Young Consumers' Attitudes Toward Autonomous Vehicles – An Empirical Approach

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Abstract. Automotive industry has been undergoing significant alteration. Innovative technologies change vehicles toward fully autonomous ones, also known as self-driven cars. Experts on automotive industry present a wide range of advantages and possible disadvantages of the new modes of transportation, but they all agree that autonomous vehicles will become part of our lives in some point of the future. The success of self-driven cars depends not only on the technical features of the vehicles, but on the customers' trust and confidence inspired in the autonomous cars users. Deloitte studies conducted in 2017 and 2018 show that young consumers are most trustful and eager to use self-driven cars. To identify the youngsters' attitudes toward autonomous vehicles and factors influencing consumers' aptitude for self-driven cars a direct quantitative research was conducted on a group of 152 respondents representing Y and Z Generations in January and February 2018. The research findings show rather moderate will of young customers to use autonomous vehicles, but they stay open-minded. The main factor determining their choice is safety (in general) of the self-driven cars, what indicates what the main concern of car manufacturers should be.

Keywords: Autonomous vehicles · Self-driven cars · Young consumers Attitudes

1 Introduction

Autonomous vehicles (AVs) are a rapidly evolving technology which only a few years ago was still considered science fiction. The precise impact of AVs on individuals, communities and industries is, as yet, unclear, but as the technology is tested and refined, demand for AVs is certain to grow, particularly among the young. According to 2017 Deloitte study [Deloitte Global Automotive Consumer Study 2017] young consumers representing Y and Z generations are generally more interested in fully autonomous vehicles and more inclined to use them in future, while elder generations remain sceptical about self-driving cars. Taking also into consideration the fact the young consumers are the most numerous generations with the increasing purchasing power, their choices will strongly influence the automotive industry determining the future success or failure of autonomous vehicles.

J. Mikulski (Ed.): TST 2018, CCIS 897, pp. 41–54, 2018.
https://doi.org/10.1007/978-3-319-97955-7_3

Attitudes of young consumers representing Y and Z Generations toward autonomous vehicles are the subject matter of interest in the paper. Self-driven cars as an emerging transportation means, mostly preferred by young consumer were described and generations Y and Z were characterized on the basis on literature studies. The theoretical deliberation was supplemented by empirical direct quantitative research conducted in January and February 2018 on a group of 152 respondents of Y and Z Generations. The objectives of the study focussed on understanding factors influencing consumers' aptitude for fully autonomous vehicles. The study also sought to assess the respondents' innovativeness (i.e. the predilection for purchasing novelties appearing in the market) and the level of their confidence in autonomous vehicles. Conclusions were drawn and future research areas were identified.

2 Autonomous Vehicles as a New Mode of Transportation

Innovations in connectivity, mobile phones, apps, and smart card technology are changing the automotive industry. Moreover, automotive consumers will expect car manufacturers or service providers to adjust and integrate technology with their connected lifestyles—both inside and outside the vehicle [1].

Meanwhile automotive companies have been working on the implementation of innovative technologies and vehicle concepts that have the potential to transform the automobile (and more broadly transportation) sector. What we may observe now is the so-called "connected car"—a fully digitized vehicle with Wi-Fi, advanced infotainment systems and apps, vehicle-to-vehicle communications that let cars on the road "talk" to each other, exchanging basic safety data such as speed and position, real-time location services and routing based on traffic conditions, and networked Web links that facilitate vehicle diagnostics and repairs [2].

The "intelligent car" has become a reality. There are four levels (types) of autonomous (driverless) vehicles, i.e.:

- Level 1 - Basic: allows the vehicle to assist the driver by performing specific tasks like anti-lock braking (prevent from skidding) and/or traction control (to prevent loss of grip with the road);
- Level 2 - Advanced: combines at least two functions such as adaptive cruise control and lane centring technology in unison to relieve the driver of control of those functions;
- Level 3 - Limited self-driving: allows the vehicle to take over all driving functions under certain traffic and environmental conditions. If conditions changed, the vehicle would recognize this and the driver would then be expected to be available to take back control of the vehicle;
- Level 4 - Full self-driving: allows the vehicle to take over all driving functions for an entire trip. The driver would simply need to provide an address and the vehicle would take over and require no other involvement from the driver [3].

Autonomous vehicles involve the application of intelligent automation. In general, automation is defined as technology that actively selects data, transforms information, and makes decisions or controls processes. The decision-making process employed in

the technology is based on inherent artificial intelligence (AI), hence the term "intelligent automation". Autonomous driving and autonomous vehicles are currently among the most intensively researched and publicly followed technologies in the transportation domain [4].

Literature studies allowed for identifying main advantages and disadvantages of autonomous vehicles. They are briefly presented in Fig. 1.

Fig. 1. Advantages and disadvantages of autonomous vehicles [5]

Researchers claim, that introducing autonomous vehicles may generate particular advantages, i.e.: AV technology can dramatically reduce the frequency of crashes - technologies that permit the car to be primarily responsible for driving (Level 4) will likely further reduce crash statistics because driver error is responsible for a large proportion of crashes. This is particularly true given that 29% of the crash fatalities in European Union in 2015 involved alcohol use by one of the drivers [6].

Sensory technology could potentially perceive the environment better than human senses, seeing farther ahead, better in poor visibility, detecting smaller and more subtle obstacles, more reasons for less traffic accidents.

AV technology may have different effects on land use in the developing world - AV technology may permit countries to skip some aspects of conventional, human-driver cantered travel infrastructure, like parking space. Parking the vehicle and difficult maneuvering would be less stressful and require no special skills. The car could even just drop the passenger off and then park itself.

AV technology will also increase mobility for those who are currently unable or unwilling to drive. Level 4 AV technology, when the vehicle does not require a human driver, would enable transportation for the disabled, or those too young to drive. The benefits for these groups would include independence, reduction in social isolation, and access to essential services.

Another identified advantage is that AV technology of Level 3 and 4 is likely to substantially reduce the cost of congestion, since occupants of vehicles could undertake

other activities. Since AV technology is likely to decrease the cost of congestion, it will also likely decrease the private cost of driving that a particular user incurs. Commute times could also be reduced drastically. Traffic could be coordinated more easily in urban areas to prevent long tailbacks at busy times.

The increase in mobility that AVs offer to the youngsters, elderly or disabled, AV technology may also have the contrary effect, i.e. increase in the negative externalities of driving, including congestion and an increase in overall fuel consumption. AV technologies may also disrupt existing institutions. By making proximate parking unnecessary, Level 4 AV technology may undermine the parking revenues that are an important and reliable source of funding to many cities. By providing a new level of mobility to some users, it may distract road users from public transit systems. Currently, one of the key attractions of public transit is riders' ability to undertake other tasks in transit. Autonomous vehicle technology may erode this comparative advantage. Further, many jobs could be lost once drivers become unnecessary, like taxi, truck, and bus drivers [7].

Before realizing the vision of fully autonomous vehicles, many technical and legal challenges remain to be solved [4]. In general, robotic systems, including AVs, use a "sense-plan-act" design. In order to sense the environment, AVs use a combination of sensors, including lidar (light detection and ranging), radar, cameras, ultrasonic, and infrared. A suite of sensors in combination can complement one another and make up for any weaknesses in any one kind of sensor.

While robotic systems are very good at collecting data about the environment, making sense of that data remains probably the hardest part of developing an ultra-reliable AV. For localization, the vehicles can use a combination of the Global Positioning System (GPS) and inertial navigation systems (INS).

Challenges remain here, as well, because these systems can be somewhat inaccurate in certain conditions. In order to permit autonomous operation without an alert backup driver at the ready, the technology will need to degrade gracefully, in such a way that a catastrophe is avoided. For example, if some element of the system fails in the middle of busy traffic, there must be a sufficiently robust back-up system so that even with the failure, the vehicle can manoeuvre to a safe stop. Developing this level of reliability is challenging. The role of vehicle to vehicle (V2V) and vehicle to infrastructure (V2I) communication in enabling AV operation also remains unclear. While this technology could ease the task of automated driving in many circumstances, it is not clear that it is necessary. Moreover, V2I might require substantial infrastructure investments—for example, if every traffic signal must be equipped with a radio for communicating with cars [7].

The main question remains uncertain – will consumers place their trust in the new technology? Recent findings from the 2018 Deloitte Global Automotive Consumer Study suggest that consumers may be worming to the concept of fully self-driven vehicles. Percentage of customers who think fully autonomous vehicles will not be safe is visibly decreasing (see Fig. 2).

Research shows an increasing customers' aptitude for advanced vehicle technologies. First, interest in various levels of autonomous vehicle technology varies across global markets. Consumers in Mexico, Brazil and China appear most sanguine – probably due to high number of accidents and road fatalities caused by human error.

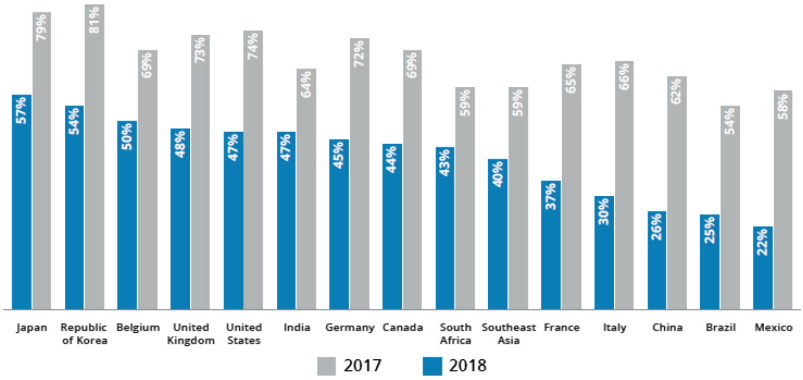

Fig. 2. Percentage of consumers who thing fully autonomous vehicles will not be safe (2017 vs. 2018) [8]

The differentiation of attitudes toward self-driven vehicles depends not only on geographical location (the country of origin) but on the consumers' age as well (see Fig. 3).

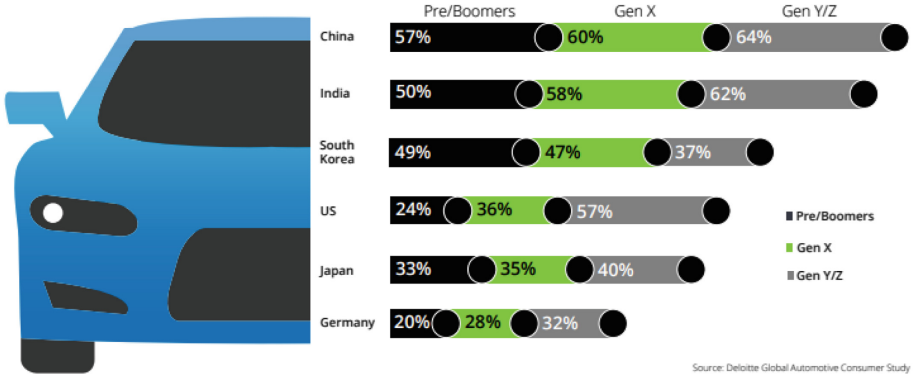

Fig. 3. Consumer interest in fully autonomous vehicles, by generation [8]

Young consumers representing Generations Y and Z are generally more interested in fully autonomous vehicles (64% of youngsters from China, 62% youngsters from India and 57% from US), but despite this, they have concerns with safety [9].

3 Young Consumers as an Emerging Market Segment

Young consumers constitute an important part of the contemporary society. The meaningful role they play dates from the mid of the XX century, when first in the USA, then in Europe and other parts of the world, young consumers' market segment was identified and appreciated.

The term "young consumer" is ambiguous and equivocal of nature, defined and described in literature in many ways. Olejniczuk-Merta [10] identifies young consumers as children and youngsters by the age of 19, clinging in the social and legal aspect. It may be observed, that this group is highly heterogeneous internally and consist of:

- children by the age of 11, mainly dependent on parents or legal guardians but influencing their purchasing decisions to various extent, developing personal preferences towards products and brands,
- teenagers at the age 12–14, more independent in the decision-making process, following market opinion leaders,
- youngsters at the age of 15 and more, quite independent buyers [10].

Fan and Xiao describe young consumers as a segment of youngsters at the age of 15–25, having own market preferences, and strongly influencing purchasing decision of other. They also introduce a sub-segment of young consumers, called "young-adult", at the age of 18–25, having the capacity to act in law, open to innovations [11].

Contemporary young consumers may be described by generations. There are two generations relating to young customers, i.e. Generation Y and Generation Z.

Generation Y covers people born between the 1980's and the year 1995. This generation has been shaped by the technological revolution that occurred throughout their youth. Generation Y grew up with technology, so they are proficient with the latest technology and gadgets such as iPhones, laptops and tablets. They are often referred to as "Millenials" or "Millennium generation", "next generation", "digital generation" and the "generation of flip-flops and iPods". They have "tamed" technological innovations and actively apply digital media and digital technologies; they are considered to be audacious generation that is open to new challenges [9].

Generation Z customers were born in 1995 or later [12] and are highly educated, technologically savvy, innovative and creative [13]. It is the first generation born into a digital world that lives online and virtually integrates and engages with its favourite brands [14]. Generation Z are heavy users of technology and they see it as an instrument for them [15]. Generation Z is a challenge, since it appears that they behave differently to earlier generations and this behaviour can lead to changes in consumer behaviour [16]. Wood asserts that four trends are likely to characterize Generation Z as consumers:

(1) An interest in new technologies,
(2) An insistence on ease of use,
(3) A desire to feel safe,
(4) A desire to temporarily escape the realities they face.

They have experienced a lot in their brief lifetimes and have encountered political, social, technological and economic changes [17]. Consumers are less loyal to retailers and they expect retailers to get the product to them, as a consequence retailers feel pressure to find new ways to grab and hold consumers' attention. They have higher expectations, no brand loyalty and care more about the experience [13].

As autonomous vehicles are still within the product development process, the present young consumers of Generations Y and Z are likely to be the target group for

the self-driven cars. Their attitudes toward AV will determine the future of mobility, resulting in AVs' success or failure.

4 Young Consumers' Attitudes Toward Autonomous Vehicle – Direct Research Findings

To explore the young consumers' attitudes toward autonomous vehicles, a direct quantitative research was conducted in January 2018. The method used in the study was a survey among 159 young inhabitants of the Silesian region as subjects of the research (representing Generations Y and Z). The number of participants was then reduced to 152, i.e. these respondents who declared they were familiar with the term "an autonomous vehicle" or "a self-driven car". Table 1. illustrates the sample characteristics.

Table 1. Sample characteristics (N = 152) [own study]

Categories	Total sample (%)
1. Gender	
a. Male	57.1
b. Female	42.9
2. Age	
a. 17–18 years	38.2
b. 19–22 years	42.1
c. 23–25 years	19.7
3. Material status in comparison to other people at the same age	
a. Definitely better	8.6
b. Rather better	39.5
c. Neither better nor worse	46.6
d. Rather worse	5.3
e. Definitely worse	0

The study was conducted on a small and unrepresentative sample and thus does not allow for drawing any general conclusions. However, the research in question made it possible to become familiar with the young customers' opinions and attitudes toward autonomous vehicles as a form of future transportation mode. The study also sought to assess the advanced vehicle technology features determining the young customer's aptitude for autonomous vehicles.

Respondents were asked to declare which opinions about self-driven cars they agree with. All survey participants expressed an opinion that self-driven cars "will have the overall capacities to get them where they need to go", according to 85.6% autonomous vehicles "will have the features to get them where they need to go" and for three quarters of them (76.9%) self-driven cars will provide save and fast journeys".

Simultaneously, respondents do have concerns that autonomous vehicles may solve the road accidents problems, will provide error-free ride. The answers of the respondents are presented in Fig. 4.

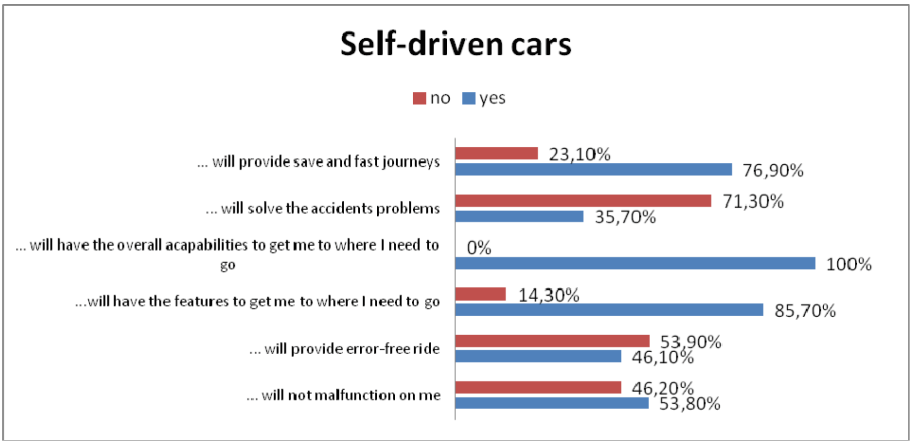

Fig. 4. Respondents' opinions about self-driven cars [own study]

Respondents were asked about their intention to use self-driven cars in future. 10% of young customers declare using autonomous vehicles as soon as they appear in the market and 53% may use them when they became popular. 30% seems to be sceptical, being on the opinion that self-driven cars may not be most preferred but respondents may eventually like the idea. Only 2% of respondents declare they have no intention of using autonomous vehicles in future. The discussed answers are presented in Fig. 5.

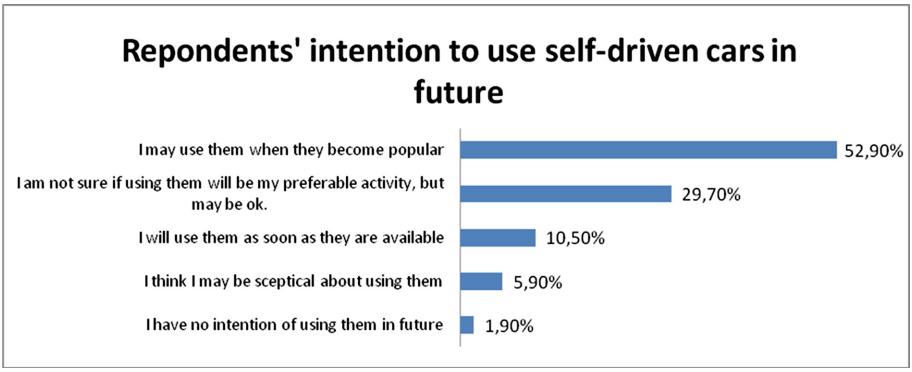

Fig. 5. Respondents' declared intention to use self-driven cars in future [own study]

The autonomous vehicles are perceived as innovative, high-tech products. The intention of purchasing and using them may be correlated with customer's innovativeness. To investigate the interdependence between the intention to use self-driven cars and customers' innovativeness, the study participants were asked to declare to what extend they may agree with several statements revealing their strive for novelties. Their opinions are presented in the form of semantic profile in Fig. 6 as a weighted average.

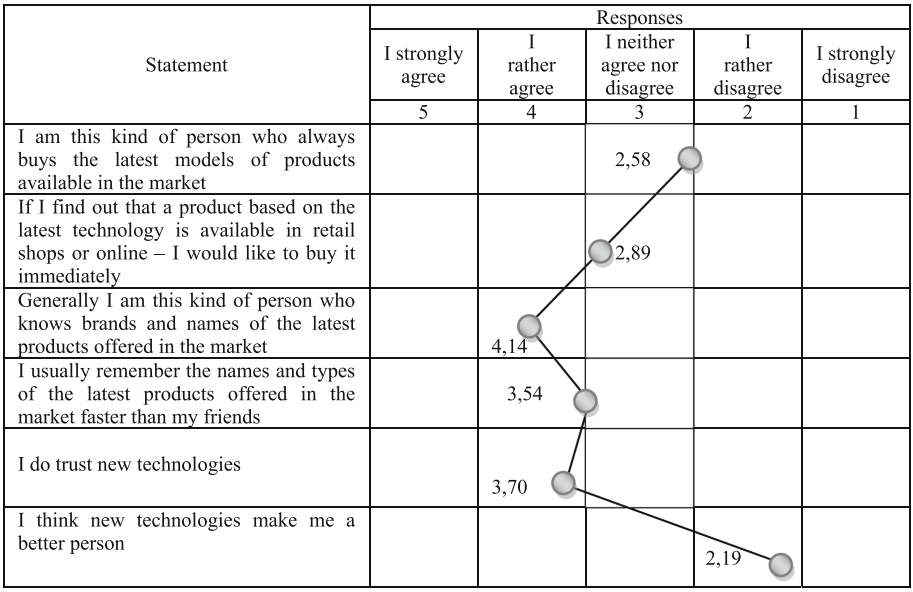

Fig. 6. Semantic profile presenting respondents' declared opinions on novelties [own study]

According to the results obtained in the survey, respondents declare to be rather familiar with the novelties appearing in the market ("*Generally I am this kind of person who knows the brands and names of the latest products offered in the market*") sooner than their friends ("*I usually remember the names and types of the latest products offered in the market faster than my friends*"). The study participants rather put their faith in novelties ("*I trust new technologies*"). Asked if they are eager to buy immediately the latest models of products available in the market, respondents present differentiated opinions. 16.7% of respondents declare they rather agree with the statement *"I am this kind of person who always buys the latest models of products available in the market*" while 50% disagree (25% *rather disagree* and 25% *strongly dissagree*). The weighted average of responses formed on the level of 2.58 (where *strongly agree* is ranked 5 points and *strongly disagree* – 1 point). Further differentiation may be noticed in customers opinions toward a statement: "*If I find out that a product based on the latest technology is available in retail shops or online – I would like to buy it immediately*" – 15.8% of respondents declare they agree with this

statement (7.9% - *strongly agree* and also 7.9% - *rather agree*), over a half of the study participants (53.8%) *rather disagree* and 30.3% cannot make up their minds.

Comparing the respondents' strive for novelties and the intention to buy high-tech, innovative self-driven car, we may notice a concurrence – they do declare to be innovative to a moderate degree as well as they present cautious apptitude to use them in future (as presented in Fig. 5).

Respondents were also enquired about their attitudes toward computers and robots. Their opinions are presented in the form of semantic profile in Fig. 7 as a weighted average.

Statement	Responses				
	I strongly agree	I rather agree	I neither agree nor disagree	I rather disagree	I strongly disagree
	5	4	3	2	1
Computers (robots) are responsible for many of the good things we enjoy	4.9				
The use of computers (robots) is enhancing our standard of living		4,31			
Life will be easier and faster with computers (robots)		4,22			
Computers (robots) are dehumanizing the society			3,44		
The overuse of computers (robots) may be harmful or damaging to humans		4,10			
People are becoming slaves to computer (robots)			3,18		
Soon our world will be completely run by computers (robots)			3,00		
Computers (robots) will assist people with the least preferred tasks		3,80			
Computers (robots) will never replace people	4,65				

Fig. 7. Semantic profile presenting respondents' declared opinions on computers (robots) [own study]

Generally, survey participants agree (*strongly agree* or *rather agree*) that computers (robots) are responsible for many of the good things they enjoy, the use of computers is enhancing their standard of living, life will be easier with computers, because robots may assist people with the least preferred tasks. Simultaneously robots will never replace people, and the overuse of computers (robots) may be harmful or damaging to humans. The presented opinions clearly reveal their positive but not exaggerated attitudes toward robots.

Respondents were also asked to indicate the technology features they found useful in a tech-advanced car. Their opinions are presented in Fig. 8. It was a multiple choice question, so the answers do not sum up to 100%.

Among the most useful technology features of tech-advanced cars respondents pointed at informing driver of dangerous driving situation (indicated by 80% of survey participants), taking steps in medical emergency or accident (70%) and recognizing objects on road to avoid collision (also indicated by 70% of respondents).

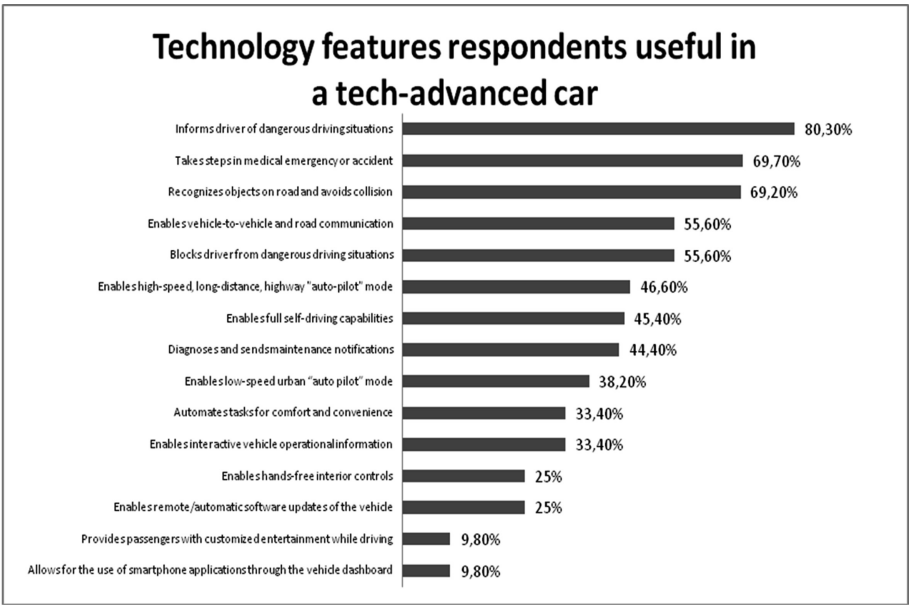

Fig. 8. Graphical presentation of respondents opinion on technology features perceived useful in a tech-advanced car [own study]

A half of the young customers participating in the survey (55.6%) find bloking driver from dangerous situation and vehicle-to-vehicle road communication as important features of tech-advanced cars.

The least necessary features in the respondents opinions were: hand-free interior control, remote software updates (indicated by 25% of the study participants), customised entertainment while driving and the use of smartphone applications through the vehicle dashboard (indicated by 10% of respondents).

Generally, all the technology features indicated in Fig. 5 and evaluated by the respondents may be grouped into 4 categories, i.e.: safety (S), connectivity (CT), automatisation (AUT) and convenience (CONV). The detailed assignment of features to one of the above-mentioned categories is presented in Table 2.

The perceived usefulness and importance of the appointed categories is presented in Fig. 9.

As presented in Fig. 9, the study participants perceive safety as the most useful and desired features category (indicated by 64% of respondents). Up till now autonomous vehicles are not thought to be safe means of transportation, which may explain the lack of enthusiasm of young customers toward self-driven cars.

The second ranked category was car automatisation (indicated by 41% of), then followed by connectivity (30%) and convenience (23%). It may ba assumed that comfort and convenience provided by autonomous vehicles are not that important comparing with the secure journeys.

Table 2. Technology features perceived useful in a tech-advanced car by categories [own study]

Category	Technology features
1. Safety (S)	1.1. Informs driver of dangerous driving situations 1.2. Takes steps in medical emergency or accident 1.3. Recognizes objects on road and avoids collision 1.4. Blocks driver from dangerous driving situations 1.5. Diagnoses and sends maintenance notifications
2. Connectivity (CT)	2.1. Enables vehicle-to-vehicle and road communication 2.2. Enables remote/automatic software updates of the vehicle 2.3. Allows for the use of smartphone applications through the vehicle dashboard
3. Automatisation (AUT)	3.1. Enables high-speed, long-distance, highway "auto-pilot" mode 3.2. Enables full self-driving capabilities 3.3. Enables low-speed urban "auto pilot" mode 3.4. Automates tasks for comfort and convenience
4. Convenience (CON)	4.1. Enables interactive vehicle operational information 4.2. Enables hands-free interior controls 4.3. Provides passengers with customized entertainment while driving

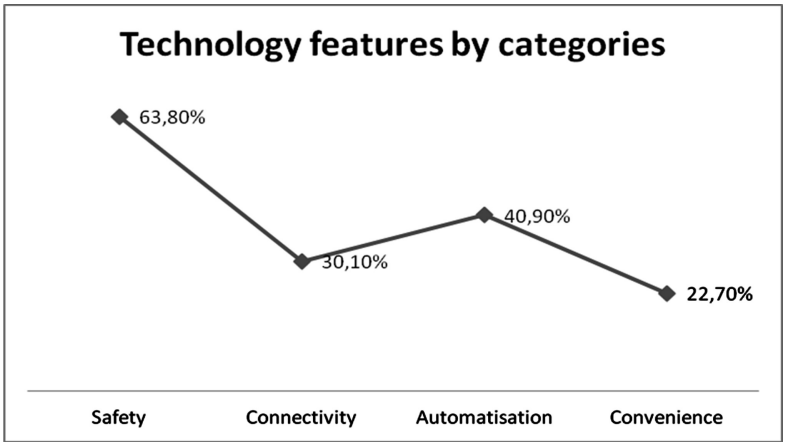

Fig. 9. Technology features by categories [own study]

5 Conclusion

Autonomous cars are technology-advanced vehicles which gain interest and trust worldwide. According to experts on automotive industry, self-driven cars may provide a wide range of challenges and advantages, having a significant impact on future transportation modes. Driverless cars will force changes in the existing infrastructure and urban planning system may reduce consumers' privacy and generate high cost (i.e. prices, as advanced high-tech goods are expensive). Legal issues need to be solved and the legislation procedures will take time.

Simultaneously, autonomous cars are supposed to reduce the frequency of car crashes, increase mobility of those who are unable or unwilling to drive, reduce cost of congestions (including fuel savings and transport cost cuttings) and make traffic coordination more efficient. Other benefits refer to autonomous cars' users who will experience more comfortable rides.

The future success or failure of driverless vehicles mainly depends on customers' aptitude to use them. Studies show that customers' intention to use autonomous cars varies in terms of geographical location (country of origin) and age – young customers are more open-minded and technology-trusting than the elder ones.

Survey conducted on young customers representing Y and Z generations from Silesian region show that over 50% of respondents are willing to purchase and use autonomous vehicles after they have become popular. 10% of youngsters participating in the research declare to buy these vehicles as soon as they appear in the market, and only 2% is on the opinion they have no intention to use them. Young consumers perceive themselves as innovators aware of the latest novelties, but not necessarily purchasing them immediately when available in the market. Respondents present positive attitudes toward computers and robots, appreciate their impact on standard of living but also declare computers or robots will never replace people. Asked about the most useful technology features of autonomous vehicles, respondents points at informing driver of dangerous driving situation (indicated by 80% of survey participants), taking steps in medical emergency or accident (70%) and recognizing objects on road to avoid collision (also indicated by 70% of respondents). The above-mentioned features stand for "safety" category. It clearly indicates that the dominant factor determining customers' aptitude to use self-driven cars is safety.

The conducted research enabled to indentify young customers' attitudes toward self-driving cars and understand factors influencing consumers' aptitude for these vehicles. The study was conducted on a small and unrepresentative sample and thus does not allow for drawing any general conclusions, which makes a limitation of the study and indicates the potential for further research on customers' attitudes toward autonomous vehicles.

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