (Li et al., 2022; Useche et al., 2022; Widyanti et al., 2024).

Intention to use autonomous vehicles is shaped by a complex interaction of psychological, socio-demographic, cultural, and technological factors. Understanding these dynamics and differences is essential to fostering acceptance and supporting widespread adoption of AV technology. Future research should continue to explore these dimensions, particularly in relation to emerging trends in technology and changing societal attitudes toward innovation.

According to the results obtained from the literature review, the following hypotheses were proposed for this research.

H_1–H_7 (Gender): Optimism, innovativeness, discomfort, insecurity, anthropomorphism, attitude, and future use intention vary by gender.

H_8–H_{14} (Income): Optimism, innovativeness, discomfort, insecurity, anthropomorphism, attitude, and future use intention vary by income level.

H_{15}–H_{21} (Marital status): Optimism, innovativeness, discomfort, insecurity, anthropomorphism, attitude, and future use intention vary by marital status.

H_{22}–H_{28} (Car ownership): Optimism, innovativeness, discomfort, insecurity, anthropomorphism, attitude, and future use intention vary by car ownership.

H_{29}–H_{35} (Age): Optimism, innovativeness, discomfort, insecurity, anthropomorphism, attitude, and future use intention vary by age.

H_{36}–H_{42} (Education): Optimism, innovativeness, discomfort, insecurity, anthropomorphism, attitude, and future use intention vary by education level.

3. METHODOLOGY

In the research part of this study, data were collected with the voluntary participation of consumers living in Türkiye and aged 18 and over. The surveys were delivered to the

participants via online survey method and the convenience sampling method was preferred. One of the main reasons for choosing convenience sampling is the ease and speed of data collection. Researchers often face constraints such as limited time and resources, which makes convenience sampling an attractive option. Studies have shown that convenience sampling allows data to be collected quickly from easily accessible participants. This method is especially useful in exploratory studies or when investigating phenomena that require rapid results (Iqbal et al., 2018; Paluri and Mehra, 2016; Mulyono vd., 2023). Convenience sampling allows researchers to collect preliminary data that can inform future studies or hypotheses, especially in situations where traditional sampling methods may not be practical (Speak et al., 2018; Iortyom et al., 2018). Another important advantage of convenience sampling is its cost-effectiveness. As financial support for research becomes increasingly limited, especially in the social sciences, the ability to conduct studies at lower costs is important (Mullinix et al., 2015; Jeong et al., 2018; Coppock and McClellan, 2019). This economic efficiency is important in fields where budget constraints are a common challenge, and this method allows researchers to maximize their output without compromising the quality of their findings (Jager et al., 2017; Landers and Behrend, 2015). Despite these practical advantages, convenience sampling has important limitations. Since the participants were not selected through a probability-based sampling procedure, the findings cannot be considered statistically representative of the broader population in Türkiye. In addition, the online administration of the questionnaire may have increased self-selection bias by attracting individuals who are more digitally connected, more interested in technology, or more willing to participate in online studies. Therefore, the findings should be interpreted with caution regarding generalizability and should be regarded as evidence derived from an accessible sample rather than a nationally representative population.

The survey form of the research consists of two parts. The first part includes questions aimed at determining the socio-demographic and economic characteristics of the participants, and the second part includes scale questions aimed at revealing the perspectives of the participants regarding optimism, innovativeness, discomfort, insecurity, anthropomorphism, attitude, and intention to use. The questions for the optimism, innovativeness, discomfort and insecurity dimensions in the scale questions were adapted from the scale developed by Parasuraman and Colby (2015), the questions for the anthropomorphism dimension were adapted from the studies of Gursoy et al. (2019), the questions for the attitude towards use dimension were adapted from the studies of Rese et al. (2014) and Taylor and Todd (1995), and the questions for the intention to use dimension in the future were adapted from the study of Rese et al. (2014). The questions were asked on a five-point Likert scale. Ethics committee approval was received for the research survey from Bursa Uludağ University Research and Publication Ethics Committee on August 25, 2023 (decision number 23 taken in the 2023-07 session). The survey was kept open in the Google Forms application between December 1, 2024, and December 20, 2024, for the participants to answer. During this process, data was collected from a total of 391 people. This sample size can be used according to studies indicating that a sample size of 384 or more is sufficient for the analysis for unknown population sizes (Mujakachi and Tsvere, 2023; Oduro et al., 2024).

Age and income variables were grouped to obtain more analytically interpretable categories in mean comparisons. This grouping strategy enabled comparison of relatively younger and older age groups with relatively lower and higher income groups within a simpler framework. However, it should be noted that converting such variables into binary groups may reduce within-group diversity and should therefore be considered a limitation of the study.

In this study, firstly demographic data were analyzed. In addition, an independent sample t-test was applied to determine the differences according to gender, income level, marital status, car ownership, and age. ANOVA was applied to determine the differences of individuals according to education. The SPSS Package program was used to analyze the data.

The choice of statistical techniques was determined by the structure of the grouping variables and the study's aim. Independent-samples t-tests were used for variables with two independent groups: gender, income level, marital status, car ownership, and age group. One-way ANOVA was used for education level because this variable contained more than two categories. When the overall ANOVA was statistically significant, Scheffé post hoc comparisons were conducted to determine which groups differed.

4. ANALYSIS RESULTS

In the data analysis, the reliability of the scale dimensions was first evaluated. In the second part of the study, the t-test was used, and in the last part, the Scheffe method from ANOVA Post Hoc Analysis was used. The Scheffe method was preferred and interpreted because of its feature of revealing in detail which dimensions differed between each other (Bilici, 2024).
In addition, the normal distribution of the responses in the study was analyzed and skewness and kurtosis tests were performed.

In statistical analysis, skewness and kurtosis are the basic measures used to evaluate the normality of data distributions. Threshold values for skewness and kurtosis tests are important in determining whether a data set deviates from a normal distribution. The generally accepted threshold is ±1.96. Values above or below this value generally indicate non-normal distribution (Orçan, 2020; Kim, 2013). According to the responses in this study, according to the skewness analysis results, the data ranged between -1.646 and 1.403. According to the kurtosis analysis results, the data ranged between -1.144 and 1.402. According to these results, it can be stated that the survey responses were normally distributed.

Before the reliability analysis, the measurement structure's construct validity was examined through an exploratory factor analysis. The overall Kaiser–Meyer–Olkin (KMO) value was 0.777, and Bartlett's test of sphericity was statistically significant ($\chi^2 = 16039.007$, $p < 0.001$), indicating that the data were suitable for factor analysis. The seven-factor solution explained 58.540% of the total variance. In addition, subscale-level analyses showed that KMO values ranged from 0.750 to 0.904 and that item loadings were generally within acceptable limits. Overall, the factor loading pattern supported the multidimensional structure of the scale, and the factor solution was considered adequate for construct validity assessment.
Cronbach's alpha is a widely used statistic to assess the internal consistency of a set of items in a questionnaire or test. It quantifies how closely related a set of items are as a group, essentially measuring the extent to which they all reflect the same underlying construct. The interpretation of Cronbach's alpha values is of critical importance, especially for researchers in the fields of psychology, education, and health sciences. Commonly accepted thresholds for interpreting Cronbach's alpha values are as follows: values below 0.50 are unacceptable, values between 0.50 and 0.60 are poor, values between 0.60 and 0.70 are questionable, values between 0.70 and 0.80 are acceptable, and values above 0.80 are considered good or excellent (Burgos-Benavides, 2023; Klein et al., 2022; Özdemir et al., 2019; Rosário et al., 2017).

The Cronbach alpha values obtained in this study show that the scale and the statements under it have high internal consistency among each other. The Cronbach alpha value of the optimism dimension is 0.892, which reveals that the items of this dimension are perfectly consistent. Similarly, the innovation dimension has a perfect internal consistency with a value of 0.900. The value of 0.754 obtained in the discomfort dimension is at an acceptable level, which shows that the items of this dimension have sufficient consistency. The insecurity and anthropomorphism dimensions show a very good level of internal consistency with values of 0.841 and 0.849, respectively. The attitude dimension shows a consistency that can be considered excellent with a value of 0.899, while the Cronbach alpha value of 0.948 for the intention to use in the future dimension reveals that this dimension has excellent internal

consistency. The general Cronbach alpha value of 0.874 calculated for the entire scale shows that the scale provides reliable measurement and has a high level of internal consistency.

Whether the responses given by consumers differed between genders for each dimension was determined by an independent sample t-test. 204 men and 187 women participated in the survey. The results of the t-test conducted according to the gender variable are shown in Table 1 below.

Table 1. T-test results by gender

	Levene's Test for Equality of Variances		t-test for Equality of Means						
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper
Optimism	0.716	0.399	1.387	389	0.168	0.23291039	0.16791533	-0.09908806	0.56490885
Innovation	0.198	0.657	-2.466	389	0.015	-0.40816733	0.16549097	-0.73537239	-0.08096227
Discomfort	1.437	0.233	-0.832	389	0.407	-0.14038868	0.1686536	-0.47384681	0.19306946
Insecurity	1.979	0.162	-1.000	389	0.319	-0.16844051	0.16846872	-0.50153312	0.16465209
Anthropomorphism	1.926	0.167	0.523	389	0.602	0.08826213	0.16890761	-0.24569824	0.4222225
Attitude	0.730	0.394	-1.780	389	0.077	-0.29752589	0.16717949	-0.62806944	0.03301767
Intent	4.451	0.037	-2.324	389	0.022	-0.38550707	0.16588143	-0.71348414	-0.05753000

H_1 hypothesis was formulated as the level of optimism differs significantly by gender. According to the t-test results in Table 1, there is no significant difference in the level of optimism between women and men ($t(389) = 1.387$, $p = 0.168$). Therefore, the H_1 hypothesis is rejected. It can be stated that the level of optimism does not differ by gender.

H_2 hypothesis was formulated as the level of innovativeness differs significantly by gender. According to the t-test results in Table 1, there is a significant difference between women and men in the perception of innovativeness ($t(389) = -2.466$, $p = 0.015$). Men have a higher perception of innovativeness than women. Therefore, the H_2 hypothesis is accepted. It can be stated that the level of innovativeness differs by gender.

H_3 hypothesis is formulated as the level of discomfort differs significantly by gender. According to the t-test results in Table 1, there is no significant difference in the level of discomfort between women and men ($t(389) = -0.832$, $p = 0.407$). Therefore, the H_3 hypothesis is rejected. According to this result, it can be concluded that the level of discomfort does not differ by gender.

H_4 hypothesis is formulated as the level of insecurity differs significantly by gender. Based on the t-test results in Table 1, it can be stated that there is no significant difference between women and men in the level of insecurity ($t(389) = -1.000$, $p = 0.319$). Therefore, the H_4 hypothesis is rejected. It can be stated that the level of insecurity does not differ by gender.

H_5 hypothesis was formulated as the level of anthropomorphism differs significantly by gender. According to the t-test results in Table 1, there is no significant difference between men and women in the perception of anthropomorphism ($t(389) = 0.523$, $p = 0.602$). Therefore, the H_5 hypothesis is rejected. It can be stated that the level of anthropomorphism does not differ by gender.

According to hypothesis H_6, attitudes differ significantly according to gender. According to Table 1, there is no significant difference between women and men in the attitude level ($t(389) = -1.780$, $p = 0.077$). However, since the p value is close to 0.05, this difference should be evaluated with caution. Hypothesis H_6 is rejected. It can be concluded that the attitude level does not differ according to gender, but this difference is on the borderline.

H_7 hypothesis is formulated as the intention to use in the future differs significantly by gender. According to Table 1, there is a significant difference between women and men in the intention to use in the future ($t(389) = -2.324$, $p = 0.022$). Men have a higher intention level than women. Therefore, hypothesis H_7 is accepted. From here, it can be concluded that the intention to use in the future differs by gender.

According to these analyses, it can be stated that consumer perceptions about autonomous cars differ in some areas according to gender. Significant differences were found especially in innovativeness (H_2) and intention (H_7). There is no significant difference in other factors.
Whether the responses given by consumers differed according to the income level variable for each dimension was determined by the independent sample t-test. While 155 people from the survey participants earned an income of 30,000 TL and below, 236 people earned an income of 30,001 TL and above. The results of the t-test conducted according to the income level variable are shown in Table 2 below.

Table 2. T-test results by income level

	Levene's Test for Equality of Variances		t-test for Equality of Means						
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper
Optimism	0.677	0.412	-0.124	389	0.901	-.02103663	0.16913213	-0.35544092	0.31336765
Innovativeness	0.059	0.809	-0.640	389	0.523	-.10811359	0.16889278	-0.44204463	0.22581746
Discomfort	2.406	0.123	0.183	389	0.855	.03098709	0.16912112	-0.30339542	0.36536960
Insecurity	0.323	0.571	-0.762	389	0.447	-.12868163	0.16878902	-0.46240752	0.20504425
Anthropomorphism	0.198	0.657	1.034	389	0.303	.17426308	0.16849448	-0.15888045	0.50740661
Attitude	0.566	0.453	0.092	389	0.927	.01555287	0.16913640	-0.31885985	0.34996559
Intent	0.041	0.839	-0.395	389	0.693	-.06681551	0.16904657	-0.40105063	0.26741961

According to the results in Table 2, it can be stated that consumer perceptions about autonomous cars do not show a significant difference according to income level. All hypotheses regarding income level were rejected. This shows that income level is not a determining factor on the perceptions in the study.

Whether the responses given by consumers differed according to the marital status variable for each dimension was determined by the independent sample t-test. 217 of the participants were married and 174 were single. The results of the t-test conducted according to the marital status variable are shown in Table 3 below.

Table 3. T-test results by marital status

	Levene's Test for Equality of Variances		t-test for Equality of Means						
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper
Optimism	3.085	0.081	-1.53	389	0.128	-0.25757	0.168347	-0.590421	0.075281
Innovativeness	3.568	0.061	-2.202	389	0.029	-0.367421	0.166873	-0.697359	-0.037484
Discomfort	1.726	0.191	-1.872	389	0.063	-0.313816	0.167658	-0.645307	0.017675

Insecurity	1.967	0.163	-1.188	389	0.237	-0.20061	0.168903	-0.534562	0.133342
Anthropomorphism	7.811	0.006	-2.035	389	0.044	-0.340418	0.167285	-0.67117	-0.009667
Attitude	0.013	0.909	-0.824	389	0.411	-0.389539	0.169345	-0.474365	0.195286
Intent	0.178	0.674	-0.695	389	0.488	-0.117701	0.169464	-0.452762	0.217360

Hypotheses were interpreted according to the results in Table 3. Accordingly, according to hypothesis H_{15}, the level of optimism differs significantly according to marital status. According to the t-test results, there is no significant difference in the level of optimism between married and single individuals ($t(389) = -1.53$, $p = 0.128$). Therefore, hypothesis H_{15} is rejected.

According to hypothesis H_{16}, the level of innovativeness differs significantly according to marital status. According to the t-test results, there is a significant difference in the perception of innovativeness between married and single individuals ($t(389) = -2.202$, $p = 0.029$). Single individuals have a higher perception of innovativeness than married individuals. Therefore, hypothesis H_{16} is accepted. It can be concluded that the level of innovativeness differs according to marital status.

According to hypothesis H_{17}, the level of discomfort differs significantly according to marital status. According to the t-test results, there is no significant difference in the level of discomfort between married and single individuals ($t(389) = -1.872$, $p = 0.063$). However, since the p value is close to 0.05, this difference should be evaluated with caution. Therefore, hypothesis H_{17} is rejected. It can be concluded that the level of discomfort does not differ according to marital status, but this difference is on the borderline.

According to hypothesis H_{18}, the level of insecurity differs significantly according to marital status. According to the t-test results, there is no significant difference in the level of insecurity between married and single individuals ($t(389) = -1.188$, $p = 0.237$). Therefore, hypothesis H_{18} is rejected.

According to hypothesis H_{19}, the level of anthropomorphism differs significantly according to marital status. According to the t-test results, there is a significant difference in the perception of anthropomorphism between married and single individuals ($t(389) = -2.035$, $p = 0.044$). Single individuals have higher anthropomorphism perception than married individuals. Therefore, hypothesis H_{19} is accepted. It can be concluded that the level of anthropomorphism differs according to marital status.

According to hypothesis H_{20}, the attitude level differs significantly according to marital status. According to the t-test results, there is no significant difference between married and single individuals in attitude ($t(389) = -0.824$, $p = 0.411$). Therefore, hypothesis H_{20} is rejected.
According to hypothesis H21, the intention to use in the future differs significantly according to marital status. According to the t-test results, there is no significant difference between married and single individuals in intention to use in the future ($t(389) = -0.695$, $p = 0.488$). Therefore, hypothesis H_{21} is rejected.

According to the analysis results in Table 3, consumer perceptions of autonomous cars differ in some areas according to marital status. Significant differences were found especially in the factors of innovativeness (H_{16}) and anthropomorphism (H_{19}). There is no significant difference in other factors according to marital status.

Whether the responses given by consumers differed according to the variable of owning or not owning a car for each dimension was determined with an independent sample t-test. 251 of the survey participants owned a car and 140 did not own a car. The results of the t-test conducted according to the variable of owning a car are shown in Table 4 below.

Table 4. T-test results according to car ownership

	Levene's Test for Equality of Variances		t-test for Equality of Means						
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper
Optimism	1.896	0.171	-1.679	389	0.095	-0.303212	0.18059	-0.660271	0.053847
Innovativeness	8.911	0.003	-2.163	389	0.032	-0.388112	0.179417	-0.742852	-0.033372
Discomfort	4.809	0.030	-0.278	389	0.781	-0.050739	0.182361	-0.4113	0.309822
Insecurity	1.430	0.234	0.162	389	0.872	0.02948	0.182395	-0.331147	0.390108
Anthropomorphism	0.774	0.380	-0.042	389	0.967	-0.007651	0.182411	-0.36831	0.353008
Attitude	1.520	0.220	-1.348	389	0.180	-0.244351	0.181231	-0.602677	0.138975
Intent	0.281	0.597	-0.982	389	0.328	-0.178566	0.181782	-0.537982	0.18085

According to the analysis results in Table 4, it was determined that consumer perceptions about autonomous cars showed a significant difference in terms of innovativeness (H_{23}) according to car ownership. There was no significant difference in other factors.

Whether the responses given by consumers differed according to age groups was determined with an independent sample t-test. 176 of the survey participants were 34 years old and under, and 215 people were 35 years old and over. The results of the t-test conducted according to the age variable are shown in Table 5 below.

Table 5. T-test results by age

	Levene's Test for Equality of Variances		t-test for Equality of Means						
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper
Optimism	1.884	0.172	3.160	389	0.002	0.517522	0.163771	0.193717	0.841327
Innovativeness	0.415	0.520	3.449	389	0.001	0.561323	0.16273	0.239576	0.883069
Discomfort	1.651	0.201	-0.125	389	0.901	-0.021142	0.169542	-0.356357	0.314074
Insecurity	0.068	0.794	-0.505	389	0.615	-0.085483	0.169397	-0.42041	0.249445
Anthropomorphism	10.223	0.002	1.248	389	0.214	0.210366	0.16861	-0.123007	0.543738
Attitude	0.055	0.815	2.221	389	0.028	0.37007	0.166621	0.040631	0.69951
Intent	0.041	0.982	1.939	389	0.054	0.324443	0.167304	-0.006347	0.655232

The hypotheses are interpreted according to the results in Table 5. According to hypothesis H_{29}, the level of optimism differs significantly by age. According to the t-test results, there is a significant difference in the level of optimism between individuals aged 34 and below and 35 and above ($t(389) = 3.16$, $p = 0.002$). Individuals aged 34 and below have a higher level of optimism towards autonomous cars than individuals aged 35 and above. Therefore, hypothesis H_{29} is accepted. It can be concluded that the level of optimism differs by age.

According to hypothesis H_{30}, the level of innovativeness differs significantly by age. According to the t-test results, there is a significant difference in the perception of

innovativeness between individuals aged 34 and below and 35 and above (t(389) = 3.449, p = 0.001). Individuals aged 34 and below have a higher perception of innovativeness towards autonomous cars than individuals aged 35 and above. Therefore, hypothesis H_{30} is accepted. From here, it can be concluded that the level of innovativeness varies according to age.

According to hypothesis H_{31}, the level of discomfort varies significantly by age. According to the t-test results, there is no significant difference in the level of discomfort between individuals aged 34 and below and 35 and above (t(389) = -0.125, p = 0.901). Therefore, hypothesis H_{31} is rejected.

According to hypothesis H_{32}, the level of insecurity varies significantly by age. According to the t-test results, there is no significant difference in the level of insecurity between individuals aged 34 and below and 35 and above (t(389) = -0.505, p = 0.615). Therefore, hypothesis H_{32} is rejected.

According to hypothesis H_{33}, the level of anthropomorphism differs significantly by age. According to the t-test results, there is no significant difference in the perception of anthropomorphism between individuals aged 34 and below and 35 and above (t(389) = 1.248, p = 0.214). Therefore, hypothesis H_{33} is rejected.

According to hypothesis H_{34}, attitude differs significantly by age. According to the t-test results, there is a significant difference in the level of attitude between individuals aged 34 and below and 35 and above (t(389) = 2.221, p = 0.028). Individuals aged 34 and below have more positive attitudes than individuals aged 35 and above. Therefore, hypothesis H_{34} is accepted. It can be stated that attitude differs by age.

According to hypothesis H_{35}, future usage intention differs significantly by age. According to the t-test results, there is no significant difference in future usage intention between individuals aged 34 and under and 35 and over (t(389) = 1.939, p = 0.054). However, since the p-value is close to 0.05, this difference should be evaluated with caution. Hypothesis H_{35} is rejected. It can be stated that future usage intention does not differ by age in the use of autonomous cars, but this difference is on the borderline.

According to the results in Table 5, consumer perceptions about autonomous cars differ in some areas according to age. As a result, significant differences were found in optimism (H_{29}), innovativeness (H_{30}) and attitude (H_{34}). There is no significant difference in other factors.

Whether the responses given by consumers differ according to their educational background for each dimension was determined with the ANOVA test. Of the participants in the survey, 72 people have an associate degree or lower, 198 people have a bachelor's degree and 121 participants had a postgraduate degree. The results of the ANOVA analysis conducted according to the educational background variable are shown in Table 6 below.

Table 6. ANOVA analysis results according to the education status variable

Construct	Assoc. degree or below − Bachelor's degree	Assoc. degree or below − Postgraduate	Bachelor's degree − Postgraduate
Optimism (H36)	0.155 (0.791)	0.331 (0.321)	0.175 (0.660)
Innovativeness (H37)	0.140 (0.828)	0.023 (0.995)	-0.118 (0.831)
Discomfort (H38)	0.056 (0.970)	0.106 (0.891)	0.050 (0.968)
Insecurity (H39)	0.095 (0.917)	0.124 (0.854)	0.029 (0.989)
Anthropomorphism (H40)	0.860 (0.001**)	0.597 (0.019*)	-0.263 (0.361)
Attitude (H41)	0.593 (0.032*)	0.334 (0.302)	-0.259 (0.394)
Future use intention (H42)	0.485 (0.102)	0.213 (0.617)	-0.272 (0.364)

Note: Mean difference is calculated as the first group minus the second group. Positive values indicate higher scores in the first group.

According to hypothesis H_{40}, the level of anthropomorphism differs significantly according to education. According to the ANOVA results in Table 6, there are significant differences in anthropomorphism perception between education levels. Individuals with an associate degree or below have a higher perception of anthropomorphism than individuals with a bachelor's degree ($p = 0.001$) and postgraduate ($p = 0.019$) levels. Therefore, hypothesis H_{40} is accepted. It can be stated that the level of anthropomorphism differs according to education.

According to hypothesis H_{41}, attitude differs significantly according to education. According to the ANOVA results in Table 6, attitude differs significantly according to education level. Individuals with an associate degree or below have a more positive attitude than individuals with a bachelor's degree ($p = 0.032$). Therefore, hypothesis H_{41} is accepted. It can be stated that the level of attitude differs according to education.

According to hypothesis H_{42}, intention to use in the future differs significantly according to education. According to the ANOVA results in Table 6, there is no significant difference in future use intention between education levels. In the comparisons made between associate degree and below, bachelor's degree, and postgraduate education levels, p values were above 0.05 (for example, $p = 0.102$ between Associate Degree and Below and Bachelor's Degree). Therefore, hypothesis H_{42} is rejected.

The analyses, the results of which are shown in Table 6, reveal that consumer perceptions of autonomous cars differ in some areas according to education level. These areas are anthropomorphism (H_{40}) and attitude (H_{41}). There is no significant difference in other factors.

5. CONCLUSION

This study examines how consumer perceptions of autonomous cars differ according to socio-demographic and economic factors. The findings revealed how age, gender, marital status, income level, education level and car ownership affect consumers' intentions and perceptions about autonomous vehicles. When the age factor is analysed, it is seen that individuals aged 34 and younger exhibit higher optimism, innovativeness and positive attitudes than individuals aged 35 and older. According to this result, young individuals have a more open-minded and positive perspective towards autonomous vehicles. Regarding gender, it was found that males had a higher perception of innovativeness and intention to use autonomous vehicles in the future than females. This finding indicates that men are more prone to technology and men reported higher innovativeness and future use intention.

Regarding marital status, it was observed that single individuals had higher perceptions of innovativeness and anthropomorphism than married individuals. This shows that single individuals are more open to new technologies and find autonomous vehicles more humanistic. When income level is analysed, there is no significant effect of income level on perceptions of autonomous vehicles. This shows that income level does not appear to be a determining factor on this issue. In terms of educational level, there are significant differences in anthropomorphism and attitude levels according to educational level. Individuals with associate's degrees and below have higher perceptions of anthropomorphism and more positive attitudes than those with bachelor's and graduate degrees. In car ownership, it has been observed that individuals who do not own a car have a higher perception of innovativeness than car owners. This shows that individuals who do not own a car are more open to new technologies. These findings show that socio-demographic factors significantly affect intentions and perceptions about autonomous vehicles. In particular, age, gender, marital status, and educational status shape consumers' attitudes and intentions towards autonomous vehicles.

These findings are broadly consistent with previous studies suggesting that age and gender may play meaningful roles in shaping perceptions and acceptance of autonomous vehicles. In particular, the more positive orientation of younger individuals towards autonomous vehicle-

related dimensions aligns with studies highlighting younger consumers' greater openness to technological innovation. Similarly, the higher innovativeness and future use intention observed among men are compatible with prior research indicating that gender can function as a differentiating factor in technology-related evaluations. The education-based differences observed in anthropomorphism and attitude also suggest that perceptions of autonomous vehicles may be shaped not only by rational evaluations but also by symbolic interpretation. By contrast, the lack of a significant income effect indicates that economic status alone may not be sufficient to explain autonomous vehicle-related perceptions in the present sample.

Future research can be conducted with larger sample groups in different geographical regions. This will increase the generalizability of the findings and help us understand how perceptions towards autonomous vehicles change in different cultural and economic contexts. Furthermore, long-term studies can be conducted to examine how perceptions of autonomous vehicles evolve. Such studies will allow us to understand better the technology adoption process and changes in consumer behavior. For example, how the attitudes of different age groups towards autonomous vehicles change over time or how the perceptions of individuals with different income levels towards autonomous vehicles evolve.

Furthermore, studies conducted in different countries and cultures can reveal cultural differences in perceptions of autonomous vehicles and help us understand global trends in this area. Future research could also focus on safety and autonomous vehicles' ethical and legal aspects. This would be an essential step towards the social acceptance and widespread adoption of autonomous vehicles.

Car manufacturers and policymakers should develop marketing strategies targeting young users. Since young individuals are more open and positive towards autonomous vehicles, unique campaigns and information activities can be carried out for this demographic group. Furthermore, considering the differences in perceptions based on education level, customised communication strategies can be developed for individuals with different education levels. For example, more straightforward and transparent information materials can be prepared for individuals with lower levels of education. In contrast, more technical and detailed information can be provided for individuals with higher levels of education. Policymakers can organize training programs and awareness-raising campaigns to promote the adoption of autonomous vehicles. This can positively influence the perceptions of individuals, especially those with lower education levels, towards autonomous vehicles. Furthermore, establishing safety and regulatory frameworks can increase consumers' trust in autonomous vehicles. For example, strict testing and certification processes can be implemented to increase the safety and effectiveness of autonomous vehicles.

Furthermore, informing the public about autonomous vehicles' legal and ethical aspects and providing transparency on these issues can increase consumer confidence. Car manufacturers can also organize campaigns to highlight the advantages of autonomous vehicles and address consumer concerns. This may accelerate the adoption process of autonomous vehicles and contribute to shaping consumer perceptions in a positive direction.

CONFLICT OF INTEREST

Authors approve that to the best of their knowledge, there is not any conflict of interest or common interest with an institution/organization or a person that may affect the review process of the paper.

AUTHOR CONTRIBUTION

İ. Kürşad Türkoğlu was responsible for defining and managing the conceptual and design processes of the study, the writing phases of the article, and the data collection processes; Fatih Bilici was responsible for defining and managing the conceptual and design processes of the study, data collection and data analysis, and the interpretation of the analysis processes.

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