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STEERING INTO THE FUTURE: PUBLIC PERCEPTIONS AND ACCEPTANCE OF AUTONOMOUS BUSES

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ABSTRACT: This study examines the social factors influencing the acceptance of autonomous buses, with a focus on perceived benefits, safety, and comfort. It also explores whether these factors differ among residents of cities with varying sizes and urban mobility solutions. A survey was conducted in three Polish cities, collecting data from 1,160 respondents. Structural Equation Modelling (SEM) was used to analyse relationships between perceived benefits, safety, comfort, and future intentions to use autonomous buses. Results indicate that safety and comfort positively influence future intentions to use autonomous buses. However, the effect of perceived benefits varies across cities, suggesting that urban mobility conditions shape public acceptance. The study focuses on Polish cities, which may limit generalizability. Future research should examine other geographical contexts. Findings provide insights for policymakers and manufacturers on enhancing public trust and promoting autonomous bus adoption. Improving public awareness and addressing safety concerns may increase societal acceptance of autonomous mobility. The study uniquely assesses how city characteristics influence social acceptance of autonomous buses.

KEYWORDS: autonomous buses, public acceptance, perceived benefits, safety, urban mobility

Introduction

The growing attention toward autonomous vehicles (AVs) in urban mobility is largely driven by their ability to revolutionise transportation, promote sustainability, and enhance city living. They are regarded as a crucial element in the transition to smart cities and sustainable urban development. The European Commission has acknowledged automated mobility as essential for lowering emissions, improving road safety, and mitigating congestion (European Commission, 2018).

The autonomous vehicle market is expected to experience substantial expansion, fuelled by technological progress and emerging business opportunities. However, its development will be influenced by competitive forces, regulatory policies, and public adoption (Gulc & Budna, 2024). Integrating AVs into current transportation systems presents both challenges and benefits, with shared mobility services (Gulc, 2024) anticipated to be a key factor in the early stages of deployment.

The diversity of autonomous vehicle applications will shape the future market for these solutions (Budna et al., 2025). Even today, their potential uses are highlighted in: urban and rural transportation (Dianin et al., 2024; Xing et al., 2025); freight and logistics (autonomous trucks and cargo vehicles (J. Li et al., 2021); transportation of medical supplies (Adnan, 2024); manufacturing environments (Autonomous mobile robots (AMRs)) and autonomous guided vehicles (AGVs) (Zhao & Chidambareswaran, 2023); agriculture (De Francesco et al., 2025).

According to Alatawneh and Torok (2025), AV sales could peak at approximately 12.5–13.4 million units annually around 2042–2044. At the same time, research conducted by Rezaei et al. (2023) on a sample of 11,000 respondents, confirmed that the overall weighted average market acceptance of autonomous vehicles (AVs) among the 11,057 surveyed individuals was 65%.

Despite the growing market for autonomous vehicles and their applications, both the benefits and negative impacts of this developing technology remain a subject of scientific inquiry. The literature highlights both positive and negative effects of autonomous vehicle development in the context of urban mobility. Among the negative aspects of autonomous mobility development, one concern is the increase in Vehicle Miles Traveled (VMT), which could potentially offset the reductions in emissions (Uzzaman & Muhammad, 2024). Autonomous vehicles (AVs) could promote urban expansion and alter land use patterns, leading to varied impacts on emissions and overall environmental quality (Pimenta et al., 2023).

On the other hand, the presence of autonomous vehicles in urban spaces is considered to offer numerous potential benefits. Autonomous vehicles (AVs), especially when combined with shared mobility systems, are anticipated to transform urban passenger transport by providing adaptable, on-demand services that may lessen the reliance on private car ownership (Acheampong et al., 2021; Cugurullo et al., 2020). The adoption of autonomous vehicles (AVs) is expected to support urban sustainability by minimising car dependency, reclaiming parking areas, and potentially curbing urban sprawl. This shift could result in more efficient land use, along with lower pollution levels and reduced traffic congestion (Duarte & Ratti, 2018; Tomaszewska & Florea, 2018; Winkowska et al., 2019). Autonomous vehicles (AVs) have the potential to lower greenhouse gas emissions by enhancing fuel efficiency, incorporating electric vehicle technology, and optimising driving patterns (Uzzaman & Muhammad, 2024). AVs improve traffic flow and decrease congestion, further helping in reducing emissions (Rahman & Thill, 2023b). The advancement of autonomous vehicles (AVs) is fueled by technological progress and evolving societal perspectives on mobility. These vehicles offer enhanced convenience, safety, and accessibility, enabling users to make more efficient use of their travel time (Sadeghpour & İnce, 2024).

A comprehensive understanding of the future evolution and possible integration of autonomous vehicles (AVs) requires an in-depth exploration of individual perspectives that influence their adoption (Waltermann & Henkel, 2025). The literature also indicates that policymakers should prioritise comprehensive public awareness initiatives to prepare society for the adoption of new driving technologies (Alatawneh & Torok, 2025).

The future development of autonomous vehicle applications will largely depend on public acceptance of these solutions (Ejdys & Gulc, 2022). Among the key factors influencing social acceptance of autonomous vehicles (AVs) are perceived benefits, as well as concerns related to their safety and user comfort.

DOI: 10.34659/eis.2025.92.1.1140

In Poland, research on autonomous vehicles remains limited. A survey conducted by Bączkowska et al. (2023) on a sample of 1,067 Poles examined the general level of knowledge about autonomous vehicles, the perceived potential benefits of their implementation (increased travel safety, shorter travel time, reduced traffic congestion in cities, creation of new jobs), and the perceived barriers (lack of legal regulations, insufficient road infrastructure, absence of service rules, and lack of traffic regulations) (Bęczkowska et al., 2023) The analysis of the results indicated a low level of knowledge among respondents. In 2019, Dudziak et al. (2021) conducted a study on a sample of 579 Poles, aiming to analyse selected factors influencing the perception of autonomous vehicles. The researchers focused on the impact of demographic variables (age, gender) on the perception of autonomous vehicles, as well as the scope of perceived benefits (comfort, more efficient use of time, safety, less stress, greater mobility and independence) and drawbacks (boredom, no driving pleasure, redundant driving course, being used to driving a car, no control over electronics, elimination of professions, cybercrimes) of the analyzed technology (Dudziak et al., 2021).

In addition to the social characteristics of users, city features and geographical factors may also play a significant role in the adoption of autonomous vehicles (Gulc & Budna, 2023). There is still no consensus on how residential variations impact the adoption of autonomous vehicles (AVs) (Zhang & Kamargianni, 2023).

The authors sought to answer two research questions.

1. Are the social factors (perceived benefits, comfort and safety) determining the acceptance of autonomous vehicles differentiated among residents of cities varying in size and implemented mobility solutions?
2. To what extent does the theoretical model, reflecting the relationships between three variables – perceived benefits, user comfort and safety, and future intentions to use AVs – align with the characteristics of cities differing in size, and consequently, in their urban mobility solutions and user needs?

The novelty of the conducted research is manifested, among other things, in the fact that the Authors attempted to examine whether the factors determining social acceptance of AVs technology are differentiated among residents representing different-sized settlement units, cities.

The remainder of the article includes sections covering the literature review, which served as the foundation for constructing the theoretical model, a description of the research methodology, an analysis and discussion of the results, as well as conclusions and recommendations.

An overview of the literature

Autonomous vehicles (AV) represent a technological revolution that aims to change the way people travel (Panasewicz & Jorge, 2023), but their acceptance by the general public depends on overcoming various psychological-social factors (Xing et al., 2025). Many authors identify social factors which relate to demographic characteristics such as age (Ding et al., 2022; Chen et al., 2022; Sciaccaluga & Delponte, 2020; Glimm & Fabus, 2024), gender (Chen et al., 2024; Tapia et al., 2024),demographic differences (Hafeez et al., 2024), education level (Pang et al., 2024; Sitinjak et al., 2024), average monthly spending (Shen & Deng, 2022), income (Ding et al., 2022; Chen et al., 2022; Pang et al., 2024) or driver's licence possession (Glimm & Fabus, 2024). Authors Chen et al. (2024) and Wang et al. (2022) indicate that men show more positive attitudes towards autonomous vehicles than women, while the authors Sutarto et al. (2023) show no significant differences. According to Pang et al. (2024), education level influences attitudes towards autonomous vehicles, which is confirmed by the research that women have less knowledge about autonomous vehicles than men, which may partly explain the differences in their attitudes (Tapia et al., 2023). Furthermore, people who earn more are more willing to pay for an autonomous vehicle (Rezaei et al., 2023).

Differences in perceptions of autonomous vehicles may also be due to other psychological (personal) factors, which mainly include attitudes (Yuen et al., 2020;Acheampong & Cugurullo, 2019), experience (Shen & Deng, 2022; Sciaccaluga & Delponte, 2020; Zilahy, 2023) or hedonic motivation (Quinones et al., 2024; Yuen et al., 2020; Kettles & Van Belle, 2019). Authors Yuan and Yu (2024) point out that previous experience with driver assistance systems supports the initial development of trust to AV. Compatibility with lifestyles and travel needs (Guo et al., 2021; Jing et al., 2020), perceived benefits (Acheampong & Cugurullo, 2019), usefulness and ease of use (Li et al., 2022; Jing et al., 2020; Acheampong & Cugurullo, 2019; Chen et al., 2022) or anxiety (Böhm et al., 2017) are also important factors influencing the acceptance of autonomous vehicles. People value their comfort and convenience, and they choose modes of transport that satisfy their needs (Paschalidis et al., 2020). The success of autonomous vehicles is also based on the provision of liability, privacy, cybersecurity (Alawadhi et al., 2020; ; Hossain et al., 2024;Li et al., 2022; Seuwou et al., 2020) and regulatory frameworks (Othman, 2021; Raj et al., 2020; Tripathi, 2024). Legislation has not only guarantee the safety of users, but also provided rules for liability in the case of breakdowns or traffic incidents. There is no doubt that discomfort and distrust negatively affect attitudes towards autonomous vehicles (Bilici & Türkoğlu, 2024), but it can be changed by social influence (Böhm et al., 2017) and mass media (Zilahy, 2023). Social media can play a crucial role in popularising autonomous vehicles, highlighting their many benefits through dynamic campaigns and engaging content (Hendra et al., 2025).

The holistic approach to autonomous vehicles focuses on people and their needs, but developments in technology (Alawadhi et al., 2020; Asmussen et al., 2020; Hossain et al., 2024; Othman, 2021), infrastructure (Alawadhi et al., 2020) or vehicle design (Hossain et al., 2024) affect willingness to use new technology (Rahman & Thill, 2023a, 2023b; Böhm et al., 2017) and trust to AV (Jing et al., 2020; Ahmed et al., 2022; Zilahy, 2023; Kettles & Van Belle, 2019). Author Ejdys (2017) identifies two characteristic features of trust in technology: functionality and the willingness to rely on technology. In the context of autonomous vehicles, these two aspects are fundamental because users need to be confident that these systems will work as expected (Ejdys, 2020), and that they will be able to entrust them with their safety (Szpilko et al., 2023) and comfort in their daily journeys. Fear of losing control of the vehicle, fear of autonomous system failure and mistrust of artificial intelligence technology are common emotional reactions towards autonomous vehicles, therefore, user safety remains one of the key aspects (Prasetio & Nurliyana, 2023).

A number of research findings confirm that users' perceived benefits of autonomous vehicles positively influence future use intentions (Acheampong & Cugurullo, 2019; Golbabaei et al., 2020; Huang, 2023; Meidute-Kavaliauskiene et al., 2021; Yuen et al., 2021; Orsot-Dessi et al., 2023; Wishart et al., 2023). Perceived benefits and usefulness are positively associated with attitudes and intentions towards using private automated vehicles (Kaye et al., 2021). These users' perceived benefits of autonomous vehicles include enjoyment, trust, usefulness, and the productive use of travel time (Huang, 2023). Users' perceptions of the characteristics of AV innovation, such as relative advantage, compatibility, and visibility, influence their perceptions of the usefulness and ease of use of the technology, which in turn impact their intention to use it (Yuen et al., 2021). Additionally, psychological driving pleasure (Orsot-Dessi et al., 2023) and positive attitudes, along with social norms, are significant determinants of users' intention to use AVs (Wishart et al., 2023). Perceived drawbacks are negatively related to intention to buy AVs and to use robotaxis, but not to attitude toward AVs (Li et al., 2022). However, despite a positive outlook towards AVs, disabled people are reluctant to use them due to a lack of trust in the technology. Policymakers can influence public attitudes and promote the adoption of AVs among impaired persons by addressing both the perceived benefits and risks of the technology (Thapa et al., 2021). Overall, users' perceptions of AVs' advantages strongly drive their future intentions to use them, although trust and safety concerns still present challenges (Golbabaei et al., 2020; Kaye et al., 2021). Taking the above into account, the following research hypothesis has been formulated.

H1: Users' perceived benefits of autonomous vehicles positively determine future user intentions in terms of their use

The influence of safety on customers' future intentions to use autonomous vehicles has been analysed in previous studies. However, it is defined differently – either from a negative perspective as concerns about safety or from a positive perspective as perceived safety. Concerns regarding safety negatively impact intention to use autonomous vehicles (Wishart et al., 2023). However, perceived safety of autonomous vehicles positively predicts intention to use them (Meidute-Kavaliauskiene et al., 2021; Yuen et al., 2021; Widyanti et al., 2024) while perceived risks negatively influence intention (Meidute-Kavaliauskiene et al., 2021; Orsot-Dessi et al., 2023). It was also found that the perceived safety of AVs and their attributed value for transport and road safety mediate the associations between drivers' features and the final intention of using autonomous vehicles. The results of

DOI: 10.34659/eis.2025.92.1.1140

Montoro et al. (2019) study suggest that perceived safety and the value attributed to AVs significantly influence the intention of adopting them (Montoro et al., 2019). Consequently, safety is a critical determinant of the future AV market share (Alatawneh & Torok, 2025). Therefore, the primary recommendations for manufacturers of vehicles would be to indicate that the autonomous vehicle is not risky or that its risk is considerably less than that of a human-driven vehicle (Wishart et al., 2023). Emphasising the safety, crash prevention, and efficiency benefits of autonomous vehicles may increase their acceptance and adoption among drivers (Yuen et al., 2021). The conducted literature review has allowed for the formulation of the following research hypothesis.

H2: Users' perceived safety and comfort of autonomous vehicles positively determine future user intentions in terms of their use

The impact of comfort issues on AV future use is often considered in the literature. Traditionally, comfort refers to a state of physical and mental well-being, characterised by the absence of pain and the satisfaction of bodily needs. This definition has historical roots, with the term gaining prominence in the eighteenth century as part of the ideal lifestyle, reflecting material well-being and emotional support (Odile-Bernez, 2014; Pinto et al., 2017). The comfort of autonomous vehicles positively determines future user intentions to use them, with trust, hedonic motivation, social influence, compatibility, and effort expectancy as key determinants (Foroughi et al., 2023). Comfort and trust in shared autonomous vehicles are positively correlated and increase with experience, but comfort is not directly determined by vehicle attributes (Paddeu et al., 2020). Moreover, the comfort of autonomous vehicles positively determines future user intentions, but this effect differs between innovative and lagging users (Keszey, 2020). Factors that can enhance comfort in AVs include good communication channels and ensuring the AV's capabilities match user expectations (Peng et al., 2024). Discomfort negatively affects attitudes towards autonomous vehicles (Bilici & Türkoğlu, 2024). On the contrary, other research revealed that the comfort of autonomous vehicles does not positively determine future user intentions to use them, as private car ownership remains the preferred travel mode (Pakusch et al., 2018), while factors like knowledge, perceived risk, attitude, subjective norm, and perceived behavioral control do (Jing et al., 2019). However, it is worth highlighting that, from a technical perspective, comfort and safety considerations impact the development of autonomous driving technologies (Aledhari et al., 2024). Therefore, to encourage AV adoption, manufacturers should focus on improving user comfort, emphasising reduced risks compared to human-driven vehicles (Bilici & Türkoğlu, 2024; Orsot-Dessi et al., 2023).

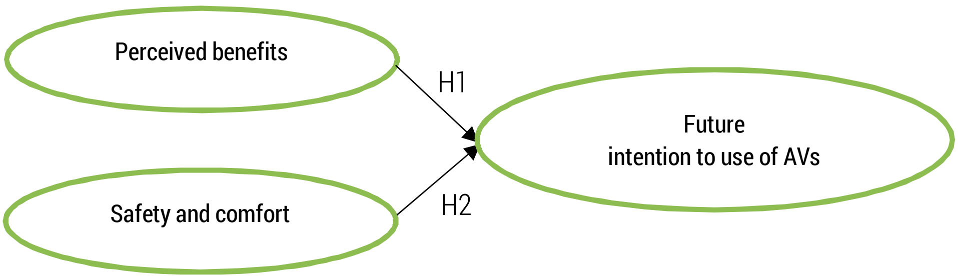

Figure 1. Theoretical model

There is still no consensus on how residential variations impact the adoption of autonomous vehicles (AVs) (Zhang & Kamargianni, 2023). However, research suggests that the size of a city is one factor that influences the development of smart cities and autonomous mobility (Campisi et al., 2021). Larger cities with higher population growth are more likely to be prepared for AV integration. A study in Shanghai demonstrated that 128,000 shared AVs could meet the motorised travel demands of 3 million users, highlighting the potential for efficient AV fleet sizing in large cities (Wang, 2020). City characteristics, including population density, political ideology, and government expenditures, influence attitudes towards AV regulation. Local officials are generally optimistic about AVs' potential to improve safety, reduce congestion, costs and pollution (Freemark et al., 2019).

The literature review conducted on examined constructs – perceived benefits, safety and comfort and future intention to use – enabled the development of the theoretical model shown in Figure 1.

Research methods

Research data and sample

The study was conducted between November and December 2024 on a total sample of 1,160 Poles representing three cities in Poland. The selection of cities for the study was based on their characteristics, both demographically and in terms of the urban mobility solutions used. The basic characteristics of the cities included in the study are shown in Table 1.

Table 1.

Characteristics	Łomża city	Warszawa City	Wrocław City
population density (number of residents per 1 km^2, 2023)	1,827.7	3,599.4	2,301.0
population in thousands (2023)	59.7	1,861.6	673.7
area in km^2 (2023)	33	517	293
Length of the network of bicycle paths in the city (km, 2023)	42.6	773.4	368.0
Density of bicycle paths (km/100 km^2, 2023)	130.4	149.5	125.8
Bicycle roads per 10,000 population (km/10,000 inh, 2023)	7.13	4.15	5.47
Number of "Park&Ride" parking lots (2023)	1	217	11
Number of traffic accidents (2023)	13	610	615
Number of injured in road accidents' (2023)	14	694	666
Number of bicycles rented per 1000 inhabitants (2023)	344	2,638	2,773
Average annual levels of particulate matter (μg/m^3, 2023)	.	22.2	20.8

Data were collected using the CAPI (Computer-Assisted Personal Interviewing) technique, supported by CATI (Computer-Assisted Telephone Interviewing) or CAWI (Computer-Assisted Web Interview). The samples were nearly equal in size across the cities and accounted for the diversity of respondents in terms of age, gender, and education, reflecting the characteristics of the general population. The respondents' demographic structure based on gender, age, and education is presented in Table 2.

Table 2. Respondents' demographic structure based on gender, age, and education

	Łomża city		Warszawa City		Wrocław City	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Gender						
Female	214	55.4	207	53.8	205	52.7
Male	172	44.6	178	46.2	184	47.3
Total	386	100.0	385	100.0	389	100.0
Age						
Below 18	10	2.6	11	2.9	16	4.1
18–28 years	49	12.7	41	10.6	44	11.3
29–44 years	133	34.5	135	35.1	114	29.3
45–59 years	87	22.5	85	22.1	88	22.6
Over 60 years old	107	27.7	113	29.4	127	32.6

DOI: 10.34659/eis.2025.92.1.1140

	Łomża city		Warszawa City		Wrocław City	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Total	386	100	385	100.0	389	100.0
Education level						
Primary education	38	9.8	21	5.5	30	7.7
Vocational education	87	22.5	58	15.1	89	22.9
Secondary education	147	38.1	122	31.7	158	40.6
Higher education	114	29.5	184	47.8	112	28.8
Total	386	100.0	385	100.0	389	100.0

Measurement

Based on the literature, an initial set of eight variables was identified, reflecting factors determining the acceptance and future intentions regarding the use of autonomous vehicles. A five-point Likert scale was employed for variable assessment, where 1 indicated "strongly agree" and 5 indicated "strongly disagree."

An Exploratory Factor Analysis (EFA) was conducted to extract the underlying constructs. At the adopted regression coefficient value threshold of 0.6, one variable was removed from the factor set: I think that introducing autonomous buses would reduce staffing problems related to the shortage of drivers.

The EFA facilitated the identification of three constructs, which were named as follows: 1. Perceived Benefits (PB), 2. Comfort and Safety (CS) and 3. Future Intentions (FI).

Table 3. Results of Exploratory Factor Analysis (EFA) with regression loadings for individual variables

Individual variables	Łomża city			Warszawa City			Wrocław City		
	1	2	3	1	2	3	1	2	3
I believe that the introduction of autonomous buses will help reduce traffic congestion and increase road capacity.	0.78			0.87			0.77		
I think that autonomous buses can be more environmentally friendly than traditional diesel buses.	0.78			0.61			0.84		
I believe that autonomous buses will be more punctual and run more frequently than traditional buses.	0.77			0.77			0.83		
I would feel comfortable riding an autonomous city bus (without a driver).		0.63			0.75			0.85	
I believe that autonomous buses can be a safe means of transportation.		0.86			0.88			0.78	
I believe that in the future, autonomous vehicles (buses, cars) will be common on our streets.			0.87			0.59			0.90
In the future, I will use autonomous city buses.			0.61			0.92			0.77

Kaiser-Meyer-Olkin (KMO) Coefficient and Bartlett's Sphericity Test were used as applicability criteria in Factor Analysis. The results of these measures indicate whether variable reduction is meaningful and whether it will yield the intended outcomes. The Kaiser-Meyer-Olkin (KMO) coefficient compares partial correlations with bivariate correlation coefficients. It takes values within the range of 0 to 1, where low values suggest that variable reduction will be minimal. It is generally assumed that a KMO value ≥ 0.5 provides a satisfactory level of variable reduction. Bartlett's sphericity test examines whether there are significant correlations between variables by verifying whether the correlation matrix is an identity matrix. A significant test result leads to the rejection of this hypothesis, confirming that correlations between variables exist, indicating the presence of underlying factors. Results of Kaiser-Meyer-Olkin (KMO) Coefficient and Bartlett's Sphericity Test are pre-

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sented in Table 4. In Table 4, the last column also indicates the cumulative percentage of explained variance of the analysed variables.

Table 4. Results of Kaiser-Meyer-Olkin (KMO) Coefficient and Bartlett's Sphericity Test

	KMO Coefficient	Bartlett's Sphericity Test	Cumulative Percentage of Explained Variance of the Analyzed Variables
Łomża City	0.923	< 0.001	83.90%
Warszawa City	0.903	< 0.001	80.68%
Wrocław City	0.916	< 0.001	88.09%

For the measurement scales thus identified, reliability and validity indicators were calculated. A Cronbach's alpha coefficient and Composite Reliability (CR) coefficient above 0.7 confirms the high reliability of the scales (Netemeyer et al., 2003). Validity was assessed in terms of convergent validity using the (Average Variance Extracted – AVE). The AVE above 0.5 confirms the high validity of the scales (dos Santos & Cirillo, 2023) (Table 5).

Table 5. Results of the Reliability and Validity Assessment of Measurement Scales

<table>
<tr><th></th><th>Individual variables</th><th>AVE</th><th>CR</th><th>α-Cronbacha</th></tr>
<tr><td>Abrr.</td><td colspan="4">Perceived Benefits (PB)</td></tr>
<tr><td>PB1</td><td>I believe that the introduction of autonomous buses will help reduce traffic congestion and increase road capacity.</td><td rowspan="3">1) 0.600
2) 0.571
3) 0.661</td><td rowspan="3">1) 0.818
2) 0.796
3) 0.854</td><td rowspan="3">1) 0.888
2) 0.831
3) 0.917</td></tr>
<tr><td>PB1</td><td>I think that autonomous buses can be more environmentally friendly than traditional diesel buses.</td></tr>
<tr><td>PB1</td><td>I believe that autonomous buses will be more punctual and run more frequently than traditional buses.</td></tr>
<tr><td>Abrr.</td><td colspan="4">Comfort and Safety (CS)</td></tr>
<tr><td>SC1</td><td>I would feel comfortable riding an autonomous city bus (without a driver).</td><td rowspan="2">1) 0.568
2) 0.669
3) 0.665</td><td rowspan="2">1) 0.720
2) 0.801
3) 0.779</td><td rowspan="2">1) 0.822
2) 0.827
3) 0.862</td></tr>
<tr><td>SC2</td><td>I believe that autonomous buses can be a safe means of transportation.</td></tr>
<tr><td>Abrr.</td><td colspan="4">Future Intentions (FI)</td></tr>
<tr><td>FI1</td><td>I believe that in the future, autonomous vehicles (buses, cars) will be common on our streets.</td><td rowspan="2">1) 0.562
2) 0.593
3) 0.696</td><td rowspan="2">1) 0.713
2) 0.735
3) 0.820</td><td rowspan="2">1) 0.747
2) 0.739
3) 0.796</td></tr>
<tr><td>FI2</td><td>In the future, I will use autonomous city buses.</td></tr>
</table>

1) Łomża; 2) Warsawa; 3) Wrocław.

Results of the research

To test research hypotheses, Structural Equation Modelling (SEM) was employed, allowing for the analysis of causal relationships between variables. The verification of the four hypotheses was conducted based on the structural path coefficients. The figure 2 presents structural path estimates between constructs and variables.

Structural Equation Modelling (SEM) was applied to examine the research hypotheses, enabling the analysis of causal relationships among variables. The validation of the three hypotheses was carried out using structural path coefficients. Figures 2 (a, b, c) illustrate the estimated structural paths between constructs and variables

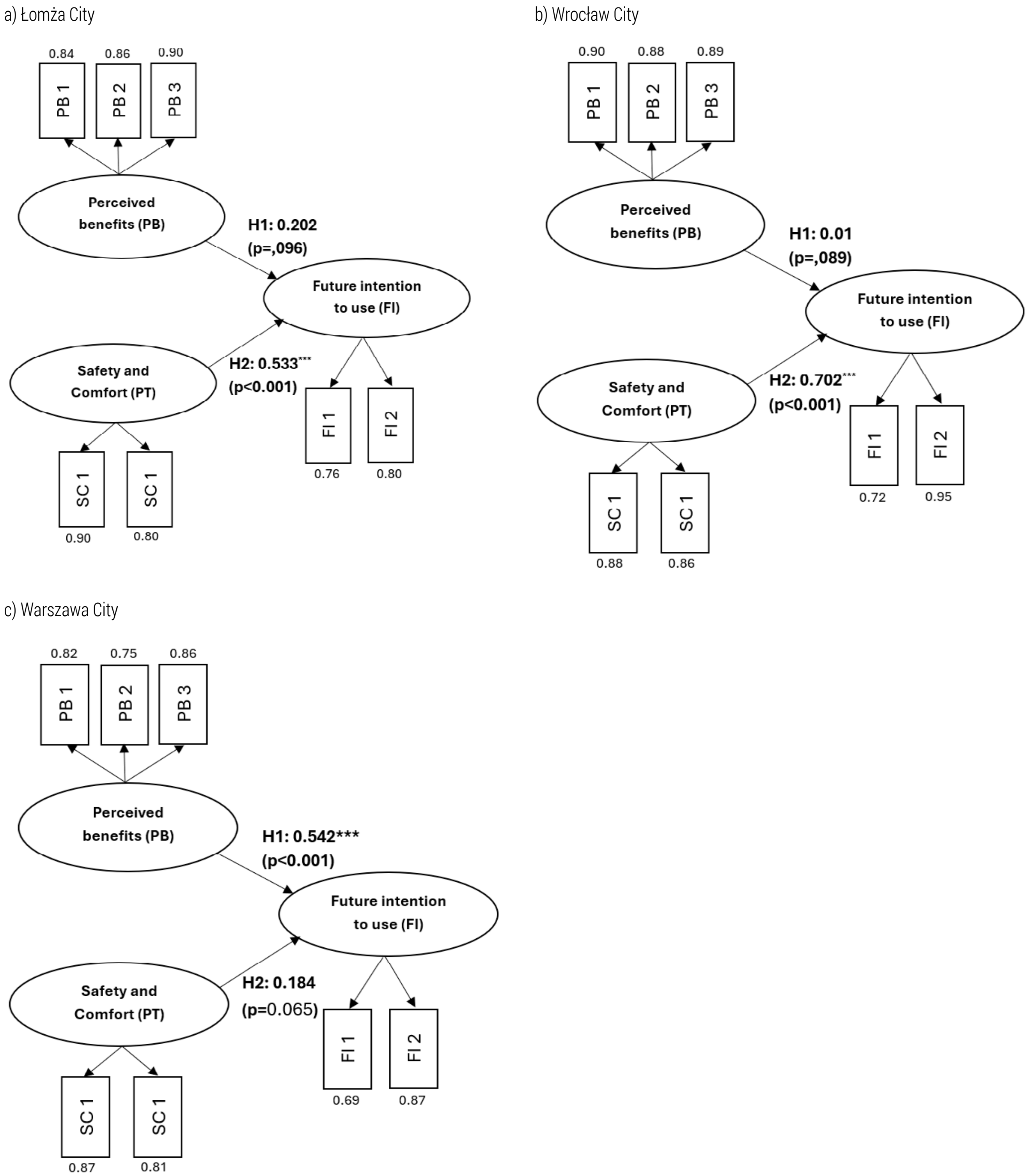

Figure 2. Measurement models for three cities a) Łomża, b) Wrocław, c) Warszawa

The analysis of factor loadings of paths and the p-value indicate that all four hypotheses have been confirmed (Table 6). The obtained model fit indices confirm that the model fits well. Among researchers, there is a consensus on the fundamental model fit measures. According to Iacobucci (Iacobucci, 2010), the Chi-square test (CMIN) should be indicated first, along with degrees of freedom and p-value. An ideal model fit is confirmed by a Chi-square statistic indicating no statistically significant relationship (p>0.05). However, the Chi-square statistic has significant limitations as it is sensitive to sample size. With large samples, the Chi-square statistic will almost always indicate poor

DOI: 10.34659/eis.2025.92.1.1140

model fit ($p<0.05$). A solution used in such situations is the Chi-square statistic divided by degrees of freedom (CMIN/DF), and its value should not exceed 3, with an acceptable level being 5. Commonly used model fit measures include RMSEA, CFI, GFI, AGFI. The measurement model exhibits a high level of fit, as confirmed by the RMSEA (Root Mean Square Error of Approximation) with a value of 0.033. For the RMSEA, values within the range <0; 0.05> indicate good model quality, with 0.08 being the upper limit for satisfactory estimation and 0.1 as the threshold for model rejection. Regarding the GFI (Goodness of Fit Index) and AGFI (Adjusted Goodness of Fit Index), values above 0.9 indicate acceptable model fit.

Table 6. The results of the hypothesis statistical verification

Relationship between Constructs	Estimate	Standard Error	Capability Ratio	p	Hypothesis Testing
Łomża City					
H1: PB FI	0.202	0.121	1.667	0.096	Reject
H2: SC FI	0.533	0.113	4.712	***	Support
χ^2 = 27,325; degrees of freedom (df) = 11; χ^2/df = 2,484; $p < 0.05$					
Wrocław City					
H1: PB FI	0.010	0.075	0.136	0.892	Reject
H2: SC FI	0.702	0.084	8.389	***	Support
χ^2 = 26,134; degrees of freedom (df) = 11; χ^2/df = 2,376; $p < 0.05$					
Warszawa City					
H1: PB FI	0.542	0.124	4.370	***	Support
H2: SC FI	0.184	0.100	1.847	0.065	Reject
χ^2 = 32.120; degrees of freedom (df) = 11; χ^2/df = 2.920; $p < 0.001$					

	Łomża City	Wrocław City	Warszawa City
CMIN/DF	2.484	2.376	2.920
GFI	0.980	0.981	0.976
AGFI	0.949	0.951	0.939
RMSEA	0.062	0.060	0.071
CFI	0.922	0.940	0.902

Discussion/Limitation and future research

The findings of this study provide insights into the social acceptance of autonomous buses by examining the impact of perceived benefits, safety, and comfort on future intentions to use autonomous vehicles. The results suggest that these factors are not uniformly influential across different urban settings, highlighting the role of city-specific mobility conditions in shaping public attitudes.

The significant role of safety and comfort in shaping future user intentions aligns with previous research emphasising safety concerns as a crucial determinant of autonomous vehicle adoption (Wishart et al., 2023; Meidute-Kavaliauskiene et al., 2021). This finding reinforces the need for vehicle manufacturers and policymakers to focus on ensuring both technical safety and user-perceived security in autonomous transportation (Yuen et al., 2021; Montoro et al., 2019).

Perceived comfort and safety play a significantly greater role in smaller cities (Łomża, Wrocław) compared to a large metropolitan area such as Warsaw. In smaller urban areas, factors related to perceived benefits stemming from the improved functionality of transport systems become less relevant. The prominence of safety as a statistically significant determinant of future intentions to use

DOI: 10.34659/eis.2025.92.1.1140

autonomous vehicles in smaller cities may also be attributed to lower levels of knowledge and awareness, which, in turn, contribute to higher concerns among potential users.

While perceived benefits were a significant predictor of future intentions in Warsaw, they did not have a substantial effect in smaller cities such as Łomża and Wrocław. In smaller towns, where urban mobility is not a significant issue, the role of perceived benefits from the introduction of autonomous vehicles may be less pronounced. They are not regarded as a means of transportation capable of addressing existing problems, such as congestion or air pollution. The lack of a significant effect of perceived benefits on future use intentions in smaller cities may be attributed to a lower level of public awareness and technological readiness (Bęczkowska et al., 2023). One of the questions included in the questionnaire was: "Have you heard about autonomous vehicles – vehicles (such as buses or passenger cars) that move without a driver?" This question allowed assessment of respondents' general awareness regarding autonomous vehicles. The percentage of respondents who had heard about this technology varied significantly between cities ($P<0.001$). The highest percentage of respondents familiar with autonomous vehicles was found in Wrocław (64.2%), followed by Warsaw (45.5%) and Łomża (41.4%). The smallest city, Łomża, had the lowest awareness of the technology. Additionally, statistically significant differences were observed in responses concerning safety, comfort, perceived benefits, and future intentions between respondents who had heard of autonomous vehicles and those who had not ($P<0.001$). Similar relationships were demonstrated in the Warsaw study. Only in relation to the statement: "I believe that the introduction of autonomous buses will help reduce traffic congestion and increase road capacity," were there no statistically significant differences observed between groups with varying levels of awareness ($P=0.065$). The response to this question may stem from the fact that traffic congestion in the city is perceived as such a significant issue that respondents likely do not believe autonomous buses could effectively resolve it, and thus their level of knowledge about this technology does not influence this perception.

In Wrocław, where the largest proportion of respondents had heard about autonomous vehicles, only responses to the statement, "I believe that in the future, autonomous vehicles (buses, cars) will be common on our streets," showed statistically significant differences between groups with varying awareness of autonomous vehicles ($P<0.001$). No statistically significant differences were observed regarding the remaining statements. The above findings confirm that knowledge about modern solutions, such as driverless buses, significantly influences the evaluation of this technology in the context of social acceptance.

Similar observations have been made in previous research, indicating that knowledge gaps, regulatory uncertainties, and infrastructure limitations hinder public trust in autonomous mobility (Othman, 2021; Zhang & Kamargianni, 2023). These findings suggest that targeted awareness campaigns and pilot programs could improve the perceived advantages of autonomous transportation in smaller urban areas (Hendra et al., 2025).

Achieved results also suggest that larger cities with developed mobility infrastructures may provide conditions that enhance the perceived utility of autonomous buses, a notion supported by previous studies on urban planning and autonomous vehicle adoption (Campisi et al., 2021; Freemark et al., 2019).

Additionally, this study contributes to the ongoing debate on the role of urban density and infrastructure in shaping public attitudes towards autonomous mobility. Previous research has demonstrated that factors such as population density, political ideology, and public expenditure influence acceptance rates (Freemark et al., 2019). Our results further validate the argument that mobility solutions tailored to city-specific characteristics can influence the perceived utility and safety of autonomous vehicles (Rahman & Thill, 2023a).

While this study provides valuable insights into the acceptance of autonomous buses, it has some limitations. First, the study is geographically limited to three Polish cities, which may affect the generalizability of the findings. Future research could extend this analysis to a broader range of cities across different countries as well.

Secondly, while this study focused on perceived benefits, safety, and comfort, other psychological and demographic factors may also play significant roles in shaping user intentions. Future research could integrate additional factors to develop a more comprehensive understanding of the determinants of autonomous vehicle acceptance like: awareness, knowledge and loyalty.

Thirdly, the evaluation of analysed factors, especially perceived benefits, would be more reliable during the pre-implementation phase of testing AVs, but so far, there are no such tests on a large scale in Poland. Therefore, future research would cover the social acceptance of AVs after testing by Polish society.

Lastly, the study relies on self-reported survey data, which may be subject to response biases. Future research could incorporate experimental methods, such as real-world autonomous bus trials or simulation studies, to assess user perceptions in more naturalistic settings.

Overall, this study highlights the varying impact of perceived benefits, safety, and comfort on the acceptance of autonomous buses across different urban contexts. By considering these findings, policymakers and industry stakeholders can tailor their strategies to enhance public trust and facilitate the widespread adoption of autonomous mobility solutions.

Conclusions

This research offers important insights into the social factors affecting the acceptance of autonomous buses, emphasising the significance of perceived benefits, safety, and comfort. The results indicate that public attitudes toward autonomous mobility are influenced by the urban environment, with notable variations between large metropolitan areas and smaller cities.

From a practical standpoint, the findings suggest that policymakers and transportation planners should adapt their approaches based on local conditions. In major cities like Warsaw, where issues such as traffic congestion and pollution are more pronounced, highlighting the efficiency and environmental advantages of autonomous buses may enhance public approval. Conversely, in smaller cities such as Łomża and Wrocław, safety and comfort play a more decisive role in influencing adoption. To address public concerns, targeted awareness campaigns, safety demonstrations, and transparent communication about the dependability of autonomous systems could foster greater trust and acceptance.

From a scientific perspective, this study adds to the ongoing discussion on the factors influencing public perceptions of autonomous vehicles. The findings align with previous research, which identifies safety as a key concern for potential users (Meidute-Kavaliauskiene et al., 2021; Yuen et al., 2021), while also reinforcing the notion that urban infrastructure and demographic characteristics significantly impact acceptance levels (Freemark et al., 2019; Zhang & Kamargianni, 2023).

Additionally, the study sheds light on the influence of city size on public attitudes toward autonomous mobility. While prior research has debated the effect of urban density on autonomous vehicle adoption, this study provides empirical evidence suggesting that perceived benefits are more relevant in larger cities, whereas safety and comfort take precedence in smaller towns. These findings highlight the necessity for further research on how local mobility conditions shape public acceptance of emerging transportation technologies, particularly across different geographical settings.

Acknowledgements

This research was funded in part by the National Science Centre [2022/45/B/HS4/01414].

The contribution of the authors

Conceptualisation, J.E.; literature review, J.E., A.G. and K.B.; methodology, J.E., A.G. and K.B.; formal analysis, J.E.; writing, J.E., A.G., K.B. and J.E.G.; conclusions and discussion, J.E., A.G., K.B. and J.E.G.

The authors have read and agreed to the published version of the manuscript.

References

Acheampong, R. A., & Cugurullo, F. (2019). Capturing the behavioural determinants behind the adoption of autonomous vehicles: Conceptual frameworks and measurement models to predict public transport, sharing and ownership trends of self-driving cars. Transportation Research Part F: Traffic Psychology and Behaviour, 62, 349-375. https://doi.org/10.1016/J.TRF.2019.01.009

Acheampong, R., Cugurullo, F., Guériau, M., & Dusparic, I. (2021). Can autonomous vehicles enable sustainable mobility in future cities? Insights and policy challenges from user preferences over different urban transport options. Cities, 112, 103134. https://doi.org/10.1016/J.CITIES.2021.103134

Adnan, N. (2024). Exploring the future: A meta-analysis of autonomous vehicle adoption and its impact on urban life and the healthcare sector. Transportation Research Interdisciplinary Perspectives, 26, 101110. https://doi.org/10.1016/j.trip.2024.101110

Ahmed, M., Iqbal, R., Amin, S., Alhabshneh, O., & Garba, A. (2022). Autonomous Vehicle and its Adoption: Challenges, Opportunities, and Future Implications. *2022 International Conference on Emerging Trends in Computing and Engineering Applications (ETCEA)*, 1-6. https://doi.org/10.1109/ETCEA57049.2022.10009804

Alatawneh, A., & Torok, A. (2025). Projecting AV sales in the EU-27 and UK: Insights from Euro emission standards and historical trends. Transport Policy, 163, 91-101. https://doi.org/10.1016/j.tranpol.2025.01.009

Alawadhi, M., Almazrouie, J., Kamil, M., & Khalil, K. A. (2020). A systematic literature review of the factors influencing the adoption of autonomous driving. International Journal of System Assurance Engineering and Management, 11(6), 1065-1082. https://doi.org/10.1007/s13198-020-00961-4

Aledhari, M., Rahouti, M., Qadir, J., Qolomany, B., Guizani, M., & Al-Fuqaha, A. (2024). Motion Comfort Optimization for Autonomous Vehicles: Concepts, Methods, and Techniques. IEEE Internet of Things Journal, 11(1), 378-402. https://doi.org/10.1109/JIOT.2023.3287489

Asmussen, K. E., Mondal, A., & Bhat, C. R. (2020). A socio-technical model of autonomous vehicle adoption using ranked choice stated preference data. Transportation Research Part C: Emerging Technologies, 121, 102835. https://doi.org/10.1016/J.TRC.2020.102835

Bęczkowska, S., Czerepicki, A., Grabarek, I., Kozłowski, M., & Zysk, Z. (2023). Autonomous Vehicles as Viewed by Future Users in Poland. Sustainability, 15(24), 16627. https://doi.org/10.3390/su152416627

Bilici, F., & Türkoğlu, İ. K. (2024). Autonomous Vehicle Technology and Technology Acceptance: The Role of Technological Readiness on Consumers' Attitudes Towards Driverless Cars and Intention to Use in the Future. Fırat Üniversitesi Mühendislik Bilimleri Dergisi, 36(1), 383-407. https://doi.org/10.35234/fumbd.1385541

Böhm, P., Kocur, M., Firat, M., & Isemann, D. (2017). Which Factors Influence Attitudes Towards Using Autonomous Vehicles? *Proceedings of the 9th International Conference on Automotive User Interfaces and Interactive Vehicular Applications Adjunct*, 141-145. https://doi.org/10.1145/3131726.3131751

Budna, K., Rogowska, W., & Szpilko, D. (2025). Autonomiczny transport przyszłości – ocena ryzyka zagrożeń latających taksówek. Academy of Management, 9(1), 214-243. https://doi.org/10.24427/az-2025-0012

Campisi, T., Severino, A., Al-rashid, M. A., & Pau, G. (2021). The development of the smart cities in the connected and autonomous vehicles (Cavs) era: From mobility patterns to scaling in cities. *Infrastructure* 6(7). https://doi.org/10.3390/infrastructures6070100

Chen, Y., Shiwakoti, N., Stasinopoulos, P., & Khan, S. K. (2022). State-of-the-Art of Factors Affecting the Adoption of Automated Vehicles. Sustainability, 14(11), 6697. https://doi.org/10.3390/su14116697

Chen, Y., Shiwakoti, N., Stasinopoulos, P., Khan, S. K., & Aghabayk, K. (2024). Exploring the association between socio-demographic factors and public acceptance towards fully automated vehicles: Insights from a survey in Australia. IET Intelligent Transport Systems, 18(1), 154-172. https://doi.org/10.1049/itr2.12441

Cugurullo, F., Acheampong, R., Dusparic, I., & Guériau, M. (2020). The transition to autonomous cars, the redesign of cities and the future of urban sustainability. Urban Geography, 42, 833-859. https://doi.org/10.1080/02723638.2020.1746096

De Francesco, C., Centorame, L., Toscano, G., & Duca, D. (2025). Opportunities, Technological Challenges and Monitoring Approaches in Agrivoltaic Systems for Sustainable Management. Sustainability, 17(2), 634. https://doi.org/10.3390/su17020634

Dianin, A., Gidam, M., Ravazzoli, E., Stawinoga, A. E., & Hauger, G. (2024). Individual accessibility impacts of public transport automation on (groups of) rural dwellers. Journal of Public Transportation, 26, 100098. https://doi.org/10.1016/j.jpubtr.2024.100098

Ding, Y., Li, R., Wang, X., & Schmid, J. (2022). Heterogeneity of autonomous vehicle adoption behavior due to peer effects and prior-AV knowledge. Transportation, 49(6), 1837-1860. https://doi.org/10.1007/s11116-021-10229-w

dos Santos, P. M., & Cirillo, M. Â. (2023). Construction of the average variance extracted index for construct validation in structural equation models with adaptive regressions. Communications in Statistics – Simulation and Computation, 52(4), 1639-1650. https://doi.org/10.1080/03610918.2021.1888122

Duarte, F., & Ratti, C. (2018). The Impact of Autonomous Vehicles on Cities: A Review. Journal of Urban Technology, 25, 18-23. https://doi.org/10.1080/10630732.2018.1493883

Dudziak, A., Stoma, M., Kuranc, A., & Caban, J. (2021). Assessment of Social Acceptance for Autonomous Vehicles in Southeastern Poland. Energies, 14(18), 5778. https://doi.org/10.3390/en14185778

Ejdys, J. (2017). Determinanty zaufania do technologii. Przegląd Organizacji, 935(12), 20-27. https://doi.org/10.33141/po.2017.12.03 (in Polish).

Ejdys, J., & Gulc, A. (2022). Factors Influencing the intention to use Assistive Technologies by older adults, Human Technology, 18(1), 6-28. https://doi.org/10.14254/1795-6889.2022.18-1.2

Ejdys, J. (2020). Trust-Based Determinants of Future Intention to Use Technology, Foresight-Russia, 14(1), 60-68. https://doi.org/10.17323/2500-2597.2020.1.60.68

European Commission. (2018). Communication from The Commission to The European Parliament, The Council, The European Economic and Social Committee, The Committee of The Regions, On the road to automated mobility: An EU strategy for mobility of the future, Pub. L. No. 52018DC0283. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex:52018DC0283

Foroughi, B., Nhan, P. V., Iranmanesh, M., Ghobakhloo, M., Nilashi, M., & Yadegaridehkordi, E. (2023). Determinants of intention to use autonomous vehicles: Findings from PLS-SEM and ANFIS. Journal of Retailing and Consumer Services, 70, 103158. https://doi.org/10.1016/j.jretconser.2022.103158

Freemark, Y., Hudson, A., & Zhao, J. (2019). Are Cities Prepared for Autonomous Vehicles?: Planning for Technological Change by U.S. Local Governments. Journal of the American Planning Association, 85(2), 133-151. https://doi.org/10.1080/01944363.2019.1603760

Glimm, F., & Fabus, M. (2024). Determinants of the Willingness to Use Autonomous Mobility as a Service in Germany. Future Transportation, 4(3), 746-764. https://doi.org/10.3390/futuretransp4030035

Golbabaei, F., Yigitcanlar, T., Paz, A., & Bunker, J. (2020). Individual predictors of autonomous vehicle public acceptance and intention to use: A systematic review of the literature. In Journal of Open Innovation: Technology, Market, and Complexity, 6(4), 1–27. https://doi.org/10.3390/joitmc6040106

Gulc, A., & Budna, K. (2024). Classification of Smart and Sustainable Urban Mobility. Energies, 17(9), 2148. https://doi.org/10.3390/en17092148

Gulc, A. (2024). Mapping Smart and Sustainable Mobility Innovations in Modern Cities. Proceedings of the Future Technologies Conference (FTC) 2024, Vol. 2, 372-379, Lecture Notes in Networks and Systems, vol. 1155, Cham, Springer. DOI:10.1007/978-3-031-73122-8_24

Gulc, A., Budna, K. (2023). Czynniki determinujące wdrożenie rozwiązań z zakresu zrównoważonej i inteligentnej mobilności miejskiej. Przegląd Organizacji, 3, 24-36. DOI: 10.33141/po.2023.03.03

Guo, Y., Souders, D., Labi, S., Peeta, S., Benedyk, I., & Li, Y. (2021). Paving the way for autonomous Vehicles: Understanding autonomous vehicle adoption and vehicle fuel choice under user heterogeneity. Transportation Research Part A: Policy and Practice, 154, 364-398. https://doi.org/10.1016/j.tra.2021.10.018

Hafeez, F., Mas'ud, A. A., Al-Shammari, S., Sheikh, U. U., Alanazi, M. A., Hamid, M., & Azhar, A. (2024). Autonomous Vehicles Perception, Acceptance, and Future Prospects in the GCC: An Analysis Using the UTAUT-Based Model. World Electric Vehicle Journal, 15(5), 186. https://doi.org/10.3390/wevj15050186

Hendra, H., Fadhilah, N., Yani, I., Violin, V., Apramilda, R., & Kushariyadi, K. (2025). The Role of Marketing Campaigns Through Social Media and Perceived Usefulness on Purchase Intention of Electric Vehicle. International Journal of Engineering, Science and Information Technology, 5(2), 18-22. https://doi.org/10.52088/ijesty.v5i2.766

Hossain, N., Rahman, M. M., Ramasamy, D., Kadirgama, K., & Noor, M. M. (2024). Advancements, challenges, and implications for navigating the autonomous vehicle revolution. Journal of Mechanical Engineering and Sciences, 18(2), 10077-10093. http://dx.doi.org/10.15282/jmes.18.2.2024.9.0796

Huang, T. (2023). Psychological factors affecting potential users' intention to use autonomous vehicles. PLoS ONE, 18(3): e0282915. https://doi.org/10.1371/journal.pone.0282915

Iacobucci, D. (2010). Structural equations modeling: Fit Indices, sample size, and advanced topics. Journal of Consumer Psychology, 20(1), 90-98. https://doi.org/10.1016/j.jcps.2009.09.003

Jing, P., Huang, H., Ran, B., Zhan, F., & Shi, Y. (2019). Exploring the factors affecting mode choice intention of autonomous vehicle based on an extended theory of planned behavior-A case study in China. Sustainability, 11(4), 1155. https://doi.org/10.3390/su11041155

Jing, P., Xu, G., Chen, Y., Shi, Y., & Zhan, F. (2020). The determinants behind the acceptance of autonomous vehicles: A systematic review. Sustainability, 12(5), 1719. https://doi.org/10.3390/su12051719

Kaye, S. A., Somoray, K., Rodwell, D., & Lewis, I. (2021). Users' acceptance of private automated vehicles: A systematic review and meta-analysis. Journal of Safety Research, 79, 352-367. https://doi.org/10.1016/j.jsr.2021.10.002

Keszey, T. (2020). Behavioural intention to use autonomous vehicles: Systematic review and empirical extension. Transportation Research Part C: Emerging Technologies, 119. https://doi.org/10.1016/j.trc.2020.102732

Kettles, N., & Van Belle, J.-P. (2019). Investigation into the Antecedents of Autonomous Car Acceptance using an Enhanced UTAUT Model. *2019 International Conference on Advances in Big Data, Computing and Data Communication Systems (IcABCD)*, 1-6. https://doi.org/10.1109/ICABCD.2019.8851011

Li, D., Huang, Y., & Qian, L. (2022). Potential adoption of robotaxi service: The roles of perceived benefits to multiple stakeholders and environmental awareness. Transport Policy, 126, 120-135. https://doi.org/10.1016/j.tranpol.2022.07.004

Li, G., Liang, Y., Wang, H., Chen, J., & Chang, X. (2022). Factors Influencing Users' Willingness to Adopt Connected and Autonomous Vehicles: Net and Configurational Effects Analysis Using PLS-SEM and FsQCA. Journal of Advanced Transportation. https://doi.org/10.1155/2022/7489897

Li, J., Rombaut, E., & Vanhaverbeke, L. (2021). A systematic review of agent-based models for autonomous vehicles in urban mobility and logistics: Possibilities for integrated simulation models. Computers, Environment and Urban Systems, 89, 101686. https://doi.org/10.1016/j.compenvurbsys.2021.101686

Li, Z., Cheng, K. W. E., & Chan, K. K. W. (2022). An Overview of Factors Influencing the Mass Adoption of Self-Driving Vehicles. *2022 IEEE 9th International Conference on Power Electronics Systems and Applications (PESA)*, 1-5. https://doi.org/10.1109/PESA55501.2022.10038422

Meidute-Kavaliauskiene, I., Yıldız, B., Çiğdem, Ş., & Činčikaitė, R. (2021). Do people prefer cars that people don't drive? A survey study on autonomous vehicles. Energies, 14(16), 4795. https://doi.org/10.3390/en14164795

Montoro, L., Useche, S. A., Alonso, F., Lijarcio, I., Bosó-Seguí, P., & Martí-Belda, A. (2019). Perceived safety and attributed value as predictors of the intention to use autonomous vehicles: A national study with Spanish drivers. Safety Science, 120, 865-876. https://doi.org/10.1016/j.ssci.2019.07.041

Netemeyer, R., Bearden, W., & Sharma, S. (2003). *Scaling Procedures*. SAGE Publications, Inc. https://doi.org/10.4135/9781412985772

Odile-Bernez, M. (2014). Comfort, the Acceptable Face of Luxury: An Eighteenth-Century Cultural Etymology. Journal for Early Modern Cultural Studies, 14(2), 3-21. https://doi.org/10.1353/jem.2014.0015

Orsot-Dessi, P., Ashta, A., Mor, S. (2023). The determinants of the intention to use autonomous vehicles. African Journal of Science, Technology, Innovation and Development, 15(5), 650–660. https://doi.org/10.1080/20421338.2023.2174754

Othman, K. (2021). Public acceptance and perception of autonomous vehicles: a comprehensive review. AI and Ethics, 1(3), 355-387. https://doi.org/10.1007/s43681-021-00041-8

Paddeu, D., Parkhurst, G., & Shergold, I. (2020). Passenger comfort and trust on first-time use of a shared autonomous shuttle vehicle. Transportation Research Part C: Emerging Technologies, 115, 102604. https://doi.org/10.1016/j.trc.2020.02.026

Panasewicz, K. & Jorge, A.A. (2023). Perspective of future use of autonomous robotaxes in cities. Academy of Management, 7(3), 213-232. DOI: 10.24427/az-2023-0042

Pang, S. M., Ho, J. S., Tan, B. C., Lau, T. C., & Khan, N. (2024). Navigating the Road to Acceptance: Unveiling Psychological and Socio-Demographic Influences on Autonomous Vehicle Adoption in Malaysia. Sustainability, 16(18), 8262. https://doi.org/10.3390/su16188262

Paschalidis, E., Hajiseyedjavadi, F., Wei, C., Solernou, A., Hamish Jamson, A., Merat, N., Romano, R., & Boer, E. R. (2020). Deriving metrics of driving comfort for autonomous vehicles: A dynamic latent variable model of speed choice. Analytic Methods in Accident Research, 28, 100133. https://doi.org/10.1016/J.AMAR.2020.100133

Pakusch, C., Stevens, G., Boden, A., & Bossauer, P. (2018). Unintended effects of autonomous driving: A study on mobility preferences in the future. Sustainability 10(7). https://doi.org/10.3390/su10072404

Peng, C., Horn, S., Madigan, R., Marberger, C., Lee, J. D., Krems, J., Beggiato, M., Romano, R., Wei, C., Wooldridge, E., Happee, R., Hagenzieker, M., & Merat, N. (2024). Conceptualising user comfort in automated driving: Findings from an expert group workshop. Transportation Research Interdisciplinary Perspectives, 24, 101070. https://doi.org/10.1016/j.trip.2024.101070

Pimenta, A. R., Kamruzzaman, M., & Currie, G. (2023). Long-term effects of autonomous vehicles on the built environment: a systematic scoping review towards conceptual frameworks. Transport Reviews, 43(6), 1083-1117. https://doi.org/10.1080/01441647.2023.2189325

Pinto, S., Caldeira, S., Martins, J. C., & Rodgers, B. (2017). Evolutionary analysis of the concept of comfort. Holistic Nursing Practice, 31(4), 243-252. https://doi.org/10.1097/HNP.0000000000000217

Prasetio, E. A., & Nurliyana, C. (2023). Evaluating perceived safety of autonomous vehicle: The influence of privacy and cybersecurity to cognitive and emotional safety. IATSS Research, 47(2), 160-170. https://doi.org/10.1016/J.IATSSR.2023.06.001

Quinones, M., Romero, J., Schmitz, A., & Díaz-Martín, A. M. (2024). What factors determine the intention to use and recommend public autonomous shuttles in a real-life setting? European Journal of Management and Business Economics. https://doi.org/10.1108/EJMBE-07-2023-0224

Rahman, M. M., & Thill, J. C. (2023a). What Drives People's Willingness to Adopt Autonomous Vehicles? A Review of Internal and External Factors. Sustainability, 15(15), 11541. https://doi.org/10.3390/su151511541

Rahman, Md. M., & Thill, J. (2023b). Impacts of Connected and Autonomous Vehicles on Urban Transportation and Environment: A Comprehensive Review. Sustainable Cities and Society, 96, 104649. https://doi.org/10.1016/j.scs.2023.104649

Raj, A., Kumar, J. A., & Bansal, P. (2020). A multicriteria decision making approach to study barriers to the adoption of autonomous vehicles. Transportation Research Part A: Policy and Practice, 133, 122-137. https://doi.org/10.1016/J.TRA.2020.01.013

Rezaei, A., Cao, M., Liu, Q., & De Vos, J. (2023). Synthesising the Existing Literature on the Market Acceptance of Autonomous Vehicles and the External Underlying Factors. Journal of Advanced Transportation, (1), 6065060. https://doi.org/10.1155/2023/6065060

Sadeghpour, M., & İnce, E. B. (2024). Early Perspectives: Exploring the Potential Impacts of Autonomous Vehicles Through the Lens of Urban Mobility and Urban Form. Periodica Polytechnica Transportation Engineering, 52(3), 213-228. https://doi.org/10.3311/pptr.23576

Sciaccaluga, M., & Delponte, I. (2020). Investigation on human factors and key aspects involved in Autonomous Vehicles -AVs- acceptance: new instruments and perspectives. Transportation Research Procedia, 45, 708-715. https://doi.org/10.1016/J.TRPRO.2020.02.107

Seuwou, P., Chrysoulas, C., Banissi, E., & Ubakanma, G. (2020). Measuring consumer behavioural intention to accept technology: Towards autonomous vehicles technology acceptance model (AVTAM). Advances in Intelligent Systems and Computing, 1159, 507–516. https://doi.org/10.1007/978-3-030-45688-7_51

Shen, Y., & Deng, G. (2022). Examination of the Influential Factors for Intention to Use Shared Autonomous Vehicles Based on Discrete Choice Models. *2022 IEEE 7th International Conference on Intelligent Transportation Engineering (ICITE)*, 308-313. https://doi.org/10.1109/ICITE56321.2022.10101459

Sitinjak, C., Simic, V., & Pamucar, D. (2024). Psychological factors shaping public acceptance of the adoption of autonomous vehicles in Indonesia. Journal of Transport & Health, 34, 101726. https://doi.org/10.1016/J.JTH.2023.101726

Sutarto, A. P., Ansori, N., Widyanti, A., Trapsilawati, F., Rifai, A. P., Erlangga, R., & Woodman, R. (2023). Driving the Future: Using TAM and UTAUT to Understand Public Acceptance of Fully Autonomous Vehicles. *2023 10th International Conference on ICT for Smart Society (ICISS)*, 1-8. https://doi.org/10.1109/ICISS59129.2023.10291794

Szpilko, D., Budna, K., Drmeyan, H., & Remiszewska A. (2023). Sustainable and smart Mobility – Research Directions. A systematic literature review. Economics and Environment, 3(86), 31-61. https://doi.org/10.34659/eis.2023.86.3.584

Tapia, J. L., Sánchez-Borda, D., Iniesta, C., Badea, F., & Duñabeitia, J. A. (2023). Your language drives me nuts! Fostering Acceptance of Autonomous Vehicles. Research Square [Preprint]. https://doi.org/10.21203/rs.3.rs-3404499/v1

Tapia, J. L., Sánchez-Borda, D., Iniesta, C., Badea, F., & Duñabeitia, J. A. (2024). Shifting Perceptions and Emotional Responses to Autonomous Vehicles Using Simulated Experiences. Behavioral Sciences, 14(1), 29. https://doi.org/10.3390/bs14010029

Thapa, D., Gabrhel, V., & Mishra, S. (2021). What are the factors determining user intentions to use AV while impaired? Transportation Research Part F: Traffic Psychology and Behaviour, 82, 238-255. https://doi.org/10.1016/j.trf.2021.08.008

Tomaszewska, E.J. & Florea, A. (2018). Urban smart mobility in the scientific literature – bibliometric analysis. Engineering Management in Production and Services, 10(2), 41-56. https://doi.org/10.2478/emj-2018-0010

Tripathi, V. (2024). Advancing Autonomous Vehicle Regulations in India: A Comparative Analysis and Global Engineering Insights. Indian Journal of Transport Engineering, 4(2), 1-11. https://doi.org/10.54105/ijte.B1909.04021124

Uzzaman, A., & Muhammad, W. (2024). A Comprehensive Review of Environmental and Economic Impacts of Autonomous Vehicles. Control Systems and Optimization Letters, 2(3), 303-309. https://doi.org/10.59247/csol.v2i3.131

Waltermann, J., & Henkel, S. (2025). The human element in autonomous driving: Motivations, expectations, and behavioral change. Technological Forecasting and Social Change, 213, 123992. https://doi.org/10.1016/j.techfore.2025.123992

Wang, G. (2020). Research on the Fleet Size of Shared Autonomous Vehicles in the Future City: An Example in Shanghai. *CICTP 2020: Advanced Transportation Technologies and Development-Enhancing Connections – Proceedings of the 20th COTA International Conference of Transportation Professionals*. https://doi.org/10.1061/9780784482933.389

Wang, S., Li, Z., Wang, Y., & Aaron Wyatt, D. (2022). How do age and gender influence the acceptance of automated vehicles? – Revealing the hidden mediating effects from the built environment and personal factors. Transportation Research Part A: Policy and Practice, 165, 376-394. https://doi.org/10.1016/J.TRA.2022.09.015

Widyanti, A., Erlangga, R., Sutarto, A. P., Trapsilawati, F., Ansori, N., Woodman, R., Pawitra, T. A., & Rifai, A. P. (2024). Driving forward together: The common intention of Indonesians in different residential areas to use autonomous vehicles. Transportation Research Interdisciplinary Perspectives, 24, 101049. https://doi.org/https://doi.org/10.1016/j.trip.2024.101049

Winkowska, J., Szpilko, D. & Pejić, S. (2019). Smart city concept in the light of the literature review. Engineering Management in Production and Services, 11(2), 70-86. https://doi.org/10.2478/emj-2019-0012

Wishart, D., Weaver, S., & Apuli, A. (2023). Autonomous vehicles: What are your intentions? Transportation Research Part F: Traffic Psychology and Behaviour, 99, 450-459. https://doi.org/10.1016/j.trf.2023.08.011

Xing, Y., Li, L., Sheng, X., Zhou, H., & Han, X. (2025). Understanding public perceptions of autonomous vehicles: A structural model to urban-rural differences and psychological factors. Transport Policy, 165, 70-84. https://doi.org/10.1016/j.tranpol.2025.02.016

Yuan, M., & Yu, R. (2024). Exploring the influential factors of initial trust in autonomous cars. Ergonomics, 1-19. https://doi.org/10.1080/00140139.2024.2439915

Yuen, K. F., Cai, L., Qi, G., & Wang, X. (2021). Factors influencing autonomous vehicle adoption: an application of the technology acceptance model and innovation diffusion theory. Technology Analysis and Strategic Management, 33(5), 505-519. https://doi.org/10.1080/09537325.2020.1826423

Yuen, K. F., Huyen, D. T. K., Wang, X., & Qi, G. (2020). Factors influencing the adoption of shared autonomous vehicles. International Journal of Environmental Research and Public Health, 17(13), 1-16. https://doi.org/10.3390/ijerph17134868

Zhang, Y., & Kamargianni, M. (2023). A review on the factors influencing the adoption of new mobility technologies and services: autonomous vehicle, drone, micromobility and mobility as a service. Transport Reviews, 43(3), 407-429. https://doi.org/10.1080/01441647.2022.2119297

Zhao, X., & Chidambareswaran, T. (2023). Autonomous Mobile Robots in Manufacturing Operations. *2023 IEEE 19th International Conference on Automation Science and Engineering (CASE)*, 1-7. https://doi.org/10.1109/CASE56687.2023.10260631

Zilahy, D. (2023). Under-Estimated Factors in the Adoption of Self-Driving Cars. Interdisciplinary Description of Complex Systems, 21(2), 199-205. https://doi.org/10.7906/indecs.21.2.9

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KIEROWANIE W PRZYSZŁOŚĆ: POSTRZEGANIE I AKCEPTACJA SPOŁECZNA AUTONOMICZNYCH AUTOBUSÓW

STRESZCZENIE: Celem przeprowadzonych badań była analiza społecznych uwarunkowań wdrożenia autonomicznych autobusów, ze szczególnym uwzględnieniem postrzeganych korzyści, bezpieczeństwa i komfortu. Przeprowadzone badania miały również na celu weryfikację na ile analizowane czynniki różnią się w zależności od wielkości miast i stosowanych rozwiązań w zakresie mobilności miejskiej. Badania ankietowe zostały przeprowadzone w trzech polskich miastach (Łomża, Warszawa, Wrocław), na próbie 1 160 respondentów. Do analizy zależności między postrzeganymi korzyściami, bezpieczeństwem, komfortem a przyszłymi intencjami korzystania z autonomicznych autobusów wykorzystano modelowanie równań strukturalnych (SEM). Wyniki wskazują, że bezpieczeństwo i komfort mają pozytywny wpływ na przyszłe intencje w zakresie korzystania z autonomicznych autobusów. Jednocześnie wpływ postrzeganych korzyści różni się w zależności od miasta, co sugeruje, że warunki mobilności miejskiej kształtują społeczną akceptację analizowanej technologii.

SŁOWA KLUCZOWE: autonomiczne autobusy, komfort i bezpieczeństwo, postrzegane korzyści, bezpieczeństwo, transport miejski

DOI: 10.34659/eis.2025.92.1.1140