FACTORS NEGATIVELY AFFECTING THE QUALITY OF WORK OF PTI TECHNICIANS - THE CASE OF THE SLOVAK REPUBLIC

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Resume
The authors examine the negative impact of objective and subjective factors on the quality of work of periodical technical inspection stations (PTI) technicians. In this context, the authors conducted a survey among the PTI technicians and vehicle operators. From the results formulated in the article, it emerged that the quality of PTI technicians' work, and thus the entire PTI, is negatively affected mainly by the high degree of subjectivity entrusted to PTI technicians, when evaluating the technical condition of vehicles (94.12 %) and the resulting scope for incorrect judgments and influencing the result of PTI (corruption, acquaintances), and the approach of PTI owners (influencing technical inspections results due to fear of losing customers, pressure on quantity over quality, method of rewarding the PTI technicians, etc.). The authors also propose some measures to improve the quality of PTI activities.

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1 Introduction

To increase the road traffic safety, every civilized country has minimum technical requirements that must be met by vehicles in the road traffic. The introduction of regular inspections of the technical condition of vehicles and regular measurement of emissions is also related to this [1].

The periodical technical inspection station (PTI) is a workplace specialized in carrying out technical control. From the point of view of safety, these workplaces are very important. Through them, errors on the vehicle, its parts, systems, components, or separate technical units, are identified to eliminate the possibility of traffic accidents [2]. The technical suitability of these vehicles for operation in the road traffic is assessed based on the detected faults on the vehicles.

Technical inspections are carried out in approved premises using approved devices. Technical inspections are directly carried out by the PTI technicians, who must have the necessary education, experience and qualifying examination.

Given that the basic element of PTI is the PTI technician, who is a human being with all the human qualities that underwrite his work, PTI technicians are also the weakest link in the process of performing technical inspection and need to be given special attention. They carry out technical inspections independently and under their own name, as a part of which they have the task of identifying all the defects on the vehicles and categorizing them correctly. The PTI technicians are individually responsible for their activities. Given that the work of PTI technicians has a direct impact on the road safety, it is very important how they perform it.

Various objective and subjective factors can negatively affect the quality of work of the PTI technicians. They objectively create prerequisites for the activity of PTI technicians, the subjective ones directly affect their activity, and respectively they can also complement or condition each other. In this context, it is also necessary to distinguish between the intentional and unintentional actions, degree of culpability, etc. In the article, the authors focused on investigation of

the objective and subjective factors that can negatively influence the activities of the PTI technicians in the case of the Slovak Republic.

1.1 Literature review

Technical inspections have a significant impact on road safety, and the technician plays an important role in it. A study by Schulz and Franck analyzed the benefits of introducting a new system of technical controls in Pakistan in 2016. The results show a measurable impact of technical controls on reducing the traffic accidents [3].

The importance of technical inspections is described in the article by Klemenc et al. They analyzed the results of technical inspections of selected EU countries - Slovenia, Germany and Finland. According to the results of technical inspections in Slovenia, the lighting and braking systems are among the most significant defects. These systems check within the framework of technical inspection can be considered as objective diagnostic methods [4].

Checking the brake system is the most important diagnostic activity during the technical inspection from the point of view of vehicle safety. Although commonly available objective methods for diagnosing the brake systems in the form of roller brake testers are currently used, these methods are also constantly evolving. This is mainly due to the possible influence of the brake performance result by the the technician (e.g., manipulation of the tire pressure). This problem is analyzed by Ajami et al. [5].

Obs, Glowinski and Kurpisz analyzed the technical condition of vehicles in western Poland. On a representative sample of vehicles, they described the most significant defects detected during technical inspections in Poland. The value of vehicle ineligibility in this country is significantly low - 3% [6].

To objectify the performance of technical inspections and eliminate the influence of the technician, it is possible to expect the implementation of several diagnostic systems in the future, which would enable the detection of the defects of various vehicle parts. Since the road vehicles are increasingly equipped with electronic systems, it will be necessary to diagnose these systems during the technical inspections. Authors of [7] analyzed the possibilities of checking adaptive systems in road vehicles.

In some EU countries, the technical condition of the vehicle's suspension is now objectively checked. One of these countries is Poland, where suspension testers are used for checking the technical condition of this vehicle system. Szczypinski-Sala, Kot and Hankus dealt with the possibilities of testing the spring system [8].

In addition, during the inspection of the vehicle's exhaust system, it is possible to expect the introduction of new measuring devices to identify the concentration of pollutants, such as NOx, or particle numbers. Franzetti et al. pointed out the importance of measuring the volume of nitrogen oxides during the checking of the vehicle's emission system [9].

Todić, petkovic and Vranjes also analyzed the composition of gasoline and diesel engines exhaust gases and the possibilities of checking them during the technical inspections [10].

2 Material and methods

The basic documents and sources for application of investigation methods are data from the Automated National Information System of Technical Inspections (CIS TK), which stores data on the results of technical inspections from all the PTIs in the Slovak Republic and methodological instructions for carrying out technical inspections, issued by the Ministry of Transport of the Slovak Republic (MOT). Additional data on PTI, PTI technicians, PTI technician competence training and qualifying examinations, were obtained from the Technical Service of Technical Inspections TESTEK, as, as well as from the first author's own work at the MOT.

All the obtained data were further processed by the authors of the work, and statistical methods and tools, as well as graphic interpretation, were used for their processing [11]. The results of a survey, conducted by the authors for this purpose among PTI technicians and vehicle operators, form the basis for elaboration of this article.

A questionnaire was created to find out the opinions of the PTI technicians on the setting of their competence training, which they must undergo by law, as well as to find out other factors that can negatively affect their activity, consisting in not evaluating defects on vehicles. The survey was conducted through an electronic questionnaire developed in the Google Forms application, through which the PTI technicians were asked eight questions. This survey was carried out between February 10, 2023 and February 28, 2023, and PTI technicians were informed about it through CIS TK. The survey questions were divided into two groups. The first group consisted of questions related exclusively to the educational system of PTI technicians, and the second group consisted of questions related to other factors potentially influencing the activity of a PTI technician.

At the same time, an orientation survey was conducted among vehicle operators on factors negatively influencing the results of technical inspections. The survey was conducted among random vehicle operators throughout Slovakia, who were asked two questions and their answers were recorded in a paper questionnaire.

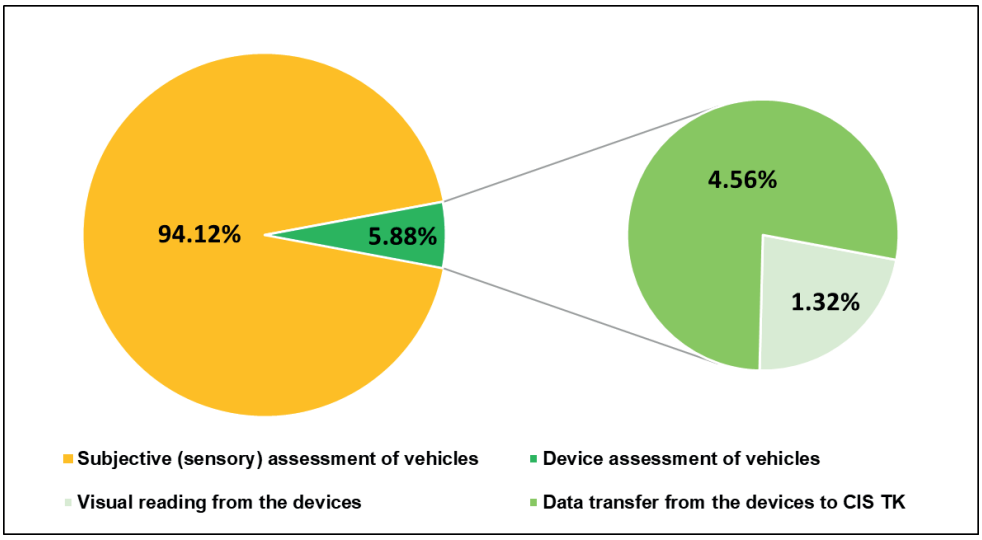

Figure 1 *Sensory and device assessment of vehicles*

3 Investigation of factors negatively affecting the quality of work of the PTI technicians

Within this section, selected factors negatively influencing the activity of PTI technicians, are examined. For this purpose, however, it is necessary to first examine the conditions creating space for the action of factors that negatively affect the activity of the PTI technician. In the case of PTI technicians, the degree of subjective decision-making when assessing the technical condition of vehicles, which was legislatively entrusted to them by the state, can naturally be considered as such a basic condition. The greater the scope for subjective judgments PTI technicians have in their work, the greater the scope for influence of factors negatively affecting the quality of their work.

3.1 Investigating the degree of subjectivity and technology in the work of the PTI technicians

The PTI technicians assess the technical condition of a vehicle, its parts, components and separate technical units, through devices and senses (sight, hearing, smell and touch) as part of the technical inspection, based on their knowledge acquired through formal education, competence training and their experience. Intuitively, it can be assumed that wherever a PTI technician evaluates the result of some control item by means of a device or technological equipment, the probability of a wrong judgment during its evaluation naturally decreases, and vice versa. The more control items the technician evaluates only visually or by senses, the greater the space opens up for the subjective perception of the state of the checked items of the vehicle, and thus also for the emergence of a wrong judgment. PTI's technological equipment intended for carrying out technical inspection thus creates prerequisites for an objective assessment of the technical condition of vehicles. To identify the relationships between the subjective and technological evaluation of vehicles, and thus the margin of error of the PTI technicians in performing the technical inspection, an analysis was carried out of the control items for which the assessment requires the PTI technological equipment (devices), and an analysis of the control items for which the PTI technicians use only their senses [12]. The result of the analysis is recorded in Figure 1.

From Figure 1 one can see that out of all the vehicle items inspected (986), up to 94.12% are evaluated by subjective assessment, i.e., based on the senses (especially visually) and only 5.88% by the PTI devices. However, in the background of the control items that are evaluated through devices, there is another determinant that causes their dichotomy. Namely, 1.32% of control items are evaluated based on the visual reading of the value from the device (pressure gauge, thermometer, tread depth gauge, etc.) and 4.56% are evaluated based on the data transferred to CIS TK (braking tester, mobile application for braking test measurement and error codes from the On-board diagnostics (OBD) control unit of vehicles), [13]. However, the difference between them is significant. In the case of measured data, which are then visually read directly from the device, without being transferred to CIS TK, they may be misinterpreted by the PTI technicians and there is no proof of their relevance for the supervision bodies. When data (defects) are transferred directly from the devices to CIS TK, the possibility of their incorrect interpretation is eliminated and, at the same time, they serve as proof of the correctness or incorrectness of the assessment of related control items by PTI technicians. This causes the highest objectivity of the technical assessment condition of vehicles.

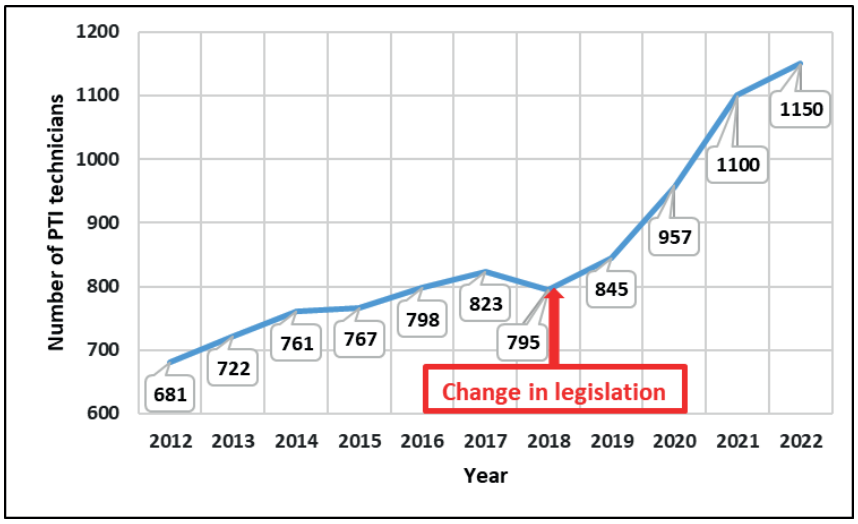

Figure 2 *Development of the number of the PTI technicians in the period 2012 - 2022*

The above points out the three basic ways of non-relational (technical) work of the PTI technician. The first way refers to parts of the technical inspection where judgments are based solely on a subjective basis. The second method points to the reality of a continuous combination of subjective judgments with the help of the use of available devices means, i.e., their parallel and simultaneous referentiality. In the third method, devices are considered the only frame of reference for the PTI technician's decision-making about vehicle faults, in which the subjective judgments are not a relevant basis for the decision-making. At the same time, all the three mentioned methods of non-relational work of the PTI technician are significantly permeated by the education and mechanical experience of the PTI technicians.

Devices (objective) assessment of defects on vehicles represents for the PTI technicians not only a prescribed, but an internalized reference point for decision-making, as well, and therefore the simplest and most objective way of performing the technical inspection. This is the strongest point of technical inspection of vehicles. However, the subjective (sensory) assessment of the vehicle's technical condition is the most decisive in the process of technical inspection, and for the PTI technician it is the most used and most important tool for identifying the vehicle defects. It also represents the most demanding part of non-relational work, where there is a very high risk of incorrect judgment by the PTI technician, caused by unintentional or even intentional actions. This is the weakest point of technical inspection [14].

Based on the aforementioned finding, it is possible to examine the impact of specific factors (from objective to subjective) that can negatively influence the activity of the PTI technicians through their subjective (sensory) assessment of the technical condition of a vehicle.

3.2 Investigating the impact of the PTI technicians' education on selected negative indicators

If we do not take into account other factors, the basic prerequisite for the activity of the PTI technician is his knowledge and skills. He acquires them formally through official education at school in a certain curriculum, covered by an educational institution, and he acquires them informally during his work, as a part of compulsory training for technicians and through practice. However, both of these types of education can play an important role in terms of the quality of work performed by the PTI technicians. To assess the formal and informal education of the PTI technicians for their work, a survey will be conducted within this section.

Compared to the previous legislation, in the Slovak Republic Act No. 106/2018 Coll. among other things, they simplified the conditions regarding the education and experience of persons wishing to become the PTI technicians. The required technical education in defined fields and relevant experience can be replaced by an exam to verify knowledge about vehicles, the so-called pre-education. The exam may be voluntarily preceded by professional training. The aim of this was to make the work of the PTI technician available to a larger number of people, since at the time of creation of the relevant legislation, there was a decrease in the number of PTI technicians, as well as interest in this work. Similarly, with the new legal arrangement, compared to the previous one [15], the PTI network was also released, which means that conditions were established for creation of other PTIs [16], and the related need for new technicians.

This became apparent immediately, when after the Act No. 106/2018 Coll. the number of the PTI technicians began to rise sharply, which is shown in Figure 2.

Given that the replacement of formal technical

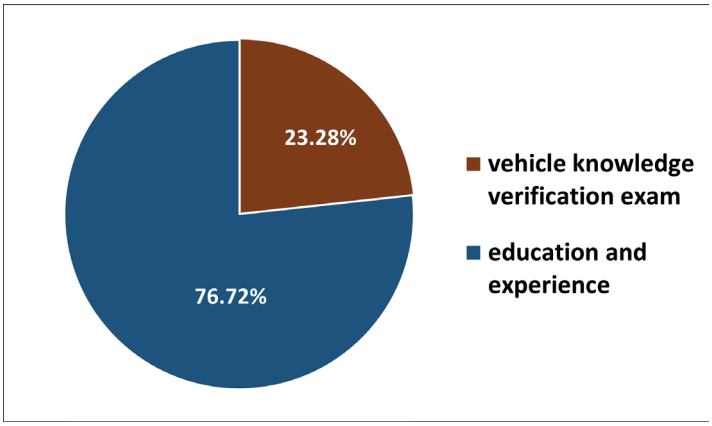

Figure 3 *Percentage share of education of participants in the basic competence training of the PTI technicians in the period 2020-2022*

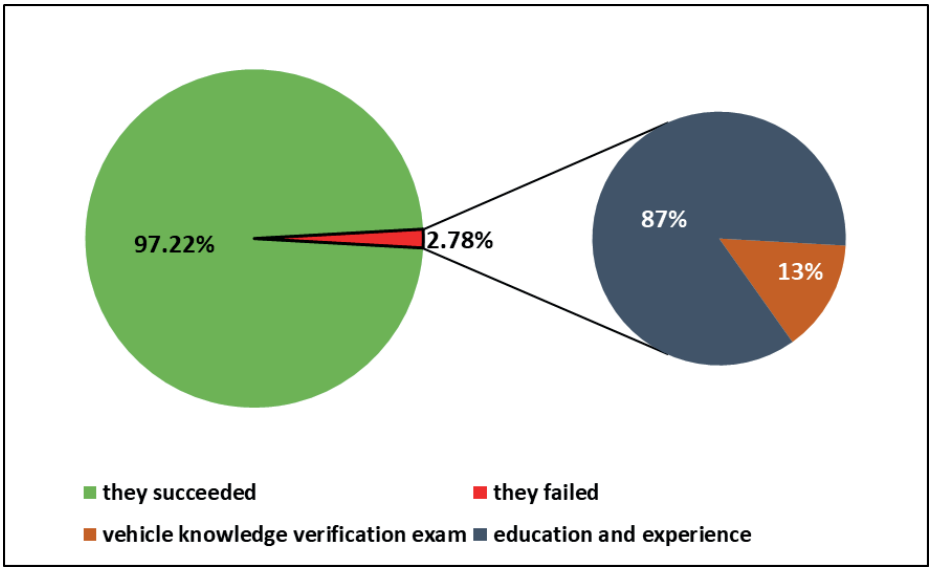

Figure 4 *The overall success rate of the exams in the period 2020-2022 and the relationship to the education of the PTI technicians*

education and related experience with an exam to verify knowledge about vehicles, the so-called pre-education can be considered as a factor that could theoretically negatively affect the work of a technician, from the point of view of insufficient knowledge and experience resulting from the absence of relevant formal education, the above will be subjected to investigation, from the point of view of selected critical indicators, which are success in the technician's professional qualifying exam, and violation of regulations consisting in failure to identify serious and dangerous defects on vehicles by the PTI technicians.

For the purposes of that research, the basic benchmark was the ratio of the number of the PTI technicians who were replaced by the fulfilment of proper educational conditions in the relevant technical fields, and the practice by vehicle knowledge verification exam, to the number of technicians who fulfilled those conditions properly. The subjects of the research were persons who participated in the basic competence training of the PTI technicians in 2020, 2021 and 2022. From the mentioned persons, those who successfully completed the vehicle knowledge verification exam, before the basic competence training, and those who fulfilled the proper requirements for education and experience, were identified. By comparing them to each other, the percentages were calculated, which are shown in Figure 3.

From Figure 3 can be seen that in the monitored period, almost a quarter of the graduates of the basic competence training of the PTI technicians did not have a formal education, but replaced it with an exam to verify their knowledge of vehicles. In the following section, these basic preferential shares of groups of technicians are compared to selected critical indicators and their influence is investigated.

As a result of replacing the formal education of the PTI technicians with an exam to verify their knowledge about vehicles, the success of the technical inspection technicians' professional competence exams that followed the basic training in the years 2020, 2021 and 2022 is presented in Figure 4.

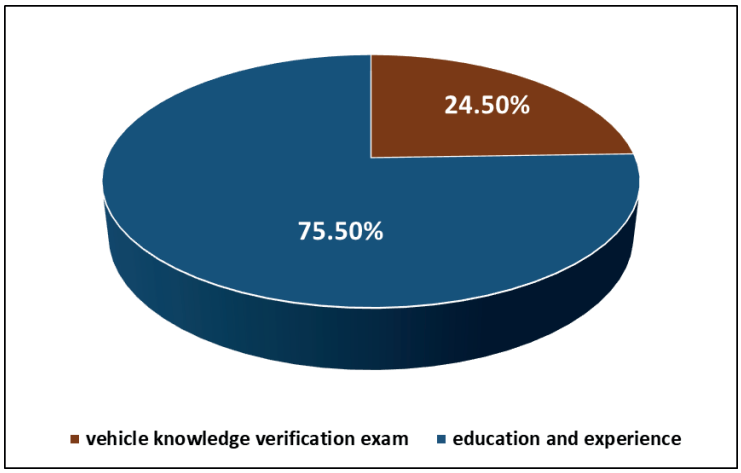

Figure 5 *Percentage share of education of the PTI technicians who were found to be in violation of regulations in the period 2020-2022*

In Figure 4 is shown that in the observed period, after the basic competence training of the technicians, a total of 97.22 % of the graduates of the basic competence training were successful in the qualifying examinations for the professional competence of technical inspection technicians, and 2.78 % of the graduates of the basic competence training were unsuccessful (after all three exam dates). Of the unsuccessful graduates of basic training in the qualifying exams, 87 % met the proper requirements for education and experience of a PTI technician, and 13 % of them replaced it by an exam to verify the knowledge of vehicles. Based on the mentioned criterion, it is therefore not possible to conclude that the replacement of proper education and experience with a vehicle knowledge verification exam for participants in the basic competence training of the PTI technicians, in the period 2020 - 2022 have resulted in their failure in the PTI technician qualifying exam. The share of people with the so-called pre-education, among those who failed the PTI technicians' professional competence exams (13 %), is lower than their overall share among graduates of basic competence training (23 %).

The impact of replacing the formal education of the PTI technicians with a vehicle knowledge verification exam on the activity of the technical inspections technician was investigated in such a way that for the period of 2020 - 2022 all the PTI technicians were identified for whom the professional supervision authorities found violations of related regulations, which consisted in not recording serious and dangerous defects on vehicles. Subsequently, it was investigated to what extent those PTI technicians fulfilled the conditions for proper education and experience according to Act No. 106/2018 Coll., and to what extent they replaced this education and experience with the vehicle knowledge exam. The result of this comparison is shown in Figure 5.

From Figure 5, it is clear that of the PTI technicians, who were found by the supervisory authorities to have violated regulations in the period 2020 - 2022 by not detecting serious and dangerous defects on vehicles, 75.50 % met the conditions for proper education and experience according to Act No. 106/2018 Coll., and 24.50 % replaced this education and experience with a vehicle knowledge verification exam. The mutual ratio of fulfillment of the conditions for the education of the PTI technicians among the technicians who violated the regulations was almost identical to the mutual ratio of the fulfillment of the conditions for the education among the graduates of the basic competence training (Figure 3). Based on the mentioned criterion, it is therefore not possible to conclude that the replacement of proper education and experience with a vehicle knowledge verification exam for the PTI technicians in the period 2020 - 2022 would result in a higher rate of violation of regulations by such the PTI technicians, as a result of their lower level knowledge and experience in the field.

Thus, the mentioned survey did not prove the influence of individual alternatives of the required education of the PTI technicians on the selected critical indicators. The replacement of proper technical education and experience with a vehicle knowledge verification exam had no effect on this category of people's success in PTI technicians' qualifying competence exam, nor on their rate of violation of regulations in connection with the failure to identify serious and dangerous defects on vehicles. In other words, in connection with the research on the impact of the the PTI technicians education on the selected critical indicators, no negative phenomenon was identified, which could be interpreted as a consequence of the lower level of knowledge and experience of the PTI technicians, resulting from the replacement of their formal education and experience with the vehicle knowledge verification exam, and, therefore, negatively affecting the quality of work of the PTI technicians.

Within this, however, only the requirements for the technician in terms of formal education were examined. What is more essential for the work of the PTI technician is the system of their mandatory competence trainings, which are already precisely focused on performance

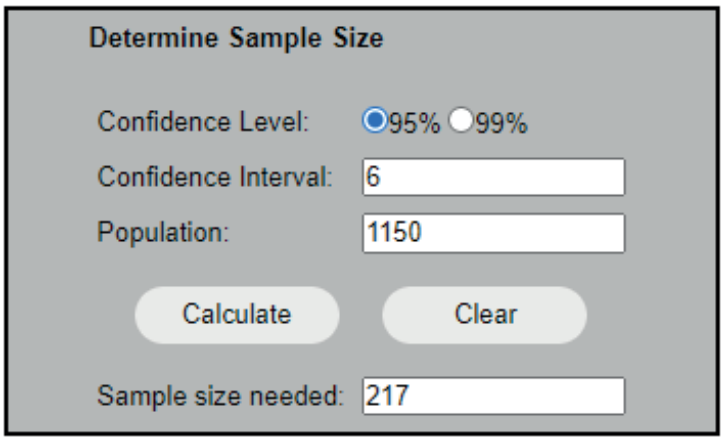

Figure 6 *Determining the sample size using the Sample Size Calculator service [18]*

of the PTI technician's work. However, whether this informal education (competence training) of the PTI technicians is suitable for their activity was investigated by a questionnaire survey, which is evaluated in the following section of the article.

3.3 Survey about the competence training conducted among the PTI technicians

In connection with the search for answers to some research questions, a survey was conducted among the PTI technicians in the Slovak Republic, which was methodically described in section 2. Part of the questions of this survey were related to the competence training of the PTI technicians, to which the technicians are required by law to undergo (basic competence training and refresher training). The subject of this part of the survey was the assessment of the sufficient setting of the competence training for the technician's work (content, scope, frequency), from the point of view of the PTI technicians.

In this context, the PTI technicians were asked the following four questions:

1. In your opinion, is the current system of competence training and refresher training for technicians sufficient for quality technician work? (Answer option "YES" or "NO").
2. In your opinion, is the knowledge acquired at the mandatory competence training of PTI technicians (basic training/refresher training) sufficient for the job of a technician? If not, state what and how you would change the training. (Answer option "YES" or "NO"; when answering "NO" a free text field was displayed).
3. In addition to the current PTI technician refresher training, would you welcome more frequent training without a qualifying exam? (Answer option "YES" or "NO"; when answering "YES", the following answer options were displayed: "EVERY YEAR", "EVERY TWO YEARS", "OTHER INTERVAL" - with the option of entering the free text).
4. Would you change the competence training and examination system for technicians in any other way? (Answer option "YES" or "NO"; when answering "YES" a free text marking field was displayed).

To determine the minimum sample of the PTI technicians, data on the number of the PTI technicians at the start date of the survey was used, i.e., 10/02/2023. According to the CIS TK, 1150 PTI technicians were registered on that date, [17]. The Sample Size Calculator was used to calculate the sample [10], with the following parameters:

- The confidence level (Confidence Level), 95 % is the most often used, therefore this standard value was used.
- A confidence interval is a type of interval estimate of an unknown parameter in statistics; in this case the number 6 was chosen.
- In this case, the total number of statistical units of the basic file (Population) is 1150.

The result is the minimum sample calculation shown in Figure 6, which, in this case, is 217.

As a part of the evaluation of the questionnaire survey, it was found that 255 PTI technicians participated in the survey, which sufficiently fulfilled the calculated minimum sample, or was significantly exceeded. It follows from the above that the results of the survey can be fully used and considered representative within the set criteria. The answers to each survey question were processed and then presented in graphs. Answer to question No. 1 is shown in Figure 7.

From the results of the answers to questionnaire question No. 1, it is shown that more than two-thirds of PTI technicians who participated in the survey are satisfied with the system of basic competence training and further refresher training of technicians (70.40 %). Less than a third were dissatisfied (29.60 %). In this context, however, it is necessary to mention that question No. 1 was formulated in general terms, i.e., whether the technicians are generally satisfied with the system of their competence training, i.e., they must

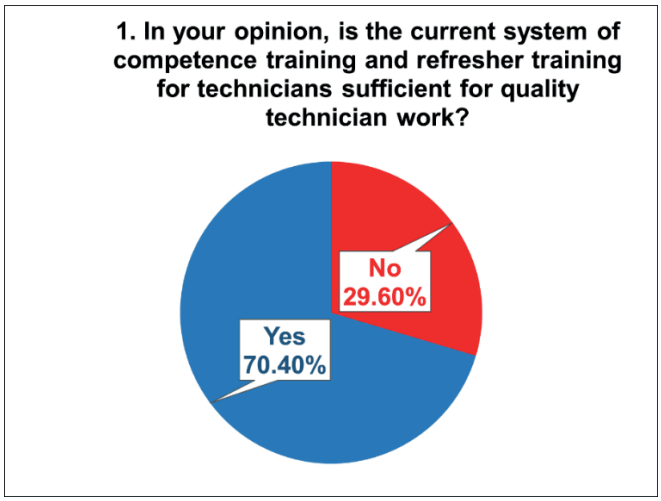

Figure 7 *Answer to question No. 1 survey*

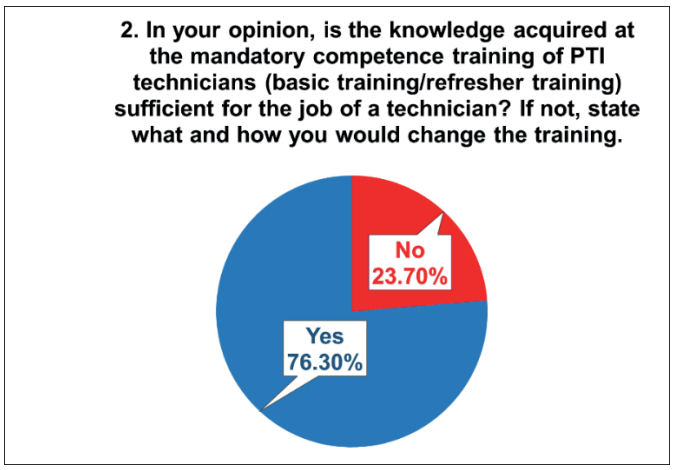

Figure 8 *Answer to question No. 2 survey*

first undergo the basic competence technician training and then, at regular intervals, a refresher trainings. Question No. 1 was not concerned with satisfaction of the PTI technicians with the training content. Only question No. 2, the answers to which are shown in Figure 8, covered that aspect.

The answers to question No. 2 showed that more than three-quarters of PTI technicians are satisfied with the knowledge they acquired at mandatory technician competence training (76.30 %), or they consider this knowledge sufficient for their work. Less than a quarter do not consider this knowledge sufficient (23.70 %). Of the disaffected the PTI technicians, 53 took the opportunity to state how they would change the training by entering free text. According to their answers, the vast majority of them would make change, in particular, for refresher training to be more frequent, either based on the shorter periodicity, or changes in methodological instructions or legislation. The current 5-year period of refresher training is perceived as significantly insufficient for the PTI technicians. In addition, many PTI technicians would do away with the exams that are mandatory at the end of each refresher training. Furthermore, in training, the technicians would welcome more practical demonstrations and examples, as well as more hours of practice.

A separate question is No. 3, the answer to which is shown in Figure 9.

According to the answers to question No. 3, up to 92.10 % of PTI technicians would welcome, in addition to the current refresher training courses for technicians (every 5 years with a qualifying exam), more frequent training without a qualifying exam. Only 7.90 % of the PTI technicians polled would be opposed. The PTI technicians who would like more frequent refresher training, to the sub-question asking to choose a specific shorter training interval, 51.30 % of them answered that they would like to have training every year, 38.90 % would like to train every two years and 9.80 % would choose a different PTI technician training interval. Of the PTI technicians who chose a different training interval in the survey, 22 used the opportunity to indicate which one (by entering the free text). The majority of their answers showed that they would like the PTI technician refresher training to take place as needed, especially in connection with new changes in methodological instructions or legal regulations.

Proposals for further changes to the competence

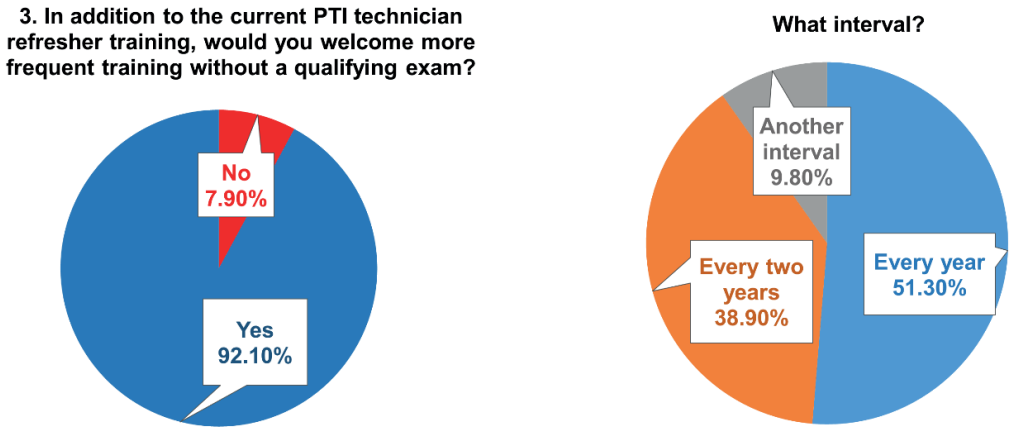

Figure 9 *Answer to question No. 3 survey*

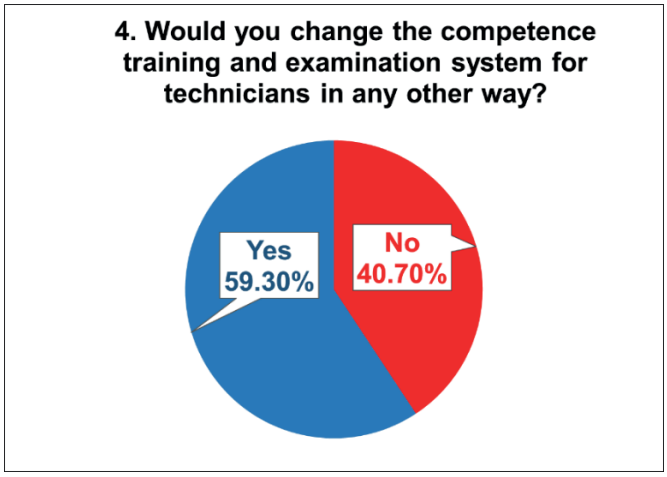

Figure 10 *Answer to question No. 4 survey*

training of PTI technicians (except those that were the subject of questions No. 1-3) were the topic of question No. 4, the answers to which are shown in Figure 10.

To question No. 4 PTI technicians who took part in the survey answered that 59.30% would change the competence training and qualifying examination of technicians in some other way, and 40.70% would not change it in any other way. Of the PTI technicians who chose the "Yes" option in the survey, 136 used the option to enter the free text. Again, the overwhelming majority of their responses indicated that they would like more frequent refresher training for PTI technicians, preferably on a yearly basis and without qualifying exams to stress them out. Qualifying exam would be recommended by PTI technicians only for those technicians who were found to be in violation of the regulations by the supervisory authorities.

The results of the presented questionnaire survey showed that more than 70% of PTI technicians, who participated in the survey considered, found the setting of the competence training to be sufficient, as well as more than 76% of the technicians consider the knowledge they acquired at these trainings to be sufficient, as well. However, as regards the frequency of refresher training, the situation was clear. More than 90% of PTI technicians, who participated in the survey, expressed an opinion that, in addition to the current refresher training conducted in 5-year periods, they would welcome even more frequent training conducted mainly at annual intervals. Such an opinion was often repeated in the answers of PTI technicians in the form of inserting the free text. At the same time, there were repeated requests to put more emphasis on the practical part of the training and to explain the current changes in the legislation. Regarding the open questions, many PTI technicians also demanded the cancellation of the qualifying exam, which currently ends the five-year competence training in the Slovak Republic.

3.4 Survey conducted among the PTI technicians on the technical inspections results influenced by the PTI owners

In the previous part of the article, objective factors that could negatively affect the quality of work of PTI technicians were investigated by authors. In addition to these, there are also the subjective factors that can

play an even more important role in the evaluation of vehicles. The risk of negatively influencing the result of the technical inspection by PTI owners, as well as the PTI technicians, is the greatest. In connection with the investigation of the existence, manifestations and reasons for influencing the results of technical controls by the PTI owners, a questionnaire survey was conducted among the PTI technicians, which is evaluated in this part of the article.

The survey was already methodically described in section 2. Part of the survey questions was related to performance of the work of PTI technicians, and the subject was the search for factors that could negatively affect the quality of work of PTI technicians by directly or indirectly influencing the result of technical inspections by the owner of PTI.

In this context, the PTI technicians were asked the following four questions:

1. Does the PTI owner interfere with the way inspections are carried out (e.g., require you to overlook certain faults on preferred vehicles)? If so, describe how. (Answer option "YES" or "NO"; when answering "YES" a free text marking field was displayed).
2. Are you also rewarded based on the number of inspections performed? (Answer option "YES" or "NO").
3. What is your average monthly salary (gross)? (The following answer options were displayed here: "from 500 € to 1000 €", "from 1001 € to 1500 €", "from 1501 € to 2000 €", from "2001 € to 2500 €" and "from 2501 € and more").
4. Are you satisfied with the quality of the working environment? If not, give reasons. (Possibility of answering "YES" or "NO"; when answering "NO" a free text field was displayed).

Since the mentioned questions were asked by the PTI technician as a part of the survey, which was already described in subsection 3.3, the same parameters apply to it, and the answers to the questions can be considered representative within the set criteria. The answers to each survey question were processed and then graphically presented. Answer to question No. 1 is shown in the graph in Figure 11.

From the results of the answers to question No. 1 it was shown that for almost a fifth of the PTI technicians (20.20 %) who participated in the survey, the PTI owner intervenes in the way the technical inspection is carried out, i.e., demands that certain defects on the preferred vehicles be overlooked. Almost four fifths of the PTI technicians (79.80 %) are not interfered with by the owner in the performance of their work. Of the PTI technicians whose PTI owner interferes with their activities, 38 used the opportunity to indicate in what way (by entering the free text). To a lesser extent, the PTI technicians reported being pressured by the PTI owners to inspect the vehicles of their acquaintances for faults. However, the overwhelming majority of their responses revealed that the PTI owners pressure the PTI technicians in particular to overlook defects on vehicles due to the fear of losing customers and moving them to competitors. In this context, they are putting pressure on the PTI technicians to look for defects on vehicles that are not visible on the cameras. They are mainly focused on performance (carrying out technical checks on as many vehicles as possible in the shortest possible time) at the expense of quality. Quantity brings the PTI sales, quality leads to customer outflows. The above can be considered one of the essential factors that negatively affects the quality of work of the PTI technicians and at the same time undermines the purpose for which the PTI was created. In particular, the impact of quantity on the work of technicians is expressed in the answers to question No. 2, shown in Figure 12.

From the answers to question No. 2 it is shown that more than a half of the PTI technicians who participated in the survey are also rewarded based on the number of technical inspections performed (55.70 %). The complementary part of the PTI technicians stated that they are not rewarded based on the number of technical inspections performed (44.30 %). In relation to the confidence interval of the survey, the answers to this question can be considered balanced. Remuneration of the PTI technicians for the number of technical inspections performed is intended to motivate the higher work productivity (performance of more technical

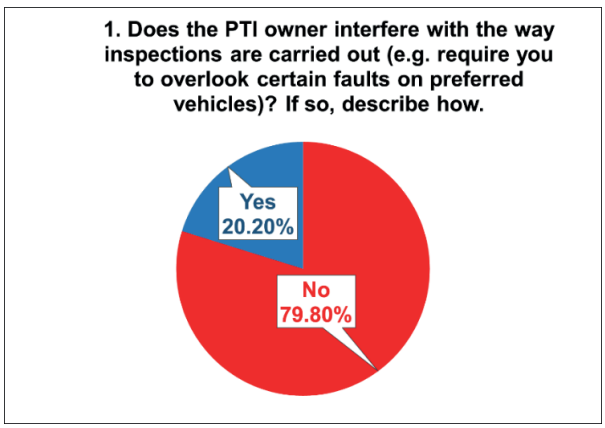

Figure 11 *Answer to question No. 1 survey*

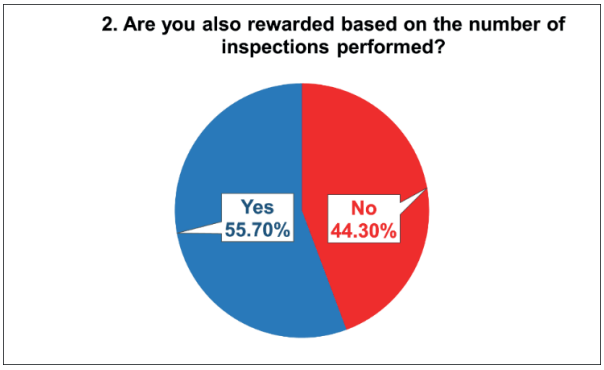

Figure 12 *Answer to question No. 2 survey*

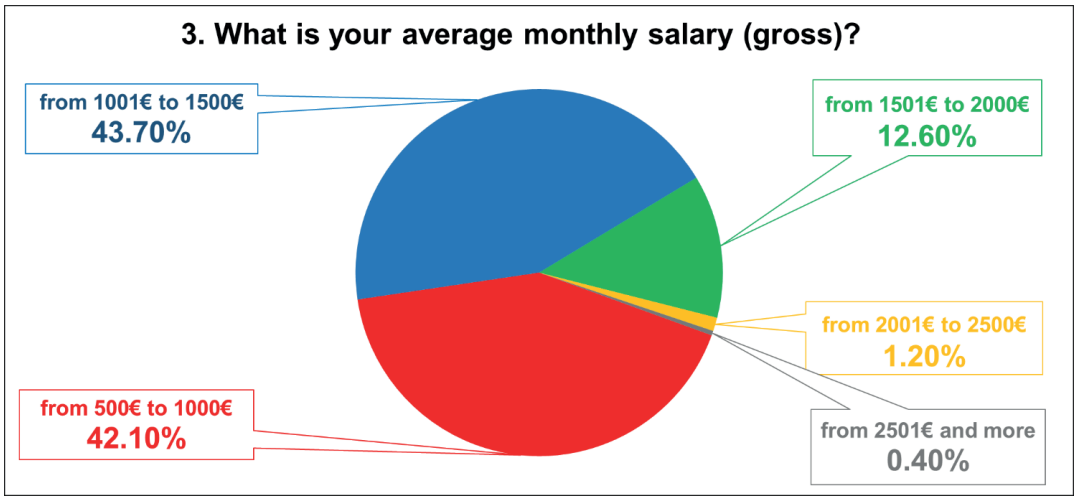

Figure 13 *Answer to question No. 3 survey*

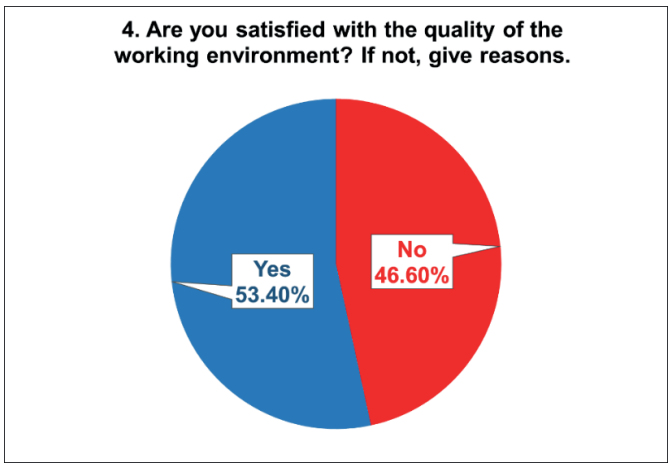

Figure 14 *Answer to question No. 4 survey*

inspections per unit of time), which also brings the PTI owners higher sales. However, the above can also be considered as one of the factors that negatively affects the quality of work of the PTI technicians, as it indirectly forces them to perform the technician's work inconsistently. The following question 3 deals specifically with the remuneration of the PTI technicians, answers to which are shown in Figure 13.

Of all the PTI technicians who took part in the survey, the largest part has a monthly salary between 1,001 € and 1,500 € (43.70 %). The PTI technicians, whose monthly salary ranges from 500 € to 1,000 € (42.10 %), closely followed and in third place are technicians whose monthly salary ranges from 1,501 € to 2,000 € (12.60 %). Technicians whose monthly salary is between 2,001 € and 2,500 € and 2,501 € and more made up a negligible part of the sample (1.20% and 0.40%, respectively,). Given that at the end of 2022, the average nominal monthly salary of an employee in the Slovak economy reached 1,304 €, according to the survey, at least 42.10% of the PTI technicians do not reach it. In relation to the answers to question No. 2, however, it is possible to assume that the gross salary data do not indicate the actual monthly income of the PTI technicians, as they do not include an additional (variable) salary component that depends on the number of technical inspections performed. At the same time, the relevance of the data on the monthly salary of the PTI technicians is distorted by the fact that, due to the preservation of anonymity, it is not known from which region the technicians who participated in the survey came from. However, for the purposes of a rough idea of the salaries of the PTI technicians to exclude extremes that would naturally result in the emergence of other negative phenomena, the collected data is sufficient.

Last but not the least, the quality of the PTI technicians' performance can be influenced by the quality of the work environment in which the PTI technicians work. This is addressed in the following question No. 4, answers to which are shown in Figure 14.

From the answers to question No. 4 it is shown that slightly more than a half of the PTI technicians who participated in the survey are satisfied with the quality of the working environment (53.40 %). Slightly less than half are not satisfied (46.60 %). In relation to the confidence interval of the survey, the answers to this question can be considered balanced. Of the PTI technicians who are not satisfied with the quality of the

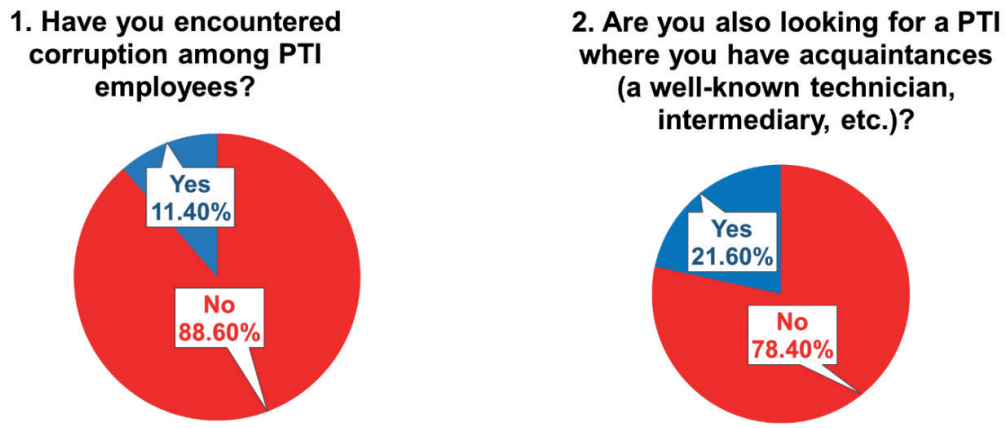

Figure 15 *Answer to survey questions*

working environment, 90 used the opportunity to state the reasons for their dissatisfaction (by entering free text). From the majority of their answers, it emerged that they most negatively perceive factors harmful to health at the workplace, such as exhaust gases, noise, dust, cold and drafts. Furthermore, the PTI technicians pointed to inadequate working conditions (equipment of premises for employees), insufficient evaluation, the fact that they are pushed to high performance by the owners of PTI, and at the same time are constantly monitored and controlled by professional supervision authorities and sanctioned. The PTI technicians consider the mentioned to be very stressful and mentally exhausting. In the case of disgruntled the PTI technicians, however, their answers can be considered predictable in a way, since the negatives, they state, result from the very nature of their activity. It is also not excluded that employees of other related industries (e.g., car repair shops, tire repair shops, etc.) would respond in the same way, and therefore it is not certain whether the negative phenomena declared by the PTI technicians could be influenced or improved by regulatory measures. Nevertheless, the dissatisfaction of the PTI technicians with the quality of the working environment can be considered as one of the factors that negatively affect the quality of their work.

The results of the presented questionnaire showed that the quality of work of the PTI technicians is negatively influenced by PTI owners, either through the direct interventions (exerting pressure to overlook faults on vehicles and to perform a large number of inspections), or indirectly through their evaluation system and the quality of the work environment.

Just as the PTI owners directly or indirectly negatively affect the quality of work of the PTI technicians, so the technicians themselves consciously influence the results of technical inspections, i.e., they deliberately do not evaluate all the serious and dangerous defects on vehicles. The existence and reasons for such actions of the PTI technicians is described by authors in the following part of the article.

3.5 Survey of influencing the results of technical inspections by the PTI technicians conducted among vehicle operators

The fact that the PTI technicians intentionally influence the results of technical controls follows from the results of professional supervision performed on the PTI by supervisory authorities [19-22]. Publicized and non-publicized criminal prosecutions of the PTI technicians for crimes of corruption, in turn, help to complete the idea of the PTI technicians' motivation for such actions. Intentional influencing of the results of technical inspections by the PTI technicians can also be indirectly demonstrated through research.

As the above is a very sensitive topic, it was not practical to conduct a relevant survey directly among the PTI technicians as they would probably not admit it. Therefore, a survey conducted on the subject among vehicle drivers, who subject their vehicles to regular technical inspections at the PTI, could provide more information. Due to the high number of vehicle drivers, as well as the fact that the mentioned topic is not the main goal of this article, the survey was only indicative, on a random sample. The subject of the survey was the confirmation or refutation of the existence of intuitive factors that have the effect of consciously influencing the results of technical inspections by the PTI technicians, i.e., corruption and acquaintances at the PTI. The basis for this is the answers of vehicle drivers who submit vehicles to regular technical inspections at the PTI.

In this context, randomly selected vehicle drivers were asked the following two survey questions:

1. Have you encountered corruption among the PTI employees? (Answer option "YES" or "NO")
2. Are you also looking for a PTI where you have acquaintances (a well-known technician, intermediary, etc.)? (Answer option "YES" or "NO")

Total of 88 people participated in the survey and the results of their answers were processed and then graphically depicted in Figure 15.

The answers to questions showed that more

than a tenth of the vehicle drivers interviewed had encountered corruption among the PTI employees. At the same time, more than a fifth of drivers also look for the PTI for a technical vehicle inspection where they have some acquaintances (technician, intermediary, etc.). Given that this is an indicative survey, the declared values may not be exact. That was not even the goal of the survey. The goal of the survey was only to confirm or refute the existence of negative factors that distort the PTI system, which was confirmed. The essence of the corrupt behavior of the PTI technicians is to intentionally assess a vehicle with serious and dangerous defects as fit for operation in the road traffic, and to ignore these defects for a bribe. The same applies to the so-called acquaintances on the PTI, which are sought by drivers of vehicles with the same intention.

Thus, the mentioned survey indirectly showed that the PTI technicians themselves deliberately influence the result of technical inspections, thereby reducing the quality of their work, as well as its value, and this also with the help of corrupt behavior and loss of impartiality, which can be considered a significant deforming element of technical inspections and an ethical problem. At the same time, the above can be considered as one of the essential factors that negatively affects the quality of work of the PTI technicians, thus undermining the purpose for which the PTI were established.

4 Conclusions and discussion

In this article, objective and subjective factors, negatively affecting the quality of work of the PTI technicians, were investigated by authors in the case of the Slovak Republic. At the beginning, the weakest link of technical inspections was defined, which is the PTI technician and his wide scope for subjective assessment of defects on vehicles, which creates the danger of wrong judgments and fraud. Of all the vehicle items checked, up to 94.12 % are assessed by subjective assessment, i.e., based on the senses (especially visually) and only 5.88 % by the PTI devices. This can be eliminated by deploying technical means monitoring the activity of the PTI technicians (e.g., monitoring and recording devices) with the possibility of archiving them. Likewise, technical means preventively eliminating the risk of incorrect (intentional, unintentional) evaluation of the results of technical inspections (devices with a connection to CIS TK, e.g., braking tester or mobile device [23]) play an extremely positive role. From the aforementioned, as well as related studies [24], it can be deduced that by deploying technical means, progress can be achieved in the quality of the PTI activities with a positive impact on the road traffic safety.

Furthermore, by examining the influence of specific (objective) factors that can negatively influence the activity of the PTI technicians, through their subjective (sensory) assessment of the technical condition of a vehicle, it was found that the effect of formal education of the PTI technicians on selected critical indicators (success in qualifying exams after the basic training of the PTI technicians and violation of regulations during the performance of technical controls) did not manifest itself. No such negative phenomenon was identified, which could be interpreted as a consequence of the lower level of knowledge and experience of the PTI technicians, resulting from the replacement of their formal education and experience with a vehicle knowledge verification exam, thus negatively affecting the quality of work of the PTI technicians.

The authors of article also examined whether the informal education of the PTI technicians (the system of their mandatory competence trainings, which are already precisely focused on the performance of the PTI technician's work) is satisfactory for their activity. This was done through a questionnaire survey among the PTI technicians. The results of this survey mainly showed that up to 92 % of the PTI technicians would like to have more frequent technician refresher training, mostly every year (51 %), without a qualifying exam, with an emphasis on changing technical inspection regulations and practical demonstrations.

As for the cancellation of qualifying exams after the refresher training, the opinions of the PTI technicians can be justified by efforts to make conditions easier and eliminate stressful situations, rather than professionally justified requirements. In addition, the complete abolition of qualifying exams could ultimately lead to a reduction in the quality of the PTI, as then the PTI technicians would not be motivated to approach mandatory competence training responsibly and any increase in their frequency could be ineffective (passive completion). However, the current qualifying exam, which the PTI technicians currently have to pass every five years after the refresher training, could be simplified by consisting of a shortened written test with practical part.

As for the requirements of the PTI technicians that their refresher training take place mainly at 1-year intervals, it would be very appropriate to respond by complying to this request, i.e. the frequency of refresher training for the PTI technicians would be shorter, e.g., every 18 months, while after the completing the third refresher training, the PTI technicians would have to pass a qualifying examination. In addition, a comparison of the competence training of selected EU states that published information on the method of providing training for the PTI technicians (Croatia, Czech Republic, Finland, Hungary, and Lithuania) showed that the frequency of refresher training in these states varies from 1 year to 3 years, [25]. With such a large dynamics of changes in regulations in the field of technical inspections, the 5-year intervals of further refresher training for the PTI technicians in the Slovak Republic are really insufficient, with a possible negative impact on the quality of work of the PTI

technicians.

In addition to the objective factors affecting the work of the PTI technicians, authors in the article are also examined the subjective factors that can play an even more important role in the evaluation of vehicles. The risk of negatively influencing the result of the technical inspection by the PTI owners as well as the PTI technicians, is the greatest. In connection with investigation of the existence, manifestations and reasons for influencing the results of technical controls by the PTI owners, a questionnaire survey was conducted among the PTI technicians. The result of this survey was that the PTI owners influence the PTI technicians to overlook defects on vehicles (especially those not visible on cameras) due to fear of losing customers and moving them to competitors. They are mainly focused on performance (carrying out a technical inspection on as many vehicles as possible in the shortest possible time) at the expense of quality. Even according to the quantity criterion, the PTI technicians are mostly evaluated. Given that the PTI technicians are employees of the PTI owners, they must respect the will of their employer.

The current setting of sanctions for violation of related regulations in the Slovak Republic is mainly aimed at the PTI technicians. Sanctions are graded according to the severity of the PTI technician violations and are applied separately for each violation. They range from 30 ↑ to 1,200 ↑, in combination with the obligation to complete special refresher training with a qualifying exam (the so-called penalty). In the case of the most serious violations, it is possible to withdraw the PTI technician's certificate, with the provision that the technician will not be able to perform his work for 10 years. On the other hand, it is possible for the PTI owner to be fined from 2,000 € to 5,000 € (usually only 2,000 €) under certain circumstances (failure to detect defects on the vehicles by several PTI technicians) and, in the case of the most serious violations, to withdraw the license to operate a the PTI (the so-called objective responsibility of the PTI owner) [26]. In relation to the common violation of regulations by the PTI technicians, the occasional sanction imposed by the PTI owner does not motivate then at all to influence the PTI technicians to perform technical inspections of a higher quality. The revenue that the PTI owners receive from the amount of technical inspections performed is far higher and more motivating than the occasional fine for not detecting defects on vehicles by the PTI technicians (the poor quality of their work). For the above reason, it would be appropriate to introduce one more sanctioning measure into the legal system of the Slovak Republic, in addition to the financial sanction, which would be aimed directly at the main motivation of the PTI owners. This would institute a temporary suspension of the PTI. If, at a given the PTI, it was determined by the professional supervision authorities, in one inspection, that the PTI technicians did not detect or record a certain number of serious or dangerous defects on vehicles, the administrative authority would decide to suspend the activity of the given the PTI for a certain period of time (for example, from a few days to a few weeks), depending on the number of undetected defects by technicians.

The mentioned measure would provide that the PTI owners would be more motivated to supervise the PTI technicians and influence them to detect all the serious and dangerous defects on vehicles, and therefore to perform their work with higher quality, and not the other way around, as it emerged from the conducted survey. The threat of a sudden decrease in sales, resulting from the temporary impossibility of performing the technical inspections, as a result of poor quality work of the PTI technicians, could eliminate the negative influence of the results of technical inspections on the part of the PTI owners and improve the quality of the PTI's work.

Furthermore, a survey, reported in this article, was carried out by authors on the influence of the results of technical inspections by the PTI technicians, carried out among the vehicle operators. From the aforementioned survey (as well as from the results of expert supervision carried out over the PTI [27]), it emerged that the PTI technicians themselves deliberately influence the result of technical inspections, including with the help of corrupt behavior and the so-called acquaintances, which can be considered a significant deforming element of technical inspections. At the same time, the above can be considered as one of the essential factors that negatively affects the quality of work of the PTI technicians, thus undermining the purpose for which the PTI were established. However, it is very difficult to apply any measures to improve the quality of the PTI activity to this phenomenon. This is a cross-sectional phenomenon, and its effective elimination is not easy. On the one hand, the Slovak Republic is fighting against corruption at the PTI so that in Act No. 106/2018 Coll. defined certification according to STN ISO 37001 Management systems against corruption, as one of the conditions for obtaining authorization to operate the PTI [28], however on the other hand, no ISO standard will prevent the PTI technician from corruption. Likewise, the occasional crackdown on corruption among the PTI technicians by law enforcement agencies has a preventive effect only in the short term. This is a significant ethical problem and the attempt to eliminate corruption at the PTI is a huge challenge for the future.

Authors of this article, objective and subjective factors negatively affecting the quality of work of the PTI technicians in the Slovak Republic environment, were investigated. However, the question remains whether the results of this article would not have been predictable, even without any research being carried out in this area. The basic element of technical inspections is the PTI technician, who is a human being with all the human qualities that underlie his work. Taking this fact into account, then one could intuitively assume that the

work of every person (not excluding the PTI technician) is positively affected by the degree of use of technical means that prevent fraud and enable better control, as well as the fact that the greater the scope for subjective judgments, the more room there is for mistakes and fraud, that no one does a full-quality job, that the one who has been entrusted with the authority to decide on something is also prone to corrupt behavior (especially if he has a low salary), that the essence of business is creation of profit and retaining customers, and that the more measures are taken aimed at eliminating phenomena, caused by the human factor, the more the quality of the resulting product or service would increase. On the other hand, without research, it would not be possible to adopt these general assumptions automatically for the PTI environment in the Slovak Republic, but in particular, it would not be possible to determine the extent and importance of individual factors that influence the quality of the PTI activity. Moreover, a fully harmonized system of technical controls is in place within the EU member states, however, no comparable average vehicle evaluation results [29]. At the same time, in each state, a person with the same human characteristics and according to the same rules performs the technical control. From the above, it follows that in each EU country there are certain specificities that more or less influence the quality of the PTI activities, and therefore it certainly made sense to get to know them in detail, and examine them in the Slovak Republic environment. Because this is the only way to effectively target them when creating measures to improve the quality of the PTI activities.

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Conflicts of interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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