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Polish city residents' social perception of autonomous vehicles[1]

Pojazdy autonomiczne w percepcji społecznej mieszkańców polskich miast

Abstract

The paper presents the results of a social study relating to the awareness and attitudes of city residents towards the prospects of using autonomous vehicles as a means of urban transportation, including last-mile transportation. The main objective of the study was to find answers to the following questions: 1) what is the current state of city residents' knowledge of autonomous vehicles, 2) what attitude respondents have towards the phenomenon under study, 3) what determinants may foster acceptance of this form of transportation as part of daily mobility, 4) what scenarios for travel using self-drive cars are most likely at present. The source base consisted of contributions from 648 respondents qualified for the study based on the criterion of place of residence. Data analysis and interpretation were carried out using the SPSS package and using statistical tests. The results of the study allow us to draw the conclusion that the use of autonomous vehicles as part of daily mobility requires achieving a state of public awareness where the choice of autonomous transportation will become, for city residents, a conscious and desirable form of mobility in urban agglomerations, competitive to other modes of transport.

Keywords:
autonomous vehicles, 5SEA, social acceptance, travel preferences and scenarios, city residents

Streszczenie

W artykule przedstawiono wyniki badań społecznych odnoszące się do świadomości i postaw mieszkańców miast wobec możliwości użytkowania pojazdów autonomicznych jako środka transportu ostatniej mili. Ich głównym celem było znalezienie odpowiedzi na następujące pytania: 1) jaki jest aktualny stan wiedzy mieszkańców miast na temat pojazdów autonomicznych, 2) jaką postawę reprezentują respondenci względem badanego zjawiska, 3) jakie determinanty mogą sprzyjać akceptacji tej formy transportu w ramach codziennej mobilności, 4) jakie scenariusze podróży z użyciem samochodów bez kierowcy są obecnie najbardziej prawdopodobne. Podstawę analizy danych stanowiły odpowiedzi pochodzące od 648 respondentów zakwalifikowanych do badania na podstawie kryterium miejsca zamieszkania. Analizę oraz interpretację danych przeprowadzono z wykorzystaniem pakietu SPSS. Wyniki badań pozwalają na sformułowanie wniosku, zgodnie z którym wykorzystanie pojazdów autonomicznych w transporcie miejskim wymaga osiągnięcia takiego stanu świadomości społecznej, w którym wybór tej formy transportu będzie stanowił dla mieszkańców miast uświadomioną i pożądaną formę przemieszczania się po mieście, konkurencyjną wobec innych środków transportu.

Słowa kluczowe:
pojazdy autonomiczne, 5SEA, akceptacja społeczna, preferencje i scenariusze podróży, mieszkańcy miast

JEL: J6, R11, R41

Introduction

Dynamic development of new technologies is setting ambitious new goals for transportation mobility solutions. In the study devoted to this issue, a great deal of attention is currently being paid to the automation of road transportation and the role that autonomous vehicles (AVs) will play in making urban infrastructure more interactive and efficient (Parekh et al., 2022; Świtała & Łukasiewicz, 2021;

Faisal et al., 2019). Undoubtedly, the increased interest in the aforementioned issue has been greatly influenced by the concept of the smart city, in which a special role is attributed to new technologies such as IoT (Internet of Things), 5G communications, as well as automated and autonomous forms of travel (Richter et al., 2022; Kamiński, 2021; Guevara & Cheein, 2020; Porru et al., 2020).

Despite numerous benefits of autonomous road transportation, including improved safety, lower energy consumption, reduced greenhouse gas emissions, shorter travel times, and increased parking availability (Wang et al., 2020; Othman, 2022), the arrival of AVs to the roads may be accompanied by public resistance due to existing transportation habits, and partly due to fear of the unknown. Studies have shown that in broad segments of society, views on autonomous vehicles are not yet fully crystallized, often accompanied by distrust and uncertainty about the changes that society will face in the near future (Agrawal et al., 2023). It is likely that autonomous vehicles, along with CAV (connected and automated vehicle) technology, may interfere with passengers private lives to a greater extent than traditional forms of transportation, which may also be one of the reasons for the lack of widespread willingness to practice this mode of travel (Khan et al., 2021). X. Sun et al. (2020), point out that under current circumstances, most customers are not ready to make a decision regarding the purchase of an autonomous car. More often, they go for traditional or partially automated vehicles, while fully autonomous transportation is less trusted (Bansal & Kockelman, 2018). A study by McKinsey & Company also found that today's society's readiness to use fully automated vehicles is rather low (Deichmann et al., 2023). However, public caution about the changes brought about by advanced road transport technologies is nothing new. This course of action follows from the logic and nature of public attitudes towards the most radical innovations. According to E. Heiskanen et al. (2007), in such cases, the sources of social resistance should be traced to difficulties in understanding the utility of new products.

According to the authors, previous studies have devoted relatively little space to the problems of autonomous transportation considered from a social perspective, although other related aspects have been studied. A similar thesis is presented by X. Sun et al. (2020) who point out that the reference literature still lacks observation results concerning the social impact of road vehicle automation. J. P. N. Silva et al. (2021) indicate a lack of recognition results to determine how this solution can be adapted by the market and gain acceptance of traffic participants. A. Talebian and S. Mishra (2018), on the other hand, point out that the majority of the diagnoses available are based on expert knowledge and relate to technology transfer and sales estimation. Moreover, according to A. Faisal et al. (2019), there is a research gap in the literature related to recognizing both the positive and negative impacts of autonomous vehicles on the operation and development of cities.

Guided by the above findings, this paper undertakes considerations that are directed at solving the research problem, which boils down to seeking answers to the following four questions: 1) what is the current state of city residents' knowledge of autonomous vehicles, 2) what attitude respondents have towards the phenomenon under study, 3) what determinants may foster acceptance of this form of transportation as part of urban transportation, 4) what scenarios for travel using self-drive cars are most likely at present. A hypothesis has also been formulated, according to which the social perception of autonomous vehicles depends on age, gender, educational level, and city size.

Previous studies

The subject of the study, the results of which are presented in this paper, is road transportation carried out with vehicles classified as level five autonomy (5SEA). It means full autonomy of the vehicle, i.e. a situation in which all activities of the transportation process are carried out by the vehicle control system (Ondrus et al., 2020). The means of transportation in question, also referred to as self-drive cars, move without human intervention, are able to sense the environment in which they are located, determine their position, recognize the driving styles of other means of transportation, including other unmanned vehicles, and adjust all driving parameters to the road conditions (Świtała & Łukasiewicz, 2021).

The hallmark of AVs is their ability to behave interactively and monitor their environment, which in practical operation requires the acquisition, processing and sharing of large data sets in real time. Thanks to advances in technology, including IoT, vehicles are communicating with each other, road infrastructure and smart city management systems, creating the so-called connected autonomous vehicles (CAVs) (Yigitcanlar et al., 2019). However, in order for these vehicles to move efficiently on the urban road network, it may be necessary to set aside lanes for their exclusive use (Ye & Yamamoto, 2018).

Although the fifth level of vehicle autonomy is currently in early stages of implementation and is

still undergoing intensive improvement, issues related to it have attracted attention of researchers and academic centres from various countries for many years (Thorpe et al., 1991; Rillings, 1997; Broggi et al., 1999; Urmson & Whittaker, 2008; Chong et al., 2011; Zhao et al., 2018; Dixon et al., 2020).

The research conducted to date in the area of autonomous vehicles has been multidirectional in nature, diverse in its subject matter, and based on the analysis of both secondary and primary data sources using various research methods and techniques. The most common issues include technological aspects related to driving control and the design of systems for this purpose (Zhao et al., 2018; Hussain & Zeadally, 2019), interactions occurring between the driver and vehicle (Karatas et al., 2019; Sun et al., 2018), safety issues and risk assessment (Hulse et al., 2018; Guo et al., 2020), ethical dilemmas (Gogoll & Müller, 2017; Taylor & Bouazzaoui, 2019), and machine learning mechanisms (i.a. Stilgoe, 2018). The authors W. Y. Ayele and G. Juell-Skielse (2018), using the results of LDA thematic modelling, identified thirteen major topic areas related to AVs. Most of the research undertaken was aimed at technological development, considered an essential element in ensuring conditions for the widespread use of AVs. In contrast, observations of social and technical transformation and related implications for sustainable development were implemented relatively least frequently. It is, therefore, advisable that subsequent studies take into account a broader cognitive context that goes beyond understanding the AV technical picture and relates more to the social and economic sciences. As E. Fraedrich and B. Lenz (2014) observe, this appears to be a prerequisite for large-scale implementation of the solution under study.

Research by K. Othman (2021) indicates that the key implementation barrier for autonomous vehicles will not be technological challenges, but problems related to lack of social acceptance. The difficulties involved are also pointed out by other researchers. For example, C. Rödel et al. (2014) present results showing that a vehicle's level of autonomy affects acceptance and experience of using AV technology. Researchers Y. Nishihori et al. (2020), meanwhile, emphasize that favourability towards AVs is determined by country of residence, and is also largely determined by sociodemographic characteristics, including gender, age and education level. A. Talebian and S. Mishra (2018), referring to a survey of 327 residents of the city of Memphis, conclude that marketing tools will play a minor role in creating conditions conducive to social acceptance of autonomous vehicles. For this reason, relevant activities in the field of social research should be included among the initiatives for autonomous transportation solutions. Their scope should include both issues related to public expectations, willingness to travel with AVs and related preferences, as well as the level of public confidence in this form of transportation.

Cities, as areas with particularly high traffic volumes and complex spatial structures, are frequent objects of analysis related to autonomous transportation. The sources of this interest can be traced not only to the continued urbanization of regions and the phenomenon of urban sprawl, but also to the role that urban centres play today in creating numerous innovations. In the literature on urban issues these entities are often referred to as innovation generators (Marceau, 2008; Athey et al., 2008; Somers et al., 2016). The concept of smart urban mobility, which refers to the integration of sustainable and smart vehicles and smart transportation systems compatible with them through information technology, plays a special role here (Cassandras, 2017). Urban agglomerations are currently implementing numerous investment activities dedicated to sustainable mobility. They are directed towards the development of electrification of transport infrastructure and micro-mobility responsible for promoting pedestrian and bicycle traffic.

This is no different for autonomous vehicles, which are being tested in many metropolitan areas to confirm their safe behaviour in real-world conditions. Examples of such cities include, in USA, Phoenix where ride-hailing services for fully autonomous vehicles have been provided since 2018; San Francisco which has autonomous vehicle pilot programmes from Aurora, Cruise, Uber, and Zoox; and Cupertino which is a test site for Apple-branded vehicles (Matthews, 2020). Mobileye's autonomous vehicles, meanwhile, can be seen on the streets of New York City since 2021 (Valdes-Dapenda, 2021). Studies are also being conducted in metropolitan areas of other countries, including Buenos Aires and Paris (CTDT, 2023), as well as in several Polish cities: Rzeszow, Gdansk, Jaworzno, and Krakow, where autonomous trams were tested in 2018 (Darowska et al., 2020).

According to R. Zakharenko (2016), the spatial effects of urban transportation autonomation will be observable in the urban structure of modern cities, mainly through a decrease in the demand for parking spaces, which currently occupy 20 to 40% of the city centre space (Larson et al., 2020). According to the Los Angeles Transportation Agency, people looking for parking space generate up to 30% of the entire city traffic. This is a significant source of traffic congestion and environmental pollution (Fagnant & Kockelman,

2014). The effects of autonomation will also be seen in behavioural changes in the area of transportation mobility, driven mainly by a reduction in transportation costs and passengers' willingness to accept longer trips. Furthermore, the development of autonomous driving may significantly contribute to the reduction of traffic accidents and congestion, as well as to a positive effect of additional leisure time resources (Yaqoob et al., 2020). This, in turn, would lead to de-escalation of stress for drivers and passengers. The autonomation of vehicles can also play an important role in improving service quality in relation to passenger mobility, which is considered to be crucial challenge for transit managers (Sahraei et al., 2023).

Materials and research methods

The opinion poll was based on a nationwide sample of the country's population aged 16 and over, comprising 1,067 respondents with a confidence level of 95% and a maximum error of 3%. It was carried out using stratified random sampling with the variables quoted: gender, age, size of city/town of residence and region. For the purposes of this study, a subpopulation of urban residents of 648 respondents was extracted from the sample, which in percentage terms accounted for 60.73% of all its participants.

The study employed a poll method using an electronic CAWI questionnaire, and the data collected in this way were verified and processed using appropriately selected statistical tools available in IBM SPSS Statistics software. The basis for analysing the observation results was the measures of descriptive statistics: frequency distributions, arithmetic means and standard deviations. Correlation tests were used to examine the relationship between the background variables and the socio-demographic characteristics of respondents. A Chi^2 test was used to examine differences in respondents' answers due to metric variables.

The sample structure in terms of socio-demographic characteristics is shown in Table 1. As can be seen, it varied in terms of age, gender,

Table 1
Research sample structure

No.	Sociodemographic characteristics	Distribution of responses	%
1.	Sex	Female	54.60
		Male	45.40
2.	Age	16–24 years old	9.90
		25–34 years old	19.00
		35–49 years old	24.40
		50–59 years old	14.80
		60–69 years old	21.10
		70 years old and over	10.80
3.	Place of residence	Town up to 20,000 citizens	14.80
		City from 20,000 to 100,000 citizens	40.30
		City from 100,000 to 200,000 citizens	12.50
		City from 200,000 to 500,000 citizens	13.00
		City above 500,000 citizens	19.40
4.	Education	Elementary	3.20
		Secondary	49.20
		Higher (bachelor's degree/engineer's degree)	14.70
		Higher (master's degree)	29.50
		Higher (PhD and above)	3.40
5.	Type of education	Technical	36.90
		Economic	19.00
		Legal	2.90
		Humanities	19.90
		Lack of professional education	12.80
		Other	8.50

Source: own work.

education and place of residence. The largest group were people aged 35–49 (24.40%), while the smallest group were young people, i.e. those aged 16–24 (9.90%). The percentage of elderly people was almost 32%, including 10.80% respondents aged 70 and over. Women made up more than a half of the survey sample. There was a strong representation of those with secondary education (49.20%), while the fewest respondents declared having elementary education (3.20%) and higher education with a degree or academic title (3.40%).

Considering the education profile, more than 1/3 of the survey participants had technical education, while almost 13.00%, on the other hand, indicated having had no professional education. The largest group of respondents were residents of cities with populations between 20,000 and 100,000 (40.30%), while the smallest group were residents of small towns with a population of up to 20,000 (14.80%).

The unified part of the questionnaire examining the level of social consciousness in the context in question was made up of questions on the current state of knowledge about autonomous vehicles, the respondents' attitudes towards this solution, as well as the recognition of circumstances conducive to the acceptance of transportation based on them and the travel scenarios possible.

Respondents' opinions were measured using two types of scales, i.e. binary nominal scales with "yes/no" responses and five-point ordinal scales based on single or multiple choice response categories.

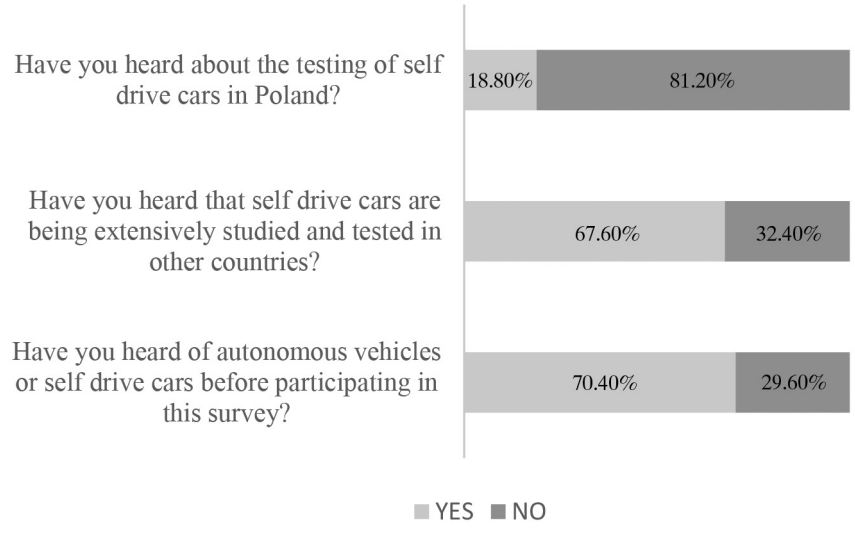
Findings

Current state of knowledge on autonomous vehicles

Turning to the analysis of respondents' opinions on autonomous vehicles, it should be noted that the first three research questions were aimed at recognizing the current state of knowledge about them (also referred to as self-drive cars). Respondents were asked to imagine a situation in which a self-drive vehicle is waiting for them in front of a train station building or at public transportation stop to take them to their destination, providing so-called last-mile ("door-to-door") transportation. It could be public transport, an autonomous taxi or a self-drive car booked on demand via a smartphone app. Once aboard a vehicle (assuming it's a self-drive taxi/car), the respondent must enter the destination using an interface – such as a keypad or by voice – so the vehicle knows where they want to go.

Figure 1 shows the distribution of responses to questions about respondents' knowledge of autonomous vehicles. First, respondents were asked a question: "Have you heard of autonomous vehicles or self-drive cars before participating in this survey?". In response to this question, 70.40% of respondents indicated the "yes" answer, while 29.60% marked the "no" answer. A similar distribution was also found for a question designed to test respondents' knowledge of research and development efforts in autonomous transportation modes. Thus, to a related question,

Figure 1
Respondents' knowledge of autonomous vehicles (yes/no)



Source: own work.

67.60% of respondents confirmed that they had heard of such projects implemented in other countries. In contrast, 32.40% gave a negative response. What seems most interesting is that the majority of the survey participants have no knowledge of this type of research being conducted in Poland. It should be observed that the percentage of negative responses turned out to be very high, as it accounted for more than 80% of the total declarations.

Table 2 summarizes the results of the analysis of the relationship between how the above questions were answered and the socio-demographic characteristics of the respondents. For the first two questions, the results of the Chi^2 test indicate statistically significant differences in responses between men and women. In percentage terms, more than 77% and 79% of men gave affirmative responses, i.e. 12% and 19% more than women, respectively, indicating that men have greater awareness of the topic under consideration than women. Analysis of the data shows that the share of respondents claiming to have knowledge of autonomous vehicles is at similar levels across age groups, as is the case with city size groups. When asked about their knowledge of autonomous vehicle research, respondents' educational background proved to be a far more differentiating characteristic in their responses. Compared to those with elementary or secondary education, respondents with a university degree were more likely to declare familiarity with the subject, especially on a question indicating awareness of research being conducted in Poland. In this case, the differences between the study groups proved to be statistically significant.

In addition to the foregoing, respondents were asked whether the mass media provide them with information regarding autonomous vehicles to the extent necessary to understand their operation. The distribution of responses shows that almost a half of respondents (47.70%) believe that this topic is rarely covered by the media. The percentage of negative responses in this case was 28.50%, while 23.80% of respondents declared no opinion on the subject. Socio-demographic characteristics did not significantly affect the distribution of responses, although there were noticeable differences between the declarations of respondents with elementary and higher education, especially those with a degree or diploma, for whom the percentage of con-firmatory responses was 36.40% i.e. almost double that of the comparison group.

Respondents' attitudes towards autonomous vehicles

In the next question, respondents were asked to express their opinion on autonomous vehicles. The responses were measured using an ordinal scale, where 1 meant a "negative" rating and 5 meant a "positive" rating. The data show that the average score was 3.57, with 95% probability across the entire study population it was between 3.49 and 3.64. This value falls well above the middle of the scale (3), indicating that respondents preferred to give answers indicating their positive attitude towards self-drive cars (57.70%). The percentage of neutral responses of "neither positive nor negative" was 29.00%, and negative ratings were at the level of 13.30%. It is worth noting that the preponderance of unequivocally positive ratings over unequivocally negative ones turned out to be more than five times. The opinion of respondents was not found statistically significantly different by gender ($p > 0.05$). The average for women was 3.62, while the average for men was 3.51. Neither was it found that the respondents' ratings were differentiated by the level of education, its type (technical education, economic education, etc.), nor the respondents' place of residence. The results of the Chi^2 test indicate that the statistically

Table 2

Results of the relationship between respondents' knowledge of autonomous vehicles and the socio-demographic characteristics studied (analysis of differences using Chi^2 test)

No.	Characteristics	Have you heard of autonomous vehicles or self-drive cars before participating in this survey?		Have you heard that self-drive cars are being extensively studied and tested in other countries?		Have you heard about the testing of self-drive cars in Poland?	
		Chi^2	p	Chi^2	p	Chi^2	p
1.	Age	0.842	0.974	5.781	0.328	1.380	0.927
2.	Sex	12.078	0.001**	21.149	0.001**	0.074	0.785
3.	Education	6.143	0.189	3.871	0.424	11.786	0.019*
4.	City size	1.419	0.841	6.970	0.137	2.843	0.584

* significance level $p < 0,05$; ** significance level $p < 0,01$; *** significance level $p < 0,001$.
Source: own work.

significant variable differentiating respondents' ratings appeared to be their awareness related to the testing of autonomous vehicles in the country ($Chi^2 = 9.381$, $p < 0.05$). Respondents having the awareness tend to be more positive than those from the opposite group. In the first case, the vast majority of urban residents, 68.00%, express a rather positive opinion of the presence of autonomous vehicles in urban space. In the second group, the rate of positive and rather positive responses turned out to be almost 13% lower, and amounted to 55.30%.

Determinants of widespread acceptance of transportation based on autonomous vehicles

The study also aimed at identifying determinants that could play a key role in achieving widespread acceptance for transportation based on autonomous vehicles (Table 3). Respondents were asked about their own view of what conditions would have to be met to create a situation where their movement around the city would actually be accomplished by autonomous vehicles. Responses were measured using a 5-point scale, where 1 meant "definitely yes" and 5 meant "definitely not". Overall, there is little difference between the conditions, ranging from 2.10 for gaining more theoretical knowledge to 2.20 for popularizing the idea of self-drive cars through the media. Respondents' opinions are therefore close to a rating of 2 ("rather yes"). Overall, all the determinants included in the analysis are of similar importance to respondents. However, the standard deviation values indicate a low degree of agreement within each statement.

The analysis of socio-demographic differences shows that significant differences in the distribution of responses between men and women can be found in the question relating to the popularization of the idea of self-drive cars by the media ($Chi^2=9,434$, $p < 0.05$). Women were more likely to give positive answers than men. No other variables were found to determine respondents' answers in this regard.

Travel scenarios using autonomous vehicles

Another problem addressed in the study was the identification of travel scenarios with an assessment of respondents' willingness to travel by autonomous vehicles. They were also asked to express their approval or disapproval of the idea of autonomous cars moving on the road without drivers or passengers.

The study shows that the scenario involving travel by self-drive taxis is the most likely, with the highest willingness of respondents to accept the travel option under consideration (2.59). In contrast, they were least likely to approve of a scenario involving autonomous commercial vehicles in road traffic (2.86). The percentage of negative responses ("rather not", "definitely not") in this case is more than 11% higher compared to self-drive taxis and exceeds 33%. It is noteworthy, however, that in every case submitted there was a willingness to accept travel, at more than 40%. A detailed distribution of responses is shown in the Table 4.

Spearman rank correlation analysis indicates that there is a statistically significant relationship (at $p < 0.001$) between all travel scenarios and respondents' opinion of autonomous vehicles. The

Table 3
Determinants of widespread acceptance of transportation based on autonomous vehicles

No.	Specification	$\bar{x}$	σ	Definitely yes [1]	Rather yes [2]	Neither yes nor no [3]	Rather not [4]	Definitely not [5]
				%				
1.	Gaining more theoretical knowledge of the technologies used in autonomous vehicles	2.10	0.88	23.30	52.50	16.70	5.90	1.70
2.	Media popularization of the idea of self-drive cars	2.20	0.91	20.20	50.3	20.70	6.80	2.00
3.	Getting personal experience with autonomous vehicles by a large group of users	2.12	0.87	23.00	51.20	18.20	6.30	1.20
4.	Meeting all of the above conditions together	2.10	0.90	25.30	48.10	18.70	6.50	1.40

Source: own work.

Table 4
Respondents' willingness to accept travel scenarios using autonomous vehicles

No.	Specification	$\bar{x}$	σ	Definitely yes	Rather yes	Neither yes nor no	Rather not	Definitely not
				%				
1.	Unmanned cars moving on roads without passengers	2.79	1.12	11.40	33.20	27.50	20.40	7.60
2.	Autonomous vehicles used as commercial vehicles, such as trucks, vans or garbage trucks	2.86	1.19	12.20	31.90	22.70	23.60	9.60
3.	Self-drive public transportation vehicles, such as buses	2.76	1.17	13.70	34.10	22.20	21.90	8.00
4.	Self-drive taxis	2.55	1.09	15.90	40.10	22.20	17.00	4.80

Source: own work.

study shows that the willingness to accept them clearly increases with the respondents' willingness to express a positive opinion of autonomous vehicles. This relationship is particularly evident in the case of acceptance of the appearance of autonomous taxis on the roads, where more than 90% of the responses in the "definitely yes" category were given by respondents with a positive attitude towards the initiative described. Several statistically significant associations with socio-demographic variables were also observed. It turns out that the willingness to accept travel scenarios involving self-drive public transportation vehicles increases as we move to younger age groups ($p < 0.01$). For example, the percentage of "definitely yes" and "rather yes" declarations was 19.10% for those aged 70 and over and 43.50% for those aged 25–34. On the other hand, the level of education and the size of the city of residence significantly correlate with respondents' willingness to accept the scenario of travel involving cars without a driver and passengers ($p < 0.05$). The data show that while the percentage of declarations accepting the aforementioned scenario for those with elementary education is at 28.60%, the percentage for respondents with higher education ranges from 45.20% to 50.20%, depending on the degree completed. Approval of travel using self-drive cars and passengers was most often expressed by residents of large cities with a population of more than 200,000 people (54.80%), and least often by residents of small cities, i.e. with a population of less than 20,000 people (40.70%).

Discussion and conclusions

Driving autonomous vehicles is a reality that just a few years ago might have been considered by city residents in the sphere of unattainable dreams and distant future plans. However, advances in technology have already made many urban centres interested in the "smart cities" programme and facing many dilemmas in introducing new solutions, both in the area of AVs and the CAV technology. Under its influence, transformations are underway in the social and spatial structure of cities, improvements in the level of public services, and consequently also changes in the quality of residents' life.

The purpose of this paper was to present the results of the direct study relating to social consciousness and attitudes towards the possibility of using autonomous vehicles as part of urban transportation, including when making last-mile trips. The problem addressed was discussed from the perspective of users of urban road transportation and their opinions on the use of the aforementioned vehicles in daily travel. The main research attention was focused on seeking answers to the following four questions: 1) what is the current state of city residents' knowledge of autonomous vehicles, 2) what attitude respondents have towards the phenomenon under study, 3) what determinants may foster acceptance of this form of transportation as part of daily mobility, 4) what scenarios for travel using self-drive cars are most likely at present. Additionally, a hypothesis was formulated that social perception of autonomous vehicles depends on age, gender, education level and city size.

In attempting to answer the first question, it should be observed that most urban residents are aware of the existence of autonomous vehicles which are going to carry humans in the near future. Most of them have also heard that research and testing are being conducted in this area in other countries. The differences in the two genders' knowledge on the subject may be due to men's greater involvement in the automotive and new

technology sectors, or the fact that they have technical education more frequently.

Against this background, the results of studies relating to the testing of self-drive cars in Poland, where the percentage of negative responses amounted to more than 80% of the total declarations, look much worse. Opinions on the matter are clearly influenced by the level of education. Those with a university education stand out in particular, among whom the percentage of respondents aware of the research being conducted in Poland was found to be the highest. It seems that the low level of social consciousness of this issue that emerges from the observation can be partly explained by an insufficient role the mass media play in providing relevant information. It turns out that, according to almost half of the respondents, the mass media fail to provide enough information to make people understand the operation of such vehicles. Since the news media have a particularly strong influence on public opinion and the creation and dissemination of knowledge (Kranenburg, 2017), their opinion-making role should have a significant impact on changing social attitudes. An increase in acceptance of solutions based on autonomous transportation would then be the effect of these measures.

The study results show that respondents are more likely to form positive rather than negative opinions about autonomous vehicles. In this case, the variable that statistically significantly differentiated the respondents' answers turned out to be their awareness related to their testing in the country. It turns out that respondents who declare such knowledge are more likely to express approval than those in the opposite group. Many researchers view knowledge as an important correlate of social trust, which, in turn, as research shows, plays a key role in creating positive attitudes towards autonomous vehicles (Zhang et al., 2019; Choi et al., 2015). The results of the study by C. Ward et al. (2017) show that knowledge and trust, combined with age as well as risk and benefit perceptions, significantly influence the increased interest in autonomous vehicles in everyday life. The impact of trust on related decisions is also confirmed by the study of I. Nastjuk et al. (2020) and also M. König and L. Neumayr (2017).

The findings of the study of the determinants of autonomous urban travel acceptance indicate that the fulfilment of all the circumstances considered, i.e. the acquisition of knowledge by respondents about the technologies used in autonomous vehicles, the popularization of the idea of self-drive cars by the media, and the acquisition of personal experience with this type of vehicle, is a prerequisite for the existence of real acceptance of the solution studied. Indeed, almost 70% of the study participants made such a declaration. The study proves that women are more likely to change their attitude towards this form of travel, provided that the topic is given due prominence in the public discourse, thus knowledge about the operation of autonomous vehicles is more wide-spread. In terms of personal experience, it is worth citing the results of a study carried out as part of a pilot drive of six autonomous buses in the French city of La Rochelle. The study shows that 73% of those with experience in taking trips using autonomous vehicles indicate this mode of transportation as preferred, compared to 55% of respondents not having such experience (Piao et al., 2016). This leads to the conclusion that previous experience with AV has a significant impact on social acceptance of this form of transportation.

The final area of the study investigation was a question about respondents' willingness to accept four travel scenarios using autonomous vehicles. The results of the study indicate that the highest willingness to accept regarding this issue was recorded for the scenario involving travel by self-drive taxis. In contrast, the least popular option was the one involving the presence of autonomous commercial vehicles, such as trucks, vans or garbage trucks on the roads.

Perhaps the variable that strongly differentiates respondents in terms of the results obtained is, in this case, concern about road safety. It specifically refers to road incidents involving commercial vehicles. These, on the other hand, have a much higher risk of serious health, social and economic consequences compared to passenger cars. This seems particularly important given the many concerns and doubts raised by urban residents against AV technology. For example, B. Schoettle and M. Sivak (2015), analysing drivers' preferences towards different levels of vehicle automation, indicate that 92% of respondents report concerns about traffic safety, particularly with regard to autonomous vehicle interaction with pedestrians on the road and driving in poor weather conditions.

The study also found that willingness to accept travel scenarios involving autonomous vehicles correlates strongly with respondents' overall opinion of them. The group of variables showing a strong relationship with respondents' declarations also includes age, education level and size of the city/town of residence.

The results of the research do not allow us to fully accept or reject the hypothesis that was adopted at the beginning of the study. Mostly, the intergroup differences were statistically significant for gender and educational level. The significant differences in age and town size were less frequent. As a next research step, it may be worth considering changing the number of levels associated with traits

related to age and city size. Future studies could also test more specific research hypotheses related to the AVs adoption tendency of people. An important topic for future research is to examine other factors, both internal and external, that may play a positive or negative role in achieving widespread acceptance for the use of AVs in urban areas.

Summarizing the results of the study, it should be concluded that it is becoming necessary for the development of the autonomous vehicle initiative to achieve an adequate state of social consciousness. According to it, the use of autonomous vehicles would be an informed and desirable form of travel for city residents, competitive with other modes of transportation. Only then, as I. Nastjuk et al. (2020) point out, autonomous vehicles will become a viable and important part of the urban transportation system.

Notes/Przypisy

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Adiunkt w Zakładzie Ekonomiki Instytutu Badawczego Dróg i Mostów. W swojej pracy naukowej podejmuje zagadnienia związane z oddziaływaniem inwestycji drogowych na otoczenie gospodarcze, ze szczególnym uwzględnieniem powiązań łączących inwestycje drogowe z działalnością przedsiębiorstw transportu drogowego towarów. W ostatnich latach głównym przedmiotem jego zainteresowań badawczych były kwestie związane z mobilnością transportową oraz adaptacją przedsiębiorstw w łańcuchach i sieciach dostaw.

Mgr Paweł Czemiel

Zastępca dyrektora w Instytucie Badawczym Dróg i Mostów. Absolwent Collegium Civitas w Warszawie. Radny Sejmiku Warmińsko-Mazurskiego. W pracy badawczej skupia się na problematyce rozwoju regionalnej infrastruktury drogowej oraz zarządzaniu strategicznym w samorządach lokalnych.