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THE CHARACTERISTICS OF MOTOR VEHICLE TECHNICAL TESTS ON THE EXAMPLE OF SELECTED VEHICLE INSPECTION STATIONS

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Abstract

In recent years, Poland has seen a dynamic increase in the number of vehicles on the road. Vehicles participating in road traffic come from both the domestic market, some registered as new, and are imported from foreign markets. The latter are mainly imported from Western Europe and from the American market. Vehicles imported onto the domestic market are several years old and quite often considerably worn out. On the other hand, vehicles from the American market are relatively new and sometimes damaged as a result of road incidents. The aim of this work is to perform a comparative analysis of the results of vehicle technical tests. Research was conducted at two regional vehicle inspection stations over three consecutive years. As part of this analysis, questions about the number of successful and unsuccessful technical tests were answered by the test type. In addition, the number of vehicles using the services of the various stations was evaluated, and the number of vehicle technical tests was analysed by the energy supply of those vehicles. This was followed by the comparison of the test results with the nationwide data in the Central Register of Vehicles and Drivers. A decrease in the number of unsuccessful vehicle tests was noted. Moreover, a greater number of tests of electric vehicles has been noted recently, which may be advantageous to the environment in the future.

Keywords: vehicle diagnostics; vehicle technical tests, vehicle inspection stations; defects; vehicle condition verification

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1. Introduction

Vehicle diagnostics is performed during vehicle tests and its aim is to check the technical condition of the vehicle [1, 15]. Periodic technical inspection is designed and performed to ensure the safe use of the vehicle on public roads [16, 29] and eliminate vehicles causing excessive air pollution [3, 8]. At present, air pollution is the greatest hazard to health and the environment in Europe [20, 21], especially in urban areas [9, 25]. For the purposes of the inspection, diagnostic lines designed for the assessment of the technical condition of the steering, wheel, braking and suspension systems are used [7, 5]. Owing to new diagnostic technologies, there are many opportunities to diagnose the condition of various systems [6, 11, 28]. Control stands are equipped with new generation diagnostic devices, which enables precise survey technology, for example with regard to fume emissions [4], as well as braking and suspension system efficiency [22, 26, 27]. With the development of automotive industry and the appearance of autonomous vehicles, the number of electronic systems to be checked during a periodic test is growing [12]. Inspection and survey activities on a vehicle subject to a periodic test are conducted for each system separately [17, 31]. The final result of the technical condition assessment is affected by the technical condition of all the sub-assemblies making up the vehicle [14]. A four-level scale is used to assess the technical condition [23]. The first level of the assessment of the vehicle's technical condition is that no defects are found. All systems and mechanisms operate correctly. The second level in the vehicle assessment is finding minor defects ("UD"). The noted defects neither affect road traffic safety nor contribute to environmental pollution [13]. The vehicle successfully passes the periodic technical test. The minor defects are recorded in the Central Vehicle and Driver Register (CEPiK) and the vehicle owner is advised of the defects. The third criterion means the identified major defects ("UP)", which affect road traffic safety or environmental protection. Those defects result in the unsuccessful assessment of the tested vehicle. In such a case, an entry is made in the CEPiK register, and the defects are recorded. The owner hands the vehicle over to a specialised workshop for the necessary repairs. After the abnormalities have been rectified, before the lapse of 14 days, the owner presents the vehicle for rechecking from the point of view of the defects found during the periodic test. The repeated assessment of the vehicle's technical condition may be undertaken by the same inspection station, which found defects during the periodic test. Current laws do not force the diagnostician to pay attention to the technical condition of the components other than those examined before, which may have been damaged during 14 days. The fourth group on the scale is the dangerous defects ("UN"). Defects of that type directly jeopardise road traffic safety and order. In such a case, the registration certificate or its equivalent is seized. The document is handed over to the issuing authority. A relevant entry is made in the Central Vehicle and Driver Register, and the vehicle user is informed about the need to repair or phase out the vehicle. Moving around by that vehicle poses a hazard to both the vehicle user and other road traffic participants, or directly affects environmental pollution [30].

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2. Research methodology

Statistical data was analysed on the basis of two selected Regional Vehicle Inspection Stations (OSKP 1 and OSKP 2), which operate in the Nowy Sącz country in Poland.

The period of observations comprises years 2019–2022. In that period, the following number of vehicles were tested:

- year 2019 – 8,081 vehicles for OSKP 1 and 3,237 for OSKP 2,
- year 2020 – 8,494 vehicles for OSKP 1 and 3,323 for OSKP 2,
- year 2021 – 8,489 vehicles for OSKP 1 and 3,675 for OSKP 2,
- year 2022 – 8,523 vehicles for OSKP 1 and 3,794 for OSKP 2.

In this study, vehicle technical tests are divided in accordance with Article 81 of the Road Traffic Law Act of 20 June 1997 (Dz. U. [*Journal of Laws of the Republic of Poland*] of 2023, item 1047, as amended):

- the number of successful and unsuccessful vehicle technical tests by the test type:
  - technical tests consisting in defect re-checking,
  - tests for compliance with technical conditions,
  - additional tests,
  - periodic tests,
- the number of technical tests by the vehicle type:
  - cars,
  - goods vehicles/truck tractors,
  - goods trailers/semitrailers,
  - farm tractors,
  - buses,
  - other vehicles,
- the number of technical tests by the type of energy supply:
  - diesel oil,
  - petrol,
  - LPG,
  - electric.

The number of technical tests at the stations under analysis was also compared with data in the Central Vehicle and Driver Register (CEPiK) and with information obtained from Statistics Poland (GUS), with the breakdown assumed above retained.

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3. Statistical analysis of the results

This chapter presents the results of the statistical analysis of diagnostic tests in accordance with the categories described in the previous chapter.

3.1. The number of successful or unsuccessful vehicle technical tests

Tables 1–4 present the number of technical vehicle tests conducted in 2019–2022 in each of the regional vehicle inspection stations under analysis.

Tab. 1. Number of technical tests in 2019

Test type	Test result	Number of tests	
		OSKP 1	OSKP 2
technical tests consisting in defect rechecking	fail	6	3
	pass	226	167
tests for compliance with technical conditions	fail	0	0
	pass	2	0
additional tests	fail	11	3
	pass	239	122
periodic tests	fail	221	164
	pass	7376	2778

Tab. 2. Number of technical tests in 2020

Test type	Test result	Number of tests	
		OSKP 1	OSKP 2
technical tests consisting in defect rechecking	fail	16	1
	pass	295	109
tests for compliance with technical conditions	fail	0	1
	pass	3	1
additional tests	fail	8	3
	pass	229	198
periodic tests	fail	292	114
	pass	7651	2896

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Tab. 3. Number of technical tests in 2021

Test type	Test result	Number of tests	
		OSKP 1	OSKP 2
technical tests consisting in defect rechecking	fail	14	4
	pass	295	105
tests for compliance with technical conditions	fail	0	0
	pass	5	0
additional tests	fail	21	1
	pass	228	147
periodic tests	fail	297	101
	pass	7632	3317

Tab. 4. Number of technical tests in 2022

Test type	Test result	Number of tests	
		OSKP 1	OSKP 2
technical tests consisting in defect rechecking	fail	10	2
	pass	269	109
tests for compliance with technical conditions	fail	0	0
	pass	6	0
additional tests	fail	11	1
	pass	234	147
periodic tests	fail	267	111

Based on the data in the tables above, it follows that fewer vehicle technical tests were conducted at the OSKP 2 station irrespective of the year or test type. That situation is influenced by, first of all, the location. The station is located at a small town below 10,000 inhabitants. Moreover, there are other two vehicle inspection stations in the same location and the immediate surroundings.

Over the years under review, there has been an upward trend in the number of periodic tests. This situation is due to the fact that the inhabitants of the town in which station is located acquire more vehicles. It also follows from the tables that not all the periodic tests are successful. In the analysed period, the diagnosticians working at OSKP 1 failed a total of 1077 cars, which is approximately 10% of all periodic tests. The situation is similar at the OSKP 2 station. There, the diagnosticians failed a total of 490 cars, representing approximately 12% of all periodic tests. The reason for the unsuccessful assessment of the technical condition of vehicles may be that drivers take less care of their vehicles, which is caused by irregular service, the vehicle age and, therefore, significant wear and tear, which translates into higher failure rates. Corrosion spots are very often observed on the chassis of cars, and in the case of the suspension system, even traces of fretting wear [18, 19].

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Some of the vehicles failing the periodic test underwent a repair consisting in the remedying of the defects pointed out by the diagnosticians within the deadline set out in the law. The vehicles were then subjected to the technical test, this time yielding a positive result, while the remaining vehicles were most probably phased out from road traffic.

3.2. The number of vehicle technical tests by the vehicle type

Tables 5–8 summarise the number of vehicle technical tests by the vehicle type.

Tab. 5. The number of technical tests in 2019 by the vehicle type

Vehicle type	Number of tests	
	OSKP 1	OSKP 2
Cars	6128	2221
Goods vehicles/truck tractors	892	461
Goods trailers/semitrailers	183	149
Motorbikes/motorcycles	355	63
Farm tractors	324	48
Buses	19	102
Other vehicles	62	46

Tab. 6. The number of technical tests in 2020 by the vehicle type

Vehicle type	Number of tests	
	OSKP 1	OSKP 2
Cars	6173	2330
Goods vehicles/truck tractors	850	525
Goods trailers/semitrailers	112	152
Motorbikes/motorcycles	319	75
Farm tractors	309	57
Buses	17	60
Other vehicles	62	59

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Tab. 7. The number of technical tests in 2021 by the vehicle type

Vehicle type	Number of tests	
	OSKP 1	OSKP 2
Cars	6262	2589
Goods vehicles/truck tractors	835	475
Goods trailers/semitrailers	122	136
Motorbikes/motorcycles	288	97
Farm tractors	390	94
Buses	15	99
Other vehicles	74	66

Tab. 8. The number of technical tests in 2022 by the vehicle type

Vehicle type	Number of tests	
	OSKP 1	OSKP 2
Cars	6753	2869
Goods vehicles/truck tractors	842	538
Goods trailers/semitrailers	131	162
Motorbikes/motorcycles	321	142
Farm tractors	358	62
Buses	17	110
Other vehicles	101	89

Periodic car tests are most often conducted at the analysed vehicle inspection stations, which run controlled economic activity in vehicle technical tests. The second largest group are goods vehicles, trailers and semitrailers which are coupled with truck tractors thus making up a combination vehicle. Single-track vehicles, which have become a popular means of transport at short distances in recent years, take a significant share in the number of periodic tests at the stations under analysis. The advantages of motorbikes and motorcycles include easy travel on congested roads and a smaller problem with parking in town centres. At OSKP 1, many more periodic tests of farm tractors are conducted than at OSKP 2, and that situation is influenced by the station location. On the other hand, many more bus periodic tests are conducted at OSKP 2. The reason is that there are companies engaging in tourism-related activity in passenger transport in the neighbourhood. Other vehicles classified by the Road Traffic Law Act as "other motor vehicles" are colloquially called quads. These have an insignificant share among vehicles subjected to periodic tests at the stations under review.

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3.3. The number of technical tests of vehicles by their energy supply

Tables 9–12 summarise the number of vehicle technical tests by the vehicle energy source.

Tab. 9. The number of technical tests in 2019 by the type of energy supply

Type of vehicle energy supply	Test result	Number of tests	
		OSKP 1	OSKP 2
Diesel oil	pass	4646	1765
	fail	36	8
Petrol	pass	3137	1176
	fail	14	4
LPG	pass	633	285
	fail	1	0
Electric	pass	0	0
	fail	0	0

Tab. 10. The number of technical tests in 2020 by the type of energy supply

Type of vehicle energy supply	Test result	Number of tests	
		OSKP 1	OSKP 2
Diesel oil	pass	4541	1787
	fail	16	4
Petrol	pass	3188	1315
	fail	9	1
LPG	pass	527	317
	fail	3	0
Electric	pass	1	2
	fail	0	0

Tab. 11. The number of technical tests in 2021 by the type of energy supply

Type of vehicle energy supply	Test result	Number of tests	
		OSKP 1	OSKP 2
Diesel oil	pass	4656	1966
	fail	9	3
Petrol	pass	3206	1451
	fail	2	1
LPG	pass	554	338
	fail	0	1
Electric	pass	2	3
	fail	0	0

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Tab. 12. The number of technical tests in 2022 by the type of energy supply

Type of vehicle energy supply	Test result	Number of tests	
		OSKP 1	OSKP 2
Diesel oil	pass	4587	1963
	fail	11	3
Petrol	pass	3799	1830
	fail	9	2
LPG	pass	583	361
	fail	1	1
Electric	pass	6	14
	fail	0	0

It follows from the data in the tables above that the biggest group is the one with vehicles fuelled with diesel oil. This state of affairs is influenced by the age and type of vehicles tested at the stations under analysis, a significant proportion being farm tractors, buses and, above all, goods vehicles, whose power unit are compression ignition engines. Vehicles equipped with spark–ignition engines fuelled with petrol and, alternatively, liquefied gas (LPG), appear in greater numbers in the years under review, which is evidence of the gradual change of the energy source in passenger vehicles. This process will occur slowly as drivers replace their vehicles. Economic considerations that we observe at filling stations when we refuel our vehicles contribute to this state of affairs; we have been seeing a price difference between petrol and diesel oil for a longer time. In addition, the citizens' environmental awareness is growing, and the restrictions introduced by local authorities in various towns and cities in relation to older vehicles emitting significant volumes of pollutants into the atmosphere are not insignificant. Single cars equipped with electric motors, whose energy source does not emit pollutants into the environment and in which energy supply more and more frequently comes from renewable sources, are slowly beginning to appear at the stations under analysis, too.

4. The comparative analysis of vehicle technical tests with the data in the Central Vehicle and Driver Register

The conducted vehicle technical tests were compared in this chapter. The comparison was made by the test type, and the results of unsuccessful vehicle tests were compared. The analysis comprises data from two regional vehicle inspection stations and the data gathered in the Central Vehicle and Driver Register.

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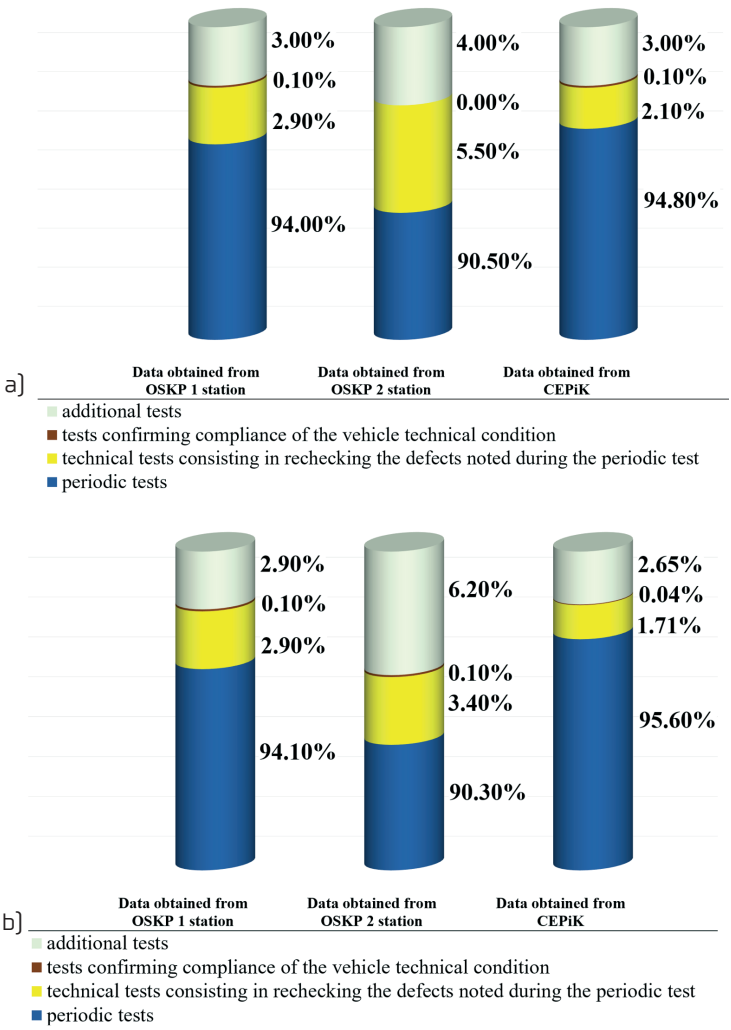
4.1. The number of successful vehicle technical tests

In the following diagrams in Figure 1 a)–d) the number of technical tests conducted at the OSKP 1 and OSKP 2 stations is compared with the data presented by the Central Vehicle and Driver Register. The data kept in the register has been gathered at vehicle inspection stations all over the country. The tests were summarised in percentages broken down by the following:

- periodic tests,
- technical tests consisting in rechecking the defects noted during the periodic test,
- tests confirming compliance of the vehicle technical condition,
- additional tests.



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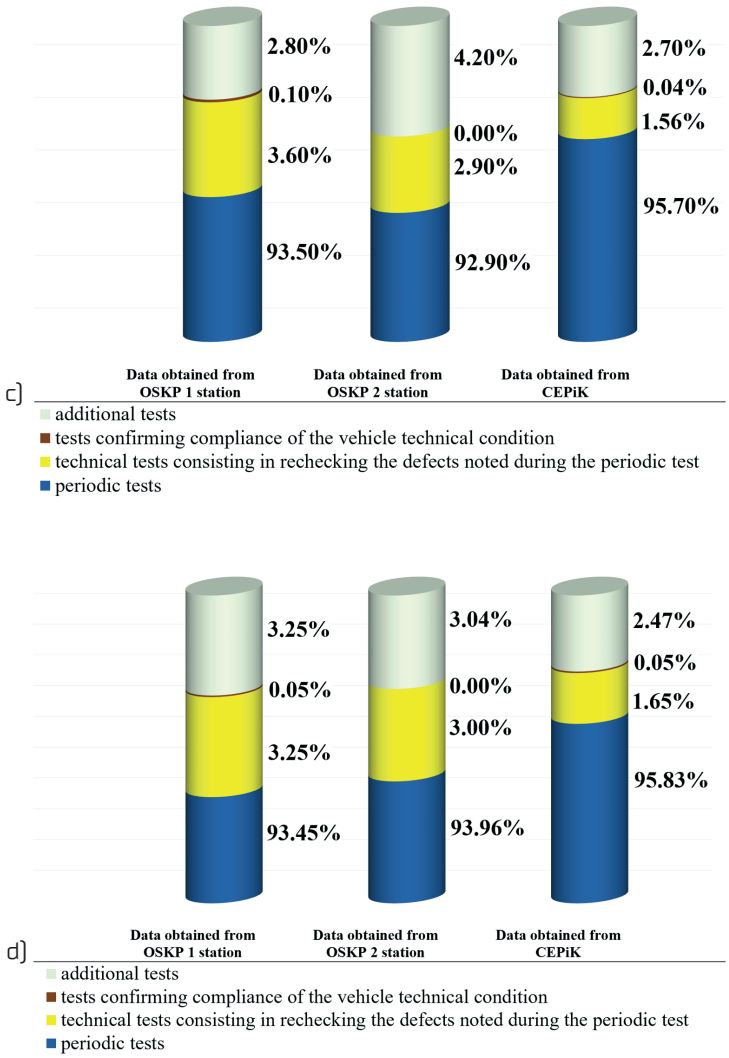

Fig. 1. The summary of tests at OSKP 1 and OSKP 2 with the data from the Central Vehicle and Driver Register: a) for the year 2019, b) for the year 2020, c) for the year 2021, d) for the year 2022

Based on that data, the continuous increase in the number of periodic technical tests can be seen. The reason for this may be the general increase in the number of cars due to the increase in the Poles' purchasing power. Vehicles purchased and brought into the country from abroad, which are usually several years old, play an important role in this respect, which means that a periodic technical test is conducted every year and not, as is the case with new vehicles, three years after the first registration and then after the next two years. The situation is similar with technical tests to confirm compliance with technical conditions.

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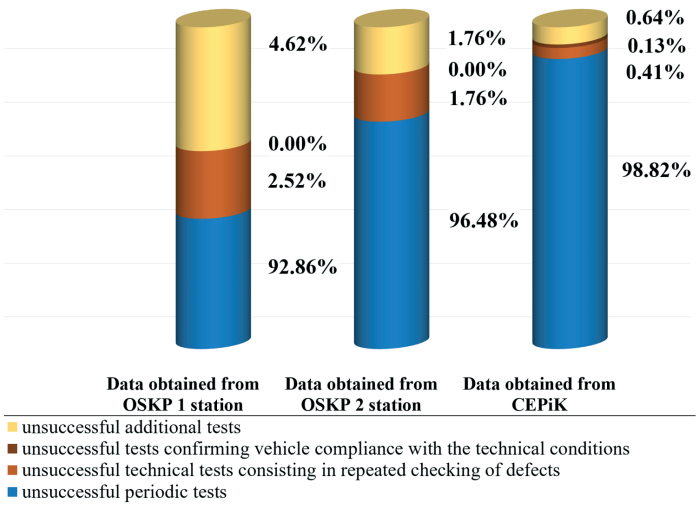
An increase in numbers is noted here at both regional vehicle inspection stations and nationwide. In this case, the growth in the number of tests may be caused by the society becoming wealthier, as well as by the fact that historic vehicles are becoming more and more popular, fashionable and prestigious. The number of tests consisting in defect rechecking is slightly decreasing due to the decline in the number of unsuccessful technical tests.

4.2. The number of unsuccessful vehicle technical tests

In the diagrams in Figure 2 a)–d) the number of unsuccessful technical tests conducted at the OSKP 1 and OSKP 2 stations is compared with the data presented by the Central Vehicle and Driver Register. Successful tests are summarised in percentages broken down by:

- unsuccessful periodic tests,
- unsuccessful technical tests consisting in repeated checking of defects,
- unsuccessful tests confirming vehicle compliance with the technical conditions,
- unsuccessful additional tests.

a)



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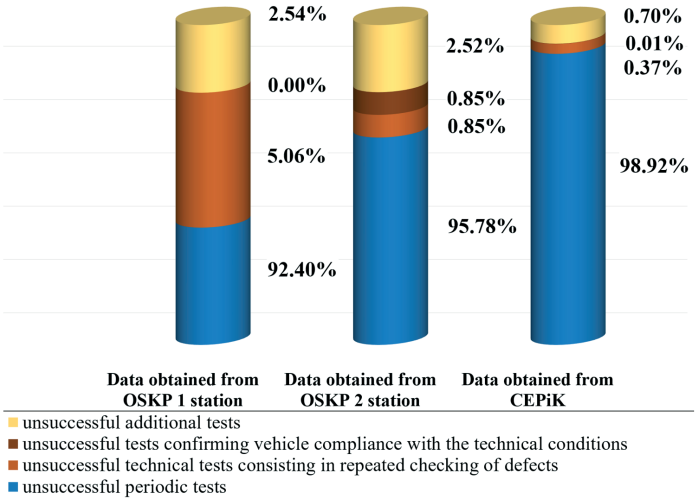
b)



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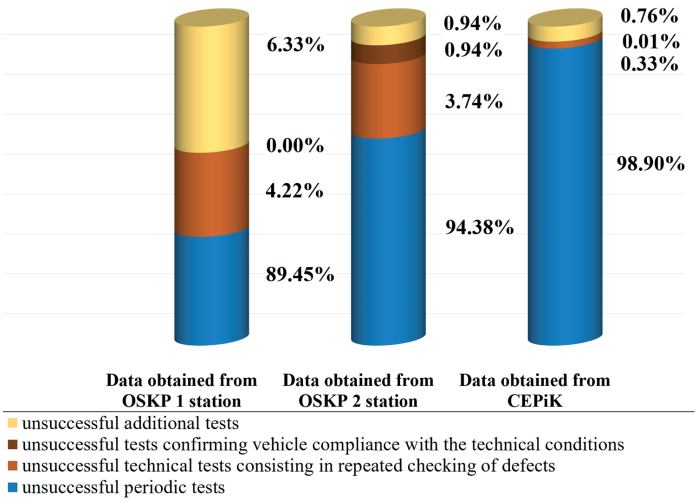

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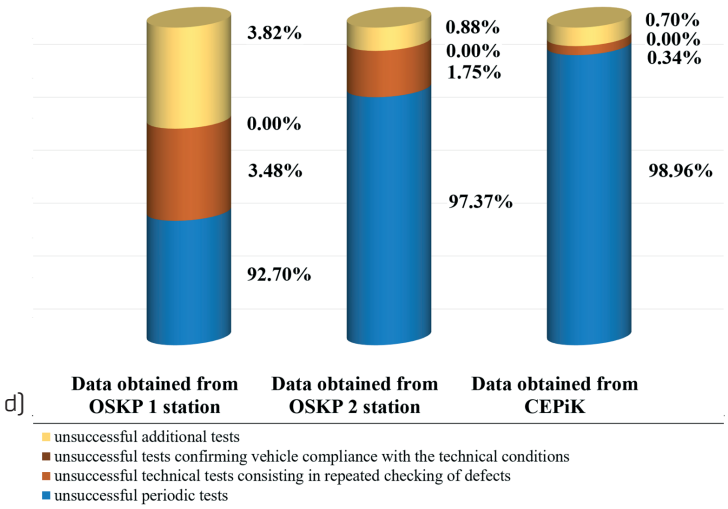

Fig. 2. The summary of successful tests at OSKP 1 and OSKP 2 with the data from the Central Vehicle and Driver Register: a) for the year 2019, b) for the year 2020, c) for the year 2021, d) for the year 2022

The diagrams for years 2019–2022 above show the fall of the number of unsuccessful periodic tests. The data from the Central Vehicle Register for OSKP 2 and national data are similar. A slight increase occurred at OSKP 1, however. The smaller number of unsuccessful test may be caused by the fact that there are more and more newer vehicles in a better technical condition and by the fact that customers pay greater attention to the technical condition of their vehicles. The citizens' attitude towards the technical condition has changed in recent years; people take greater care of their vehicles and thus the number of unsuccessful technical tests decreases.

4.3. The number of vehicle technical tests by the vehicle type

The vehicles subjected to technical tests are compared by the vehicle type. The results of the analysis for the various years are summarised in Figure 3.

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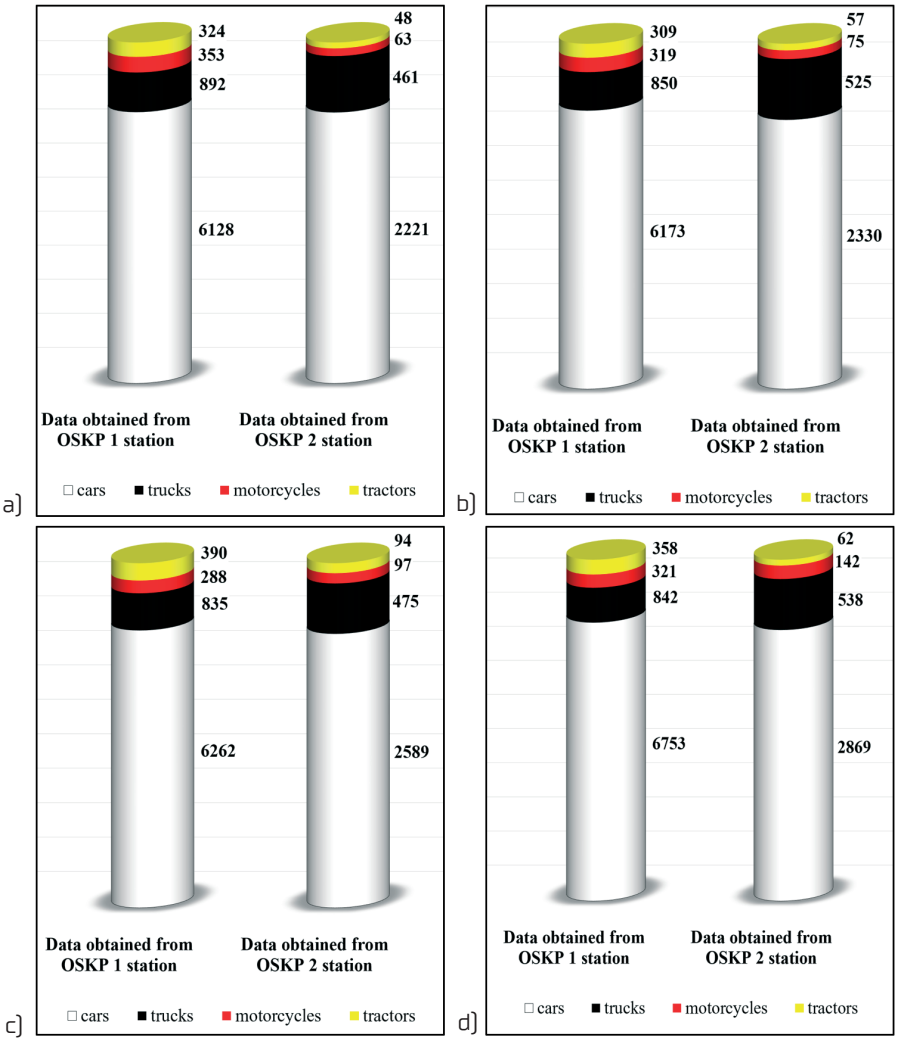

Fig. 3. The number of vehicle technical tests by the vehicle type: a) year 2019, b) year 2020, c) year 2021, d) year 2022

Over the four consecutive years, the biggest group of vehicles subjected to periodic tests were cars and goods vehicles with the maximum permissible weight up to 3.5 t. The next group in terms of the number of tests are goods vehicles. The significant difference in the number of farm tractor periodic tests is caused by the location of the vehicle inspection station. OSKP 1 is located in a large commune specialising in farm production. OSKP 2 is situated in a health resort town, where agriculture is a very small part of the activity of the local population. Single-track vehicles have become quite popular recently, and motorbikes and motorcycles also have their share among the vehicles tested at the stations.

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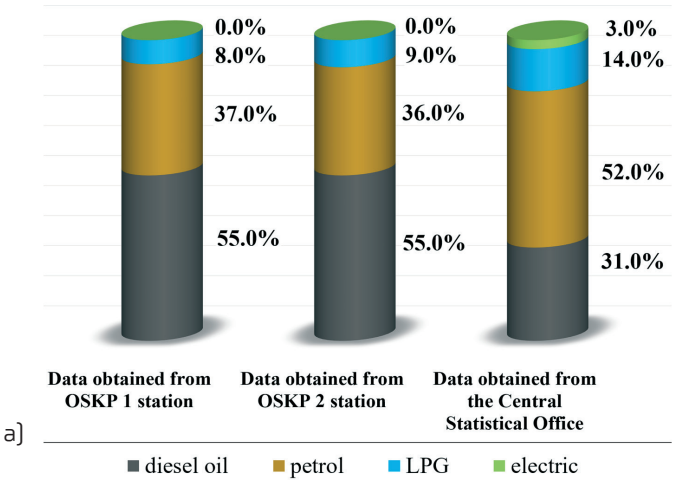
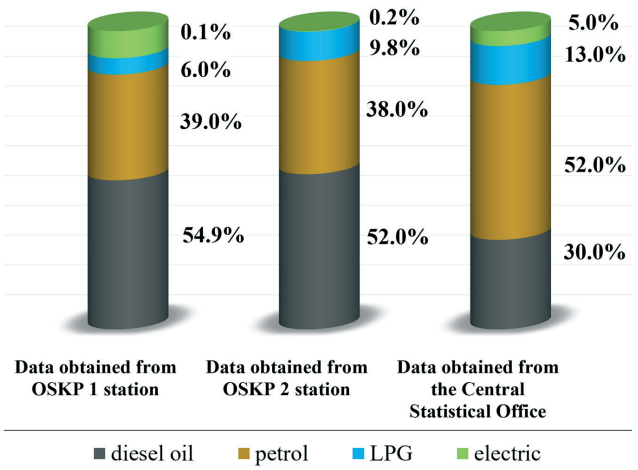
4.4. The number of vehicle technical tests by the fuel type

In this item, the number of technical tests conducted at the two vehicle inspection stations in 2019–2022 is compared by the fuel type. The results were compared with the data obtained from Statistics Poland in selected years in terms of the vehicles registered in Poland by power supply type (Figure 4).



a)



b)

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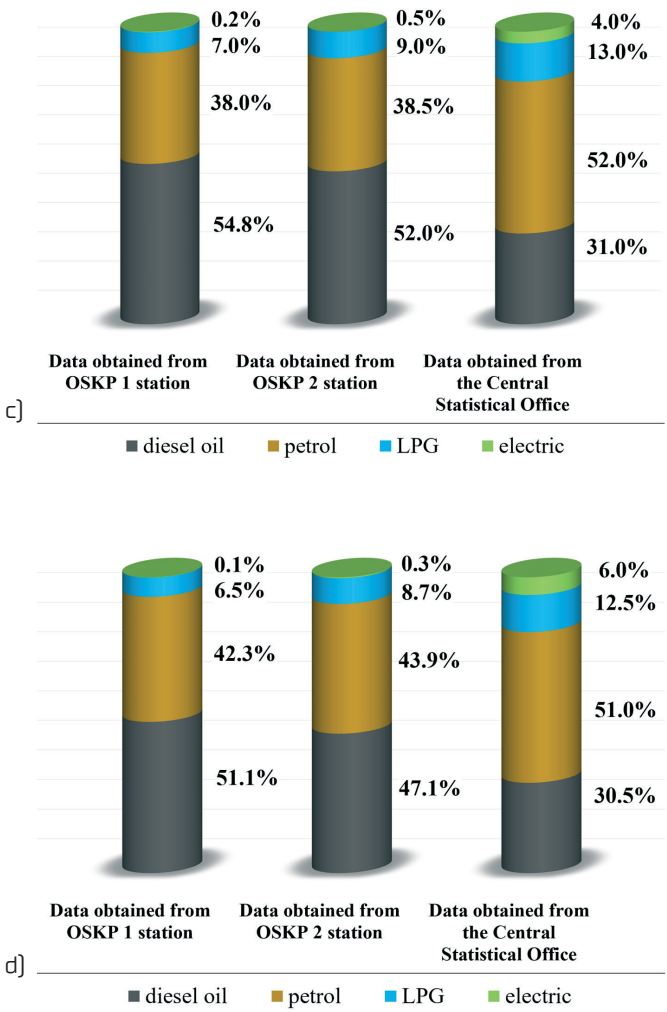

Fig. 4. The number of technical tests of vehicles by their energy supply: a) year 2019, b) year 2020, c) year 2021, d) year 2022

At OSKP 1 and OSKP 2, compression-ignition vehicles are the biggest group at certain periods, and those vehicles are more than one half of all the tested vehicles. On the national scale, the data from Statistics Poland show that the relevant percentage is approximately 30%.

In 2019, due to exceeding exhaust emissions, 0.77% of vehicles equipped with a compression-ignition engine did not receive a positive result (these data apply to OSKP 1 stations), while in the case of OSKP 2 stations, 0.45% of vehicles obtained a negative result.

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In 2020, for the same reason, 0.35% of vehicles equipped with a compression-ignition engine failed the tests in the case of OSKP 1 stations and 0.22% of vehicles in the case of OSKP 2 stations.

In 2021, at OSKP 1 station, 0.19% of vehicles equipped with a diesel engine failed a positive exhaust emission test, and at OSKP 2 station – 0.15%.

The second largest group by the fuel type are spark ignition vehicles. At the vehicle inspection stations under analysis, the percentage of such vehicles is approximately 30%, and this is over 50% according to Statistics Poland.

In 2019, due to exceeding the exhaust gas pollution standard, 0.51% of vehicles equipped with a spark-ignition engine did not receive a positive result (in the case of the OSKP 1 station), while in the case of the OSKP 2 station, 0.33% of the vehicles did not receive a positive result.

In 2020, 0.28% of vehicles equipped with a spark-ignition engine (in the case of OSKP 1 station) and 0.30% of vehicles tested at OSKP 2 station failed the test. The reason was also exceeded exhaust emission values.

In 2021, in the case of the OSKP 1 station, 0.06% of vehicles equipped with a spark ignition engine did not pass the exhaust emission test, and in the case of OSKP 2 station, this value was 0.21% of vehicles.

The third group is petrol vehicles also using LPG as an alternative fuel. In that case, both at OSKP 1 and OSKP 2, the percentage is similar to that at Statistics Poland. This is from 8% to 14%. The list does not include vehicles that did not pass the tests because their number is negligible in relation to the number of vehicles with a positive test result.

It follows from the aforementioned data that the greatest number of tests at OSKP 1 and OSKP 2 stations are conducted on vehicles with a spark-ignition engine. The reason for that is certainly the location of the station at which many more farm tractors, goods vehicles and buses are tested. This may be due to the fact that the average age of cars in that area may be much older than in the rest of the country. The data obtained from Statistics Poland indicates that among newly registered vehicles, diesel oil as the source of energy is used in one third of the total number of newly arrived vehicles on Polish roads.

Electrically powered vehicles are a novelty at OSKP 1 and OSKP 2. Those are vehicles that appear at a vehicle inspection station for the first time. Pursuant to the Road Traffic Law Act, a brand new vehicle is subjected to a periodic test before the lapse of three years. The data from Statistic Poland also shows an upward trend in the number of electrically powered vehicles.

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5. Summary and conclusions

The data for the analysis was obtained from the Central Vehicle and Driver Register, Statistics Poland and two regional vehicle inspection stations located in the Małopolskie Region, the county of Nowy Sącz. The first station is located in a large commune specialising in agriculture and pomiculture. The other station is located in a tourist and health resort specialising in mineral water extraction.

The analysis shows the diversification of vehicles subjected to periodic tests. The OSKP 1 station has a much greater share of farm tractors compared to OSKP 2. The station located in the mineral water basin leads the way in the number of truck tractors and semitrailers designed for coupling with those tractors.

Based on the data analysis, an increase in the number of vehicles registered in Poland can be seen in 2019–2022. The average vehicle age in Poland in 2021 was 14.3 years and in 2022 it will be 15.8 years, which is rather high and, compared to Western European countries, ranks our country at a very low position.

When analysing the number of vehicles that have difficulties obtaining a positive periodic test result due to the defects, both at OSKP1 or OSKP 2, but also on the national list from the Central Vehicle and Driver Register, it can be noted that those defects have a direct impact on road user safety and are a frequent cause of road incidents. Defects affecting environmental protection, detected during periodic tests, are mainly related to gas emissions in the process of the combustion of fuels driving spark-ignition and compression-ignition engines. Polish road users travel in vehicles with high emission standards – Euro 1, Euro 2 or Euro 3. In relation to that, those emissions have significant influence on air quality and contribute considerably to environmental pollution.

According to the data from the Central Vehicle Register, the percentage of all types of tests and activities at vehicle inspection stations in Poland in 2021 yielding negative results was 6.7%. At the OSKP 1 station under review, that ratio was 10.3%, while at OSKP 2 the figure was 9.9%. For comparison, in Germany, as much as 20% of vehicles have a problem with passing the technical test at the first attempt.

Vehicles undergoing periodic technical tests between 2019 and 2022 present a increasing number of defects, which is the result of maintaining those vehicles in an increasingly better technical condition. The average age of vehicles on the road is slightly decreasing, however. The trend is evidence of vehicle owner responsibility and awareness of the great impact of a serviceable vehicle on the safety of road traffic, its participants and the environment.

The data from Statistics Poland indicates that more vehicles are registered year by year, with an increasing share of newly registered electrically powered vehicles [10].

In the near future, this will translate into the number of such vehicles tested at vehicle inspection stations.

The following conclusions can be drawn from the analysis of the compiled documentation and analysis of the technical testing system:

- providing vehicle inspection stations with equipment enabling a wider range of diagnostics of the on-board electronic systems in vehicles should be considered,
- compulsory supplementary training for vehicle diagnosticians in new systems, including those for electric vehicles, should be introduced,
- the methodology of diesel oil engine emission testing should be extended to include the measurement of substances most hazardous to health, that is nitrogen oxides and hydrocarbons [2, 24]. Those substances are not tested at present, and they pose a great hazard to human health and contribute to environmental degradation.

6. References

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