

# ANALYSIS OF THE IMPACT OF THE TECHNICAL CONDITION OF VEHICLES ON ROAD SAFETY

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## Abstract

Every year too many people lose their lives and health on Polish roads. At best, it only ends with damage to their cars. The number of accidents is very high. Despite the construction of new, safer roads, the number of collisions continues to rise, and death, every year, is suffered by about three thousand accident participants. On average, forty-one thousand people are injured annually. The main causes of accidents are failure to adjust speed to prevailing conditions or traffic regulations, driving under the influence of alcohol and random events, as well as the technical condition of the vehicles.

The purpose of the article is to answer the question of how the technical condition of the vehicles affects traffic safety. For this reason, an assessment of the technical condition of vehicles during a periodic examination at a vehicle inspection station was made. Based on the study, it can be concluded that the largest percentage of defects detected during the examination is in the tire 40% and steering 40%, defects that are particularly important from the point of view of traffic safety, which were demonstrated during the examination.

**Keywords:** vehicle technical inspection; traffic safety; vehicles; road transport

## 1. Introduction

Every year too many people lose their lives and health on Polish roads. In the best case scenario, it ends only with damage to the car. The number of accidents is very high. Despite the construction of new, safer roads, the number of collisions is steadily increasing, and death, each year, is suffered by about three thousand accident participants. On average, 41,000 people are injured each year. The main causes of accidents are failure to adjust speed to prevailing conditions or traffic regulations, driving under the influence of alcohol and random events.

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Safety is a basic human need. When asked about the most important values, most people mention: work, respect, health, feelings, intangible and material goods, and, above all, life. This translates into the fact that security for humans is the natural and most important need in life. None of us would like to live with a sense of insecurity. When we get into a car, we check its technical condition because we want to make sure everything is in order. Before going to bed, we check that we are sure the front door to the house has been properly locked, and before going on vacation, we make sure everything has been properly secured. This shows how we make sure we have a high level of security at every step and don't want anything bad to happen to us. Lack of security creates a sense of danger, anxiety and panic in man and social groups, which brings many difficulties. To avoid this, human beings, social groups, institutions and international systems act and must act to ensure the highest possible level of security in order to completely eliminate, or at least push back threats as far and as effectively as possible [5].

The European area is governed by the provisions of the United Nations Economic Commission for Europe (ECE), under which a group of experts develops detailed rules called regulations. They are annexed to the agreement on the adoption of uniform conditions for the approval and mutual recognition of the approval of vehicle equipment and parts. The ECE regulations describe the technical requirements that vehicle equipment and parts should meet and specify, among other things, methods for vehicle approval testing.

In order to assess the safety of human performance, the human-technical-environmental system is analyzed. However, in the analysis of issues that concern safety, it can be narrowed down to a system analysis (Figure 1).

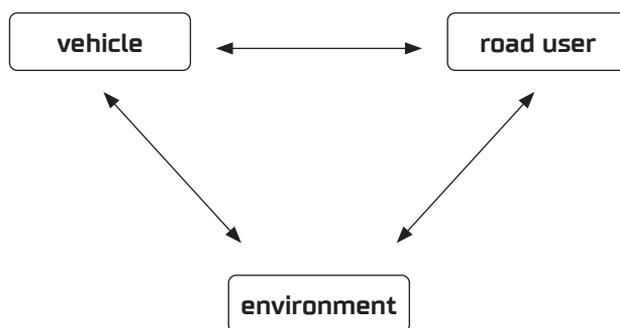


Fig. 1. V-R-E system [6]

“Traffic participant” is any user of the road, and therefore the user of a car, motorcycles. Elements of the V-R-E system are present in most of the conducted analyses related to traffic safety issues. Assessing the level of traffic safety is not an easy task. The level depends on:

- drivers' skills,
- the design of the car,
- the infrastructure necessary for road traffic.

Safe driving on the road is compliance with a number of established rules and principles therefore we should not disregard them. Improving road safety is influenced by a number of elements related not only to promoting appropriate behavior among drivers, but also proper organization of traffic, proper technical condition of roads and vehicles. Training and examinations for future drivers are also important. Road traffic safety is also a scientific field that includes not only the above-mentioned aspects, but also issues related to traffic supervision, emergency medical services or transport psychology [8]. The problem of operating transportation equipment related to its safety has been addressed in other publications from different angles. For example, the paper [3] analyzed parking brakes.

In the literature, three-wheeled vehicles have also been analyzed for safety [2] and headlights have been studied [12]. Quantification of Road Vehicle Performance Parameters under Laboratory Conditions. Analyzed in [9] a Facility for performance testing of power transmission units [4]. Road accident severity is an attribute used to determine the severity of traffic collisions. Predicting accident severity is important for relevant authorities to develop road safety policies to prevent accidents and reduce injuries [10, 11], fatalities and property damage [1, 13–14].

## 2. Analysis of traffic incidents

The analysis of the causes of road accidents in Poland covers the years 2001–2020. During this period, there were 819,002 accidents in which 1,016,219 people were injured and 84,289 people were killed (Figure 2). Over the past 19 years, the highest number of incidents was recorded in 2001. Over time, the number of accidents decreased, but the downward trend was interrupted by incidents in 2007 and 2008, where a significant increase can be seen. Years such as 2002, 2004 and 2011 are characterized by a slight increase in the number of accidents, which does not change the overall trend.

In 2020, the fewest traffic accidents occurred since 1975, when accident statistics were kept. This is the result of the SARS-CoV-2 pandemic, during which preventive measures in the form of traffic restrictions were applied. Compared to 2019, there was a decrease of as much as 22.3% (Figure 2).

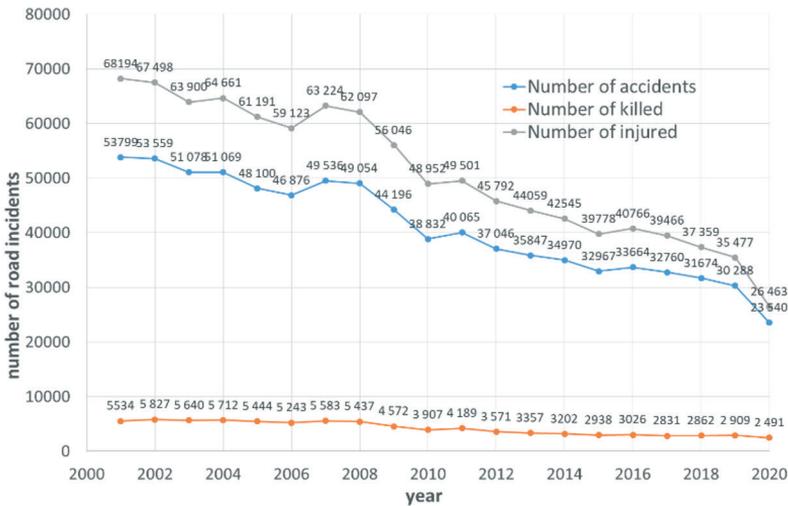


Fig. 2. Trend of accidents, injuries and fatalities from 2001 to 2020 [7]

The most common cause of traffic accidents is improper human action. Man and his behavior is the most significant factor in traffic safety between 2001 and 2020, there were 668,474 accidents caused by drivers, accounting for as much as 81.6% of all accidents (Figure 3).

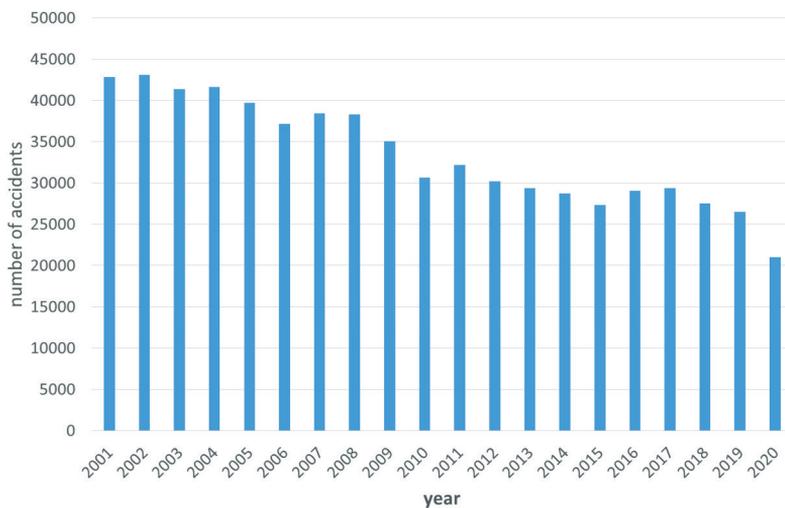


Fig. 3 Road accidents caused by vehicle drivers between 2001 and 2020 [7]

Accidents due to the driver's fault occur (Figure 4), as the most common is:

- failure to adjust speed to traffic conditions (22.7%),
- failure to respect the priority of passing (20.6%),
- improper overtaking (5.1%),
- improper behavior toward a pedestrian (9.7%),
- driving on the wrong side of the road (1.7%),
- failing to maintain a safe distance between vehicles (5.2%).



**Fig. 4. Sum of the most common causes of accidents due to the driver's fault from 2001 to 2020 [7]**

The second group that causes the most accidents on the roads are pedestrians, who caused 98,728 accidents between 2001 and 2020. This represents 12.1% of the total number of road accidents in the period under review (Figure 5). The most common cause of accidents due to pedestrians is (Figure 6):

- careless entry onto the roadway (50.9%),
- entering the roadway from behind an obstacle (10.8%),
- crossing the roadway in an unauthorized place (10.0%),
- entering the roadway at a red light (7.7%).

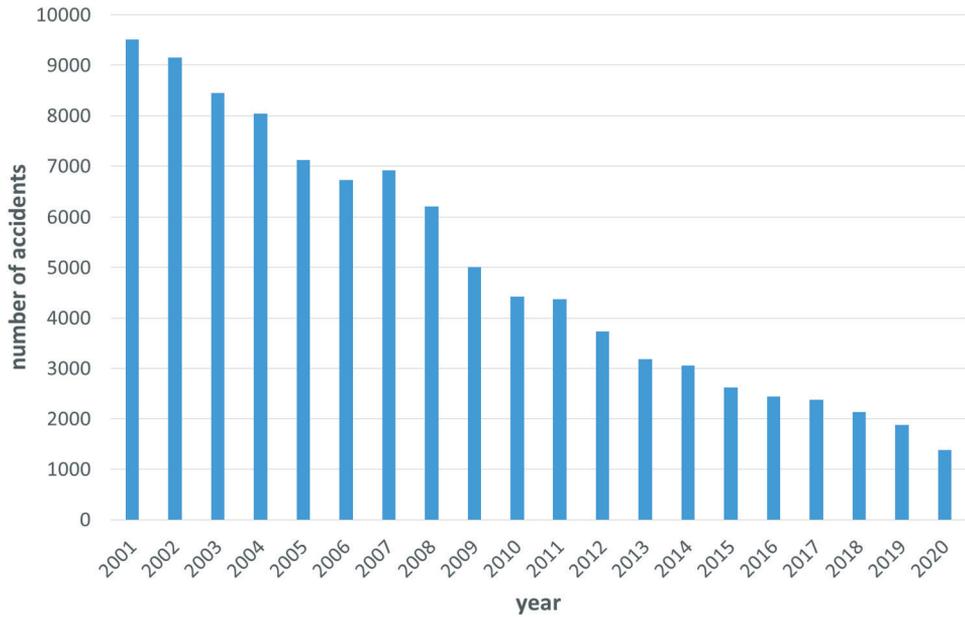


Fig. 5. Number of road accidents caused by pedestrians from 2001 to 2020 [7]

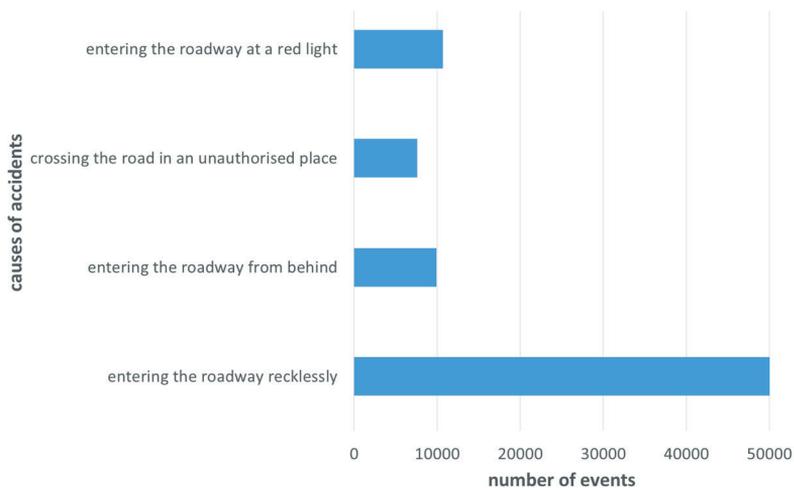
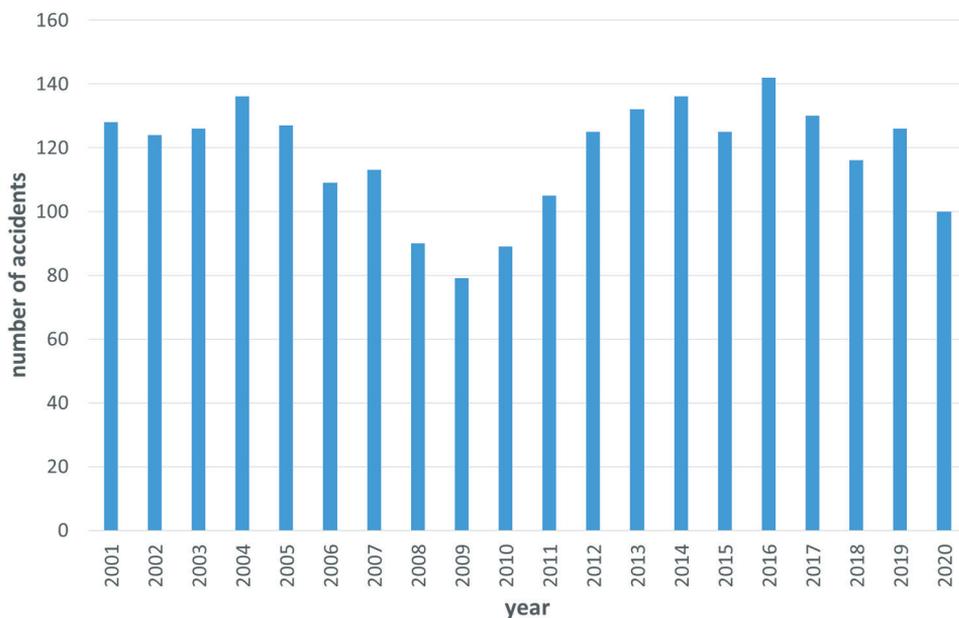


Fig. 6. Sum of the most common causes of accidents due to pedestrians from 2001 to 2020 [7]

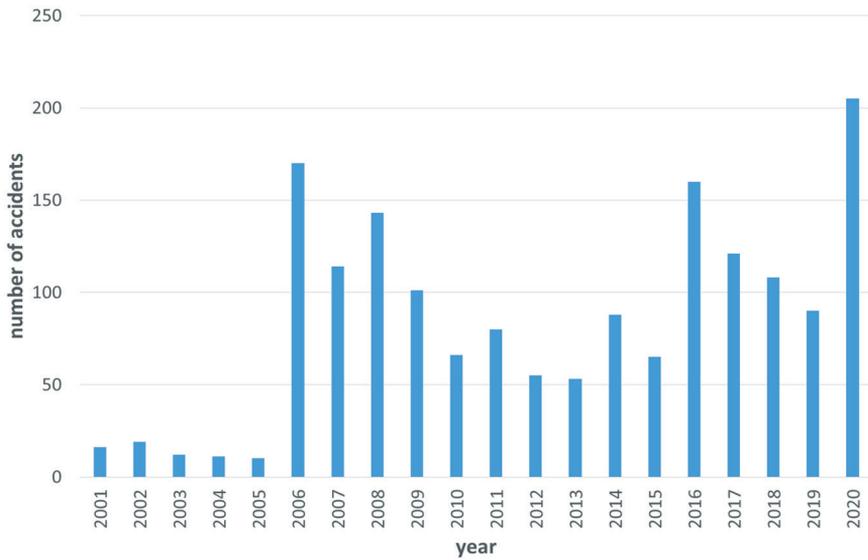
The group that contributes least to causing accidents are passengers. In the last 19 years, 2358 accidents occurred due to their fault. These incidents account for 0.29% of all accidents, so their percentage is very small. Such accidents can occur as a result of falling out of the vehicle or jumping out of it (Figure 7).



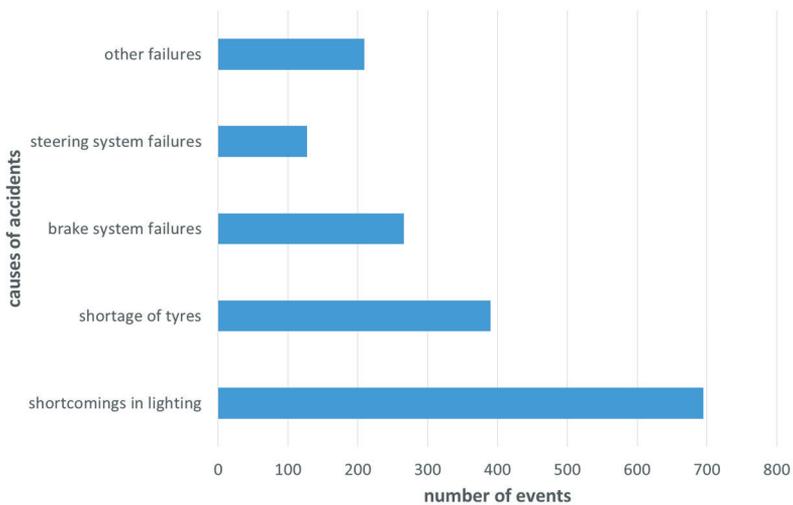
**Fig. 7. Number of road accidents caused by passengers from 2001 to 2020 [7]**

Another cause of traffic accidents is technical malfunction of the vehicle. It is most often caused by (Figures 8–9):

- deficiencies in lighting [41.2%],
- deficiencies in tires [23.1%],
- defects in the braking system [15.8%],
- steering system defects [7.5%],
- other defects [12.4%].



**Fig. 8. Number of traffic accidents due to vehicle malfunctions from 2001 to 2020 [7]**



**Fig. 9. Sum of the most common causes of traffic accidents due to vehicle technical failure from 2001 to 2020 [7]**

Accidents caused by vehicle malfunctions qualify as “vehicle” traffic safety factors. They account for less than 0.5% of all accidents and are easily preventable. The most common causes of these accidents are deficiencies in lighting and tires. Such causes can be easily eliminated by at least applying daily vehicle maintenance or seasonal maintenance. A daily inspection is performed before each trip, which allows you to organoleptically verify the overall condition of the vehicle, including the condition of the lighting, the condition of the operating fluids, tires, the operation of the windshield wipers or the braking system. In addition to a lack of lighting, a vehicle can pose a danger on the road through misaligned lamps and the use of inappropriate bulbs. The condition of tires should also be checked during each seasonal service that prepares the vehicle for further use, and tires should be replaced with summer or winter tires depending on the season. Driving a vehicle with worn tire tread, as well as visible defects [hardening and evaporation of tires] poses a risk to road safety.

A smaller percentage of accidents were caused by brake or steering system failure. Causes of brake system failure can include leaking lines, worn friction linings, worn brake drums and discs, leaking calipers or brake cylinders. In the steering system, the most common causes are: working out of ball joint components (wishbone ball stud), rubber-metal bushings in the control arms, excessive play in the tie rods or tie rod ends, leaks in the power steering gear (oil leaks). In power steering gears with electric power steering (electric motor), there is a failure of the steering gear end position sensors. Poor technical condition of the vehicle poses a great danger on the road, which is why regular inspections are so important, and if you notice alarming symptoms suggesting deterioration of the vehicle, you should immediately go to a car mechanic. Even seemingly trivial faults, combined with bad weather conditions, can lead to a traffic accident with serious consequences.

### 3. Results and discussion

The study was conducted between December 2020 and January 2021. The study consisted of analyzing periodic inspection data from vehicle inspection stations. It was conducted at the Authorized Toyota Dealer Station, owned by Tadeusz Ukleja. The tests were performed by an authorized diagnostician.

#### a. Purpose and scope of the tests

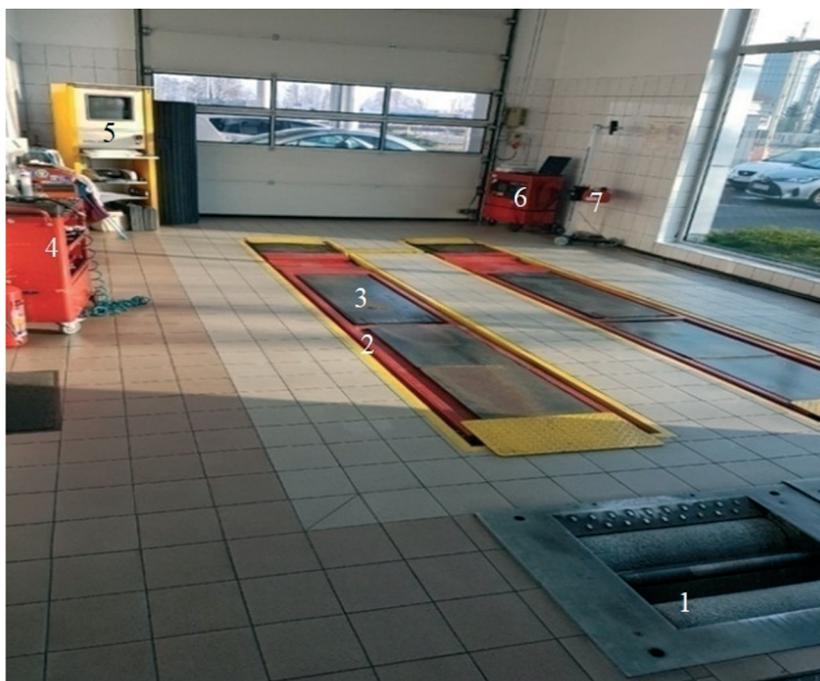
The purpose of the study was to assess the technical condition of vehicles at the Vehicle Inspection Station during periodic inspection. The results obtained can serve as a guideline for those responsible for safety in road transport and for the employees of the Vehicle Inspection Station. A total of 136 vehicles were tested between December 6, 2020 and January 15, 2021.

## b. Subject of the study

The subject of the study was the vehicles of vehicle inspection station (VIS) customers who went for a periodic technical examination. Most of the vehicles were Toyota brand due to the combination of the service of this brand with the inspection station, but the station was also visited by vehicles of other brands. Among those examined we also have unicycles, mopeds and motorcycles, hybrid cars, cars powered by conventional fuels, as well as those powered by liquefied petroleum gas (LPG). Of the vehicles surveyed, 59% were gasoline-powered and 36% were diesel-powered. The largest group consisted of vehicles with mileage of up to 50,000 kilometers, mostly these were vehicles purchased at a neighboring dealership, this is due to the fact that the VIS is owned by an authorized Toyota dealership. Most of the vehicles surveyed were between 5-10 years old and had the EURO 4 exhaust gas standard.

## c. Test site

The test stand was an VIS at the TOYOTA dealership and service center in 64-850 Ujście at 45 Pila St (Figure 10).



**Fig. 10. Inside view of the VIS: 1 - roller device for checking the operation of brakes, 2 - scissor lift, 3 - automotive diagnostic trolley, 4 - tool cabinet, 5 - diagnostic line control unit, 6 - smoke meter, 7 - device for checking the lights of motor vehicles**

#### **d. Test Methodology**

The tests were conducted in accordance with the current regulations for conducting technical tests. According to the new regulations, a person who wants to perform a technical examination first pays a fee for the technical examination, and then the diagnostician performs a number of control activities mentioned earlier in the article.

The technical inspection station uses a state program such as Central Register of Vehicles and Drivers (CEPiK), and it is into this program that the diagnostician enters the basic identification data of the vehicle after the customer has paid the appropriate amount for the examination. The time allotted for the examination of a vehicle is about 40 minutes and in practice ends after about 30 minutes. The diagnostician, after performing the test on the diagnostic line and with the help of all other possible devices that are on the equipment of the diagnostic station and examining organoleptically the results obtained and possible defects, enters into the system and determines the result of the test as negative or positive, to the database also enters information about the number of kilometers driven by the tested vehicle.

The diagnostician examining the vehicle on the DiTec Line 30-2 diagnostic line, which is located at the Toyota VIS in Ujście, after each test the customer prints the effect of the vehicle test with the obtained parameters, on the next page there is a printout of such test.

#### **e. Discussion**

Based on the survey, defects were found in: 40% of the steering system, 40% of the tires and in 20% of the electrical system. Out of a group of 136 vehicles, only 4 came out of the test with a negative result, which is about 3%. 43% of the vehicles surveyed were in the 5–10 year range, while 36% were in the 10–20 year range. 23% of the cars surveyed had mileage up to 50,000 km, 21% up to 100,000 km. According to statistics [7] and the number of negative 5% nationwide of all results, this result can be considered authoritative and goes some way to showing how many defects are detected in vehicles.

It is particularly important to take care of the condition of the vehicle's tires, since the tire is the only component in contact with the ground it is worth taking care of good tires and verify that the tire has not been damaged during operation, such visual inspection should be carried out by the operator, in the case of the steering system, visual inspection of the steering gear and own observation of the operation of the system, evaluation of clearances in the steering system.

### **4. Conclusion**

It probably doesn't take long to convince anyone these days about the importance of road safety issues. Therefore, it is necessary to build safe cars and observe proper operation while using the vehicle. It is possible to see the changes in a relatively short period of time how

the design of vehicles is developing, and especially how quickly the systems responsible for improving road safety have developed recently. However, vehicles on Polish roads are statistically more than 14 years old, so it is impossible not to find technical faults in such a vehicle. Interestingly, however, other police statistics show that the cause of road accidents in the context of poor technical condition of vehicles is only 2% of all accidents, the main cause that appears in the reports is excessive speed. Diagnostic tests at VIS are aimed at cyclic verification of cars in terms of their technical condition and systems responsible for safety, elimination of cars that do not meet the technical conditions contained in the regulations applicable to be observed by diagnostic stations. Based on the results of the technical survey and analysis of the literature and legislation on VISs, conclusions can be made:

- The statistics show that technical malfunctions in the tested vehicles represent a small percentage, detection at the level of 5% of the negative results issued, during the test we get the result of about 3% of negative results, taking into account the fact that vehicles on Polish roads are at least several years old, it follows that diagnosticians either do not do their job reliably and often faulty vehicles receive a positive test result, or the modern awareness of road safety makes vehicle owners properly service their vehicles, remove all defects on time, immediately after the occurrence.
- The analysis of the regulations shows that during the technical examination should be checked even such elements as seat belts, the ability to open windows in the car, etc. in practice, the examination does not proceed in such detail much depends on the experience and commitment of the diagnostician, who during the organoleptic evaluation by eye assesses many elements, only when something arouses his suspicions verifies the element more thoroughly. Each examination lasted about half an hour. This seems to be sufficient time to check the vehicle, but it largely depends on the knowledge and experience of the diagnostician performing the examination.
- Analyzing the literature and tracing the history of safety systems, it can be seen that in recent times a very large role is assigned to safety in vehicles already at the design stage. New vehicles provide a high level of safety for the driver and passengers, but in the context of technical examinations, as well as used vehicles, it is important for the driver to be knowledgeable about the systems the vehicle is equipped with, how they work, and be able to assess whether the systems are operational. However, it is important to remember that state-of-the-art safety systems are no substitute for common sense when driving and will not provide 100% protection during a collision or accident.
- Analyzing the historical regulations on the scope and manner of technical tests, it can be seen that the regulations on technical tests change often enough to keep up with the development of vehicle design and equipment of these vehicles, and the scope of these tests is constantly increasing.

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