TRANSPORT PROBLEMS 2022 Volume 17 Issue 3
PROBLEMY TRANSPORTU DOI: 10.20858/tp.2022.17.3.06

Keywords: control systems; road traffic safety; road transport; vehicle technical condition

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THE IMPACT OF ROADSIDE TECHNICAL INSPECTIONS ON TRANSPORT AND LOGISTICS SYSTEMS IN THE SLOVAK REPUBLIC

Summary. Road transport safety, apart from environmental protection, is one of the most important tasks for the contemporary world. Annually, about 50 million people are injured in road accidents around the world, of which nearly 1.5 million die as a result. Transport safety consists of many activities and includes various initiatives, including legal changes, training, preventive actions, building safe road infrastructure, and the production of safe vehicles and control systems. This article deals with the issue of performing roadside technical inspections in the Slovak Republic. Specifically, it analyses the results of these roadside technical inspections in individual counties of the Slovak Republic and examines their possible impact on transport and logistics systems in these counties. The correlation analysis showed that the number of checks under the technical roadside inspections is weakly related to the number of logistics centres, but the number of such inspections is moderate in relation to the number of failed vehicles (correlation coefficient = 0.44079). In addition, due to the age of the vehicles, the number of serious and dangerous faults found on them during maintenance inspection increases.

1. INTRODUCTION AND LITERATURE REVIEW

Road traffic accidents have recently become a significant issue in the 21st century [1], along with environmental protection [2, 3]. Road transport safety is a frequently discussed problem in the literature [4-12]. Accidents in road transport are mainly caused by defective elements of the transport system, which occur as a result of the errors of road users, vehicle breakdowns, road infrastructure breakdowns, deterioration of weather or nature, vandalism, or acts of terrorism [13-19]. Worldwide, almost 3,700 people are killed every day in road accidents involving pedestrians or various means of transport, such as cars, motorbikes, bicycles, buses and trucks [20]. In most countries, the costs of injuries represent up to 3% of the gross domestic product [21]. In 2011, the EU established a "vision zero" goal aimed at decreasing the traffic-related death rate to almost 0% by 2050. The literature in this scientific area includes many papers on the zero vision perspective in selected European countries [13, 22-25]. Some recent scientific publications highlight the potential benefits of technical roadside inspections (TRI) as a concept [26, 27], whereas others are critical of the concept [28, 29] or claim otherwise [43, 44].

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However, these are mainly articles on the TRI concept as such, and only a limited amount of empirical research is available. In achieving this goal, vehicle technology is expected to make a major contribution to road safety [32]. Periodic roadworthiness tests constitute a part of a system aiming at ensuring the good technical condition of vehicles during operation, as well as their maintenance in a friendly and safe environment. In addition to the aforementioned tests, this system should involve regular roadside inspections of the safety of commercial vehicles, as well as the vehicle registration procedure, which enables the confiscation of the driving license of a person posing a danger to road safety. Regular inspections should be the basic tool to ensure good technical conditions. TRIs of roadworthiness commercial vehicles should only complement regular inspections.

Several standards and technical requirements have been adopted in the EU in relation to vehicle safety and environmental performance [20, 30, 31]. Through a system of unexpected TRIs, it is necessary to ensure that vehicles remain in good technical condition. TRIs represent a key element in achieving a consistently high level of technical condition of commercial vehicles during their use. Such inspections contribute to improved road safety, decreased vehicle emissions, and fair competition in road transport through the recognition of different control levels among the EU Member States.

Road safety is significantly affected by the technical condition of both new and used vehicles. In the case of new vehicles, more stringent safety standards can be implemented by authorities, thus affecting traffic safety.

Maintenance is the most realistic way to maintain a used vehicle in good condition. Most motorized countries have various forms of roadworthiness inspections for motor vehicles. Periodic motor vehicle TRIs have been introduced in EU countries, most US states and New Zealand. Vehicle roadside checks are less common outside of the EU but occur in some places in the United States. Vehicle regulations and the related vehicle model approval system, which is employed as the approval as well as control systems for new vehicles (i.e. compliance control), are almost similar in all motorized countries [45].

Research conducted in Norway, which used the number of injured people as the dependent variable, showed that this parameter was closely related to the roadside inspections of light-duty vehicles since they were involved in the majority of cases with casualties. It was calculated that increasing the frequency of inspections by 50% would reduce the number of traumatic accidents by 0.7% (95% Cl [-1.7; +0.3]) in the case of light-duty vehicles, and 3.4% (95% Cl [-9.2; +2.5]) for heavy vehicles. The above-mentioned effects concern all accidents involving light and heavy-duty vehicles, not only those related to controlled vehicles [45, 46]. This article presents the issue of performing roadside technical inspections in individual regions of the Slovak Republic (SR). Specifically, this study analyses the results of these roadside technical inspections and examines their possible impact on transport and logistics systems in these regions through statistical analysis, which has never been explored before. This paper does not evaluate the effectiveness of TRIs and their impact on road safety.

2. MATERIAL AND METHODS

The paper took into account all the data obtained from two sources: the information system of TRIs in the SR and the information system of technical inspections of stationary technical vehicle inspection stations of the SR for 2019. Data on the number of carriers from the road transport information system of the SR were also used.

These data were subjected to correlation analysis. Specifically, a correlation was sought between the number of checks under TRIs and the number of logistics centres. The correlation between the age of vehicles and the amount of serious and dangerous defects was also investigated. Based on the data, an analysis, synthesis and comparison were also performed in this article.

3. EU LEGISLATIVE REQUIREMENTS FOR TRIS

The field of TRIs is currently governed by one EU directive (i.e. Directive 2014/47/EU) [32] of the European Parliament and of the Council of 3 April 2014 on the roadside inspection of commercial

vehicles operating in the EU and repealing Directive 2000/30/EC (hereinafter referred to as "Directive 2014/47/EU"). This directive was implemented into the legal system of the Slovak Republic, as well as other EU member states [33].

Directive no. 2014/47/EU introduced TRIs as additional inspections in road traffic to regular technical and emission inspections of cars [32]. The aforementioned directive is applicable to commercial vehicles with a design speed over 25 km/h in categories M2, M3, N2, N3, O3 and O4, as well as T5 wheeled tractors with a design speed over 40 km/h. It contains a description of the TRI system (initial TRI, more detailed TRI), determines the percentage of vehicles inspected in a calendar year (at least 5% of the total amount of vehicles registered in a Member State) and determines the carrier risk assessment system and the number of faults detected on the vehicles operated by each carrier are entered into the risk assessment system. This information is used to check carriers with a high degree of risk in more detail and more frequently. Furthermore, the duties of drivers and the requirements for TRI control technicians are specified here.

4. TRI IMPLEMENTATION SYSTEM IN THE SLOVAK REPUBLIC

TRIs are performed by members of the traffic police as one of the activities in the performance of their service when supervising the safety and smoothness of road traffic. The main goal of performing TRIs is to reduce the risk of accidents related to the technical condition of cars.

According to Act of law no. 106/2018 Coll. [34], a TRI is an unannounced and unexpected inspection of the technical condition of a vehicle, which is performed by the Police Force of the SR in supervising the safety and smoothness of road traffic independently by an inspection technician outside the technical inspection station or an emission inspection technician outside the emission control workplace on buses, trucks over 3.5 t and trucks with trailers over 3.5 t.

The TRI system consists of two parts (both of which apply to all EU countries):

- **An initial TRI** consists of a visual assessment of the technical condition of a stationary car. In the initial TRI, the following are taken into account:

a) The documents needed to drive the vehicle in road traffic are checked.
b) The latest vehicle inspection certificate is inspected.
c) If available, the latest roadside inspection report is checked.
d) The technical condition of a vehicle is assessed visually, with an emphasis on lighting and light signalling devices, wheels/tires, springs (visible faults), the layout of the chassis (visible faults), tachograph (installation), speed limiting devices (installation), fuel and/or oil leaks, and the steering mechanism.
e) The vehicle load attachment can be assessed visually.
f) A roadworthiness test might be carried out by any method deemed appropriate in order to justify the decision to subject a vehicle to a thorough roadworthiness test or to request the rectification of defects without delay.
g) The elimination of the defects mentioned in the report from the previous roadside inspection is verified [35].

- **A more detailed TRI** shall be performed on the basis of the result of the initial TRI and shall include the items set out in Annex no. 1 of Decree no. 135/2018 Coll., drawing particular attention to the brakes, tires, wheels, and chassis safety; environmental loads; and the recommended methods that are used in testing these items [36]. If the vehicle's roadworthiness certificate or roadworthiness test report states that one of the items set out in Annex no. 1 of Decree no. 135/2018 Coll. has been inspected during the previous three months, this item will be checked only if such a check is justified on the basis of the existence of a manifest error. A more detailed TRI is performed through the mobile control unit, through designated roadside inspection equipment, and at the technical inspection station or the emission control workplace [35, 36].

The mobile control unit is a portable system of control equipment needed to perform a more detailed TRI, within which members of the police force who work as TRI technicians are qualified to perform a more detailed road technical inspection. The designated TRI device is designed to perform an initial TRI and a more detailed TRI. Such a device may comprise permanently installed control equipment.

The mobile control units and the designated TRI equipment are equipped with a suitable device to perform more detailed TRIs, including the equipment needed to evaluate the condition and effectiveness of the brakes, steering and suspension of the vehicle and the environmental load as required [37].

In the Slovak Republic, members of the police force have six mobile units (three Mercedes Actros and three Avia vehicles), which ensure the activities of TRIs throughout the SR. If the mobile control units or road control machinery do not have the equipment needed to check the item detected in the initial TRI, the check shall be carried out at the technical inspection station, emission control station or at a designated TRI facility where this item can be subjected to a more detailed check [38].

TRIs may not be performed on vehicles that have undergone a roadworthiness test during the last three months. It is essential in the performance of the TRI that these inspections are performed without discrimination in terms of the driver's nationality or the state of vehicle registration. An important part of the implementation of TRIs is the selection of vehicles, which should be based on a purposeful approach with every effort to identify vehicles that are most likely to be insufficiently maintained. For the initial TRI, a member of the police force selects vehicles with a high risk profile of a transport company. A member of the police force may also select vehicles for the TRI at random or if there is a suspicion of any of the following:

a) The vehicle is technically ineligible.
b) The vehicle may endanger safety, the environment or public health.
c) The load on the vehicle does not meet the requirements for securing it in the proper and safe manner.

Detailed data on the execution of the TRI of each vehicle, including the result of the inspection, shall be recorded by the police corps' control technicians in the national automated road technical control information system (AIS CTK) [39]. At the end of the TRI, the members of the Police Force, through the AIS TRI, will issue a document entitled report on the TRI of the vehicle, which contains all the necessary data related to the TRI. If a fault is detected, the inspection technician records in the report the exact code of the fault with the corresponding verbal description and its evaluation (minor, serious or dangerous). In addition, the technician indicates whether the fault has been rectified on site, or whether it needs to be checked at a stationary control station. On the basis of the detected faults, the technician shall indicate the result of the inspection (satisfactory condition, unsatisfactory condition or prohibition or restriction of the use of the vehicle with dangerous faults). The imposition of a fine is also recorded in the report. A copy of this report must be provided to the driver by the inspection authorities.

5. RESULTS OF TRIs IN THE SLOVAK REPUBLIC IN 2019

In 2019, individual departments of the police force entrusted with the implementation of TRIs performed TRIs in individual counties. A total of 8,881 vehicles were inspected (4,787 SK vehicles, 3,724 EU vehicles and 370 third-country vehicles) [40]. A graphic representation of the TRIs performed in 2019 in the distribution of individual counties is shown in the following figures (Fig. 1 and Fig. 2).

A member of the police force can detain registration certificate parts I and II, the registration document from the vehicle issued abroad or the registration number plate and can prohibit the use of the vehicle in road traffic if either of the two criteria below is met:

1. The vehicle is unfit or technically unfit for road traffic, or the vehicle has been removed from the register or from road traffic.
2. The driver has not shown that the vehicle has been subjected to a roadworthiness test or an emission test within the prescribed period.

"Technical incapacity" refers to anything faulty that has been found on a vehicle which may directly endanger the performance of the vehicle or may be a source of danger to road safety, the environment, public health, pollution or damage to the road (dangerous as it has been found on the vehicle). In 2019, TRIs evaluated vehicles as unfit for road traffic with a ban on use until the dangerous fault has been removed and a technical inspection has been performed (with the withdrawal of the registration certificate and registration number plates) according to the following graphic representation in Fig. 3.

It follows from the above data that the most technically ineligible vehicles with a ban on use were evaluated by TRIs in the Banská Bystrica Region (437), and the fewest were reported in the Trenčín Region (27).

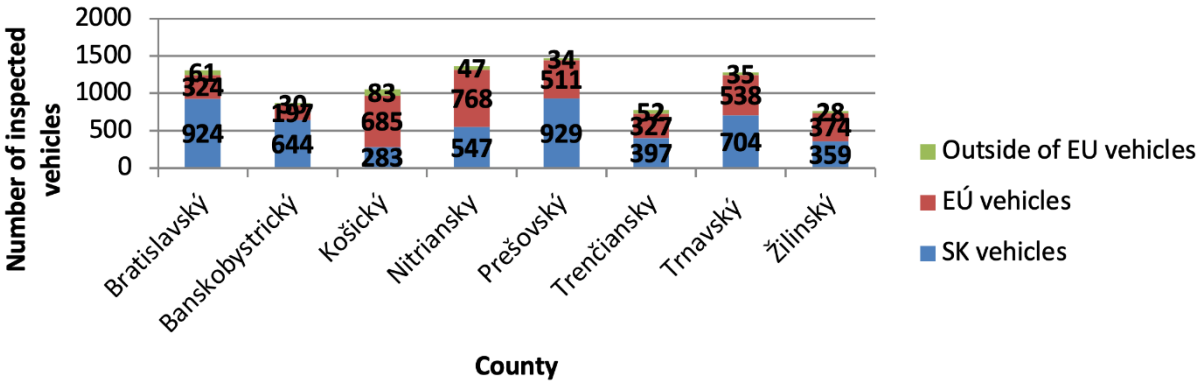

Fig. 1. The number of TRIs performed in 2019 in individual counties

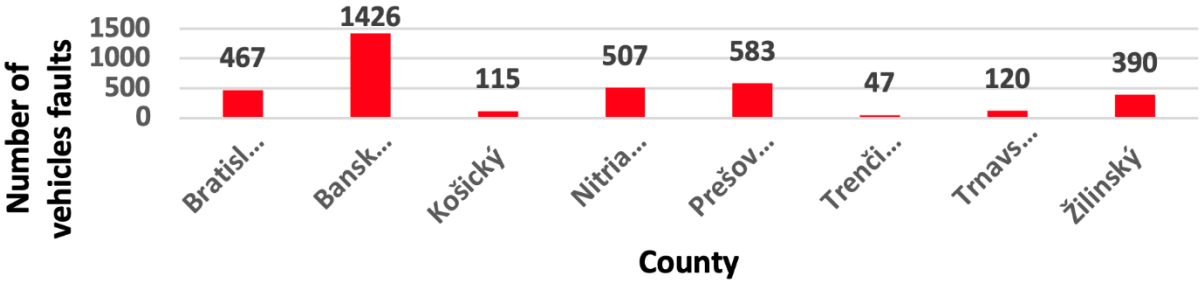

Fig. 2. The number of defects diagnosed on vehicles in 2019 in individual counties

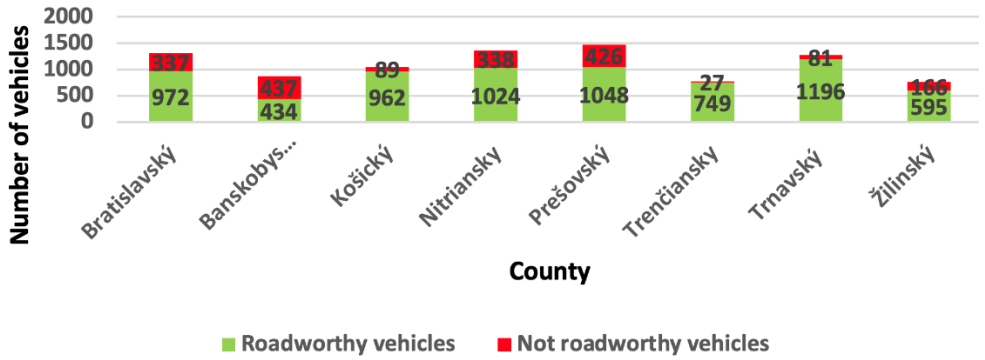

Fig. 3. Conclusions of TRIs in 2019 in individual counties

6. TRANSPORT AND LOGISTICS SYSTEMS IN THE SLOVAK REPUBLIC AND THEIR POSSIBILITIES FOR INFLUENCING TRIs

According to one definition of logistics, it represents the science of coordinating the active and passive elements of a company at a favourable time and cost to improve its flexibility and adaptability to changing market conditions. The subjects of logistics are the transport, handling and storage of all materials, semi-finished products and products along the entire route from suppliers through the manufacturing company to customers. The contents of logistics are the organization, planning, management, execution and control of all relocation and storage processes in production and circulation. The role of logistics is the global optimization of material movement in production and circulation. The tool used to achieve this is the connection of the subsystems into an integrated system, in which the material flow and the corresponding information flow are coordinated and controlled. The aspect of logistics is also characterized by a high degree of targeting, which is aimed at maximizing customer service. The degree of service can be expressed by three parameters: delivery time (a company with good service is able to ensure a short delivery time), flexibility (the supplier's ability to provide a high

level of service, even in case of unforeseen events) and the reliability of delivery (i.e., deliveries take place at the specified time and quality).

6.1. Logistics centres and logistics parks in the Slovak Republic

A logistics centre is a regional supplier-customer junction that provides customers with transport and handling services associated with the comprehensive provision of production and sale of products. A logistics park, according to Act of law no. 193/2001 Coll. [41], is an industrial park in an area defined by the zoning plan of a municipality or the zoning plan of a zone on which industrial products or services of one or more entrepreneurs are or will be sold or performed.

Transport to logistics parks is mainly carried out by road, rail, rail siding or combined transport. However, the transport of materials and goods from logistics parks is no longer usually carried out by rail, as few manufacturing companies have a connection to the rail network.

In particular, logistics centres ensure the flow of large quantities of goods between subcontractors and manufacturers and between producers and consumers. The role of the logistics centres of the retail chain is to ensure the continuous operation of large retail networks through supplies. These centres are built mainly near highways or roads with easy motorway connections. The selected logistics centres and parks in the Slovak Republic are shown in Fig. 4.

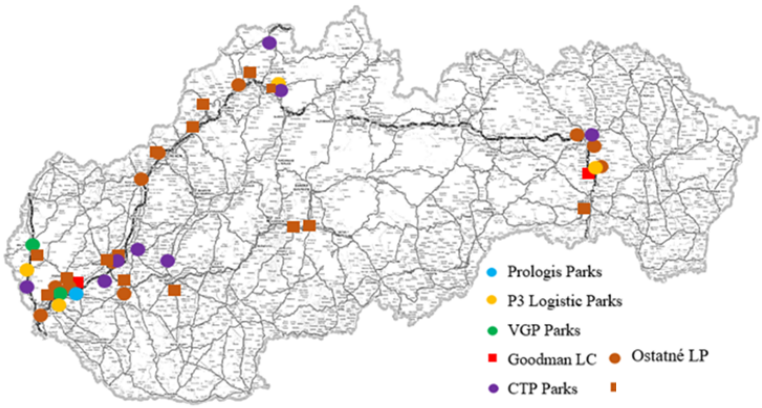

Fig. 4. Selected logistics centres and parks in the Slovak Republic [42]

The logistics centres and parks in the SR are characterized by a highly uneven distribution, with the majority located in southwest Slovakia. This is due to the favourable transportation connections in this area, including those to neighbouring countries and industrial plants based in this area (primarily the automotive sector). An example is logistic company DSV Slovakia, s.r.o., which supplies warehouses in the vicinity of Senec for some customers to EU countries and for specific customers outside Europe. Significant factors are mainly built highways and expressways in this area (D1, R1, D2). There is also a crossroads of international roads to Austria, the Czech Republic, Hungary, and Poland. Railway infrastructure has a relatively marginal impact. Only a few logistics centres and parks have access to the railway siding in the SR [42].

6.2. Impact of TRIs on transport and logistics systems in the SR

The most important element of the logistics system is transport. A large part of logistics costs is transport costs. The logistics chain from the material supplier to the customer consists largely of transport links (the so-called transport chain). When choosing transport, performance characteristics are decisive in terms of logistics (i.e. flexibility, transport time and reliability). Therefore, from this point of view, transport and logistics systems can also be negatively affected to a certain extent by TRI if a ban on the use of these vehicles for road traffic is issued when dangerous errors are detected on vehicles. From all statistical data collected for the purposes of this article, only related items were selected, on the basis of which ratio calculations and comparisons were made within counties in order to examine the impact of TRI on transport and logistics systems in the region. These outputs are recorded in Tab. 1 and

Tab. 2). Tab. 1 also contains a number of places where TRI are most often performed. Based on the outputs shown in Tab. 1 and Tab. 2, it is possible to formulate the following conclusions.

The **Trenčín Region** involves a relatively low number of performed TRIs with the lowest average number of detected faults on inspected vehicles, as well as those with the lowest share of ineligible vehicles for road traffic with a ban on the use of these vehicles in road traffic. TRIs were performed with almost the same ratio of Slovak carriers to foreign ones. There are six logistics parks and centres in the Trenčín Region with a usable area of 285,832 m^2. Thus, in terms of the consequences of TRIs, there was no impact on transport and logistics systems in this region in 2019.

In the **Trnava Region**, an above-average number of TRIs were performed, with a very low average number of detected faults on inspected vehicles and a low share of ineligible vehicles for road traffic with a ban on the use of these vehicles in road traffic. TRIs done on vehicles of Slovak carriers were performed only with a slightly higher rate compared to foreign ones. There are 11 logistics parks and centres in the Trnava Region with a usable area of 436,080 m^2. Thus, in terms of the consequences of TRIs, there was no impact on transport and logistics systems in this region in 2019.

Table 1

Summary of the results of TRIs in individual counties of the SR

Region	Number of vehicles inspected through TRIs	Number of faults detected	Technically unfit vehicles	Logistics centres	Number of places where TRIs are performed
Bratislavský	1,309	467	337	15	8
Banskobystrický	871	1,426	437	2	24
Košický	1,051	115	89	5	25
Nitriansky	1,362	507	338	3	30
Prešovský	1,474	583	426	3	33
Trenčiansky	776	47	27	6	9
Trnavský	1,277	120	81	11	25
Žilinský	761	390	166	6	26

Table 2

Proportion of occurrence of monitored parameters

Region	Average number of faults detected on a vehicle	The share of technical incompetence of vehicles in TRIs [%]	Share of SK vehicles in TRIs [%]
Bratislavský	0.36	25.74	70.59
Banskobystrický	1.64	50.17	73.94
Košický	0.11	8.47	26.93
Nitriansky	0.37	24.82	40.16
Prešovský	0.40	28.90	63.03
Trenčiansky	0.06	3.48	51.16
Trnavský	0.09	6.34	55.13
Žilinský	0.51	21.81	47.17

The **Košice Region** involved an average number of performed TRIs, with a low average number of detected faults on inspected vehicles and a low share of ineligible vehicles for road traffic with a ban on the use of these vehicles in road traffic. TRIs were performed overwhelmingly for vehicles of foreign carriers. There are five logistics parks and centres with a usable area of 434,000 m^2 in the Košice region. Thus, in terms of the consequences of TRIs, there was no impact on transport and logistics systems in this region in 2019.

The **Žilina Region** had the lowest number of performed TRIs but a high average number of detected faults on inspected vehicles with an average share of ineligible vehicles for road traffic with a ban on their use. TRIs were performed for vehicles of Slovak carriers only at a slightly lower rate compared to foreign ones. There are six logistics parks and centres in the Žilina Region with a usable area of 188,021 m^2. In this region, in terms of the consequences of TRIs, there may have been some impact on transport and logistics systems in 2019.

In the **Nitra Region**, a high number of TRIs were performed, with an average number of detected faults on inspected vehicles but a higher share of ineligible vehicles for road traffic with a ban on their use. TRIs of vehicles of Slovak carriers were performed at a lower rate compared to foreign ones. There are three logistics parks and centres in the Nitra Region. In this region, in terms of the consequences of TRIs, transport and logistics systems could have been affected in 2019.

In the **Bratislava Region**, a high number of TRIs were performed, with an average number of detected faults on inspected vehicles but a higher share of ineligible vehicles for road traffic with a ban on their use. TRIs done on vehicles of Slovak carriers were performed at a significantly high rate compared to foreign ones. There are 15 logistics parks and centres in the Bratislava Region with a usable area of 978,413 m^2. In this region, in terms of the consequences of TRIs, transport and logistics systems could have been affected in 2019.

The **Prešov Region** had the highest number of TRIs performed, with an average number of detected faults on inspected vehicles but a higher share of ineligible vehicles for road traffic with a ban on the use of these vehicles in road traffic. TRIs on vehicles of Slovak carriers were performed at a high rate compared to foreign ones. There are three logistics parks and centres with a usable area of 22,000 m^2 in the Prešov Region. In this region, from the point of view of the consequences of TRIs, there could have been a significant impact on transport and logistics systems in 2019.

In the **Banská Bystrica Region**, a low number of TRIs were performed, with the highest average number of detected faults on inspected vehicles and the highest share of ineligible vehicles for road traffic with a ban on the use of these vehicles in road traffic. TRIs on vehicles of Slovak carriers were performed at a significantly high rate compared to foreign ones. There are two logistics parks and centres with a usable area of 23,000 m^2 in the Banská Bystrica Region. In this region, in terms of the consequences of TRIs, the most significant impact on transport and logistics systems may have occurred in 2019.

The analysis of the distribution of most common TRI places showed that the police mostly use frequented roads for these inspections, which are more likely to be driven by vehicles of interest. Within individual regions, the number and dispersion of TRI locations are relatively wide and do not focus only on locations near logistics centres and parks. As far as TRI execution sites through mobile technical units are concerned, the situation is more complicated. In this case, a paved surface of a sufficient area near the road is required on which it is possible to safely guide the vehicle from the road for inspection and safely release the vehicle back onto the road. It is also necessary to have a permit to enter the land in question.

The situation regarding the influence of TRIs in relation to logistic flows is described above. For a deeper analysis, the correlation coefficient of the number of TRIs and the number of detected faults was checked in relation to the number of logistics centres in the Slovak Republic. The correlation analysis showed that the correlation coefficient of the number of vehicles inspected under TRIs to the number of logistics centres is 0.20301, which indicates a weak positive correlation (verified by the p-value test at the level of significance $\alpha = 0.05$). On the other hand, in the case of the number of detected defects to the number of logistics centres, there is a moderate negative correlation of -0.41001 (verified by the p-value test at the level of significance of $\alpha = 0.05$), showing that the increased number of defects has no connection with the increased number of logistics centres. A weak negative correlation of -0.27139 (verified by the p-value test at the level of significance $\alpha = 0.05$) was found in the case of the number of inoperative vehicles to the number of logistics centres. Thus, the number of checks in TRIs is the most related to the number of logistics centres, while the number of detected faults depends on factors other than the number of logistics centres. The number of TRI controls showed a moderate positive correlation (0.44079) with the number of inoperative vehicles, which confirms that a more efficient control system reveals and eliminates inoperative vehicles from road traffic.

6.3. Significant factors influencing the occurrence of vehicle faults

During the normal operation of a vehicle, many of its elements and subassemblies are exposed to wear. Dangerous defects can occur without regular inspection and maintenance. In general, new vehicles are characterized by a better technical condition than old ones. In Norway, the roadworthiness test for passenger cars performed in 1990 indicated that vehicles up to four years old exhibited 0.89 technical defects per vehicle, on average [45, 47]. The vehicles aged greater than 13 years were characterized by 5.57 technical defects per vehicle, on average. As far as heavy-duty vehicles are concerned, the relationship between technical condition and age is less understood. Nevertheless, numerous heavy-duty vehicles are known to be technically defective [45, 48]. Studies conducted in the United States [45, 49] showed that articulated trucks with technical defects exhibited a 1.7-fold higher rate of accidents than those without such defects. However, neither of these studies clearly presents the scope and quality of the performed roadside inspections. Both studies examined a number of confounding factors that may explain the differences in risk levels between states. If logistics and transport systems can be negatively affected to some extent by TRIs in the event that a ban on the use of these vehicles for road traffic is issued when dangerous faults are detected, then it is necessary to mention the essential factors that affect the occurrence of these faults on vehicles. These may be, for example, the manufacturer of the vehicle, the use intensity of the vehicle, regular maintenance or the environment in which the vehicle is operated. The abovementioned factors influence the vehicle failure rate only to a limited extent; however, the deterioration of the technical condition of a vehicle throughout its service life is a well-known fact. These criteria are relevant to every vehicle in use.

It is possible to test this hypothesis at any time. For instance, using the technical inspection information system of the SR [40], the 2019 data on the vehicle's temporal efficiency and inability by age were filtered. These data are shown in Fig. 5. The research sample consisted of 1,466,824 vehicles.

It is clear from the time course of eligibility and ineligibility of vehicles in the SR that the number of serious and dangerous defects identified in the course of technical inspections increases with the age of vehicles. In vehicles up to four years of age, 5.93% of serious and dangerous defects were detected, and in vehicles older than 16 years, this was the case for as much as 17.49% of serious and dangerous defects. However, this is not a random phenomenon affecting a single year or country. This pattern has also been shown by a study conducted on a similar topic in other Member States of the EU. In addition, it was indicated that due to their higher weight and longer distance wear and tear, buses and heavy goods vehicles break down at a faster rate and experience more frequent serious and dangerous failures than passenger cars.

It follows that the factor with the greatest influence on the occurrence and amount of technical defects found in a vehicle during a roadworthiness test is the age of the vehicle and the vehicle mileage (which corresponds to its age).

In Slovakia in 2019, the average ages of light trucks, heavy goods vehicles and buses were 13.2, 12.7 and 12.3 years, respectively. As the average age of vehicles of Slovak carriers and the related incidence of faults on these vehicles is relatively high, in general, this can also affect transport and logistics systems through the results of TRIs, in which Slovak carriers participate.

Lastly, it should also be mentioned in this context that the financial impact on the carrier operator of a ban on the use of a vehicle with dangerous faults is not limited to a possible fine that is imposed by the inspecting Member State authorities. Other costs which may be incurred include the cost of towing a vehicle to the facility conducting roadworthiness tests for a more thorough inspection, the cost of the inspection itself, as well as the cost of necessary repairs to eliminate the faults. It is also necessary to take into account the indirect costs that the carrier may incur by not meeting the schedule. In addition to possible losses due to the cessation of shipments, significant negative consequences include the loss of customer confidence and the threat of losing business in the area.

Finally, in accordance with Directive no. 2014/47/EU, as of 20 May 2019, the information on the number and severity of faults has to be provided to the risk assessment system of carriers created under Directive 2006/22/ES of the European Parliament and of the Council of 15 March 2006. Based on the minimum conditions for the implementation of Council Regulations (EHS) No 3820/85 and EHS No 3821/85 on social legislation relating to road transport and repealing Council Directive 88/599/ EHS

[43], the vehicles owned by the carriers having a high risk profile are to be subjected to more frequent TRIs.

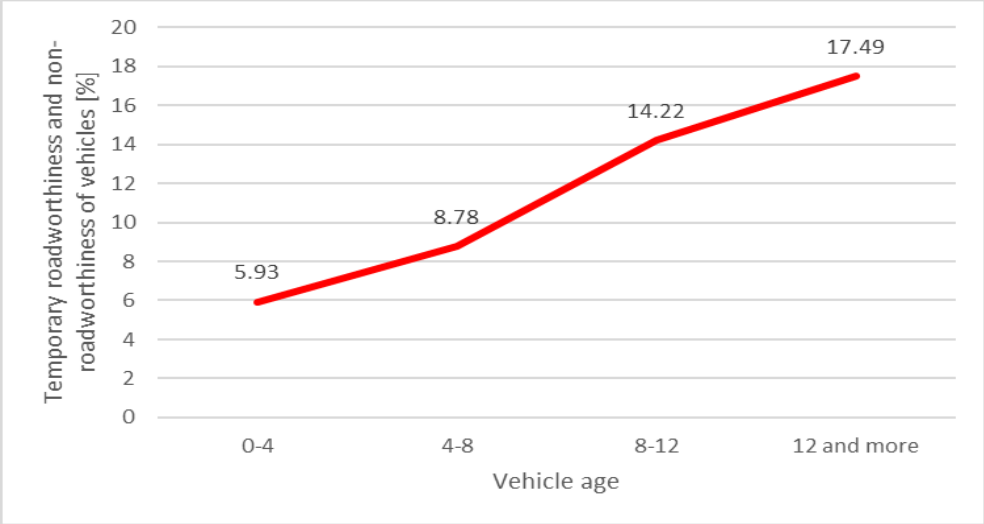

Fig. 5. Dependence of the occurrence of vehicle faults depending on age in the Slovak Republic in 2019

7. RESULTS AND DISCUSSION

In the Slovak Republic, 8,881 TRIs were performed in 2019, which represents approximately 7.06% of the total number of registered vehicles of categories subject to TRIs. Most vehicles were inspected in the Prešov Region, and the fewest were inspected in the Žilina Region. Of all inspected vehicles in the SR, the share of vehicles registered in Slovakia was 53.9%. The highest proportion of vehicles registered in Slovakia was inspected at TRI in the Bratislava region (70.59%) and the lowest in the Košice region (26.93%). The total disqualification of vehicles for road traffic with a ban on the use of vehicles reached the value of 21.40% at the TRI in Slovakia in 2019, while the number of disqualified vehicles was the highest in the Banská Bystrica region (50.17%) and the lowest in the Trenčín region (3.48%).

Regarding the possible impact of TRIs on transport and logistics systems in individual counties of Slovakia with regard to the higher percentage of ineligible vehicles for road traffic evaluated through TRIs in individual regions and the related bans on the use of such vehicles in road traffic until the identified faults are eliminated, this may occur in the Žilina, Nitra, Bratislava, Prešov and Banská Bystrica Regions, especially in the last two regions named.

The correlation analysis showed that the number of inspections under TRI is weakly related to the number of logistics centres, while the relationship between the number of detected faults and the number of logistics centres depends on other factors. It has also been shown that the number of TRIs has a moderate relation with the number of inoperative vehicles.

However, the most important factor that objectively affects the occurrence of faults on vehicles and, thus, the result of any roadworthiness test is vehicle age. Therefore, it is necessary to maintain the vehicle fleet in the best possible technical condition or to renew it regularly. This will prevent possible sanctions, losses due to the cessation of shipments, loss of customer confidence and threats to business.

8. CONCLUSION

It should be noted that in most cases, there are significant differences between individual counties of the SR regarding the number of TRIs performed and their results. These differences cannot be explained by specific regional specifics or objective laws. Therefore, this phenomenon is most likely caused by subjective factors, which are mainly priorities, the level of equipment and the deployment of individual

units of the police force which perform these TRIs in individual counties. For this reason, the TRI results may change from year to year in individual counties of the Slovak Republic.

Appropriate studies do not provide a solid basis for quantifying the impact of vehicle roadside inspections on transport and logistics systems or on the number of accidents. However, the results show that the existence of roadside inspections or increases in their frequency contribute to the reduction of traffic accidents.

As TRIs aim to exclude vehicles in a technically unfit condition from traffic, systematic and random inspections of vehicles are also a major contribution to increasing road safety. Their exact impact could be the subject of future studies.

Acknowledgements

This research was funded by the project of institutional research of the Faculty of Operation and Economics of Transport and Communications, University of Žilina no. 2/KCMD/2021 Research on the impact of urban logistics on the environment.

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Received 06.01.2022; accepted in revised form 30.08.2022