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Analysis of Failures Admitted and Not Admitted by Types of Cars as Part of Authorized Periodic Technical Inspections

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Abstract: This paper aims at an analysis of the defects found in motor vehicles during the mandatory technical inspections carried out in an authorized periodic inspection station. Periodic technical inspection is defined as an inspection designed and carried out to ensure that a vehicle can be used safely on public roads and that it complies with the mandatory safety and environmental characteristics. The analysis of the defects was performed by centralizing the data of the vehicles that were presented for the periodic technical inspection within a station in Galati and that were detected with defects. The study was conducted for the period 2019-2020. In the first phase, for each case, the date of submission to the periodic technical inspection process, make, model, year of manufacture, total mileage and constant defect were highlighted. Subsequently, for a complex analysis, the country of origin of the vehicle manufacturer was identified and the defects found were grouped into categories that refer to the subassembly to which it refers. Following the correlation made between faults and the country of origin, we noticed that English vehicles are the most prone to faults that refer to the exhaust system, the steering system, the signaling system and those classified as other non-conformities.

Keywords: car; statistical analysis; Pearson function

JEL Classification: C15

1. Introduction

Periodic technical inspection is defined as an inspection designed and carried out to ensure that a vehicle can be used safely on public roads and that it complies with the mandatory safety and environmental characteristics. Vehicles registered or registered in Romania may be kept in circulation only if there is evidence of compliance with the specific technical requirements established by regulations, by conducting periodic technical inspections. The categories of vehicles subject to periodic technical inspection and the periodicity of technical inspection are as follows:

- vehicles intended for the transport of persons who have, besides the driver's seat, more than 8 seats - at 6 months;

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- motor vehicles intended for the transport of persons who, apart from the driver's seat, have at most 8 seats, at 2 years, respectively at 1 year in the case of motor vehicles that are at least 12 years old, except for vehicles of historical interest;
- vehicles used for transporting people by taxi or rental - at 6 months;
- motor vehicles used for learning to drive - one year, except for motor vehicles used for learning to drive which have, outside the driver's seat, more than 8 seats, for which the periodicity is 6 months;
- special ambulance vehicles - one year;
- motor vehicles intended for the transport of goods, having a maximum total authorized mass of more than 3500 kg - per year;

The periodic technical inspection certifies the conformity of the vehicle in terms of road safety, environmental protection and classification in the category of use according to the destination. The periodic technical inspection consists in the control of the assemblies, subassemblies and parts directly accessible, as well as of the obligatory endowments provided by the norms regarding the safety of the road traffic, the protection of the environment and the use according to the destination.

2. Materials and Methods

In order to elaborate the case study, the centralization of the vehicles that were presented for the periodic technical inspection within a station from Galati municipality and that were detected with defects was resorted to. The study was conducted for the period 01.01.2019 - 31.08.2020. In the first phase, for each case, the date of submission to the periodic technical inspection process, make, model, year of manufacture, total mileage and the defect found were highlighted. Subsequently, for a complex analysis, the country of origin of the vehicle manufacturer was identified and the defects found were grouped into categories that refer to the subassembly to which it refers. Analysis of technical deficiencies depending on the brand, figure 1.1, highlights the fact that the least prone to failures are Peugeot, Nissan, Mercedes, Citroen, Fiat and Seat and the most prone are Chevrolet, Opel, Ford, VW and Dacia. We believe that we should carry out an in-depth analysis that also considers the share of each brand in the car fleet in order to be able to draw a true conclusion.

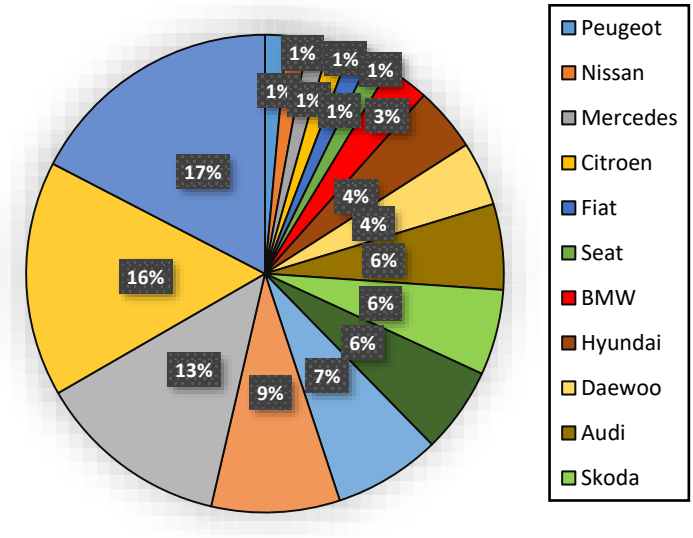

Figure 1. Analysis of Deficiencies by Brand

Following the analysis regarding the country of origin of the manufacturer, figure 2, it is found that the most prone to non-conformities are the vehicles from Germany, England and Romania, and the least prone are the Italian and Japanese. Given the overall picture we have of the local car fleet, we can say in a somewhat subjective way that French vehicles (with a very high market share) and Korean vehicles (with increasing share) are the least prone to non-conformities. given that the values obtained for them are in the middle zone but occupy a significant share of the market.

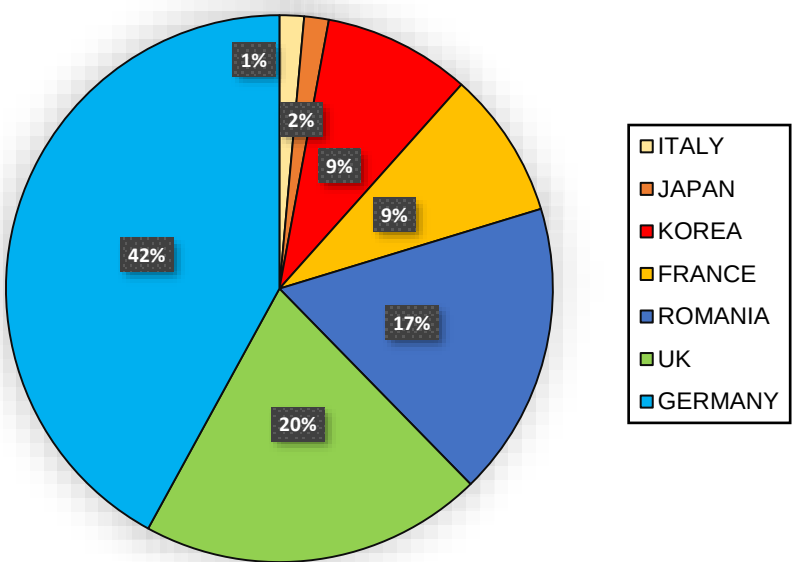

Figure 2. Graph of Deficiencies by Country of Origin of the Manufacturer

Analysing the deficiencies according to the criterion of age, figure 3, it is observed that the largest share, in the case of motor vehicles with found defects, has those with an age between 10 and 20 years. The result is validated by the fact that the Romanian car fleet is aging. So the vehicles in this category are

also the most common, but also the most defective. For vehicles between 5 and 10 years old, we consider that the result is a fair one compared to the total number in the market. With regard to vehicles older than 20 years, we can say that the share is small due to the decrease in the number of vehicles compared to the total number of the fleet. Finally, regarding vehicles that are less than 5 years old detected with defects, we can say that this is an isolated case and can be attributed to the mode of operation.

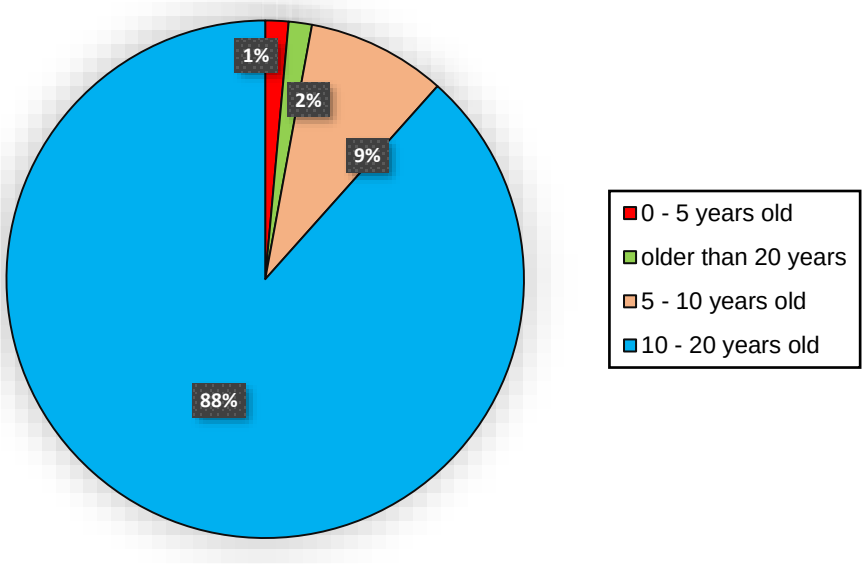

Figure 3. Graph of Deficiencies by Age

In the next stage, it was analyzed how the total number of kilometers influences the magnitude of failures in cars. Thus, we notice that the largest share of the total number of vehicles detected with defects has those with a distance of over 200,000 km, an aspect that is easy to predict. The values obtained are similar to those obtained for vehicles with a distance between 100 001 and 150 000 km but also for those with a distance between 150 001 km and 200 000 km, in total the three categories totaling a score of 90% of the total sample analyzed , according to figure 4.

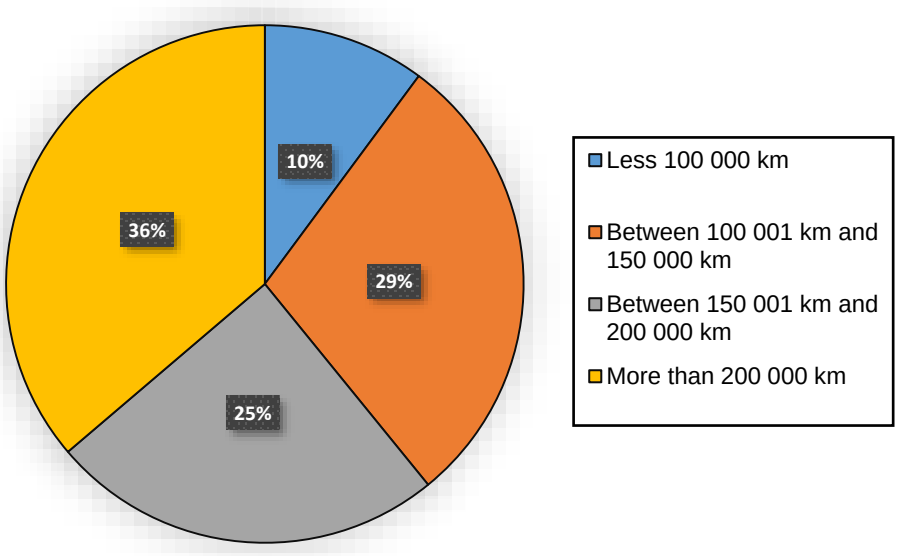

Figure 4. Graph of Deficiencies by Kilometers Traveled

The type of faults detected were centralized from the perspective of the subassembly at which the fault was detected. Thus, it is observed that the most common faults are those of the steering system. In second place are the faults present in the signaling system, figure 5.

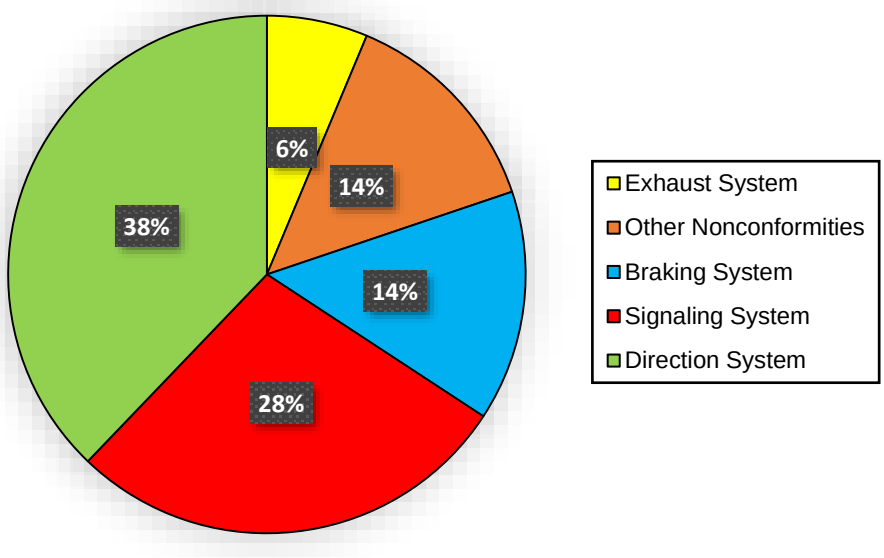

Figure 5. Graph of Deficiencies by Subsystem

Next, a correlational study was performed between various previously identified parameters. In order to do this in an Excel worksheet, the Pearson function was used, which returns a correlation coefficient. The interpretation of the Pearson correlation coefficient, r, is:

r ϵ [0; 0.2] very weak correlation, non-existent;

r ϵ [0.2; 0.4] weak correlation;

r ϵ [0.4; 0.6] reasonable correlation;

r ϵ [0.6; 0.8] high correlation;

r ϵ [0.8; 1] very high correlation - very close relationship between variables.

Following the data processing, shown in figure 6, it is observed that there are two types of correlations: perfect correlations if the value of the coefficient is 1 and very close correlations given that the other calculated values fall in the range [0.8, 1]. Given that the study included a vehicle produced in Italy and Japan, we consider that it would be erroneous to say that all vehicles with such provenance have defects in the braking systems, exhaust or other non-conformities.

Following the analysis of the graph, we notice that the weakest correlation is between the defects of the steering system and the country of origin of the vehicle. The best correlation is made between failures in the exhaust system, the braking system and those in the category of other non-conformities on the one hand and the country of origin of the manufacturer. We can conclude that if we buy a car whose

manufacturer originates in England we will have several defects that refer to the exhaust system, the steering, the signalling and those classified as other non-conformities. However, they present a higher risk of developing defects in the steering system.

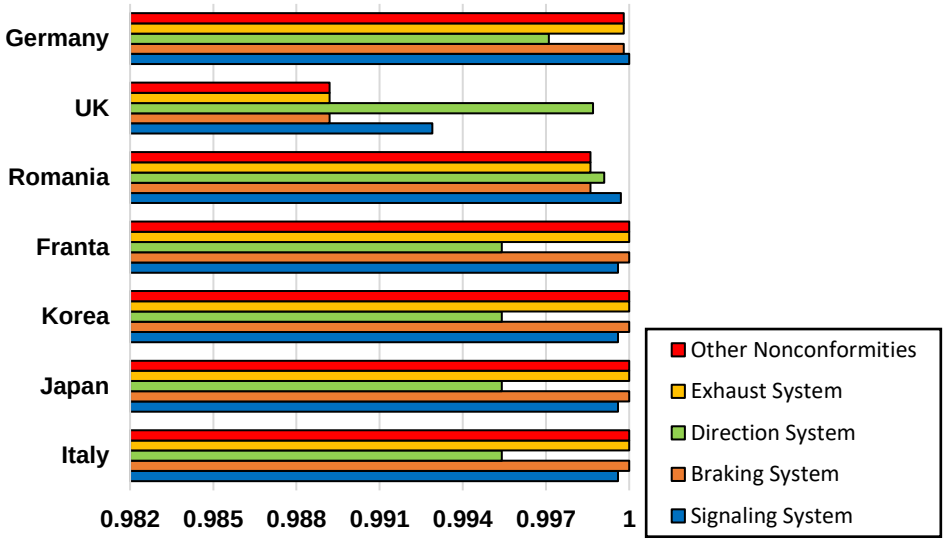

Figure 6. Graph of the Pearson Correlation Coefficient between the Deficiencies and the Country of Origin of the Vehicle

Figure 7 and Figure 8 show the correlation coefficients that make the connection between the detected defects and the make of the vehicle. Analyzing the results of this phase we also notice that between the processed data there is a perfect correlation or a high rank correlation.

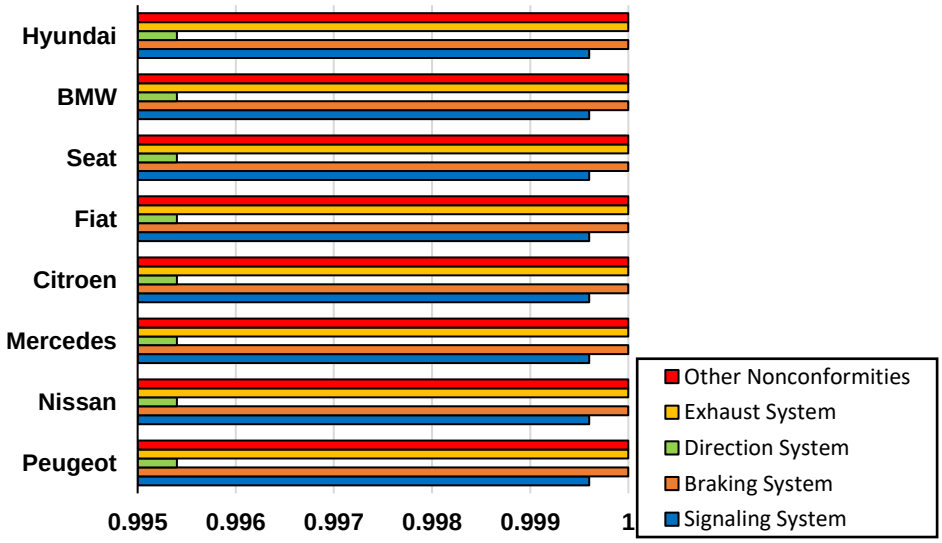

Figure 7. Graph of the Pearson Correlation Coefficient between Deficiencies and the Make of the Vehicle

We can say that between the defects identified in the braking systems, steering systems, exhaust systems and those classified as other non-conformities, on the one hand, and the malfunctions found in Peugeot,

Nissan, Mercedes, Citroen, Fiat, Seat, BMW, Hyundai, Daewoo, Audi, Skoda, Renault, Chevrolet and Opel, on the other hand there is a perfect correlation. Given the small number of units analysed between the brands Peugeot, Nissan, Mercedes, Citroen, Fiat, Seat and BMW, we believe that they should be removed from this analysis. It is noted that the defects reported in each system show the same evolution for each brand with one exception - Ford. In this case we can see that they are the least defective given the small value of the Pearson correlation coefficient. On the other hand, taking into account the large number of vehicles of this type analysed, the previous statement is reinforced. In the case of Ford, the most common faults are in the steering system followed by the signaling system.

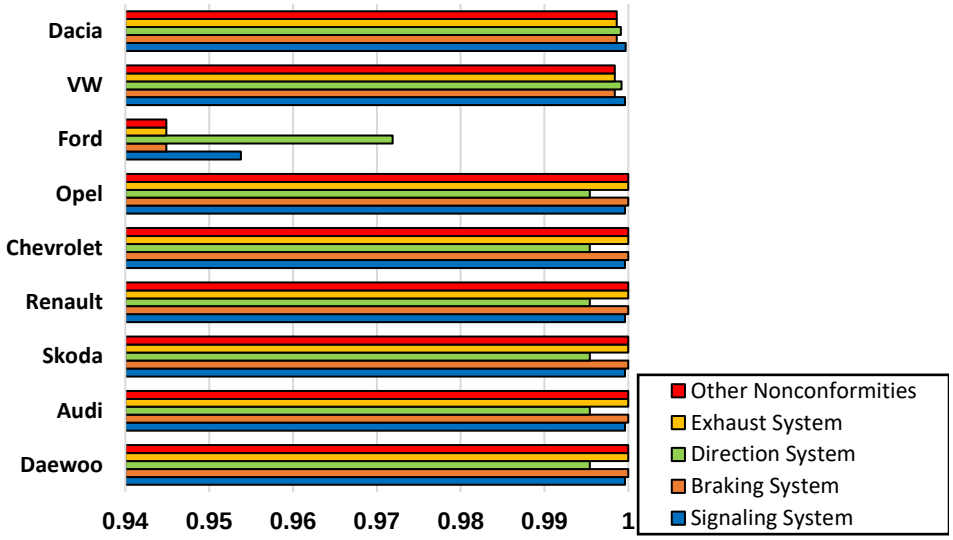

Figure 8. Graph of the Pearson Correlation Coefficient between Deficiencies and the Make of the Vehicle

Finally, the correlation between the failures of the vehicle systems and the total turnover of the vehicles was analysed. After processing this data set, figure 9, it is observed that the signalling system most often fails between 150 000 and 200 000 km, the braking system in the range of 100 000 km to 150 000 km, the steering system has deficiencies then when the turnover is more than 200 000 km, the exhaust system within the range of 100 000 km to 150 000 km and failures in other non-conformities less than 100 000 km.

Analysing the graph in figure 9 we can draw a series of conclusions. The lowest probabilities of failure are the exhaust system, the braking system and those classified for other non-conformities in the case of vehicles with a driving capacity of more than 200,000 km. On the other hand, exhaust, braking, signalling and other categories are more likely to fail in the case of vehicles with a driving capacity of less than 100 000 km. This hypothesis defies logic, but on a subjective subject we can find a fairly well-founded argument. Vehicles are generally prone to wear and tear. However, the owners of vehicles with a short distance of kilometres, consider that they have a slower rate of failure, inspect them less often, and for this reason the defects are detected less often. In other words, the owners of vehicles with a high mileage are aware that the wear is very high, and for this reason they inspect them more often, which has the direct effect of detecting defects and thus repairing them.

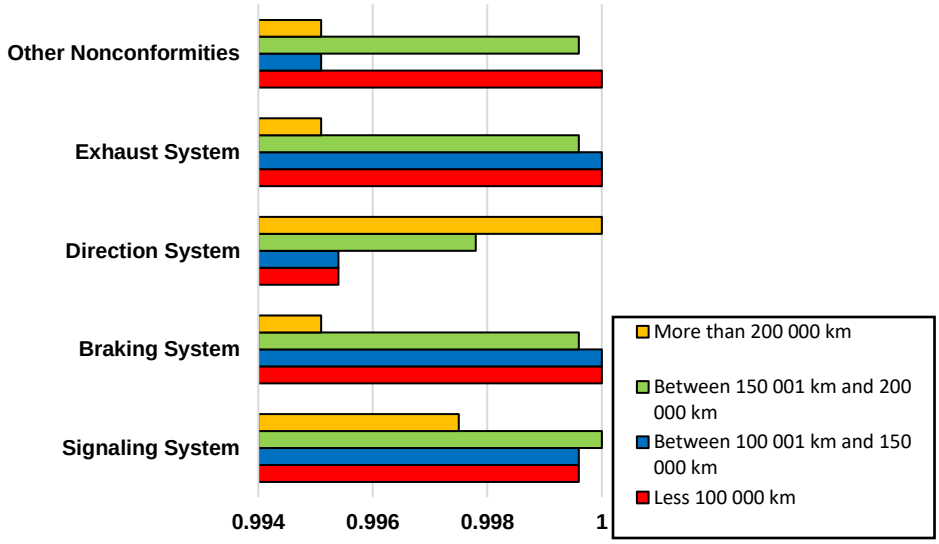

Figure 9. Correlation Graph between Systems with Deficiencies and Total Vehicle Mileage

3. Conclusions

The work accurately depicts reality, with reference to a period of about one calendar year. At the time of data collection, the archive could not be accessed for 1 full calendar year. The paper makes an analysis of the defects found in the periodic inspections of the vehicles according to the make of the vehicle, the country of origin, the total distance in kilometres and the year of manufacture. Notions of statistics were used in order to make correlations between the data collected.

Following the correlation made between faults and the country of origin, we noticed that English vehicles are the most prone to faults that refer to the exhaust system, the steering system, the signalling system and those classified as other non-conformities. Analysing the results after compiling the data that refer to the correlation between defects and the brand, we notice that Ford stands out. From the data obtained it results that they are the least defective considering the probability of being detected with defects in any of the systems. The statement is reinforced by the fact that there are many existing Ford car units in the Romanian fleet, so the possibility of errors is low.

Regarding the defect-course correlation, we can say that the obtained result must be analysed subjectively. It has been observed that the least defective vehicles are those with a distance of more than 200,000 km. We can say that the owners of these types of vehicles being aware of high wear and tear prepare more thoroughly for the technical inspection so that they perform the necessary repairs before the verification process. We believe that this paper can be a model for the development of a future study. Certainly the field is a complex one and the accuracy of the results depends to a large extent on the dispersion of the types of vehicles in the entire car fleet in Romania. From such a study, conclusions can be drawn that would lead to changes in current standards that refer to pollution and safety.

4. Acknowledgement

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